



# NORTH AND CENTRAL WATERSHEDS

LRGVDC - WATERSHED PROTECTION PLAN ANNUAL MEETING 2022

JUNE 30, 2022

LINDA NAVARRO, M.S.



## **TCEQ Clean Water Act 319 Project Funding**

- **Watershed Characterization for the North and Central Watersheds**

## **UTRGV Thesis Project**

- **Watershed Characterization Publication**

## **TWDB Projects**

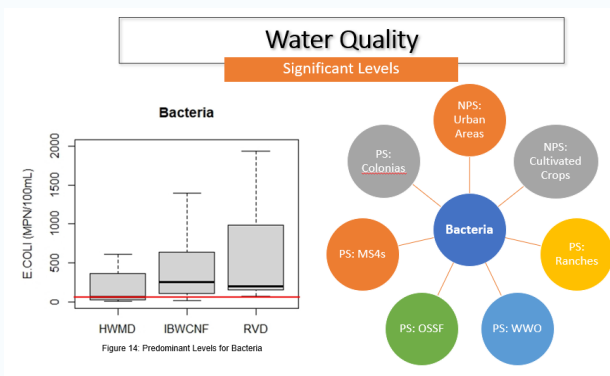
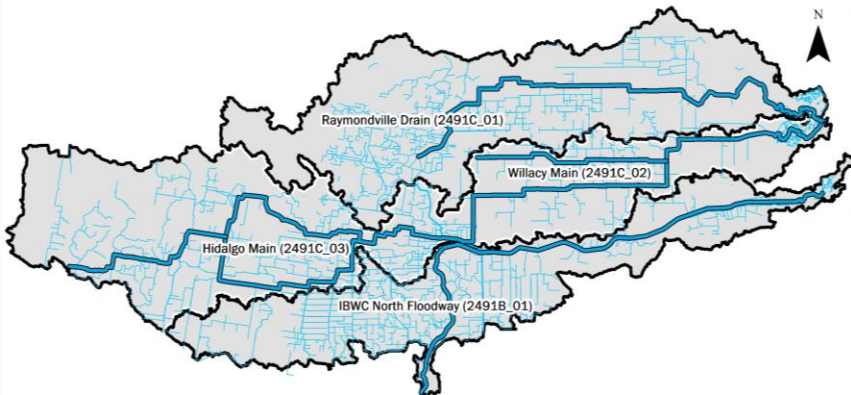
- **Texas Water Development Board Fresh Water Flows (TWDB FWF)**
- **Texas Water Development Board Flood Infrastructure Fund TWDB FIF**

## **Future Work**

- **TCEQ Clean Water Act 319 Phase II**
  - **September 2022**
- **Final Watershed Characterization Report to be submitted**

# NORTH AND CENTRAL WATERSHEDS CHARACTERIZATION

**UTRGV Thesis Project**  
**Development of a Cyberinfrastructure for Assessment of the Lower Rio Grande Valley North and Central Watersheds Characteristics**



Delineation of Watersheds/Subwatersheds



Map Development



Cyberinfrastructure and Database




Flow and Water Quality Graphs



USGS NHD Markup Application

Article

## Development of a Cyberinfrastructure for Assessment of the Lower Rio Grande Valley North and Central Watersheds Characteristics

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**Abstract:** Lower Laguna Madre (LLM) is designated as an impaired waterway for high concentrations of bacteria and low dissolved oxygen. The main freshwater sources to the LLM flow from the North and Central waterways which are composed of three main waterways: Hidalgo/Willacy Main Drain (HWMD), Raymondville Drain (RVD), and International Boundary & Water Commission North Floodway (IBWCNF) that are not fully characterized. The objective of this study is to perform a watershed characterization to determine the potential pollution sources of each watershed. The watershed characterization was achieved by developing a cyberinfrastructure, and it collects a wide inventory of data to identify which one of the three waterways has a major contribution to the LLM. Cyberinfrastructure development using the Geographic Information System (GIS) database helped to comprehend the major characteristics of each area contributing to the watershed supported by the analysis of the data collected. The watershed characterization process started with delineating the boundaries of each watershed. Then, geospatial and non-geospatial data were added to the cyberinfrastructure from numerous sources including point and nonpoint sources of pollution. Results showed that HWMD and IBWCNF watersheds were found to have a higher contribution to the water impairments to the LLM. HWMD and IBWCNF comprise the potential major sources of water quality impairments such as cultivated crops, urbanized areas, on-site sewage facilities, colonias, and wastewater effluents.

**Keywords:** watershed management; nonpoint source pollution; point source pollution; water quality; pollutant loadings; South Texas



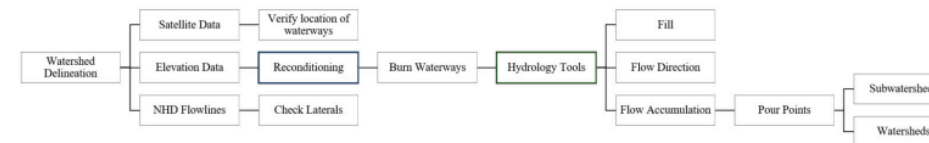
**Citation:** Navarro, L.; Mahmoud, A.; Ernest, A.; Oubeidillah, A.; Johnstone, J.; Chavez, I.R.S.; Fuller, C. Development of a Cyberinfrastructure for Assessment of the Lower Rio Grande Valley North and Central Watersheds Characteristics. *Sustainability* **2021**, *13*, 11186. <https://doi.org/10.3390/su132011186>

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into the DEM is an attempt to force alignment between topographically derived flowlines and independently mapped hydrography [35].



**Figure 2.** Watershed delineation methodology.

Once processing the LIDAR elevation data, the hydrology tools were used to develop elevation raster files such as fill, flow direction, and flow accumulation. Only three pour points were added manually to each corresponding waterway and then automated subwatersheds were developed. With the subwatersheds delineated, the overall watershed boundaries for the three watersheds were determined based on the flow accumulation lines. The flow accumulation lines correspond to the flow path for each watershed based on elevation data. The flow accumulation lines embody the actual waterways in mostly all the watersheds. The watershed boundaries correspond to the flowlines and follow an enhanced methodology for the type of terrain in the region.

### 3.3. Data Collection

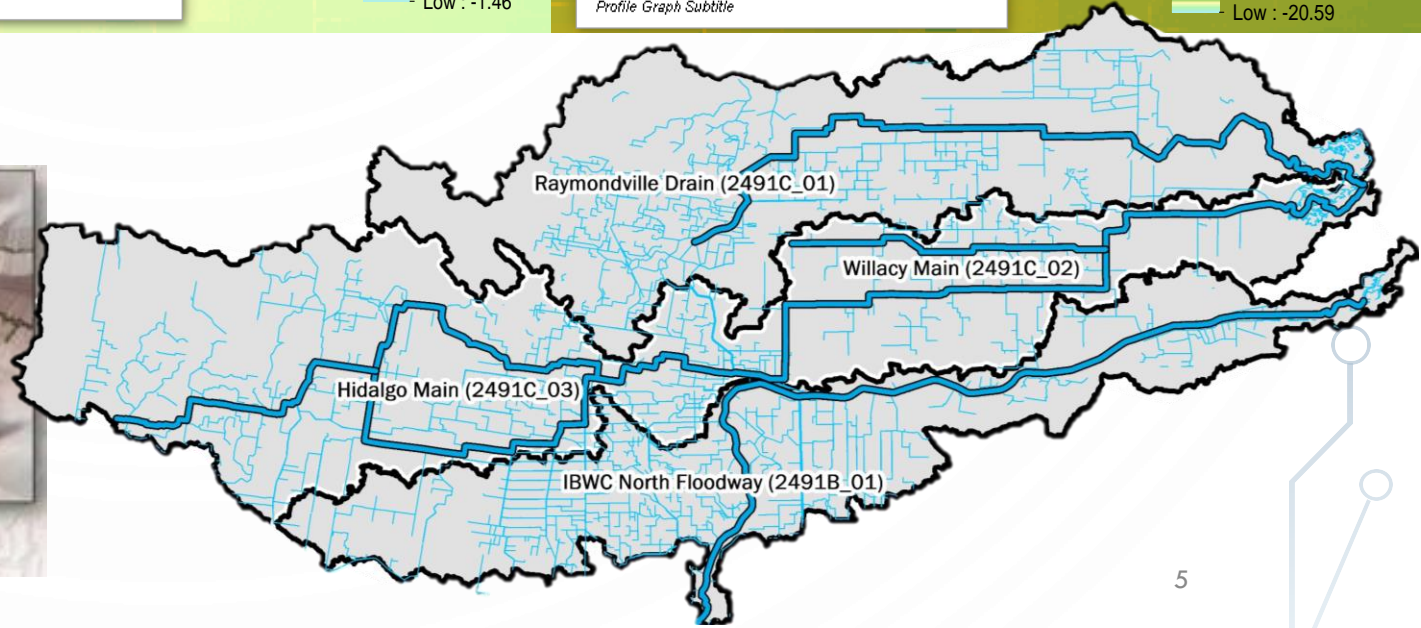
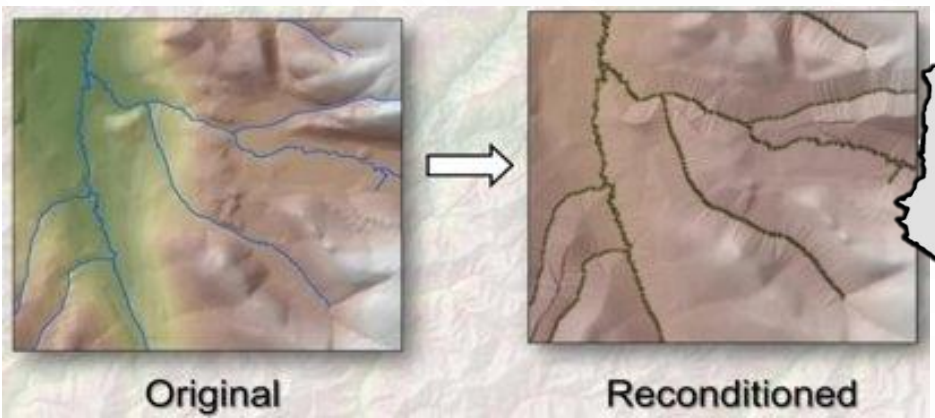
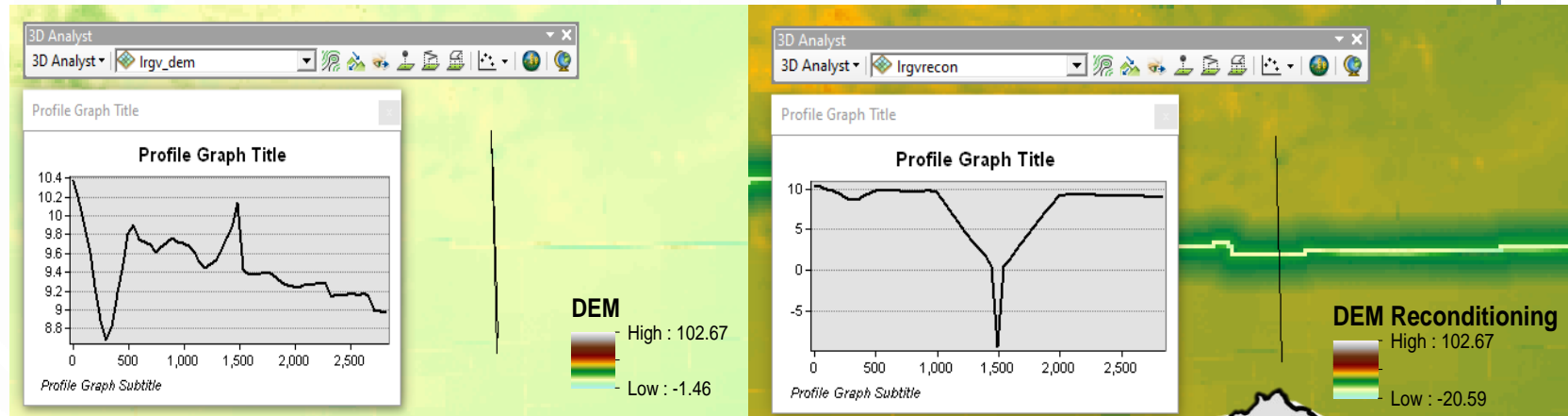
The study was developed based on the guidelines of the United States Environmental Protection Agency (USEPA) Handbook for Developing Watershed Plans to Restore Our Waters [36]. A summary of the data used in the study can be found in Table 1. NPS pollutant loads through sediment and runoff courses are highly related not only to land use/cover characteristics but also to topography [37–39]. This study integrates land cover data from the 2016 National Land Cover Database (NLCD) [40] with a spatial resolution of 30 m to determine relative contributions of NPS pollution in the north and central watersheds. The land cover type data identified as NPS pollution encompass urban and agricultural areas only. Each watershed was treated individually to characterize the type of land cover in the area. The NPS pollutants identified within the watersheds were cultivated crops areas and urbanized areas and South Texas large ranches (STLR), species, wildlife management areas (WMA), Onsite Sewage Facility (OSSF), and colonias.

**Table 1.** Data sources used for characterization the IBWCNF, HWMD and RVD.

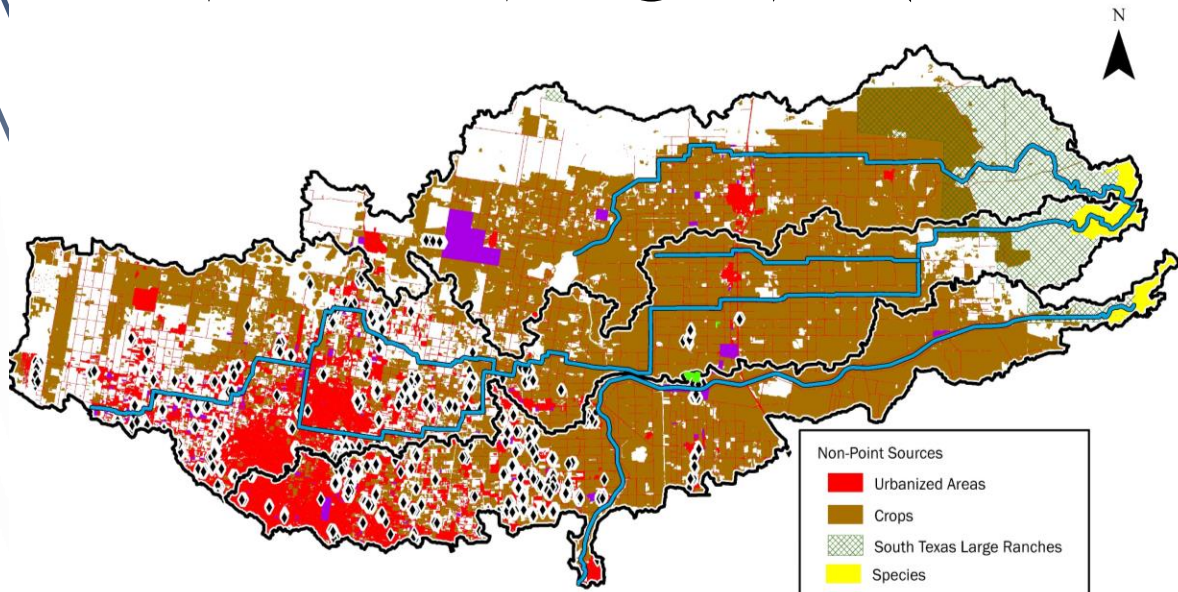
| Data                | Source       | Year      | Usage                                 |
|---------------------|--------------|-----------|---------------------------------------|
| LIDAR Data          | USGS, TNIRIS | 2018      | Watershed Delineation                 |
| Hydrograph (NHD)    | USGS         | 2012–2019 | Watershed Delineation                 |
| Land Cover          | NLCD         | 2016      | NPS                                   |
| STLR                | TCEQ         | 2018      | NPS                                   |
| TLAP                | TCEQ         | N/A       | PS                                    |
| WWO                 | TCEQ         | N/A       | PS                                    |
| MSW                 | TCEQ         | N/A       | PS                                    |
| OSSF                | Colonias     | 2021      | NPS                                   |
| MS4s                | TCEQ         | N/A       | PS                                    |
| Colonias            | TCEQ         | 2015      | NPS; OSSF points                      |
| Desalination Plants | TWDB         | 2021      | PS                                    |
| Address Points      | TNRIS        | 2018      | OSSF points                           |
| IBWC Gage Stations  | IBWC         | 2012–2020 | Flow data (IBWCNF)                    |
| SWQM Station        | TCEQ         | 2011–2019 | Flow and water quality (IBWCNF)       |
| SWQM Stations       | TCEQ         | 2017–2019 | Flow and Water quality (HWMD and RVD) |

# DELINEATION OF WATERSHEDS

- Reconditioning
  - LIDAR Elevation 2018
  - 60 m resolution
- ArcGIS Hydrology Tools

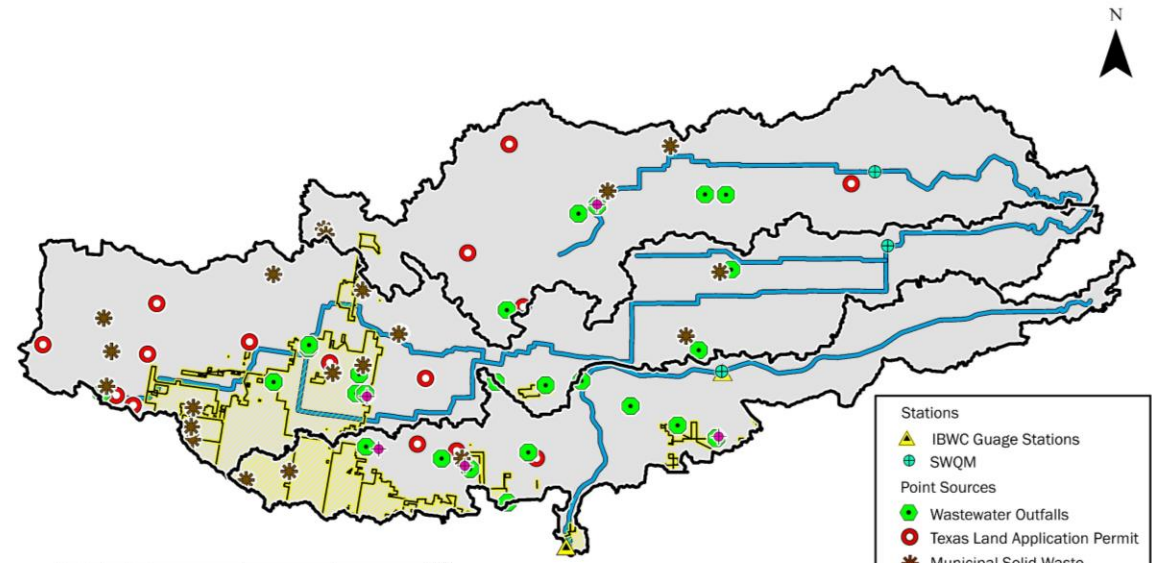


# MAP DEVELOPMENT



**Non-Point Sources**

- Urbanized Areas
- Crops
- South Texas Large Ranches
- Species
- Wildlife Management Areas
- Onsite Sewage Facilities
- Colonias

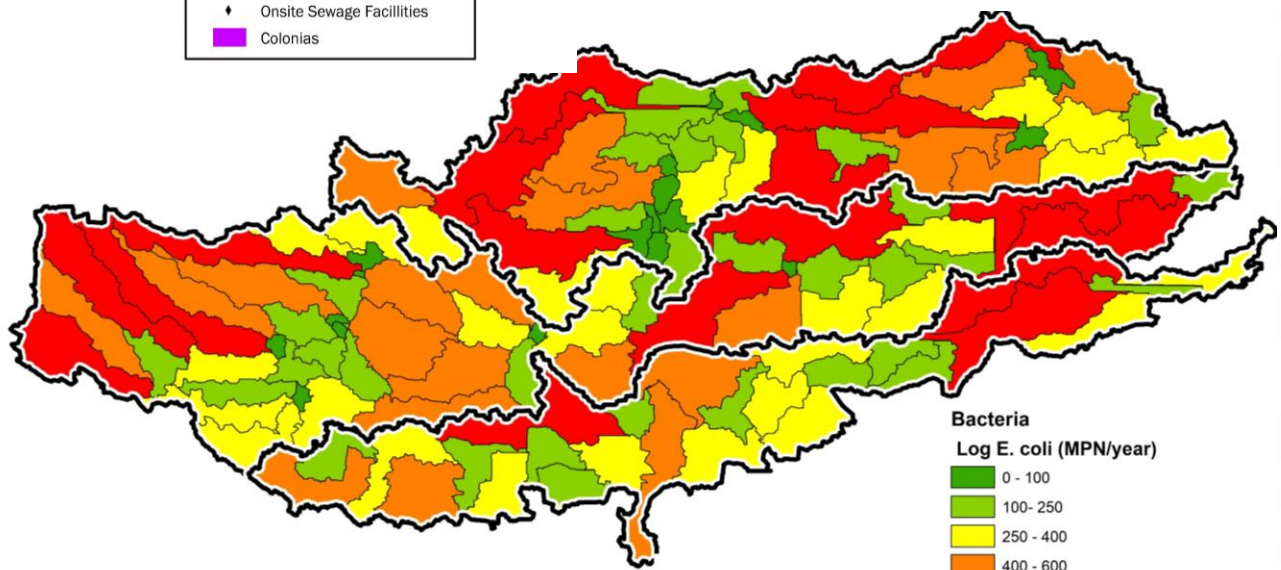


**Stations**

- IBWC Gauge Stations
- SWQM

**Point Sources**

- Wastewater Outfalls
- Texas Land Application Permit
- Municipal Solid Waste
- MS4 Permit
- Desalination Plants

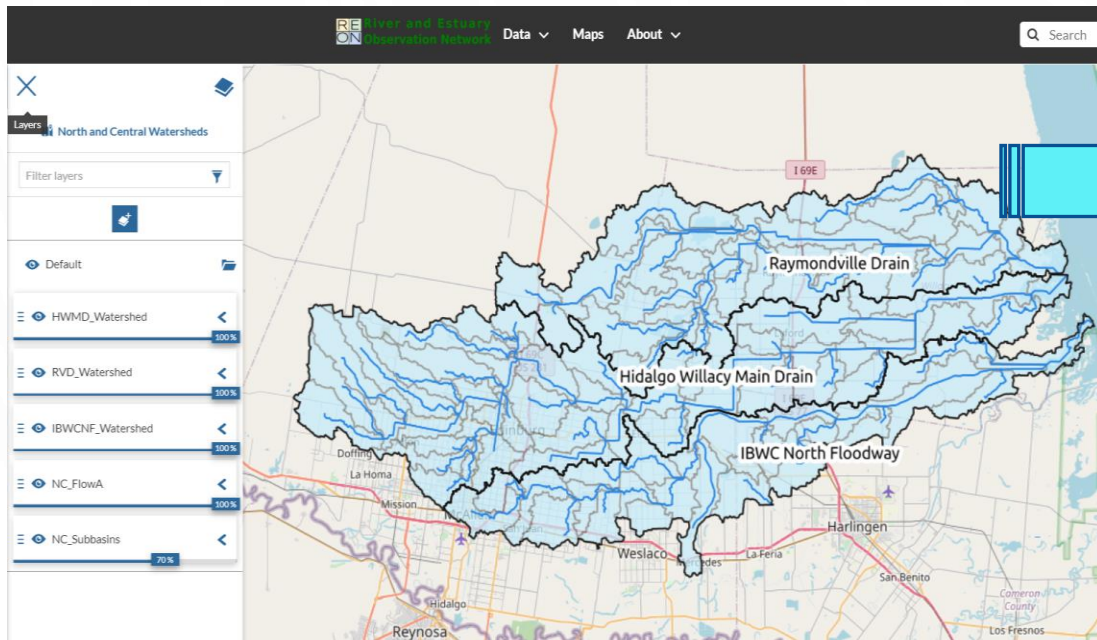


**Bacteria**

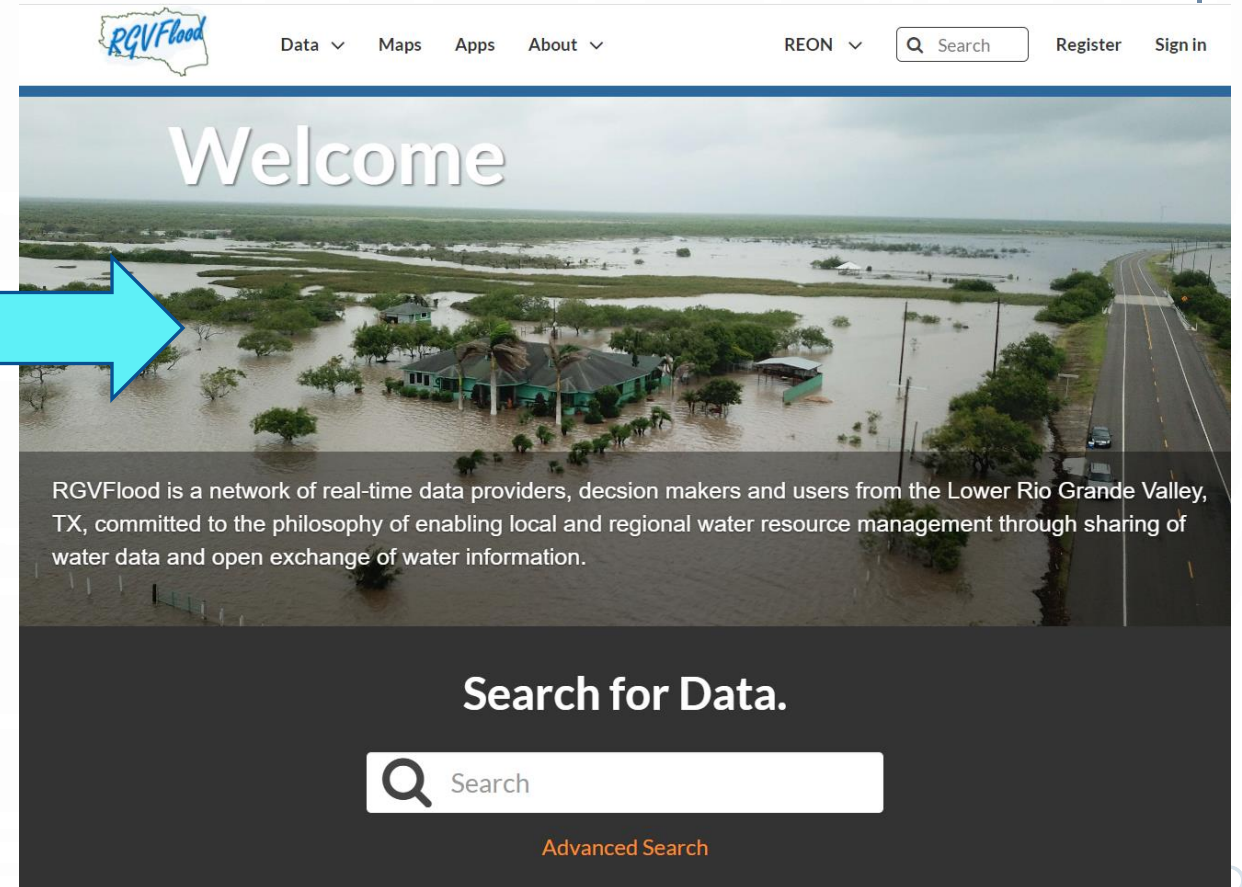
**Log E. coli (MPN/year)**

- 0 - 100
- 100 - 250
- 250 - 400
- 400 - 600
- 600 - 950

# CYBERINFRASTRUCTURE



REON.CC



[RGVFlood Website](#)

# WATER QUALITY AND FLOW DATA

## Hidalgo Willacy Main Drain

- Clean Rivers Program
- 8 Samples
- 2017-2019

## Raymondville Drain

- Clean Rivers Program
- 8 Samples
- 2017-2019

## IBWC North Floodway

- SWQMs
- 29 Samples
- 2011-2019





### Water Quality

Significant Levels

#### Bacteria

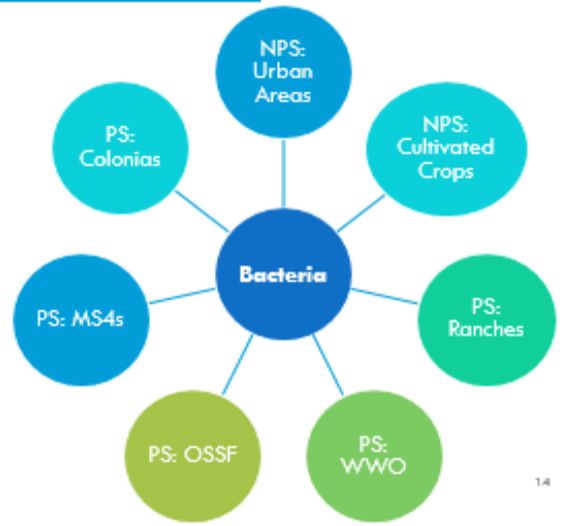
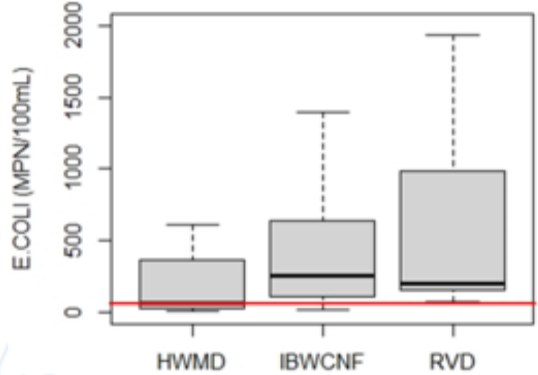


Figure 14: Predominant Levels for Bacteria

14

### Water Quality

Significant Levels

#### Total Nitrogen

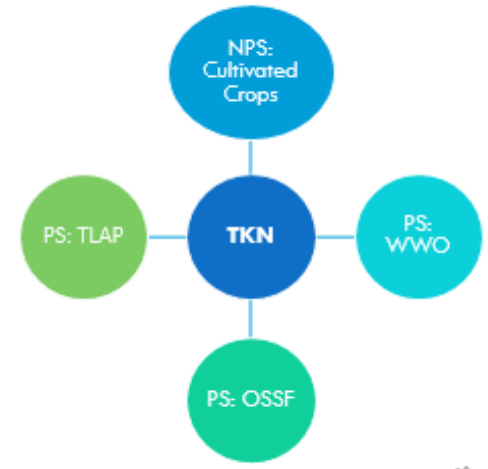
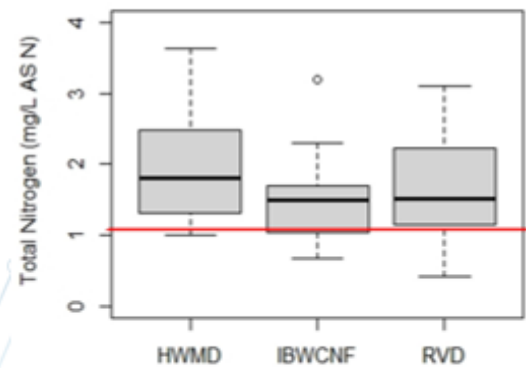


Figure 16: Predominant Levels for Total Nitrogen

13

### Water Quality

Significant Levels

#### Nitrate + Nitrite

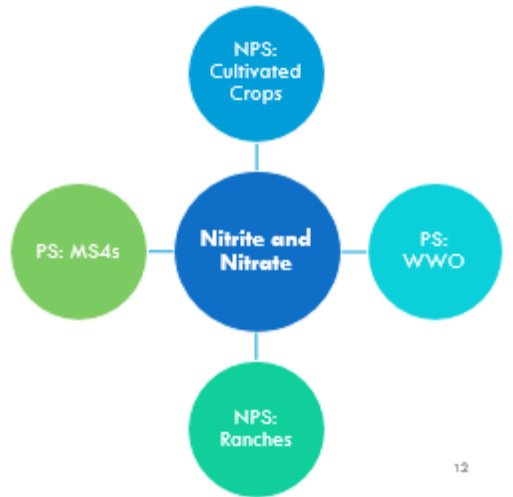
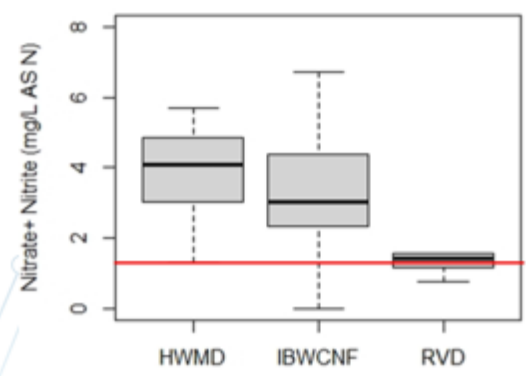


Figure 18: Predominant Levels for Nitrate and Nitrite

12

### Water Quality

Significant Levels

#### Chlorophyll-a

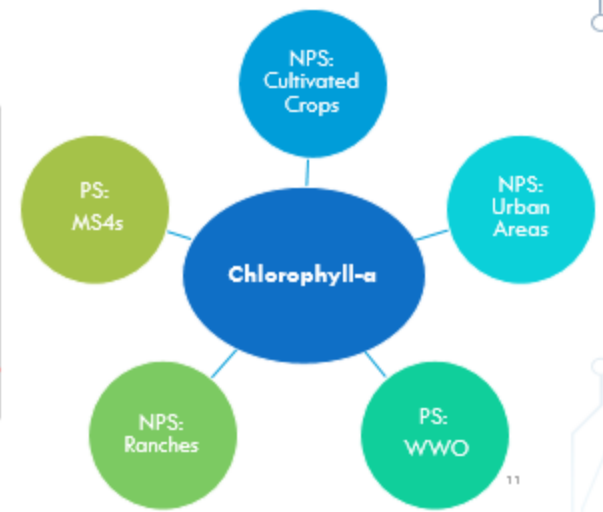
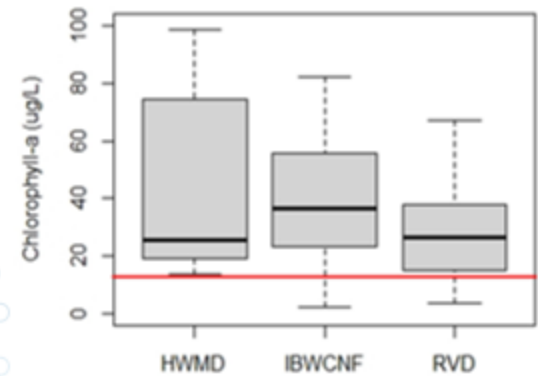


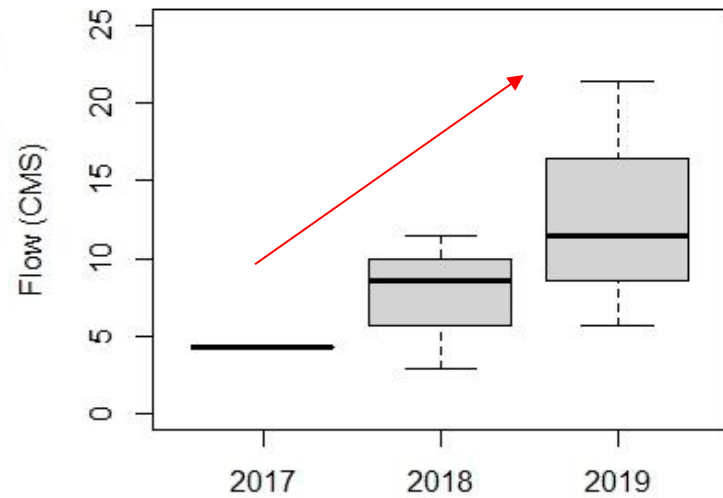
Figure 19: Predominant Levels for Chlorophyll-a

11

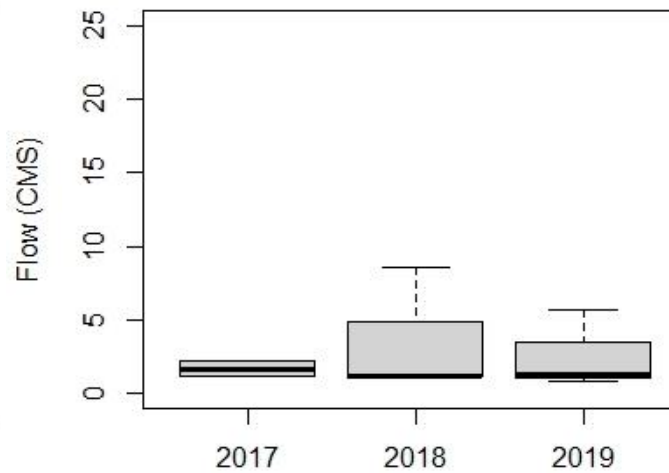
# FLOW DATA

|        | HWMD | RVD | IBWCNF  |
|--------|------|-----|---------|
| Median | 7.1  | 1.2 | 1.8     |
| Mean   | 8.8  | 2.7 | 6.3     |
| Min    | 2.9  | 0.9 | 0       |
| Max    | 21.4 | 8.6 | 8,412.6 |

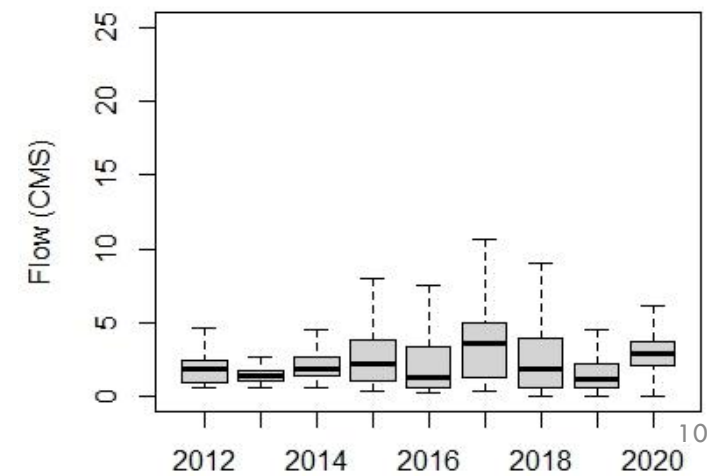
**HWMD**



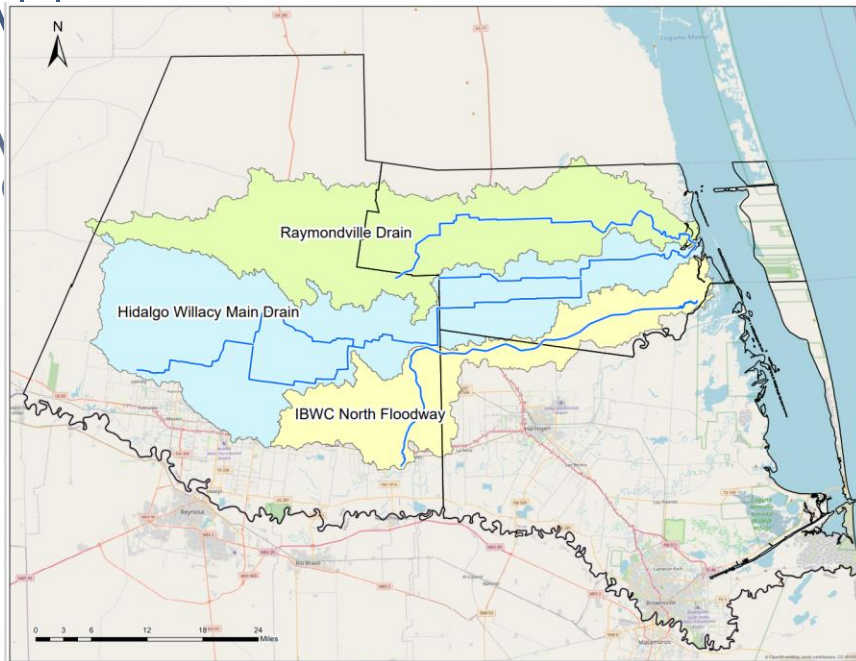
**RVD**



**IBWCNF Near Sebastian**



# USGS NHD MARKUP



The screenshot shows the USGS Markup App interface. At the top left is the USGS logo with the tagline 'science for a changing world'. The interface includes a 'Markup App' sidebar with various tool icons. The main content area is divided into several sections:

- Workflow Selection:** A dropdown menu set to 'Target Existing'.
- Select feature source:** A dropdown menu set to 'WBD - HUC 10'.
- Feature Selection:** A section for selecting specific features.
- Features Found:** A list of features with checkboxes and unique identifiers:
  - {CEE23068-028C-4B32-BFB3-BA771DCC4B40}
  - {1D599DB2-BA7E-439D-AB73-4D567738495B}
  - {2D20F44A-E9C8-43B0-85AF-9AB72001CA65}
  - {3798D8C6-136F-5150-F054-...}
- Issue type action:** A dropdown menu set to 'Update Existing Feature'.
- Buttons:** 'Select' (green) and 'Re-Identify' (orange) buttons.
- Map:** A map of Texas showing watershed boundaries in blue and green. Labels include 'TEXAS', 'La Sal Vieja', 'Monte Alto Reservoir Number 2', 'Raymondville', 'Lyford', 'Doolittle', 'Sanbur', 'San Carlos', 'Elsa', 'Munillo', 'Mila Doce', 'Santa Rosa', 'Combes', 'Primera', 'Harlingen', 'San Benito', 'Laureles', 'Llano Grande', 'Mercedes', 'La Feria', 'South Alamo', 'Midway North', 'North Alamo', 'San Juan', 'Phan', 'McAllen', 'Mission', 'Palmer', 'La Hon', 'Alto', 'La Vega', 'Valley International Airport', 'Cago Atascos', 'Laguna Atascosa', and 'Lagu Ma'.
- Feature Details:** A panel at the bottom right showing details for 'Feature 1':
  - OBJECTID: 11348
  - SHAPE: Polygon
  - TNMID: {7890047D-D66F-44C9-986A-4AB3FB2AF130}
  - MetaSourceID: {EADAEAF5E-1D6D-45E0-9835-A54326F647A9}
  - SourceDataDesc: Null
  - SourceIdentifier: Null

At the bottom of the interface is a 'Cancel' button and a footer with various links: DOI Privacy Policy | Legal | Accessibility | Site Map | Contact USGS | U.S. Department of the Interior | DOI Inspector General | White House | E.gov | Open Government | No Fear Act | FOIA | Version 2.1.0.0 Last Modified.

- Completed by UTRGV Graduate Student
- Markup App
- Recommend delineated watersheds for Watershed Boundary Datasets HUC 10

# FWF PROJECT MONITORING EFFORTS

- RTHS-Stage Heights: REON websites
- Two Quarterly Monitoring Campaigns
  - 2021-2022
  - Water quality samples
  - Flow measurements
- Future: Developing Rating Curves for Design



TWDB 1

- Raymondville Drain



TWDB 2

- Hidalgo Willacy Main Drain



TWDB 3

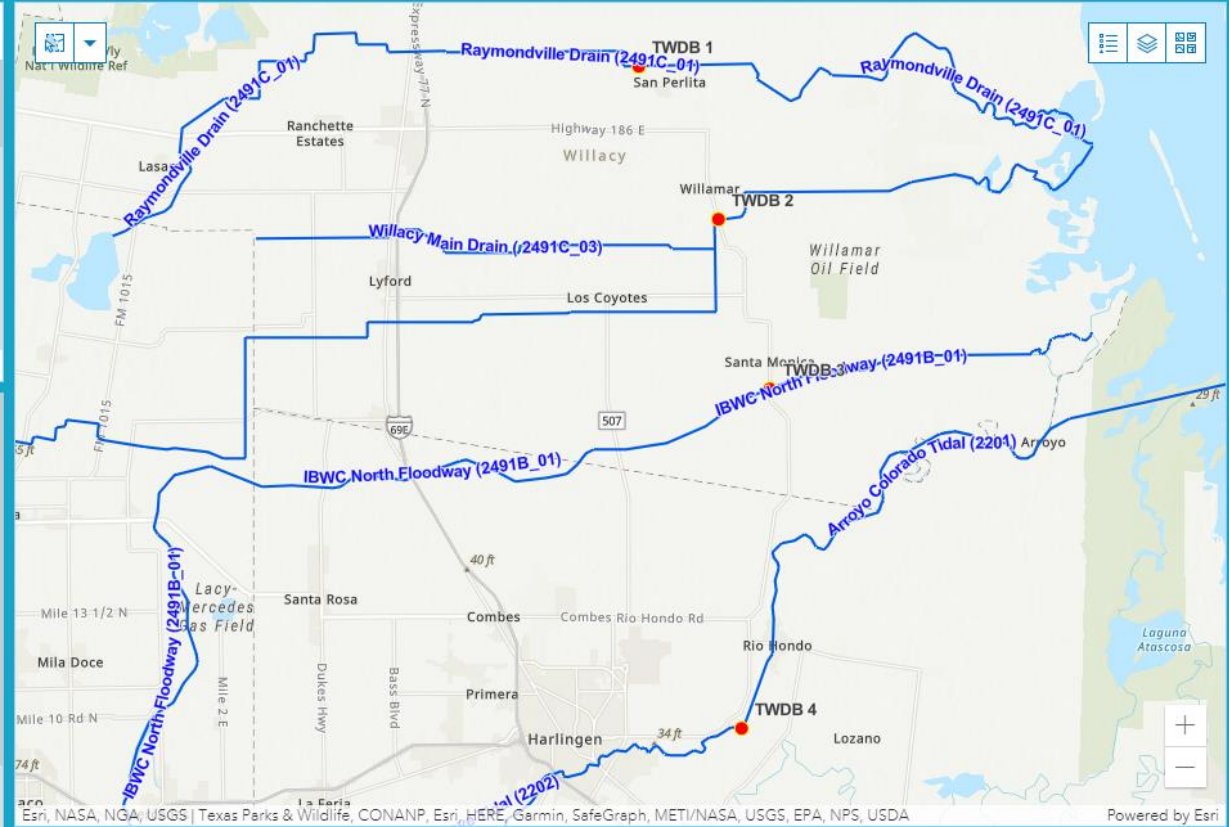
- IBWC North Floodway

## TWDB Freshwater Flows 2nd Quarter Monitoring Campaign

Select RTHS Station  
TWDB 1

### Field Data

|  |   |
|--|---|
| Attendees for Field Work Activities            | Christopher_Fuller,Mitch_Scoggins,Linda_Navarro,Ivan_Santos |
| Additional Attendees for Field Work Activities |   |
| Date Field Work                                |   |
| Purpose of Field Work                          | FWF Monitoring Campaign                                     |
| Stations ID                                    | TWDB 1  |
| Station ID                                     |   |
| Time of the Records                            | 11:22 am  |



| Stations ID | RTHS Stage Height | Staff Gage Reading | Temperature | pH   | SC (uS/cm) | DO (mg/L) |
|-------------|-------------------|--------------------|-------------|------|------------|-----------|
| TWDB 1      | 0.925'            | 0.925' +/- 0.005'  | 25.408      | 8.00 | 5463.7     | 7.09      |

# WATER QUALITY AND FLOW DATA

| Station ID | Waterway                   | Date       | Total Coliform | E. coli      | TKN [mg/L] | Total, NO2+NO3 [mg/L] | Total P [mg/L] | Flow [CMS] |
|------------|----------------------------|------------|----------------|--------------|------------|-----------------------|----------------|------------|
| TWDB 1     | Raymondville Drain         | 12/01/2021 | >2419.16       | 3.1          | 1.51       | <b>2.89</b>           | 0.212          | 2.462      |
|            |                            | 04/12/2022 | >2419.6        | <b>727</b>   | <0.05      | <b>1.78</b>           | 0.468          | 1.532      |
| TWDB 2     | Hidalgo Willacy Main Drain | 12/01/2021 | >2419.16       | <b>579.4</b> | 1.66       | <b>6.23</b>           | 0.393          | 4.229      |
|            |                            | 04/12/2022 | >2419.60       | <b>727</b>   | 1.5        | <b>3.87</b>           | 0.512          | 3.483      |
| TWDB 3     | IBWC North Floodway        | 12/08/21   | >2419.16       | <b>159.7</b> | 0.657      | <b>8.39</b>           | 0.234          | 5.02       |
|            |                            | 4/12/2022  | >2419.60       | <b>150</b>   | 1.28       | <b>4.61</b>           | 0.464          | 1.859      |

# NORTH AND CENTRAL WATERSHED CHARACTERIZATION PHASE II

- Extend Phase I Lower Rio Grande Valley-North and Central Watershed Characterization (UTRGV)
- Provide combination of continuous and event-based monitoring (modeled after LLM-BSC WPP)
- RTHS- stream monitoring
- 3 monitoring stations commissioned by TWDB-FWF
  - Raymondville Drain
  - Hidalgo-Willacy Main Drain
  - USIBWC North Floodway
- Monitoring Campaigns
  - Quarterly- water quality and hydrodynamic measurements
- DO, Water Temp, Conductivity, pH, Nitrate/Nitrite, Total Phosphorus, TKN, and *E. coli*
- ADCP discharge transects, flow measurements to develop discharge rating curves as a function of stage height

Project Lead

- RATES

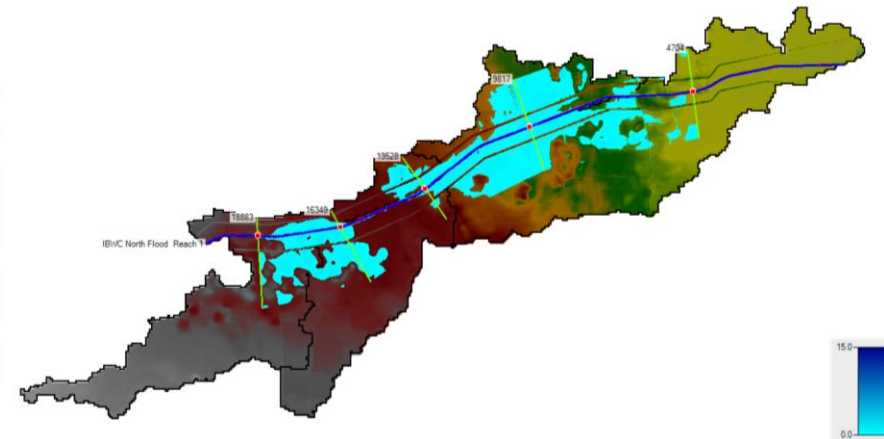
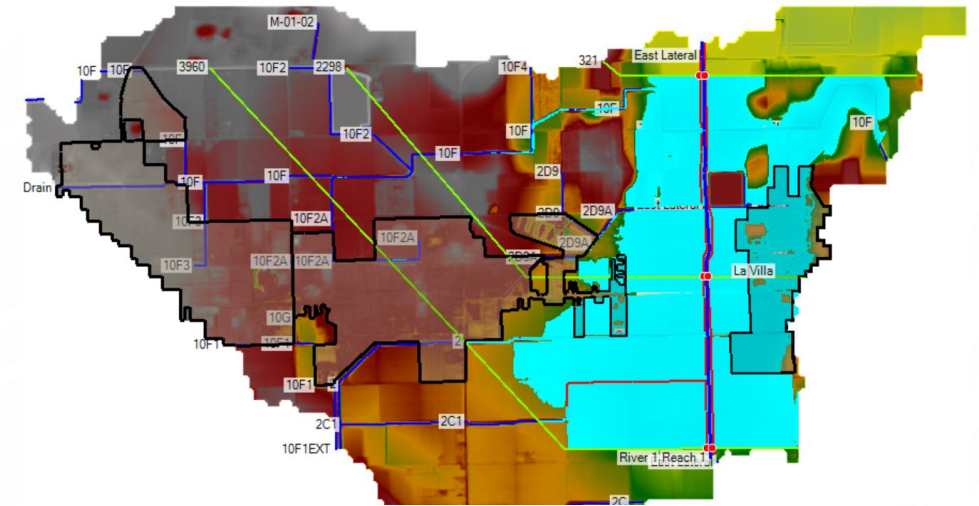
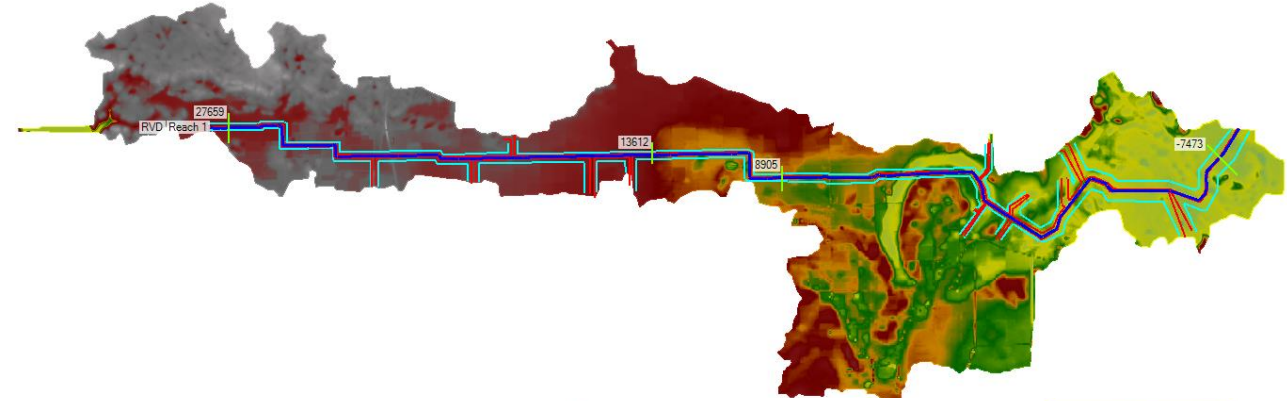
Budget:

- Total: \$225,000
- Federal: \$135,000
- Match: \$90,000
  - Lower Rio Grande Valley-TPDES Stormwater Tasks Force
  - Cameron County Texas



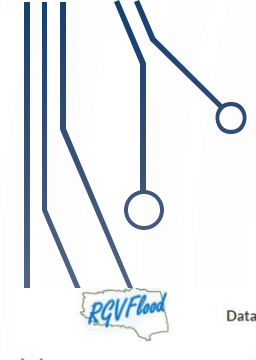
# FIF PROJECT MODELLING EFFORTS

- Hydrologic and Hydraulic
  - Ultimate Operational Hydrologic Model
    - WRF-Hydro Model
  - Preliminary Model for HEC-RAS Development
    - HEC-HMS
  - Hydraulic Model HEC-RAS
- Hydrologic Model
  - Precipitation Data: NOAA Frequency Storm Events
    - 10- year
    - 50- year
  - Land Cover Data from Texas Natural Resources Information System (TN
- Hydraulic Model HEC-RAS
  - LiDAR elevation data from 2018- (TNRIS)
  - Roughness Coefficient





# RAYMONDVILLE DRAIN



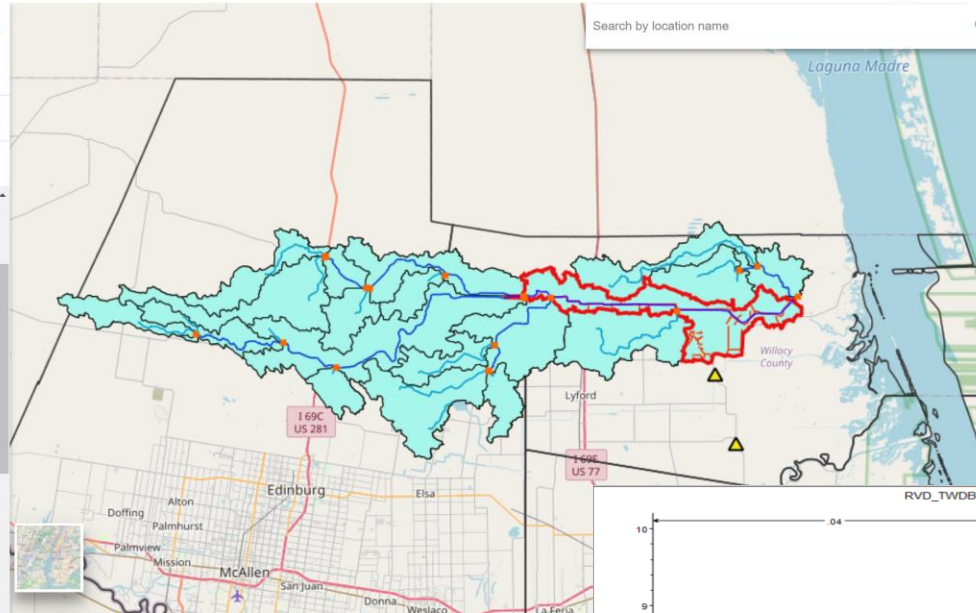
Raymondville Drain Modelling

Filter layers

- CHO5\_RVD 100%
- CHO4\_RVD
- azure line 100%
- CHO3\_RVD
- cyan line 100%
- TWDB1\_SHED
- Red 100%
- NHD\_TWDB1\_2
- red line 100%

Data Maps Apps About

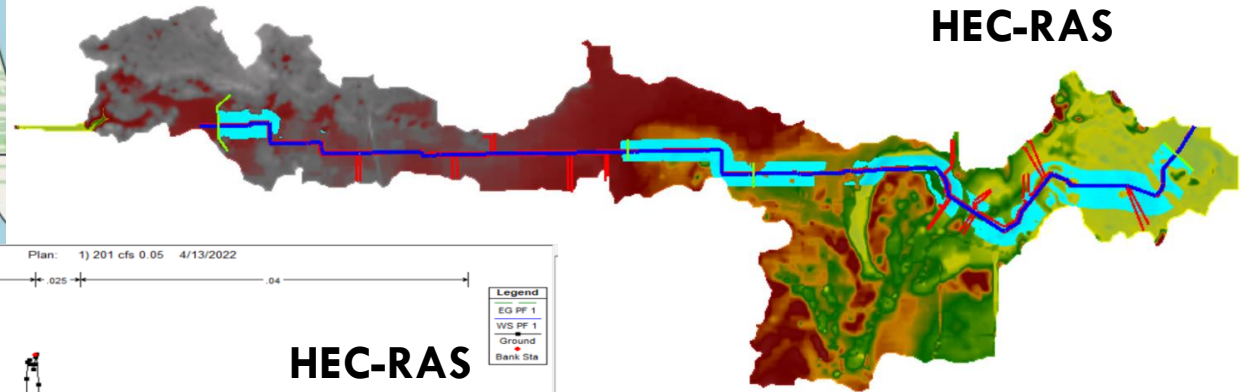
Search Linda N



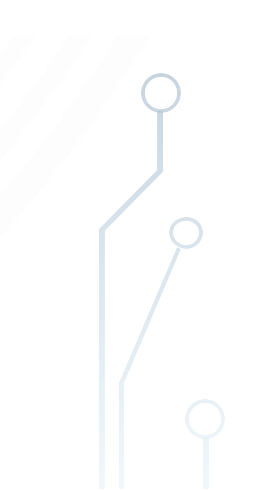
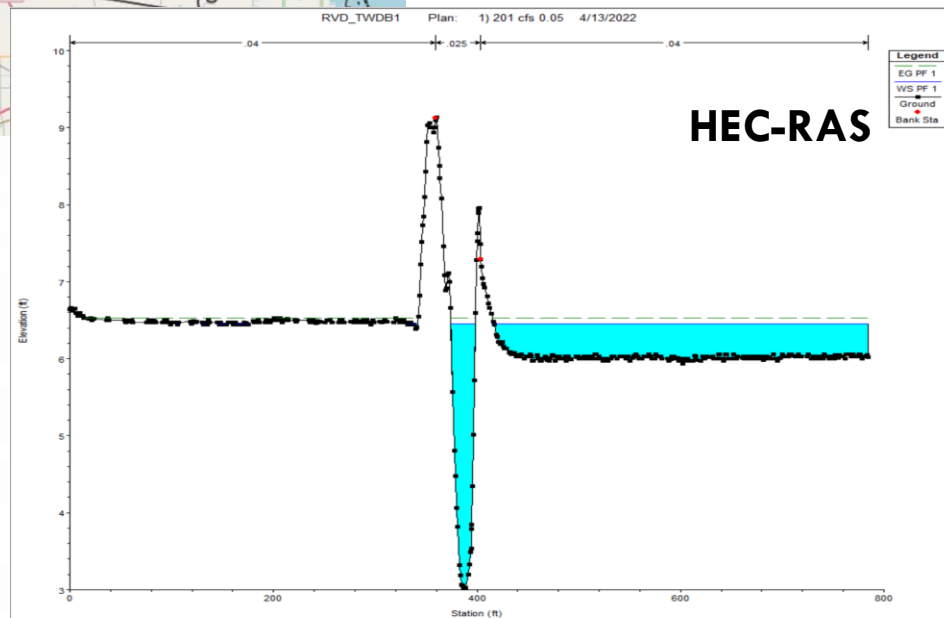
**HEC-HMS**



**HEC-RAS**

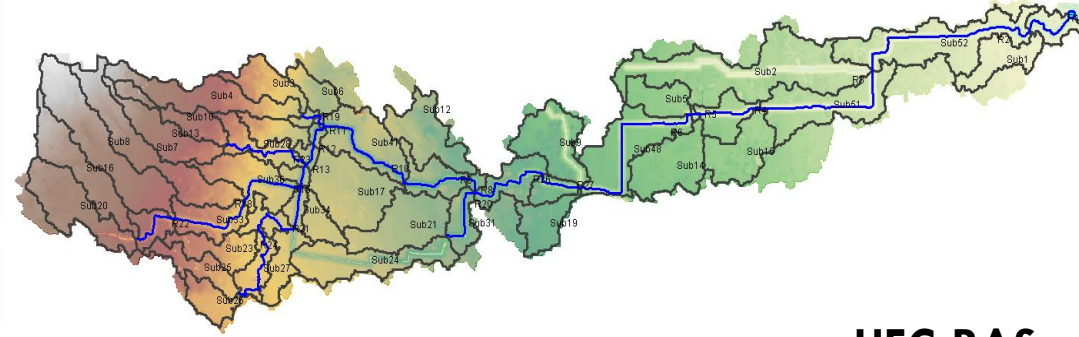
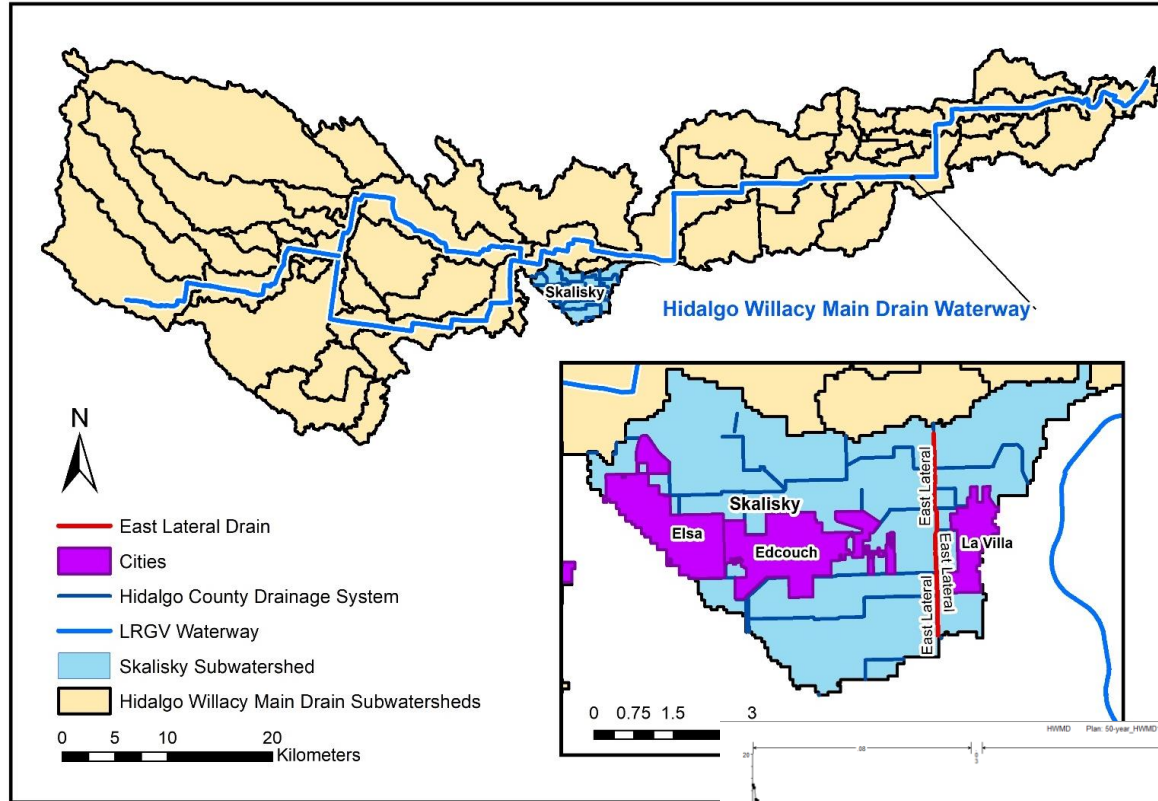


**HEC-RAS**

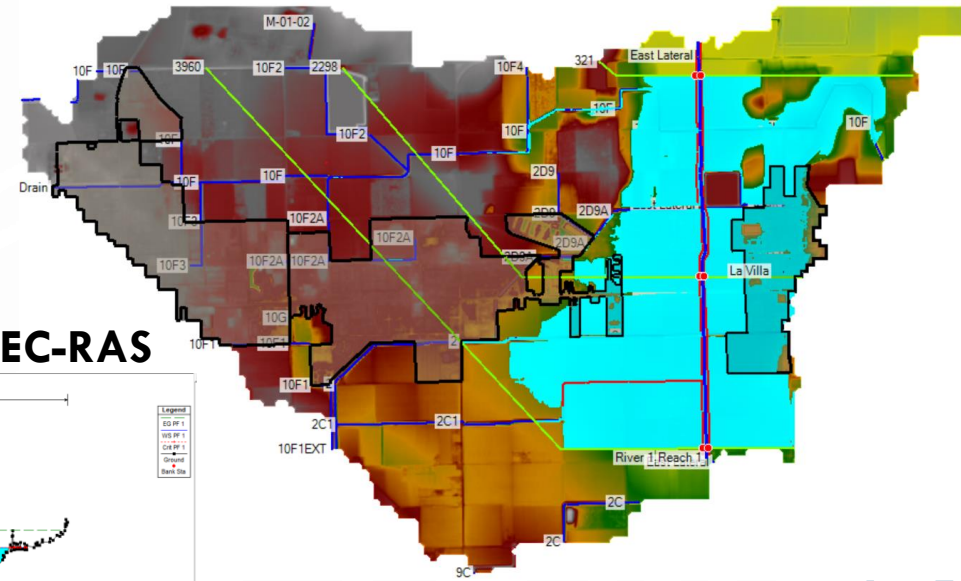


# HIDALGO WILLACY MAIN DRAIN

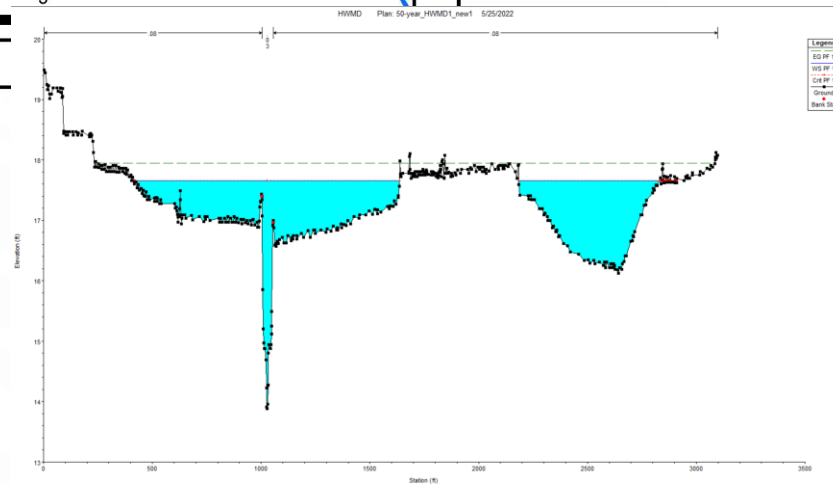
HEC-HMS



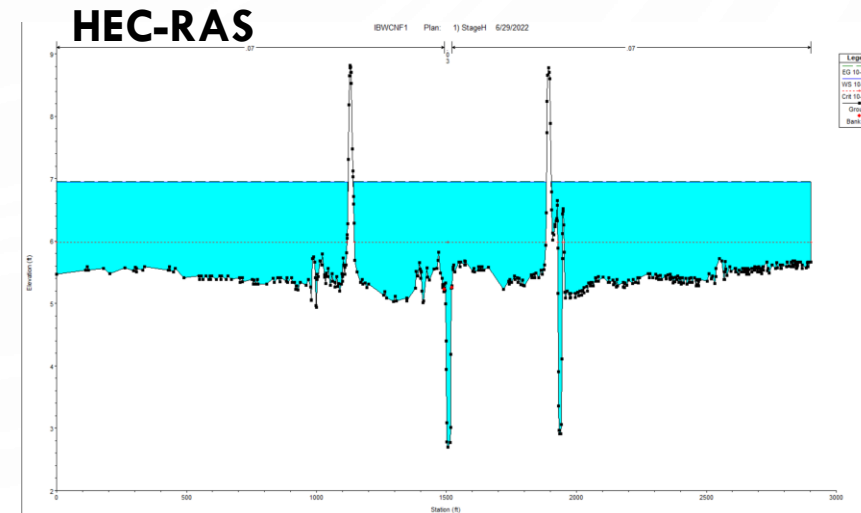
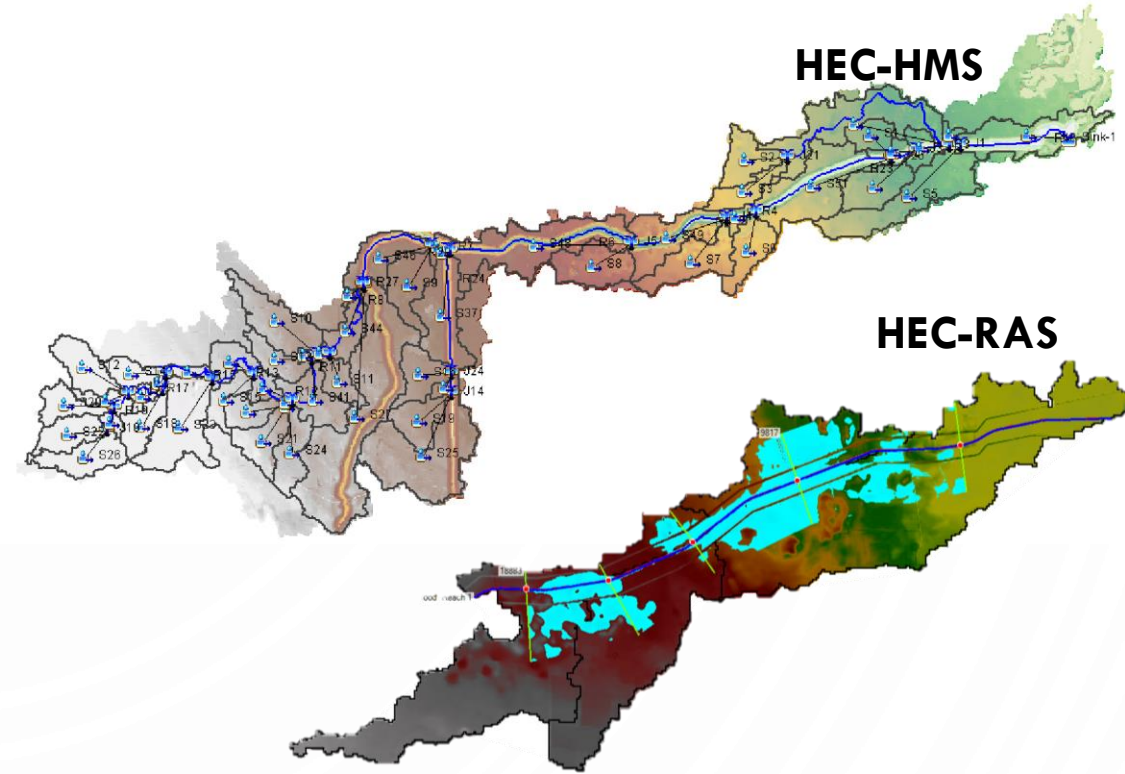
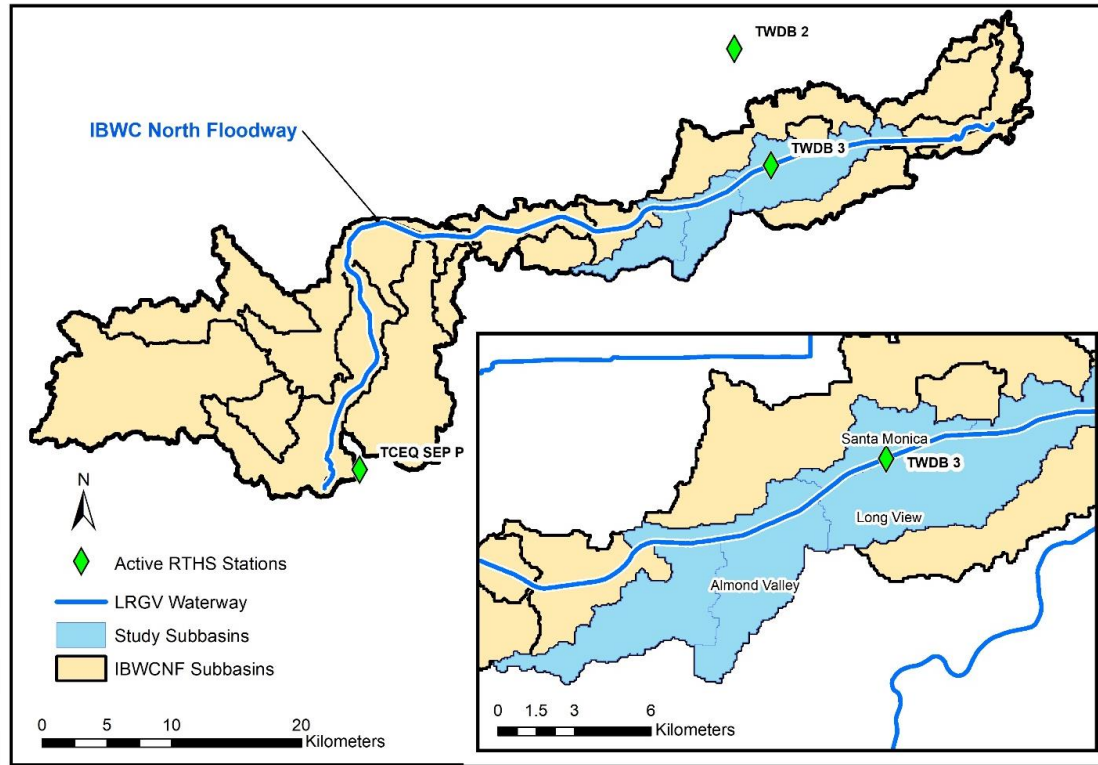
HEC-RAS



HEC-RAS



# IBWC NORTH FLOODWAY





## CURRENT AND FUTURE EFFORTS

- 319 Project
  - Watershed Characterization Report Draft by July 2022
- FWF
  - 3<sup>rd</sup> Sampling Event July 19-20 2022
- FIF
  - Modelling Effort for IBWC North Floodway Prototype
  - Deploying RTHS Stations

# QUESTIONS

Christopher Fuller, PhD.

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Linda Navarro, M.S.

Watershed Engineer

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