Levee Analysis and Mapping Plan
Mon Bijou Project

Settlement of Mon Bijou, St. Croix, U. S. Virgin Islands

February 2020

FEMA

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Acronyms

BFE	Base Flood Elevation
CERC	Community Engagement and Risk Communication
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
LLPT	Local Levee Partnership Team
LOMR	Letter of Map Revision
NFIP	National Flood Insurance Program
NLD	National Levee Database
SFHA	Special Flood Hazard Area
STARR II	Strategic Alliance for Risk Reduction
USACE	U.S. Army Corps of Engineers

Definitions

The terms below have been used in this document. Additional terms are provided in FEMA's *Guidance for Flood Risk Analysis and Mapping, Levees* (February 2019) in the Glossary. This guidance document is available from the FEMA Library at https://www.fema.gov/media-library-data/1556726741363-2334a11b0de5b35a1e3210353c06148f/Levee_Guidance_Feb_2019.pdf.

Base Flood Elevation (BFE)** – Elevation of a flood having a 1% chance of being equaled exceeded in any given year. Also referred to as the 100-year flood. This elevation is the basis of the insurance and floodplain management requirements of the NFIP.

Levee Reach Analysis and Mapping Procedures* – Levee Analysis and Mapping Procedures include Sound Reach, Freeboard Deficient, Overtopping Analysis, Structure-based Inundation, and Natural Valley. Details on these approaches can be found in FEMA's *Guidance for Flood Risk Analysis and Mapping, Levees* (February 2019).

Leveed Area – A spatial feature in the National Levee Database defined by the lands from which floodwater is excluded by the levee system.

Levee Reach* – A portion of a levee system (usually a length of a levee) that may be considered for analysis purposes to have approximately uniform representative properties.

Levee System* – A flood hazard-reduction system that consists of one or more levee segments/reaches and other features such as floodwalls and pump stations, which are interconnected and necessary to ensure exclusion of the design flood from the associated hydraulically independent levee-impacted area, and which are constructed and operated in accordance with sound engineering practices.

Local Levee Partnership Team (LLPT)* – A workgroup that is facilitated by FEMA when a levee system will be analyzed by levee analysis and mapping procedures for non-accredited levees. The primary function of this group is to share information/data and identify options based on stakeholder roles and knowledge.

National Levee Database (NLD)* – The NLD, developed by the United States Army Corps of Engineers (USACE) in cooperation with FEMA, is a dynamic, searchable inventory of information for all levee systems in the nation. The database contains information to facilitate and link activities, such as flood risk communication, levee system evaluation for the NFIP, levee system inspections, floodplain management, and risk assessments. The NLD continues to be a dynamic database with ongoing efforts to add levee data from federal agencies, states, and tribes.

Non-Accredited Levee System* – A levee system that does not meet the requirements in the NFIP regulations at Title 44, Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR 65.10), Mapping of Areas Protected by Levee Systems, and is not shown on a FIRM as reducing the base flood hazards.

Zone A –** The Special Flood Hazard Area (except coastal V Zones) shown on a community's Flood Insurance Rate Map where no base flood elevation is provided.

Zone D –** Area of undetermined but possible flood hazard.

*Term description from FEMA's *Guidance for Flood Risk Analysis and Mapping, Levees* (February 2019).

**Term description from FEMA's Floodplain Glossary

Executive Summary

This report focuses on the Mon Bijou Levee System located in the settlement of Mon Bijou, St. Croix, U. S. Virgin Islands. This system was constructed as part of the U.S. Army Corps of Engineers (USACE) Flood Control Channel Project. The Federal Emergency Management Agency's (FEMA's) Flood Insurance Study (FIS) report and Flood Insurance Rate Map (FIRM) for the U. S. Virgin Islands do not show the Mon Bijou Levee System as providing reduced flood hazard to the Mon Bijou residential community from the Salt River. To improve this depiction of flood risk on a future FIRM, certified data must be provided to FEMA, and deemed complete, to show that the levee systems meet the minimum requirements of Title 44, Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR 65.10). As of the date of this levee plan, no data has been received by FEMA in support of 44 CFR 65.10. Therefore, the levee systems would be considered non-accredited in a future remapping effort.

FEMA's guidance was revised in 2013 to incorporate new Levee Analysis and Mapping Procedures for non-accredited levees, which provides a suite of flexible procedures to perform flood hazard analysis and mapping for non-accredited levee systems (see Section 1 of this report). FEMA Region II has initiated a Levee Discovery project where the Levee Analysis and Mapping Procedures (see Section 2) are being applied to the Mon Bijou Levee System.

In June 2019, FEMA Region II partnered with stakeholders from the Territory of the U.S. Virgin Islands representing the Settlement of Mon Bijou to form a collaborative Local Levee Partnership Team (LLPT) and worked to determine potential Levee Analysis and Mapping Procedures that would apply to the Mon Bijou Levee System (see Sections 3 and 4 respectively). The process involved collecting and evaluating available data, creating and evaluating an initial data analysis (see Section 5), and detailed discussions on mapping needs.

This levee plan summarizes the information gained through the extensive coordination and collaboration with the LLPT and through the initial data analysis performed. This plan also outlines potential reach analysis procedures and paths forward for future mapping of the flood hazard within the levee-impacted areas of the Mon Bijou Levee System in the Settlement of Mon Bijou (see Section 6).

Representatives for the Territory of the U.S. Virgin Islands expressed interest in pursuing a Letter of Map Revision (LOMR) to reflect the changes that the Salt River diversion project has made to topography and flood risk. This LOMR would show the levee system and stream diversion project as reducing, but not eliminating, flood risk on a future FIRM. This identification of flood risk within the levee-impacted areas would be similar to the Natural Valley analysis results from the Levee Analysis and Mapping Procedures for the Settlement of Mon Bijou.

1 Introduction

FEMA, its Production and Technical Services provider Strategic Alliance for Risk Reduction II (STARR II), and Community Engagement and Risk Communication (CERC) provider Resilience Action Partners initiated the Levee Analysis and Mapping Procedures process for non-accredited levees in the Settlement of Mon Bijou. Recent technological advances in data collection methods and hydrologic and hydraulic modeling were leveraged as part of this process, which also:

- Leverages local knowledge and data, with proactive stakeholder engagement in LLPTs;
- Aligns available resources for engineering analyses and mapping commensurate with the level of risk in leveed areas; and
- Considers the unique characteristics of each levee system from an engineering perspective.

The levee system in the Settlement of Mon Bijou is not currently accredited. FEMA is using the Levee Analysis and Mapping Procedures process to develop refined flood hazard mapping in areas landward of the levees. Updated regulatory flood hazard mapping is not anticipated in this community for several years, so this effort is intended to provide a more realistic representation of levee-related flood hazards in the Settlement of Mon Bijou for community officials and emergency managers to use in development and preparedness planning.

The Levee Analysis and Mapping Procedures process is conducted in four phases:

- **Phase 0: Flood Structure Identification and Review:** Levee systems are identified and verified as being constructed, operated, and maintained as flood risk reduction structures. An LLPT is established during this phase.
- **Phase 1: Analysis and Mapping Plan Preparation:** LLPT meetings are held periodically to review available data and documentation. Discussions assist in the preparation of an Analysis and Mapping Plan based on the available information.
- **Phase 2: Analysis Preparation and Results Review (if applicable):** Analysis is performed by FEMA and shared with the LLPT to validate results against available data and documentation. Results are compared to effective FISs to update the LAMP Plan, if necessary. Draft maps prepared at this stage may be used as best available data for floodplain management.
- **Phase 3: FIRM Update, Due Process, and Effective FIRM Issuance:** FIRM panels are updated with Phase 2 results. Communities and FEMA follow all NFIP regulatory due process procedures, and updated FIRM panels are adopted as the regulatory basis for local floodplain management.

This levee plan is the result of the collaboration between FEMA, Representatives from the Territory of the U.S. Virgin Islands government including the U.S. Virgin Islands Department of Public Works, and U.S. Virgin Islands Department of Planning and Natural Resources, USACE, and other stakeholders. The plan summarizes the stakeholder coordination, initial data analysis, and options to depict the flood hazard with the levee system on a future FIRM.

The Mon Bijou Levee System in the Settlement of Mon Bijou would be considered non-accredited in a future remapping effort unless information is provided to support the accreditation of the levee system. FEMA is using the Levee Analysis and Mapping Procedures for non-accredited levees process to develop refined flood hazard mapping in levee-impacted areas.

2 Levee System Description

2.1 Flood Damage Reduction Project in the Settlement of Mon Bijou

The Mon Bijou Levee System was designed and constructed by USACE as part of the Flood Control Channel Project to reduce flood risk within the Settlement of Mon Bijou. Upon completion in 2006, the project was turned over to the U.S. Virgin Islands Department of Public Works (USVI DPW), which is responsible for operating and maintaining the levee and channel. The Mon Bijou Levee System extends approximately 0.3 miles along the right bank of Salt River, located at the north end of the Mon Bijou residential community as shown in Figure 1. Surveyed elevation data from the USACE National Levee Database (NLD) was available to inform the analysis of the Mon Bijou Levee System. Survey locations containing elevation data are presented as survey points in Figure 1.

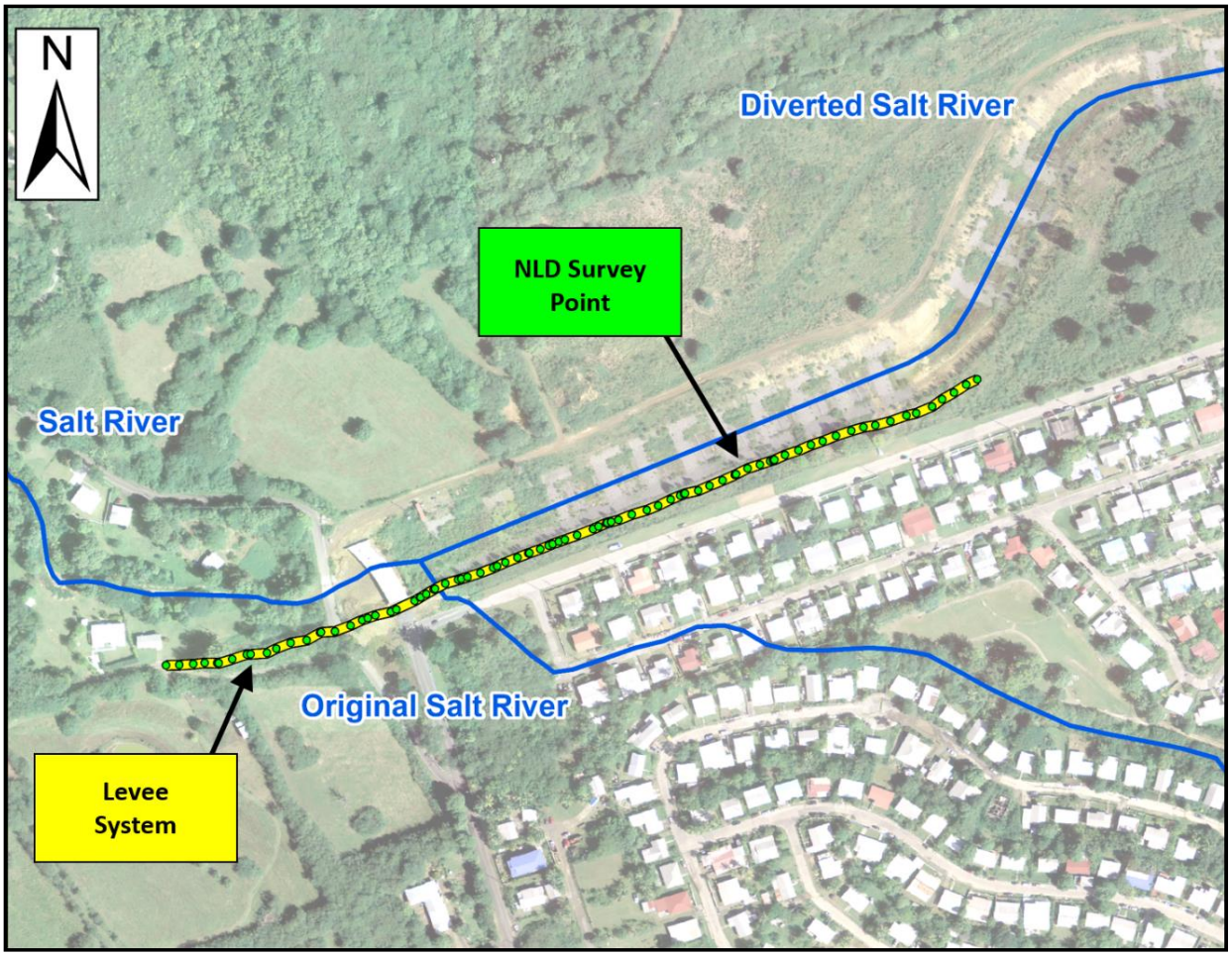

Figure 1: Location Map

2.2 Community NFIP and FIRM History

Table 1 and Table 2 summarize the communities' NFIP and FIRM history.

Table 1. Summary of Project Area

County	Community	Participating in the NFIP?	Estimated Number of Potentially Impacted Structures in Levee-impacted Area[1]
Saint Croix	U. S. Virgin Islands	Yes	120

Table 2. Community Map History

Community Name	Initial Identification	Flood Hazard Boundary Map Revision Date(s)	FIRM Effective Date	FIRM Revision Date(s)
U. S. Virgin Islands	February 25, 1977	N/A	October 15, 1980	April 16, 2007 August 3, 1992

The Mon Bijou Levee System and the stream diversion project are not currently reflected on the effective FIRM for the island of St. Croix.

2.3 Levee Analysis and Mapping Procedures Process Tasks

The Levee Analysis and Mapping Procedures process is divided into six distinct tasks: LLPT compilation, Field Reconnaissance, Perform Initial Levee Analysis, Flood Risk Outreach, Complete Levee Analysis and Mapping Procedures, and Produce Preliminary Products/Issue Preliminary (see Table 3).

[1] See Table 5 for additional information regarding potentially impacted structures.

Table 3. Project Tasks

Task	Details	Tentative Start/ End Dates*
LLPT Compilation (Phase 0)	Identification and outreach to individuals to serve on the LLPT.	4/1/2019 – 5/31/2019
Field Reconnaissance (Phase 1)	LLPT to determine levee reaches to study and potential analysis of those reaches. Perform field reconnaissance of these reaches.	6/3/2019-6/7/2019
Perform Initial Levee Analysis and develop Levee Analysis and Mapping Procedures (Phase 1)	FEMA to collaborate with the LLPT to develop analysis based on Field Reconnaissance findings and Levee Analysis and Mapping Procedures.	2/1/2019 - 7/31/2019
Flood Risk Outreach (Phase 2)	LLPT to assess results of the Field Reconnaissance and perform levee analysis tasks. LLPT to work at the local level to disseminate findings that could impact local communities.	10/28/2019
Complete Levee Analysis and Mapping Procedures; Finalize LAMP mapping (Phase 2)	FEMA to complete detailed analysis based on chosen approach, develop mapping, and finalize Levee Analysis and Mapping Procedures; develop final analysis and mapping.	TBD
Produce Preliminary Products / Issue Preliminary (Phase 3)	FEMA to develop Preliminary Products (including FIRM database) from revised analysis above if that is the direction from FEMA and LLPT.	TBD

*All schedules are tentative and will be adjusted at the pace of the LLPT.

3 Local Levee Partnership Team

The LLPT was formed to provide FEMA with data and input, in addition to feedback on the procedures to be used for analyzing and mapping the levee reach based on local levee conditions. The stakeholders who participated in the LLPT for this project are listed in Table 4.

Table 4. LLPT Participants

LLPT Member	Contact Information
Ellerton Maynard	U.S. Virgin Islands Department of Planning and Natural Resources (DPNR) 340.773.1082, ext. 2201, ellerton.maynard@dpnr.vi.gov
Yasmine Garib	U.S. Virgin Islands Department of Planning and Natural Resources (DPNR) 340.773.1082, yasmine.garib@dpnr.vi.gov
Colin Brown	U.S. Virgin Islands Department of Planning and Natural Resources (DPNR) 340.773.1082, colin.brown@dpnr.vi.gov
Anita E. Nibbs	U.S. Virgin Islands Department of Planning and Natural Resources (DPNR) 340.773.1082, anita.nibbs@dpnr.vi.gov
Gregory Richards	U.S. Virgin Islands Department of Planning and Natural Resources (DPNR) 340.514.8881, gregory.richards@dpnr.vi.gov

LLPT Member	Contact Information
Aymee Santana	Virgin Islands Territorial Emergency Management Agency (VITEMA) 340.773.2244, aymee.santana@vitema.vi.gov
Arcadio Peña	Virgin Islands Territorial Emergency Management Agency (VITEMA) 787.934.6854
Graciela Rivera	Virgin Islands Territorial Emergency Management Agency (VITEMA) 340.332.3051, graciela.rivera@vitema.vi.gov
Dennis Brow	U.S. Virgin Islands Department of Public Works (DPW) 340.773.1290, dennis.brow@dpw.vi.gov
Kaisha Arnold	U.S. Virgin Islands Department of Public Works (DPW) 340.773.1290, kaisha.arnold@dpw.vi.gov
Ana Montanez-Kiture	Office of the Governor 340.773.14104, ana-montanez-kiture@go.vi.gov
Randall Rabb	U.S. Army Corps of Engineers (USACE) randall.l.rabb@usace.army.mil
Melissa Griffith	FEMA Joint Recovery Office – U.S. Virgin Islands 202.374.2183, Melissa.griffith@fema.dhs.gov
Sandra Lashley	FEMA II Region Mitigation 202.344.1035, Sandra.lashley@fema.dhs.gov
Shenelle Dore	FEMA Environmental and Historical Preservation (EHP) 202.701.9056, shenelle.dore@fema.dhs.gov
Gay Bindocci	U.S. Department of the Interior, Natural and Cultural Resources Recovery Support Function (NCR RSF) 202.253.0244, cynthia_m_bindocci@ios.doi.gov
Juan Bossano	FEMA Hazard Mitigation Grant Program Contractor – Witt O'Brien's 337.513.9455, jbossano@wittobriens.com
Peter Durkin	VITEMA Contractor – Witt O'Brien's 845.518.1498, pdurkin@wittobriens.com
Shudipto Rahman	FEMA Region II 202.702.4273, Shudipto.Rahman@fema.dhs.gov
Srikanth Koka	STARR II 703.849.0584, skoka@dewberry.com
Jordan Wetzig	STARR II 703.849.0346, jwetzig@dewberry.com
Beatriz Pérez	Resilience Action Partners 703.317.6530, bperez@mbakerintl.com
Matt Kroneberger	Resilience Action Partners 212.237.6373, matt.kroneberger@ogilvy.com
Tom Smith	Resilience Action Partners 703.317.6267, tsmith@mbakerintl.com

4 Stakeholder Engagement

4.1 LLPT Meeting 1

A FEMA-led project team engaged the Mon Bijou Levee System stakeholders at the first LLPT Kick-Off Meeting on June 3, 2019, held at the U.S. Virgin Islands Department of Planning and Natural Resources office. The intent of the meeting was to establish contact, explain the Levee Analysis and

Mapping Procedures process, and discuss the application of the Levee Analysis and Mapping Procedures to the Mon Bijou Levee System.

At the initial LLPT 1 meeting (LLPT 1), representatives from FEMA provided an overview to the invited Levee Analysis and Mapping Procedures communities, answered questions concerning FEMA products, terminology, and procedures, and provided a timeline for the Levee Analysis and Mapping Procedures projects. FEMA explained in detail the five procedures outlined in the Levee Analysis and Mapping Procedures Final Approach Document and the major distinctions of Levee Analysis and Mapping Procedures in comparison with earlier levee analyses. FEMA and their contractor led a discussion about the applicability of each procedure to the levees.

Representatives from local stakeholders provided additional background on the Mon Bijou Levee System and discussed USACE involvement in the construction and current condition of the levee system. (See Appendix A for minutes for the LLPT 1).

4.2 LLPT Meeting 2

The second LLPT Meeting was held on October 28, 2019 to review the initial data analysis and discuss outcomes from the data collection process. During the meeting, the FEMA project team discussed the results of the initial data analysis for the Natural Valley and Structure-based Inundation Procedures. Results of the Levee Analysis and Mapping Procedures led to a discussion about methods for reducing the community's flood insurance burden by developing new mapping. Levee ownership and maintenance was also covered for the Mon Bijou Levee System to ensure the levee continues to provide reduced flood risk to the community.

Appendix B provides additional details regarding the LLPT Meeting 2, and Appendices C through F provide information from the data collection.

4.3 LLPT Meeting 3

The third LLPT Meeting was held on March 18, 2020 to review the draft levee analysis and mapping plan with the LLPT prior to it being finalized.

5 Initial Data Analysis

STARR II developed an initial data analysis to approximate the inundation area of the 1-percent-annual-chance flood for each relevant Levee Analysis and Mapping Procedures approach. This informed the discussions in LLPT Meeting 2 prior to LLPT Meeting 3. Details of the initial data analysis and application of reach analysis procedures are provided below. Appendix F provides supporting data.

5.1 Hydrologic Analysis

The 1-percent-annual-chance event for the Salt River was analyzed and flow hydrographs were calculated as part of the initial data analysis. To develop the flow event a HEC-HMS rainfall-runoff model was developed for the Salt River. National Oceanic and Atmospheric Administration (NOAA) Atlas 14-point precipitation frequency estimates were used to estimate the 24-hour, 1-percent-annual-chance rainfall depth for the Salt River watershed; frequency temporal distribution

was used to define the 24-hour rain event. The Soil Conservation Service (SCS) Curve Number was used to estimate hydrologic losses; unit hydrograph procedure was applied to develop sub-basin hydrographs. The Muskingum-Cunge method was used for channel routing. Hydrographs at significant points of interest were extracted and used in the hydraulic model.

5.2 Reach Analysis

Topographic data (0.5-meter Post-Hurricane Maria Digital Elevation Model, 2018, available through FEMA) and levee profile data from the USACE National Levee Database (NLD) website along with as-built plans were reviewed to define the levee system and reach boundary for the initial data analysis. A levee reach is any continuous section of a levee system to which a single reach analysis procedure (Section 5.2 through 5.5) may be applied.

Based on the review of the available levee crest data, the Mon Bijou Levee System meets minimum freeboard requirements of 44 CFR 65.10 as shown in levee profile exhibit in Appendix C.

For the initial data analysis, the Mon Bijou Levee System was considered a single reach. The levee system is relatively short (0.33 miles), continuous, and uniformly constructed.

5.3 Natural Valley Procedure

The Natural Valley Procedure was modeled by preserving the topographic features of the levee reach and channelization in the underlying terrain. The modeled levee crest elevations were then lowered to equal the ground elevation of the landside levee toe, which allowed flow on both sides of the levee structure. The resulting floodplain is characterized by flow diversion and potential for floodplain storage. An unsteady 2-Dimensional flow simulation would analyze such a floodplain better than a 1-D steady flow analysis. Therefore, HEC-RAS 5.0.7 software, which has 2-D flow analysis capability, was selected. The 1-percent chance Natural Valley floodplain reflecting levee-lowered scenario was developed using the HEC-RAS model of Salt River floodplain.

5.4 Structure-based Inundation Procedure

For the Structure-based Inundation Procedure, hypothetical breach analyses were completed at two independent locations along the levee reach. Current guidelines recommend one breach to occur at the upstream end of the levee system and one to occur at the downstream end of the levee system. This guidance was used in conjunction with engineering judgment based on available topographic and geologic data and available freeboard at each point along the levee system to develop two likely breach locations. Breach widths were estimated to span 165 feet for both locations. Each breach was analyzed individually using HEC-RAS 5.0.7 (2-Dimensional, unsteady flow). The breach locations were developed for analysis purposes only and are not intended to indicate future breach development at these locations. All 1-percent-annual-chance inundation floodplains associated with each of the two breach areas were composited to develop the final visual depiction of the potential Structure-based inundation floodplain boundary and depth. Breach locations developed for this model are presented in Figure 2.

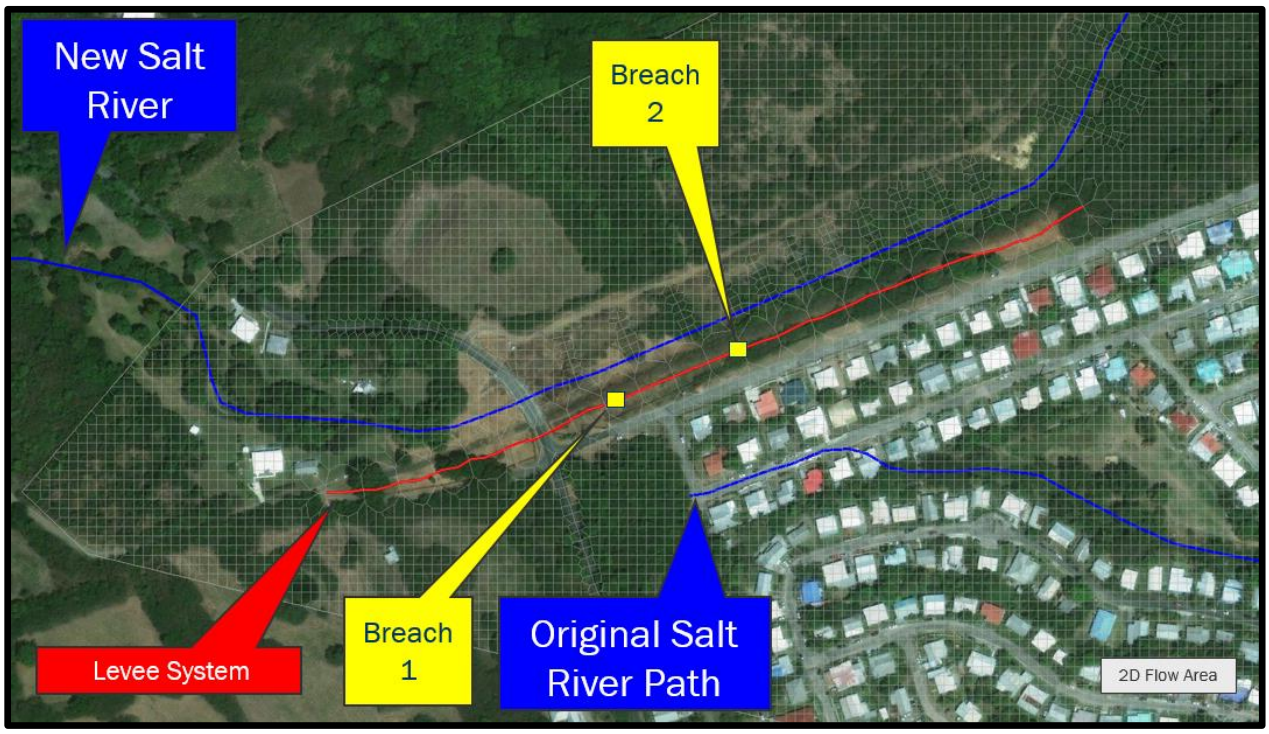

Figure 2: Breach Location Map

5.5 Freeboard Deficient and Overtopping Procedures

For the purposes of the initial data analysis of the Freeboard Deficient Procedure and Overtopping Procedure, the Mon Bijou Levee crest elevations were estimated to be elevated at or above the Base Flood Elevation (BFE) and above the minimum freeboard requirements developed from the BFE. Therefore, the Freeboard Deficient and Overtopping Procedures do not apply. Appendix C includes the levee profile exhibit.

5.6 Sound Reach Procedure

A Sound Reach is described as a reach that has been designed, constructed, and maintained to withstand the flood hazards posed by a 1-percent-annual-chance flood, in accordance with the standards in 44 CFR 65.10 of the NFIP regulations, but is part of a levee system that has not been accredited. In the case of the Mon Bijou Levee Systems, current available data does not indicate that the Sound Reach Procedure applies.

5.7 Review of Initial Data Analyses

The effective FIRM does not reflect the current diverted Salt River flow path, but instead presents the Zone AE and Floodway going along the original flow path through the Mon Bijou residential area. The Natural Valley procedure results reflect the currently existing Salt River flow path and identifies the potential flood risk if the levee system was not in place to reduce the flood hazard. Figure 3 illustrates the approximate inundation area for the 1-percent-annual-chance flood for the

Natural Valley Procedure within the levee-impacted area. Figure 4 shows the approximate depth grid for the Natural Valley Procedure within the levee-impacted area.

Appendix F (DVD) provides additional information regarding the methodology used in the Initial Data Analyses.

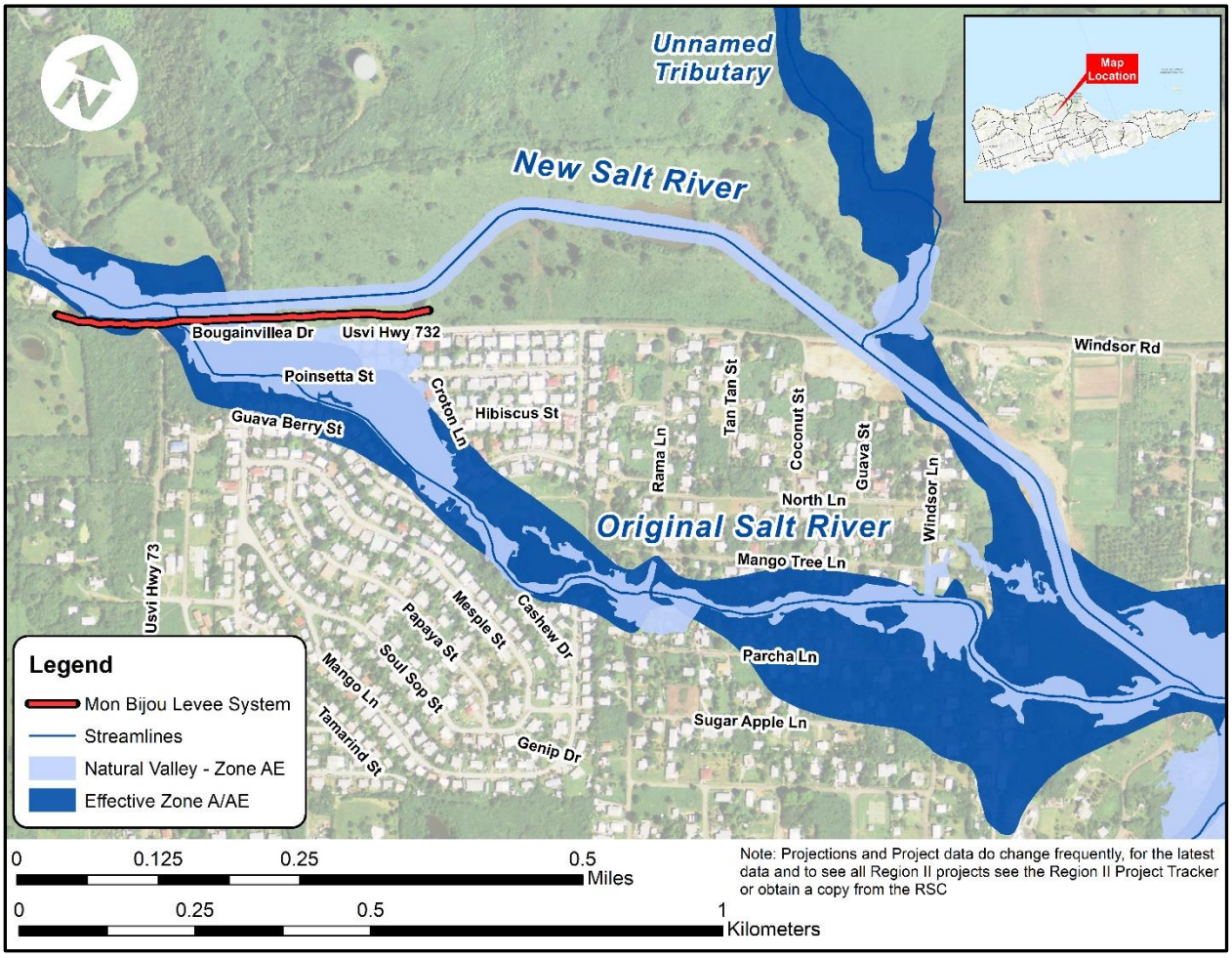

Figure 3: Natural Valley Procedure

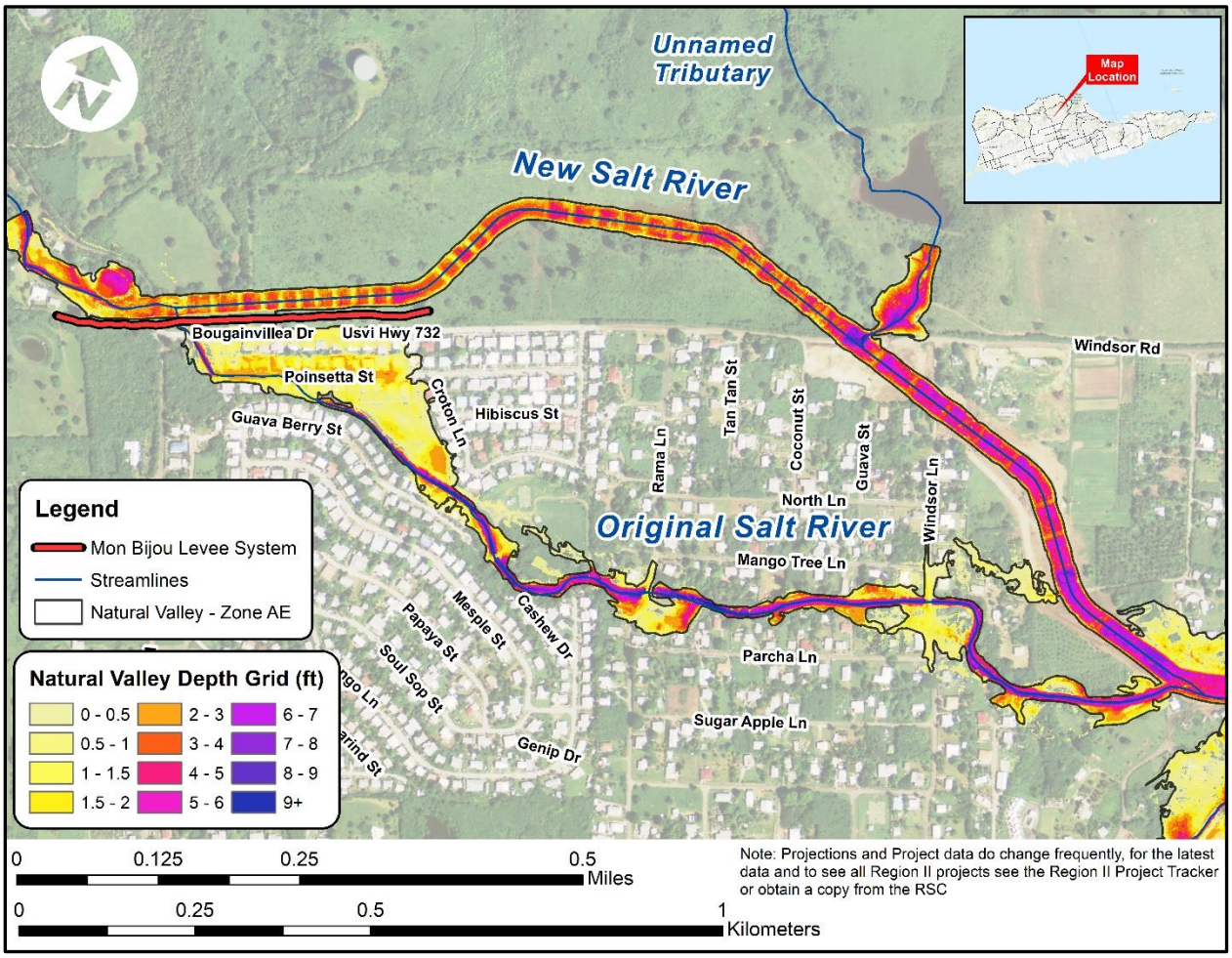

Figure 4: Natural Valley Procedure Flood Depth Grid

The composite results of the Structure-based Inundation Procedure, shown in

Figure 5 and Figure 6, yield a similar inundation area compared to the Natural Valley Procedure within the levee-impacted areas. The Structure-based Inundation Procedure yielded a slightly increased inundation area near the levee and yielded decreased extents downstream of the Original Salt River path. The Structure-based Inundation procedure applies hypothetical breaches to a levee without a history of breaching. The Natural Valley Procedure would be used to map the levee flood hazard if incomplete or no additional data is provided for the levee systems.

The results of the Structure-based Inundation Procedure can be used by community officials and emergency managers to inform emergency action planning and outreach to residents living within the levee-impacted area. The Structure-based Inundation Procedure is an important reminder that if there is a breach in the levee system, areas near a breach are at increased risk due to higher velocity flow and inundation which could happen with little or no warning.

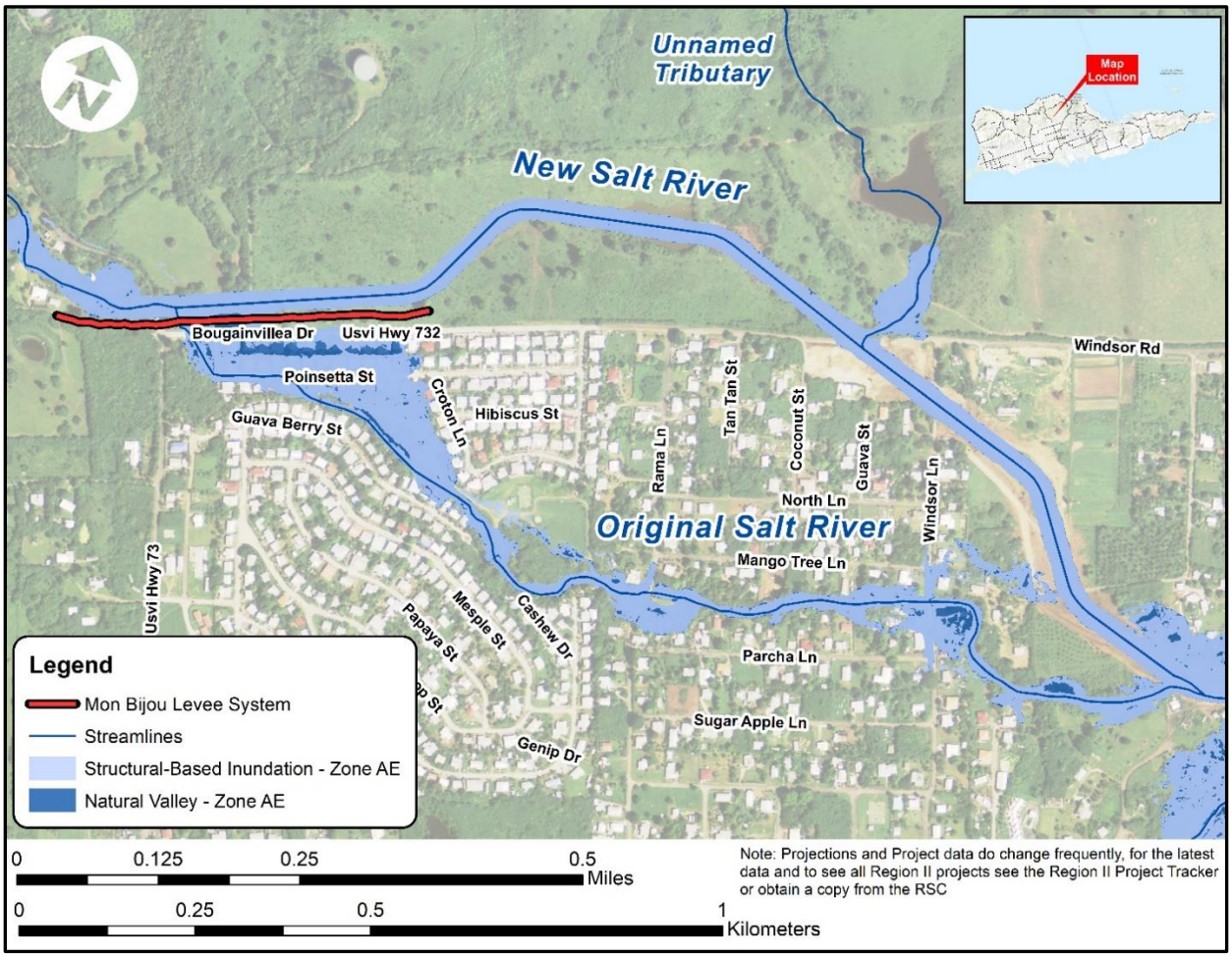

Figure 5: Structure-based Inundation Procedure

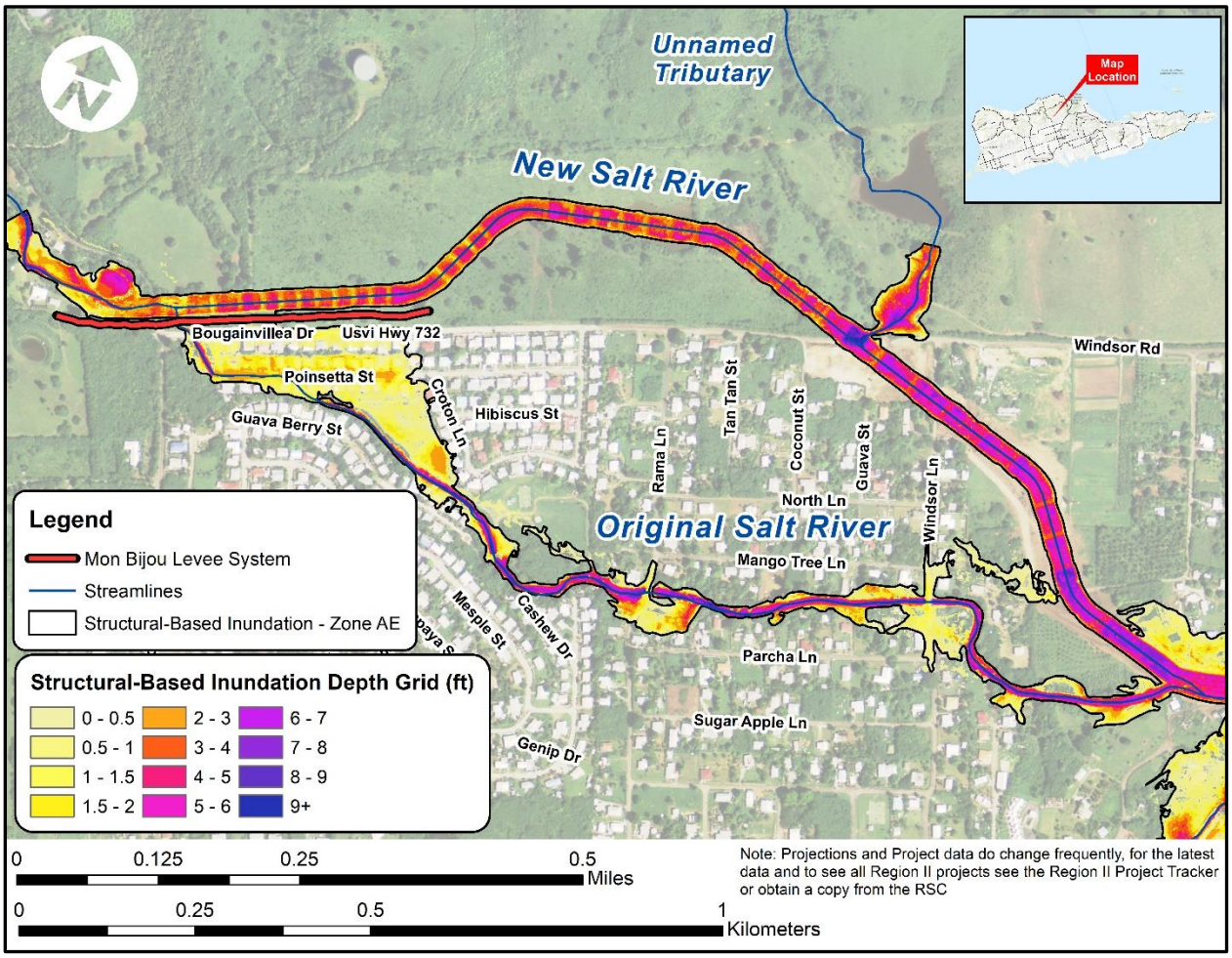

Figure 6: Structure-based Inundation Procedure Flood Depth Grid

Table 5 includes a summary of the results obtained from the Initial Data Analysis.

Table 5. Results from the Initial Data Analysis

Reach	Approximate Length of Levee Segment (ft)	Comments: Natural Valley Procedure[2] (Figure 3)	Comments: Structure-based Inundation Procedure[3] (Figure 5)
		Approximate # Structures[4] Impacted by Zone AE: 50	*Approximate # Structures Impacted by Zone AE: 51*
Mon Bijou	1,750	Results from updated hydraulic model (2D). Estimates potential inundation/levee-impacted area if not mapped as reducing flood hazard.	Inundation extents similar to the Natural Valley Procedure for the 1-percent-annual chance flood. May be utilized for emergency planning.

[2] Depicts levee reach as not reducing flood hazard. No additional data required to support future analysis or mapping.
[3] All minimum requirements of 44 CFR 65.10 are met. Certified data compliant with 44 CFR 65.10 required to support future analysis or mapping.
[4] Approximate number of structures impacted estimated from aerial imagery.

6 Path Forward

6.1 Levee Analysis and Mapping Procedures

The Mon Bijou Flood Control Channel Project includes the Mon Bijou Levee System. Neither the levee system nor the diverted Salt River are shown as reducing flood hazard on the effective FIRM. As no data in support of the 44 CFR 65.10 requirements have been received by FEMA in support of the levee project, the levee systems would be considered non-accredited in a future remapping effort.

FEMA engaged representatives from the Territory of the U.S. Virgin Islands throughout the Levee Analysis and Mapping Procedures for non-accredited levees process to help identify potential options to evaluate the flood hazard for the levee-impacted areas. The community is considering moving forward with a LOMR to map the reduced flood hazard due to the levee systems on the future FIRM. Accreditation of the levee was not considered by the community due to the lack of data needed for accreditation.

Should the community be able to provide 44 CFR 65.10-compliant data for the Mon Bijou Levee System, the flood hazard of the associated levee-impacted areas could be shown as shaded Zone X plus interior drainage Special Flood Hazard Area. If the community does not provide 44 CFR 65.10-compliant data, the effective FIRM dated April 16, 2007, would be revised to show updated flood risk using the Natural Valley Procedure once the FEMA Regional Office incorporates updates into future mapping studies.

FEMA anticipates updating the flood hazard maps in the future and would inform the community prior to the initiation of any update project. Should 44 CFR 65.10-compliant levee data be provided prior to the Letter of Final Determination for the countywide mapping project, it would be incorporated into the final countywide mapping. However, data in support of 44 CFR 65.10 may be submitted at any time through the Letter of Map Revision (LOMR) process to update the FIRM. It is recommended that the community coordinate with FEMA Region II in advance of any submittal to keep the Region apprised of the levee status. For reference, Appendix D includes FEMA's Levee Accreditation Checklist.

7 References

FEMA, Flood Insurance Study, U. S. Virgin Islands, April 2007.

FEMA, Guidance for Flood Risk Analysis and Mapping, Levees, February 2018.

FEMA, Non-Accredited Levee Analysis and Mapping Guidance, September 2013.

USACE, National Levee Database (https://levees.sec.usace.army.mil/#/), 2019.

Appendix A
Stakeholder Engagement - LLPT Meeting 1 Information

Appendix B
Stakeholder Engagement - LLPT Meeting 2 Information

Appendix C
Freeboard Profile Comparison

Appendix D
Levee Accreditation Checklist

Appendix E
Collected Data

(Full Appendix Provided on DVD)

Appendix F
Initial Data Analysis

(Full Appendix Provided on DVD)