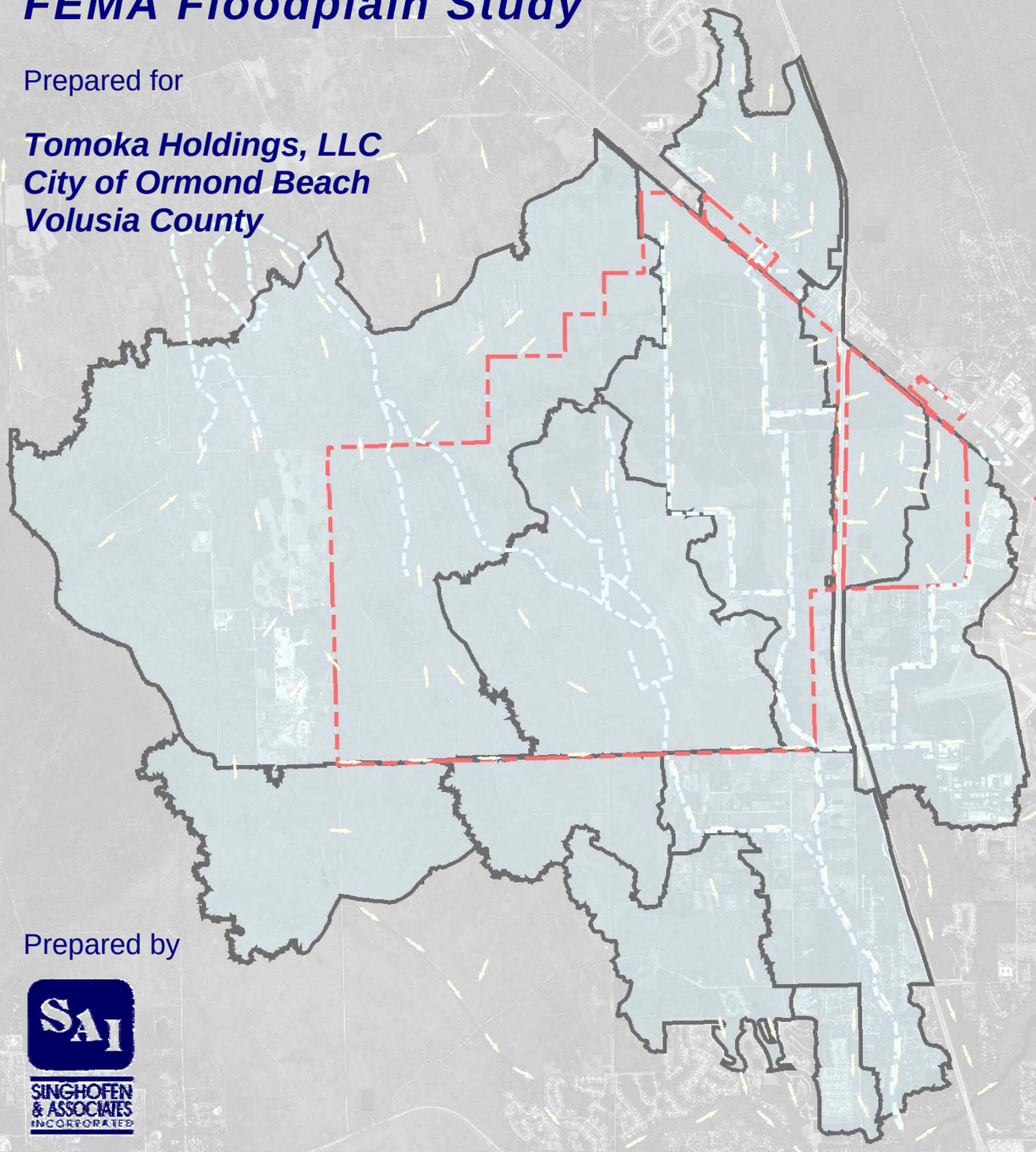
# Ormond Crossings

## FEMA Floodplain Study

Prepared for

***Tomoka Holdings, LLC***
***City of Ormond Beach***
***Volusia County***



Prepared by


***Singhofen & Associates, Inc.***
***Stormwater Management***
***and Civil Engineering***


***June 2009***

# Table of Contents

**Section 1 - Introduction and Background**
1.1 Introduction ..... 1-1
1.2 Study Area ..... 1-1
1.3 Project Background ..... 1-2
1.4 Study Objectives ..... 1-3
1.5 Report Organization ..... 1-4

**Section 2 – Method of Analysis**
2.1 Hydrologic Data Development ..... 2-1
2.1.1 Sub-Basin Drainage Data ..... 2-1
2.1.2 Drainage Areas and Curve Numbers ..... 2-1
2.1.3 Time of Concentration ..... 2-2
2.1.4 Unit Hydrograph and Rainfall ..... 2-5
2.2 Hydraulic Data Development ..... 2-6
2.2.1 Node and Link Nomenclature ..... 2-6
2.2.2 Node Data (i.e. Stage Area, Boundary Conditions, Initial Conditions) ..... 2-7
2.2.3 Link Data (i.e. Culverts, Drop Structure, Weirs, Channels, Bridges) ..... 2-10
2.3 Data Collection and Field Reconnaissance ..... 2-12
2.3.1 Data Collection and Site Reconnaissance ..... 2-12
2.3.2 Western Offsite Drainage Area ..... 2-13
2.3.3 Field Survey ..... 2-14
2.3.4 Supplemental Field Survey ..... 2-14

**Section 3 - Existing Conditions Analysis**
3.1 Model Development ..... 3-1
3.2 Stormwater Analysis ..... 3-1
3.3 Simulation Results ..... 3-1
3.3.1 Model Results Comparisons ..... 3-1
3.3.2 Flooding Areas ..... 3-3
3.4 Summary of Existing Conditions ..... 3-4

**Section 4 - References** ..... 4-1

# Figures

## Figures


Figure 1.1 Vicinity Map ..... 1-5
Figure 1.2a Overall Drainage Map ..... 1-6
Figure 1.2b Updated FEMA Floodplain Area ..... 1-7
Figure 1.3 SJRWMD, CDM, and SAI Basin Map ..... 1-8
Figure 1.4 Western Offsite Drainage Area ..... 1-9

Figure 2.1 Computing Runoff Curve Numbers with Arc GIS ..... 2-2
Figure 2.2 Average Velocities for Estimating Travel Time for Shallow Concentrated Flow ..... 2-4
Figure 2.3 Boundary Conditions – Tomoka River outfall location ..... 2-9
Figure 2.4 Boundary Conditions – Northwestern outfall location ..... 2-9

Figure 3.1 Groover Branch Profile Comparison ..... 3-5
Figure 3.2.1 Flood Profile – Eastern Onsite Drainage Ditch ..... 3-6
Figure 3.2.2 Flood Profile – Western Onsite Drainage Ditch ..... 3-7
Figure 3.2.3 Flood Profile – Groover Branch ..... 3-8
Figure 3.2.4 Flood Profile – Groover Branch Eastern Tributary ..... 3-9
Figure 3.2.5 Flood Profile – Groover Branch Western Tributary ..... 3-10
Figure 3.3 Existing Conditions Floodplain Map ..... Map Pocket


# Tables

## Tables


Table 2.1 Rainfall Data ..... 2-5
Table 2.2 ICPR Group Designations and Descriptions ..... 2-7

Table 3.1 Maximum Stages ..... 3-12
Table 3.2 Maximum Stage Comparisons ..... 3-17
Table 3.3 Roadway Flood Evaluation ..... 3-18

# Technical Appendix

**The following Technical Appendices are also provided digitally and are included on DVD, which is located in the front cover of the Floodplain Study.**

**Appendix A – Hydrologic Information**

Table A.1 - Landuse Designation and Curve Number Table
Table A.2 - Existing Conditions Curve Number Calculations
Table A.3 - Existing Conditions Times of Concentration Calculations

**Appendix B – Survey Information**

B.1 Survey Field Notes – Geomatics Corp.
B.2 Survey Field Notes – Henrich-Luke & Swaggerty, LLC
B.3 Field Notes – Singhofen & Associates, Inc.
All Survey Photos (electronic only)

**Appendix C – Existing Conditions Model Input and Output Data**

Existing Conditions – ICPR Model (OC-FEMA.ICP)
Existing Conditions - Model Input
Existing Conditions – Basin Maximum Conditions Comparison Report
Existing Conditions - Node Maximum Conditions Comparison Report
Existing Conditions - Link Maximum Conditions Comparison Report
Existing Conditions - Link Minimum Conditions Comparison Report

**Appendix D – Maps**

L1 - Landuse Map
S1 - Soils Map

**Appendix E – FEMA LOMR Application**

E.1 – Overview & Occurrence
E.2 – Riverine Hydrology & Hydraulics
E.3 – Riverine Structures
E.4 – Topography Certification
E.5 – Effective Flood Insurance Rate Maps

**Map Set**

F1 thru F44 - Existing Conditions Floodplain Maps

## 1.1 Introduction

Singhofen and Associates, Inc (SAI) was contracted by Tomoka Holdings, LLC to conduct an existing conditions drainage study for Ormond Crossing for the use in support of permitting activities for the project to update the existing floodplains identified in the applicable effective FEMA Flood Insurance Rate Maps (FIRMs). The study included development of a stormwater model that was used to predict runoff rates and flood stages under various rainfall events (e.g. 500-yr, 100-yr, 50-yr, 25-yr, 10-yr and 2-yr storms). Development of the stormwater model included identification of offsite contributing areas, identification of natural and man-made hydraulic features, determination of existing runoff rates, and calculation of peak flood stages and flow rates for the study area. It incorporates a mix of available information including landuse, soils, plans and permit data as well as recent topography and survey. This report and supporting data describes the analysis.

## 1.2 Study Area

The Ormond Crossings project is generally bounded by U.S. Highway 1 (U.S. 1) and the FEC railroad to the north, Shedd Lane to the southeast and Durrance Lane to the southwest (Refer to **Figure 1.1**). The project is divided into two portions by I-95, with 1,680 acres located to the east of the highway and the rest of the project on the west. The model study area (Refer to **Figure 1.2a**) extends beyond the project area and includes 15,236-acres with approximately 7,087 acres in Volusia County, FL and 8,149 acres in Flagler County. The Ormond Crossings study area is located entirely within the Tomoka River Watershed. Proposed changes to FEMA floodplains are limited to the portion of the study area located within the City of Ormond Beach and Volusia County to Tymber Creek Road (See **Figure 1.2b**).

The drainage outfall for the project and adjacent areas is through a relatively small, deeply incised creek called Groover Branch. Groover Branch conveys flood flows in a southerly direction to the Tomoka River near S.R. 40 in Volusia County. The primary focus of the study is Ormond Crossings and the area south of Durrance Lane along Groover Branch. However, adjacent areas to the west and north of Ormond Crossings were also included in the analysis to account for offsite contributing areas that discharge into Ormond Crossings (Refer to **Figure 1.2a**).

Onsite land use generally consists of pasture, silviculture, and wetlands. The land uses in a majority of the offsite drainage areas consist of rural residential, pasture, forests, and wetlands with the exception of commercial areas found along the U.S. 1 corridor. For a detailed illustration and discussion of the existing land use within the study area, refer to **Section 2** of this report.

**Figure 1.2a, Figure 1.3** and **Figure 1.4** show the general drainage characteristics and topographic gradients of the study area. As illustrated in those figures, the western portion of the property contains a plateau area from which elevations slope northwesterly or southeasterly to Groover Branch. Flow directions in this area are subject to a variety of factors which are discussed further in **Section 3** of this report.

## 1.3 Project Background

The Ormond Crossings project is a Development of Regional Impact (DRI) that has been approved by the Northeast Florida Regional Planning Council (NFRPC), the East Central Florida Regional Planning Council (ECFRPC), and the City of Ormond Beach (City). The proposed project includes a mix of commerce park, residential development, recreational park and conservation areas. Updated floodplains have been determined based on more recent terrain and hydraulic data for the project site. This effort also included a peer review by consultants for the City of Ormond Beach.

Based on conversations with several landowners in the area of the project and statements made during public hearings for the project, flooding has been identified at several locations along the Groover Branch drainage system. Groover Branch serves as the primary drainage outfall for the Ormond Crossings property and some adjacent areas. The flooding includes yard flooding and roadway overtopping including Durrance Lane on the southern side of the project. It has occurred on multiple occasions and, in some instances, has resulted in flood stages being several feet above roadway crowns.

Several drainage studies have been conducted in the vicinity of the Ormond Crossings project:

- *Tomoka River Flood Plain Management Study – Tributaries to the Tomoka River* (U.S. Department of Agriculture, Soil Conservation Service - 1986)
- *Flood Insurance Study, Volusia County, Florida (Unincorporated Areas)* (Federal Emergency Management Agency - 1996)
- *Volusia County Tomoka River Watershed Management Plan: Stormwater Control, Conservation, and Aquifer Recharge Program* (Camp, Dresser, and McKee, Inc. - *1995*).

While each of these studies included the Ormond Crossings property in their analyses, the first two did so in limited detail. The study by Camp, Dresser, and McKee, Inc. (CDM) made use of field surveys along the onsite ditches and USGS quadrangle topography for most of the remaining study area. Several modifications have been made to structures in the Groover Branch system since the CDM study was completed in 1995. The existing conditions Ormond Crossings model developed by SAI includes updated, more detailed hydraulic structure and topographic information. Pickett & Associates, Inc. was initially contracted to provide Light Detection and Ranging (LiDAR) topographic survey of the Ormond Crossings project site. Updated topography was also obtained from the City of Ormond Beach for the portions of the study area in Volusia County. In addition, Geomatics Corporation and Henrich-Luke & Swaggerty, LLC were contracted to conduct field surveys of onsite and offsite hydraulic features. SAI used these surveys and updated topographic data to develop an initial existing conditions stormwater model for the study in June 2006. The basin limits of this initial model were consistent with limits developed in the CDM study and basin information adopted by the St. Johns River Water Management District (SJRWMD) (Refer to **Figure 1.3**).

A Flagler County public hearing was held in December, 2006 to discuss a future land use map amendment for areas of the proposed Ormond Crossings development within Flagler County. Comments were made during the hearing that asserted the SJRWMD basin limits were inaccurate. The basin area in question was reported to contribute runoff to the Ormond

Crossings property that was not accounted for in the initial SAI study (Refer to **Figure 1.4**). A map showing the estimated limit of these additional areas was displayed by Mr. Todd Gipe, a former employee of the SJRWMD and environmental consultant, speaking on behalf of Mr. Marcus Strickland, Jr. who owns property adjacent to the Ormond Crossings project. The basin map presented by Mr. Gipe was based on his best recollection of field observations he had made several years before.

As a result of the comments made by Mr. Strickland and his consultant, Tomoka Holdings LLC directed SAI to obtain additional topographic information for the area in question to confirm drainage patterns and, where necessary, update the stormwater modeling. SAI contracted with Jones, Edmunds & Associates, Inc. (JEA) to prepare this information. The LiDAR topography was obtained in late May 2007. Drainage flow patterns and hydraulic connections were updated in the stormwater model, as necessary, based on the new information (See SAI Watershed Boundary depicted on **Figure 1.3**).

As a result of the hearings at Flagler County and the City of Ormond Beach, a peer review of the drainage study was also recommended. The model was submitted to CDM for this peer review in August, 2007. Comments were received in the spring of 2008 which required additional topopgraphy and further analysis. The topography was obtained through a supplemental contract with JEA in March, 2008. The existing conditions Ormond Crossings stormwater model was updated with the information. The limits of the study are shown on **Figure 1.2a**. A detailed discussion of methodologies used in development and parameterization of the model and the model results is included in this report. This includes assumptions regarding the above information and how it was incorporated into the modeling.

## 1.4 Study Objectives

The primary tasks involved with performance of this study included the following:

- *Data Collection*: Collection and review of available information, reports and model data, field reconnaissance, and survey of existing hydraulic features.
- *Existing Condition Analysis*: Development of an existing conditions stormwater model based on collected data and the most current, available information (aerial photographs, LIDAR, field reconnaissance, survey, etc.) to be used for identification and evaluation of flooding extents and magnitude.
- *Report Development*: Organization and discussion of all analytical methods and results into this report.
- *FEMA LOMR*: Preparation of the FEMA LOMR package to submitted to the City of Ormond Beach.

## 1.5 Report Organization

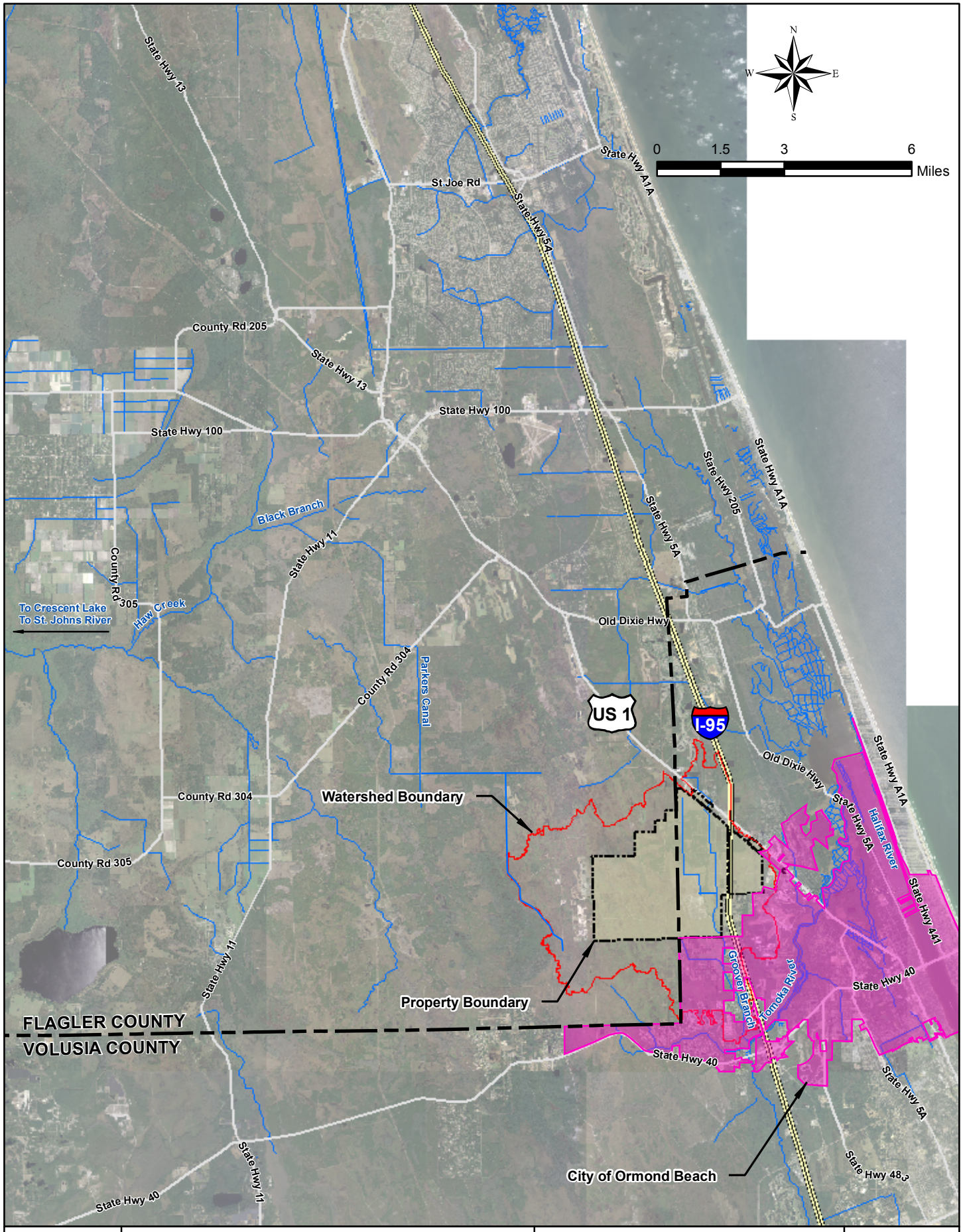
This report is organized into the following sections:

- *Section 1 – Introduction and Background* provides general background information of the project and organization of this report.
- *Section 2 – Method of Analysis* summarizes the results of data searches, interviews, field site visits, and site surveying. The section presents a summary of the methodology used for the water quantity assessment including the development of the hydrologic and hydraulic models.
- *Section 3 – Existing Conditions Analysis* presents a discussion of the existing conditions stormwater model, floodplain maps and the deficiencies identified in the drainage system.
- *Section 4 – References* include a list of documents, maps and reports utilized in performing the drainage analyses and preparing this report.

Additional information for this report is provided in a separate Technical Appendix and Map Set including the following information:

- *Appendix A* – Hydrologic data
- *Appendix B* – Survey information
- *Appendix C* – Existing Conditions Models ICPR© input and output data
- *Appendix D* – Maps (Soils and land use maps)
- *Appendix E* – The FEMA Letter of Map Revision Application (LOMR) submittal package
- *Map Set* – Basin, node, link model schematics with floodplains

A DVD is also enclosed within this report that contains digital copies of this document, the Technical Appendices and the Map Set. It includes such information as drawing files, electronic survey files, other backup calculations and the ICPR© input and output databases for the model.




| | | | |
|---|---|---|---|
| SAI | ORMOND CROSSINGS | VICINTY MAP | FIGURE: 1.1 |

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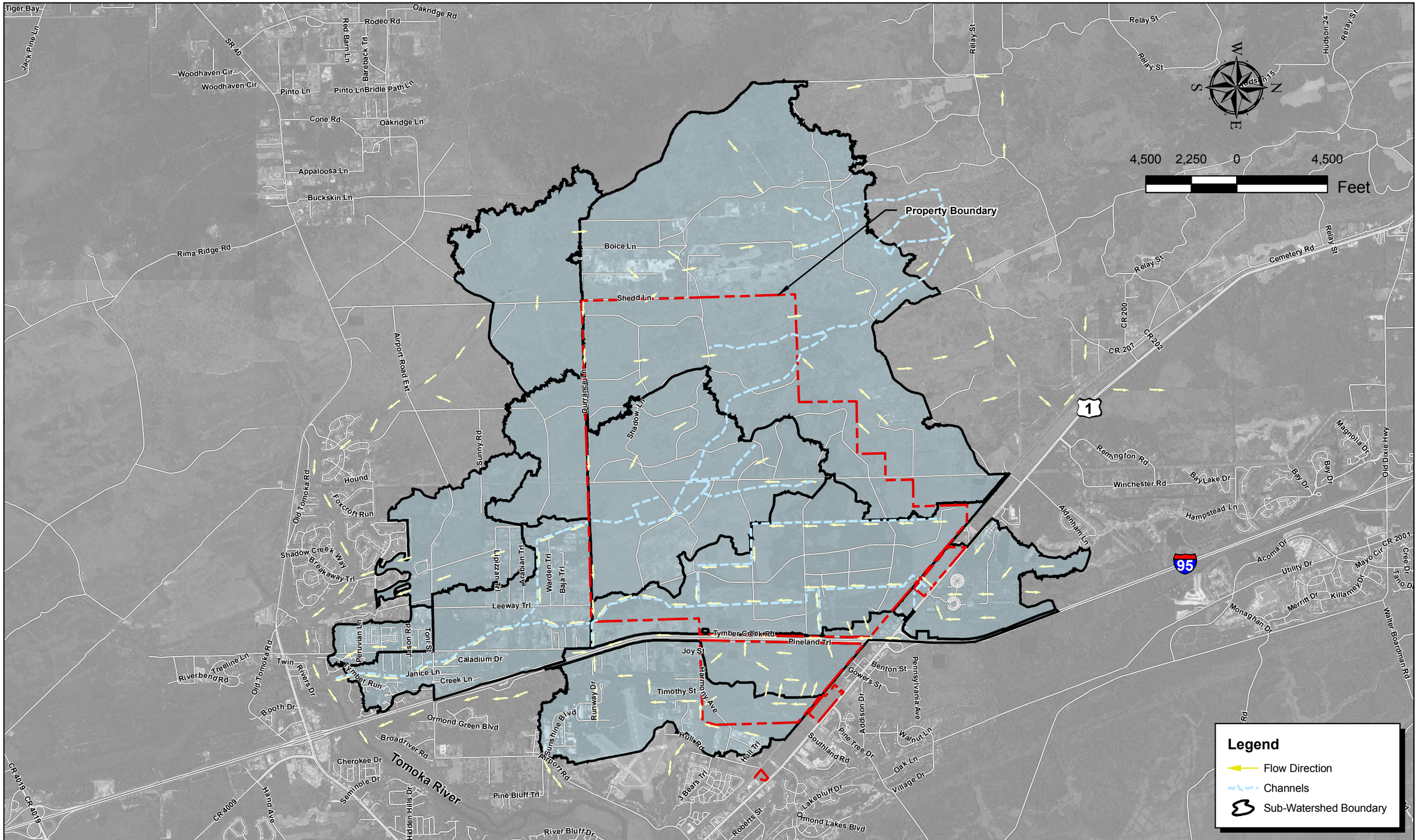


**SINGHOFEN & ASSOCIATES, INC.**
PHONE: (407) 679-3001 FAX: (407) 679-2691

**ORMOND CROSSINGS**

**OVERALL DRAINAGE MAP**

**FIGURE: 1.2a**

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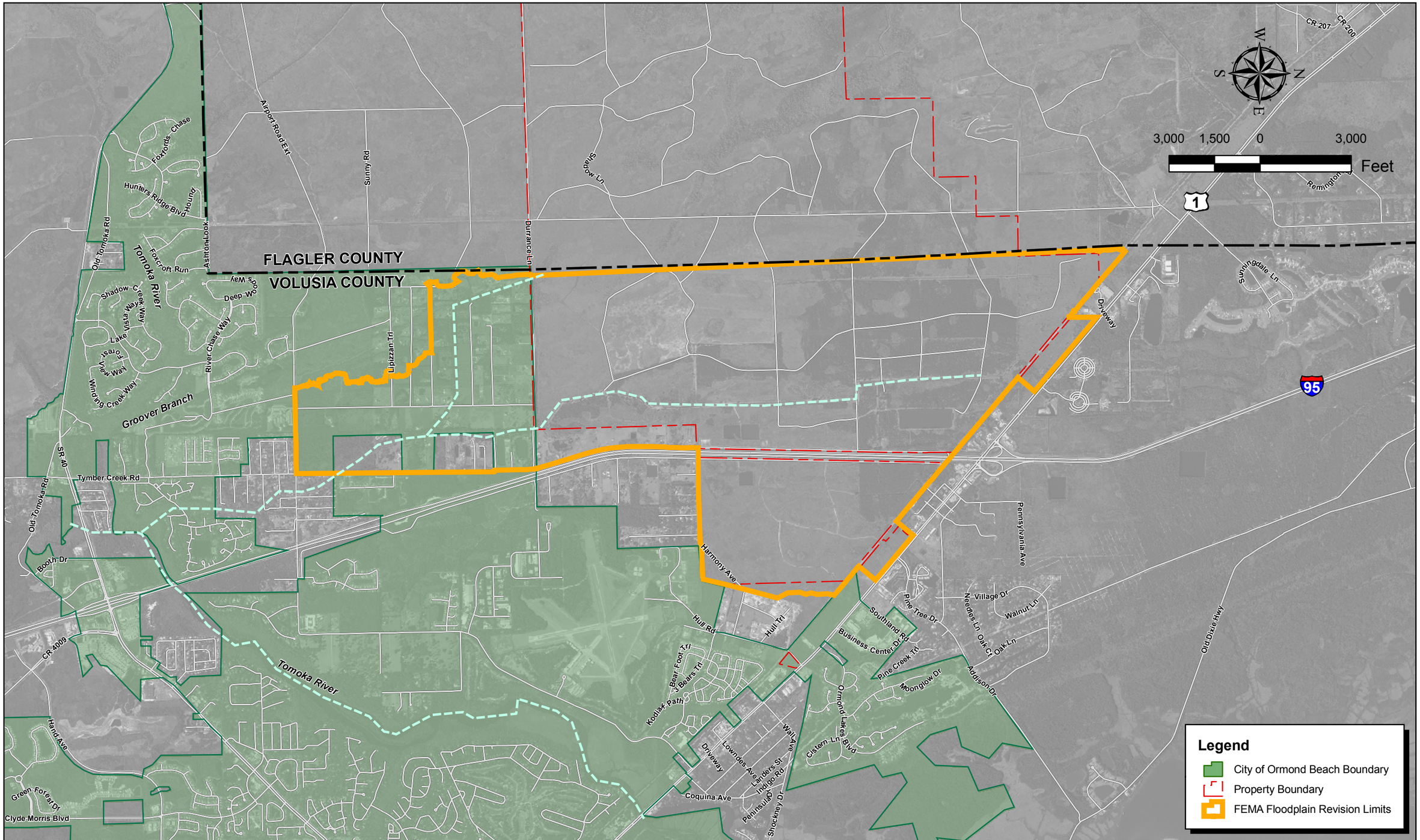


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**ORMOND CROSSINGS**

**UPDATED FEMA FLOODPLAIN AREA**

**FIGURE: 1.2b**

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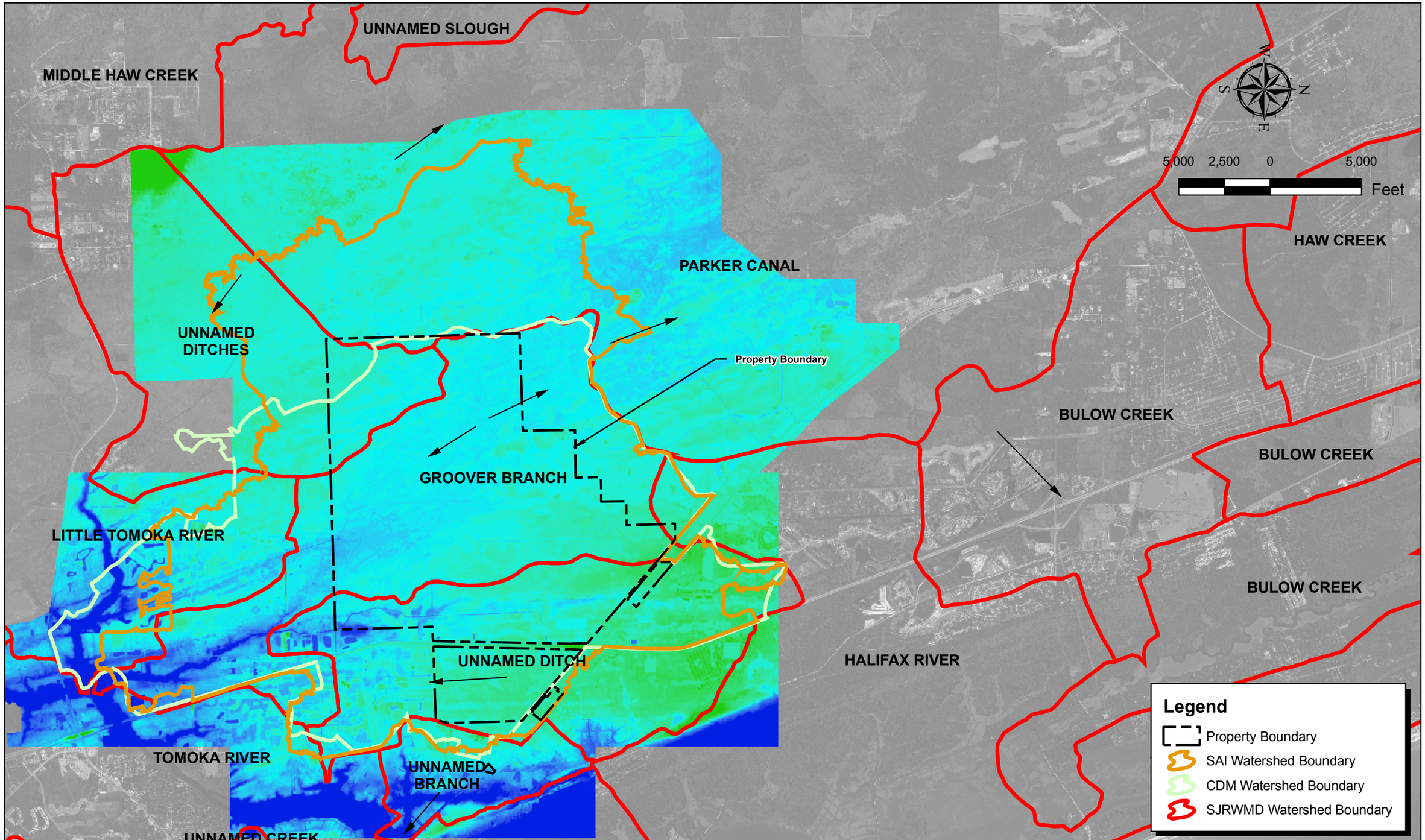


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ORMOND CROSSINGS

SJRWMD, CDM, AND SAI BASIN MAP

FIGURE: 1.3

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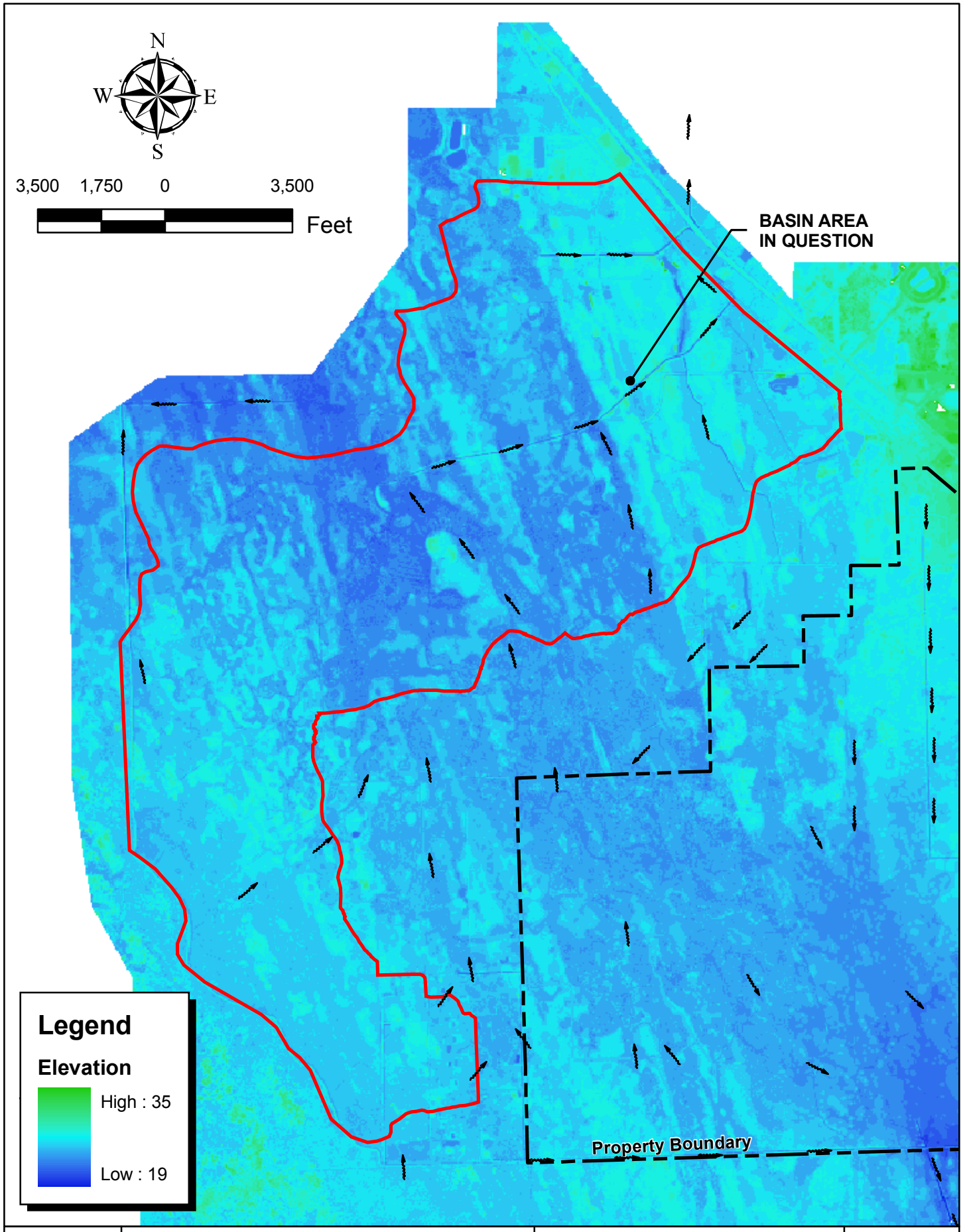


| | | | |
|---|---|---|---|
| SAI | ORMOND CROSSINGS | WESTERN OFFSITE DRAINAGE AREA | FIGURE: 1.4 |

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The Ormond Crossings drainage study involved the application of several analytical procedures for assessing the existing drainage conditions. A comprehensive hydrologic and hydraulic (H&H) computer model was prepared to simulate the rainfall-runoff process. The hydraulic responses in the drainage network were calculated throughout the study area for each of the simulated storms using the Interconnected Channel and Pond Routing program (ICPR©, Version 3.10 Service Pack 3). ICPR uses a junction-reach (node-link) representation of the watershed to calculate rates and volumes of stormwater runoff and then hydrodynamically route the runoff through the modeled drainage infrastructure. This program has been accepted by the Federal Emergency Management Agency (FEMA) for use on floodplain investigations associated with flood insurance applications. The following sections present a discussion of the development of the H&H models. Copies of all pertinent data files prepared for modeling purposes are included in the Appendices of this report.

## 2.1 Hydrologic Data Development

The SCS unit hydrograph method was used in ICPR© to generate runoff hydrographs for each sub-basin in the study area. Several hydrologic parameters are required to implement this method. These include drainage area, Natural Resource Conservation Service (NRCS) runoff curve number, percent of directly connected impervious area (DCIA), time of concentration, rainfall distribution and amount, and peak rate factor. This section describes the development of all parameters necessary to implement the SCS unit hydrograph procedure.

### 2.1.1 Sub-Basin Drainage Data

The 24 $mi^2$ study area is composed of three primary drainage outfalls. The eastern and central areas including area north of U.S. Highway 1 (U.S. 1) flow through Groover Branch to the Tomoka River. The southwestern areas flow through a large conservation area adjacent to Hunters Ridge ultimately reaching the river as well. The final area includes the northwestern system that flows toward the Sweetwater Branch and Parker Canal systems. (Refer to **Figure 1.2a**).

The number and size of the sub-basins to be described is generally a function of the complexity required for the analysis of the drainage system, including both land use and drainage infrastructure detail. Three hundred and sixty-one sub-basins were delineated to provide the level of detail that was deemed necessary to model the study area. These sub-basin divides were based on 1-ft LIDAR topography (onsite and offsite areas) and aerial photographs from the Land Boundary Information System (LABINS, 2004), field reconnaissance, permit and construction plan review, and a drainage infrastructure inventory. Maps of the drainage sub-basin delineations for the study area are included in the **Map Set** (under separate cover) and on the enclosed DVD.

### 2.1.2 Drainage Areas and Curve Numbers

Values of drainage area and weighted NRCS curve numbers (CN) were calculated for each sub-basin using ArcGIS© (Version 9.2) and a custom tool developed by SAI. The tool calculates these geographic-based parameters from digitized GIS layers of sub-basins, land uses and soil hydrologic groups. It does so by generating geographical intersections or combinations of values in the separate data layers and, through the use of lookup tables, determining geographically

weighted values for such parameters as CN and DCIA. For example, drainage sub-basins are superimposed with land use and soils data to determine area-weighted runoff curve numbers as shown in **Figure 2.1** below.

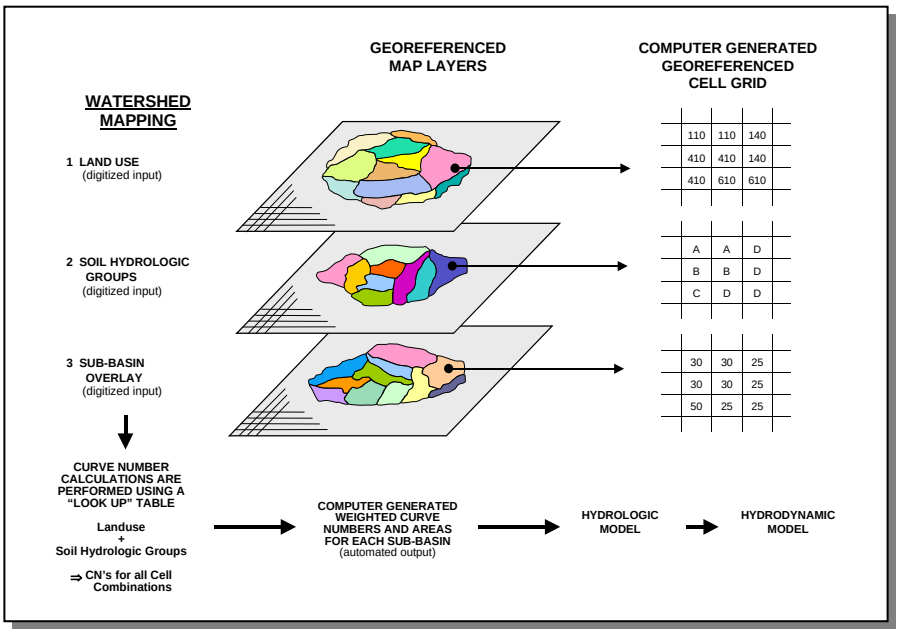



**Figure 2.1 Computing Runoff Curve Numbers with ArcGIS**

The GIS land use designations (i.e. FLUCCS codes) for the study area were obtained from Florida Department of Environmental Protection (FDEP, 2000) and updated based on recent aerials. Polygons with identical land use designations were dissolved in preparation for the CN and DCIA calculations. For an illustration of the existing conditions land use, refer to **Appendix D.**

The relationships between land use, assumed percentage of pervious and impervious area, soil hydrologic group and runoff curve number are presented in **Appendix A: Table A.1**. **Table A.1** assumes normal antecedent moisture conditions (AMCII). Furthermore, soil types with hydrologic group B/D classifications were assumed to be type D for the purpose of curve number calculations, and all water bodies or wetlands were assigned a curve number of 98. Calculated sub-basin curve numbers under existing land use conditions are included in **Appendix A: Table A.2**. A map of the soils located within the study area is included in **Appendix D**.

### 2.1.3 Time of Concentration

Time of concentration is defined in TR-55 as "the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed" (USDA, 1986). The time of concentration for any watershed or sub-basin is the summation of individual travel times computed for the various consecutive flow segments, each based on distance, slope, cover, and flow conditions as represented by **Equations 2.1** and **2.2** presented below.

The total time of concentration may be broken into three components. These components include sheet flow, shallow concentrated flow, and channel flow. Sheet flow is assumed to occur

for a maximum of 300 feet, and includes all friction factors acting on the water. The kinematic equation used to compute sheet flow is presented below (**Equation 2.1**).

Runoff typically transitions from sheet flow to shallow concentrated flow. This time component can be calculated by using **Equation 2.2**, using average flow velocity obtained from **Figure 2.2**.

$$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5} S^{0.4}}$$ **(Equation 2.1)**

where,

| | |
|---|---|
| Tt | = Sheet flow time in hours |
| n | = Manning's coefficient |
| L | = Flow length in feet |
| P2 | = 2-year/24-hour rainfall amount in inches |
| S | = Land slope in feet/feet |

Note: The use of this equation assumes a 24-hour rainfall duration.

$$T_t = \frac{L}{3{,}600 * V}$$ **(Equation 2.2)**

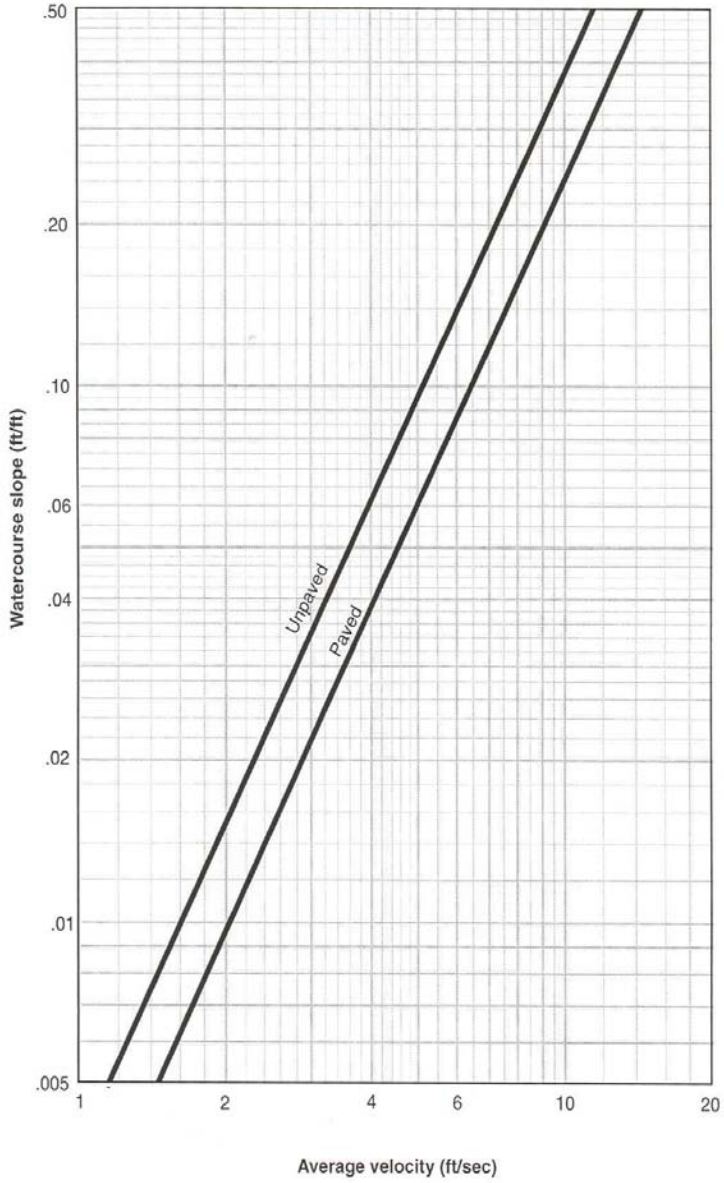
where,

| | |
|---|---|
| Tt | = Shallow concentrated flow time in hours |
| L | = Flow length in feet |
| V | = Average velocity in feet/second |
| 3600 | = Conversion factor from seconds to hours |

The final element needed when computing the time of concentration is channelized flow. Channelized flow is characterized as open channel, gutter, or pipe flow. The shallow concentrated flow equation (Eq. 3.2) is used to compute the time associated with this type of flow. However, the velocity of the water flowing through the conveyance system is calculated using Manning's equation.

The sum of all time components for the longest path within the basin determines the time of concentration. The above referenced approach was utilized to calculate times of concentration for each of the sub-basins for the Ormond Crossings model. A minimum time of concentration of 10 minutes was applied to all sub-basins. The calculated time of concentration values for each of the sub-basins are included in **Appendix A: Table A.3**.

**Figure 2.2 Average Velocities for Estimating Travel Time for Shallow Concentrated Flow**




Source: TR-55, 2nd Ed., June 1986

### 2.1.4 Unit Hydrograph and Rainfall

A unit hydrograph is the runoff response of a given basin (in terms of runoff rate versus time) that would result from 1 inch of rainfall excess. The assumption for this method is that each basin has a characteristic unit hydrograph that is a unique function of its physical configuration.

The unit hydrograph method requires that the rainfall event be divided into discrete increments over fixed time intervals. Infiltration is subtracted from each incremental value and the remainder represents the rainfall excess. Each increment of rainfall excess is then applied to the basin's unit hydrograph to obtain a response for the discrete time interval. Responses for all rainfall increments are then distributed in sequence and summed to produce a "composite" sub-basin runoff hydrograph.

The shape of the basin unit hydrograph is also dependent on the peak rate factor, "K". The peak rate factor may be calculated if measured rainfall and runoff rate information are available for a given area. However, such information is not available for the Ormond Crossings study area. Therefore, it was selected based on overall watershed properties such as the amount of depressional storage, degree of development, and overall slope of the study area. A value of 256 was used for the study area based on an average slope of 0.1 percent, which is consistent with published peak rate factor values for watersheds with very mild slopes (Wilkening, 1990). Additionally, a peak rate factor of 256 was in the Flagler County Flood Insurance Study (July, 17, 2006).

Rates and volumes of stormwater runoff were calculated using the methodology described above as implemented in ICPR©. This requires specification of rainfall time distributions for the desired storms. Rainfall for simulations of the 2-year, 25-year and 100-yr – 24 hour storms were distributed using the Soil Conservation Service – Florida modified rainfall distribution. The rainfall amounts used for each of the simulations were chosen to be consistent with the Volusia County and Flagler County FIS (July 17, 2006) which is consistent with Technical Paper 40 (National Weather Service, 1961). The values are listed in **Table 2.1** below.

Table 2.1. Rainfall Data

| Return Period (yrs) | Duration (hrs) | Rainfall Distribution | Rainfall Amount (in.) |
|---|---|---|---|
| 2 | 24 | Florida Modified | 5.0 |
| 10 | 24 | Florida Modified | 7.5 |
| 25 | 24 | Florida Modified | 9.0 |
| 50 | 24 | Florida Modified | 10.0 |
| 100 | 24 | Florida Modified | 11.0 |
| 500 | 24 | Florida Modified | 13.3 |

The model simulation results are discussed in **Sections 3** of this report. Floodplain information presented in this report is based on the 500-yr and 100-yr 24-hr rainfall events.

## 2.2 Hydraulic Data Development

Hydraulic requirements for ICPR© consist of two general data types (node data and link data). A node is defined as a discrete location in the drainage system where stages are computed (ponds, major inflow points, slope or geometry changes, etc.). Links are used to connect nodes together and convey water between them (pipes, channels, weirs, etc.). Sources of information used to generate node and link data for the model include GIS and construction plan data, on-site investigations, and field surveys. Detailed existing conditions nodal diagrams including the identification of links are depicted in GIS maps contained on the included DVD and hard copy maps are included in the Map Set (under separate cover).

### 2.2.1 Node and Link Nomenclature

A system of nomenclature has been used to incorporate identification of each primary basin of the watershed into names of the various model locations. Each node and link is designated with a five to seven character alphanumeric name. Names for the nodes and links consist of a two-character prefix and a four digit numeric value. The link names also include a designation for the link type as illustrated below:

Sub-Basin/Node designation: XXZZZZ  Link designation: XXZZZZY

where:

XX = System designation as follows:
A, B, C, D, E, F & N = Ormond Crossings
GB = Groover Branch, including tributaries
HR = Hunters Ridge
DD = Destination Daytona
MitBank = proposed mitigation bank area

ZZZZ = Unique number for a node and/or a link in a tributary

Y = Link designation:
BR = Bridge  P = Pipe
C = Channel  W = Weir
D = Drop Structure

The link name is the same as the upstream node name with the type suffix. In some cases, multiple links are connected from the same node and require additional suffixes ("D0012P1", followed by "D0012P2" for the second link, and so on).

Each node and link was also assigned to a group. Groups are used by the ICPR© program to separate the overall data set into manageable portions for input and editing purposes, organizing simulations, and retrieving results. For example, data associated with the Groover Branch system were placed in a group called "Groover". The group names are generally the same as the system designations used in the link and node nomenclature. The other nodes and links in the study area are similarly assigned to group designations as listed **Table 2.2**.

Table 2.2 – ICPR Group Designations and Descriptions

| Group Name | Description |
|---|---|
| Ormond_A | The Interstate 95 drainage system and the onsite drainage system east of Pineland Trail |
| Ormond_B | The onsite drainage area associated with the eastern drainage ditch. |
| Ormond_C | The onsite drainage area associated with the western drainage ditch. |
| Ormond_D | The onsite and offsite wetland areas west of the onsite drainage ditches. |
| Ormond_E | The onsite and offsite wetland areas west and northwest of the onsite drainage ditches. |
| Ormond_F | The offsite wetland areas adjacent to the northwest boundary condition. |
| Ormond_N | The drainage system north of U.S.1 and west of I-95 |
| MitBank | Portions of data included in a proposed mitigation bank (western property area) |
| Groover | Groover Branch drainage and tributaries |
| Hunters Ridge | Hunters Ridge Development |
| BNDY | Boundary nodes used in the model |
| DD | Portion of model associated with Destination Daytona |

Groups can be used for selectively viewing information in the ICPR© program or for executing smaller portions of the overall model, a term referred to as "patching" simulations. ICPR© patches simulations by including only data from groups that are “active” at run time while setting boundary conditions at points where active and inactive groups connect. The stage-time relationship determined at those connection points comes from previously stored results for those inactive groups. Patching should always be based on prior simulations of the entire data set. Results of a patched simulation are updated for active groups only. Inactive group results remain unchanged. Thus, patching should only be used for preliminary simulations. Final simulations should include the entire dataset in the calculations.

### 2.2.2 Node Data

Node data requirements for ICPR© include the node name and group, stage-area relationships for storage nodes or overbank areas, stage-time relationships for boundary conditions, initial water surface elevations, and base flow rates (groundwater seepage, wastewater discharges, etc.), where appropriate.

**Stage-Area Data.** Stage-Area relationships were calculated at storage nodes along each of the channel/ditch systems to account for potential overbank storage of floodwater. The storage in pipe and channel links is internally computed by ICPR© based on cross section information and link length. Therefore, the storage volumes within channel and pipe links must be excluded in

the node stage-area data to avoid double-counting. Consequently, overbank storage takeoff for channels is based on areas outside of a defined channel buffer that represents the widths of cross sections throughout the nodal network. The channel buffer used in the stage area calculations is included electronically in **Appendix D.** Other storage areas (e.g. overbank areas, etc.) consisted of depressional wetland systems and pond areas. The stage-area data for overbank and depressional areas were all calculated from the digital topographic information discussed previously.

**Boundary Conditions.** Seven boundary conditions are specified at various locations around the study area. They are identified in the model node maps which are included in the **Map Set** (under separate cover) and on the enclosed DVD. All the boundary conditions (i.e. stage-time data) except two (i.e. BNDY4 & BNDY7) were set equal to the minimum overflow elevations. These elevations were based on the topographic information previously discussed. As the topography shows, there is a certain amount of topographic relief at these locations, which suggests that tailwater elevations at these locations should have little, if any, impact to the project area flood elevations.

Boundary 4 (i.e. BNDY4) is located at the Tomoka River. The boundary data at this location was based on results generated using a SWMM model that was provided by Camp, Dresser, and McKee. That model was developed as part of the **Volusia County Tomoka River Watershed Management Plan, 1995.** The model was executed by SAI for the various storm events discussed previously using the rainfall volumes mentioned above. The stage time information for the BNDY4 node (SWMM Junction: TRM973) was then imported into ICPR© for the analyses (See **Figure 2.3**).

Boundary conditions at Node BNDY7 at the northwest corner of the study area represents an area of relatively flat terrain. The controlling elevation between this node and the remainder of the modeled area to the southeast is between elevation 24.0 ft and 24.5 ft (NAVD88). The higher elevations represent dirt roads that have been constructed in the agricultural lands at that location. Floodplain limits in this area are identified on the effective FIRM as Zone A and they closely follow the 25 foot contour (NGVD) on the USGS quadrangle map for that area. This flood stage, when adjusted to the vertical datum used for the ICPR modeling of Ormond Crossings (i.e., NAVD88) is roughly equal to the natural grades and a few limited locations along the dirt roads. There are, however, FEMA floodplain elevations established further to the west that are higher than the Zone A elevation and would have tailwater effects on flows from the study area. These elevations were used to develop time vs. stage relationships assuming the FEMA flood elevation and timing characteristics of the runoff hydrographs for adjacent basins (See **Figure 2.4**).

**Initial Conditions.** ICPR© requires an initial water surface elevation for all nodes in the model. The program automatically calculates initial flows through the links based on these initial water surface elevations. Initial elevations at locations throughout the study area were set to approximate wetland limits or the control elevation of the downstream model link for all simulations.

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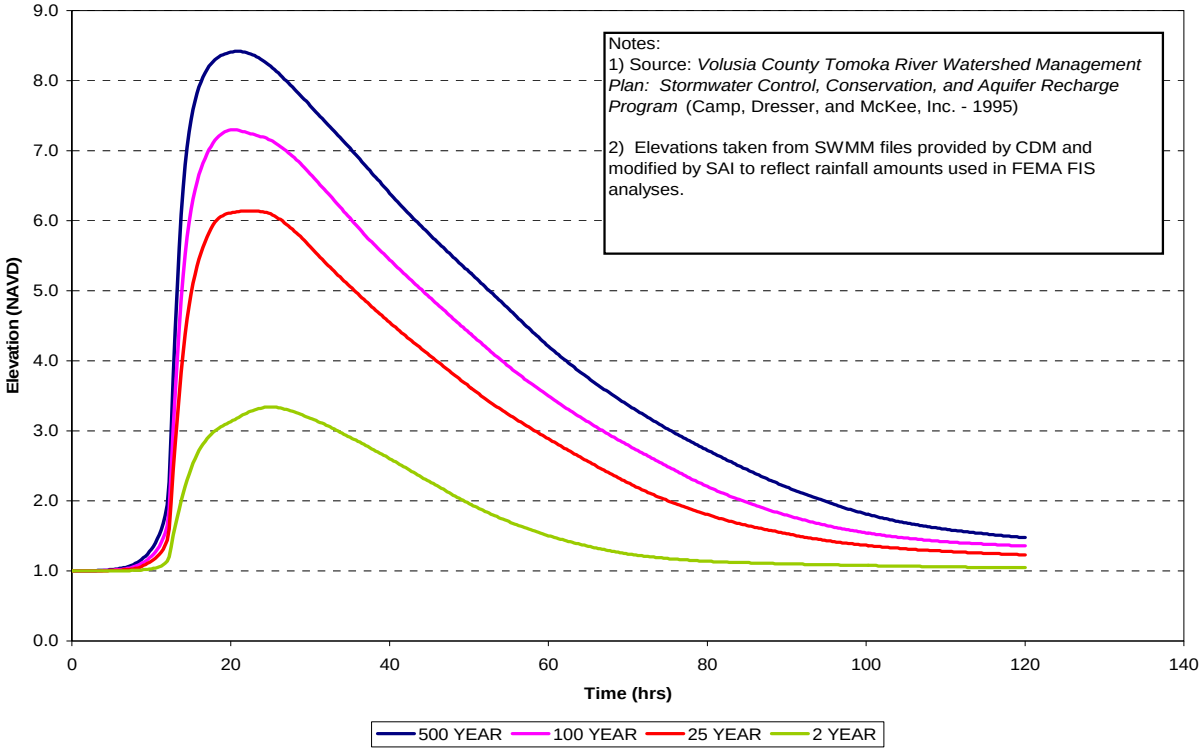



**Figure 2.3 Boundary Conditions – Tomoka River outfall location**

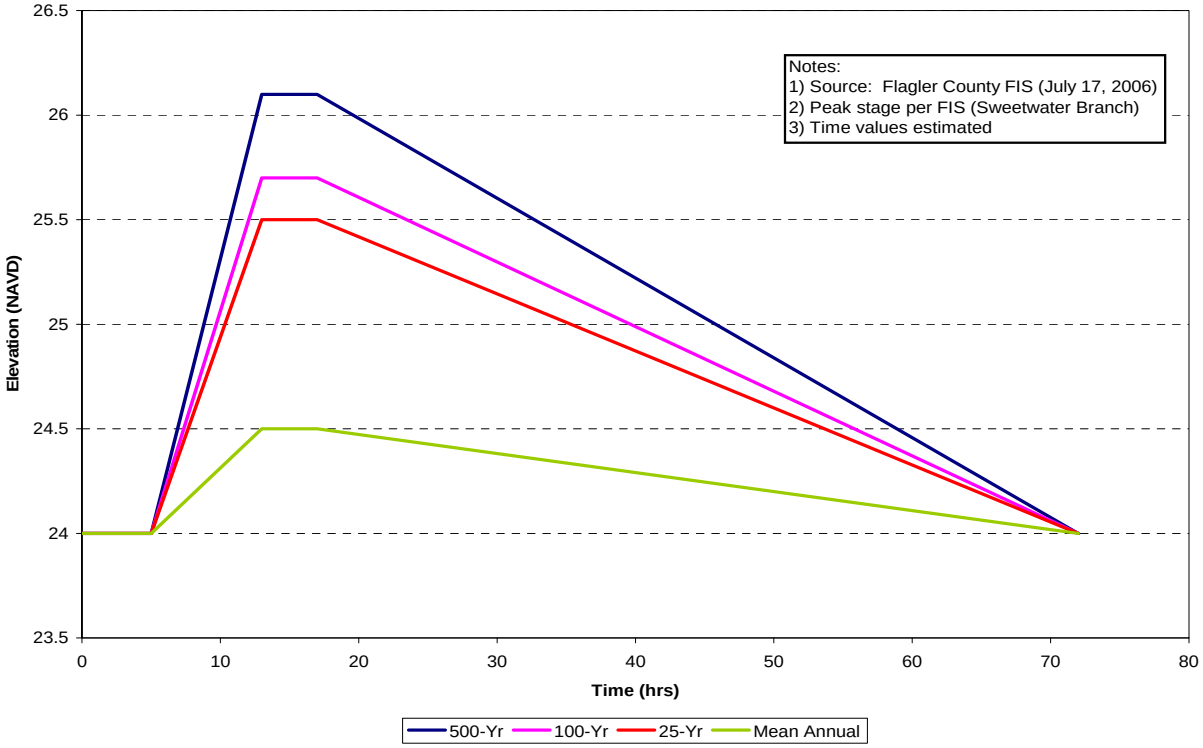



**Figure 2.4 Boundary Conditions – Northwestern outfall location**

### 2.2.3 Link Data

Link data requirements for ICPR© are specific to the type of link being used to model a given location. ICPR© link types include channels, pipes, drop structures, bridges, weirs, gates, orifices, pumps, and dam breaches. Typical data requirements for links include invert elevations, structure dimensions and type, structure condition, siltation depths and other pertinent data.

Link information was obtained from field survey, collected plan or permit data, and inspections of the primary drainage systems. The field surveys were obtained at critical locations along the drainage system (channel constrictions, road or rail crossings, etc.) and include cross sections, culverts, weirs, and other special locations of interest. The information obtained at each survey location varies as noted below. **Appendix B** includes select survey information that was used at critical structures. Note that the photographic information is excluded from this report.

**Culverts**. The survey data includes:

- Number of pipes
- Structure dimensions (i.e., length, span, rise)
- Culvert geometry type (circular, elliptical, arch or box, etc.)
- Material (concrete, corrugated metal, steel, etc.)
- Invert elevations
- End treatments (i.e., mitered end section, headwall & type, etc.)
- Condition of the pipe (bent or broken, rusted, etc.)
- Depth of siltation (if any).

Appurtenant structures (e.g., weirs, skimmers, etc.), if present, are detailed in the survey notes. Representative road profiles were typically measured extending 100 feet from the channel top of bank or centerline of the structure at a maximum of fifty (50) foot intervals. The purpose of the road profile survey was to identify areas that control stormwater flow or road overtopping. Typically, this includes the highest elevation at a given station (e.g., the edge of pavement on a super-elevated roadway as opposed to the road centerline). The elevation of the lowest channel flowline was measured 5 feet and, if possible, 50 feet ± upstream and downstream of the culvert ends. The culvert survey data also includes:

- Measurements of the water surface elevation
- Descriptions of the water color (clear, tannic, silted)
- Descriptions of the flow condition (rapid, tranquil, stagnant);
- Photographs of the channels/streams facing upstream
- Photographs of the structure faces from upstream end
- Photographs of the structures face from downstream end
- Photographs of the channels/streams facing downstream
- Detailed sketch of the structure

**Drop Structures**. The survey data includes culvert and weir geometry (road crown, number of pipes, length, span, rise, type, material, invert elevations, crest lengths and elevations).

**Weirs**. The survey data also included geometry for several weirs (crest lengths, side slopes and elevations, etc.) that were surveyed at control structures or over culvert locations. Many other

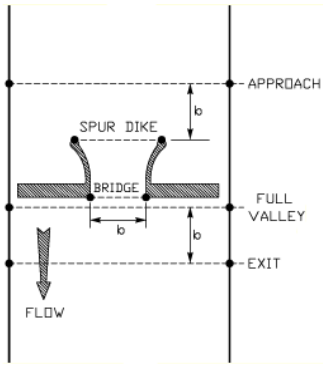
weirs were identified within the study area at roadway and natural overflow locations. Topographic data were used to define the non-surveyed weir locations.

**Channel Cross Sections**. Cross-sections were surveyed, perpendicular to flow, at specified locations within the study area. The cross section data is included in Appendix E. The channel cross-sections extend a minimum of 100 ft beyond the channel top of bank (TOB). At a minimum, survey shots were taken at the top of bank (TOB), bottom of slope (TOE), and the lowest elevation along the bottom of the channel. Roadway profiles were also surveyed and extended to the limits shown in **Appendix D** using topography. Other cross sections were obtained from the topographic information to model sheetflow channels through areas of the western portion of the study area. Please refer to the GIS map sets for locations and extents of the channel network. Manning's values were assigned primarily based upon visual inspection of aerial photographs. A value of 0.1 was used for those areas that appeared to be clear cut, 0.15 for those areas that contain marsh like areas and 0.20 for heavily vegetated locations.

Similar to the culvert data requirements, the water conditions (e.g. water surface elevations, water color, and flow conditions) were documented in the survey notes (Refer to **Appendix B**). In areas where the measured cross-sections were not perpendicular to the direction of flow (i.e., skewed), the surveyed cross-section points were projected onto a line perpendicular to flow based on an estimated skew angle. These "adjusted-station" cross-sections were used in the model for the analysis. Additionally, the channel cross-sections used in the model were limited to those portions of the cross section that would effectively convey flow. For the extents of the channel cross-sections used in the model refer channel buffer map included in Appendix E. The overbank areas which are located outside the channel buffer were hydraulically connected to adjacent nodes via natural weirs.

**Bridges.** The survey data includes:

- Detailed sketches of the bridge.
- Material of the bridge (i.e., wooden footbridge, concrete span, etc.)
- Direction of flow.
- Length of the bridge in the direction of flow.
- Width of the bridge perpendicular to flow (i.e., dimension "b" in the figure below).
- Measurement of the low chord elevation (lowest part of the underside of the bridge deck).
- Number and type of piers or piles and their width (including the ground elevation at the base as well as change(s) in width and the corresponding elevation(s) of those changes).



Six (6) cross-sections were surveyed as part of the model input data for the bridge. The sections include:

- *Approach Cross Section*: Located approximately one bridge width "b" upstream from either the spur dikes (if present) or the upstream face of the bridge.
- *Full Valley Cross Section*: Located at the immediate downstream side of the bridge.
- *Roadway Cross Section*: A road profile extending 100 feet from the ends of the bridge or as otherwise directed.
- *Bridge Opening Cross Section*: Located under the bridge.
- *Spur Dike Cross Section*: Located at the opening of the spur dike (if part of the bridge, see diagram above).
- *Exit Cross Section*: Located approximately one bridge width "b" downstream from the face of the bridge.

Similar to the culvert data requirements, the water conditions (e.g. water surface elevations, water color, and flow conditions) were documented in the survey notes. As stated above, in areas where the cross-sections were skewed, the surveyed cross-sections were projected onto a line perpendicular to flow based on the skew angle. These adjusted cross-sections were used in the model for the analysis.

## 2.3 Data Collection and Field Reconnaissance

The Ormond Crossings drainage study included an initial field reconnaissance and data collection phase to evaluate the existing drainage infrastructure within the watershed and to obtain information necessary for development of an existing conditions stormwater model. The reconnaissance phase also served to identify survey data requirements for Geomatics Corporation (Geomatics) and Henrich-Luke and Swaggerty, LLC (HLS), the survey sub-consultants contracted to conduct surveys of the study area. The following sections provide a summary of these efforts.

### 2.3.1 Data Collection and Site Reconnaissance

SAI staff conducted multiple field visits between January, 2003 and June, 2007 to inspect drainage structures and identify flow patterns in the study area. During these visits, several locations were identified for survey (e.g. bridges, pipes, weirs, etc.). Additionally, several offsite drainage areas were identified. Upon completion of the site reconnaissance, the survey sub-consultants were forwarded AutoCAD files showing each required survey location.

SAI also contacted former City staff (Judy Sloane) for availability of plans, permits or reports related to drainage in the study area. Mrs. Sloane provided a copy of the Tomoka River study referred to earlier in this report. Model files for the study were obtained by the consultant for that study (CDM). Construction plans for I-95 were obtained from Inwood Engineers, Inc. who prepared and permitted the recent expansion of the interstate. Plans for multiple developments were downloaded from the SJRWMD web site. In addition, SAI staff met with Mr. Jerry Finley of the Finley Engineering Group. Mr. Finley is the engineer responsible for design of the Plantation Bay project on the north side of U.S. 1. Mr. Finley assisted SAI in defining drainage basin divides within and around that project.

### 2.3.2 Western Offsite Drainage Area

As discussed previously, the limits of the initial stormwater model developed by SAI (prior to the Flagler County land use amendment hearing and questions raised by Mr. Marcus Strickland, Jr.) were consistent with basin limits identified by CDM during development of the Tomoka River Watershed model in the 1990's and the adopted limit used by the St. Johns River Water Management District (SJRWMD) for administration of mitigation banks. After the land use amendment hearing, SAI obtained a copy of a basin map prepared by Mr. Todd Gipe, Mr. Strickland's environmental consultant. As discussed in **Section 1**, Mr. Gipe's basin map included additional areas that were thought to contribute runoff to the Ormond Crossings project. As a result, the map and the additional topography obtained from Jones, Edmunds, and Associates, Inc. were evaluated to determine if changes were necessary to the initial Ormond Crossings stormwater model.

The topographic information is shown as a raster image on **Figure 1.4**. It indicates that the western and northwestern portion of the Ormond Crossings property contains a plateau from which elevations slope northwesterly or southeasterly. This area is also referred to as the Lake Swamp. Flow from Lake Swamp to the southeast travels through a series of wetland sloughs and interconnected depressions. There is also a network of low dirt roads and culverts throughout this area. Flow in this direction reaches tributaries of Groover Branch at the southern side of the Ormond Crossings property at Durrance Lane (just west of I-95). Groover Branch continues south from this point ultimately draining to the Tomoka River.

Drainage to the northwest from Lake Swamp is of a similar character to the southeasterly flow and can flow to the west and/or the north. The general flow direction to the west is through Parker Canal and Sweetwater Branch which flow to Haw Creek and, ultimately, Crescent Lake in Crescent City. Flow to the northeast appears possible through a large agricultural ditch that connects wetlands at the headwaters of the Parker Canal / Sweetwater Branch system to a culvert under U.S. Highway 1. Flows under U.S. 1 then may proceed through a canal towards S. Old Dixie Highway. The flow then continues east under I-95 and into Bulow Creek which ultimately flows to the Atlantic Intercoastal Waterway.

Despite indications of the topographic gradient depicted on **Figure 1.4**, it is likely that the actual flow direction in the plateau and northwestern area varies. Several factors will determine the actual flow direction including maintenance condition of the ditches and culverts, human activities and spatial variation and/or amounts of rainfall during a storm. The U.S.1 outfall may, in fact, flow southeasterly under certain conditions.

A final area of interest is located due west of Ormond Crossings (along the western property boundary). Although the general topographic gradient in the wetlands remaining in this area is to the north, ditches located during a field inspection were found that would ultimately divert runoff to the east and south towards Ormond Crossings. These ditches ultimately connect to the perimeter ditch at the southwestern corner of Ormond Crossings.

As a result of these findings, SAI expanded the modeled basin limit somewhat to the north and considerably to the west of the initial study boundary (See **Figure 1.3**). The final limit of the

contributing area was determined based upon the topography and field visits to establish the connectivity of this area to the Ormond Crossings system. The area with a direct hydraulic connection to the Ormond Crossing perimeter ditch was treated as a single sub-basin for modeling purposes. Remaining areas were subdivided and modeled using multiple weirs to allow roadway or natural overflows as required. In addition, the boundary condition at the Sweetwater / Parker Canal headwater was revised to force flows in a southeasterly direction as mentioned above.

### 2.3.3 Field Survey

Field surveys were conducted in late 2005. Geomatics and HLS surveyed multiple hydraulic features (e.g. pipes, weirs, bridges, and channel cross-sections) identified during the site reconnaissance. The information below describes the data acquired at the various survey locations for each drainage feature type. The survey data for the project is included in **Appendix B**.

### 2.3.4 Supplemental Field Survey

Several additional areas have been surveyed in and around the project since the 2005 surveys. These surveys were obtained to supplement the original surveys and prepare for design of initial phases of the project. They have been included in the modeling effort as necessary.

The ICPR© model for the Ormond Crossings study area was developed based upon concepts and approaches described in Section 2 of this report. The following sections present more specific details regarding development of the existing conditions model and discuss results of the storm analyses. All referenced tables and figures are included at the end of this section.

## 3.1 Model Development

As discussed in Section 1 of this report, the primary purpose for the drainage study was to identify how the drainage systems on the project site and surrounding areas respond to significant storm events under current conditions and develop revised floodplains based on the more recent terrain data and hydraulic data. The hydrologic calculations (i.e. times of concentration and curve numbers), model input and simulation results are included in **Appendices A** and **C**. Maps showing the drainage basins delineated for the study area, existing conditions drainage nodal network and proposed floodplain limits are included in the **Map Set** (under separate cover) and on the enclosed DVD.

## 3.2 Stormwater Analysis

The stormwater analysis includes simulation of the 2-year, 10-year, 25-year, 50-year, 100-year and 500-year rainfall events. These events were analyzed in preparation for permitting through FEMA. The rainfall depths, distributions, and durations were discussed in the previous report sections. The 100-year and 500-year results were used to develop the proposed floodplains for the Volusia County area south to Tymber Creek where they tie into the effective FIRM (See **Figure 1.2b**). All flood stage results presented in this report are relative to the NAVD88 vertical datum unless otherwise noted. The proposed floodplains are presented relative to NVGD29 vertical datum in the **Map Set** (under separate cover) and on the enclosed DVD. The NGVD29 datum was used for proposed floodplains to be consistent with the effective FEMA FIRMs.

## 3.3 Simulation Results

Initial evaluation of the Ormond Crossings existing conditions ICPR model included development of floodplain maps and flood profiles. Comparisons were made between the Ormond Crossings ICPR simulation results and the results presented in the Tomoka River study (CDM, 1995) and the Volusia County Flood Insurance Study (FEMA, February, 2003) for Groover Branch. The effective FEMA FIS includes detailed results along Groover Branch from the Tomoka River to upstream of Tymber Creek Road. Comparisons were made at key locations which primarily included roadway crossings. These comparisons were made using the maximum stages resulting from the ICPR analysis. The Ormond Crossings ICPR results were also used to identify problem flooding areas. Results of the comparisons and some discussion of problem flooding are presented in below.

### 3.3.1 Model Results Comparison

The maximum stage results for all simulated storm events are provided in **Table 3.1**. **Table 3.2** shows comparisons of peak stages between the Tomoka River modeling performed by CDM and the Volusia County FIS. Stages shown in the table are based upon the maximum stage resulting

from ICPR simulations described above. The detailed analysis of Groover Branch in the effective FEMA FIS extends from the Tomoka River to just upstream of Tymber Creek Road (ICPR Node: GB475). As shown in the table, the Ormond Crossings ICPR model results are consistent with the FEMA FIS results at Tymber Creek Road (e.g. Node GB435) for all storm events simulated. Downstream differences, however, vary considerably more and are most different at the roadway crossings at Airport Road, Linville Road and Tymber Run. The flood stage differences at these locations are primarily attributed to differences in the recently surveyed Groover Branch cross-sections used in the Ormond Crossings study as opposed to those used in the original FEMA FIS and CDM studies (Refer to **Figure 3.1**). In many locations, the Groover Branch channel inverts shown in the FEMA FIS are several feet higher than the survey data collected as part of this study.

The Ormond Crossings ICPR results upstream of Tymber Creek Road were compared to the data presented in the CDM study (SWMM model results). This comparison included additional locations along Groover Branch (upstream of the FIS detailed study), the drainage canal system east of Interstate 95, the western Groover Branch Tributary, and the FEC railroad crossing and the U.S. Highway 1 crossing. As would be expected, differences in peak stages between Ormond Crossings ICPR model results and those presented in the CDM study vary depending upon location (See **Table 3.2**). Flood stage differences between the CDM study and this study during the 100-year storm range from -2.0 -ft (i.e. GB460) to as much as +1.7-ft (i.e. Node D0008).

Several changes have occurred in the basin that contribute to the differences discussed above including the channel bedslopes along the lower reaches of Groover Branch mentioned above. Another difference that is of particular relevance to the Ormond Crossings project is the crossing under Durrance Lane along the mainstem of Groover Branch (Link: B00010P). The CDM study modeled this location as a rectangular conduit with an 8’ x 17’ rise and span, respectively. These dimensions are consistent with a bridge that was observed at this location by SAI staff during early field visits; however, the bridge has since been replaced with a 96-inch corrugated metal pipe. The culvert replacement results in a 63% reduction in flow area under the road. Consequently, predicted flood stages upstream of this crossing are higher in the Ormond Crossings ICPR model results than in the CDM SWMM results until overtopping occurs. The road elevation at the time of survey for the current study was approximately 23.3 NAVD. This is approximately 0.8 feet lower than the elevation used in the CDM modeling of 22.5 NAVD. Variations in the overtopping elevation at this location can be expected, however, since it is a dirt road that is continually being regraded and maintained. An additional bridge has also been constructed over Groover Branch south of Durrance Road (at ICPR Nodes GB670 and GB665) that tends to increase stages in the same area as described above (See ICPR Node: GB675 - **Table 3.2**).

Another factor contributing to the differing results includes the acquisition of more detailed topographic information in and around the study area, particularly to the west of the Durrance Road outfall. Based on this information, runoff is directed towards the two outfalls under Durrance Lane by a perimeter ditch that runs along the Ormond Crossings’ southern property line. A spoil bank separates runoff in this ditch from Durrance Lane which is contiguous along the entire length of Durrance except for a couple of cuts at access roads. This spoil bank has

been included in the ICPR model as an overflow weir. Furthermore, the spoil bank is of sufficient elevation from west to east to keep overtopping of Durrance Lane limited to areas in the vicinity of the eastern outfall during all but the larger storm events.

Minor changes in the 100-yr floodplain have occurred in portions of the study area east of I-95 including existing infrastructure and basin limits. Consequently, the Ormond Crossings ICPR simulation results in these areas are very similar to the CDM results (See ICPR Nodes: GB630 & GB649 – **Table 3.2**)

### 3.3.2 Flooding Areas

A flooding analysis is included in **Table 3.3**. The key criterion used to identify flooding locations was road overtopping. Excluding onsite dirt roads, roadway flooding occurs at four (4) locations in the study area during the 2-year storm. There is no predicted roadway flooding at major roads or evacuation routes including U.S. 1, Tymber Creek Road and Pineland Trail, all of which have 100-year protection.

The flooding that is predicted ranges in depths from shallow overflows of a couple inches (Tower Circle, Node: GB615) to over several feet (i.e. adjacent to the Linville Road crossing, Node: GB445) during various storm events. Flooding at Tower Circle does not appear to limit access to the industrial complex served by that road. Leeway Trail, however, is predicted to flood to relatively deep depths including nearly 2 feet during the 100-year storm. Additional flooding locations are found in the downstream reaches of Groover Branch, namely Dimmers Road and Linville Road. The flooding at these locations is quite deep; however, just a few residences appear to be affected.

Flood profiles mentioned previously depict flood profiles along primary conveyance ways including the main stem of Groover Branch (both onsite and offsite), the Groover Branch tributaries and the offsite contributing area north of U.S. Highway 1. **Figure 3.3 (Map Pocket)** depicts predicted floodplains for the 100-year 24-hour and 500-year 24-hour storm events for those areas proposed for revision. Detailed maps showing the predicted 100-year and 500-year floodplains are included in the **Map Set** (under separate cover) and on the enclosed DVD. Additionally, maps of the proposed floodplain revisions for the study area as part of the LOMR submittal package showing the effective FIRM floodplains are provided in **Appendix E**.

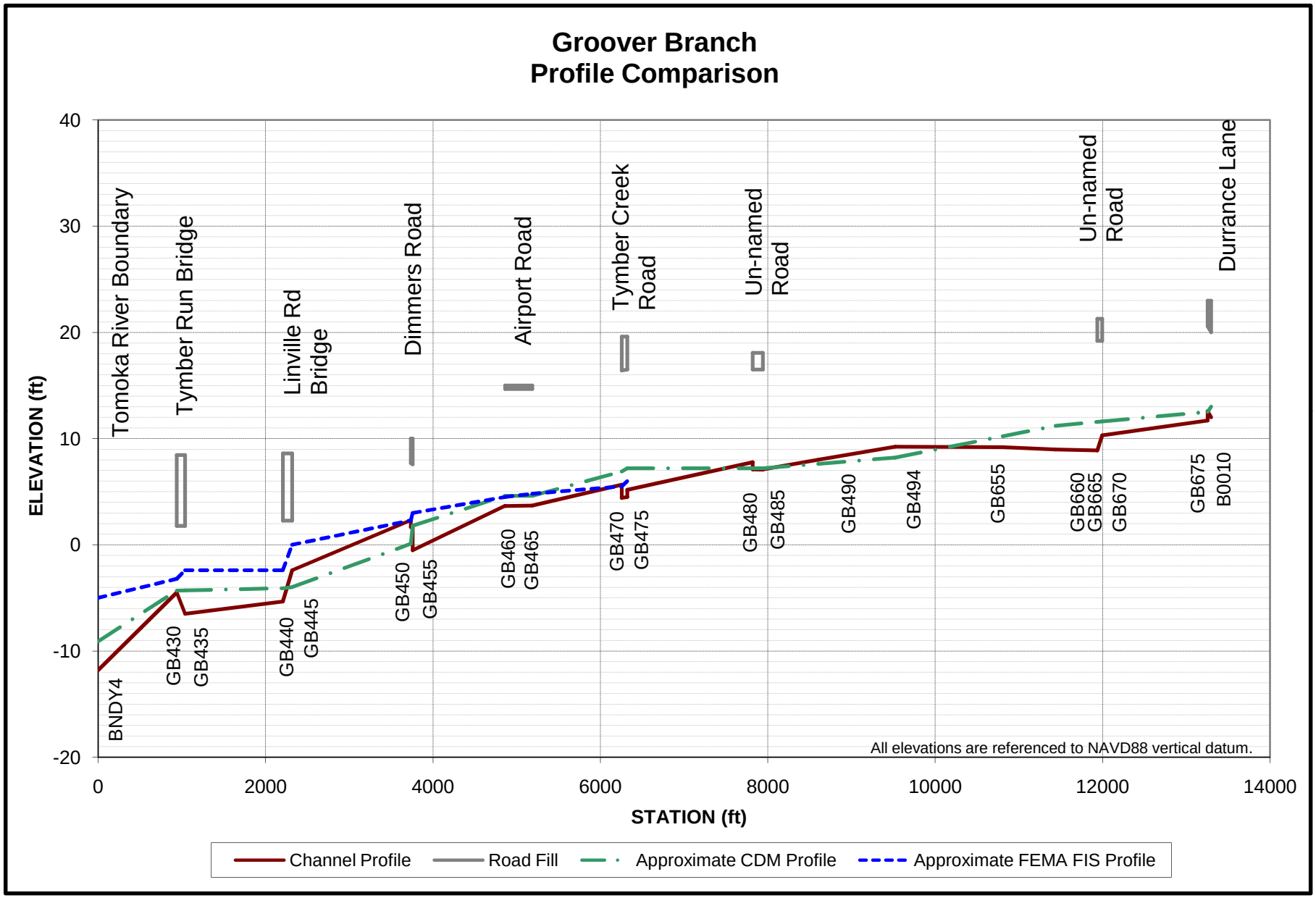
Review of the flood profiles show that during the more extreme storms, flood depths over local roadways are in excess of 2 or 3-ft in some areas (i.e. Dimmers Road, Durrance Road), but generally range from 0.5-ft to 2-ft. In general, hydraulic losses at road crossings are reasonable considering tailwater conditions. The most notable locations that generate significant losses on or in the immediate vicinity of the project occur at Durrance Road and at the contributing area north of the FEC railroad (See **Figures 3.2.1 thru 3.2.5**). The construction at Durance Road was mentioned previously (See **Section 3.3.1**). The FEC location includes two sets of culverts that provide conveyance under the railroad. The western set shown in the profile (Node: B0325), however, is significantly obstructed (> 50%) by debris. Significant hydraulic losses result in stormwater runoff backing up behind the railroad crossings because of this reduced capacity.

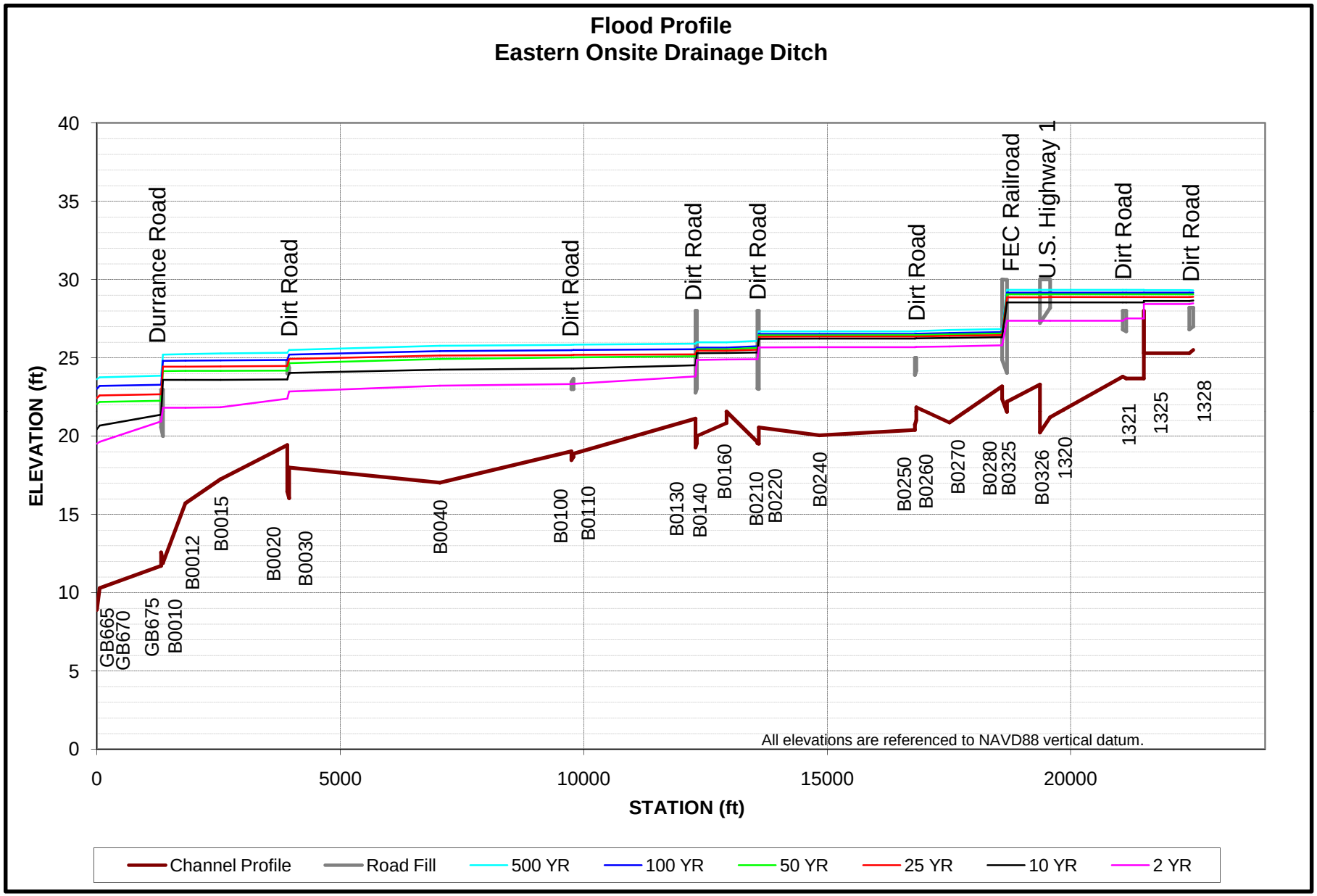
## 3.4 Summary of Existing Conditions

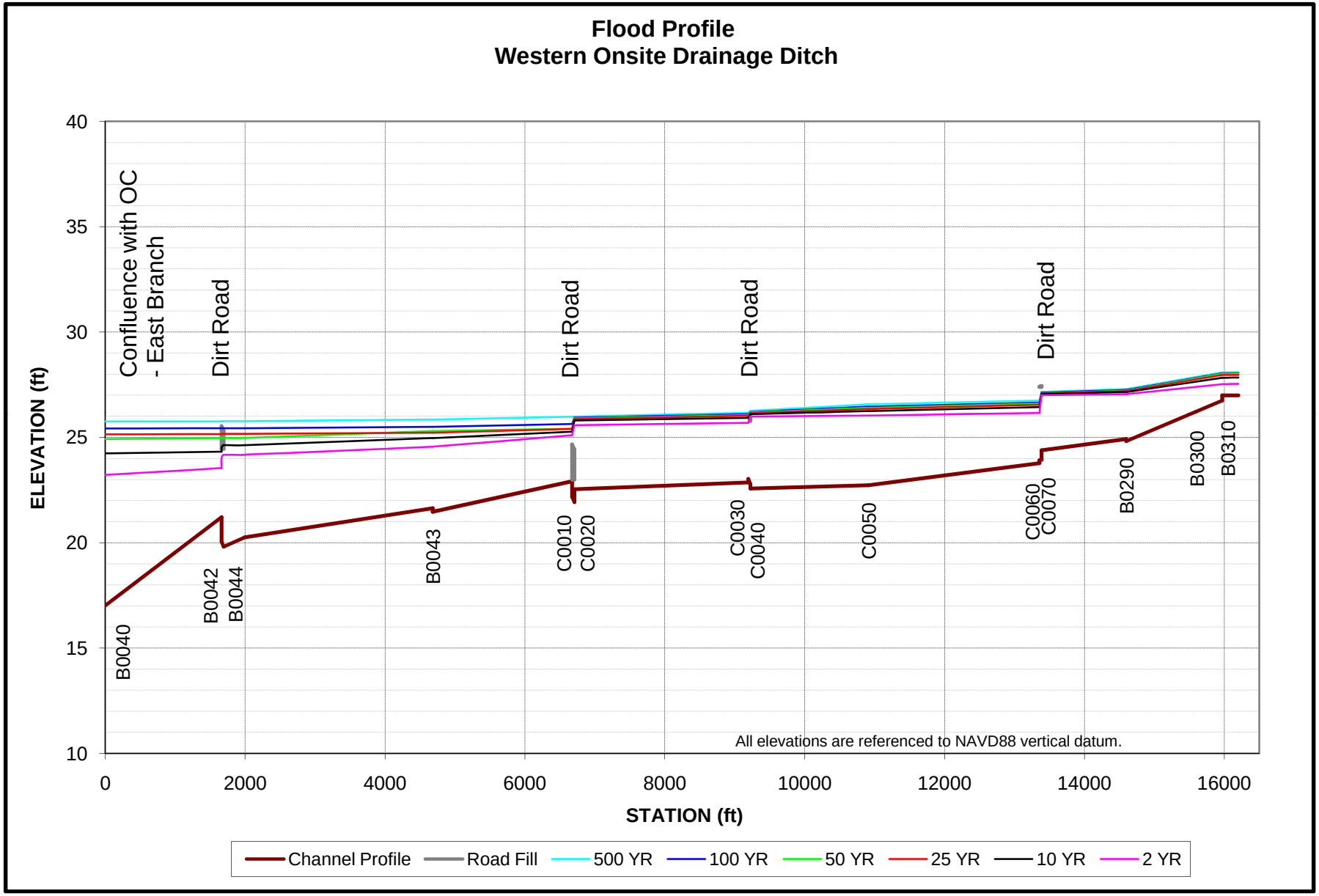
In summary, some flooding occurs during all the storm events included in the analysis. Flooding during the 2-year storm affects several roadways including:

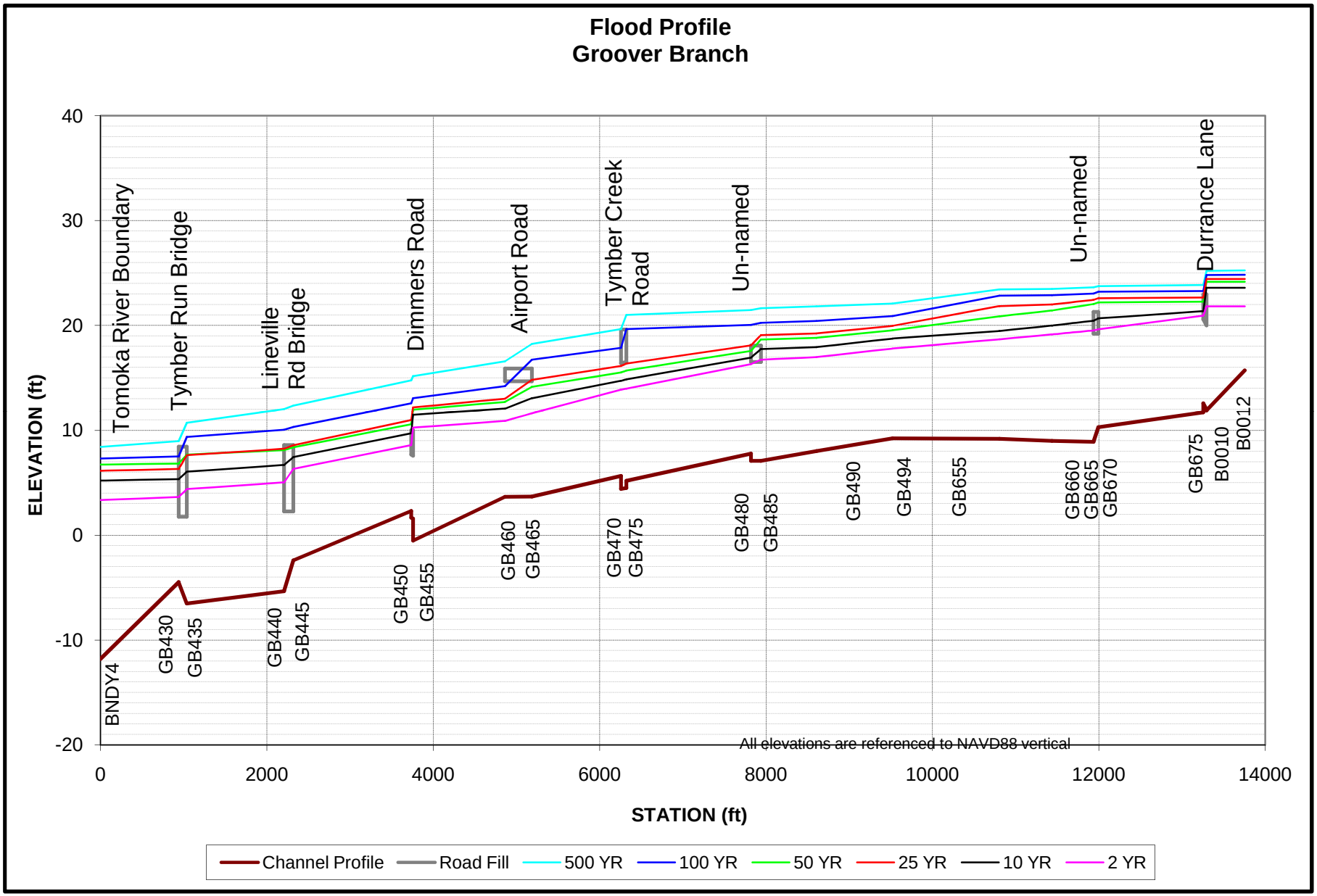
- Tower Circle
- Linville Road
- Leeway Trail
- Durrance Road

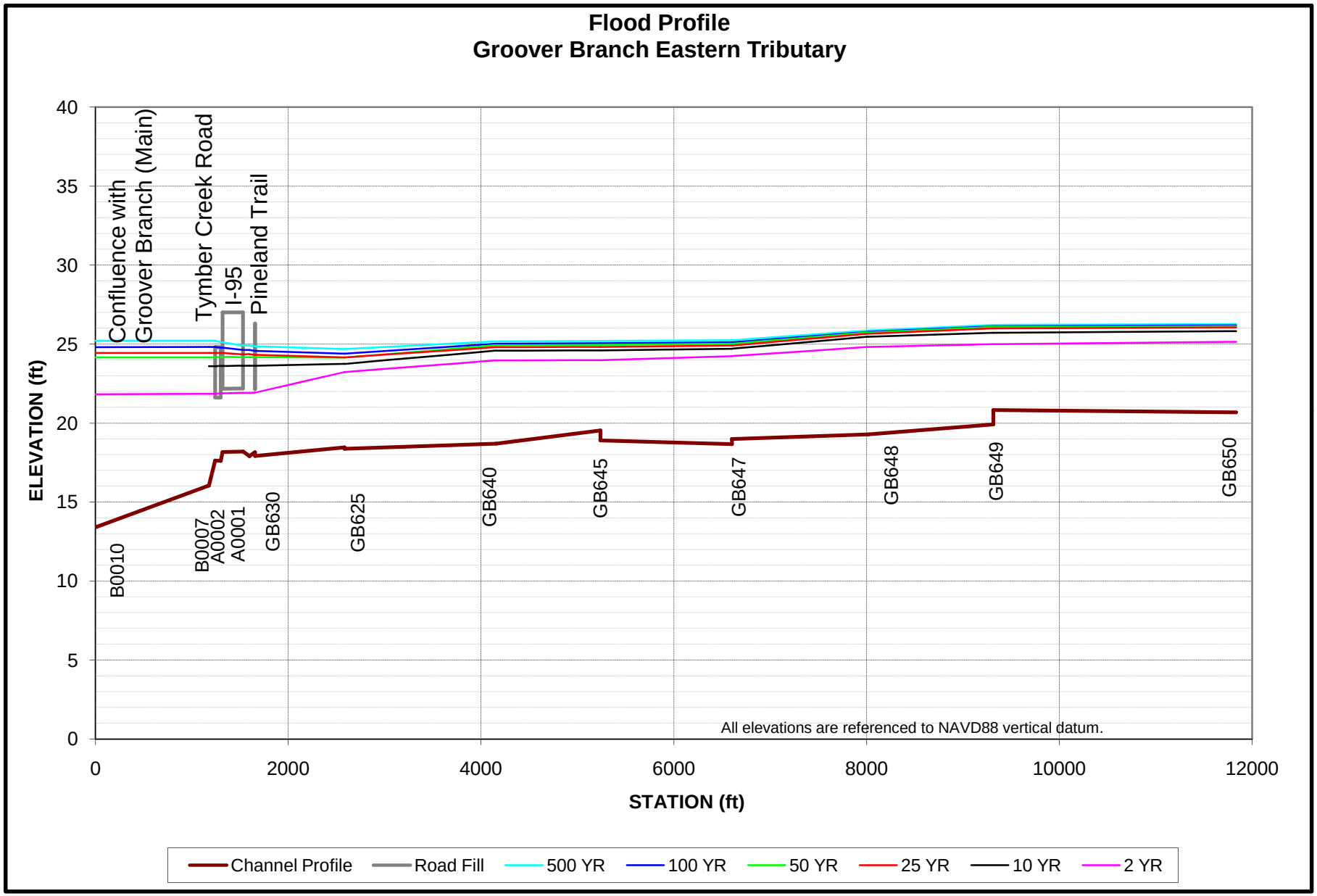
The flooding problems at these locations are related to inadequate culvert capacity or high tailwater conditions as discussed previously.

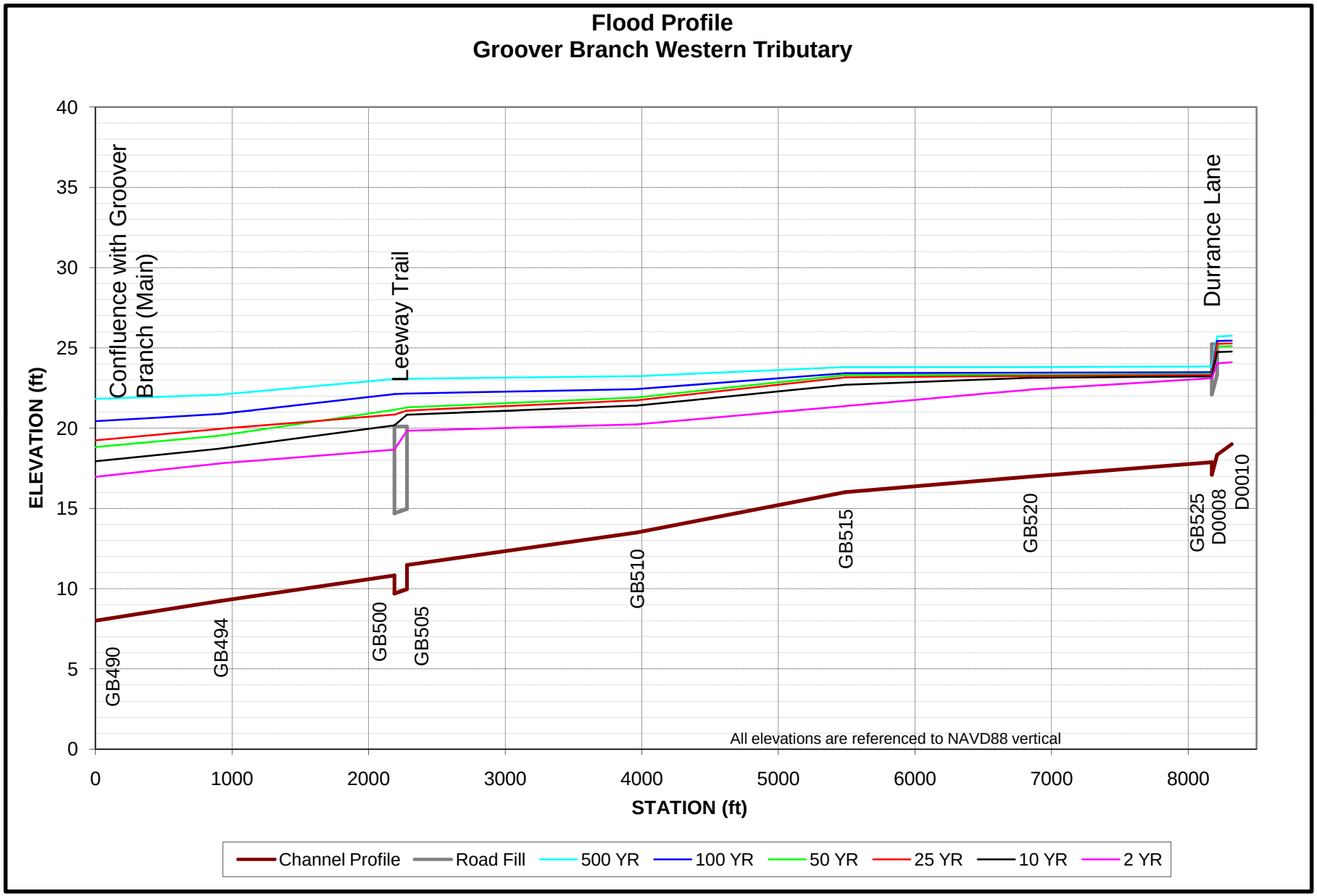

Groover Branch
Profile Comparison
ELEVATION (ft)
STATION (ft)
40
30
20
10
0
-10
-20
0
2000
4000
6000
8000
10000
12000
14000
Tomoka River Boundary
Tymber Run Bridge
Linville Rd Bridge
Dimmers Road
Airport Road
Tymber Creek Road
Un-named Road
Un-named Road
Durrance Lane
BNDY4
GB430
GB435
GB440
GB445
GB450
GB455
GB460
GB465
GB470
GB475
GB480
GB485
GB490
GB494
GB655
GB660
GB665
GB670
GB675
B0010
All elevations are referenced to NAVD88 vertical datum.
Channel Profile
Road Fill
Approximate CDM Profile
Approximate FEMA FIS Profile

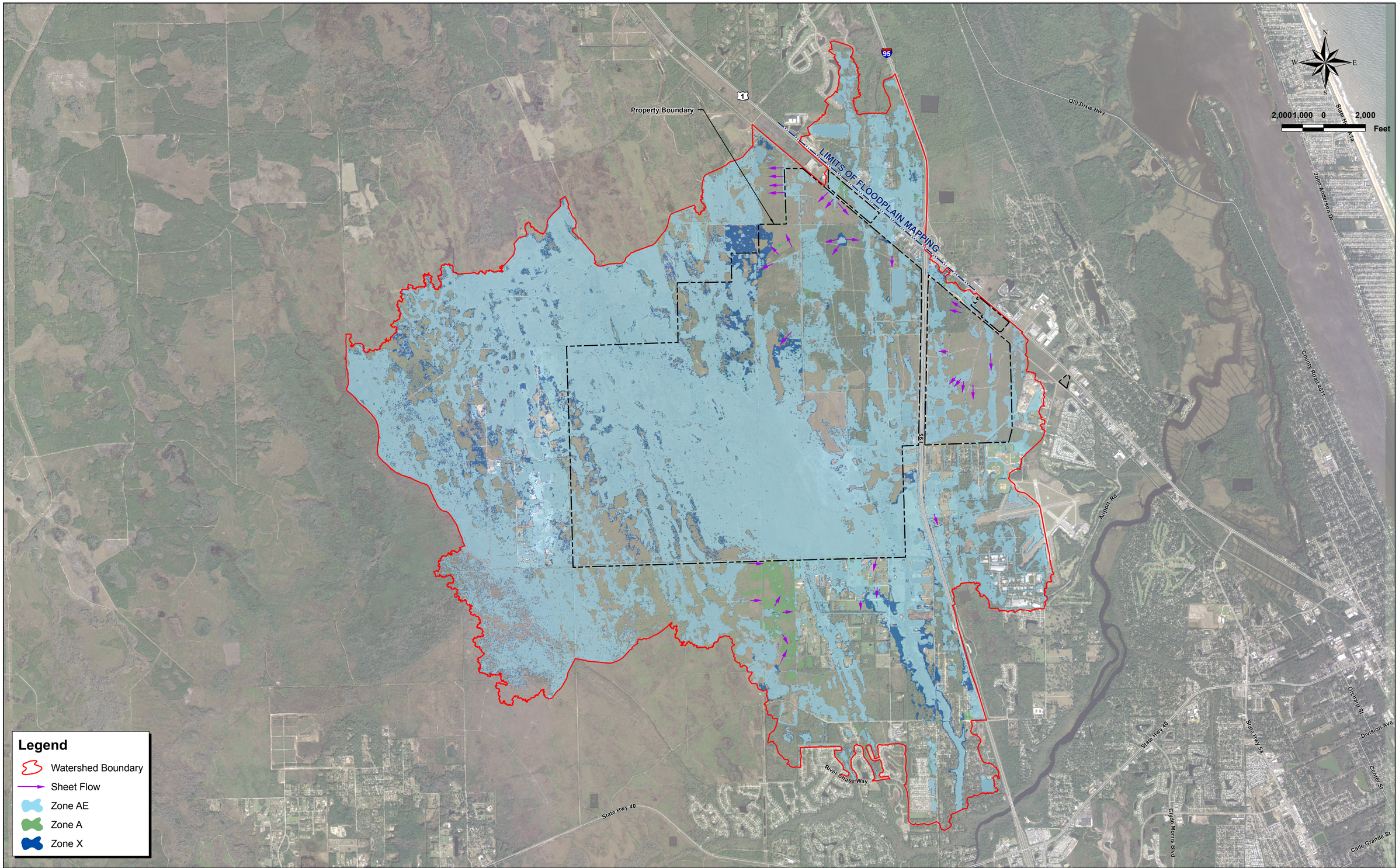

Flood Profile
Eastern Onsite Drainage Ditch
ELEVATION (ft)
STATION (ft)
0
5
10
15
20
25
30
35
40
0
5000
10000
15000
20000
Durrance Road
Dirt Road
Dirt Road
Dirt Road
Dirt Road
Dirt Road
FEC Railroad
U.S. Highway 1
Dirt Road
Dirt Road
GB665
GB670
GB675
B0010
B0012
B0015
B0020
B0030
B0040
B0100
B0110
B0130
B0140
B0160
B0210
B0220
B0240
B0250
B0260
B0270
B0280
B0325
B0326
1320
1321
1325
1328
All elevations are referenced to NAVD88 vertical datum.
Channel Profile
Road Fill
500 YR
100 YR
50 YR
25 YR
10 YR
2 YR


Flood Profile
Western Onsite Drainage Ditch
ELEVATION (ft)
STATION (ft)
40
35
30
25
20
15
10
0
2000
4000
6000
8000
10000
12000
14000
16000
Confluence with OC - East Branch
Dirt Road
Dirt Road
Dirt Road
Dirt Road
B0040
B0042
B0044
B0043
C0010
C0020
C0030
C0040
C0050
C0060
C0070
B0290
B0300
B0310
All elevations are referenced to NAVD88 vertical datum.
Channel Profile
Road Fill
500 YR
100 YR
50 YR
25 YR
10 YR
2 YR


Flood Profile
Groover Branch
ELEVATION (ft)
STATION (ft)
40
30
20
10
0
-10
-20
0
2000
4000
6000
8000
10000
12000
14000
Tomoka River Boundary
Tymber Run Bridge
Lineville Rd Bridge
Dimmers Road
Airport Road
Tymber Creek Road
Un-named
Un-named
Durrance Lane
BNDY4
GB430
GB435
GB440
GB445
GB450
GB455
GB460
GB465
GB470
GB475
GB480
GB485
GB490
GB494
GB655
GB660
GB665
GB670
GB675
B0010
B0012
All elevations are referenced to NAVD88 vertical
Channel Profile
Road Fill
500 YR
100 YR
50 YR
25 YR
10 YR
2 YR


Flood Profile
Groover Branch Eastern Tributary
ELEVATION (ft)
STATION (ft)
Confluence with Groover Branch (Main)
Tymber Creek Road
I-95
Pineland Trail
B0010
B0007
A0002
A0001
GB630
GB625
GB640
GB645
GB647
GB648
GB649
GB650
All elevations are referenced to NAVD88 vertical datum.
Channel Profile
Road Fill
500 YR
100 YR
50 YR
25 YR
10 YR
2 YR


Flood Profile
Groover Branch Western Tributary
ELEVATION (ft)
STATION (ft)
Confluence with Groover Branch (Main)
Leeway Trail
Durrance Lane
GB490
GB494
GB500
GB505
GB510
GB515
GB520
GB525
D0008
D0010
All elevations are referenced to NAVD88 vertical
Channel Profile
Road Fill
500 YR
100 YR
50 YR
25 YR
10 YR
2 YR




**SINGHOFEN & ASSOCIATES, INC.**
STORMWATER MANAGEMENT AND CIVIL ENGINEERING

**TOMOKA HOLDINGS, LLC**

**ORMOND CROSSINGS**

**EXISTING CONDITIONS FLOODPLAIN MAP**

**Figure 3.3**

Map Document: (M:\OrmondCrossings\ArcView\OC-Floodplain Map (Overall) 2008 0626.mxd)
6/18/2009 -- 12:48:11 PM

# Table 3.1. Maximum Stages

| Node ID | 2-yr 24-hr | | 10-yr 24-hr | | 25-yr 24-hr | | 50-yr 24-hr | | 100-yr 24-hr | | 500-yr 24-hr | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 |
| 1320 | 27.4 | 28.4 | 28.5 | 29.5 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| 1321 | 27.5 | 28.5 | 28.5 | 29.5 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| 1325 | 28.4 | 29.4 | 28.6 | 29.6 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| 1326 | 29.4 | 30.4 | 29.6 | 30.6 | 29.7 | 30.7 | 29.8 | 30.8 | 29.8 | 30.8 | 29.9 | 30.9 |
| 1327 | 30.1 | 31.1 | 30.2 | 31.2 | 30.2 | 31.2 | 30.2 | 31.2 | 30.2 | 31.2 | 30.3 | 31.3 |
| 1328 | 28.5 | 29.5 | 28.7 | 29.7 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| 1330 | 29.1 | 30.1 | 29.2 | 30.2 | 29.2 | 30.2 | 29.3 | 30.3 | 29.3 | 30.3 | 29.4 | 30.4 |
| A0001 | 21.9 | 22.9 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.6 | 25.6 | 24.9 | 25.9 |
| A0002 | 21.9 | 22.9 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.1 | 26.1 |
| A0009 | 21.9 | 22.9 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.3 | 26.3 |
| A0010 | 23.3 | 24.3 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.7 | 25.7 | 24.9 | 25.9 |
| A0012 | 21.9 | 22.9 | 23.6 | 24.6 | 24.5 | 25.5 | 24.2 | 25.2 | 24.8 | 25.8 | 25.2 | 26.2 |
| A0020 | 23.4 | 24.4 | 23.8 | 24.8 | 24.4 | 25.4 | 24.2 | 25.2 | 24.7 | 25.7 | 25.0 | 26.0 |
| A0021 | 23.4 | 24.4 | 23.8 | 24.8 | 24.5 | 25.5 | 24.3 | 25.3 | 24.8 | 25.8 | 25.1 | 26.1 |
| A0022 | 23.4 | 24.4 | 23.9 | 24.9 | 24.6 | 25.6 | 24.4 | 25.4 | 24.9 | 25.9 | 25.3 | 26.3 |
| A0030 | 25.0 | 26.0 | 25.5 | 26.5 | 25.7 | 26.7 | 25.8 | 26.8 | 25.9 | 26.9 | 26.1 | 27.1 |
| A0031 | 24.8 | 25.8 | 25.3 | 26.3 | 25.5 | 26.5 | 25.6 | 26.6 | 25.7 | 26.7 | 26.0 | 27.0 |
| A0032 | 24.6 | 25.6 | 25.1 | 26.1 | 25.3 | 26.3 | 25.4 | 26.4 | 25.5 | 26.5 | 25.7 | 26.7 |
| A0039 | 21.8 | 22.8 | 23.0 | 24.0 | 23.8 | 24.8 | 24.5 | 25.5 | 25.4 | 26.4 | 25.8 | 26.8 |
| A0040 | 24.9 | 25.9 | 26.1 | 27.1 | 26.4 | 27.4 | 26.5 | 27.5 | 26.7 | 27.7 | 26.9 | 27.9 |
| A0041 | 24.8 | 25.8 | 25.7 | 26.7 | 25.9 | 26.9 | 26.0 | 27.0 | 26.1 | 27.1 | 26.3 | 27.3 |
| A0042 | 24.8 | 25.8 | 25.4 | 26.4 | 25.6 | 26.6 | 25.7 | 26.7 | 25.8 | 26.8 | 25.9 | 26.9 |
| A0045 | 27.3 | 28.3 | 27.4 | 28.4 | 27.4 | 28.4 | 27.4 | 28.4 | 27.5 | 28.5 | 27.5 | 28.5 |
| A0047 | 27.3 | 28.3 | 27.4 | 28.4 | 27.4 | 28.4 | 27.5 | 28.5 | 27.5 | 28.5 | 27.5 | 28.5 |
| A0048 | 27.2 | 28.2 | 27.3 | 28.3 | 27.3 | 28.3 | 27.4 | 28.4 | 27.5 | 28.5 | 27.7 | 28.7 |
| A0050 | 26.1 | 27.1 | 26.6 | 27.6 | 26.8 | 27.8 | 26.9 | 27.9 | 27.1 | 28.1 | 27.3 | 28.3 |
| A0051 | 25.7 | 26.7 | 26.0 | 27.0 | 26.2 | 27.2 | 26.3 | 27.3 | 26.4 | 27.4 | 26.7 | 27.7 |
| A0052 | 25.4 | 26.4 | 25.7 | 26.7 | 25.9 | 26.9 | 26.0 | 27.0 | 26.0 | 27.0 | 26.2 | 27.2 |
| A0055 | 26.4 | 27.4 | 26.7 | 27.7 | 26.9 | 27.9 | 27.0 | 28.0 | 27.2 | 28.2 | 27.5 | 28.5 |
| A0056 | 27.2 | 28.2 | 27.3 | 28.3 | 27.3 | 28.3 | 27.3 | 28.3 | 27.4 | 28.4 | 27.5 | 28.5 |
| A0060 | 26.3 | 27.3 | 26.6 | 27.6 | 26.9 | 27.9 | 27.1 | 28.1 | 27.3 | 28.3 | 27.5 | 28.5 |
| A0061 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 |
| A0061A | 27.4 | 28.4 | 27.6 | 28.6 | 27.7 | 28.7 | 27.7 | 28.7 | 27.8 | 28.8 | 27.9 | 28.9 |
| A0063 | 26.3 | 27.3 | 26.6 | 27.6 | 26.9 | 27.9 | 27.1 | 28.1 | 27.3 | 28.3 | 27.5 | 28.5 |
| A0065 | 26.3 | 27.3 | 26.6 | 27.6 | 26.9 | 27.9 | 27.1 | 28.1 | 27.3 | 28.3 | 27.5 | 28.5 |
| A0067 | 27.0 | 28.0 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.3 | 28.3 | 27.5 | 28.5 |
| A0068 | 26.3 | 27.3 | 26.6 | 27.6 | 26.9 | 27.9 | 27.1 | 28.1 | 27.3 | 28.3 | 27.5 | 28.5 |
| A0070 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 |
| A0071 | 27.2 | 28.2 | 27.3 | 28.3 | 27.3 | 28.3 | 27.3 | 28.3 | 27.4 | 28.4 | 27.4 | 28.4 |
| A0072 | 28.2 | 29.2 | 28.3 | 29.3 | 28.3 | 29.3 | 28.3 | 29.3 | 28.3 | 29.3 | 28.4 | 29.4 |
| A0073 | 28.2 | 29.2 | 28.3 | 29.3 | 28.3 | 29.3 | 28.3 | 29.3 | 28.3 | 29.3 | 28.4 | 29.4 |
| A0075 | 26.4 | 27.4 | 26.6 | 27.6 | 26.6 | 27.6 | 26.7 | 27.7 | 26.7 | 27.7 | 26.8 | 27.8 |
| A0080 | 25.8 | 26.8 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 | 26.3 | 27.3 | 26.4 | 27.4 |
| A0090 | 25.8 | 26.8 | 26.0 | 27.0 | 26.1 | 27.1 | 26.2 | 27.2 | 26.3 | 27.3 | 26.4 | 27.4 |
| A0095 | 26.1 | 27.1 | 26.2 | 27.2 | 26.3 | 27.3 | 26.3 | 27.3 | 26.3 | 27.3 | 26.4 | 27.4 |
| A0100 | 26.8 | 27.8 | 26.9 | 27.9 | 27.0 | 28.0 | 27.1 | 28.1 | 27.3 | 28.3 | 27.5 | 28.5 |
| A0105 | 27.4 | 28.4 | 27.6 | 28.6 | 27.7 | 28.7 | 27.8 | 28.8 | 27.8 | 28.8 | 27.9 | 28.9 |
| A0107 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.4 | 28.4 | 27.5 | 28.5 | 27.7 | 28.7 |
| A0110 | 26.3 | 27.3 | 26.9 | 27.9 | 27.2 | 28.2 | 27.4 | 28.4 | 27.5 | 28.5 | 27.7 | 28.7 |
| A0111 | 28.0 | 29.0 | 28.2 | 29.2 | 28.3 | 29.3 | 28.4 | 29.4 | 28.5 | 29.5 | 28.7 | 29.7 |
| A0113 | 27.6 | 28.6 | 28.2 | 29.2 | 28.3 | 29.3 | 28.4 | 29.4 | 28.5 | 29.5 | 28.6 | 29.6 |
| A0113W | 27.8 | 28.8 | 28.2 | 29.2 | 28.3 | 29.3 | 28.4 | 29.4 | 28.5 | 29.5 | 28.7 | 29.7 |
| A0115 | 27.1 | 28.1 | 28.0 | 29.0 | 28.1 | 29.1 | 28.2 | 29.2 | 28.2 | 29.2 | 28.3 | 29.3 |
| A0116 | 27.5 | 28.5 | 27.6 | 28.6 | 27.7 | 28.7 | 27.7 | 28.7 | 27.8 | 28.8 | 27.8 | 28.8 |
| A0118 | 26.2 | 27.2 | 26.3 | 27.3 | 26.4 | 27.4 | 26.5 | 27.5 | 26.5 | 27.5 | 26.6 | 27.6 |
| A0118A | 26.2 | 27.2 | 26.3 | 27.3 | 26.4 | 27.4 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 |
| A0500 | 28.7 | 29.7 | 29.0 | 30.0 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 |
| A0505 | 28.8 | 29.8 | 29.0 | 30.0 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 |
| A0510 | 28.7 | 29.7 | 29.0 | 30.0 | 29.0 | 30.0 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 |
| A0515 | 28.5 | 29.5 | 28.7 | 29.7 | 28.8 | 29.8 | 28.9 | 29.9 | 28.9 | 29.9 | 29.1 | 30.1 |
| B0006 | 21.9 | 22.9 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.2 | 26.2 |
| B0007 | 21.9 | 22.9 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.2 | 26.2 |
| B0010 | 21.8 | 22.8 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.2 | 26.2 |
| B0011 | 23.0 | 24.0 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.3 | 26.3 |
| B0012 | 21.8 | 22.8 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.2 | 26.2 |
| B0013 | 21.8 | 22.8 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.3 | 26.3 |
| B0014 | 21.8 | 22.8 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.3 | 26.3 |
| B0015 | 21.8 | 22.8 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.3 | 26.3 |
| B0017 | 24.3 | 25.3 | 24.7 | 25.7 | 25.2 | 26.2 | 25.1 | 26.1 | 25.4 | 26.4 | 25.6 | 26.6 |
| B0018 | 21.8 | 22.8 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.8 | 25.8 | 25.3 | 26.3 |
| B0020 | 22.4 | 23.4 | 23.6 | 24.6 | 24.5 | 25.5 | 24.2 | 25.2 | 24.9 | 25.9 | 25.3 | 26.3 |

# Table 3.1. Maximum Stages

| Node ID | 2-yr 24-hr | | 10-yr 24-hr | | 25-yr 24-hr | | 50-yr 24-hr | | 100-yr 24-hr | | 500-yr 24-hr | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 |
| B0025 | 24.2 | 25.2 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.4 | 26.4 | 25.7 | 26.7 |
| B0027 | 23.8 | 24.8 | 24.3 | 25.3 | 24.6 | 25.6 | 24.7 | 25.7 | 25.2 | 26.2 | 25.5 | 26.5 |
| B0030 | 22.9 | 23.9 | 24.0 | 25.0 | 24.9 | 25.9 | 24.7 | 25.7 | 25.2 | 26.2 | 25.5 | 26.5 |
| B0035 | 24.5 | 25.5 | 24.7 | 25.7 | 25.2 | 26.2 | 25.0 | 26.0 | 25.4 | 26.4 | 25.8 | 26.8 |
| B0040 | 23.2 | 24.2 | 24.2 | 25.2 | 25.1 | 26.1 | 24.9 | 25.9 | 25.4 | 26.4 | 25.8 | 26.8 |
| B0042 | 23.5 | 24.5 | 24.3 | 25.3 | 25.2 | 26.2 | 25.0 | 26.0 | 25.4 | 26.4 | 25.8 | 26.8 |
| B0043 | 24.6 | 25.6 | 25.0 | 26.0 | 25.2 | 26.2 | 25.3 | 26.3 | 25.5 | 26.5 | 25.9 | 26.9 |
| B0044 | 24.2 | 25.2 | 24.6 | 25.6 | 25.2 | 26.2 | 25.0 | 26.0 | 25.4 | 26.4 | 25.8 | 26.8 |
| B0045 | 25.2 | 26.2 | 25.3 | 26.3 | 25.4 | 26.4 | 25.4 | 26.4 | 25.5 | 26.5 | 25.9 | 26.9 |
| B0047 | 26.1 | 27.1 | 26.2 | 27.2 | 26.3 | 27.3 | 26.3 | 27.3 | 26.4 | 27.4 | 26.4 | 27.4 |
| B0070 | 24.3 | 25.3 | 24.4 | 25.4 | 25.2 | 26.2 | 25.0 | 26.0 | 25.5 | 26.5 | 25.8 | 26.8 |
| B0075 | 25.8 | 26.8 | 25.9 | 26.9 | 26.0 | 27.0 | 26.0 | 27.0 | 26.0 | 27.0 | 26.0 | 27.0 |
| B0080 | 24.3 | 25.3 | 24.4 | 25.4 | 25.2 | 26.2 | 25.0 | 26.0 | 25.5 | 26.5 | 25.8 | 26.8 |
| B0090 | 25.3 | 26.3 | 25.4 | 26.4 | 25.4 | 26.4 | 25.5 | 26.5 | 25.5 | 26.5 | 25.8 | 26.8 |
| B0100 | 23.3 | 24.3 | 24.3 | 25.3 | 25.2 | 26.2 | 25.0 | 26.0 | 25.5 | 26.5 | 25.8 | 26.8 |
| B0110 | 23.3 | 24.3 | 24.3 | 25.3 | 25.2 | 26.2 | 25.0 | 26.0 | 25.5 | 26.5 | 25.8 | 26.8 |
| B0120 | 24.1 | 25.1 | 24.5 | 25.5 | 25.2 | 26.2 | 25.1 | 26.1 | 25.5 | 26.5 | 25.9 | 26.9 |
| B0125 | 25.2 | 26.2 | 25.3 | 26.3 | 25.3 | 26.3 | 25.3 | 26.3 | 25.5 | 26.5 | 25.9 | 26.9 |
| B0130 | 23.8 | 24.8 | 24.5 | 25.5 | 25.2 | 26.2 | 25.1 | 26.1 | 25.5 | 26.5 | 25.9 | 26.9 |
| B0140 | 24.9 | 25.9 | 25.3 | 26.3 | 25.5 | 26.5 | 25.5 | 26.5 | 25.6 | 26.6 | 26.0 | 27.0 |
| B0160 | 24.9 | 25.9 | 25.3 | 26.3 | 25.5 | 26.5 | 25.6 | 26.6 | 25.6 | 26.6 | 26.0 | 27.0 |
| B0170 | 25.7 | 26.7 | 26.1 | 27.1 | 26.3 | 27.3 | 26.4 | 27.4 | 26.4 | 27.4 | 26.6 | 27.6 |
| B0175 | 26.3 | 27.3 | 26.5 | 27.5 | 26.6 | 27.6 | 26.7 | 27.7 | 26.7 | 27.7 | 26.9 | 27.9 |
| B0177 | 25.6 | 26.6 | 26.1 | 27.1 | 26.3 | 27.3 | 26.4 | 27.4 | 26.4 | 27.4 | 26.6 | 27.6 |
| B0180 | 25.6 | 26.6 | 26.1 | 27.1 | 26.3 | 27.3 | 26.4 | 27.4 | 26.4 | 27.4 | 26.6 | 27.6 |
| B0182 | 25.6 | 26.6 | 26.1 | 27.1 | 26.3 | 27.3 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 |
| B0183 | 27.0 | 28.0 | 27.0 | 28.0 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 |
| B0185 | 25.6 | 26.6 | 26.0 | 27.0 | 26.2 | 27.2 | 26.3 | 27.3 | 26.4 | 27.4 | 26.7 | 27.7 |
| B0187 | 27.7 | 28.7 | 28.0 | 29.0 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 |
| B0190 | 25.9 | 26.9 | 26.3 | 27.3 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 | 26.8 | 27.8 |
| B0200 | 24.9 | 25.9 | 25.4 | 26.4 | 25.5 | 26.5 | 25.7 | 26.7 | 25.8 | 26.8 | 26.1 | 27.1 |
| B0210 | 24.9 | 25.9 | 25.3 | 26.3 | 25.5 | 26.5 | 25.6 | 26.6 | 25.7 | 26.7 | 26.1 | 27.1 |
| B0220 | 25.7 | 26.7 | 26.2 | 27.2 | 26.4 | 27.4 | 26.4 | 27.4 | 26.5 | 27.5 | 26.7 | 27.7 |
| B0230 | 27.0 | 28.0 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.2 | 28.2 |
| B0240 | 25.7 | 26.7 | 26.2 | 27.2 | 26.4 | 27.4 | 26.4 | 27.4 | 26.5 | 27.5 | 26.7 | 27.7 |
| B0250 | 25.7 | 26.7 | 26.2 | 27.2 | 26.4 | 27.4 | 26.4 | 27.4 | 26.5 | 27.5 | 26.7 | 27.7 |
| B0260 | 25.7 | 26.7 | 26.2 | 27.2 | 26.4 | 27.4 | 26.5 | 27.5 | 26.5 | 27.5 | 26.7 | 27.7 |
| B0263 | 28.0 | 29.0 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 | 28.1 | 29.1 |
| B0265 | 27.0 | 28.0 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 |
| B0267 | 25.7 | 26.7 | 26.3 | 27.3 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 | 26.8 | 27.8 |
| B0270 | 25.7 | 26.7 | 26.3 | 27.3 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 | 26.8 | 27.8 |
| B0275 | 26.1 | 27.1 | 26.3 | 27.3 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 | 26.8 | 27.8 |
| B0277 | 26.2 | 27.2 | 26.3 | 27.3 | 26.5 | 27.5 | 26.6 | 27.6 | 26.7 | 27.7 | 26.8 | 27.8 |
| B0279 | 26.3 | 27.3 | 26.5 | 27.5 | 26.5 | 27.5 | 26.6 | 27.6 | 26.6 | 27.6 | 26.8 | 27.8 |
| B0280 | 25.8 | 26.8 | 26.3 | 27.3 | 26.5 | 27.5 | 26.6 | 27.6 | 26.6 | 27.6 | 26.8 | 27.8 |
| B0290 | 27.1 | 28.1 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 | 27.3 | 28.3 |
| B0295 | 29.0 | 30.0 | 29.0 | 30.0 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 |
| B0300 | 27.5 | 28.5 | 27.8 | 28.8 | 28.0 | 29.0 | 28.0 | 29.0 | 28.0 | 29.0 | 28.1 | 29.1 |
| B0310 | 27.5 | 28.5 | 27.8 | 28.8 | 28.0 | 29.0 | 28.0 | 29.0 | 28.1 | 29.1 | 28.1 | 29.1 |
| B0323 | 30.7 | 31.7 | 30.9 | 31.9 | 31.0 | 32.0 | 31.0 | 32.0 | 31.0 | 32.0 | 31.0 | 32.0 |
| B0325 | 27.4 | 28.4 | 28.5 | 29.5 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| B0326 | 27.4 | 28.4 | 28.5 | 29.5 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| B0327 | 29.8 | 30.8 | 30.0 | 31.0 | 30.0 | 31.0 | 30.0 | 31.0 | 30.0 | 31.0 | 30.0 | 31.0 |
| B0328 | 27.4 | 28.4 | 28.5 | 29.5 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| B0329 | 29.2 | 30.2 | 29.6 | 30.6 | 29.8 | 30.8 | 29.9 | 30.9 | 30.0 | 31.0 | 30.0 | 31.0 |
| B0330 | 27.5 | 28.5 | 28.5 | 29.5 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| B0331 | 27.7 | 28.7 | 28.5 | 29.5 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| B0340 | 29.0 | 30.0 | 29.0 | 30.0 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 | 29.1 | 30.1 |
| BNDY2 | 23.0 | 24.0 | 23.0 | 24.0 | 23.0 | 24.0 | 23.0 | 24.0 | 23.0 | 24.0 | 23.0 | 24.0 |
| BNDY3 | 25.0 | 26.0 | 25.0 | 26.0 | 25.0 | 26.0 | 25.7 | 26.7 | 25.0 | 26.0 | 25.0 | 26.0 |
| BNDY4 | 3.3 | 4.3 | 5.2 | 6.2 | 6.1 | 7.1 | 6.7 | 7.7 | 7.3 | 8.3 | 8.4 | 9.4 |
| bndy5 | 23.0 | 24.0 | 23.0 | 24.0 | 23.0 | 24.0 | 23.0 | 24.0 | 23.0 | 24.0 | 23.0 | 24.0 |
| BNDY6 | 29.0 | 30.0 | 29.0 | 30.0 | 29.0 | 30.0 | 29.0 | 30.0 | 29.0 | 30.0 | 29.0 | 30.0 |
| BNDY7 | 24.5 | 25.5 | 24.0 | 25.0 | 25.5 | 26.5 | 24.0 | 25.0 | 25.7 | 26.7 | 26.1 | 27.1 |
| BNDY8 | 24.0 | 25.0 | 24.0 | 25.0 | 24.0 | 25.0 | 24.0 | 25.0 | 24.0 | 25.0 | 24.0 | 25.0 |
| C0010 | 25.1 | 26.1 | 25.3 | 26.3 | 25.4 | 26.4 | 25.4 | 26.4 | 25.6 | 26.6 | 26.0 | 27.0 |
| C0020 | 25.6 | 26.6 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 | 25.9 | 26.9 | 26.0 | 27.0 |
| C0030 | 25.7 | 26.7 | 25.9 | 26.9 | 26.0 | 27.0 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 |
| C0035 | 25.1 | 26.1 | 25.3 | 26.3 | 25.4 | 26.4 | 25.5 | 26.5 | 25.7 | 26.7 | 26.0 | 27.0 |
| C0040 | 26.0 | 27.0 | 26.1 | 27.1 | 26.2 | 27.2 | 26.2 | 27.2 | 26.2 | 27.2 | 26.3 | 27.3 |
| C0050 | 26.0 | 27.0 | 26.3 | 27.3 | 26.4 | 27.4 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 |

# Table 3.1. Maximum Stages

| Node ID | 2-yr 24-hr | | 10-yr 24-hr | | 25-yr 24-hr | | 50-yr 24-hr | | 100-yr 24-hr | | 500-yr 24-hr | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 |
| C0055 | 27.0 | 28.0 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 | 27.3 | 28.3 |
| C0056 | 27.0 | 28.0 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 | 27.3 | 28.3 |
| C0057 | 27.0 | 28.0 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 | 27.3 | 28.3 |
| C0058 | 27.0 | 28.0 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 | 27.3 | 28.3 |
| C0059 | 27.1 | 28.1 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 | 27.3 | 28.3 |
| C0060 | 26.2 | 27.2 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 | 26.6 | 27.6 | 26.8 | 27.8 |
| C0065 | 27.0 | 28.0 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 | 27.3 | 28.3 |
| C0067 | 27.0 | 28.0 | 27.1 | 28.1 | 27.2 | 28.2 | 27.2 | 28.2 | 27.2 | 28.2 | 27.3 | 28.3 |
| C0069 | 29.6 | 30.6 | 29.8 | 30.8 | 30.0 | 31.0 | 30.0 | 31.0 | 30.0 | 31.0 | 30.0 | 31.0 |
| C0070 | 27.0 | 28.0 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.2 | 28.2 |
| C0075 | 27.0 | 28.0 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 | 27.1 | 28.1 |
| D0008 | 24.0 | 25.0 | 24.7 | 25.7 | 25.3 | 26.3 | 25.1 | 26.1 | 25.4 | 26.4 | 25.7 | 26.7 |
| D0008.1 | 24.0 | 25.0 | 24.7 | 25.7 | 25.3 | 26.3 | 25.1 | 26.1 | 25.4 | 26.4 | 25.7 | 26.7 |
| D0008.2 | 24.1 | 25.1 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.5 | 26.5 | 25.8 | 26.8 |
| D0009 | 24.4 | 25.4 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.5 | 26.5 | 25.9 | 26.9 |
| D0010 | 24.1 | 25.1 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.5 | 26.5 | 25.7 | 26.7 |
| D0010.1 | 24.3 | 25.3 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.5 | 26.5 | 25.8 | 26.8 |
| D0010.2 | 24.3 | 25.3 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.5 | 26.5 | 25.8 | 26.8 |
| D0010.3 | 24.4 | 25.4 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.5 | 26.5 | 25.9 | 26.9 |
| D0011 | 24.3 | 25.3 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.5 | 26.5 | 25.8 | 26.8 |
| D0011.1 | 24.5 | 25.5 | 25.0 | 26.0 | 25.4 | 26.4 | 25.3 | 26.3 | 25.6 | 26.6 | 26.0 | 27.0 |
| D0011.2 | 24.4 | 25.4 | 24.8 | 25.8 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 25.9 | 26.9 |
| D0011.3 | 24.4 | 25.4 | 24.8 | 25.8 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 25.9 | 26.9 |
| D0011.4 | 24.9 | 25.9 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| D0011PL | 24.4 | 25.4 | 24.8 | 25.8 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 25.9 | 26.9 |
| D0012 | 25.2 | 26.2 | 25.4 | 26.4 | 25.5 | 26.5 | 25.5 | 26.5 | 25.6 | 26.6 | 26.0 | 27.0 |
| D0013 | 25.7 | 26.7 | 26.0 | 27.0 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 | 26.3 | 27.3 |
| D0014 | 25.6 | 26.6 | 25.9 | 26.9 | 26.0 | 27.0 | 26.1 | 27.1 | 26.2 | 27.2 | 26.3 | 27.3 |
| D0015 | 25.4 | 26.4 | 25.5 | 26.5 | 25.6 | 26.6 | 25.6 | 26.6 | 25.7 | 26.7 | 26.1 | 27.1 |
| D0018 | 24.9 | 25.9 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| D0020 | 24.4 | 25.4 | 24.8 | 25.8 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 25.9 | 26.9 |
| D0025 | 25.8 | 26.8 | 26.0 | 27.0 | 26.1 | 27.1 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 |
| D0030 | 25.8 | 26.8 | 26.0 | 27.0 | 26.1 | 27.1 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 |
| D0035 | 24.4 | 25.4 | 24.8 | 25.8 | 25.3 | 26.3 | 25.1 | 26.1 | 25.5 | 26.5 | 25.9 | 26.9 |
| D0040 | 26.0 | 27.0 | 26.1 | 27.1 | 26.2 | 27.2 | 26.3 | 27.3 | 26.3 | 27.3 | 26.4 | 27.4 |
| D0045 | 26.0 | 27.0 | 26.2 | 27.2 | 26.2 | 27.2 | 26.3 | 27.3 | 26.3 | 27.3 | 26.4 | 27.4 |
| D0047 | 25.2 | 26.2 | 25.4 | 26.4 | 25.5 | 26.5 | 25.5 | 26.5 | 25.7 | 26.7 | 26.1 | 27.1 |
| D0050 | 25.2 | 26.2 | 25.4 | 26.4 | 25.5 | 26.5 | 25.5 | 26.5 | 25.7 | 26.7 | 26.1 | 27.1 |
| DD-LAKEC | 30.4 | 31.4 | 30.6 | 31.6 | 30.8 | 31.8 | 30.8 | 31.8 | 30.9 | 31.9 | 31.1 | 32.1 |
| DD-LAKEC | 30.4 | 31.4 | 30.6 | 31.6 | 30.7 | 31.7 | 30.8 | 31.8 | 30.8 | 31.8 | 31.0 | 32.0 |
| DD-W | 29.0 | 30.0 | 29.2 | 30.2 | 29.4 | 30.4 | 29.5 | 30.5 | 29.7 | 30.7 | 29.9 | 30.9 |
| DD005 | 27.8 | 28.8 | 28.5 | 29.5 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.3 | 30.3 |
| DD010 | 28.2 | 29.2 | 28.6 | 29.6 | 28.9 | 29.9 | 29.1 | 30.1 | 29.2 | 30.2 | 29.4 | 30.4 |
| E0003 | 24.7 | 25.7 | 24.9 | 25.9 | 25.5 | 26.5 | 25.1 | 26.1 | 25.7 | 26.7 | 26.1 | 27.1 |
| E0005 | 24.8 | 25.8 | 25.0 | 26.0 | 25.5 | 26.5 | 25.1 | 26.1 | 25.7 | 26.7 | 26.1 | 27.1 |
| E0007 | 24.8 | 25.8 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.7 | 26.7 | 26.0 | 27.0 |
| E0010 | 24.9 | 25.9 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.7 | 26.7 | 26.1 | 27.1 |
| E0015 | 25.1 | 26.1 | 25.3 | 26.3 | 25.5 | 26.5 | 25.5 | 26.5 | 25.7 | 26.7 | 26.1 | 27.1 |
| E0020 | 26.2 | 27.2 | 26.3 | 27.3 | 26.3 | 27.3 | 26.4 | 27.4 | 26.4 | 27.4 | 26.4 | 27.4 |
| E0025 | 26.2 | 27.2 | 26.3 | 27.3 | 26.3 | 27.3 | 26.4 | 27.4 | 26.4 | 27.4 | 26.4 | 27.4 |
| E0030 | 24.8 | 25.8 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.7 | 26.7 | 26.0 | 27.0 |
| E0035 | 24.8 | 25.8 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.7 | 26.7 | 26.0 | 27.0 |
| E0037 | 24.8 | 25.8 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0040 | 24.8 | 25.8 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.7 | 26.7 | 26.0 | 27.0 |
| E0045 | 25.2 | 26.2 | 25.3 | 26.3 | 25.5 | 26.5 | 25.5 | 26.5 | 25.7 | 26.7 | 26.0 | 27.0 |
| E0050 | 24.8 | 25.8 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.7 | 26.7 | 26.0 | 27.0 |
| E0055 | 24.8 | 25.8 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0060 | 24.8 | 25.8 | 25.0 | 26.0 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0065 | 25.2 | 26.2 | 25.4 | 26.4 | 25.5 | 26.5 | 25.5 | 26.5 | 25.7 | 26.7 | 26.0 | 27.0 |
| E0070 | 24.7 | 25.7 | 24.9 | 25.9 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0075 | 24.5 | 25.5 | 24.9 | 25.9 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0080 | 24.4 | 25.4 | 24.9 | 25.9 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0085 | 25.2 | 26.2 | 25.4 | 26.4 | 25.5 | 26.5 | 25.5 | 26.5 | 25.7 | 26.7 | 26.0 | 27.0 |
| E0090 | 25.2 | 26.2 | 25.4 | 26.4 | 25.5 | 26.5 | 25.5 | 26.5 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0095 | 25.2 | 26.2 | 25.4 | 26.4 | 25.5 | 26.5 | 25.5 | 26.5 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0100 | 24.9 | 25.9 | 25.1 | 26.1 | 25.4 | 26.4 | 25.3 | 26.3 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0105 | 24.4 | 25.4 | 24.8 | 25.8 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0110 | 24.5 | 25.5 | 24.9 | 25.9 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0115 | 24.5 | 25.5 | 24.9 | 25.9 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0120 | 24.4 | 25.4 | 24.9 | 25.9 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 26.0 | 27.0 |
| E0125 | 24.4 | 25.4 | 24.8 | 25.8 | 25.4 | 26.4 | 25.2 | 26.2 | 25.6 | 26.6 | 25.9 | 26.9 |

# Table 3.1. Maximum Stages

| Node ID | 2-yr 24-hr | | 10-yr 24-hr | | 25-yr 24-hr | | 50-yr 24-hr | | 100-yr 24-hr | | 500-yr 24-hr | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 |
| E0130 | 25.1 | 26.1 | 25.1 | 26.1 | 25.4 | 26.4 | 25.1 | 26.1 | 25.6 | 26.6 | 25.9 | 26.9 |
| E0132 | 24.8 | 25.8 | 24.9 | 25.9 | 25.5 | 26.5 | 25.1 | 26.1 | 25.7 | 26.7 | 26.1 | 27.1 |
| E0135 | 24.8 | 25.8 | 24.9 | 25.9 | 25.5 | 26.5 | 25.2 | 26.2 | 25.7 | 26.7 | 26.1 | 27.1 |
| E0140 | 25.1 | 26.1 | 25.3 | 26.3 | 25.5 | 26.5 | 25.4 | 26.4 | 25.7 | 26.7 | 26.1 | 27.1 |
| E0143 | 25.1 | 26.1 | 25.4 | 26.4 | 25.5 | 26.5 | 25.6 | 26.6 | 25.8 | 26.8 | 26.1 | 27.1 |
| E0145 | 24.7 | 25.7 | 24.8 | 25.8 | 25.5 | 26.5 | 25.0 | 26.0 | 25.7 | 26.7 | 26.1 | 27.1 |
| E0150 | 25.4 | 26.4 | 25.7 | 26.7 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 | 26.2 | 27.2 |
| E0505 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 | 26.0 | 27.0 | 26.0 | 27.0 | 26.2 | 27.2 |
| E0510 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 | 26.0 | 27.0 | 26.0 | 27.0 | 26.2 | 27.2 |
| E0515 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 | 25.9 | 26.9 | 26.0 | 27.0 | 26.2 | 27.2 |
| E0520 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 | 26.0 | 27.0 | 26.0 | 27.0 | 26.2 | 27.2 |
| E0525 | 25.8 | 26.8 | 25.9 | 26.9 | 26.0 | 27.0 | 26.0 | 27.0 | 26.0 | 27.0 | 26.2 | 27.2 |
| E0530 | 25.8 | 26.8 | 25.9 | 26.9 | 26.0 | 27.0 | 26.0 | 27.0 | 26.0 | 27.0 | 26.2 | 27.2 |
| E0535 | 25.8 | 26.8 | 25.9 | 26.9 | 26.0 | 27.0 | 26.0 | 27.0 | 26.0 | 27.0 | 26.2 | 27.2 |
| E0540 | 25.4 | 26.4 | 25.5 | 26.5 | 25.6 | 26.6 | 25.6 | 26.6 | 25.7 | 26.7 | 26.1 | 27.1 |
| E1000 | 25.6 | 26.6 | 25.7 | 26.7 | 25.8 | 26.8 | 25.8 | 26.8 | 25.8 | 26.8 | 26.1 | 27.1 |
| E1005 | 26.2 | 27.2 | 26.4 | 27.4 | 26.4 | 27.4 | 26.5 | 27.5 | 26.5 | 27.5 | 26.6 | 27.6 |
| E1010 | 26.6 | 27.6 | 26.8 | 27.8 | 26.9 | 27.9 | 26.9 | 27.9 | 26.9 | 27.9 | 27.0 | 28.0 |
| F0005 | 24.6 | 25.6 | 24.7 | 25.7 | 25.5 | 26.5 | 25.0 | 26.0 | 25.7 | 26.7 | 26.1 | 27.1 |
| F0010 | 24.6 | 25.6 | 24.7 | 25.7 | 25.5 | 26.5 | 25.0 | 26.0 | 25.7 | 26.7 | 26.1 | 27.1 |
| F0015 | 24.6 | 25.6 | 24.7 | 25.7 | 25.5 | 26.5 | 25.0 | 26.0 | 25.7 | 26.7 | 26.1 | 27.1 |
| F0020 | 24.5 | 25.5 | 24.0 | 25.0 | 25.5 | 26.5 | 24.1 | 25.1 | 25.7 | 26.7 | 26.1 | 27.1 |
| F0050 | 24.8 | 25.8 | 25.0 | 26.0 | 25.5 | 26.5 | 25.1 | 26.1 | 25.7 | 26.7 | 26.1 | 27.1 |
| FQ005 | 23.3 | 24.3 | 24.1 | 25.1 | 24.2 | 25.2 | 24.3 | 25.3 | 24.4 | 25.4 | 24.6 | 25.6 |
| FQ010 | 23.3 | 24.3 | 24.1 | 25.1 | 24.2 | 25.2 | 24.3 | 25.3 | 24.4 | 25.4 | 24.6 | 25.6 |
| GB429 | 13.9 | 14.9 | 15.3 | 16.3 | 15.8 | 16.8 | 16.1 | 17.1 | 16.3 | 17.3 | 16.9 | 17.9 |
| GB430 | 3.6 | 4.6 | 5.3 | 6.3 | 6.3 | 7.3 | 6.8 | 7.8 | 7.5 | 8.5 | 9.0 | 10.0 |
| GB431 | 11.7 | 12.7 | 12.3 | 13.3 | 12.6 | 13.6 | 12.9 | 13.9 | 13.1 | 14.1 | 13.6 | 14.6 |
| GB435 | 4.4 | 5.4 | 6.1 | 7.1 | 7.6 | 8.6 | 7.7 | 8.7 | 9.4 | 10.4 | 10.7 | 11.7 |
| GB436 | 13.2 | 14.2 | 13.3 | 14.3 | 13.4 | 14.4 | 13.4 | 14.4 | 13.5 | 14.5 | 13.5 | 14.5 |
| GB440 | 5.0 | 6.0 | 6.7 | 7.7 | 8.2 | 9.2 | 8.1 | 9.1 | 10.1 | 11.1 | 12.0 | 13.0 |
| GB445 | 6.3 | 7.3 | 7.4 | 8.4 | 8.6 | 9.6 | 8.4 | 9.4 | 10.3 | 11.3 | 12.4 | 13.4 |
| GB446 | 17.0 | 18.0 | 17.7 | 18.7 | 18.1 | 19.1 | 18.2 | 19.2 | 18.2 | 19.2 | 18.3 | 19.3 |
| GB450 | 8.6 | 9.6 | 9.7 | 10.7 | 11.0 | 12.0 | 10.6 | 11.6 | 12.6 | 13.6 | 14.8 | 15.8 |
| GB455 | 10.3 | 11.3 | 11.5 | 12.5 | 12.2 | 13.2 | 12.0 | 13.0 | 13.1 | 14.1 | 15.2 | 16.2 |
| GB456 | 17.4 | 18.4 | 18.1 | 19.1 | 18.1 | 19.1 | 18.2 | 19.2 | 18.2 | 19.2 | 18.3 | 19.3 |
| GB460 | 10.9 | 11.9 | 12.1 | 13.1 | 13.0 | 14.0 | 12.7 | 13.7 | 14.2 | 15.2 | 16.6 | 17.6 |
| GB464 | 22.1 | 23.1 | 22.2 | 23.2 | 22.2 | 23.2 | 22.2 | 23.2 | 22.2 | 23.2 | 22.3 | 23.3 |
| GB465 | 11.6 | 12.6 | 13.1 | 14.1 | 14.8 | 15.8 | 14.1 | 15.1 | 16.7 | 17.7 | 18.2 | 19.2 |
| GB470 | 13.9 | 14.9 | 14.7 | 15.7 | 16.1 | 17.1 | 15.5 | 16.5 | 17.8 | 18.8 | 19.7 | 20.7 |
| GB471 | 22.2 | 23.2 | 22.3 | 23.3 | 22.4 | 23.4 | 22.5 | 23.5 | 22.6 | 23.6 | 23.0 | 24.0 |
| GB472 | 22.6 | 23.6 | 22.9 | 23.9 | 23.2 | 24.2 | 23.1 | 24.1 | 23.5 | 24.5 | 23.8 | 24.8 |
| GB473 | 22.6 | 23.6 | 22.9 | 23.9 | 23.3 | 24.3 | 23.1 | 24.1 | 23.6 | 24.6 | 23.9 | 24.9 |
| GB474 | 22.6 | 23.6 | 22.9 | 23.9 | 23.6 | 24.6 | 23.3 | 24.3 | 24.0 | 25.0 | 24.6 | 25.6 |
| GB475 | 14.0 | 15.0 | 14.8 | 15.8 | 16.4 | 17.4 | 15.7 | 16.7 | 19.6 | 20.6 | 21.0 | 22.0 |
| GB476 | 25.0 | 26.0 | 25.0 | 26.0 | 25.1 | 26.1 | 25.1 | 26.1 | 25.1 | 26.1 | 25.1 | 26.1 |
| GB477 | 23.1 | 24.1 | 23.6 | 24.6 | 24.4 | 25.4 | 24.2 | 25.2 | 24.7 | 25.7 | 25.1 | 26.1 |
| GB480 | 16.3 | 17.3 | 16.9 | 17.9 | 18.1 | 19.1 | 17.6 | 18.6 | 20.0 | 21.0 | 21.5 | 22.5 |
| GB481 | 20.8 | 21.8 | 21.3 | 22.3 | 21.5 | 22.5 | 21.6 | 22.6 | 21.7 | 22.7 | 22.1 | 23.1 |
| GB483 | 17.7 | 18.7 | 18.2 | 19.2 | 18.4 | 19.4 | 18.5 | 19.5 | 18.7 | 19.7 | 20.9 | 21.9 |
| GB485 | 16.7 | 17.7 | 17.7 | 18.7 | 19.1 | 20.1 | 18.7 | 19.7 | 20.2 | 21.2 | 21.6 | 22.6 |
| GB490 | 17.0 | 18.0 | 17.9 | 18.9 | 19.2 | 20.2 | 18.8 | 19.8 | 20.4 | 21.4 | 21.8 | 22.8 |
| GB494 | 17.8 | 18.8 | 18.7 | 19.7 | 20.0 | 21.0 | 19.5 | 20.5 | 20.9 | 21.9 | 22.1 | 23.1 |
| GB495 | 21.1 | 22.1 | 21.2 | 22.2 | 21.2 | 22.2 | 21.2 | 22.2 | 21.2 | 22.2 | 22.1 | 23.1 |
| GB500 | 18.7 | 19.7 | 20.2 | 21.2 | 20.8 | 21.8 | 21.1 | 22.1 | 22.1 | 23.1 | 23.1 | 24.1 |
| GB504 | 22.6 | 23.6 | 22.9 | 23.9 | 23.1 | 24.1 | 23.3 | 24.3 | 23.4 | 24.4 | 23.6 | 24.6 |
| GB505 | 19.8 | 20.8 | 20.8 | 21.8 | 21.1 | 22.1 | 21.3 | 22.3 | 22.2 | 23.2 | 23.1 | 24.1 |
| GB506 | 21.4 | 22.4 | 21.5 | 22.5 | 21.8 | 22.8 | 21.9 | 22.9 | 22.2 | 23.2 | 23.1 | 24.1 |
| GB507 | 23.1 | 24.1 | 23.1 | 24.1 | 23.1 | 24.1 | 23.2 | 24.2 | 23.2 | 24.2 | 23.6 | 24.6 |
| GB508 | 23.1 | 24.1 | 23.2 | 24.2 | 23.3 | 24.3 | 23.3 | 24.3 | 23.4 | 24.4 | 23.8 | 24.8 |
| GB509 | 23.1 | 24.1 | 23.1 | 24.1 | 23.2 | 24.2 | 23.2 | 24.2 | 23.3 | 24.3 | 23.6 | 24.6 |
| GB510 | 20.2 | 21.2 | 21.4 | 22.4 | 21.7 | 22.7 | 21.9 | 22.9 | 22.4 | 23.4 | 23.2 | 24.2 |
| GB515 | 21.4 | 22.4 | 22.7 | 23.7 | 23.2 | 24.2 | 23.3 | 24.3 | 23.4 | 24.4 | 23.8 | 24.8 |
| GB517 | 24.4 | 25.4 | 24.6 | 25.6 | 24.7 | 25.7 | 24.8 | 25.8 | 24.8 | 25.8 | 25.0 | 26.0 |
| GB520 | 22.4 | 23.4 | 23.1 | 24.1 | 23.2 | 24.2 | 23.3 | 24.3 | 23.4 | 24.4 | 23.8 | 24.8 |
| GB525 | 23.1 | 24.1 | 23.2 | 24.2 | 23.3 | 24.3 | 23.4 | 24.4 | 23.5 | 24.5 | 23.8 | 24.8 |
| GB526 | 23.1 | 24.1 | 23.2 | 24.2 | 23.3 | 24.3 | 23.3 | 24.3 | 23.5 | 24.5 | 23.8 | 24.8 |
| GB527 | 24.1 | 25.1 | 24.2 | 25.2 | 24.2 | 25.2 | 24.3 | 25.3 | 24.3 | 25.3 | 24.4 | 25.4 |
| GB528 | 25.4 | 26.4 | 25.6 | 26.6 | 25.7 | 26.7 | 25.7 | 26.7 | 25.8 | 26.8 | 25.9 | 26.9 |
| GB600 | 23.4 | 24.4 | 23.7 | 24.7 | 23.9 | 24.9 | 24.0 | 25.0 | 24.2 | 25.2 | 24.4 | 25.4 |
| GB605 | 23.4 | 24.4 | 23.7 | 24.7 | 23.9 | 24.9 | 24.0 | 25.0 | 24.2 | 25.2 | 24.4 | 25.4 |

# Table 3.1. Maximum Stages

| Node ID | 2-yr 24-hr | | 10-yr 24-hr | | 25-yr 24-hr | | 50-yr 24-hr | | 100-yr 24-hr | | 500-yr 24-hr | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 | NGVD88 | NAVD29 |
| GB610 | 23.4 | 24.4 | 23.7 | 24.7 | 23.9 | 24.9 | 24.1 | 25.1 | 24.2 | 25.2 | 24.4 | 25.4 |
| GB615 | 23.4 | 24.4 | 23.8 | 24.8 | 24.1 | 25.1 | 24.1 | 25.1 | 24.2 | 25.2 | 24.4 | 25.4 |
| GB617 | 25.6 | 26.6 | 25.8 | 26.8 | 25.8 | 26.8 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 |
| GB620 | 23.4 | 24.4 | 23.8 | 24.8 | 24.1 | 25.1 | 24.2 | 25.2 | 24.4 | 25.4 | 24.7 | 25.7 |
| GB625 | 23.2 | 24.2 | 23.7 | 24.7 | 24.2 | 25.2 | 24.1 | 25.1 | 24.4 | 25.4 | 24.7 | 25.7 |
| GB630 | 21.9 | 22.9 | 23.6 | 24.6 | 24.3 | 25.3 | 24.2 | 25.2 | 24.6 | 25.6 | 24.9 | 25.9 |
| GB640 | 24.0 | 25.0 | 24.6 | 25.6 | 24.8 | 25.8 | 24.9 | 25.9 | 25.0 | 26.0 | 25.2 | 26.2 |
| GB645 | 24.0 | 25.0 | 24.6 | 25.6 | 24.8 | 25.8 | 24.9 | 25.9 | 25.0 | 26.0 | 25.2 | 26.2 |
| GB646 | 24.2 | 25.2 | 24.7 | 25.7 | 25.1 | 26.1 | 25.3 | 26.3 | 25.6 | 26.6 | 26.1 | 27.1 |
| GB647 | 24.2 | 25.2 | 24.7 | 25.7 | 24.9 | 25.9 | 25.0 | 26.0 | 25.1 | 26.1 | 25.2 | 26.2 |
| GB648 | 24.8 | 25.8 | 25.5 | 26.5 | 25.7 | 26.7 | 25.7 | 26.7 | 25.8 | 26.8 | 25.9 | 26.9 |
| GB649 | 25.0 | 26.0 | 25.7 | 26.7 | 26.0 | 27.0 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 |
| GB650 | 25.1 | 26.1 | 25.8 | 26.8 | 26.0 | 27.0 | 26.1 | 27.1 | 26.2 | 27.2 | 26.3 | 27.3 |
| GB651 | 24.4 | 25.4 | 24.6 | 25.6 | 24.8 | 25.8 | 25.0 | 26.0 | 25.0 | 26.0 | 25.2 | 26.2 |
| GB652 | 24.4 | 25.4 | 24.6 | 25.6 | 24.8 | 25.8 | 25.0 | 26.0 | 25.0 | 26.0 | 25.2 | 26.2 |
| GB655 | 18.7 | 19.7 | 19.5 | 20.5 | 21.8 | 22.8 | 20.9 | 21.9 | 22.8 | 23.8 | 23.4 | 24.4 |
| GB658 | 19.6 | 20.6 | 20.5 | 21.5 | 21.1 | 22.1 | 21.4 | 22.4 | 22.9 | 23.9 | 23.5 | 24.5 |
| GB659 | 18.2 | 19.2 | 18.9 | 19.9 | 21.9 | 22.9 | 21.0 | 22.0 | 22.9 | 23.9 | 23.5 | 24.5 |
| GB660 | 19.1 | 20.1 | 20.0 | 21.0 | 22.0 | 23.0 | 21.4 | 22.4 | 22.9 | 23.9 | 23.5 | 24.5 |
| GB661 | 19.8 | 20.8 | 20.8 | 21.8 | 22.0 | 23.0 | 21.4 | 22.4 | 22.9 | 23.9 | 23.5 | 24.5 |
| GB662 | 17.8 | 18.8 | 18.3 | 19.3 | 22.0 | 23.0 | 21.4 | 22.4 | 22.9 | 23.9 | 23.5 | 24.5 |
| GB663 | 21.1 | 22.1 | 21.1 | 22.1 | 22.0 | 23.0 | 21.4 | 22.4 | 22.9 | 23.9 | 23.5 | 24.5 |
| GB664 | 16.9 | 17.9 | 17.4 | 18.4 | 21.3 | 22.3 | 18.4 | 19.4 | 23.0 | 24.0 | 23.6 | 24.6 |
| GB665 | 19.5 | 20.5 | 20.4 | 21.4 | 22.4 | 23.4 | 22.0 | 23.0 | 23.0 | 24.0 | 23.6 | 24.6 |
| GB668 | 18.1 | 19.1 | 18.8 | 19.8 | 21.3 | 22.3 | 19.4 | 20.4 | 23.0 | 24.0 | 23.6 | 24.6 |
| GB670 | 19.6 | 20.6 | 20.7 | 21.7 | 22.6 | 23.6 | 22.2 | 23.2 | 23.2 | 24.2 | 23.8 | 24.8 |
| GB671 | 25.2 | 26.2 | 25.2 | 26.2 | 25.3 | 26.3 | 25.3 | 26.3 | 25.3 | 26.3 | 25.3 | 26.3 |
| GB672 | 25.2 | 26.2 | 25.3 | 26.3 | 25.3 | 26.3 | 25.3 | 26.3 | 25.3 | 26.3 | 25.4 | 26.4 |
| GB673 | 16.8 | 17.8 | 20.7 | 21.7 | 22.6 | 23.6 | 22.2 | 23.2 | 23.2 | 24.2 | 23.8 | 24.8 |
| GB675 | 20.9 | 21.9 | 21.4 | 22.4 | 22.7 | 23.7 | 22.3 | 23.3 | 23.3 | 24.3 | 23.9 | 24.9 |
| GB678 | 17.6 | 18.6 | 20.7 | 21.7 | 22.6 | 23.6 | 22.2 | 23.2 | 23.2 | 24.2 | 23.8 | 24.8 |
| HC005 | 25.9 | 26.9 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 | 26.2 | 27.2 | 26.2 | 27.2 |
| HC010 | 25.8 | 26.8 | 26.0 | 27.0 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 | 26.2 | 27.2 |
| HC015 | 25.9 | 26.9 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 | 26.2 | 27.2 | 26.2 | 27.2 |
| HC017 | 25.9 | 26.9 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 | 26.2 | 27.2 | 26.2 | 27.2 |
| HC020 | 25.9 | 26.9 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 | 26.2 | 27.2 | 26.2 | 27.2 |
| HC025 | 26.3 | 27.3 | 26.4 | 27.4 | 26.5 | 27.5 | 26.6 | 27.6 | 26.6 | 27.6 | 26.7 | 27.7 |
| HC105 | 25.9 | 26.9 | 26.1 | 27.1 | 26.1 | 27.1 | 26.2 | 27.2 | 26.2 | 27.2 | 26.3 | 27.3 |
| HC110 | 26.2 | 27.2 | 26.4 | 27.4 | 26.5 | 27.5 | 26.5 | 27.5 | 26.6 | 27.6 | 26.7 | 27.7 |
| HC115 | 26.2 | 27.2 | 26.4 | 27.4 | 26.5 | 27.5 | 26.5 | 27.5 | 26.6 | 27.6 | 26.6 | 27.6 |
| HC120 | 26.2 | 27.2 | 26.4 | 27.4 | 26.5 | 27.5 | 26.5 | 27.5 | 26.6 | 27.6 | 26.7 | 27.7 |
| HR270 | 22.4 | 23.4 | 22.8 | 23.8 | 23.2 | 24.2 | 23.3 | 24.3 | 23.4 | 24.4 | 23.8 | 24.8 |
| HR275 | 22.4 | 23.4 | 22.8 | 23.8 | 23.2 | 24.2 | 23.3 | 24.3 | 23.4 | 24.4 | 23.8 | 24.8 |
| HR280 | 22.4 | 23.4 | 22.9 | 23.9 | 23.2 | 24.2 | 23.3 | 24.3 | 23.4 | 24.4 | 23.8 | 24.8 |
| HR281 | 20.4 | 21.4 | 20.6 | 21.6 | 20.7 | 21.7 | 20.8 | 21.8 | 20.9 | 21.9 | 21.0 | 22.0 |
| HR283 | 16.5 | 17.5 | 17.0 | 18.0 | 17.3 | 18.3 | 17.4 | 18.4 | 17.6 | 18.6 | 18.0 | 19.0 |
| HR284 | 20.0 | 21.0 | 20.8 | 21.8 | 21.1 | 22.1 | 21.2 | 22.2 | 21.3 | 22.3 | 21.4 | 22.4 |
| HR285 | 25.0 | 26.0 | 25.1 | 26.1 | 25.1 | 26.1 | 25.1 | 26.1 | 25.2 | 26.2 | 25.2 | 26.2 |
| HR286 | 22.3 | 23.3 | 22.9 | 23.9 | 23.2 | 24.2 | 23.4 | 24.4 | 23.6 | 24.6 | 23.9 | 24.9 |
| HR287 | 25.6 | 26.6 | 25.7 | 26.7 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 | 26.0 | 27.0 |
| HR288 | 25.6 | 26.6 | 25.7 | 26.7 | 25.8 | 26.8 | 25.9 | 26.9 | 25.9 | 26.9 | 26.0 | 27.0 |
| SP005 | 19.7 | 20.7 | 20.3 | 21.3 | 20.6 | 21.6 | 20.9 | 21.9 | 21.1 | 22.1 | 21.5 | 22.5 |
| SR005 | 20.2 | 21.2 | 20.5 | 21.5 | 20.6 | 21.6 | 20.6 | 21.6 | 20.7 | 21.7 | 20.7 | 21.7 |
| TC005 | 17.9 | 18.9 | 18.4 | 19.4 | 18.9 | 19.9 | 19.2 | 20.2 | 19.5 | 20.5 | 20.2 | 21.2 |

1. Conversion from NAVD88 to NGVD29 is +1.00-ft.

## Table 3.2. Maximum Stage Comparisons

| Location Description | Minimum Road Crown El. | Warning Stage | Node Relationships | Existing Condition | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2-Year | | | | | 10-yr | | | | | 25-yr | | | | | 50-yr | | | | | 100-yr | | | | | 500-yr | | | | |
| | | | NodeID | SAI Maximum Stage | CDM Maximum Stage | FEMA FIRM Maximum Stage | Difference CDM | Difference FEMA | SAI Maximum Stage | CDM Maximum Stage | FEMA FIRM Maximum Stage | Difference CDM | Difference FEMA | SAI Maximum Stage | CDM Maximum Stage | FEMA FIRM Maximum Stage | Difference CDM | Difference FEMA | SAI Maximum Stage | CDM Maximum Stage | FEMA FIRM Maximum Stage | Difference CDM | Difference FEMA | SAI Maximum Stage | CDM Maximum Stage | FEMA FIRM Maximum Stage | Difference CDM | Difference FEMA | SAI Maximum Stage | CDM Maximum Stage | FEMA FIRM Maximum Stage | Difference CDM | Difference FEMA |
| **Onsite Main Canal** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| U/S U.S. Highway 1 | 30.00 | 30.00 | 1320 | 27.36 | 26.80 | - | **0.56** | - | 28.54 | 27.50 | - | **1.04** | - | 28.88 | 27.90 | - | **0.98** | - | 29.06 | - | - | - | - | 29.17 | 28.50 | - | **0.67** | - | 29.34 | - | - | - | - |
| U/S FEC Railroad | 30.00 | 30.00 | B0325 | 27.36 | 26.80 | - | **0.56** | - | 28.53 | 27.40 | - | **1.13** | - | 28.87 | 27.80 | - | **1.07** | - | 29.05 | - | - | - | - | 29.16 | 28.20 | - | **0.96** | - | 29.34 | - | - | - | - |
| D/S FEC Railroad | 30.00 | 30.00 | B0280 | 25.79 | 26.50 | - | **-0.71** | - | 26.31 | 27.40 | - | **-1.09** | - | 26.45 | 27.80 | - | **-1.35** | - | 26.55 | - | - | - | - | 26.64 | 28.20 | - | **-1.56** | - | 26.84 | - | - | - | - |
| **Groover Branch** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Groover Branch U/S Durrance Lane | 22.97 | 22.97 | B0010 | 21.81 | 20.30 | - | **1.51** | - | 23.59 | 21.80 | - | **1.79** | - | 24.43 | 22.90 | - | **1.53** | - | 24.16 | - | - | - | - | 24.81 | 23.90 | - | **0.91** | - | 25.21 | - | - | - | - |
| Groover Branch D/S Durrance Lane | 22.97 | 22.97 | GB675 | 20.93 | 20.10 | - | **0.83** | - | 21.36 | 21.40 | - | -0.04 | - | 22.66 | 22.30 | - | 0.36 | - | 22.26 | - | - | - | - | 23.28 | 23.80 | - | **-0.52** | - | 23.86 | - | - | - | - |
| Groover Branch U/S Dirt Driveway | 17.10 | 17.10 | GB485 | 16.73 | 17.30 | - | **-0.57** | - | 17.74 | 18.50 | - | **-0.76** | - | 19.07 | 19.10 | - | -0.03 | - | 18.66 | - | - | - | - | 20.25 | 19.90 | - | 0.35 | - | 21.64 | - | - | - | - |
| Groover Branch D/S Dirt Driveway | 17.10 | 17.10 | GB480 | 16.31 | 17.20 | - | **-0.89** | - | 16.93 | 18.40 | - | **-1.47** | - | 18.10 | 19.00 | - | **-0.90** | - | 17.57 | - | - | - | - | 20.04 | 19.90 | - | 0.14 | - | 21.46 | - | - | - | - |
| Groover Branch U/S Tymber Creek Road | 19.60 | 19.60 | GB475 | 13.95 | 16.30 | - | **-2.35** | - | 14.84 | 17.60 | 15.50 | **-2.76** | -0.66 | 16.36 | 18.30 | - | **-1.94** | - | 15.68 | - | 18.00 | - | **-2.32** | 19.64 | 19.20 | 18.90 | 0.44 | **0.74** | 21.00 | - | 20.50 | - | **0.50** |
| Groover Branch D/S Tymber Creek Road | 19.60 | 19.60 | GB470 | 13.88 | 16.30 | - | **-2.42** | - | 14.72 | 17.50 | 15.25 | **-2.78** | **-0.53** | 16.14 | 18.20 | - | **-2.06** | - | 15.52 | - | 17.25 | - | **-1.73** | 17.85 | 19.00 | 17.60 | **-1.15** | 0.25 | 19.66 | - | 18.60 | - | **1.06** |
| Groover Branch U/S Airport Rd. | 15.90 | 15.90 | GB465 | 11.63 | 13.60 | - | **-1.97** | - | 13.05 | 14.90 | 14.10 | **-1.85** | **-1.05** | 14.82 | 15.60 | - | **-0.78** | - | 14.14 | - | 16.00 | - | **-1.87** | 16.74 | 16.60 | 16.80 | 0.14 | -0.06 | 18.24 | - | 17.60 | - | **0.63** |
| Groover Branch D/S Airport Rd. | 15.90 | 15.90 | GB460 | 10.90 | 13.50 | - | **-2.60** | - | 12.07 | 14.70 | 13.00 | **-2.63** | **-0.93** | 13.02 | 15.30 | - | **-2.28** | - | 12.70 | - | 14.00 | - | **-1.30** | 14.22 | 16.20 | 15.00 | **-1.98** | **-0.78** | 16.59 | - | 15.90 | - | **0.69** |
| Groover Branch U/S Dimmers Rd | 10.00 | 10.00 | GB455 | 10.26 | 10.40 | - | -0.14 | - | 11.48 | 11.00 | 10.90 | 0.48 | **0.58** | 12.17 | 11.40 | - | **0.77** | - | 11.96 | - | 12.10 | - | -0.14 | 13.05 | 12.40 | 12.40 | **0.65** | **0.65** | 15.15 | - | 13.10 | - | **2.05** |
| Groover Branch D/S Dimmers Rd | 10.00 | 10.00 | GB450 | 8.59 | 9.20 | - | **-0.61** | - | 9.72 | 10.50 | 9.00 | **-0.78** | **0.72** | 10.99 | 11.30 | - | -0.31 | - | 10.58 | - | 11.20 | - | -0.62 | 12.57 | 12.40 | 12.00 | 0.17 | 0.57 | 14.77 | - | 12.70 | - | 2.07 |
| Groover Branch U/S Linville Rd | 5.70 | 5.70 | GB445 | 6.31 | 6.90 | - | **-0.59** | - | 7.44 | 8.00 | 7.00 | **-0.56** | 0.44 | 8.57 | 9.00 | - | -0.43 | - | 8.37 | - | 8.50 | - | -0.13 | 10.31 | 10.40 | 9.10 | -0.09 | **1.21** | 12.35 | - | 10.50 | - | 1.85 |
| Groover Branch D/S Linville Rd | 5.70 | 5.70 | GB440 | 5.04 | 6.40 | - | **-1.37** | - | 6.69 | 8.00 | 6.80 | **-1.31** | -0.11 | 8.23 | 9.00 | - | **-0.77** | - | 8.10 | - | 8.00 | - | 0.10 | 10.06 | 10.40 | 9.00 | -0.34 | **1.06** | 12.02 | - | 10.50 | - | 1.52 |
| Groover Branch U/S Tymber Run | 8.00 | 8.00 | GB435 | 4.40 | 4.00 | - | 0.40 | - | 6.06 | 6.10 | 6.80 | -0.04 | **-0.74** | 7.62 | 7.40 | - | 0.22 | - | 7.69 | - | 8.00 | - | -0.31 | 9.36 | 9.20 | 9.00 | 0.16 | 0.36 | 10.72 | - | 10.50 | - | 0.22 |
| Groover Branch D/S Tymber Run | 8.00 | 8.00 | GB430 | 3.63 | 4.00 | - | -0.37 | - | 5.33 | 6.00 | 6.80 | **-0.67** | **-1.47** | 6.32 | 7.30 | - | **-0.98** | - | 6.83 | - | 8.00 | - | -1.17 | 7.52 | 9.00 | 9.00 | **-1.48** | **-1.48** | 8.97 | - | 10.50 | - | -1.53 |
| **Groover Branch Eastern Tributary** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D/S Harmony Avenue | 27.54 | 27.54 | GB649 | 24.99 | 24.80 | - | 0.19 | - | 25.71 | 25.40 | - | 0.31 | - | 25.98 | 25.70 | - | 0.28 | - | 26.07 | - | - | - | - | 26.12 | 26.10 | - | 0.02 | - | 26.21 | - | - | - | - |
| Eastern Groover Branch Tributary U/S Pineland Trail | 26.30 | 26.30 | GB630 | 21.92 | 24.20 | - | **-2.28** | - | 23.63 | 24.60 | - | **-0.97** | - | 24.31 | 24.80 | - | -0.49 | - | 24.17 | - | - | - | - | 24.56 | 25.20 | - | **-0.64** | - | 24.86 | - | - | - | - |
| U/S of I-95 Cross Drain | 27.00 | 27.00 | A0001 | 21.91 | 21.40 | - | **0.51** | - | 23.62 | 23.10 | - | **0.52** | - | 24.35 | 24.20 | - | 0.15 | - | 24.17 | - | - | - | - | 24.63 | 25.20 | - | **-0.57** | - | 24.90 | - | - | - | - |
| Durrance Lane and Tymber Creek Road Intersection U/S North Ditch | 24.80 | 24.80 | A0002 | 21.89 | 21.20 | - | **0.69** | - | 23.62 | 22.70 | - | **0.91** | - | 24.43 | 23.60 | - | **0.83** | - | 24.18 | - | - | - | - | 24.77 | 24.50 | - | 0.27 | - | 25.11 | - | - | - | - |
| Durrance Lane and Tymber Creek Road Intersection D/S North Ditch | 24.80 | 24.80 | B0007 | 21.85 | 21.20 | - | **0.65** | - | 23.59 | 22.60 | - | **0.99** | - | 24.44 | 23.50 | - | **0.94** | - | 24.16 | - | - | - | - | 24.81 | 24.30 | - | **0.51** | - | 25.21 | - | - | - | - |
| **Groover Branch Western Tributary** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Groover Branch West Tributary U/S Durrance Lane | 25.23 | 25.23 | D0008 | 24.03 | 21.00 | - | **3.03** | - | 24.74 | 22.00 | - | **2.74** | - | 25.26 | 22.80 | - | **2.46** | - | 25.09 | - | - | - | - | 25.43 | 23.70 | - | **1.73** | - | 25.71 | - | - | - | - |
| Groover Branch West Tributary D/S Durrance Lane | 25.23 | 25.23 | GB525 | 23.11 | 20.10 | - | **3.01** | - | 23.22 | 21.20 | - | **2.02** | - | 23.30 | 21.50 | - | **1.80** | - | 23.36 | - | - | - | - | 23.48 | 22.20 | - | **1.28** | - | 23.84 | - | - | - | - |
| Groover Branch West Tributary U/S Leeway Trail | 20.10 | 20.10 | GB505 | 19.84 | 18.60 | - | **1.24** | - | 20.84 | 20.00 | - | **0.84** | - | 21.09 | 20.50 | - | **0.59** | - | 21.29 | - | - | - | - | 22.16 | 21.10 | - | **1.06** | - | 23.08 | - | - | - | - |
| Groover Branch West Tributary D/S Leeway Trail | 20.10 | 20.10 | GB500 | 18.66 | 18.30 | - | 0.36 | - | 20.17 | 19.40 | - | **0.77** | - | 20.84 | 20.10 | - | **0.74** | - | 21.14 | - | - | - | - | 22.12 | 21.00 | - | **1.12** | - | 23.06 | - | - | - | - |

**Notes:**

1. Node relationships were established for each of the surveyed channel bridge/culvert crossings.
2. All units are in feet.
3. All elevations are referenced to NAVD88 vertical datum
4. Maximum stage differences greater than 0.5-ft are highlighted above.

## Table 3.3. Roadway Flooding Evaluation

| Location Description | Minimum Road Crown El. | Warning Stage | Node Relationships | Existing Condition | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 10-yr | | | 50-yr | | | 100-yr | | | 500-yr | | |
| | | | NodeID | Node Stage | Flood Status | Flooding Depth (ft) | Node Stage | Flood Status | Flooding Depth (ft) | Node Stage | Flood Status | Flooding Depth (ft) | Node Stage | Flood Status | Flooding Depth (ft) |
| **Onsite Main Canal - Eastern Tributary** | | | | | | | | | | | | | | | |
| U/S Onsite Dirt Road | 28.09 | 28.09 | B0170 | 26.08 | No | - | 26.36 | No | - | 26.43 | No | - | 26.59 | No | - |
| D/S Onsite Dirt Road | 28.09 | 28.09 | B0200 | 25.36 | No | - | 25.66 | No | - | 25.77 | No | - | 26.10 | No | - |
| **Onsite Main Canal - Western Tributary** | | | | | | | | | | | | | | | |
| U/S Onsite Dirt Road | 27.40 | 27.40 | C0070 | 27.06 | No | - | 27.11 | No | - | 27.13 | No | - | 27.16 | No | - |
| D/S Onsite Dirt Road | 27.40 | 27.40 | C0060 | 26.44 | No | - | 26.60 | No | - | 26.65 | No | - | 26.75 | No | - |
| U/S Onsite Dirt Road | 26.00 | 26.00 | C0040 | **26.11** | **Yes** | 0.11 | **26.18** | **Yes** | 0.18 | **26.21** | **Yes** | 0.21 | **26.26** | **Yes** | 0.26 |
| D/S Onsite Dirt Road | 26.00 | 26.00 | C0030 | 25.92 | No | - | **26.06** | **Yes** | 0.06 | **26.10** | **Yes** | 0.10 | **26.17** | **Yes** | 0.17 |
| U/S Onsite Dirt Road | 23.00 | 23.00 | C0010 | **25.27** | **Yes** | 2.27 | **25.41** | **Yes** | 2.41 | **25.63** | **Yes** | 2.63 | **25.99** | **Yes** | 2.99 |
| D/S Onsite Dirt Road | 23.00 | 23.00 | C0020 | **25.80** | **Yes** | 2.80 | **25.91** | **Yes** | 2.91 | **25.94** | **Yes** | 2.94 | **26.00** | **Yes** | 3.00 |
| U/S Onsite Dirt Road | 24.46 | 24.46 | B0044 | **24.63** | **Yes** | 0.17 | **24.97** | **Yes** | 0.51 | **25.43** | **Yes** | 0.97 | **25.77** | **Yes** | 1.31 |
| D/S Onsite Dirt Road | 24.46 | 24.46 | B0042 | 24.32 | No | - | **24.96** | **Yes** | 0.50 | **25.43** | **Yes** | 0.97 | **25.76** | **Yes** | 1.30 |
| **Onsite Main Canal** | | | | | | | | | | | | | | | |
| U/S U.S. Highway 1 | 30.00 | 30.00 | 1320 | 28.54 | No | - | 29.06 | No | - | 29.17 | No | - | 29.34 | No | - |
| U/S FEC Railroad | 30.00 | 30.00 | B0325 | 28.53 | No | - | 29.05 | No | - | 29.16 | No | - | 29.34 | No | - |
| D/S FEC Railroad | 30.00 | 30.00 | B0280 | 26.31 | No | - | 26.55 | No | - | 26.64 | No | - | 26.84 | No | - |
| U/S Onsite Dirt Road | 25.00 | 25.00 | B0260 | **26.23** | **Yes** | 1.23 | **26.45** | **Yes** | 1.45 | **26.53** | **Yes** | 1.53 | **26.70** | **Yes** | 1.70 |
| D/S Onsite Dirt Road | 25.00 | 25.00 | B0250 | **26.23** | **Yes** | 1.23 | **26.44** | **Yes** | 1.44 | **26.52** | **Yes** | 1.52 | **26.69** | **Yes** | 1.69 |
| U/S Onsite Dirt Road | 28.00 | 28.00 | B0220 | 26.22 | No | - | 26.44 | No | - | 26.52 | No | - | 26.68 | No | - |
| D/S Onsite Dirt Road | 28.00 | 28.00 | B0210 | 25.34 | No | - | 25.63 | No | - | 25.74 | No | - | 26.08 | No | - |
| U/S Onsite Dirt Road | 28.00 | 28.00 | B0140 | 25.29 | No | - | 25.55 | No | - | 25.64 | No | - | 25.98 | No | - |
| D/S Onsite Dirt Road | 28.00 | 28.00 | B0130 | 24.52 | No | - | 25.11 | No | - | 25.54 | No | - | 25.89 | No | - |
| U/S Onsite Dirt Road | 23.00 | 23.00 | B0110 | **24.32** | **Yes** | 1.32 | **25.03** | **Yes** | 2.03 | **25.49** | **Yes** | 2.49 | **25.84** | **Yes** | 2.84 |
| D/S Onsite Dirt Road | 23.00 | 23.00 | B0100 | **24.31** | **Yes** | 1.31 | **25.02** | **Yes** | 2.02 | **25.49** | **Yes** | 2.49 | **25.83** | **Yes** | 2.83 |
| U/S Onsite Dirt Road | 24.00 | 24.00 | B0030 | **24.04** | **Yes** | 0.04 | **24.66** | **Yes** | 0.66 | **25.20** | **Yes** | 1.20 | **25.50** | **Yes** | 1.50 |
| D/S Onsite Dirt Road | 24.00 | 24.00 | B0020 | 23.63 | No | - | **24.19** | **Yes** | 0.18 | **24.87** | **Yes** | 0.87 | **25.32** | **Yes** | 1.32 |
| Groover Branch U/S Durrance Lane | 22.97 | 22.97 | B0010 | **23.59** | **Yes** | 0.62 | **24.16** | **Yes** | 1.19 | **24.81** | **Yes** | 1.84 | **25.21** | **Yes** | 2.24 |
| **Groover Branch** | | | | | | | | | | | | | | | |
| Groover Branch D/S Durrance Lane | 22.97 | 22.97 | GB675 | 21.36 | No | - | 22.26 | No | - | **23.28** | **Yes** | 0.31 | **23.86** | **Yes** | 0.89 |
| Groover Branch U/S Dirt Drive | 20.53 | 20.53 | GB670 | **20.67** | **Yes** | 0.14 | **22.18** | **Yes** | 1.65 | **23.20** | **Yes** | 2.67 | **23.75** | **Yes** | 3.22 |
| Groover Branch D/S Dirt Drive | 20.53 | 20.53 | GB665 | 20.44 | No | - | **22.04** | **Yes** | 1.51 | **23.03** | **Yes** | 2.50 | **23.63** | **Yes** | 3.10 |
| Groover Branch U/S Dirt Driveway | 17.10 | 17.10 | GB485 | **17.74** | **Yes** | 0.64 | **18.66** | **Yes** | 1.56 | **20.25** | **Yes** | 3.15 | **21.64** | **Yes** | 4.54 |
| Groover Branch D/S Dirt Driveway | 17.10 | 17.10 | GB480 | 16.93 | No | - | **17.57** | **Yes** | 0.47 | **20.04** | **Yes** | 2.94 | **21.46** | **Yes** | 4.36 |
| Groover Branch U/S Tymber Creek Road | 19.60 | 19.60 | GB475 | 14.84 | No | - | 15.68 | No | - | **19.64** | **Yes** | 0.04 | **21.00** | **Yes** | 1.40 |
| Groover Branch D/S Tymber Creek Road | 19.60 | 19.60 | GB470 | 14.72 | No | - | 15.52 | No | - | 17.85 | No | - | **19.66** | **Yes** | 0.05 |
| Groover Branch U/S Airport Rd. | 15.90 | 15.90 | GB465 | 13.05 | No | - | 14.14 | No | - | **16.74** | **Yes** | 0.84 | **18.24** | **Yes** | 2.34 |
| Groover Branch D/S Airport Rd. | 15.90 | 15.90 | GB460 | 12.07 | No | - | 12.70 | No | - | 14.22 | No | - | **16.59** | **Yes** | 0.69 |
| Groover Branch U/S Dimmers Rd | 10.00 | 10.00 | GB455 | **11.48** | **Yes** | 1.48 | **11.96** | **Yes** | 1.96 | **13.05** | **Yes** | 3.05 | **15.15** | **Yes** | 5.15 |
| Groover Branch D/S Dimmers Rd | 10.00 | 10.00 | GB450 | 9.72 | No | - | **10.58** | **Yes** | 0.58 | **12.57** | **Yes** | 2.57 | **14.77** | **Yes** | 4.77 |
| Groover Branch U/S Linville Rd | 5.70 | 5.70 | GB445 | **7.44** | **Yes** | 1.74 | **8.37** | **Yes** | 2.67 | **10.31** | **Yes** | 4.61 | **12.35** | **Yes** | 6.65 |
| Groover Branch D/S Linville Rd | 5.70 | 5.70 | GB440 | **6.69** | **Yes** | 0.99 | **8.10** | **Yes** | 2.40 | **10.06** | **Yes** | 4.36 | **12.02** | **Yes** | 6.32 |
| Groover Branch U/S Tymber Run | 8.00 | 8.00 | GB435 | 6.06 | No | - | 7.69 | No | - | **9.36** | **Yes** | 1.36 | **10.72** | **Yes** | 2.72 |
| Groover Branch D/S Tymber Run | 8.00 | 8.00 | GB430 | 5.33 | No | - | 6.83 | No | - | 7.52 | No | - | **8.97** | **Yes** | 0.97 |

**Notes:**

1. Node relationships were established for each of the surveyed channel bridge/culvert crossings.
2. indicates that the roadway is predicted to flood during the simulated storm.
3. All units are in feet.
4. All elevations are referenced to NAVD88 vertical datum
5. SAI Flood stages based upon the maximum value of all model scenarios.

## Table 3.2. Roadway Flooding Evaluation (Cont'd.)

| Location Description | Minimum Road Crown El. | Warning Stage | Node Relationships | Existing Condition | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 10-yr | | | 50-yr | | | 100-yr | | | 500-yr | | |
| | | | NodeID | Node Stage | Flood Status | Flooding Depth (ft) | Node Stage | Flood Status | Flooding Depth (ft) | Node Stage | Flood Status | Flooding Depth (ft) | Node Stage | Flood Status | Flooding Depth (ft) |
| **Groover Branch Eastern Tributary** | | | | | | | | | | | | | | | |
| Durrance Lane and Tymber Creek Road Intersection D/S North Ditch | 24.80 | 24.80 | B0007 | 23.59 | No | - | 24.16 | No | - | **24.81** | **Yes** | 0.01 | **25.21** | **Yes** | 0.41 |
| Durrance Lane and Tymber Creek Road Intersection U/S North Ditch | 24.80 | 24.80 | A0002 | 23.62 | No | - | 24.18 | No | - | 24.77 | No | - | **25.11** | **Yes** | 0.31 |
| U/S of I-95 Cross Drain | 27.00 | 27.00 | A0001 | 23.62 | No | - | 24.17 | No | - | 24.63 | No | - | 24.90 | No | - |
| Eastern Groover Branch Tributary U/S Pineland Trail | 26.30 | 26.30 | GB630 | 23.63 | No | - | 24.17 | No | - | 24.56 | No | - | 24.86 | No | - |
| Eastern Groover Branch Tributary D/S Weir | 25.20 | 25.20 | GB625 | 23.74 | No | - | 24.13 | No | - | 24.39 | No | - | 24.68 | No | - |
| Eastern Groover Branch Tributary U/S Weir | 25.20 | 25.20 | GB620 | 23.77 | No | - | 24.16 | No | - | 24.38 | No | - | 24.67 | No | - |
| Eastern Groover Branch Tributary D/S Tower Circle | 24.00 | 24.00 | GB615 | 23.76 | No | - | **24.12** | **Yes** | 0.12 | **24.23** | **Yes** | 0.23 | **24.40** | **Yes** | 0.40 |
| Eastern Groover Branch Tributary U/S Tower Circle | 24.00 | 24.00 | GB610 | 23.73 | No | - | **24.06** | **Yes** | 0.06 | **24.17** | **Yes** | 0.17 | **24.38** | **Yes** | 0.38 |
| Eastern Groover Branch Tributary D/S Tower Circle | 23.00 | 23.00 | GB605 | **23.73** | **Yes** | 0.73 | **24.05** | **Yes** | 1.05 | **24.17** | **Yes** | 1.17 | **24.37** | **Yes** | 1.37 |
| Eastern Groover Branch Tributary U/S Tower Circle | 23.00 | 23.00 | GB600 | **23.72** | **Yes** | 0.72 | **24.04** | **Yes** | 1.04 | **24.16** | **Yes** | 1.16 | **24.36** | **Yes** | 1.36 |
| **Groover Branch Western Tributary** | | | | | | | | | | | | | | | |
| Groover Branch West Tributary U/S Durrance Lane | 25.23 | 25.23 | D0008 | 24.74 | No | - | 25.09 | No | - | **25.43** | **Yes** | 0.20 | **25.71** | **Yes** | 0.48 |
| Groover Branch West Tributary D/S Durrance Lane | 25.23 | 25.23 | GB525 | 23.22 | No | - | 23.36 | No | - | 23.48 | No | - | 23.84 | No | - |
| Groover Branch West Tributary U/S Leeway Trail | 20.10 | 20.10 | GB505 | **20.84** | **Yes** | 0.74 | **21.29** | **Yes** | 1.19 | **22.16** | **Yes** | 2.06 | **23.08** | **Yes** | 2.98 |
| Groover Branch West Tributary D/S Leeway Trail | 20.10 | 20.10 | GB500 | **20.17** | **Yes** | 0.07 | **21.14** | **Yes** | 1.04 | **22.12** | **Yes** | 2.02 | **23.06** | **Yes** | 2.96 |
| **Total Residential Structures Flooding** | | | | | **19** | | | **27** | | | **33** | | | **37** | |

**Notes:**

1. Node relationships were established for each of the surveyed channel bridge/culvert crossings.
2. ____ indicates that the roadway is predicted to flood during the simulated storm.
3. All units are in feet.
4. All elevations are referenced to NAVD88 vertical datum
5. SAI Flood stages based upon the maximum value of all model scenarios.

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