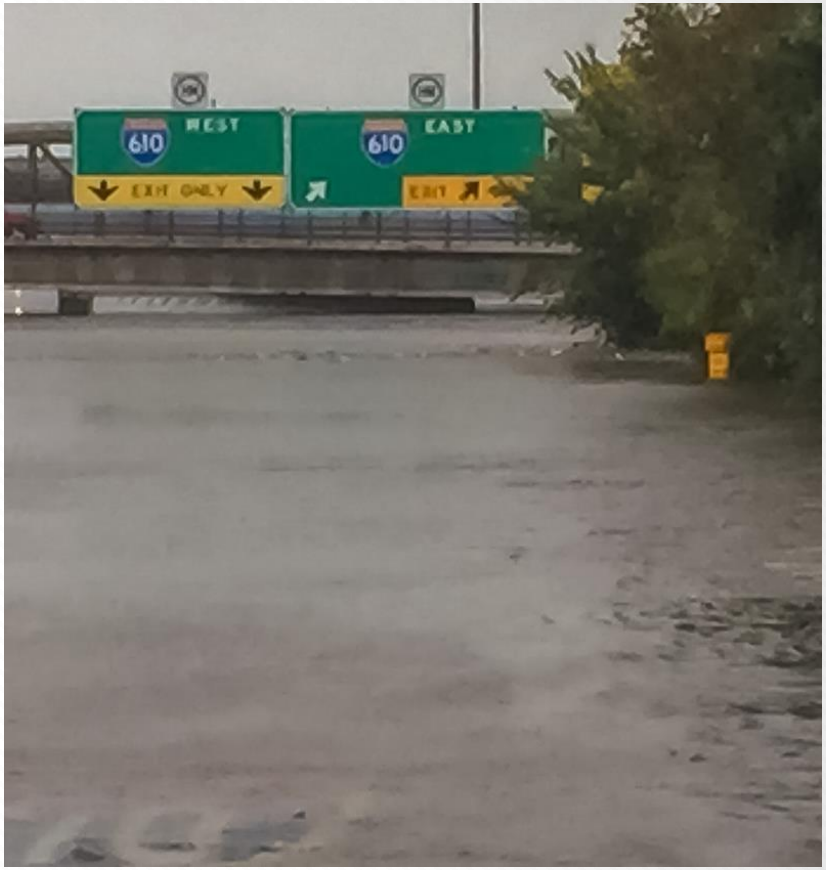
Virtual Resiliency and Durability to Extreme Weather Pilot Project Stakeholder Meeting

12 May 2020

Objectives

- Identify potential strategies to protect vulnerable and critical assets
- Identify criteria to consider when selecting a strategy



Study Team

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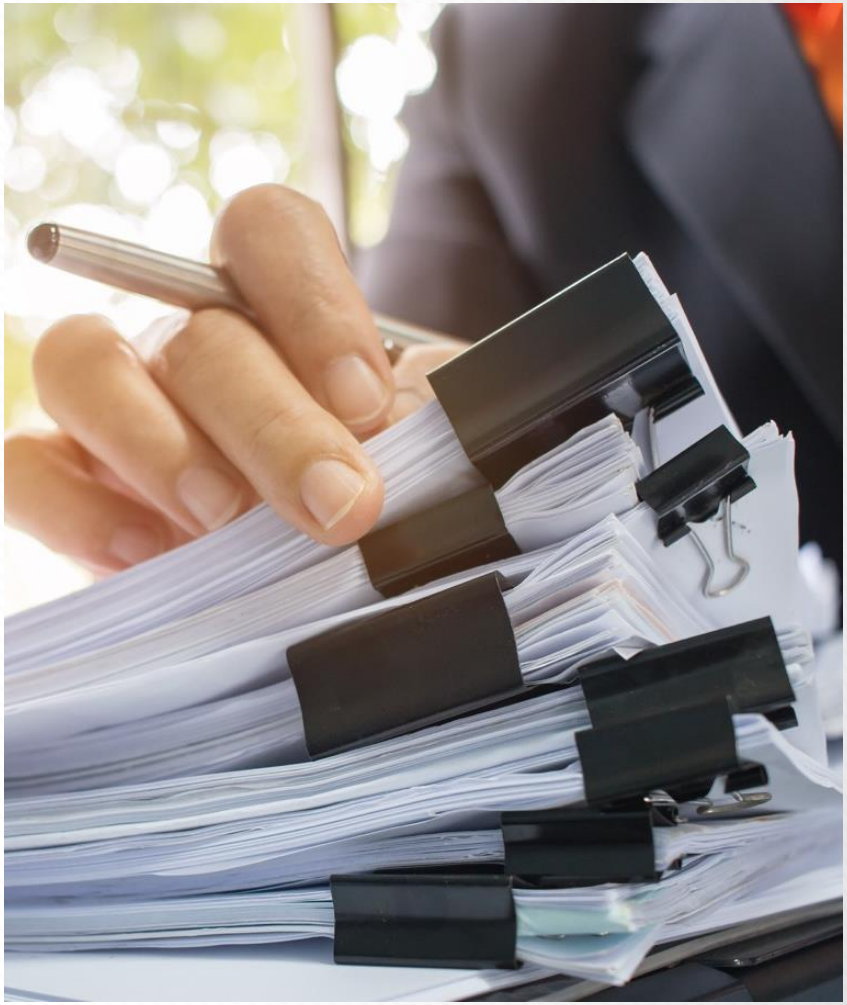


Resilience Adaptation Strategies

Category	Number of Strategies
Stormwater Management	7
Infrastructure	7
Planning/Social	5
Maintenance	1
Other	5

Resilience Adaptation Strategies

- Stormwater Management Examples
  - Increase Number of Swales and Ditches
  - Retention and Detention Ponds
  - Depressed and Raised Medians
  - Bioswales (Biofiltration Swales)
  - Green Infrastructure
  - Culvert Cleaning/Maintenance

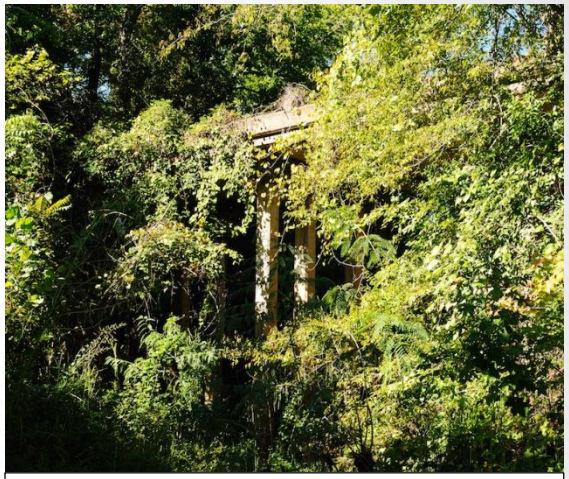
Raised Median

Depressed Median

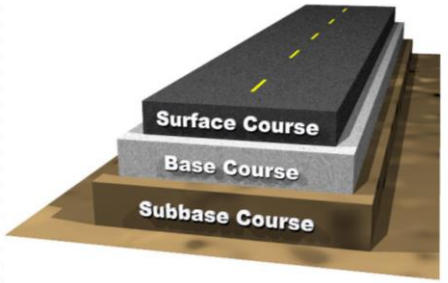
Retention and Detention Ponds

Resilience Adaptation Strategies

- Infrastructure Examples
  - Relocate or Abandon Roads
  - Enhanced Road Surface
  - Enhanced Sub-Grade
  - Hardened Shoulders
  - Raised Road Profile
  - GeoSynthetics/Geo Textiles
  - Permeable Pavement



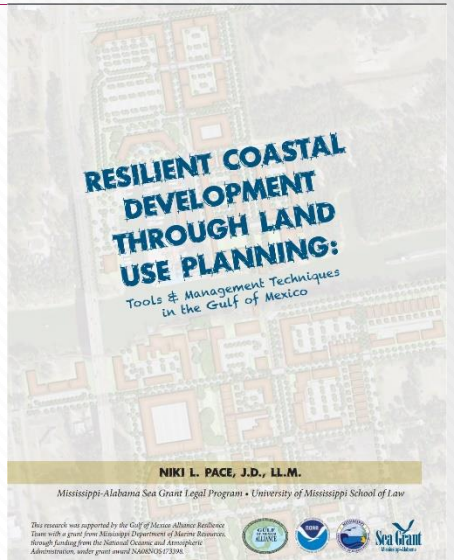
Source: Patrick Feller - Humble, Texas



https://pavementinteractive.org/reference-desk/design/structural-design/pavement-structure/

Resilience Adaptation Strategies

- Planning/Social Examples
  - Stormwater Management Plan
  - Land Use Planning
  - Shelter-in-Place
  - Prohibiting Oversize/Overweight Vehicles
  - Sensor Technologies/Monitoring Programs



http://www.gulfofmexicoalliance.org/files/projects/files/79ResilientLandUse.pdf

Resilience Adaptation Strategies

- Other examples
  - Maintain and Restore Wetlands
  - Beach Nourishment and Dune Restoration
  - Vegetation (as Erosion Control)
  - Seawalls and Revetments
  - Wave Attenuation Devices

Dune Restoration

Sea Revetment

Seawall

Resilience Adaptation Strategies

Climate Stressor	Number of Strategies
Local Flooding	20
Storm Surge	8
Sea Level Rise	3

Resilience Adaptation Strategies

- Developed Fact Sheets
  - Description
  - Strategy Category
  - Climate Stressor
  - Adaptation Response
  - Application
  - Resilience Benefits
  - Other Benefits
  - Limitations/Considerations

Resilience Adaptation Strategies

- Developed Fact Sheets
  - Decision Criteria

Effectiveness	Implementation Requirements	Ease of Implementation	Implementation Costs	Maintenance Costs
Temporary drainage easements. Keep roadway clear of stormwater by conveying excess stormwater to outfall structure	Effective with formal preventative maintenance strategy and allocated resources.	Easy	Typically included in construction costs.	Low

Resilience Adaptation Strategies

Retention and Detention Ponds¶

Description¶

Creating retention and detention ponds is an effective method for managing stormwater by collecting stormwater and releasing it at a rate that prevents flooding or erosion. The main difference between the two is that retention ponds hold water indefinitely, while detention ponds act as a temporary area for storing stormwater. Often, detention ponds are smaller than retention ponds.¶

¶

As is the case for many hydraulic design best practices, retention/detention ponds should be implemented in line with other hydraulic design elements such as cross culverts, stormwater channels or conduits, swales/ditches. For this reason, their utility and effectiveness depend in part on their inclusion in broader scale hydraulic system designs. .

STRATEGY CATEGORY¶

- Stormwater Management¶

CLIMATE STRESSOR¶

- Local flooding¶

ADAPTATION RESPONSE¶

- Prepare¶
- Protect¶
- Recovery¶

Application¶

- Urban locations¶
- Residential locations¶

Resilience Benefits¶

- When properly designed and maintained, retention and detention ponds can help reduce flooding during severe rainfall events. These ponds also benefit by:¶
  - Improving the functionality of other hydraulic design features (culverts, swales/ditches, etc.)¶

Other Benefits¶

- By collecting sediment-laden stormwater, these ponds capture heavier contaminants, such as solids and metals from our roadways, as well as other pollutants. Retained water and associated vegetation naturally filters these contaminants and returns clean water downstream.¶

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Limitations/Considerations¶

- Location¶
  - Sufficient space is required for the construction and maintenance access for these ponds. ¶
  - Topography should ensure surrounding area drains to the pond.¶
- Maintenance¶
  - Since these ponds are designed to collect sediment, it is important to regularly remove sediment buildup to ensure their holding capacity is not reduced. ¶
- Soil type/structure ¶
  - Soil type/structure must be considered to ensure effective stormwater storage by limiting infiltration. ¶
- Safety¶
  - Prohibiting public access for safety concerns must be considered.¶

Decision Criteria¶

Effectiveness¤	Implementation¶ Requirements¤	Ease of Implementation¤	Implementation Costs¤	Maintenance Costs¤
Improved stormwater collection and flood control. Improves water quality.¤	Space, soil type, topography must be considered.¤	Moderate¤	Moderate¤	Low¤

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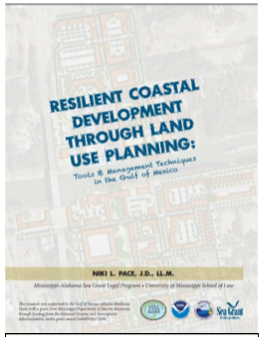
Resilience Adaptation Strategies

Land Use Planning/Climate Justice¶

Description¶



http://www.gulfofmexicoalliance.org/files/projects/files/79ResilientLandUse.pdf¶

Land use planning refers to planning the physical layout of communities and cities. Land use planning determines where development occurs (i.e., the built environment) and identifies open space or land for preservation (i.e., the natural environment).[ii] Land use planning aimed at increasing resiliency include adopting land-use codes and zoning regulations that avoid development in flood-prone areas for example (thereby reserving open space to enhance drainage), the development and adoption of development standards and building codes and incentive/disincentive programs to avoid development in vulnerable areas (for example, aimed at low income and minority housing developments). Innovative construction planning and techniques will allow communities to bounce back after a catastrophic weather-related event.¶

STRATEGY CATEGORY¶

- Planning¶

CLIMATE STRESSOR¶

- Local flooding¶
- Storm Surge¶
- Sea Level Rise¶

ADAPTATION RESPONSE¶

- Prepare¶
- Protect¶
- Recovery¶

Application¶

- Cities, communities¶

Resilience Benefits¶

- More resilient communities¶
- Open space to enhance drainage. Open spaces slow the flow of floodwater and reduce potential damage and erosion.¶

Other Benefits¶

- Conserve vulnerable natural resources, such as wetlands, watersheds, groundwater, and tidal basins. If impact fees are levied as part of a comprehensive land-use planning policy, then the revenue can be used to invest in further resilience adaptation strategies, such as stormwater management and flood control improvements associated with the new developments.¶

Limitations/Considerations¶

Adaptation strategies often focus on infrastructure and stormwater management with less emphasis on local land use planning or policy.¶

Decision Criteria¶

Effectiveness¤	Implementation Requirements¤	Ease of Implementation¤	Implementation Costs¤	Maintenance Costs¤
Very effective¤	Comprehensive planning¶ Land use codes¶ Zoning regulations¶ Development standards/Building codes¶ Incentive programs¶ Broad community stakeholder and decision-maker buy-in¤	Risk of private property owners challenging land-use policy as infringing upon property rights. ¤	Dependent on community and stakeholder support but tend to be lower with new construction/ development. ¤	Low¤

Resilience Adaptation Strategies

Raised Road Profile¶

Description¶

Roads can be raised to remain passable in the event of flooding, storm level rise, and storm surge. Raising/elevating roads are a well-established strategy and have been implemented in many coastal communities. Adequately designed culverts are needed to facilitate the drainage of water under the raised/elevated roads. ¶

https://www.miamirealestateguy.com/miami-beach-to-raise-west-avenue-1-to-2-feet-to-combat-rising-sea/¶

STRATEGY CATEGORY¶

- Infrastructure¶

CLIMATE STRESSOR¶

- Local flooding¶
- Sea Level Rise¶
- Storm Surge¶

ADAPTATION RESPONSE¶

- Prepare¶
- Protect¶
- Recovery¶

Application¶

- Road segments that are vulnerable to inundation.¶
- Stormwater management (e.g., drainage) strategies are considered less effective.¶

Resilience Benefits¶

- Ensure road is passable (specifically for emergency responders), which is important in recovery efforts.¶
- Potential reduction in damage to the road, thereby maintaining/increasing the service life of the road.¶

Other Benefits¶

- Raising road profile may eliminate persistent maintenance difficulties and associated costs.¶
- May improve motorists visibility¶

Limitations/Considerations¶

Raising the profile of a road can be expensive, and the strategy tends to be reserved for critical commuter and commerce corridors, as well as designated evacuation routes that are considered vulnerable to inundation.¶

Additional ROW may need to be acquired to allow for increased side slopes.¶

Road signs, guardrails and other appurtenances may be affected.¶

Potential impacts to adjoining homes or businesses since these properties tend to remain at a lower elevation.¶

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Decision Criteria¶

Effectiveness¤	Implementation Requirements¤	Ease of Implementation¤	Implementation Costs¤	Maintenance Costs¤
Very effective¤	Needs to be complemented with adequately designed culverts to facilitate drainage.¶ Consider inundation depth and length of inundation (period of inundation considering different scenarios)¤	Well established engineering solution.¤	High initial cost¤	No additional maintenance costs after raising the road.¤

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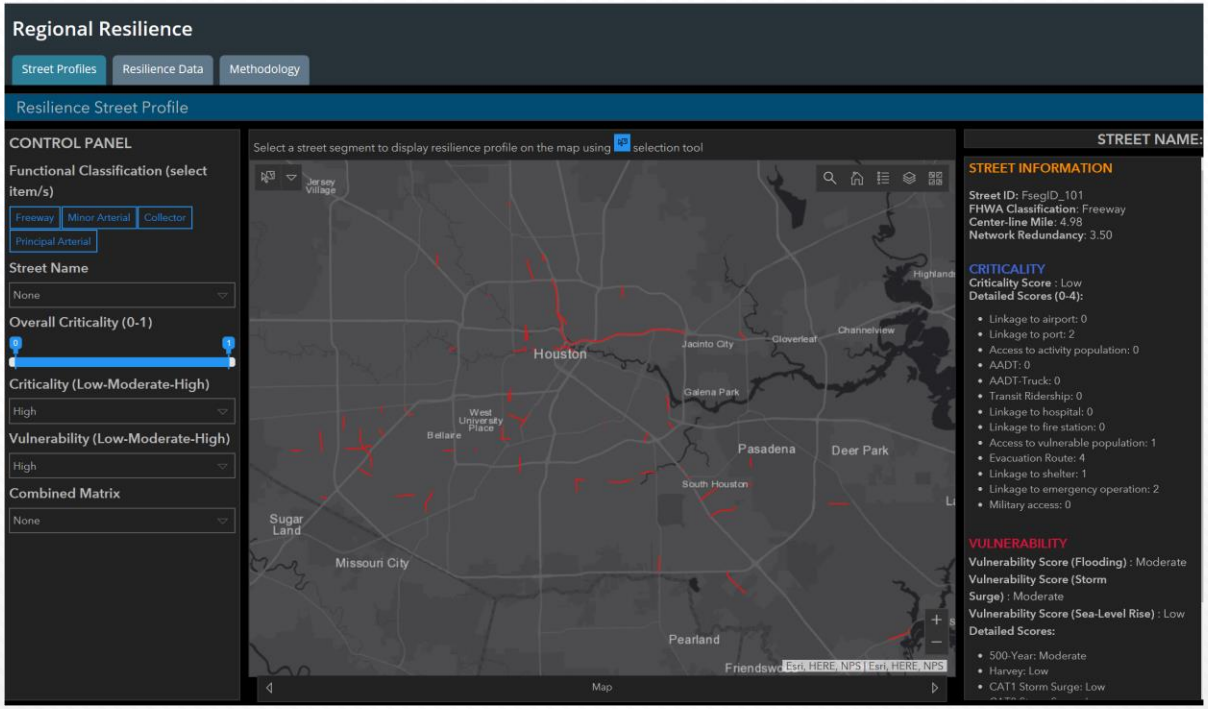
Resilience Adaptation Strategies

- Next Steps
  - Include Additional Detail
  - Case Studies



Questions