GLO River Basin Flood Study Lower Rio Grande Valley

Texas Integrated Flooding Framework Brown Bag Seminar Series

September 25, 2025

Agenda

Lower Rio Grande Valley Overview

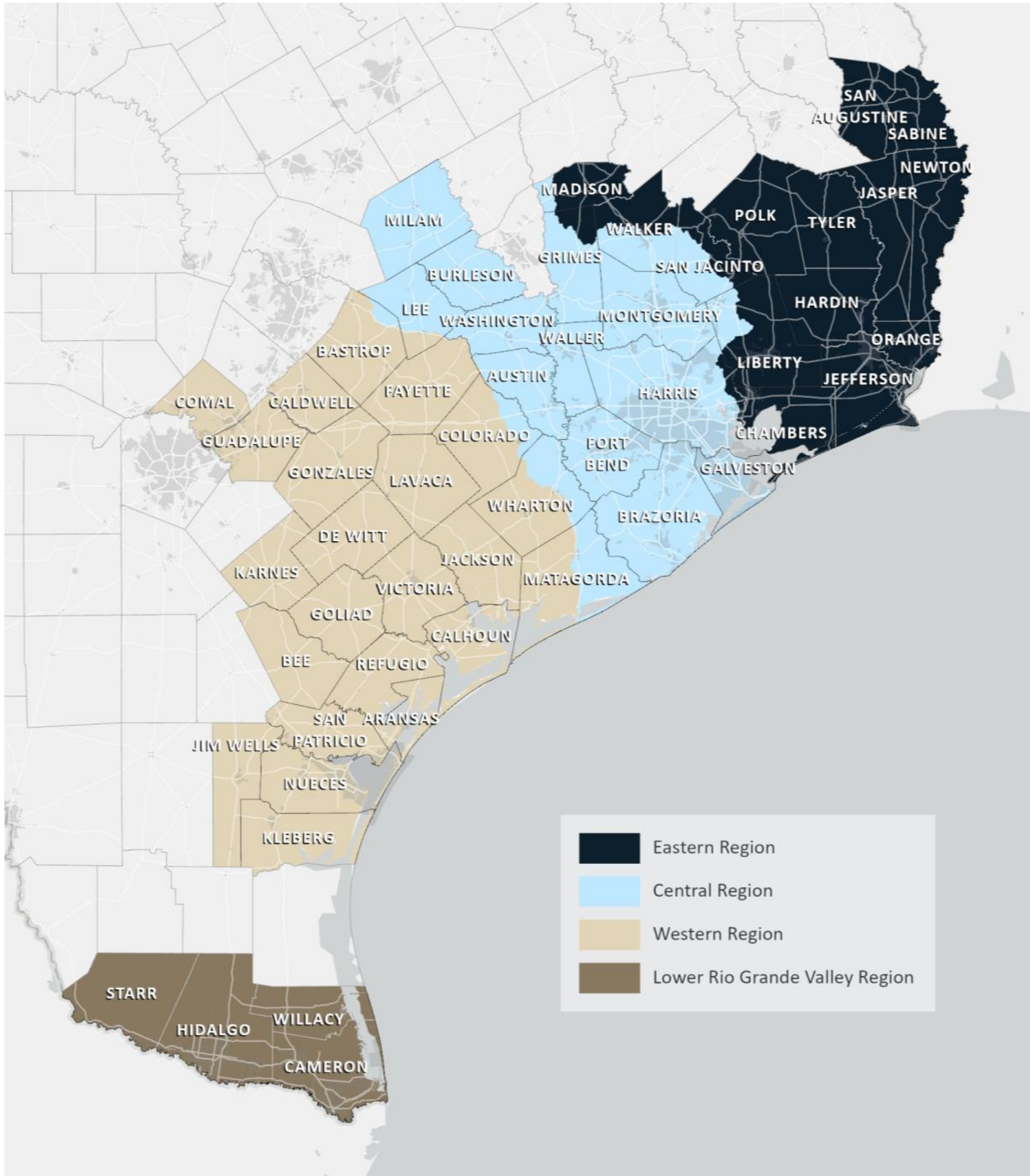
- RBFS Phases and Overview
- Phase 3 Modeled Watersheds
- Modeling Methodologies and Key Findings
- Strengths and Weaknesses
- Lessons Learned
- Hot Spot Analysis
- Phase 4 Alternatives Analysis
- Next Steps

River Basin Flood Study

Program Overview

In September 2020, the Texas General Land Office (GLO) initiated the Combined River Basin Flood Studies planning process to collect, analyze, and communicate flood risk information to help decision makers with protecting Texans from future floods. The goals for the flood study are to:

- Evaluate flood risks to our communities
- Identify flood projects that strengthen the resilience of our communities
- Identify possible funding sources for community flood projects



Phases and Timeline

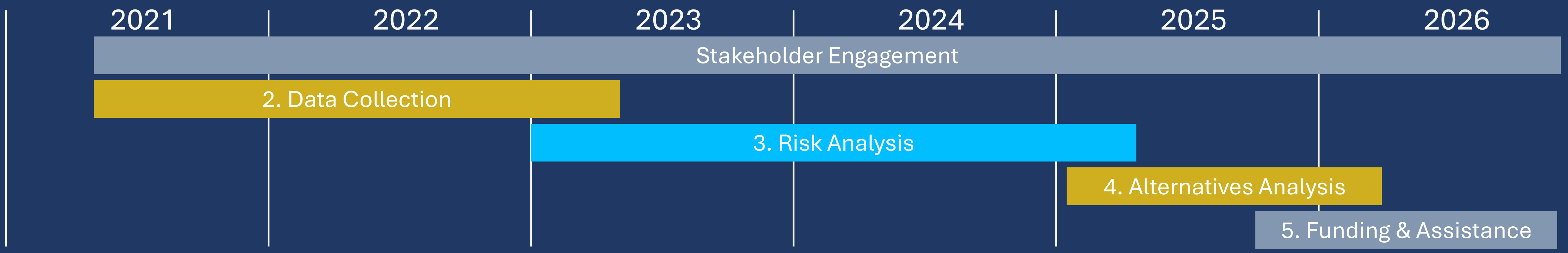
PHASE 1
STAKEHOLDER ENGAGEMENT

PHASE 2
DATA COLLECTION

PHASE 3
RISK ANALYSIS

PHASE 4
ALTERNATIVES ANALYSIS

PHASE 5
FUNDING & ASSISTANCE



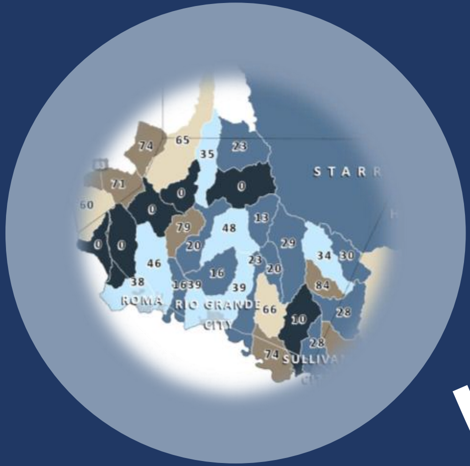
Phase Overview

Phase / Task	Outreach	Data Collection	SOP Development	Major Scope Item	Pilot Testing	Prioritization	Scoping
Phases 1&2: Outreach and Engagement & Data Collection	Engagement Plan and Outreach for General Data Collection and SWOT Analysis	Data Collection Plan and General Data Collection	Baseline Modeling SOP	Data Collection	Baseline Modeling Pilots	HUC Watershed Prioritization and Stream Level Risk Evaluation	Phase 3 Scope and Technical Action Plans
Phase 3: Evaluation of Flood Risk (Development of Baseline Models)	Outreach supporting modeling and MATCH Tool	Data Collection supporting modeling	Hot Spot Analysis SOP and Alternatives Analysis SOP	Development of Baseline Models	Alternatives Analysis Pilots	Hot Spot Analysis following 75% baseline modeling completion	Phase 4 Scope and Technical Action Plans
Phase 4: Identification of Mitigation Projects (Alternatives Analysis)	Outreach supporting alternatives and regionwide coordination	Data Collection supporting alternatives analysis		Alternatives Analysis		Regionwide prioritization of alternatives to move to Phase 5	Phase 5 Scope and Technical Action Plans
Phase 5: Determination of Funding Sources & Technical Assistance	Outreach supporting funding and regionwide coordination	Data Collection supporting funding assistance		Funding Technical Assistance	NA	NA	NA

Phase 3 Modeled Watersheds

Prioritization Process

WATERSHED PRIORITIZATION

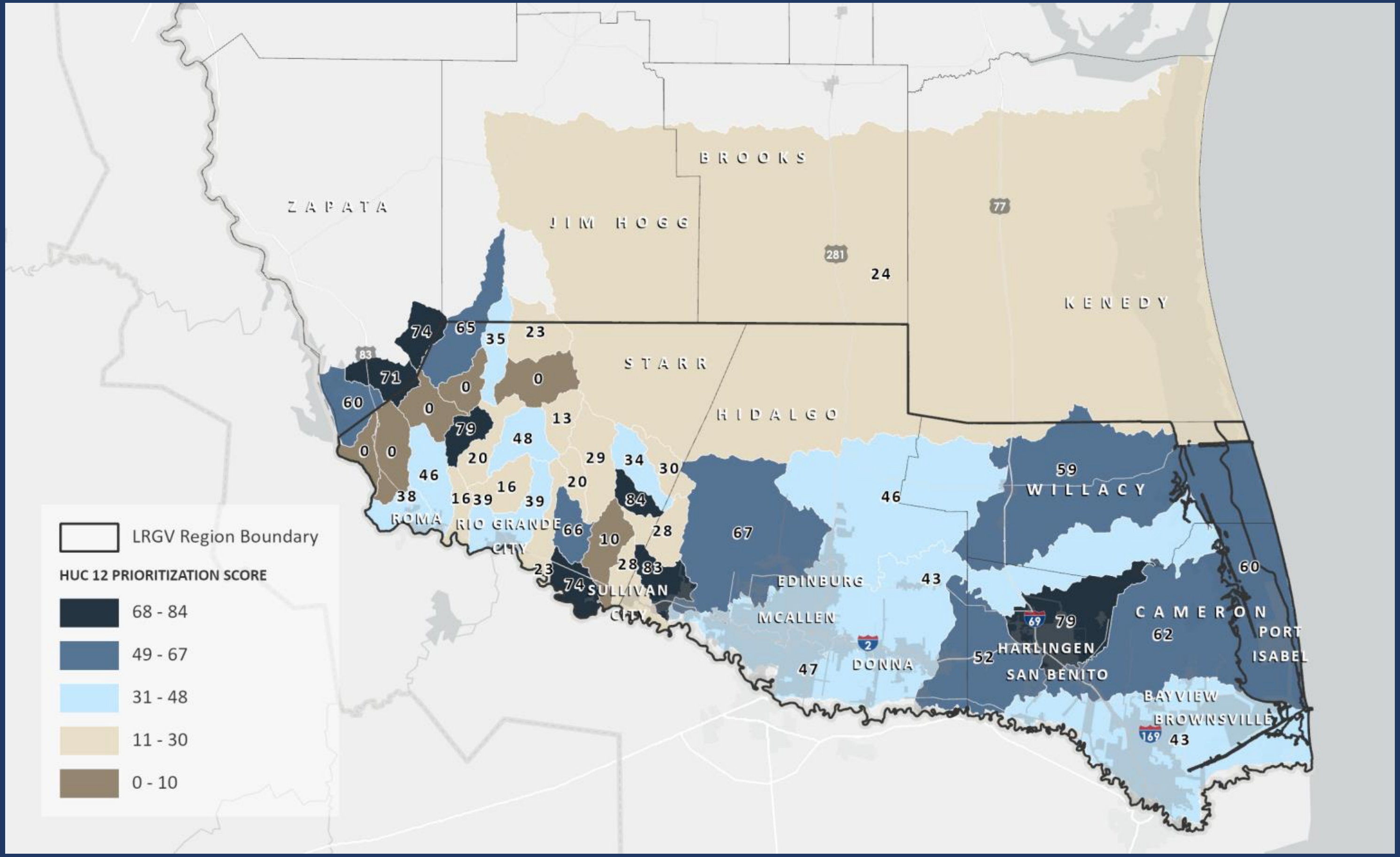


LRGV ACTIVITIES

STREAM & RISK PRIORITIZATION

Phase 3 Modeled Watersheds

HUC 12 Watershed Prioritization Challenges

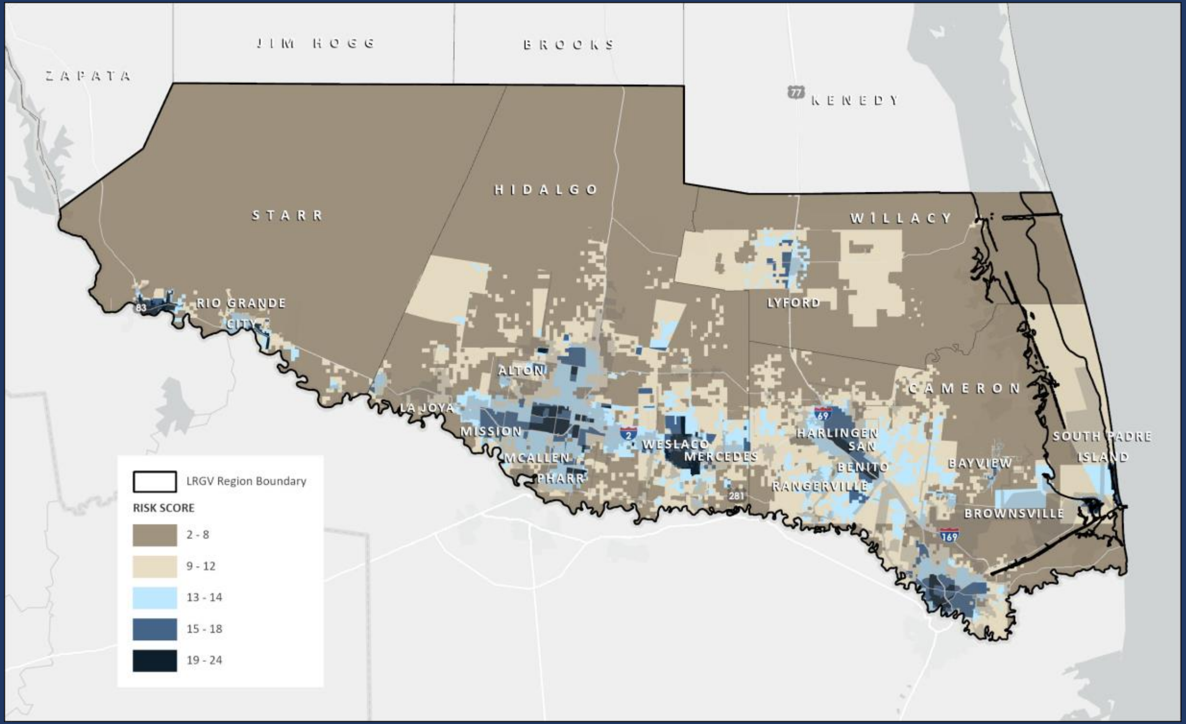


- Insufficient data for normalization
- High-risk areas with zero scores
- Potential under-represented risk in areas with limited data
- Localized prioritization challenges due to dissimilarities in HUC sizes across the region

Phase 3 Modeled Watersheds

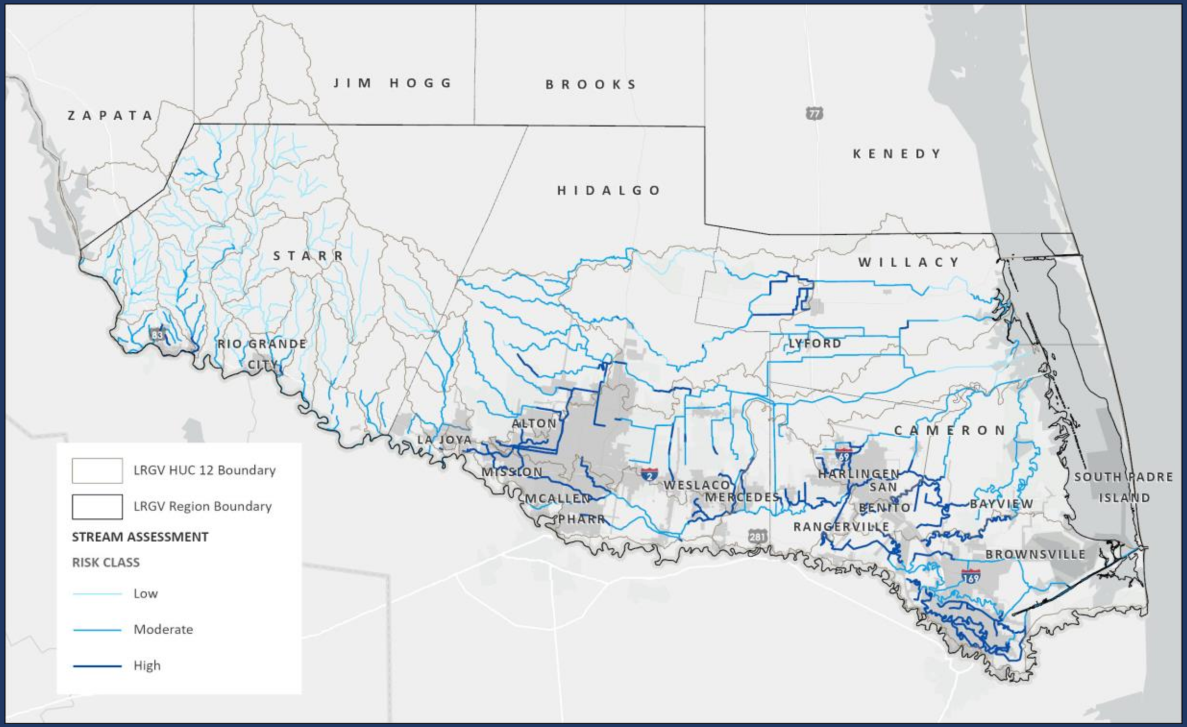
Enhanced Risk Prioritization

- Repetitive Loss Structures
- TWDB Floodplain Quilt
- USGS NHD Plus Stream Centerlines
- FEMA BLE Stream Centerlines
- TWDB Building Footprints
- Social Vulnerability Index (SoVI)
- National Flood Insurance Program Claims
- State Flood Plan - FME and FMP Datasets
- Social Vulnerability Index (SoVI)



Phase 3 Modeled Watersheds

Stream Prioritization

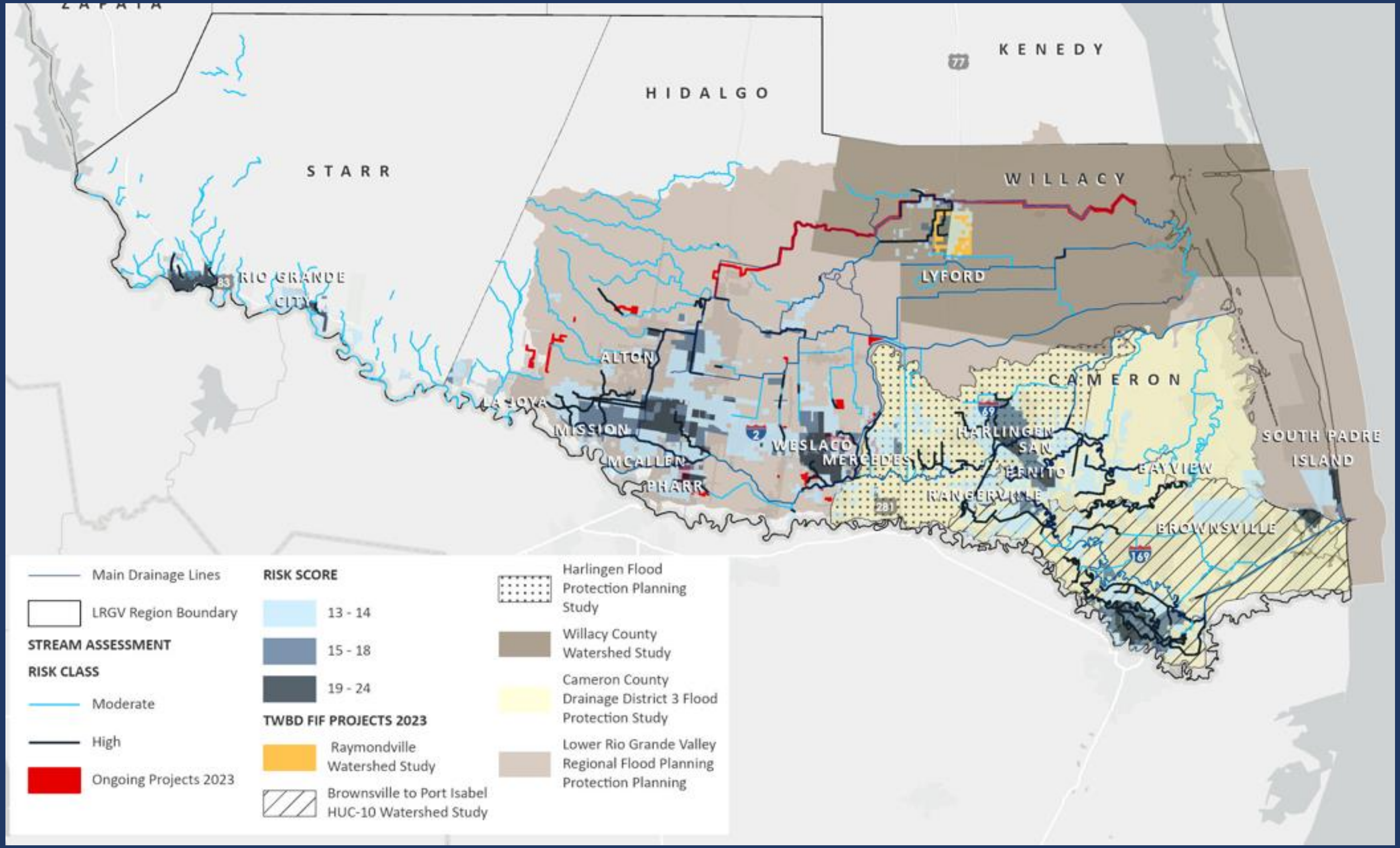


Cameron County exhibited highest stream-risk followed by Hidalgo County

County	Stream Risk (miles)		
	Low	Medium	High
Cameron	7.3	224.9	241.1
Hidalgo	20.1	325.1	142.5
Starr	463.1	142.7	9.3
Willacy	26.4	128.8	27.4

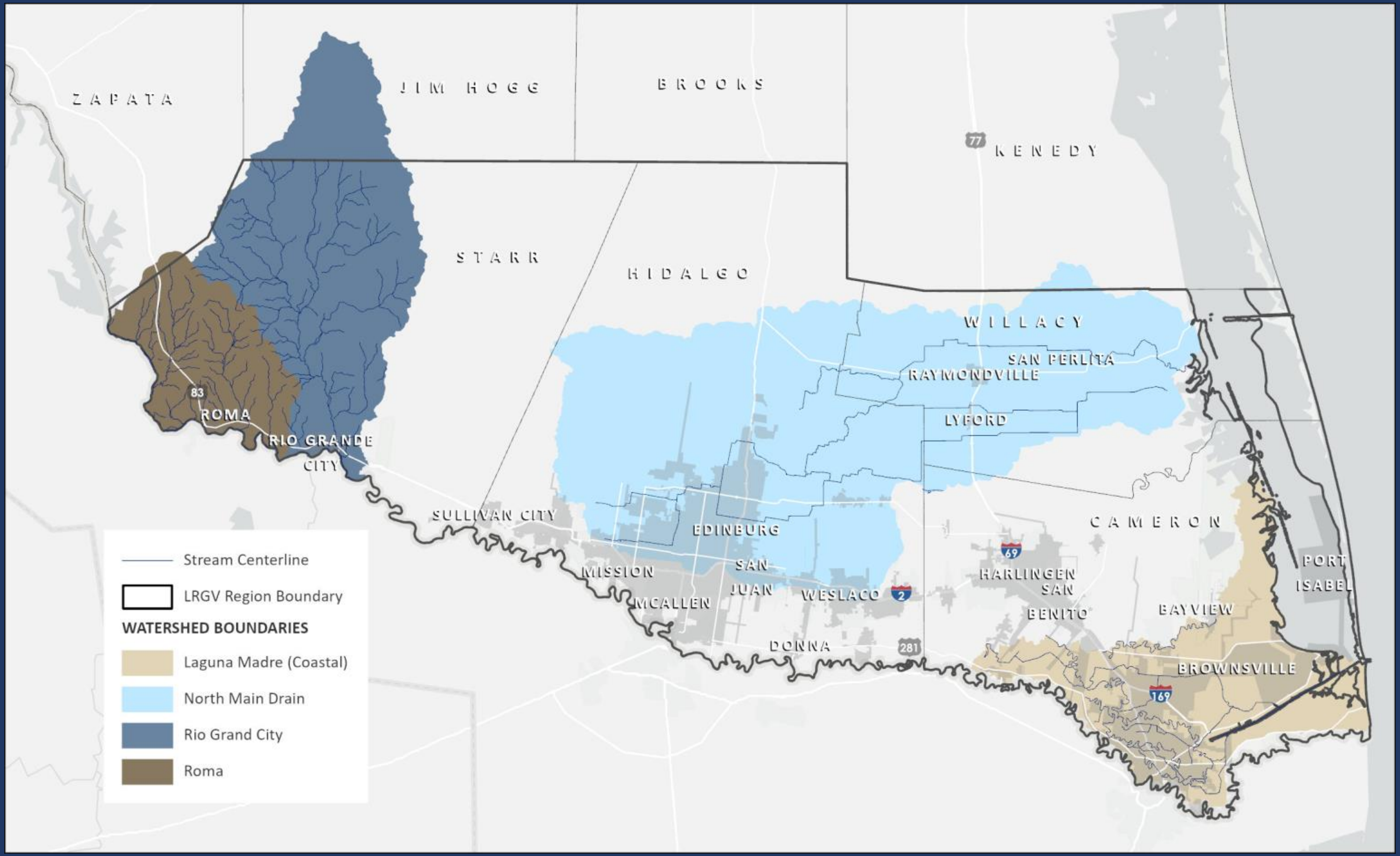
Phase 3 Modeled Watersheds

Avoiding Overlap with Ongoing Efforts



Phase 3 Modeled Watersheds

LRGV Baseline Models



- Starr County
  - Roma
  - Rio Grande City (Pilot)
- Hidalgo and Willacy Counties
  - West Main Drain
  - North Main Drain
  - South Main Drain
  - Main Floodwater Channel
  - Raymondville Drain
  - Willacy Main Drain
- Cameron County
  - Laguna Madre Coastal Communities

Phase 3 Modeled Watersheds

Level of Detail

Low
- Local Mitigation Projects
- Municipal/Drainage District Funding

Medium
- Regional Mitigation Projects
- State Agency Funding

High
- Large-Scale Mitigation Projects
- USACE Funding

Modeled Level of Detail

Low
- None – 2D Base Level Engineering covers the region

Medium
- Roma
- Rio Grande City

Medium - High
- North Main Drain
- Laguna Madre Coastal Communities

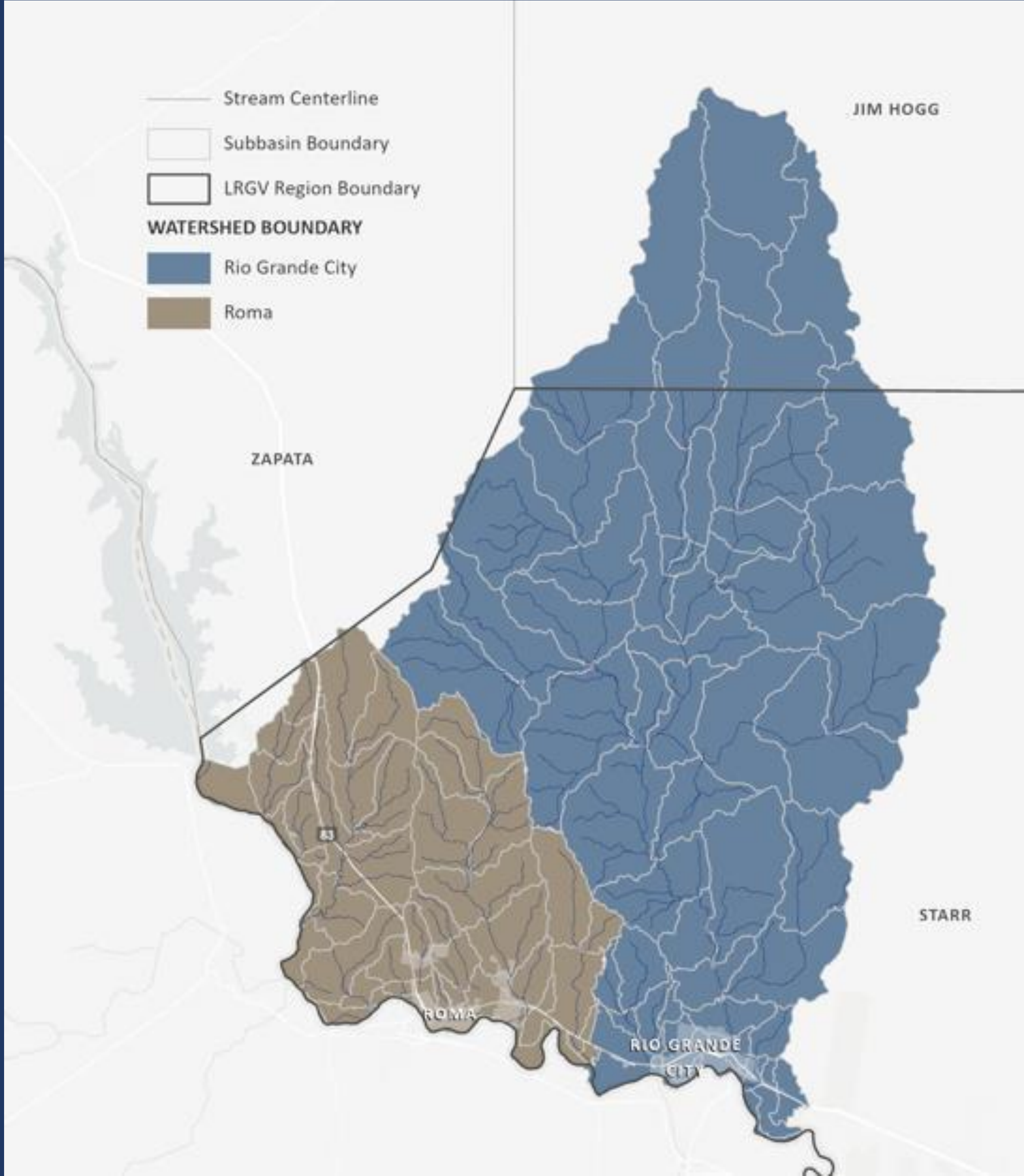
Starr County

Roma and Rio Grande City

Starr County

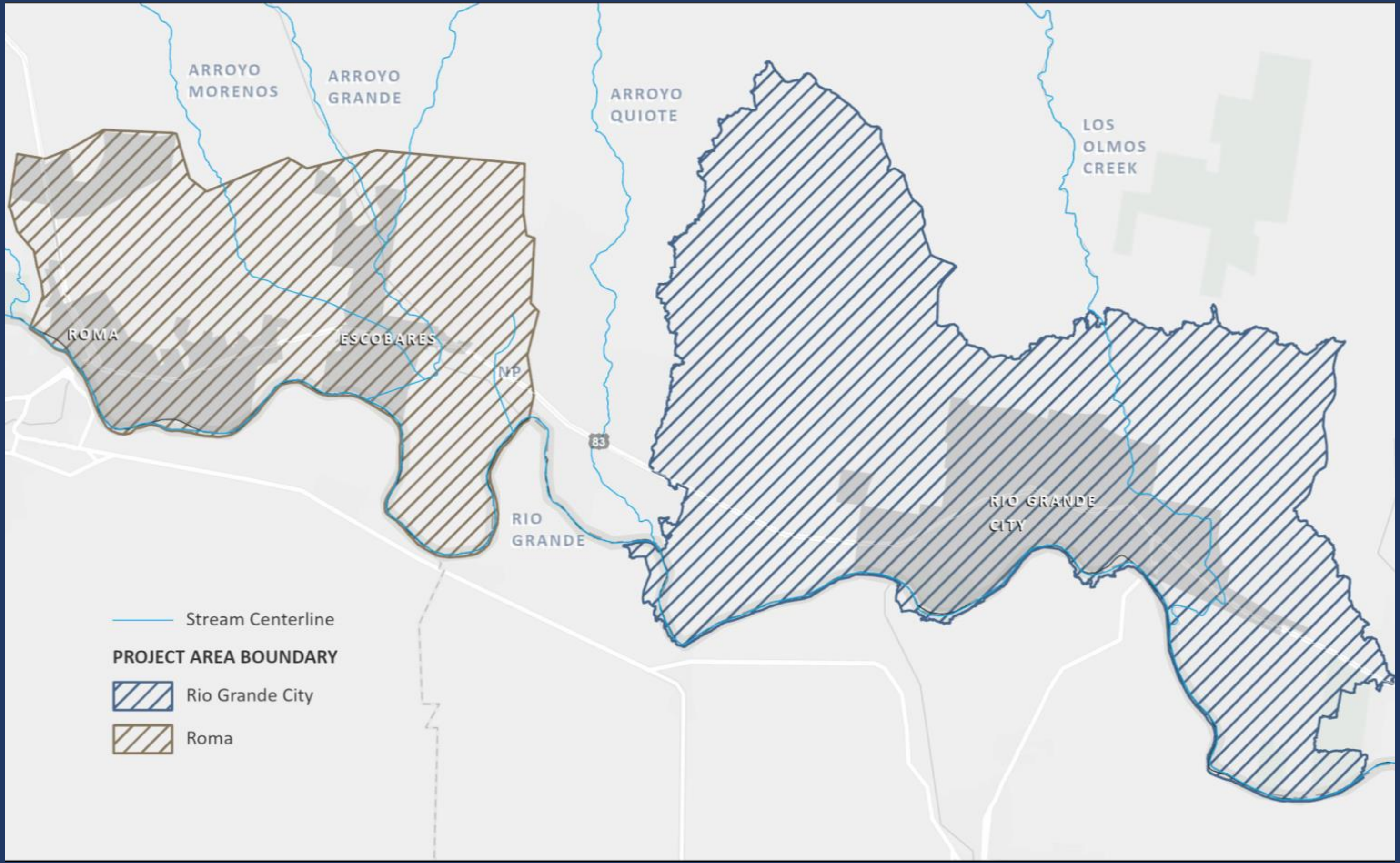
Hydrology

Software	HEC-HMS version 4.11
Subbasins	1 to 5 square miles in detailed study area
Land use and Imperviousness	NLCD 2021
Soils	SSURGO
Losses	Green and Ampt
Transform	Snyder Unit Hydrograph
Routing	2D Modified Puls
Rainfall	Atlas 14, TP40, Historic Events (limited)
Sensitivity	Loss Parameters
Calibration	USGS Regression Equations



Starr County

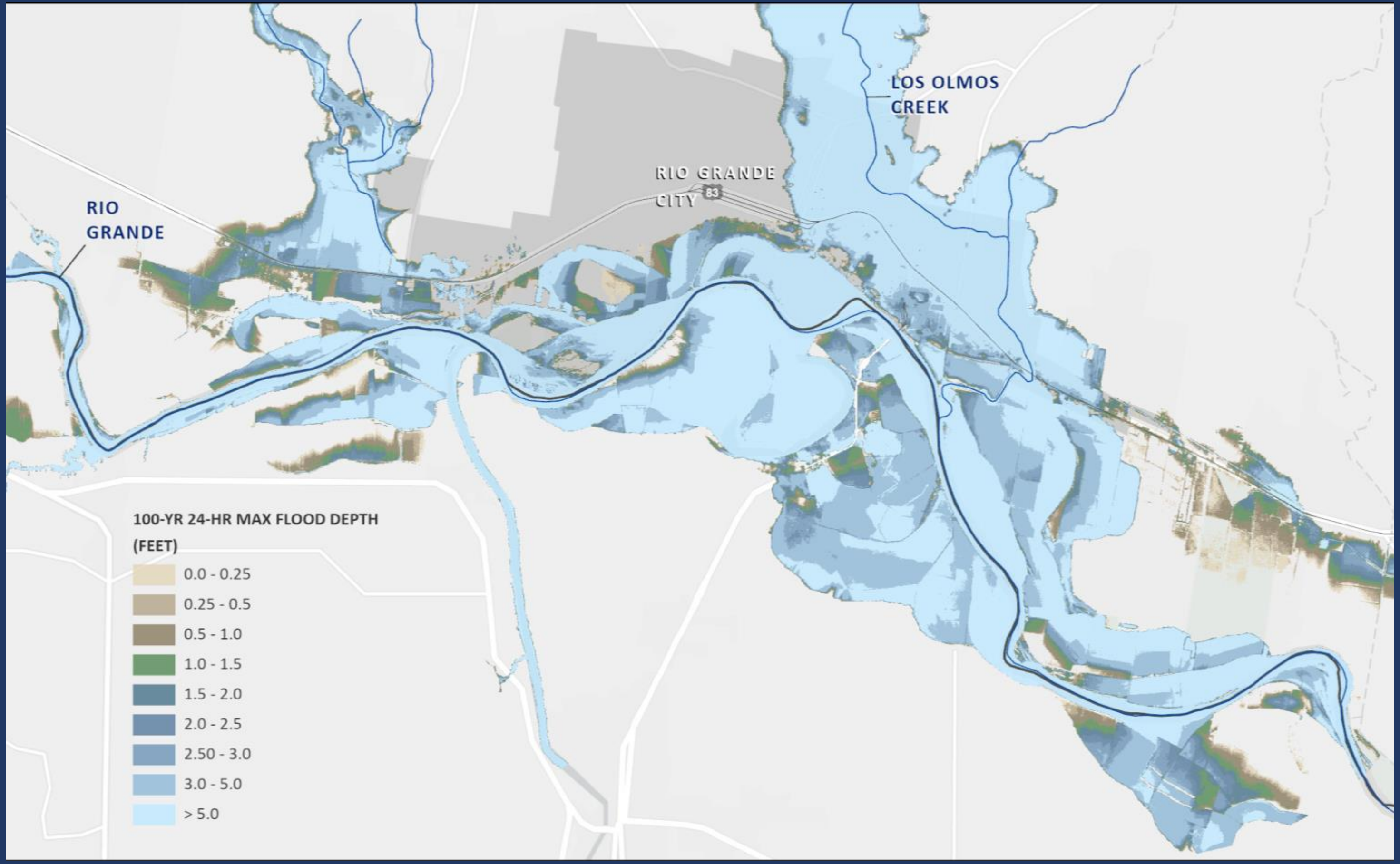
Hydraulics



Software	HEC-RAS 6.3.1 (Rio Grande City) HEC-RAS 6.4.1 (Roma)
Terrain	South Texas LiDAR (2018, 2021)
Land use	NLCD 2021 Building Footprints Aerial Imagery Spatially varied across cell face
2D Mesh	300-ft base cell size Refinements • Breaklines • Terrain modifications • Calibration regions
Structures	Survey and as-builts SA/2D Connections
Inflows	Internal/External Boundary Conditions
Sensitivity Analysis	Tolerance Parameters Equation Set
Validation	USGS Regression Equations

Starr County

Key Findings



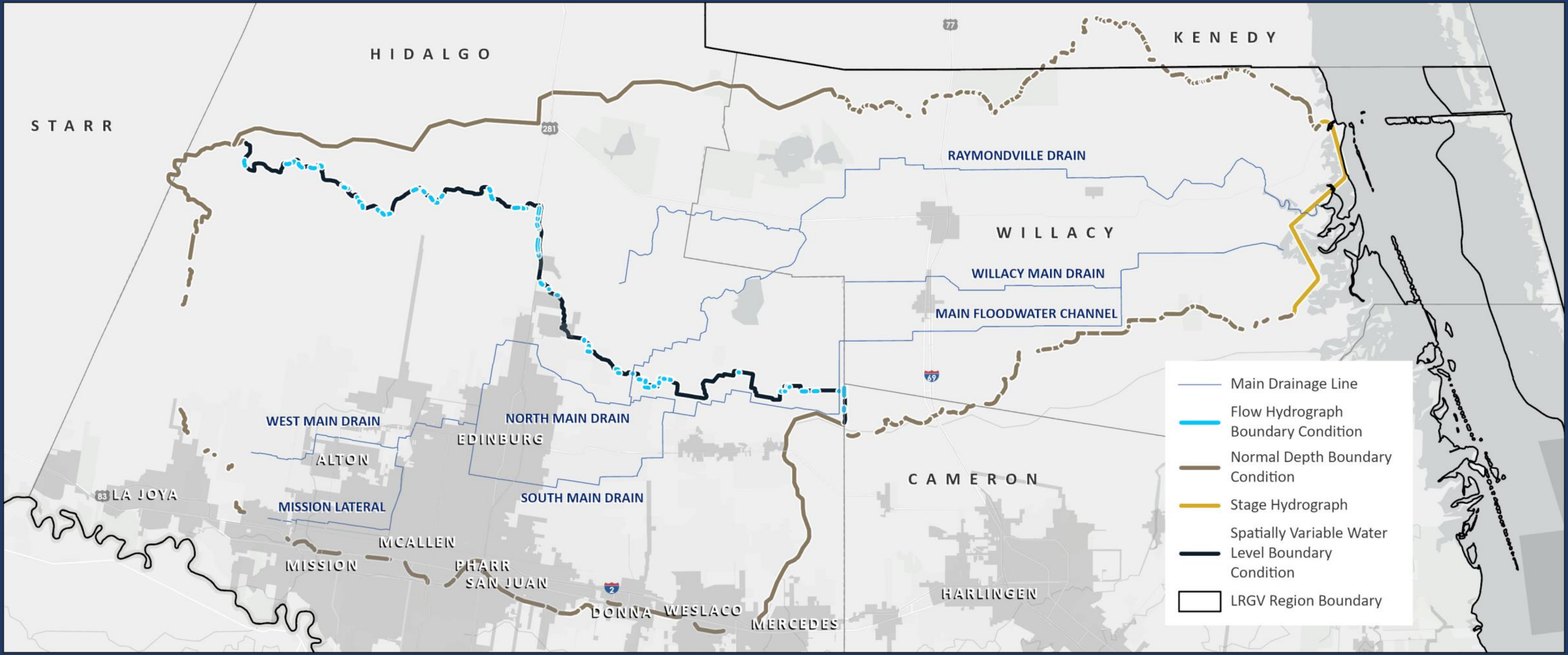
- Fluvial sources (Arroyo Roma, Arroyo Grande and Los Olmos Creek) are the dominant causes of flooding
- Pluvial flooding is a smaller yet significant source of flooding
- Communities will potentially benefit from regional and local flood mitigation projects

Hidalgo and Willacy Counties

North Main Drain

North Main Drain

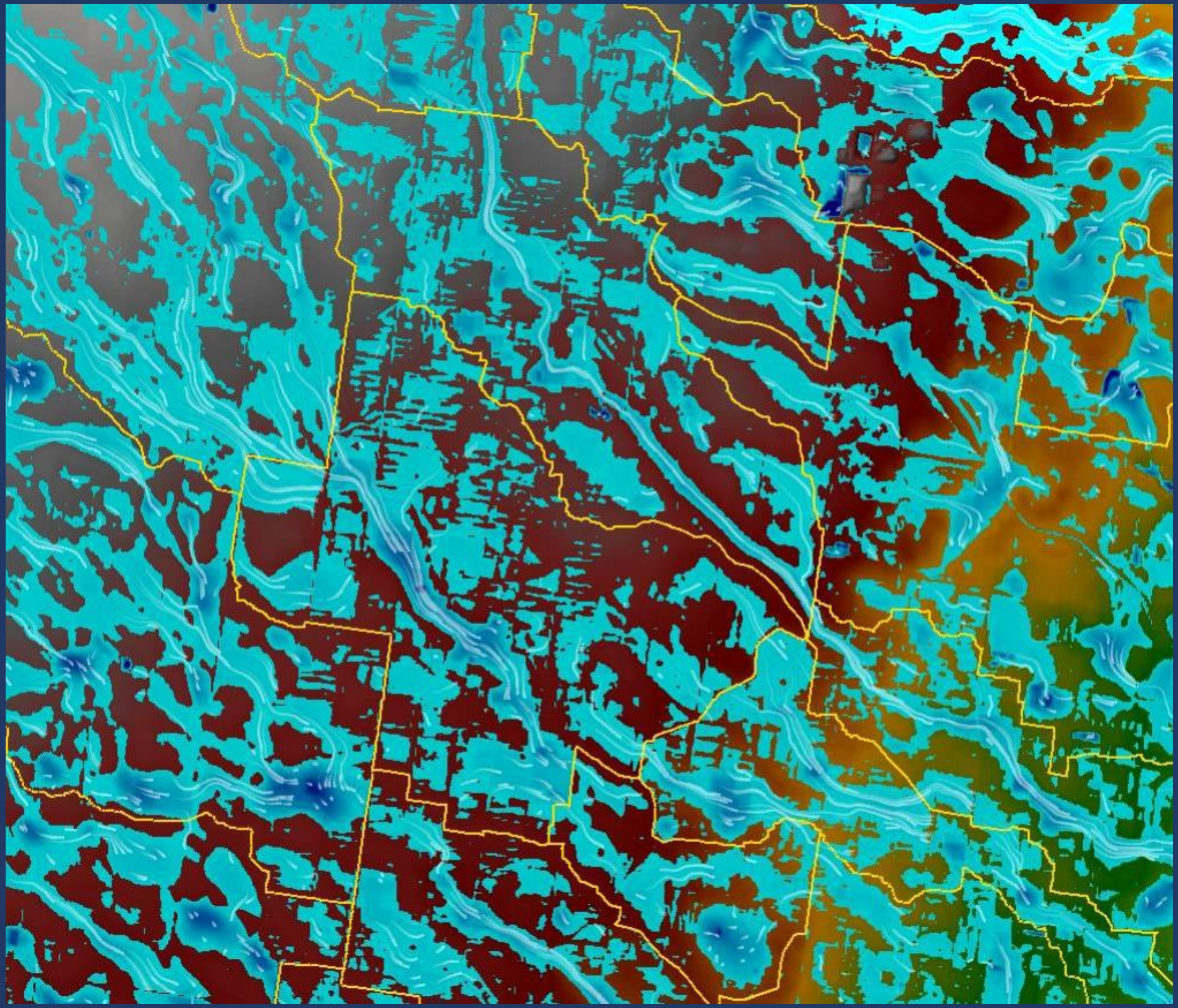
Modeling Overview



North Main Drain

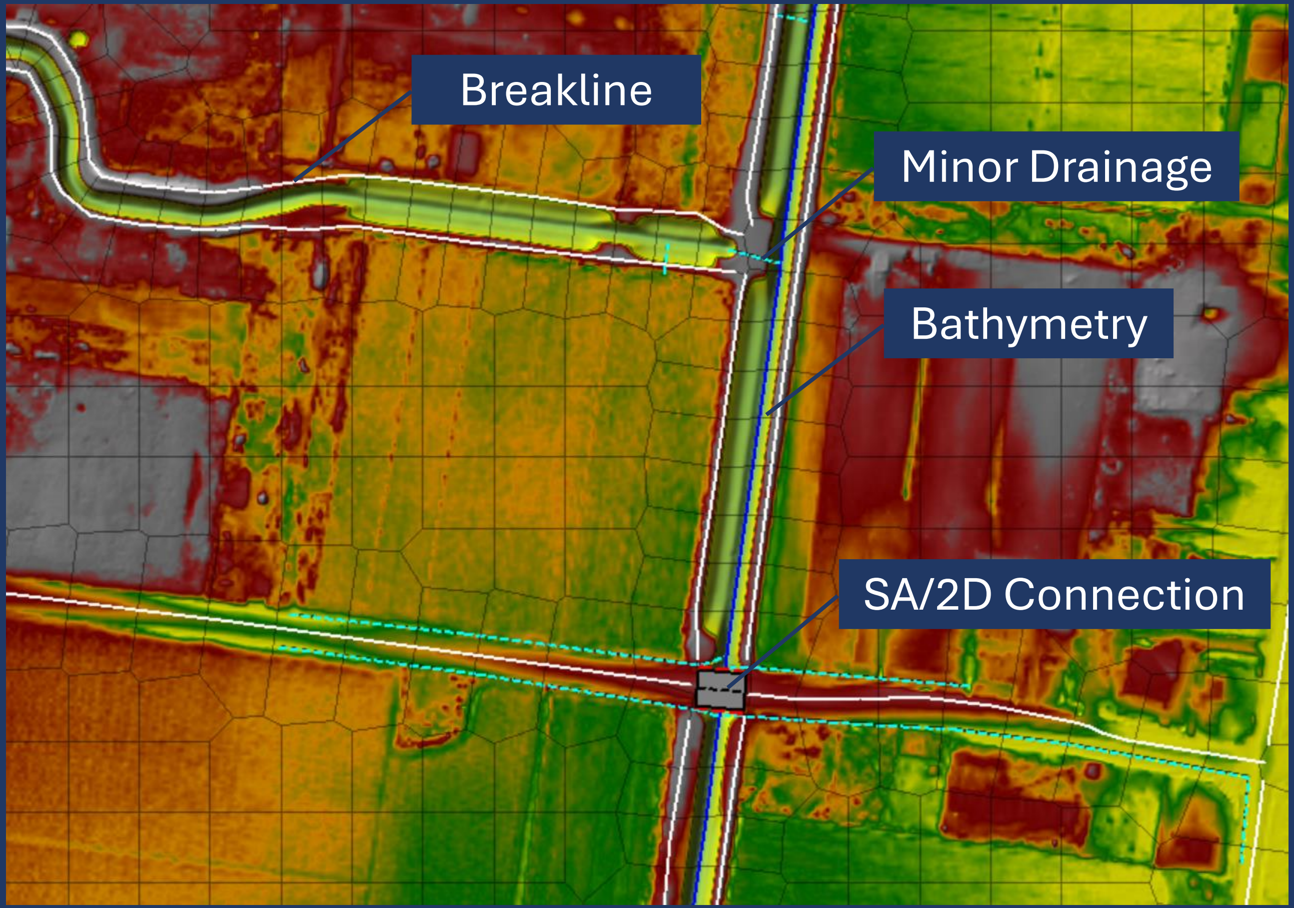
Hydrology

- 1D hydrology fails
  - Flat topography dominated by braided streams and 2D flows
  - Bi-directional flows in laterals and mains
- Rain-on-Mesh
  - Green and Ampt gridded infiltration
- Infiltration parameters basis
  - Hydrologic Soil Group (HSG)
  - Percent imperviousness
- Sensitivity Analysis
  - Saturated hydraulic conductivity
  - Initial soil water content
- Rainfall
  - AEP events - Atlas 14
  - Historic events - March 2025, June 2024, June 2021
  - Areal Reduction - Texas Storms Study



North Main Drain

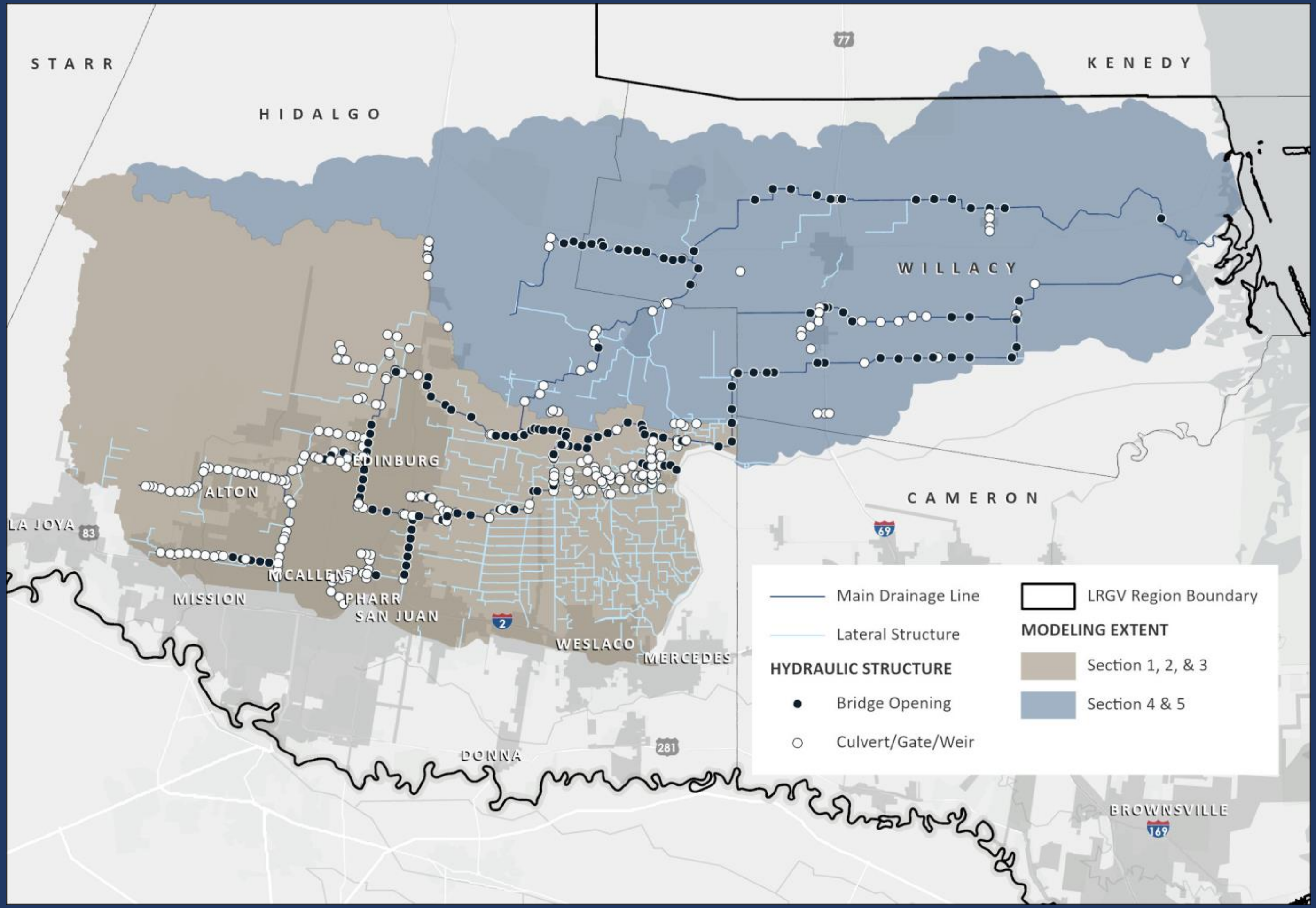
Hydraulics



Software	HEC-RAS 6.4.1
Terrain	South Texas LiDAR (2018, 2021)
Land use	NLCD 2021 Building Footprints Aerial Imagery Spatially varied Manning's n-values across cell face
2D Mesh	200-ft base cell size Refinements • Breaklines • Terrain modifications • Calibration regions
Structures	Survey and as-builts SA/2D Connections
Boundary Conditions	Flow Hydrograph Normal Depth Spatially Varying Stage Stage Hydrograph
Sensitivity Analysis	Tolerance Parameters Equation Set
Calibration	Observed Stage

North Main Drain

Surveyed Structures



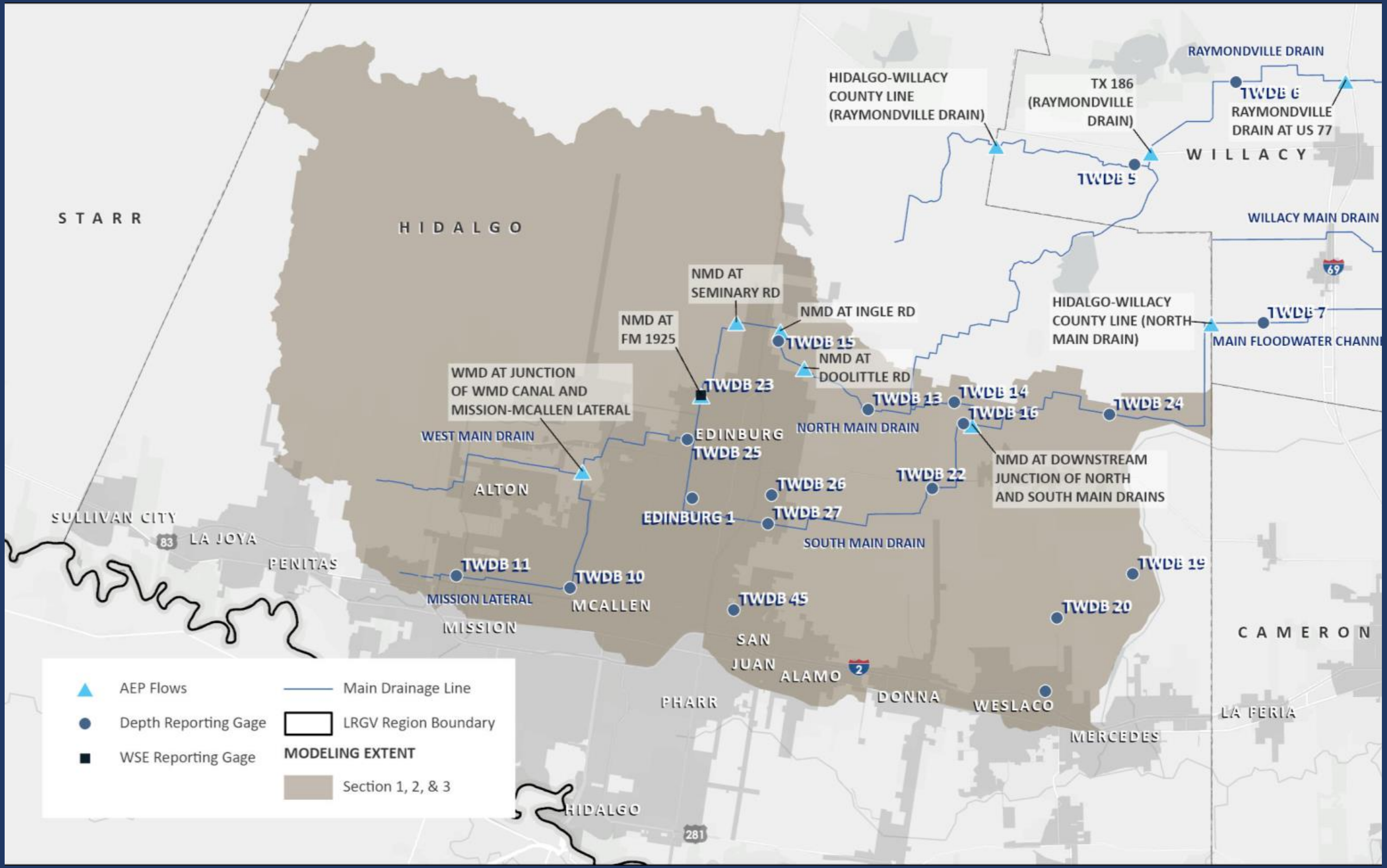
- 459 total structures included for modeling
- 307 new detailed survey structures
- 49 structures using approximate methods from aerial imagery
- 4 structures using TxDOT as-built plans
- 59 structures leveraged from the Delta Storm Project

Panchitas gate operations limited to 3,750 cfs according to FEMA FIS Hidalgo County Unincorporated Areas, June 2000

North Main Drain

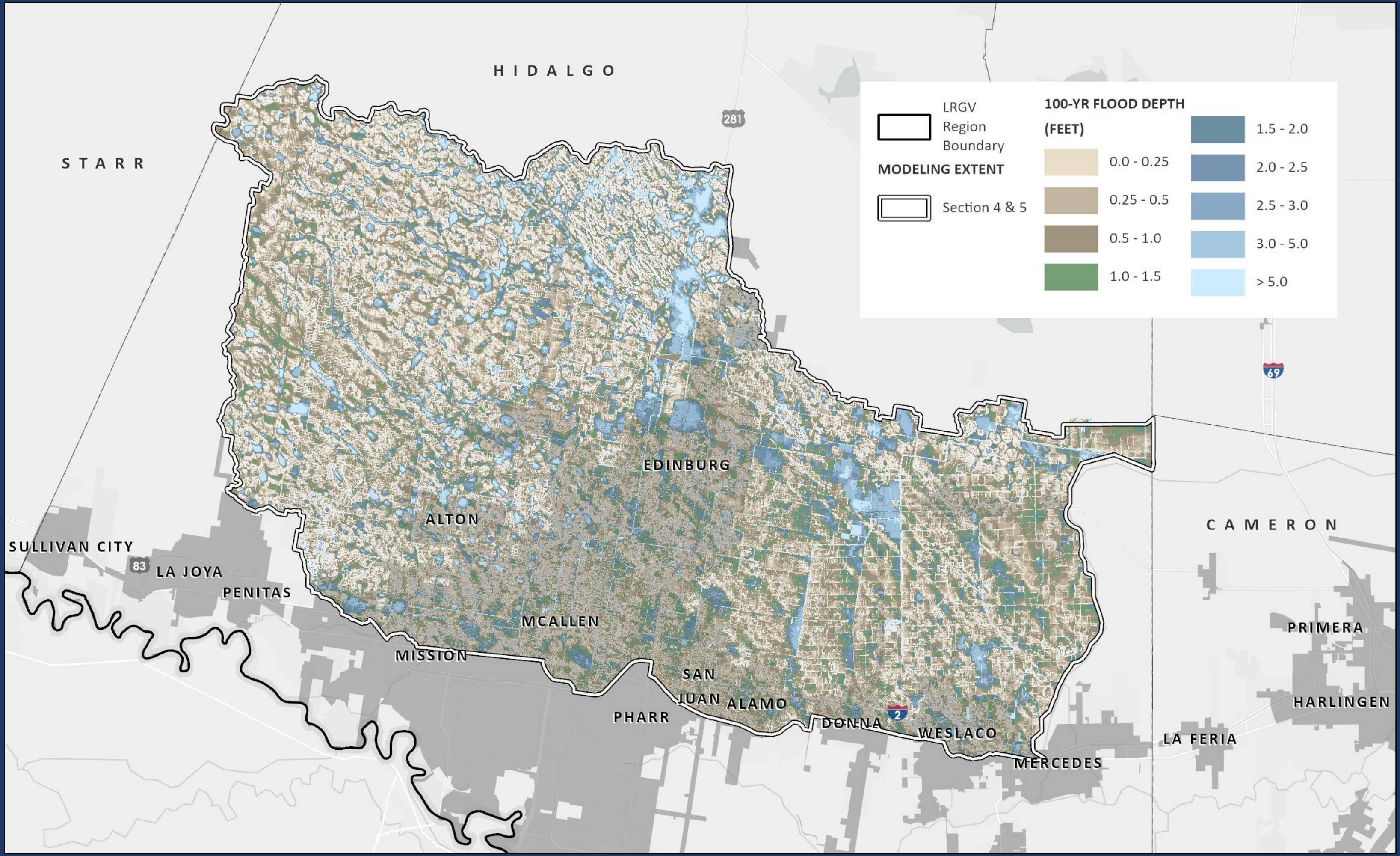
Calibration

- NMD models calibrated to 2021, 2024 (Alberto), and 2025 storm events
- Rainfall data from the Iowa Environmental Mesonet MRMS-QPE with Estimated Gage Bias Correction, 1km by 1km resolution
- Chosen based on the availability of TWDB stream stage monitoring gages
- Implemented several terrain burns to simulate local storm sewer systems draining to channels with berms



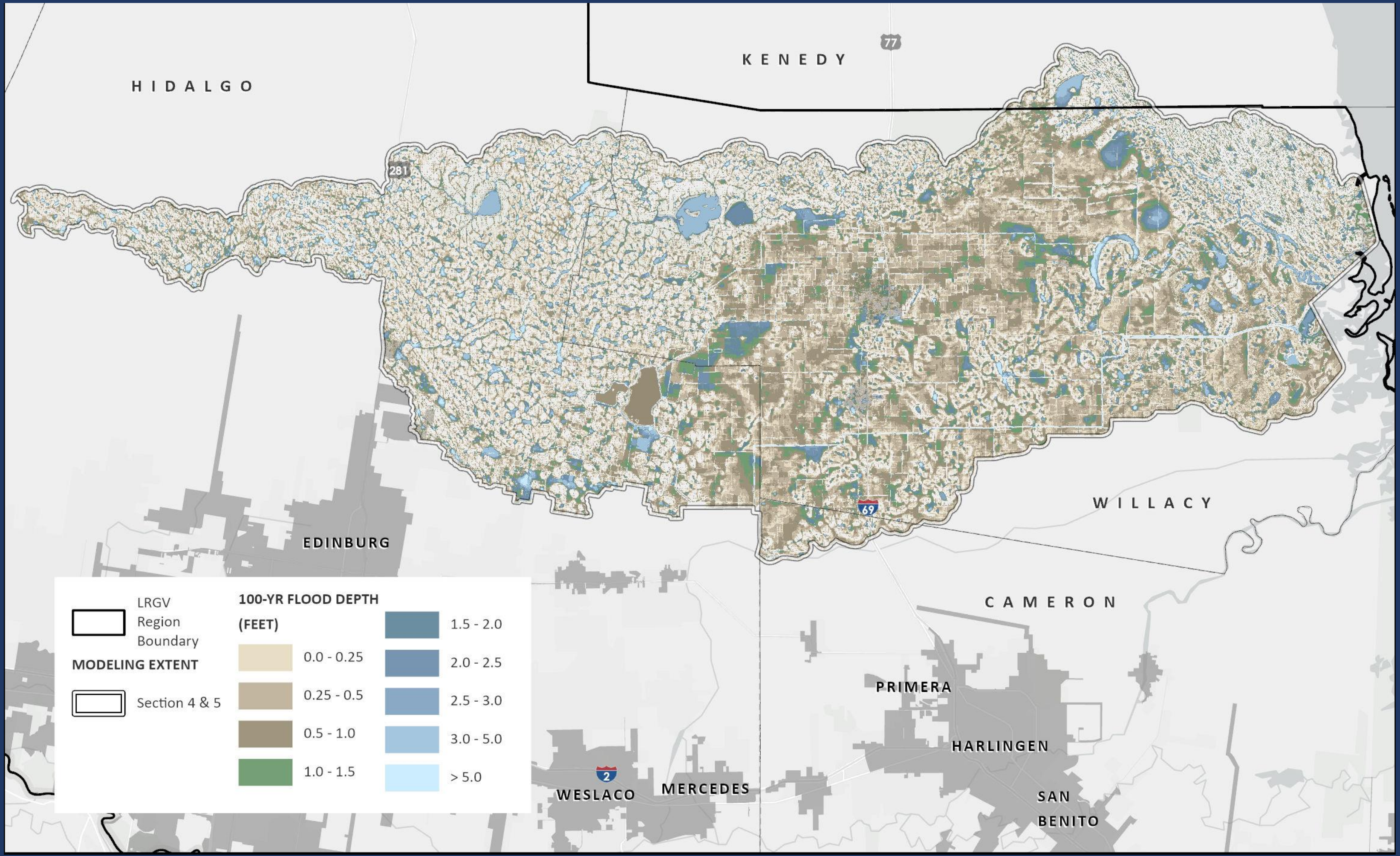
North Main Drain | Sections 1-3

Results



North Main Drain | Sections 4-5

Results



North Main Drain

Key Findings

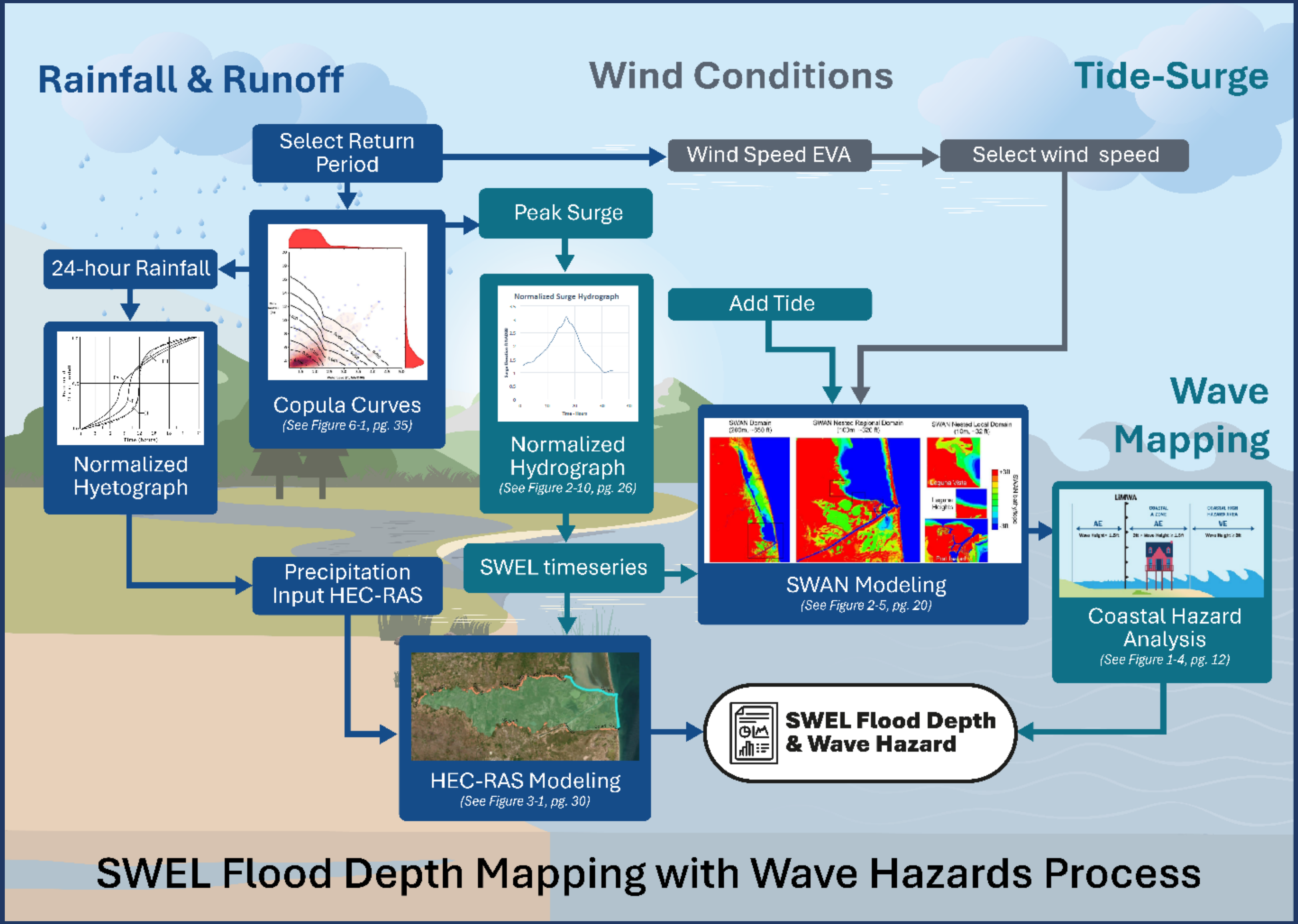
- Rainfall-runoff methodology significantly affects modeling results
- Flooding is largely driven by flat topography and conveyance constraints due to a lack of or undersized channels and channel crossings
- Incorporation of storm sewer significantly affects ponding as most of the channels have raised berms
- Detailed analyses of smaller streams may be warranted if projects are proposed in such areas

Cameron County

Laguna Madre Coastal Communities

Laguna Madre

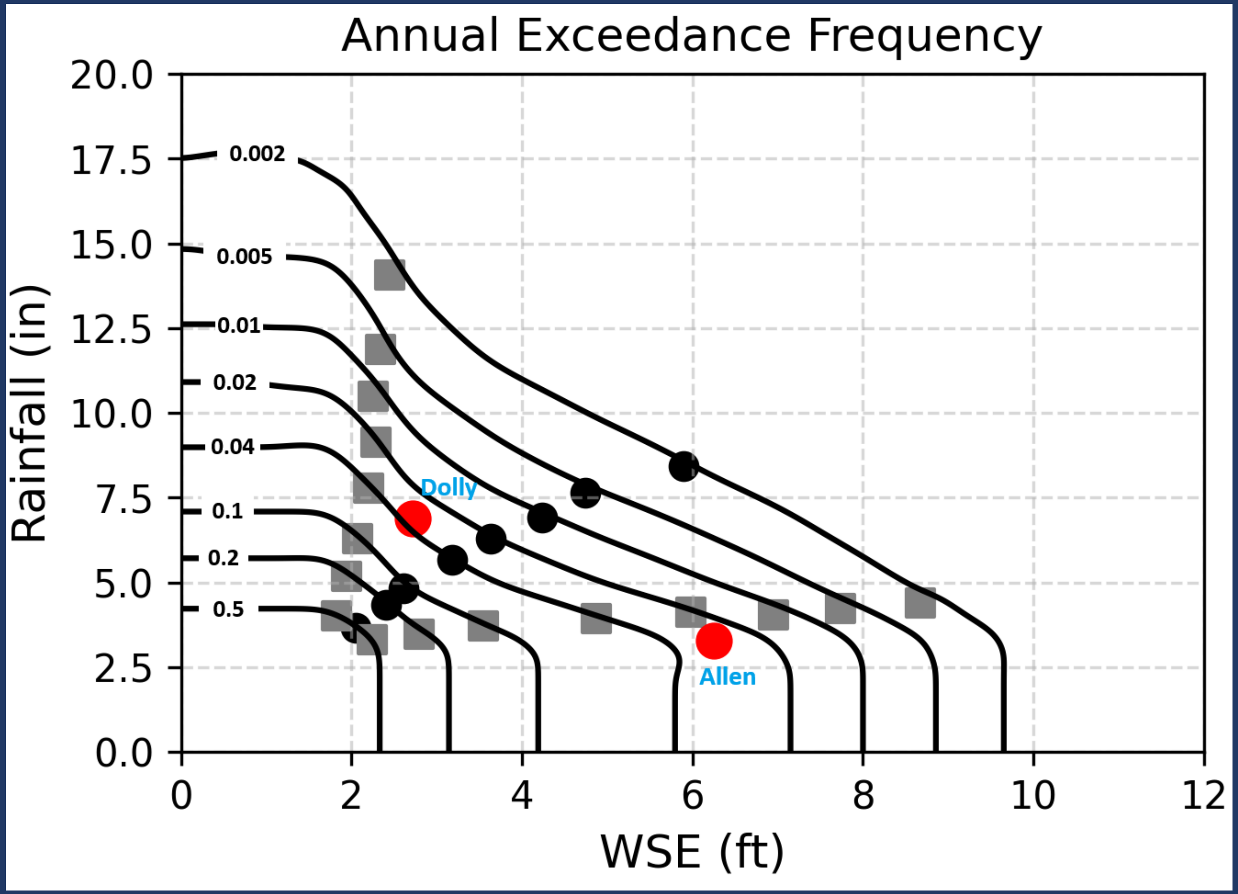
Modeling Overview



Laguna Madre

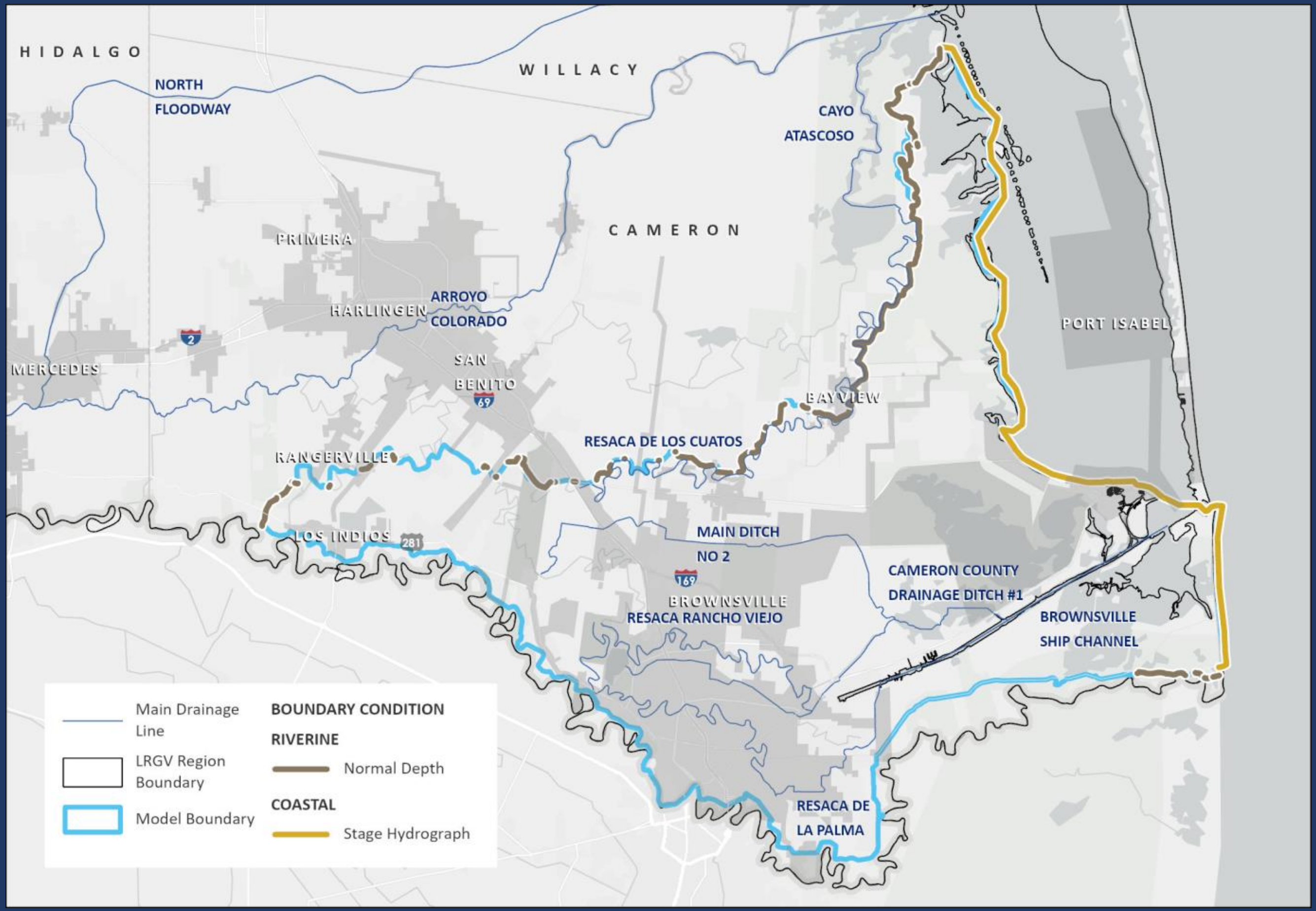
Compound Flood Risk

- Bivariate analysis performed using peaks over threshold, and long-term surge and rainfall data.
- Copula modeling for joint probability of surge and rainfall during tropical cyclones, producing three design scenarios per return period
  - Most Likely
  - Surge-Dominant
  - Rainfall-Dominant



Laguna Madre

Hydrology

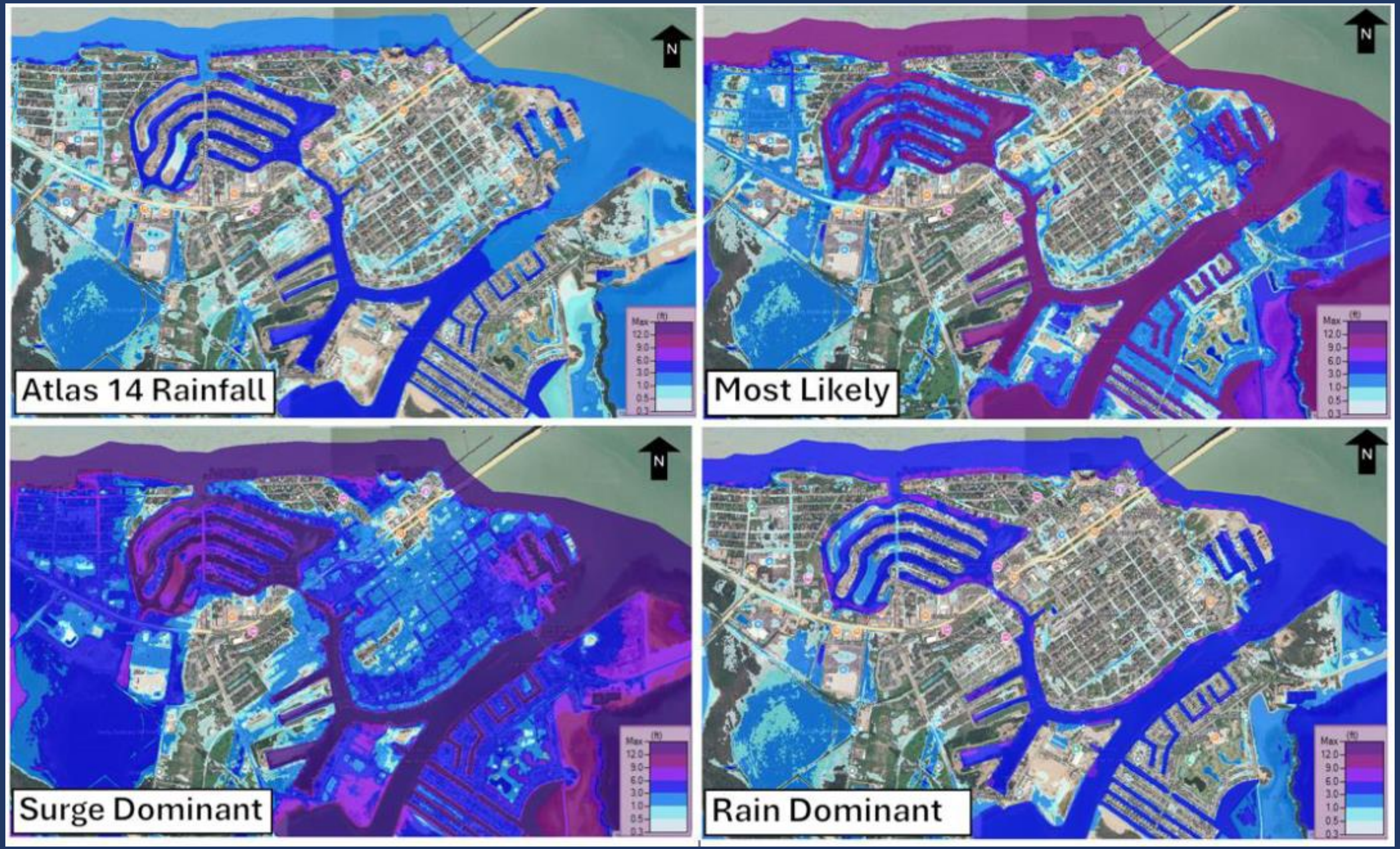


- HEC-HMS v4.11 Rainfall Runoff Model
- Limited to development of rainfall hyetographs
- NOAA Atlas 14 Precipitation
- NRCS Curve Number Loss Method Infiltration performed in RAS 2D Mesh

Laguna Madre

Hydraulics

- HEC-RAS v6.4.1, 2D Mesh
- Brownsville to Port Isabel HUC-10 FIF model (Halff, 2023) serves as the basis
- Input Data
  - AI Land Cover Dataset /Halff AI Generated Land Use
  - TWDB statewide buildings dataset
  - LiDAR Terrain - 2018 USGS South Texas LiDAR
- 200-ft base cell size
- 313 hydraulic features represented as SA/2D connections using detailed survey (most of them).



Laguna Madre

Calibration Details

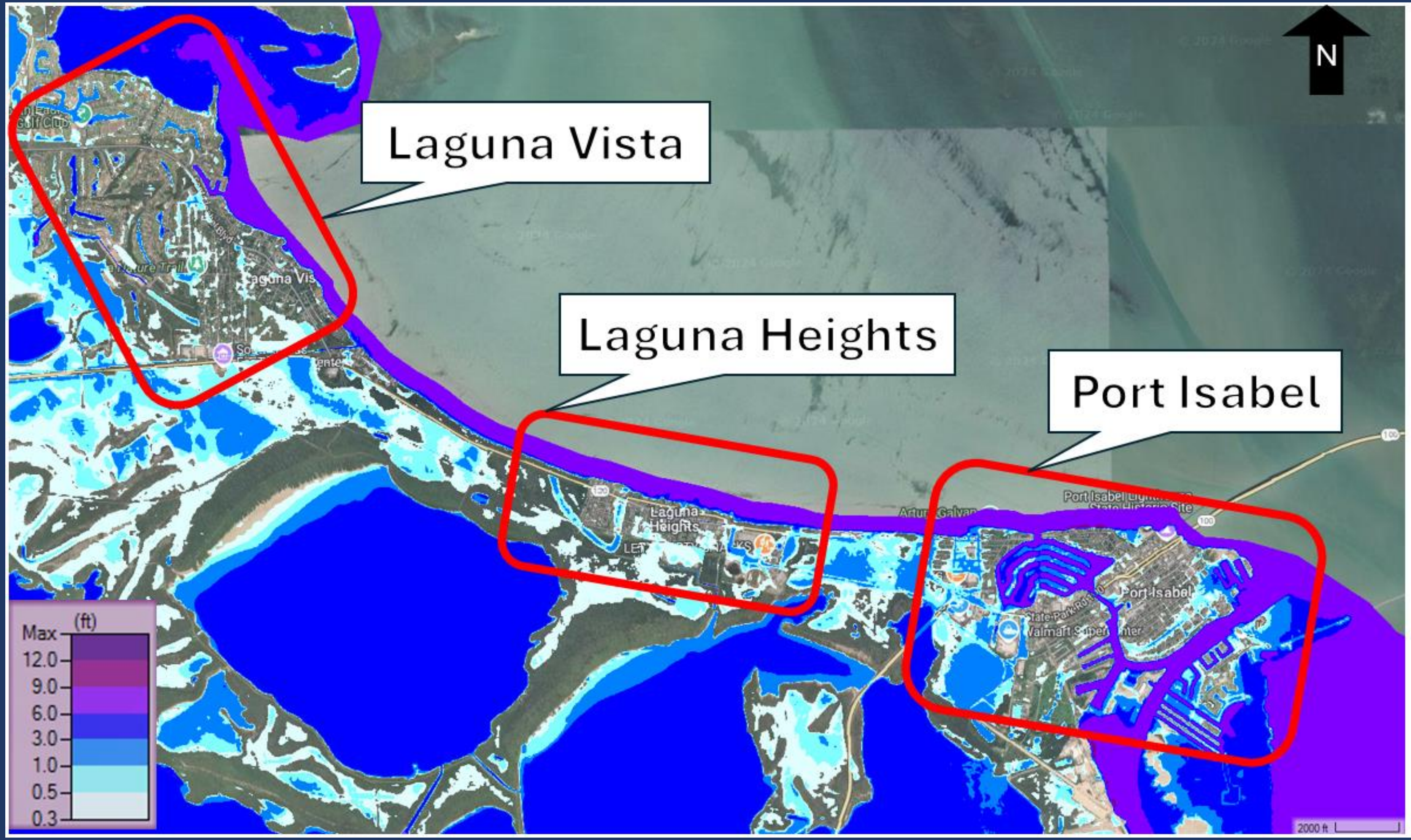
May 2022 Storm Event Selection

- High intensity during the limited USGS gage record. Delivered ~4.6 inches of rainfall in 24 hours (20% AEP intensity).
- Rainfall Data Integration MRMS gridded rainfall. Validated against gage readings.
- Stage Hydrographs and Model Calibration USGS gage stage hydrographs compared to model-generated hydrographs.

USGS Gage Location	USGS Peak Stage (feet)	May 2022 Model Peak Stage (feet)	Stage Difference (feet)
Cameron Co at FM 802	9.25	9.72	0.47
Old Main Drain at SH 04	5.49	4.90	-0.59
N Main Drain at Manzano St	20.67	20.91	0.24
N Main Drain at Boca Chica Hwy	22.51	22.93	0.42
Town Resaca at E 6th St	24.26	24.50	0.24

Laguna Madre

Key Findings



- The Surge Dominant pairs resulted in higher flood risk
- Surge Dominant condition only has an impact on Costal Communities not on inland areas
- Further analysis necessary for potential projects in the coastal communities
- Spatially static coastal boundary condition limitation

Texas General Land Office
Commissioner Dawn Buckingham, M.D.

Strengths and Weaknesses

Lower Rio Grande Valley

Strengths

- **Modern Techniques**: Developed using the latest modeling approaches, well-suited for the region's flat topography.
- **Recent Calibration**: Calibrated to recent storm events using available stage data, improving reliability.
- **Up-to-Date Data**: Incorporates the most current survey, terrain, and land use data available for the region.
- **Reusable Framework**: Models can be extended or supplemented for nearby areas without starting from scratch.

Weaknesses / Limitations

- **No Flow Gage Data**: Models could not be verified against flow.
- **Limited Stage Hydrograph Data**: Several gages only recorded depth data; assumed flowlines were used to estimate stage hydrographs.
- **Storm Sewer Systems**: HEC-RAS did not have the capability to model storm sewer features at the time; small channels were added to simulate drainage from low-lying areas and behind berms.
- **Simplified Inflows**: Crossing structures draining into the North Main Drain watershed were not modeled; terrain modifications were used instead and may need refinement to improve modeling accuracy over those areas.
- **Unverified Gate Operations**: Manual gate structures exist in the area, but operational data was unavailable to supplement the model.

Lessons Learned

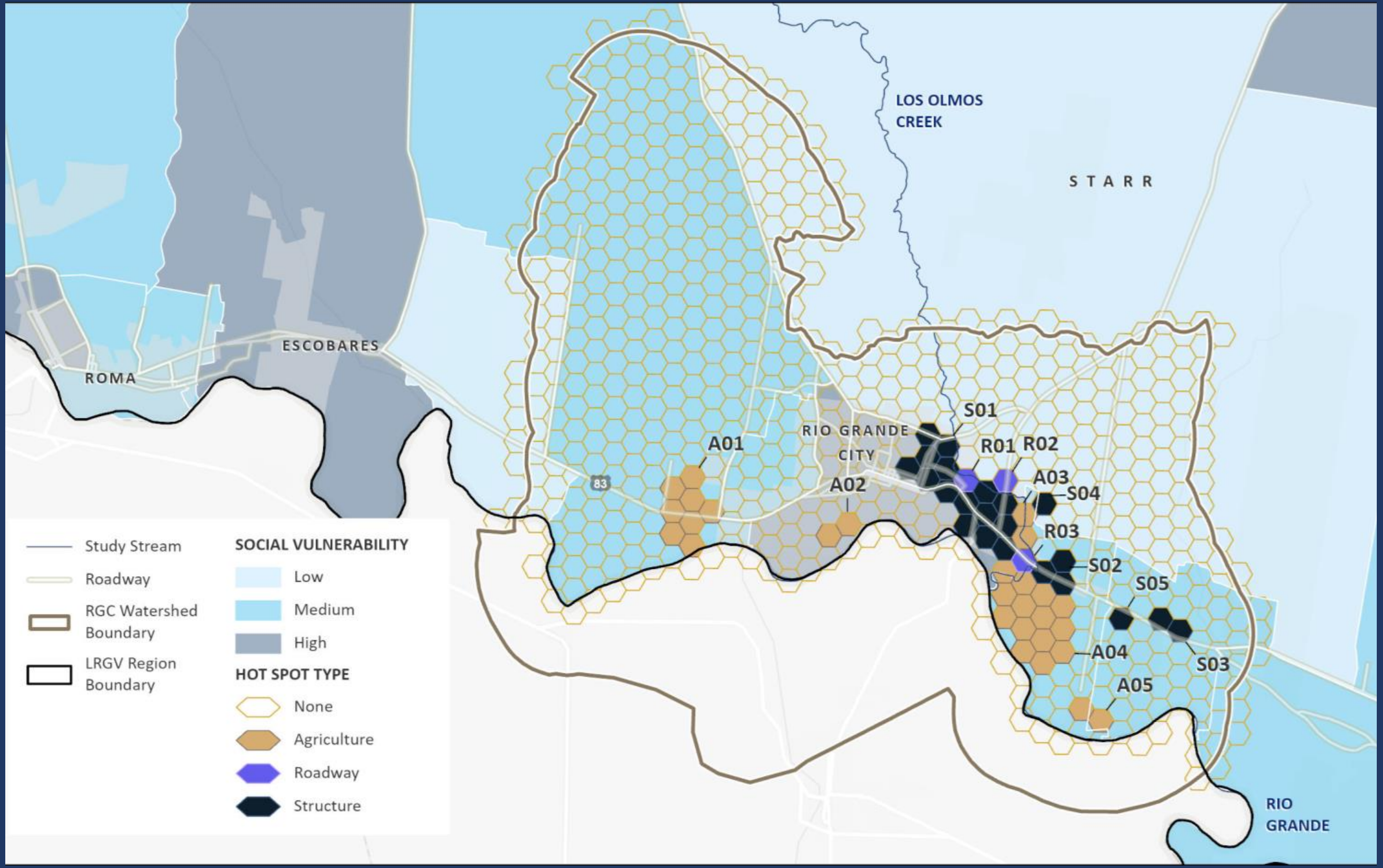
Lower Rio Grande Valley

- 1D hydrology is not suitable for majority of the LRGV due to flat topography dominated by artificial drainage and 2D flows.
- Calibration impacted by cumulative impact of minor storm sewer drainage systems and roadways.
- Infiltration and terrain modifications were important to achieving results aligned with historic events.
- Automation of spatially variable stage boundary condition improved efficiency of model simulations for AEP storms.
- Elliptical storms were not used due to the adoption of a full 2D modeling approach. Areal reduction instead relied on the results from the Texas Storms Study.

Hot Spot Analysis

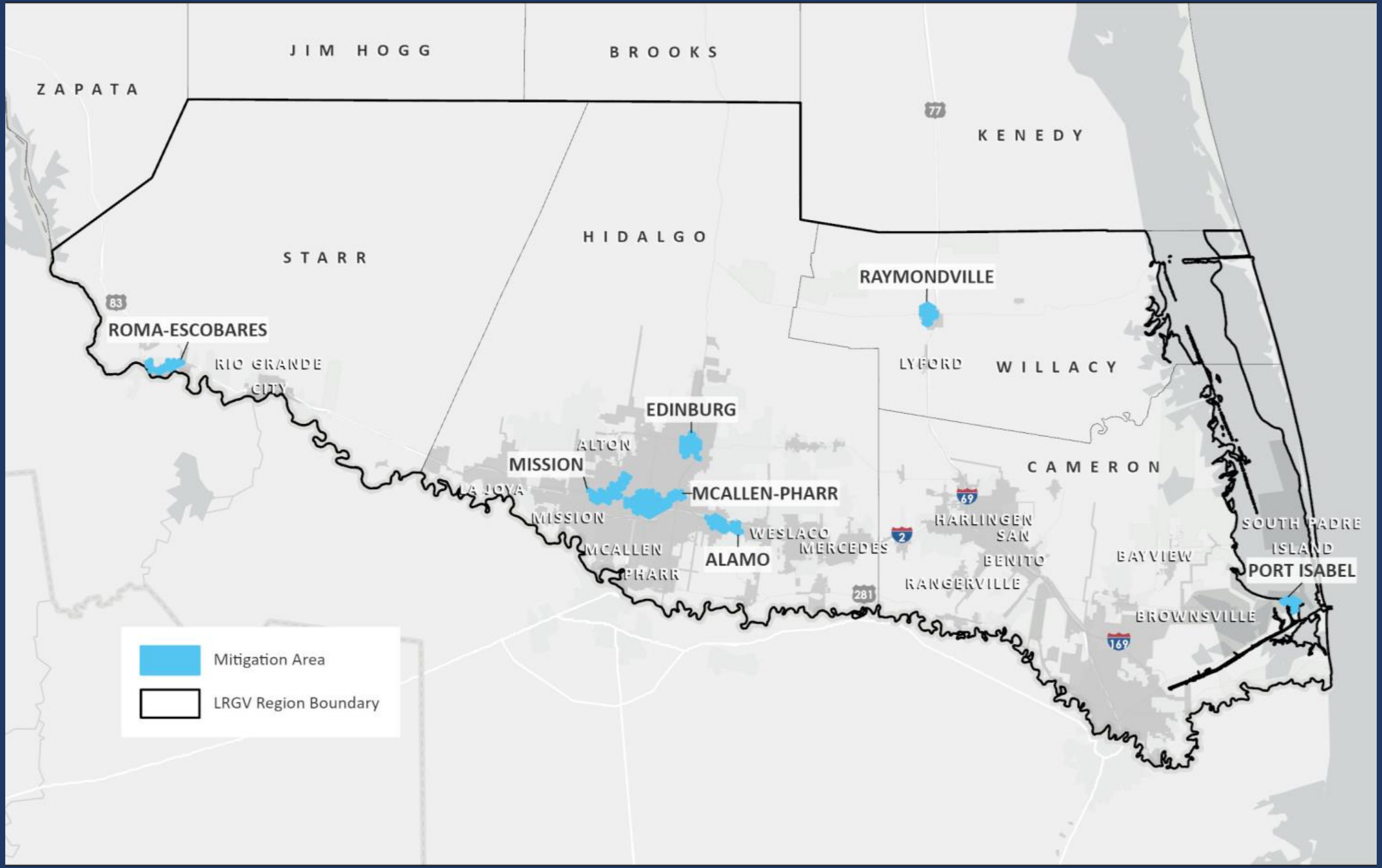
Key Findings

- Depth and WSE data from 4 baseline models
- Structures
  - Ponding > 0.1 foot
  - Building data from TWDB
  - FFE based on NSI data
- Roadways
  - Ponding > 0.5 feet
- Agricultural land
  - 1% AEP depth > 1 foot
- 2000-ft hexagonal grid
- Seven mitigation areas selected



Mitigation Areas

Lower Rio Grande Valley Phase 4



- Requesting survey data for major structures within mitigation areas to improve model accuracy
- Considering truncating original models to reduce run times
- Identifying mitigation projects to reduce flood risk
- Providing a recommended solution per mitigation area
- Funding assistance to follow

Decision milestones

Phase 4 Alternatives Analysis

Analysis Framework

Step 1

Identify Problems and Opportunities

1. Define Risk and Need
2. Conceptualize Mitigation Ideas ✓

Step 2

Collect Data and Define Mitigation Targets

1. Site Specific Data Collection for Alternatives Analysis
2. Performance Targets
3. Future Conditions and Resilience

Step 3

Formulate Alternatives

1. Screen Mitigation Concepts ✓
2. Generate Alternatives
3. Develop Modeling Plan

Step 4

Analyze Alternatives

1. Without-Project Model
2. With-Project Model
3. Develop Preliminary Comparison

Step 5 ✓

Compare Alternatives

1. Evaluate Alternatives ✓
2. Preliminary Rank/Prioritize Alternatives

Step 6

Recommend an Alternative

1. Select Recommended Alternative ✓
2. Refine Recommended Alternative

Phases and Timeline

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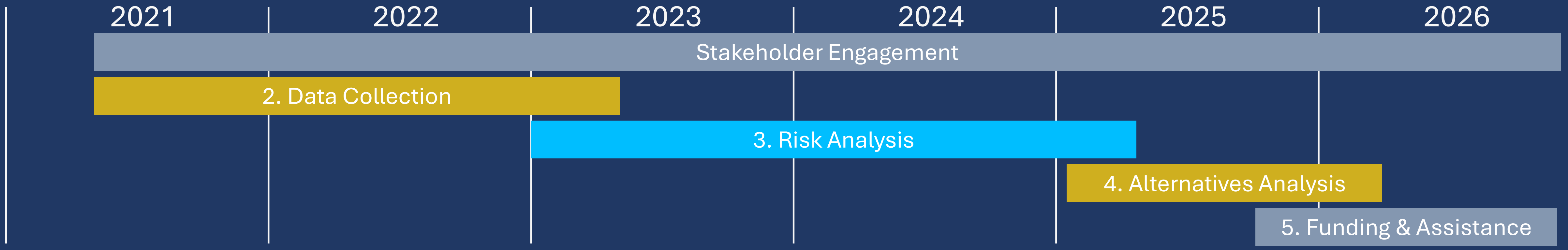

DMQT

- To be added per example once models are posted

Questions?