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TRANSPORTATION RESILIENCY FRAMEWORK STUDY

Technical Working Group Meeting #3

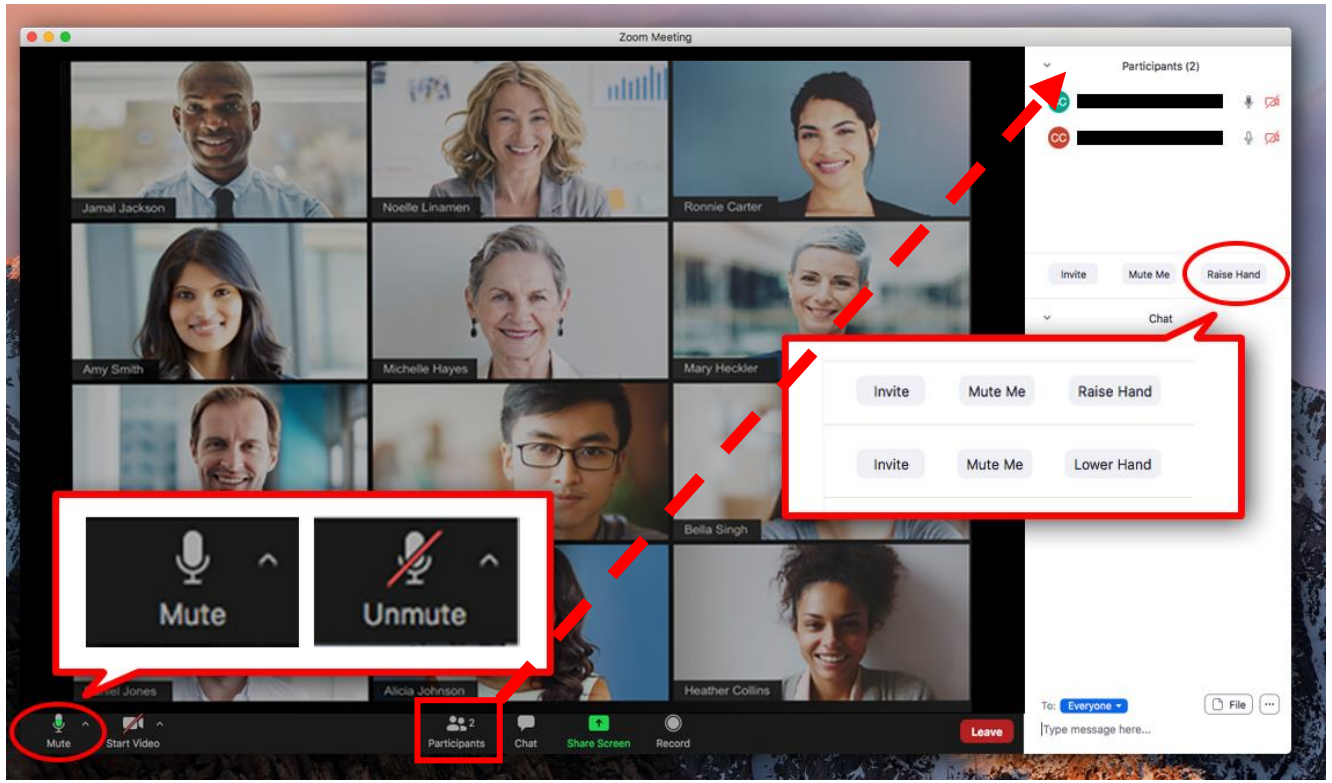
April 12, 2022

BrowardMPO.org

Meeting Housekeeping

To better everyone's experience:

- Use Tools bar at bottom for controls
- To ask a question or comment, **please raise your virtual hand**;
  Phone users dial *9
- Microphones will be muted unless called upon by the MC or presenter;
  Phone users dial *6



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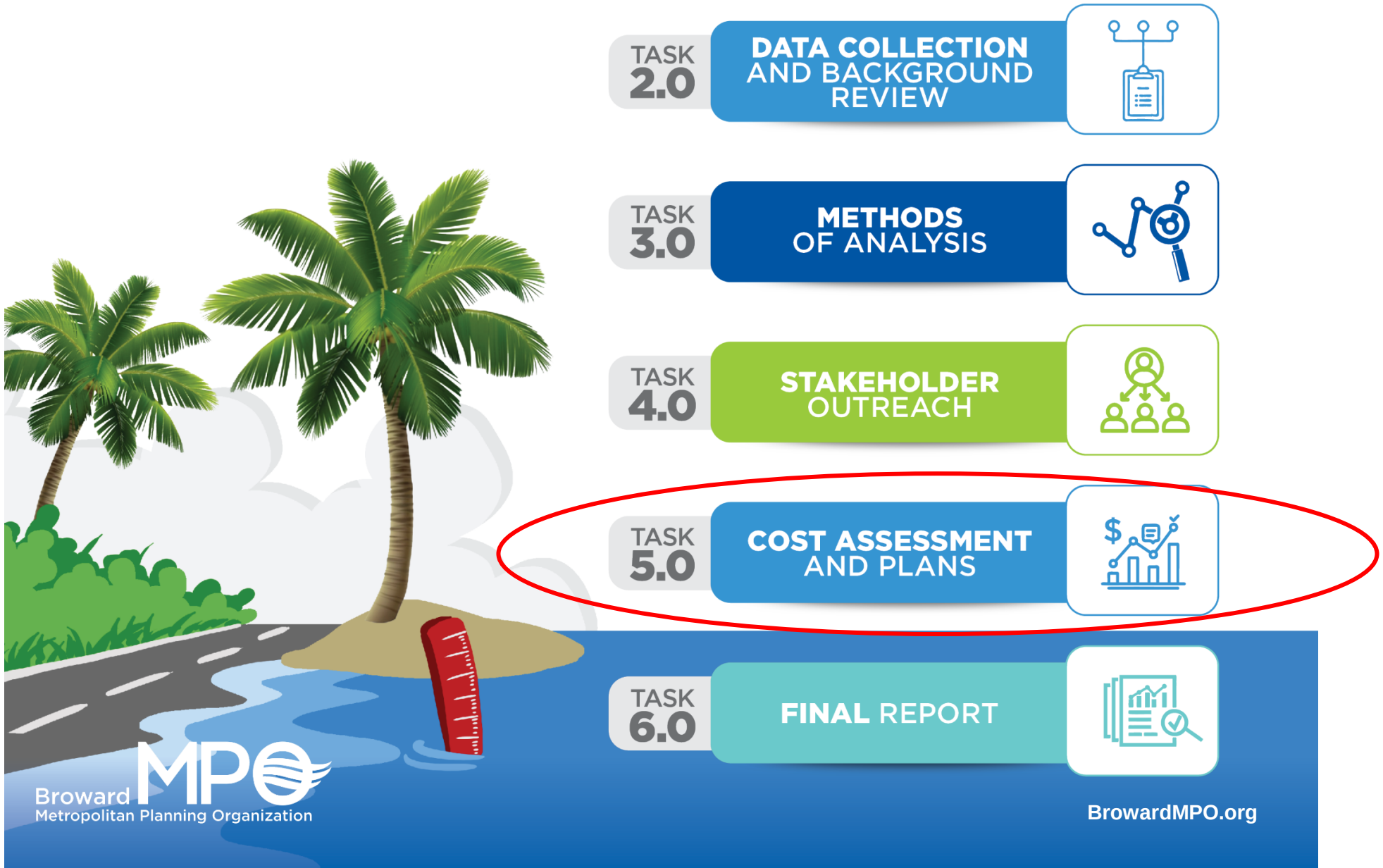
Agenda

- Welcome and Introductions
- Updates
  - Project Scope
  - Consultant Selection
- Case Studies
- Draft Framework
- Next Steps

Updates


TASK 2.0
DATA COLLECTION AND BACKGROUND REVIEW
TASK 3.0
METHODS OF ANALYSIS
TASK 4.0
STAKEHOLDER OUTREACH
TASK 5.0
COST ASSESSMENT AND PLANS
TASK 6.0
FINAL REPORT
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Updates

- Consultant Selection
  - T.Y. Lin International
  - Gannett Fleming

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Resilience Framework Study

Case Studies

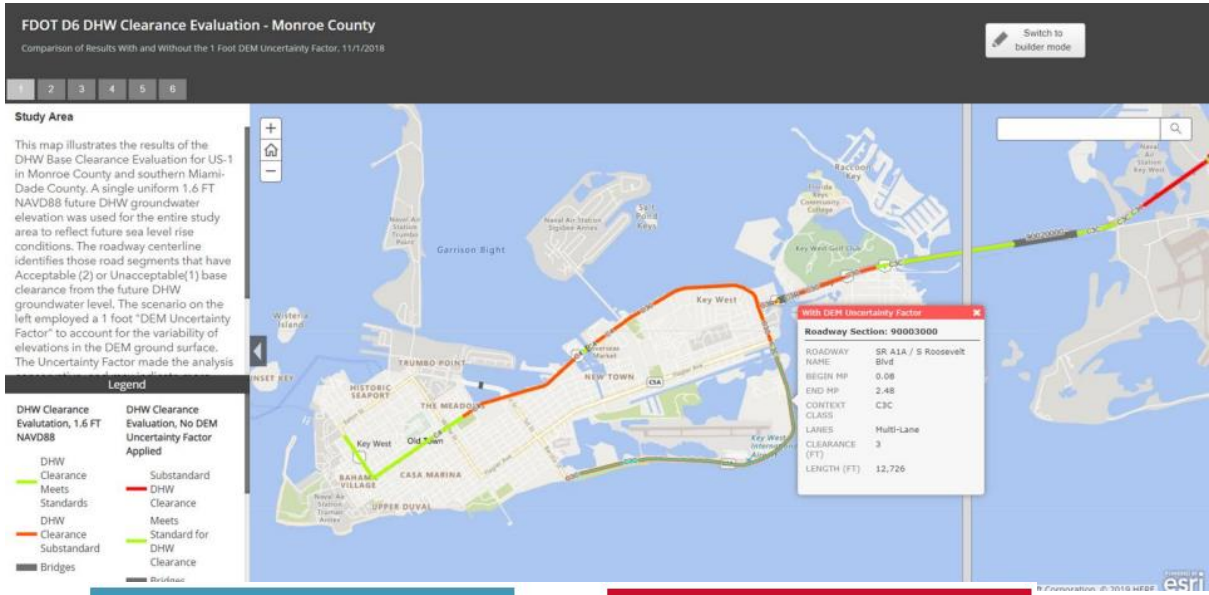
Case Studies Overview

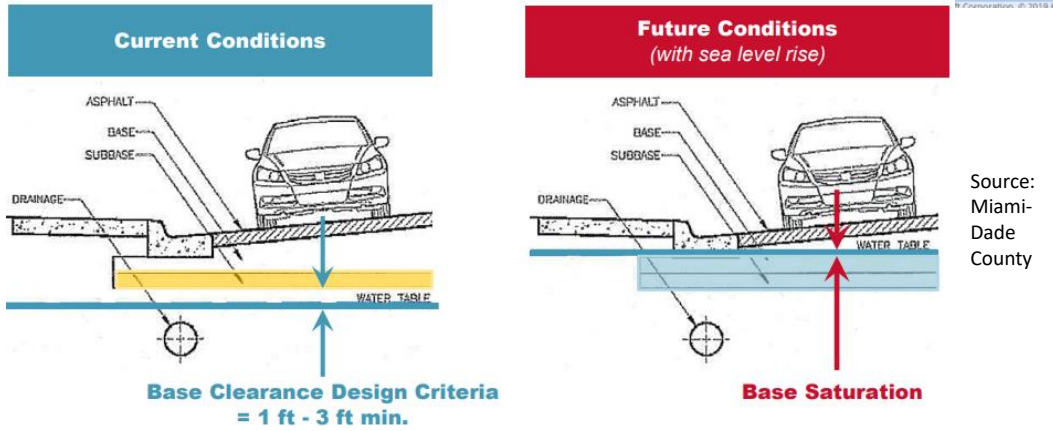
- Study of Roadway Base Clearance for State Roads in Monroe County (2018)
- Post Hurricane Sandy Transportation Resilience Study in New York, New Jersey, and Connecticut (2017)
- New York City Comprehensive Waterfront Plan (2021)

Roadway Base Clearance Study in Monroe County

- FDOT District 6 sponsored a study to review roadway pavement base clearance requirements affected by future sea level rise (SLR)
  - Intended to identify roadway segments where substandard base clearance conditions may occur in the future
  - Does not propose specific Design High Water (DHW) elevations for project design or construction
- Current design guidelines may require calculation of SLR based on rate of historical SLR
  - Some local jurisdictions, such as the City of Miami Beach, have more stringent standards
  - Acceleration in rate of increase of SLR in last 10 years, especially in Lower Keys

GIS Screening of State Highways Impacted by DHW and Base Clearance Requirements



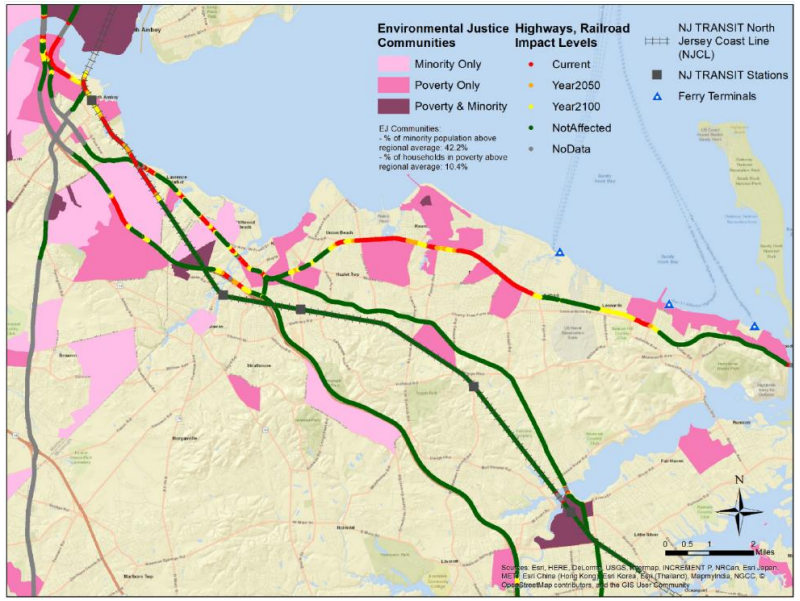


Source: Miami-Dade County

Post-Sandy Study

- Enhance NY-NJ-CT metro region's resilience to climate change, sea level rise, and extreme weather in the longer term
- Leverage lessons learned from Hurricane Sandy
- Assessed transportation system vulnerability and risk at 3 scales:
  - Regional – info that can be used by agencies throughout the study area
  - Subarea –two multimodal corridors and a costal network of critical facilities
  - Facility – selected individual facilities for engineering-informed assessments

- MPOs and transportation organizations have taken impressive steps to address climate change risks but:
  - Significant barriers due to insufficient data, uncertainty about future impacts, difficulties in coordination, insufficient funding for adaptation
  - Decision-making techniques can identify appropriate adaptation paths that consider timing of risks, need to avoid adverse impacts, costs and feasibility

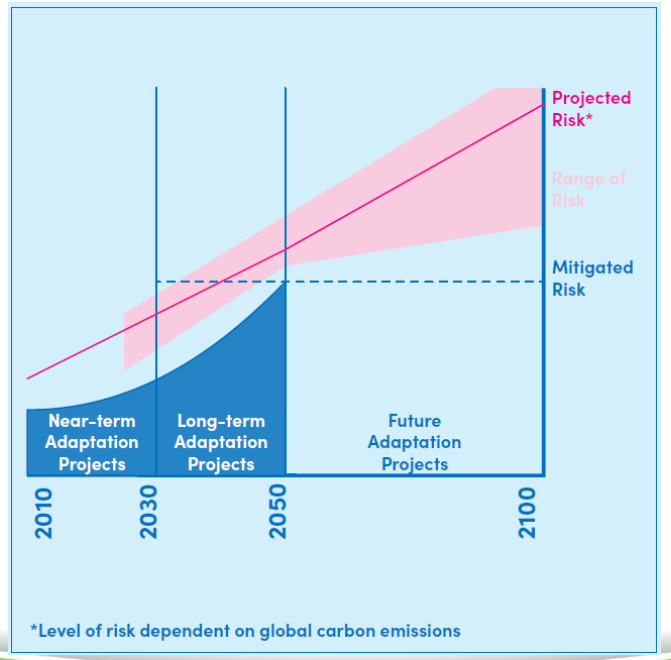


Exposure areas with environmental justice communities. Source: New Jersey Transportation Planning Authority

NYC Comprehensive Waterfront Plan

- 6 topic areas
  - **Climate Resiliency & Adaptation**
  - Waterfront Public Access
  - Economic Opportunity
  - Water Quality & Natural Resources
  - Ferries
  - Governance
- Driven by **climate justice principle** and 3 values: **Equity**, **Resiliency**, and **Health**
  - Strategies to address persistent inequities – increased chronic flooding, urban heat, limited housing choices, uneven access to waterfront spaces, etc.

- Climate effects "…will extend beyond flooding and heat to affect people, places and systems across NYC…"
  - Consider climate risk in all infrastructure investment, land use planning, and operational strategies



Source: NYC Mayor's Office of Climate Resiliency

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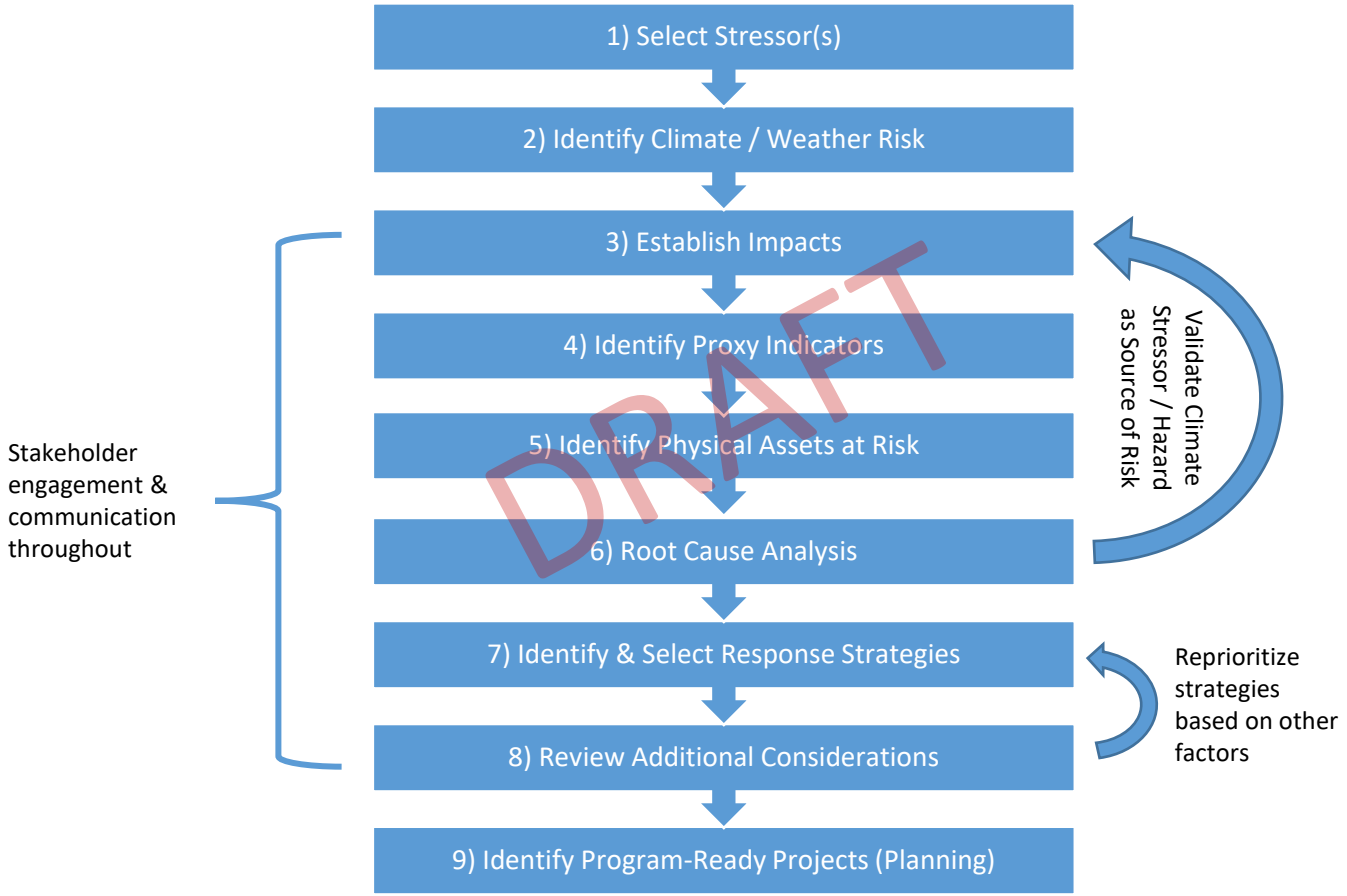
Standard Resilience Analysis Methodology

Resilience Analysis Process Overview



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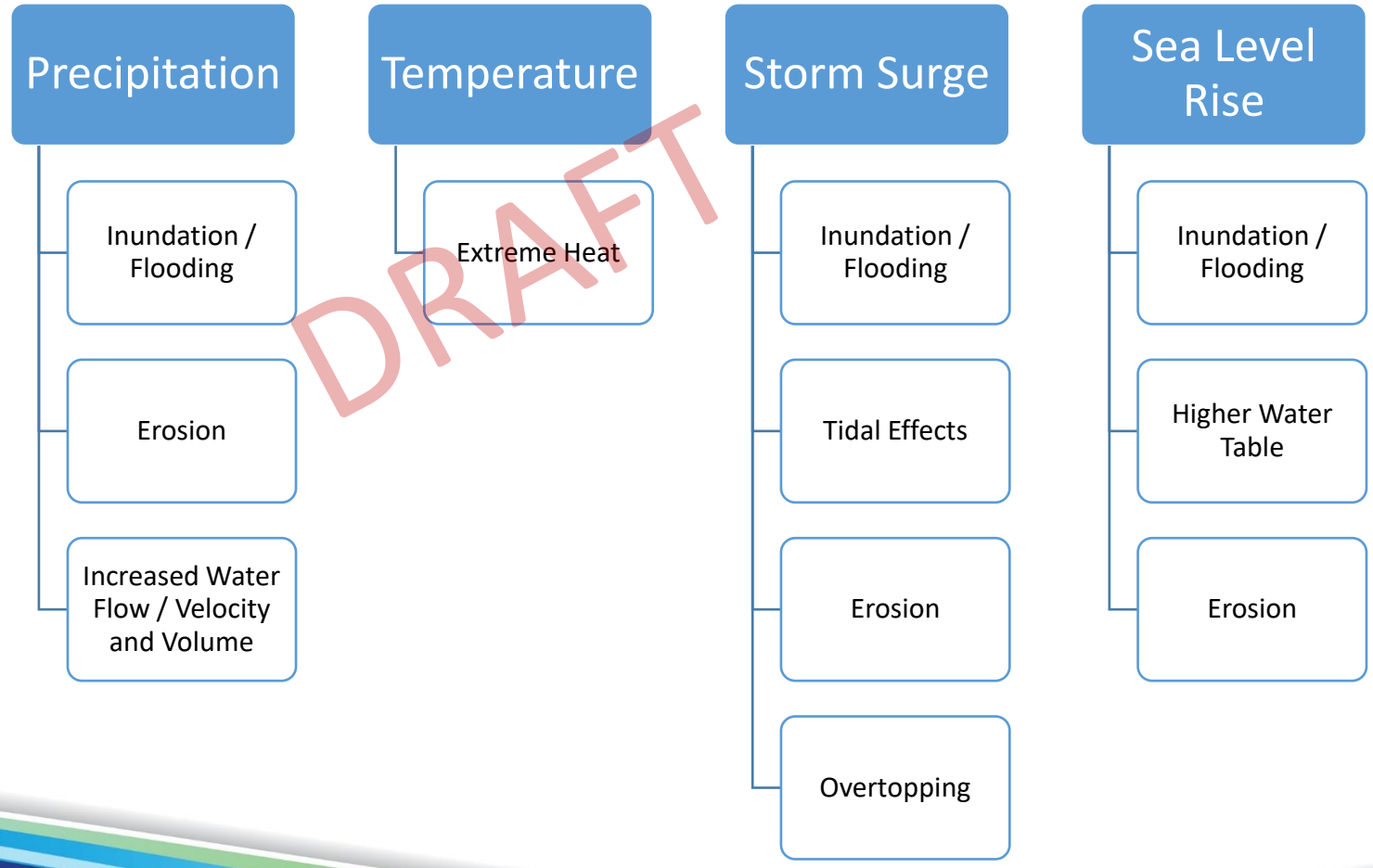
1 – Select Stressor(s)[1]

- Precipitation
- Temperature
- Storm Surge
- Sea Level Rise (SLR)

1: Stressors determined based on prior study efforts of the Broward MPO.
Programmatic Stressor-related considerations to be addressed later in the process.

2 – Identify Climate / Weather Risk

- What is the weather or climate-related risk?



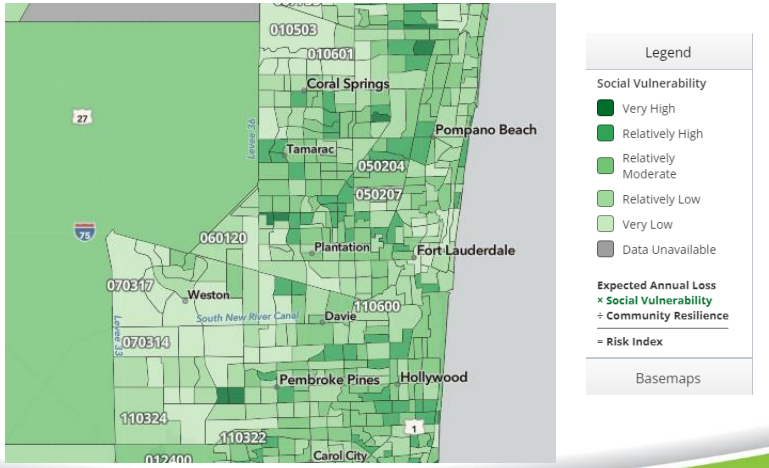
3 – Establish Impacts

Physical Infrastructure Impacts

- Temporary Asset Failure (i.e., can return to service)
- Asset Loss / Permanent Failure
- Accelerated Asset Deterioration
  - Pavement rutting, cracking, potholes
  - Foundation erosion, scour
  - Reduced asset useful life due to extreme temperatures
- Mobility Impacts / Reduced Mobility
  - Closures and system disruptions
  - Detours / evacuations
- Safety Impacts
  - Crashes due to weather conditions
  - Reductions in visibility / hazardous travel conditions

Community Resilience and Social Vulnerability

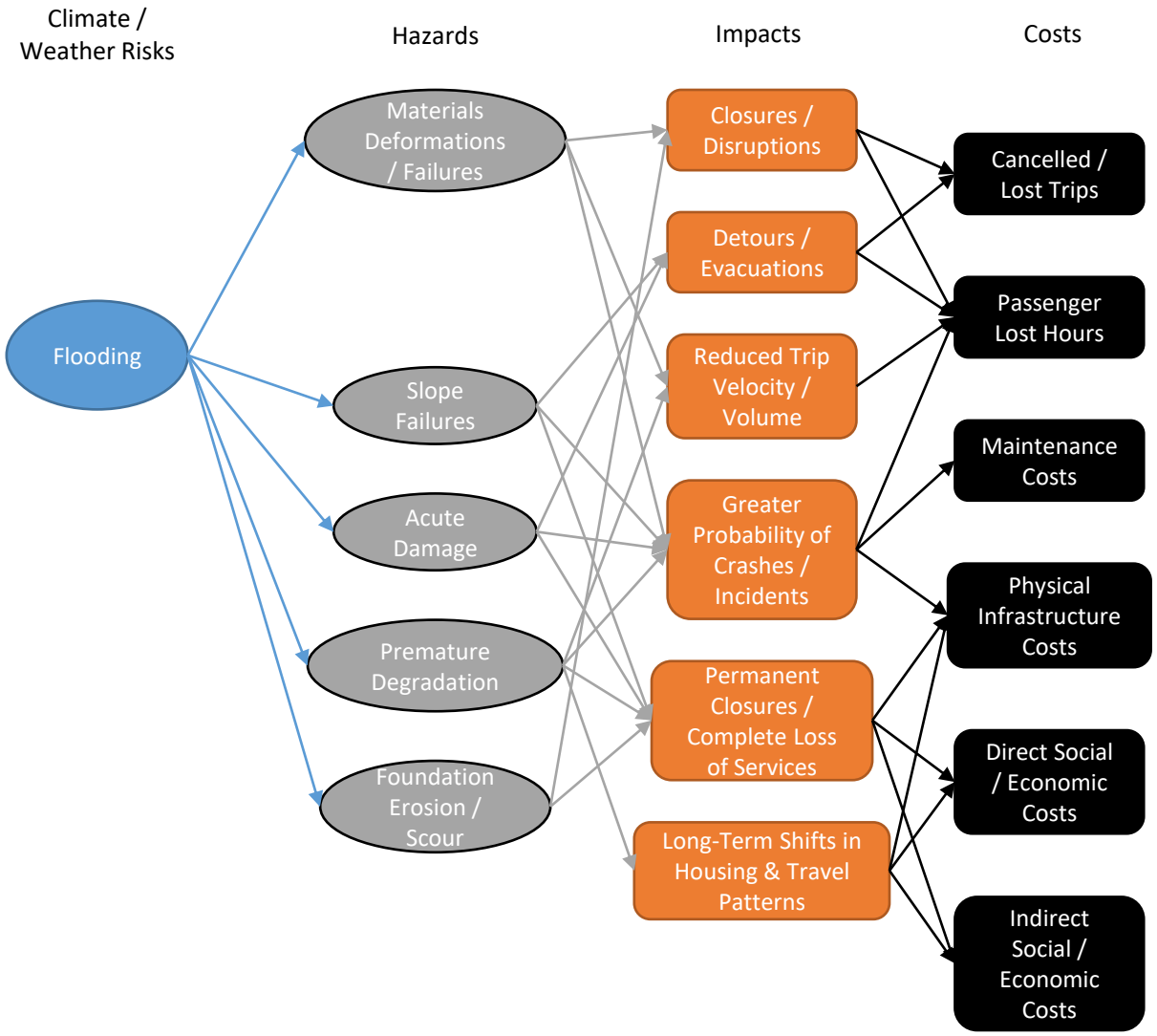
- Perform a high-level screening of social vulnerability and / or community resilience
  - Leverage state-of-the-practice tools such as FEMA's National Risk Index or NOAA's Sea Level Rise Viewer
- Consider how physical infrastructure affects social infrastructure and community resilience
- Identify and engage relevant stakeholders that are affected by physical infrastructure impacts



FEMA National Risk Index by Census Tract

3 – Establish Impacts *(Continued)*

- Collectively there are many possible direct and indirect impacts on infrastructure
  - Graphic to the right depicts how one climate risk (i.e., Flooding) results in a multitude of hazards, impacts, and costs
  - Impacts can have adverse effects on safety and economic development



4 – Identify Proxy Indicators

Utilize geospatial analysis to help identify:

- Locations within known flood / surge / hazard zones
- Low crossings / links in transportation network
- Projected temperature change by 2050 and beyond
- Locations with known previous incidents
  - Historical flooding, overtopping, erosion, embankment / slope failure, power loss to critical systems, etc.
- Soil hydrology considering water table / tidal effects in 2050

5 – Identify Physical Assets at Risk

Physical Transportation Infrastructure

- Bridges
- Culverts
- ITS Infrastructure (e.g., cameras, variable message signs, detection devices / sensors; network backbone – hubs and nodes, fiber, cabinets; etc.)
- Traffic Control Devices (e.g., traffic boxes, light poles, signals, signs, etc.)
- Pavements
- Rail
- Others (e.g., bike / ped and transit infrastructure, tunnels, seawalls, parks and rec infrastructure, signs, traffic barriers, etc.)

6 – Root Cause Analysis

- Perform root cause analysis by stressor and hazard
  - Consider different stages of asset lifecycle from planning and design / engineering to maintenance and operations
- Root cause(s) should link the climate stressor to the hazard
  - Flooding may be caused by local low points and / or other drainage issues not sea level rise
  - Increases in precipitation may not lead to decreases in embankment / slope stability in all cases
  - Probabilistic analysis may be warranted
- Determining root causes may require further research and study

Resilience Analysis Process Overview *(Feedback Loop)*

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7 – Identify and Select Response Strategies

- Toolbox will contain a listing of adaptation strategies
- User will navigate to strategies by selecting

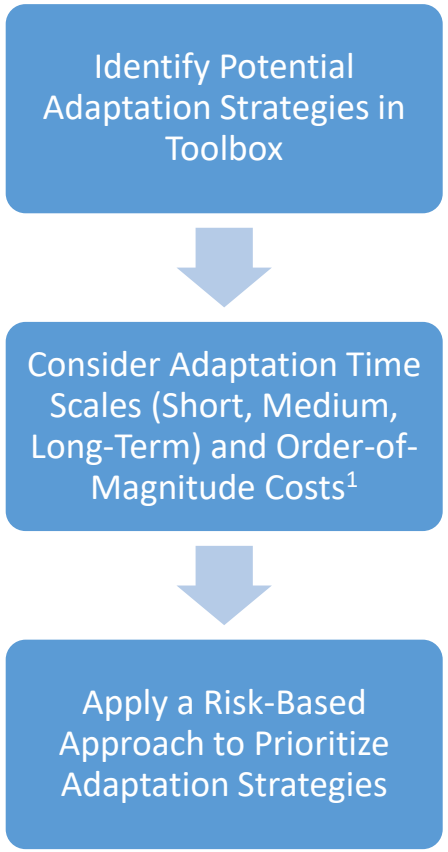
→ Stressor → Hazard → Impacts to Infrastructure → Adaptation Strategies

Stressor	Hazard	Infrastructure Impacts	Adaptation Strategies
Storm Surge	Overtopping	Increased risk of **roadway embankment / subsurface erosion** and **mass wasting** due to in/out-flow of water	• Add headwall and endwall at pipe openings • Install roadway overtopping scour protection: for example, one or more of reinforced vegetation, geotextiles, roller-compacted concrete, soil cement, cast-in-place concrete, articulating block concrete sublayers, 'rip-rap', etc. • Use native vegetation for outfall protection • Install/construct surge/flood barriers, sea/flood walls to prevent flooding of local bodies of water including rivers, roadways, and around structural assets from higher than normal sea tides • Design armoring/flood walls that can be heightened in the future with minimum additional expense • Dredging and bank stabilization • Utilize and replace outfall scour protection measures (e.g., fill material, geotextile fabric) • Utilize oyster reefs to break waves, marsh, and dune plantings to prevent erosion and tide flap on the stormwater outfall to prevent backflow • Articulated Concrete block revetment system to protect against storm surge

Illustrative example provided above. Toolbox will contain a more exhaustive listing of adaptation strategies; categorization of strategies by time scales (short, medium, long); order-of-magnitude costs (low, medium, high); and likelihood (probability) and impact (consequence) indicators to approximate risk.

7 – Identify and Select Response Strategies *(Continued)*

- Select adaptation strategies through a risk-based approach to assess and analyze corridors involving multiple assets, numerous stressors
  - Categorize strategies based on anticipated required upfront investments and anticipated time horizons to realized benefits (e.g., modifying design standards versus changes to O&M practices)
  - Rate likelihood and consequence of risks to assets based on past incidents and / or future exposure
  - Prioritize listing of potential adaptation strategies based on risk tolerance



1: Toolbox will incorporate time scales (phasing) , ROM cost estimates (e.g., low, medium, high), and risk indicators (likelihood and consequence).

8 – Review Additional Considerations

Prior to deciding on adaptation strategies consider:

- How affected assets contribute to the broader transportation network
- Socioeconomic impacts
- Environmental justice considerations
- Land use and zoning impacts
- Compliance with regulatory mandates
  - Ability to secure additional funding sources specific to risk and resiliency

Perform benefit-cost calculations for selected adaptation strategies[1]

- Define performance metrics to measure success of adaptation strategies along with expected benefit return period

1:BCA methodologies to be further detailed and defined.

8 – Review Additional Considerations *(Continued)*

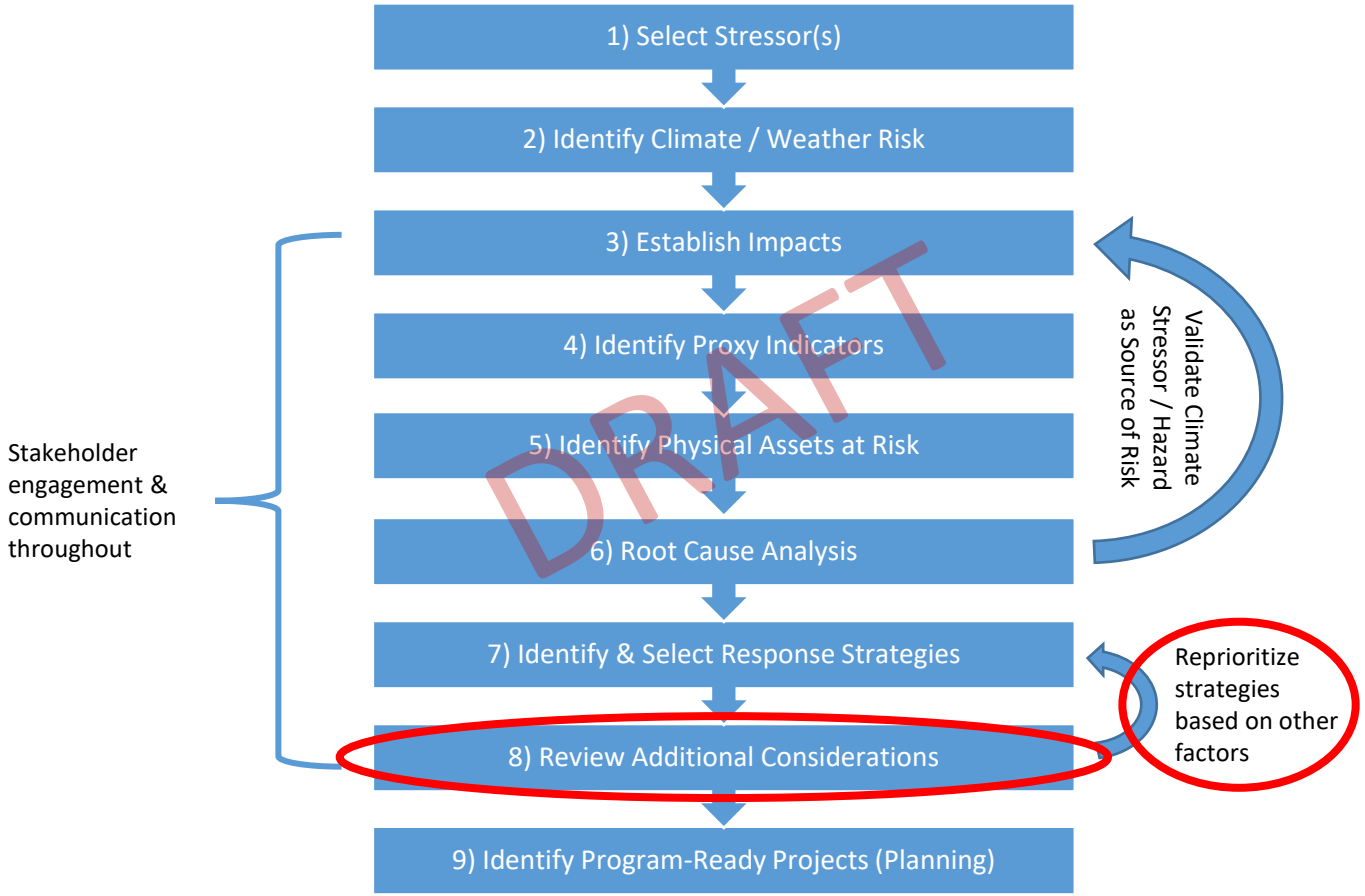
Based on the adaptation strategies selected from the toolbox, review programmatic considerations such as:

- Lack of Data / Inconsistent Data
- Inadequate / Non-Existent Policies
- Lack of Methodologies / Procedures
- Inadequately / Insufficiently Implemented Policies & Procedures
  - Identify known barriers to implementation
- Insufficient Staff Capacity / Capability

Consider willingness of partners

- Review capability and desire of partner organizations to implement strategies – give extra weight to willing, capable partners

Resilience Analysis Process Overview *(Feedback Loop)*



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9 – Identify Program-Ready Projects (Planning)

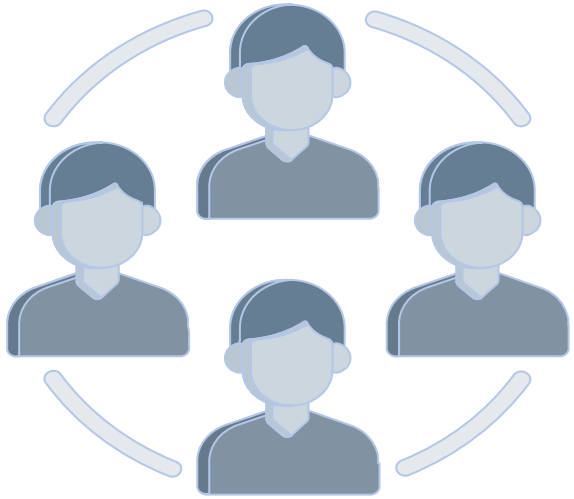
- Translate adaptation strategy (or strategies) into program-ready projects ensuring the following are defined:
  - Scope
  - Cost estimates
  - Coordination[1]
  - Resolution of support

1: Determine responsible parties for monitoring and evaluating the success of the project. Responsible parties record and monitor if metrics are achieved over expected return periods (e.g., modify pavement material design to accommodate higher temperatures over the next 25 years).

Next Steps

TASK 6.0 **FINAL** REPORT

TWG 4



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Thank You!

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