



Technical Memorandum

GIS Database Setup and Initial Elevation Analysis

Monroe County Roadway Vulnerability Analysis and
Capital Plan

Monroe County, Florida

May 11, 2020

Prepared for Monroe County



HR wood.
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Purpose of Memo

This memo outlines the process for developing the project GIS database, which will document the LiDAR roadway data for all roadway segments and locations as included in Exhibit A of the RFQ. This database is to serve as storage of all existing data received from The County and future data to be collected as per the project scope. Additionally, the memo includes the screening analysis process for the evaluation of the existing ground information and the existing Mean Higher High Water (MHHW) elevations that will be used to determine the criticality ranking of the roadway segments.

Project Intent and Description

As part of the Monroe County (The County) Roadway Vulnerability Analysis and Capital project, the roadways maintained by The County will be evaluated to develop a long-term roads adaptation plan based on design criteria, Sea Level Rise (SLR) projections, adaptation methodology, policy/financing evaluation, and public/stakeholder outreach. The primary objective of the project is to analyze the impacts of current and projected levels of SLR on all county-maintained roads and to develop an implementation plan and timeline to adapt roads for SLR. The results will be used to determine new policy considerations and design criteria for what acceptable levels of service should be.

Analysis/Methodology for the Development of the GIS Database

County Maintained Roadway Segments

The foundation of the GIS database to be used throughout the duration of the project are the county-maintained roadway segments to be evaluated as part of the study. It was imperative to correctly define all the roadway segment limits to ensure a complete analysis of the County's roadway network. In order to create a master list of roadways and ultimately the GIS layer to be used in the development of the database, a thorough analysis of three roadway segment lists was conducted.

To create the base layer of the GIS database, RFQ Exhibit A, along with the County's Roadway Atlas were used to modify an existing GIS layer also provided by The County, documented as *Streets_PCI*. The GIS *Streets_PCI* layer was developed in previous years and included some now abandoned roadway segments and had not yet been updated to include recent acquisitions. Through this analysis, all county-maintained roadway segments were confirmed, roadway names were verified and corrected, and a final master list and GIS layer was created. Refer to attached lower, middle, and upper keys maps depicting the County maintained roadway limits.

LiDAR Data

LiDAR data captured by Michael Baker International (MBI) was assessed for accuracy and coverage, the results were provided in a technical memorandum previously delivered to the County. This LiDAR data was then analyzed by the GIS team, and referenced against the full roadway segment list to ensure coverage of all roadway segments to be analyzed.

GIS Database Setup and Initial Elevation Analysis

Database Set-up

A comprehensive GIS database to document all existing conditions and roadway characteristics for all the County maintained roadway segments was developed. The specific data to be collected in the database was established based on the information needed to develop concept designs in later phases of the project. The list of data includes, roadway characteristics and general information, typical section components, bridge characteristics, additional roadway network components with potential impacts such as driveways, intersections, utilities and vegetation. Once the prioritization of the roadway segments is completed, and concept designs are being developed, this database will provide all the information needed to ensure the proposed improvements account for all appropriate roadway features, and all impacts to roadside components can be accurately assessed.

Initial Elevation Analysis

Elevation Data

The existing elevations of all of the study roadway segments was extracted from the MBI LiDAR data, the classification statistics and elevation histogram are shown in **Figure 1** and **Figure 2**, respectively.

| | |
|---------------------|---------------|
| Count: | 15076262 |
| Minimum: | -8.32 |
| Maximum: | 11.69 |
| Sum: | 55,213,452.16 |
| Mean: | 3.66 |
| Standard Deviation: | 2.48 |

FIGURE 1 – CLASSIFICATION STATISTICS

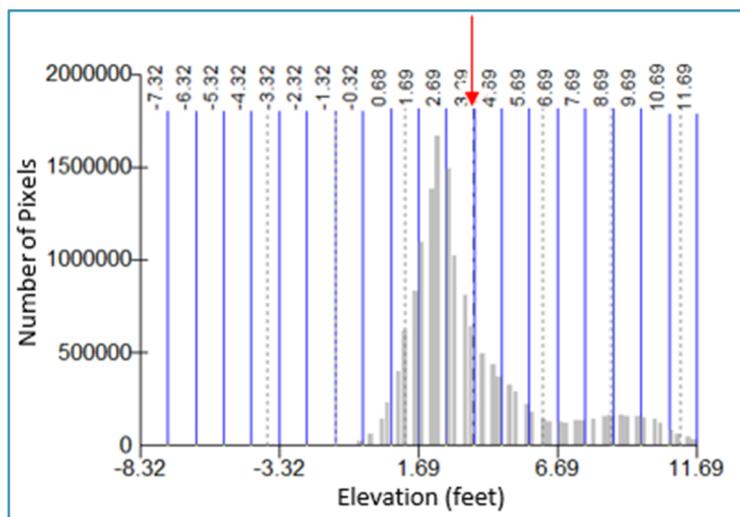


FIGURE 2 – ELEVATION HISTOGRAM

GIS Database Setup and Initial Elevation Analysis

In **Figure 2**, the most common (Mode) elevation is about +2.5 feet, and the average (Mean) elevation shown by the red arrow is +3.66 feet. The dashed vertical lines are Standard Deviations around the Mean. The lowest elevation of any significance (i.e., a visible # of pixels in the histogram) is at about -0.3 feet. There are lower elevations but their occurrence is very rare.

Interactive Map

Using the elevation data an interactive map was developed and made accessible to the public on the project website, www.keysroadsplan.com. The color coded map, seen in **Figure 3** enables the public to explore the study area, see roadway segments within the study limits, with a feature for the public to search for a specific address or location, and provides the existing elevation of the area. This tool will allow the public to search for their homes or businesses and get a snapshot of the existing elevation of where their properties are located.



FIGURE 3 – INTERACTIVE ELEVATION MAP ON PROJECT WEBSITE

The existing road elevation ranges and color designation depicted on the interactive map are defined as follows:

- Below 0' – **Red**
- 0' – 1.5' – **Orange**
- 1.5' – 4' – **Yellow**
- 4' – 6' – **Green**
- Above 6' – **Purple**

Water Levels

The County is part of the Southeast Florida Regional Climate Change Compact, whose Sea Level Rise Work Group updated the Unified Sea Level Rise Projection for Southeast Florida in 2019. The projection and guidance report considers the National Oceanic and Atmospheric Administration (NOAA) 2017 Intermediate-High projection as the high boundary and the Intergovernmental Panel on Climate Change (IPCC) projections as the low boundary up to the year 2070.

In order for the SLR and King Tide projections to be applied, the Mean Sea Level (MSL) and MHHW had to be established for the study limits. The following statement was included in the King Tide Prediction Tech Memo and it recommends the use of the NOAA Naples Gage to be used for our approach.

“Based on the observed tide range variability across the available data locations, both within Florida Bay (between Key West, Naples and Vaca Key) and along the Atlantic Ocean coastline of the keys (Key Colony Beach), it is apparent that there is a relatively high degree of spatial variability of the tidal range, while normal wind setup levels are generally similar across locations. Given that the relatively few long-term tide gauges do not resolve the tidal and normal wind setup range along much of the shoreline between and beyond the measurement locations, it is recommended that the highest tidal range and normal wind setup levels, measured at the Naples location, be applied as a reasonably conservative indicator of stillwater levels during non-storm conditions along the coastline of the Florida Keys within Monroe County.”

We also reviewed the MSL and MHHW at the three NOAA Gages from January 2015 to January 2020 and recommended the use of the Naples Gage for consistency with the rest of the data as it also provides a more conservative approach considering the difference between all three gages. This analysis yielded a MSL of -0.207' and MHHW 0.973' (NAVD88).

GIS Maps

GIS maps will be used to analyze the existing roadway elevations against the projected SLR and King Tide Predictions, this being the first step in identifying the low laying areas in The County and aiding in the prioritization process of the most vulnerable roadway segments. As part of this initial task, a screening analysis comparing the existing roadway elevations and the adopted MHHW was conducted to identify these low topographic areas along the roadway segments throughout The County that may experience current flooding scenarios.

This base scenario with the existing conditions was designated as *Scenario A00* in the *MCRVS SLR Evaluation – Scenario A* GIS map. This scenario shows the vertical clearance between the existing road elevation and the existing MHHW. **Figures 4-6** show Scenario A00 for the upper, middle and lower keys study roadway segments.

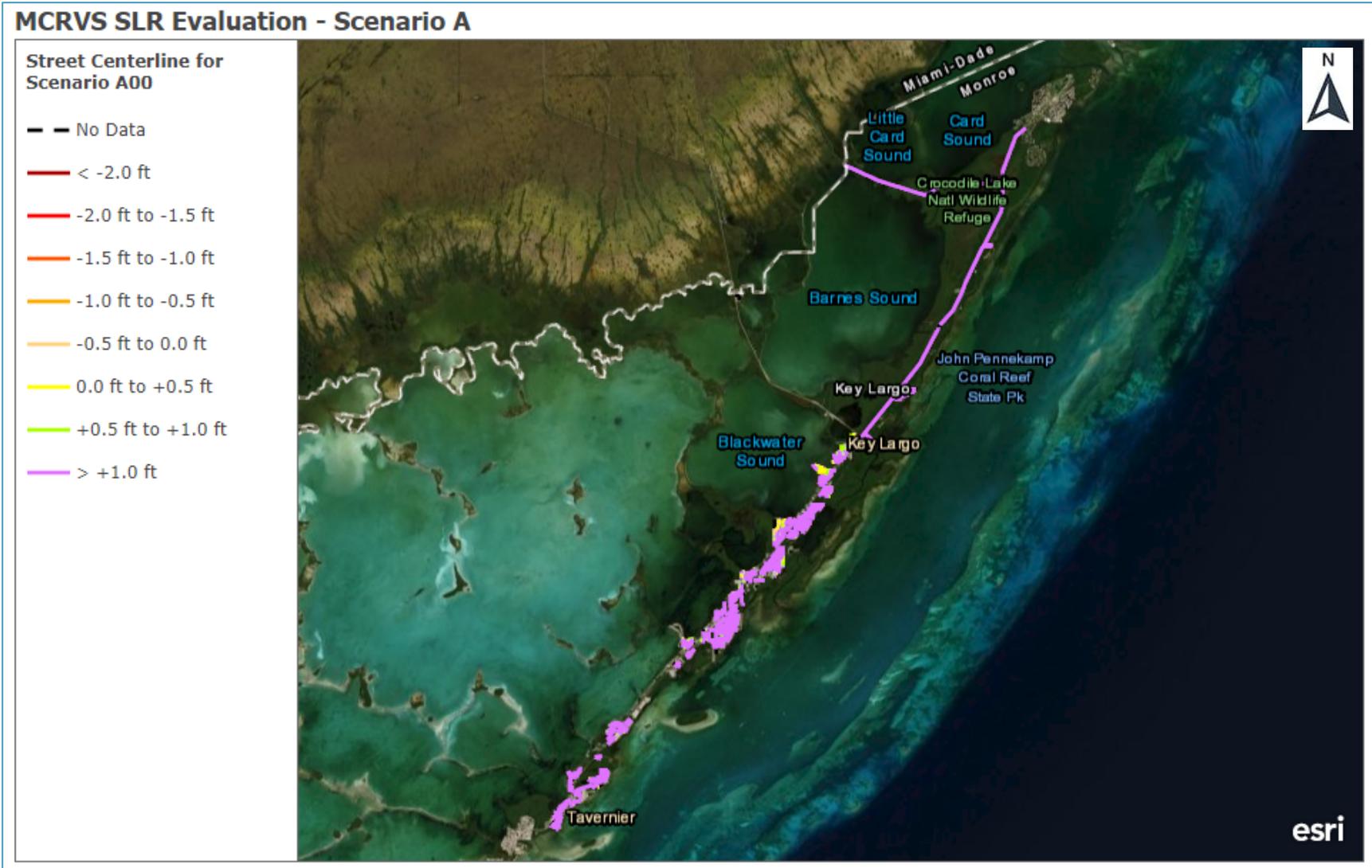


FIGURE 4. UPPER KEYS SCENARIO A00 – CLEARANCE BETWEEN ROAD ELEVATION AND MHHW



FIGURE 5. MIDDLE KEYS SCENARIO A00 – CLEARANCE BETWEEN ROAD ELEVATION AND MHHW

MCRVS SLR Evaluation - Scenario A



FIGURE 6. LOWER KEYS SCENCARIO A00 – CLEARANCE BETWEEN ROAD ELEVATION AND MHHW

GIS Database Setup and Initial Elevation Analysis

Additional maps depicting scenarios noted in **Table 1** have been developed to aid in the visualization of when and where the impact of projected SLR and King Tides becomes an issue in the study area, and for use in the concept development phase of the study.

| Scenario # | Scenario Description |
|------------|--|
| A1 | MHHW + IPCC Median SLR 2025 |
| A2 | MHHW + IPCC Median SLR 2030 |
| A3 | MHHW + IPCC Median SLR 2035 |
| A4 | MHHW + IPCC Median SLR 2040 |
| A5 | MHHW + IPCC Median SLR 2045 |
| A6 | MHHW + IPCC Median SLR 2060 |
| A7 | MHHW + IPCC Median SLR 2100 |
| B1 | MHHW + NOAA 2017 Intermediate-High SLR 2025 |
| B2 | MHHW + NOAA 2017 Intermediate-High SLR 2030 |
| B3 | MHHW + NOAA 2017 Intermediate-High SLR 2035 |
| B4 | MHHW + NOAA 2017 Intermediate-High SLR 2040 |
| B5 | MHHW + NOAA 2017 Intermediate-High SLR 2045 |
| B6 | MHHW + NOAA 2017 Intermediate-High SLR 2060 |
| B7 | MHHW + NOAA 2017 Intermediate-High SLR 2100 |
| C1 | MSL + IPCC Median SLR + King Tide 2025 |
| C2 | MSL + IPCC Median SLR + King Tide 2030 |
| C3 | MSL + IPCC Median SLR + King Tide 2035 |
| C4 | MSL + IPCC Median SLR + King Tide 2040 |
| C5 | MSL + IPCC Median SLR + King Tide 2045 |
| C6 | MSL + IPCC Median SLR + King Tide 2060 |
| C7 | MSL + IPCC Median SLR + King Tide 2100 |
| D1 | MSL + NOAA 2017 Intermediate-High SLR + King Tide 2025 |
| D2 | MSL + NOAA 2017 Intermediate-High SLR + King Tide 2030 |
| D3 | MSL + NOAA 2017 Intermediate-High SLR + King Tide 2035 |
| D4 | MSL + NOAA 2017 Intermediate-High SLR + King Tide 2040 |
| D5 | MSL + NOAA 2017 Intermediate-High SLR + King Tide 2045 |
| D6 | MSL + NOAA 2017 Intermediate-High SLR + King Tide 2060 |
| D7 | MSL + NOAA 2017 Intermediate-High SLR + King Tide 2100 |

TABLE 1 – MCRVS ELEVATION SCENARIOS

Findings

Through analysis of *Scenario A00*, the following locations have been identified as potential areas of concern due to minimal clearance between the current water levels and the existing roadway elevation. It is more likely that flooding would occur in these areas since most of the current segment elevation is 1ft or below. Based on the preliminary screening analysis, roadway segments identified as potential flooding problem areas are the Stillwright Point neighborhood, Grassy Road, Long Key Road, Summerland Road, Boyd Drive, Shaw Drive and Park Drive, as it is shown on **Figure 7** and **Figure 8**. Majority of these roadway segments are located on the west side of Key Largo, while the other roads are distributed throughout the lower Keys. All of these roadway segments are in residential areas with numerous houses and other roadway connections

GIS Database Setup and Initial Elevation Analysis

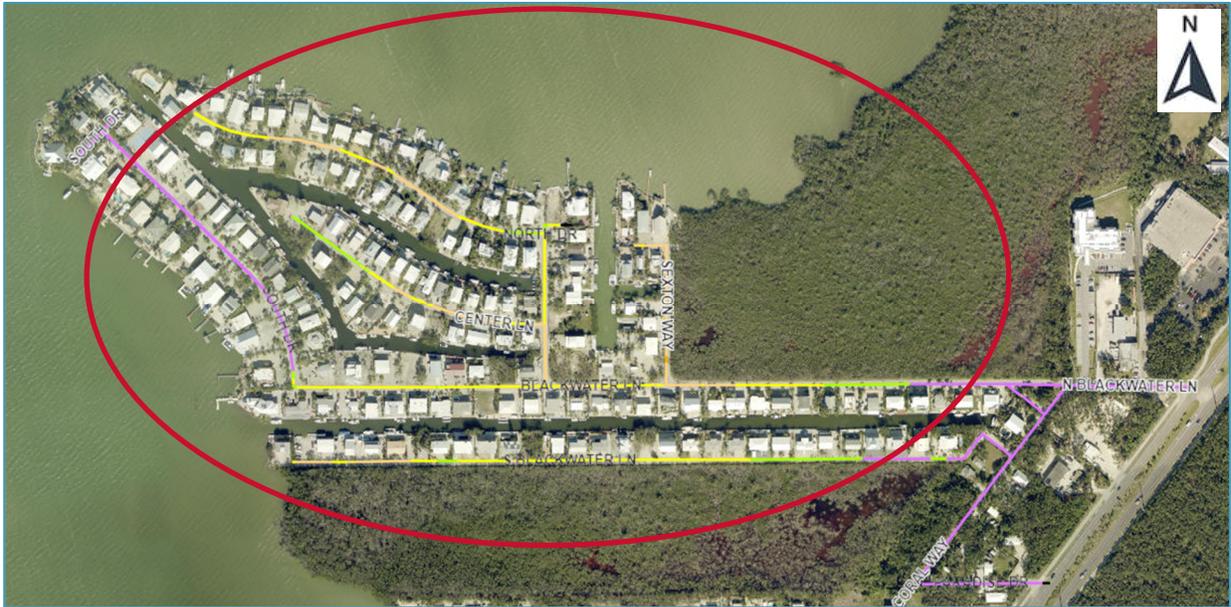


FIGURE 7 - STILLWRIGHT POINT NEIGHBORHOOD

Streets within the circle have an existing road elevations has a 0.5 ft. clearance or less from the MHHW elevation.



FIGURE 8 - WEST SIDE OF KEY LARGO

The roadways within the squares are potential problem areas, since the difference between the existing road elevation and MHHW elevation is less than 1 ft.

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The Stillwright Point neighborhood is one of the areas currently impacted the most by flooding during times when the water level increases. A map of the area was provided to the residents, and they were able to identify the locations of the frequent flooding. As seen in **Figure 9**, residents highlighted majority of North Drive, Stillwright Way, Sexton Way, the middle area of North Blackwater Lane, a large portion of Center Lane, and some problem areas in South Blackwater Lane. When compared to the screening analysis conducted, the areas of concern identified on the GIS map corresponded to those problem areas the residents identified. **Figure 10** shows clearance between existing roadway elevations and MHHW in the Stillwright Point Neighborhood.



FIGURE 9 - RESIDENTS ELEVATION MAP (STILLWRIGHT POINT)

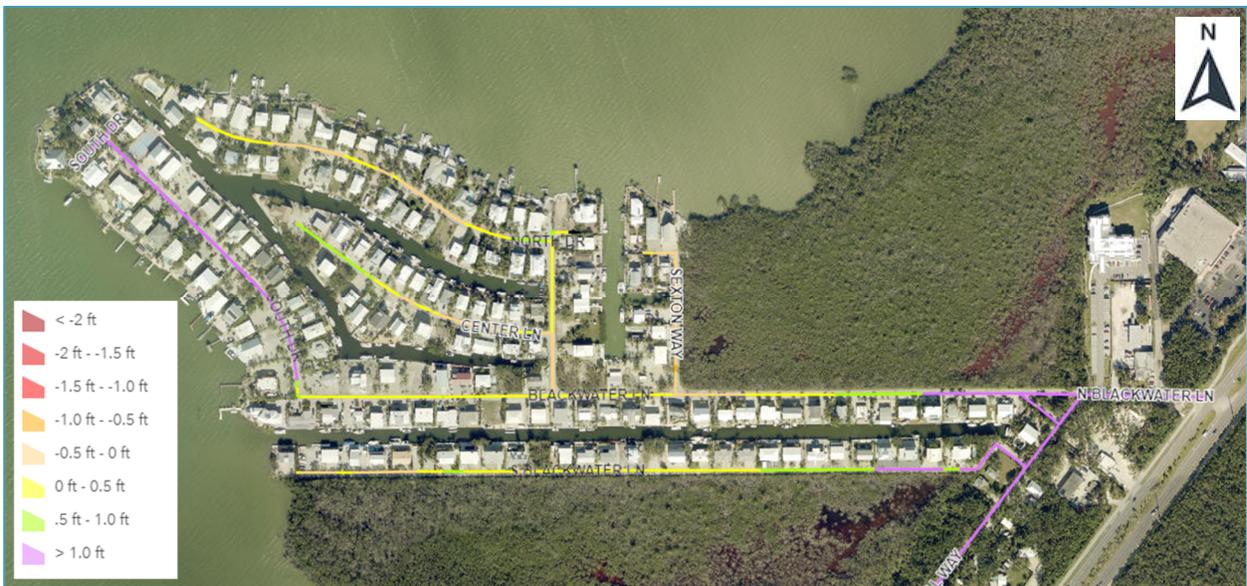


FIGURE 10 – STILLWRIGHT POINT SCENARIO A00

Conclusion

Several maps were developed in order to collect all existing conditions for all aspects of the vulnerability study which would be needed to develop the concept designs in the later phases of the project. These maps will make up the master GIS database to be delivered to The County upon completion of the study, and include utilities location, transportation facilities, environmental resources, driveway locations, drainage structure review, roadway characteristics, and critical facilities location.

The elevation analysis provides an overall picture of how the SLR projections and King Tides will affect the county-maintained roadway network. This study will evaluate all roadway segments, and through a criticality and ranking approach the areas to be considered by The County as a priority will be identified. The elevation maps developed with all the SLR and King Tide scenarios can serve as reference for the rest of the segments that will not be prioritized this time around, and give The County a base line for when those segments begin to be affected, and may need to be revisited.