# Larry Kiker Preserve

## H&H Summary Report

Lee County
Southwest Florida

Kimley»Horn

SAI SINGHOFEN & ASSOCIATES INCORPORATED

March 2024

**Exhibits**



**Tables**



**Figures**

Section

# 1

# Introduction

## 1.1 Project Description and Background

Lee County (County) wishes to convert the Larry Kiker / Hidden Cypress Preserves into a multifunctional facility that will address water quality, natural habitat preservation, and flooding conditions in the surrounding communities, while providing the community with recreational opportunities and educational tools. Kimley-Horn and Associates, Inc. (Kimley-Horn) contracted with Singhofen & Associates, Inc. (SAI) as a subconsultant to perform the hydrologic and hydraulic (H&H) modeling services associated with the project.

The Larry Kiker Preserve (LKP) lies adjacent to the Hidden Cypress Preserve and is located in southern Lee County, immediately east of I-75, south of Corkscrew Road, and north of Bonita Beach Road SE. A location map is included in **Figure 1.1**. The LKP encompasses a large wetland system. Flows into the wetland system primarily come from the north under Corkscrew Road and the east from the Corkscrew Regional Ecosystem Watershed (CREW). These contributing areas primarily consist of wetlands and open/agricultural lands, with some residential development to the north along Corkscrew Road. The primary outflows for the system are to the west under I-75 and to the south along Bonita Grande Drive towards Bonita Beach Road and Collier County. The Bonita Grande Mine, located to the southwest of the wetland system, is currently planned for redevelopment as a residential community. **Figure 1.2** depicts the flow patterns in the vicinity of the project area.

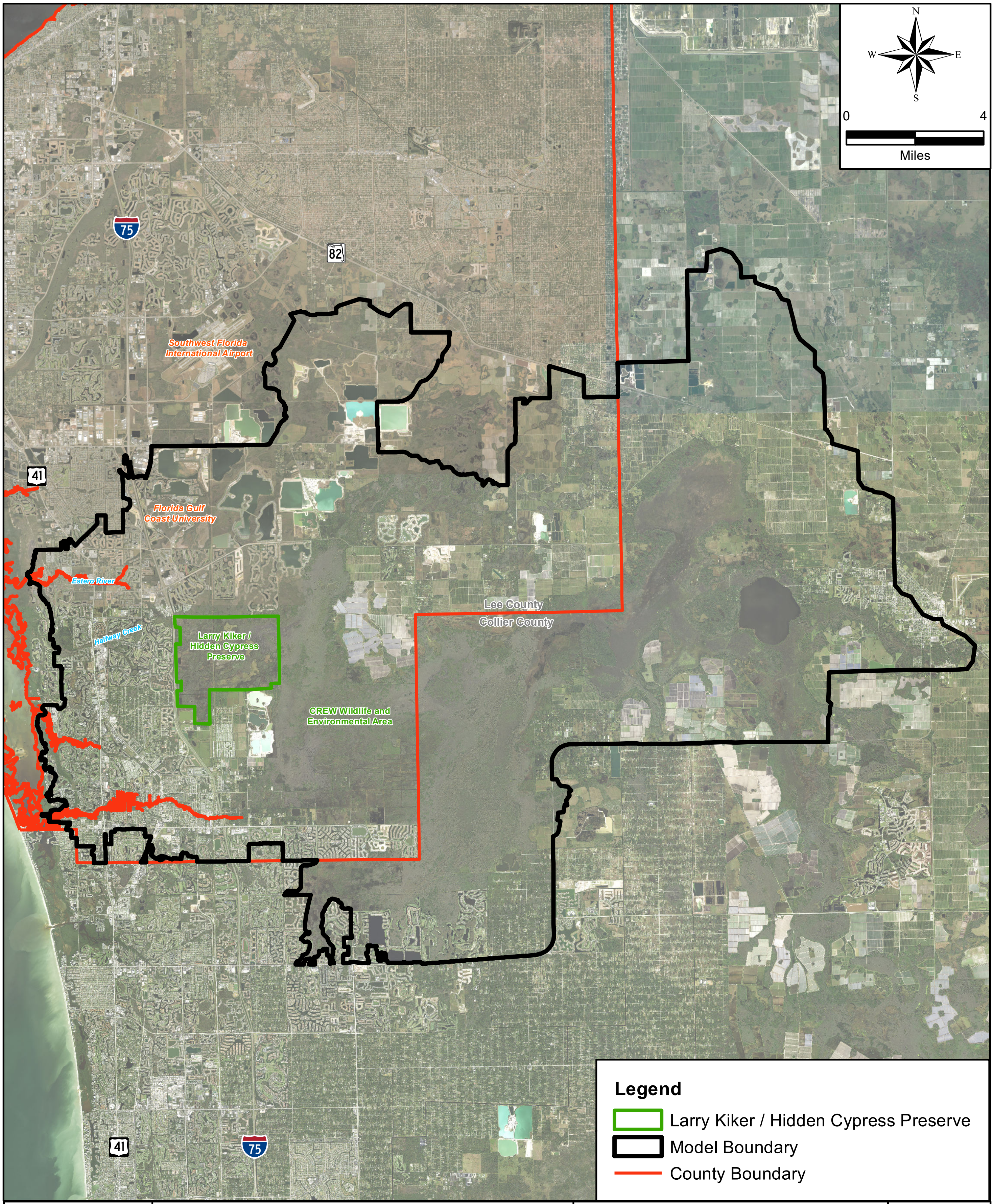
In a previous effort with the County, a Southern Lee County (SLC) ICPR4 model was developed by Streamline Technologies (*Southern Lee County Mitigation Plan, ICPR4 Modeling of East of I-75 Overland Collection Drainageway Concept Project and Crew-Flint Pen Hydrologic Restoration Concept – Final Report, 2020*, refer to **Appendix A.1**) which identified the existing flow patterns through and out of the Preserve. As part of this SLC modeling effort, two large berm alignments, referred to as the Bonita Grande Mine Berm, are being proposed around the Larry Kiker Preserve that would allow for additional stormwater storage on the property and help mitigate known flooding downstream.

## 1.2 Purpose and Objectives

This project involved creating design concepts that expanded and improved upon the proposed Bonita Grande Mine Berm by incorporating design components to achieve the County's facility goals listed in **Section 1.1**. SAI was responsible for establishing an existing conditions model for the project area to identify current flooding conditions and wetland hydroperiods. This existing conditions model was then used as the base model for the evaluation of conceptual design alternatives.

This was accomplished by completing the following general tasks:

- Collect and review pertinent data from the South Florida Water Management District, counties, and/or local communities.
- Prepare a detailed H&H model that includes all areas conveying flow through the project site.
- Calibrate/Verify the existing conditions H&H model.
- Perform continuous simulations to evaluate wetland hydroperiods on the project site.
- Develop conceptual design alternatives for the project site in coordination with Kimley-Horn and the County.

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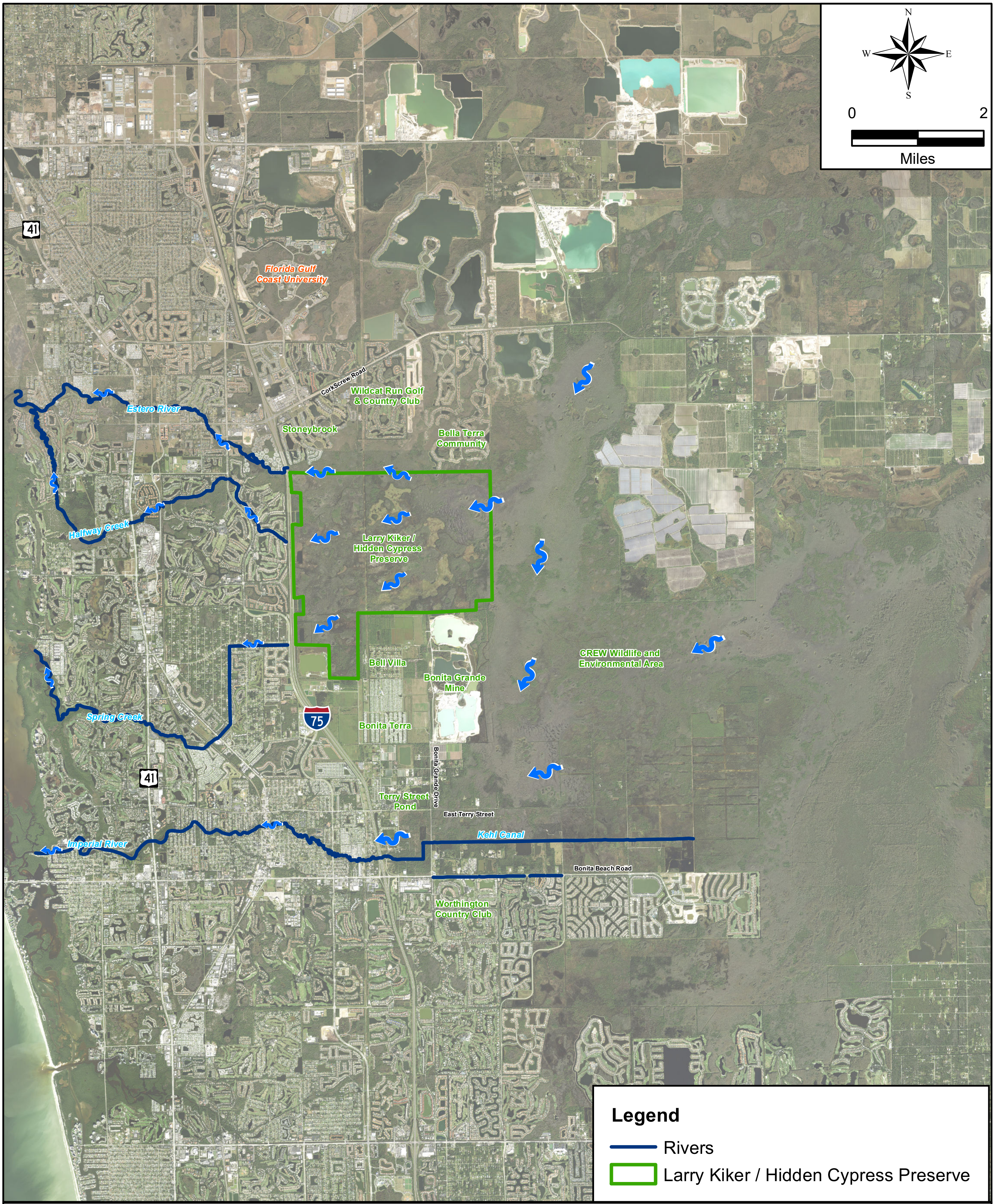
| SAI | LARRY KIKER PRESERVE | VICINITY MAP | FIGURE: 1.1 |

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| SAI | LARRY KIKER PRESERVE | EXISTING FLOW PATTERNS | FIGURE: 1.2 |

Section

2

# Data Collection

## 2.1 SLC-Logan Model Data

Available ICPR models that include drainage features within and around the Larry Kiker Preserve were collected for use in this project's existing conditions model development. The limits of each of the models considered in this project are presented in **Figure 2.1**.

### 2.1.1 Southern Lee County (SLC) Model

The *Southern Lee County Mitigation Plan, ICPR4 Modeling of East of I-75 Overland Collection Drainageway Concept Project and Crew-Flint Pen Hydrologic Restoration Concept* (**Appendix A.1**) project was completed by Lee County in 2020. This project involved creation of a detailed ICPR4 model for the southwestern portion of Lee County that also extended into northern Collier County and portions of Hendry County. The model was prepared using a combined 1D and 2D modeling approach, utilizing both 1D manual basins and 2D overland flow mesh to model surface water. **Appendix A.1** includes the report that details the development of the SLC ICPR4 Model. The Larry Kiker Preserve is modeled as part of the 2D overland flow region within the SLC model.

### 2.1.2 Village of Estero Model

The Village of Estero model domain begins east of I-75 and extends to the Gulf of Mexico coastline, approximately between Coconut Road and Estero Parkway. The two outfall channels from the Larry Kiker Preserve, Halfway Creek and Estero River, are included within the Village of Estero model. This model was prepared in ICPR4 utilizing a 1D modeling approach with the Curve Number rainfall excess method (**Appendix A.2**).

### 2.1.3 Florida Gulf Coast University Model

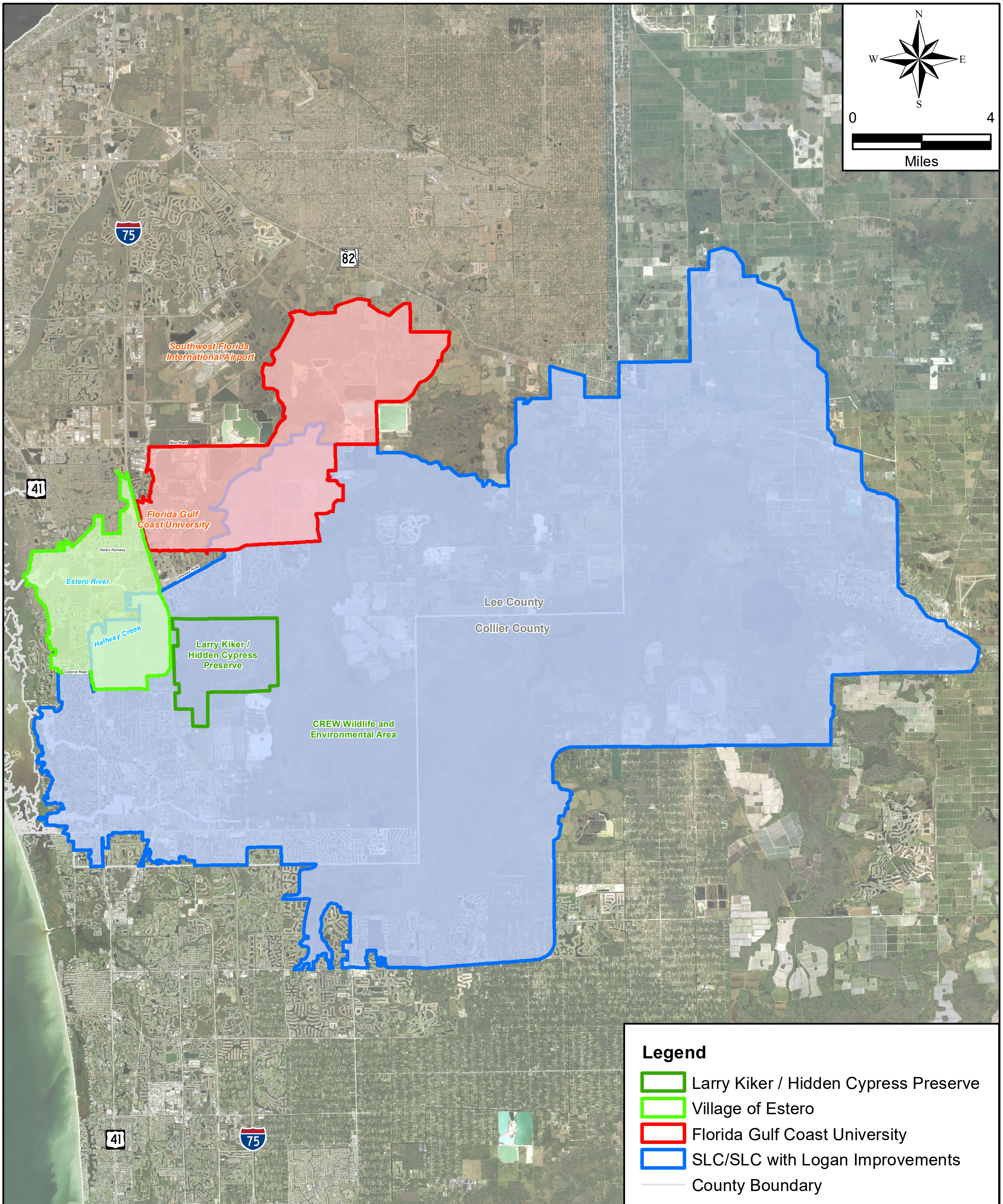
The Florida Gulf Coast University (FGCU) developed an integrated 1D and 2D surface water model for the school campus and surrounding area. This model domain is located east of I-75, north of Estero Parkway and Corkscrew Road, south of Alico Road and State Road 82. The report associated with this model development effort, *Hurricane Flood Resilience Study* (FGCU, June 2019), is included in **Appendix A.3**.

### 2.1.4 SLC Model with Logan Improvements

SAI previously prepared an updated version of the SLC ICPR4 model for a project with the City of Bonita Springs. That model is referred to as the SLC Model with Logan Improvements. This current project has included refinement of the SLC Model south of Bonita Beach Road, which is located just south of the wetland system associated with this project. The *Logan Boulevard Regional Floodway Drainage Technical Memorandum* (SAI, January 2022), included in **Appendix A.4**, describes the model update process and model results.

## 2.2 Permit Data

Environmental Resource Permits (ERPs) and Surface Water Management (SWM) permits were collected from the South Florida Water Management District (SFWMD) throughout the anticipated work area of the project. The permit files contain documents related to construction in the area including record drawings, surveys, construction plans, reports, and drainage calculations, among other files. Documents for nearly 800 permits were collected and reviewed as part of this effort. **Figure 2.2** shows the locations of the permits downloaded; many overlap each other due to subsequent permit submittals and modifications. The documents were cataloged, including important information such as permit number and vertical datum, and each were assigned reference document IDs for easier reference in the project. The reference documents and catalog table are provided as part of the final electronic deliverable.

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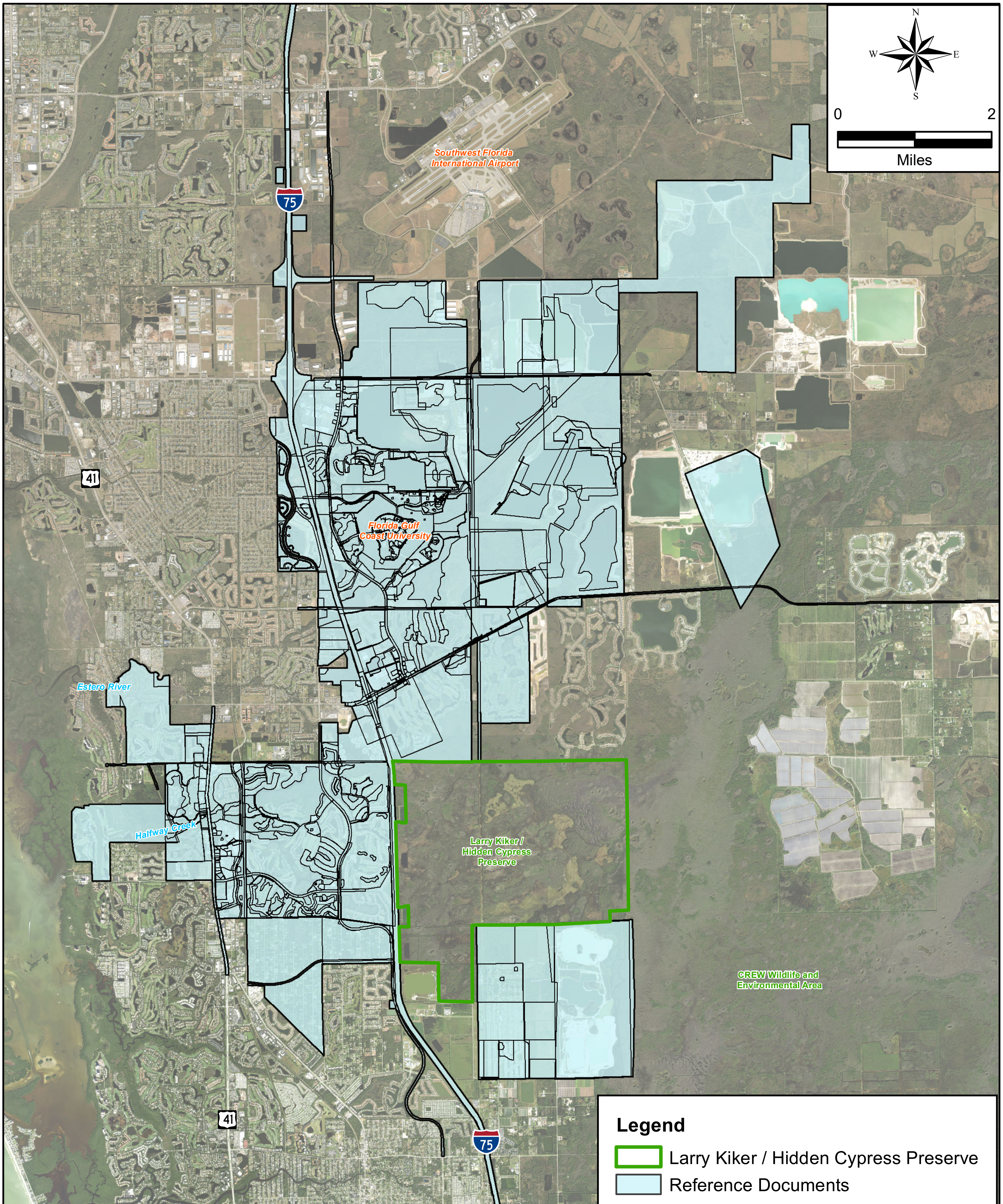
| SAI | LARRY KIKER PRESERVE | INPUT MODELS | FIGURE: 2.1 |

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| SAI | LARRY KIKER PRESERVE | REFERENCE DOCUMENT MAP | FIGURE: 2.2 |

### 2.3 Survey

Surveyed cross section data were collected along Halfway Creek by WGI, Inc. (WGI) in 2022. Additional cross sections were surveyed along FDOT ditches and cross drains, as well as some at the headwaters of the Estero River. A total of 68 channel cross sections were surveyed as part of this effort. A map of the survey locations is presented in **Figure 2.3**; The data from the survey are included electronically in the final deliverable.

### 2.4 Wetland Evaluation

The Larry Kiker / Hidden Cypress Preserve is located within a large wetland system that outfalls to the west under I-75. Kimley-Horn conducted evaluations of the wetland system to determine wetland limits, seasonal high water elevations (SHWEs), and the site conditions. Kimley-Horn provided SAI with upland limits, rather than wetland limits, indicating that the entire site is classified as wetlands besides the identified upland limits. Surveyed SHWEs were also provided throughout the project site.

### 2.5 Well Data

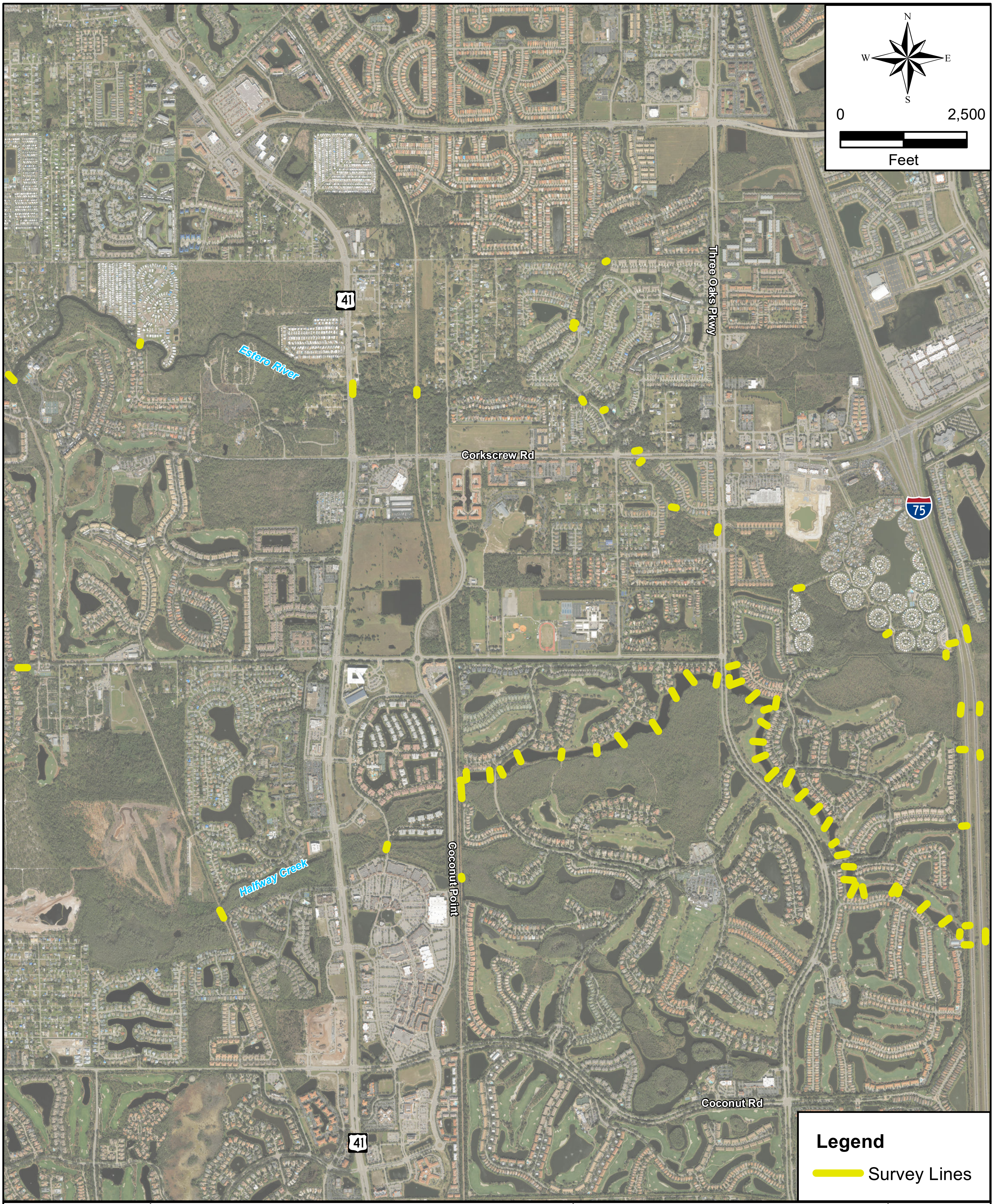
Wells with water level monitoring are located throughout the wetland system at the project site. While groundwater was not included in the modeling for this project, well data can help identify wetland water surface elevations during the wet season and indicate when water elevations are below the ground surface during the dry season. Available data for these wells were collected for review during the development of the existing conditions model and continuous simulations.

### 2.6 NEXRAD Data

NEXRAD data were obtained for the project model extents from the Southwest Florida Water Management District (SWFWMD). Available NEXRAD data were collected for the project area, including rainfall data from 1995 to 2018. These data were used in the project model’s continuous simulation.

### 2.7 Potential Evapotranspiration Data

Daily potential evapotranspiration (ET) data were obtained from the USGS for the same time period as the NEXRAD rainfall data (1995 to 2018). This information was used in the project model’s continuous simulations in conjunction with the NEXRAD data and is also included in the model for design storm simulations.

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| SAI | LARRY KIKER PRESERVE | CROSS SECTION SURVEY | FIGURE: 2.3 |

Section

3

# Existing Conditions Model

## 3.1 Model Development

The SLC Model with Logan Improvements (hereinafter referred to as the SLC-Logan Model) was used as the base model for this project, as it is considered to be an updated and improved version of the initial SLC Model. The updates to the SLC Model were limited to the southern edge of the wetland at Bonita Beach Road and include improved model detail for that portion of the wetland outfall system. This section of the report outlines the additional updates made to the SLC-Logan Model to develop an expanded existing conditions model for this project.

### 3.1.1 Incorporation of Adjacent Models

The two adjacent watershed models, Village of Estero (VOE) and Florida Gulf Coast University (FGCU), were incorporated into the SLC-Logan Model. The combined models form the working model for the current project, hereinafter referred to as the Larry Kiker Preserve (LKP) Model.

Village of Estero: The primary outfall from the project location is through numerous culvert crossings under I-75, where flow then splits through Halfway Creek to the south and tributaries leading north to the Estero River. Halfway Creek was not modeled in adequate detail in the SLC Models: The roadway crossings along Halfway Creek were modeled, but the creek itself was only included as storage areas, underestimating travel time out of the Preserve and through the creek. Similarly, Estero River lacked sufficient detail for the region. While the headwaters for the tributary leading to the Estero River were included as part of the 2D Overland Flow Region and the tributary was modeled as 1D basins with channel links, the Estero River itself was represented as a time/stage boundary condition based on USGS gage data.

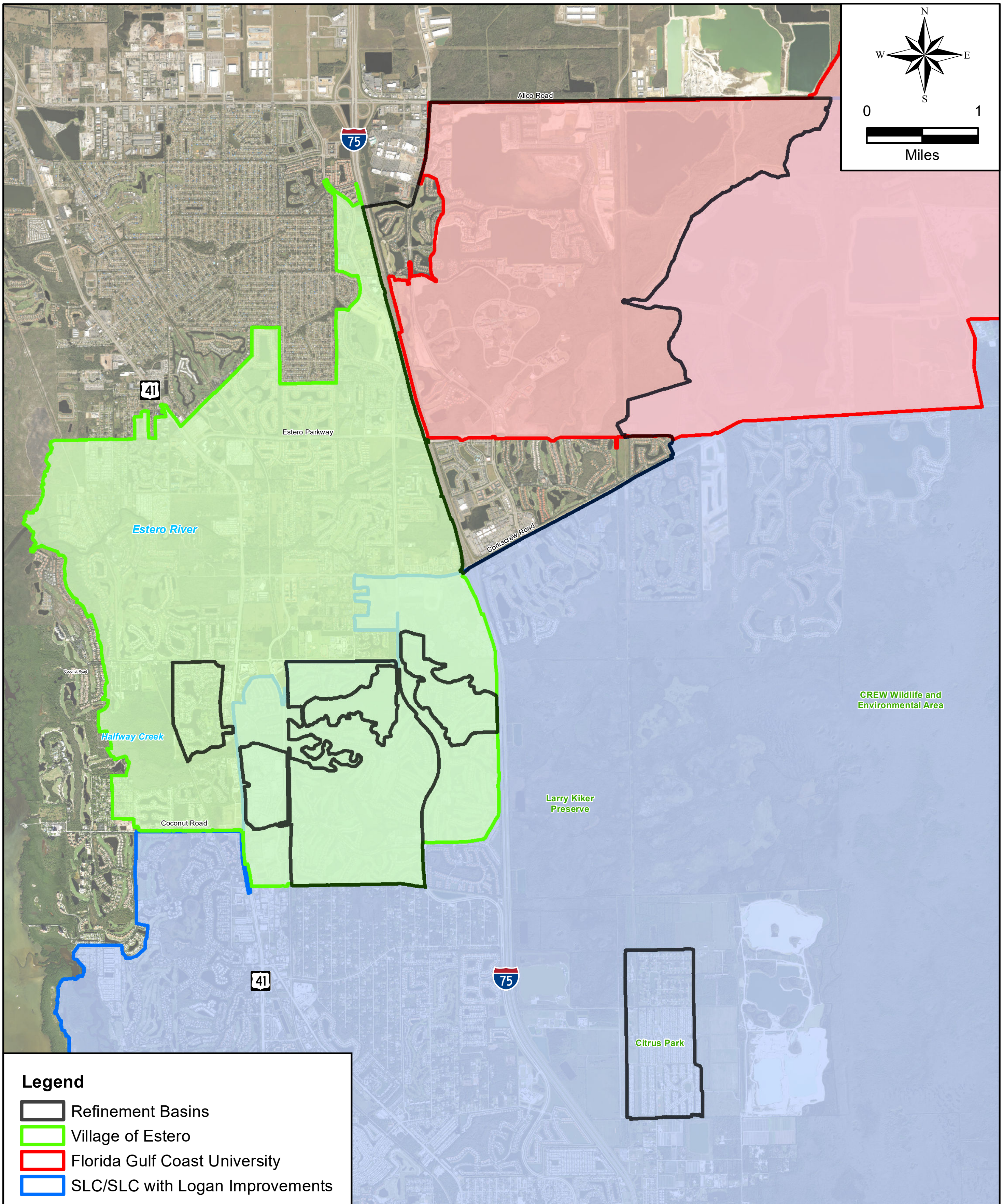
The VOE Model included detailed modeling in and around these two conveyance ways and was considered the best available data. This information was taken as-is and combined with the SLC-Logan Model. The VOE Model took precedence at any locations where the models overlapped. The land cover surface layer included in the VOE Model was incorporated into the land cover layer from the SLC Model to create the combined land cover surface layer that is used in the LKP Model. It should be noted that the VOE Model utilized the Curve Number rainfall excess method.

Florida Gulf Coast University: The FGCU campus is located just north of the SLC Model limits. The FGCU campus is surrounded by wetlands which outfall both to the west through the I-75 cross culverts and to the south towards Corkscrew Road and into the project area's wetland system. The FGCU Model was converted from a 1D/2D model to be all 1D subbasins in preparation to be combined into the LKP Model. In areas of overlap between the two models, the SLC-Logan model took priority.

### 3.1.2 Model Updates

The resulting LKP Model was reviewed to identify portions of the model that would require new updates to properly define existing conditions. Refinements in the 2D region were also made as design alternatives were developed to ensure pre and post-design mesh configurations were consistent enough to allow for accurate result comparisons. This included minor refinements to the mesh in areas such as the FDOT ditch and the Bella Terra community models. Seven refinement areas were also identified: five within the limits of the VOE Model, one encompassing a majority of the FGCU Model limits, and one in Citrus Park which is located just south of the Larry Kiker Preserve. The locations of these refinement areas are shown in **Figure 3.1**. The existing models included many of the developments in these refinement areas as large storage basins, ignoring intermediate control structures, pipes, and other restrictions which can result in inaccurate accounting of flood stages and timing. The model network was primarily updated via reference documents obtained from SFWMD, as discussed in **Section 2**.

Model updates in each refinement area included refinements to the model network and subbasin delineation including updates to model parameters (e.g., time of concentration values, land use / runoff parameters, stage/storage relationships). Subbasins were delineated using ERP documents and ArcHydro catchments that were generated based on the project DEM (discussed in **Section 3.1.3**). Hydrologic parameters were recalculated for all revised and new basins. Node storage was calculated at 0.5-feet elevation intervals for each revised subbasin using the project DEM.

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| SAI | LARRY KIKER PRESERVE | REFINEMENT AREAS | FIGURE: 3.1 |

The Green-Ampt (GA) rainfall excess method was used for this model and the calibrated parameters from the SLC-Logan Model were applied throughout. As mentioned, the VOE Model utilized the Curve Number rainfall excess parameters; As a result, all subbasins from the VOE Model had to be converted to the GA method for use in continuous simulation modeling. Time of concentration (TC) values were calculated for all revised subbasins in accordance with the NRCS Technical Release 55 (WinTR-55, 2009). The TC flow paths were divided into three main components: overland flow (i.e., sheet flow), shallow concentrated flow, and open channel flow. The kinematic wave equation for overland flow was limited to the first 100 feet. The travel time for shallow concentrated flow was calculated using the TR-55 equations that relate velocity to slope for paved and unpaved areas. The project DEM and aerial imagery were used to determine average slopes and land cover, respectively. Travel time for open channel flow was calculated for the length of the channel by determining the average velocity using Manning's equation. Open channel flow types were parameterized for TCs only where defined channels occurred and were not specifically modeled (i.e., typically roadside swales). A minimum TC value of 10 minutes was used for all subbasins. A copy of the TC calculations is included in **Appendix B**.

In addition to the updates performed in the refinement areas discussed above, additional updates were made along I-75 and Corkscrew Road, which bound the project area on the west and north, respectively. The SLC Models did not include all of the current cross drains under I-75, which together serve as the primary outfall for the Larry Kiker Preserve. Missing cross drains were added to the LKP model and the previously modeled cross drains were reviewed and updated, as needed, based on as-built data provided by FDOT. Corkscrew Road, east of I-75, was in the process of being widened during the existing conditions model development. The roadwork along Corkscrew Road included new and revised cross drains that connect to the wetland system located on the project site; these cross drains were added to the model based on available construction plan data obtained from the SFWMD.

Further updates were required along Halfway Creek in the Estero area. The VOE Model included channel links along the entire length of Halfway Creek to its outfall in the Gulf of Mexico, with irregular cross sections placed intermittently along the creek. These cross sections were reviewed and determined to be inadequate for modeling the continuous simulation. The cross section data appeared to have come from the DEM and reflected the water surface elevations rather than the channel bottom. SAI refined the channel links in this area so that nodes (and respective cross sections) were placed at observed changes in conveyance area or channel slope. Cross section information was updated based on a survey obtained from WGI, which includes the channel bathymetry. These modifications were made between I-75 and Via Coconut Point.

The combined and updated model serves as the LKP model. This model was simulated and results were reviewed for instabilities. Revisions to model parameters were made as needed to address instabilities affecting the project area. It should be noted that a detailed review of modeled areas downstream of the modifications discussed above was not included in the scope of work, and hydraulic model data in these areas were left "as-is".

The resulting LKP model is presented in **Exhibit 1**. The LKP model includes 2,670 1D Stage/Area nodes, 9 Time/Stage nodes, 13 Stage/Volume nodes, and 321 1D Node Interface points. Flow is conveyed between these nodes through a total of 4,039 1D hydraulic links including: 1,347 Pipe links, 562 Drop Structure links, 791 Channel links, 1,277 Weir links (including both structural and overland flow weirs), and 62 Rating Curve links representing bridges and pumps throughout the model domain. The model also includes a detailed 2D overland flow (OF) region that encompasses over 250 square miles.


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| **SINGHOFEN & ASSOCIATES, INC.**<br>STORMWATER MANAGEMENT AND CIVIL ENGINEERING | **LEE COUNTY** | **LARRY KIKER PRESERVE** | **EXISITING CONDITIONS MODEL** | **EXHIBIT**<br>**1** |

Map Document: (K:\COUNTY\Lee\Larry_Kiker_KH\GIS\Figures\Exh1_Exisiting_Conditions_Model_V2.mxd)
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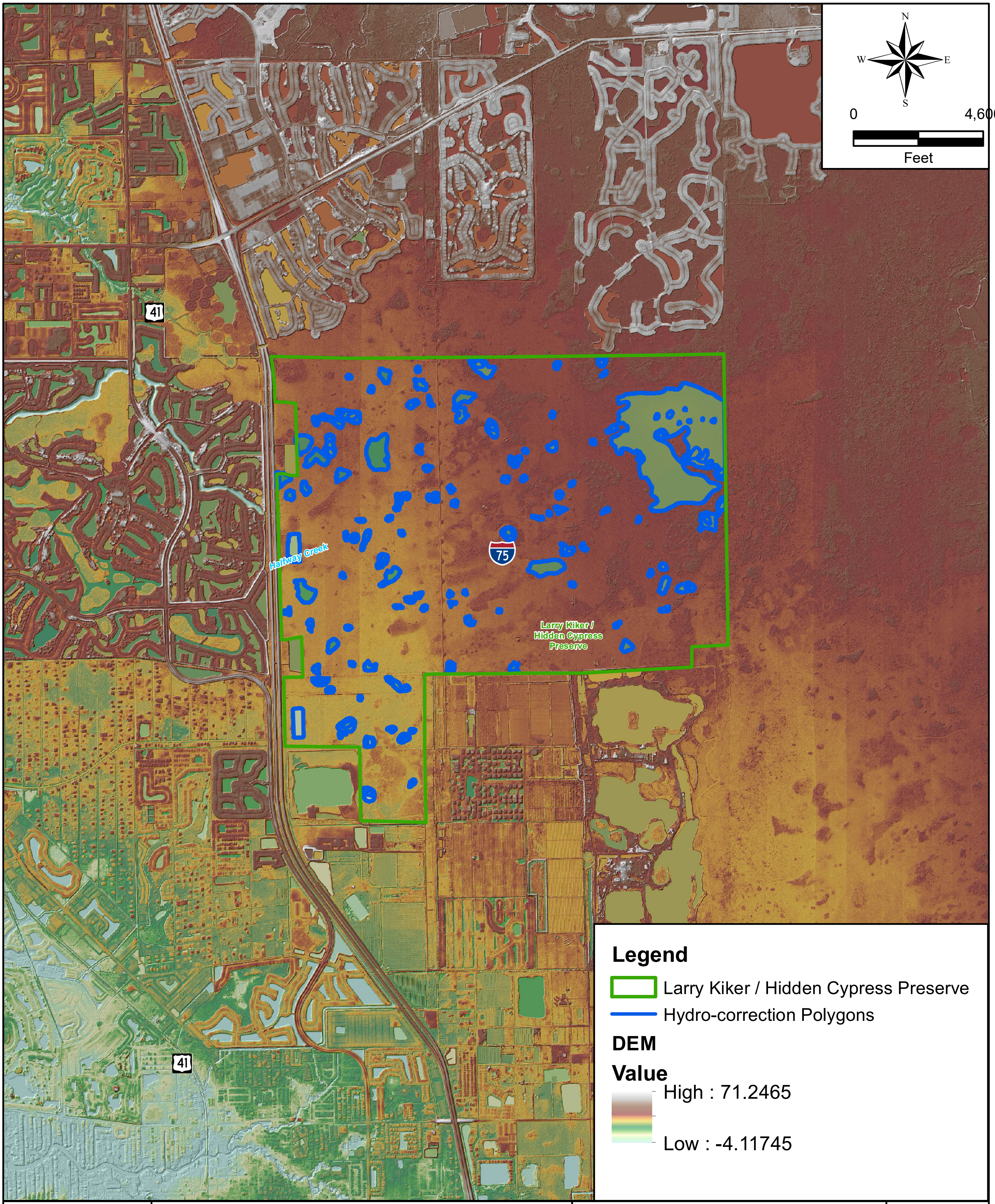
### 3.1.3 DEM Modifications

The project DEM was obtained from the SLC-Logan Model, to be consistent with the calibrated 2D base model. Additional DEM modifications were required to properly represent site conditions during the continuous simulation that was conducted to evaluate wetland hydroperiods. The DEM along Halfway Creek, between I-75 and Via Coconut Point, was hydro-corrected based on surveyed cross section data to modify the bathymetric portions of the channels. Additionally, wetland pockets were identified for hydro-corrections throughout the DEM on the project site. The hydro-corrections were based on engineering judgement as limited data at the project site was available. This effort included research of typical depths associated with the various wetland communities identified in the project area. Typically, wetlands were lowered 3-feet from the DEM surface elevation, assuming a 10:1 (horizontal:vertical) side slope from the edge of the identified wetland limits. **Figure 3.2** presents the hydro-corrected DEM in the project area, including the outline of the wetlands used in the hydro-corrections.

Some locations were identified by Kimley-Horn environmental staff during their review of the project designs where further hydro-corrections appear to be required . After SHWE data became available and were reviewed, it was found that the SHWE in some wetlands were at or below the hydro-corrected ground elevation in the wetland. This indicates that the true ground surface is still lower than the 3-foot adjustments already made by SAI. While this is not expected to affect the flood mitigation performance of the project, it could affect hydroperiod evaluations. If this issue must be addressed to successfully secure permits for the project, then additional survey will be required in the identified wetlands to determine the actual ground surface elevations and further hydro-corrections of the DEM and model simulations will be required during future phases of this project.




SAI

LARRY KIKER PRESERVE

PROJECT DEM

FIGURE: 3.2

## 3.2 Model Simulations and Results

### 3.2.1 Model Calibration / Verification

The base SLC Model was calibrated over a period between June 1, 2017, and November 1, 2017. Lee County experienced two significant rainfall events during this period; first the Invest 92L storm which occurred between August 24th and 26th, followed by Hurricane Irma which passed through the area on September 10th and 11th. The results of the SLC Model calibration are discussed in the *Southern Lee County Mitigation Plan, ICPR4 Modeling of East of I-75 Overland Collection Drainageway Concept Project and Crew-Flint Pen Hydrologic Restoration Concept – Final Report* (Streamline Technologies, 2020), included in **Appendix A.1**. The LKP Model was also simulated for this same time period in order to verify the updated model results. The NEXRAD data used in the SLC Model calibration was used in this model as well. As identified in the 2020 Streamline Technologies report (**Appendix A.1**), the NEXRAD data is believed to underpredict rainfall amounts during Hurricane Irma due to a non-functioning rainfall calibration gage, thus resulting in underpredicted flood stages in the model results.

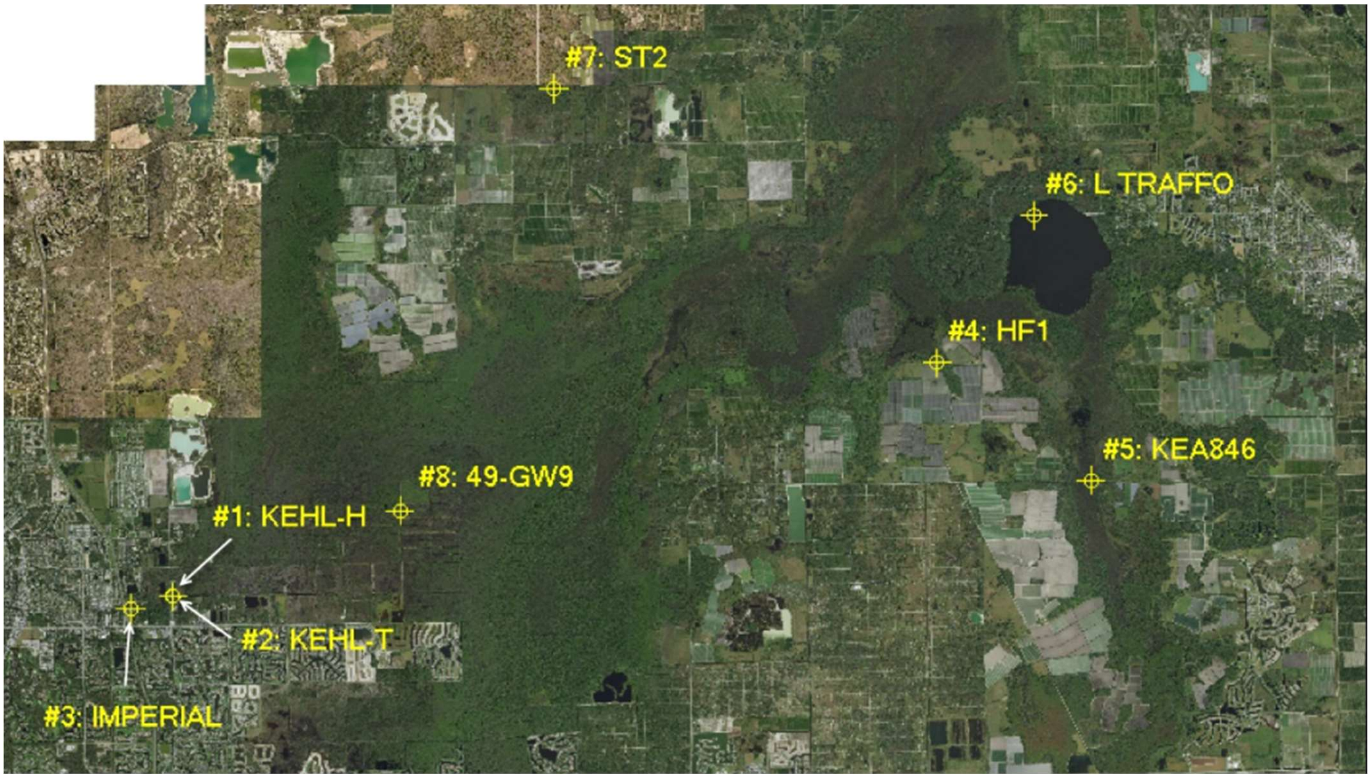
As with the SLC Model calibration, initial stages for calibration of the LKP Model were set based on the DEM elevations, allowing time between the simulation start date (June 1st) and the beginning of the first calibration storm event (August 24th) for the system to stabilize and wetlands to reach an appropriate water level prior to the September storm event.

Eight calibration gage locations were considered in the calibration results comparison; these gage locations are depicted in **Figure 3.3**. Each of these gages provided stage data during the calibration storm and Location 3 (Imperial River near Bonita Springs) included gage flow data. One gage (Location 6 – SFWMD Gage L Traffo) was not working during Hurricane Irma. Statistical metric criteria are presented in **Table 3.1**. The same statistical metrics used in the SLC Model calibration were used for the analysis of the LKP Model calibration results. Preliminary calibration results from the LKP Model were described in a memo previously prepared by SAI in October 2022. The results described below are based on a version of the same model that has been selectively revised to address stability concerns in some of the refinement areas.

**Table 3.1 – Calibration Metrics**

| METRIC | Good | Fair | Poor |
|---|---|---|---|
| Coefficient of Determination ($R^2$) | 0.6 <= COD <= 1.0 | 0.4 <= COD < 0.6 | COD < 0.4 |
| Nash-Sutcliffe Efficiency (NSE) | 0.5 <= NSE <= 1.0 | 0.0 <= NSE < 0.5 | NSE < 0.0 |
| Mean Error (ME) ft | \|ME\| <= 0.50' | 0.50' < \|ME\| <= 1.00' | \|ME\| > 1.00' |
| Mean Absolute Error (MAE) ft | 0.00' <= MAE <= 0.75' | 0.75' < MAE <= 1.50' | MAE > 1.50' |
| Root Mean Square Error (RMSE) ft | 0.00' <= RMSE <= 1.00' | 1.00' < RMSE <= 2.00' | RMSE > 2.00' |
| 1/2 Standard Deviation (Observed) ft | 2+ \|ME\|, MAE, RMSE | 1 \|ME\|, MAE, RMSE | 0 \|ME\|, MAE, RMSE |

**Figure 3.3 - Calibration Gage Locations - Southern Lee County Flood Mitigation Plan (Streamline Technologies, 2020)**




Statistical metrics are presented in **Table 3.2**. Locations 1, 4, 5, and 6 are rated "good" for all six metrics while Station 8 includes just one metric that is rated slightly below the "good" range. Stations 2, 3, and 7 include ratings that vary between "good" and "fair". The "fair" values at all stations lean closer to the "good" range than poor for the given criteria. These statistical results are similar to the results of the SLC Model calibration results. Color coding is based on qualitative statistical criteria of **Table 3.1** for "**Good**", "**Fair**" and "**Poor**" evaluations.

**Table 3.2 – Calibration Results Statistical Metrics**

| STATIONS: METRIC | #1 KEHL-H | #2 KEHL-T | #3 IMPERIAL | #4 HF1 | #5 KEA846 | #6 L TRAFFO | #7 ST2 | #8 49-GW9 |
|---|---|---|---|---|---|---|---|---|
| Coefficient of Determination ($R^2$) | 0.90 | 0.85 | 0.84 | 0.93 | 0.85 | 0.93 | 0.55 | 0.66 |
| Nash-Sutcliffe Efficiency (NSE) | 0.88 | 0.83 | 0.81 | 0.55 | 0.81 | 0.90 | 0.36 | 0.43 |
| Average Calculated ft NAVD88 | 10.76 | 10.37 | 8.16 | 19.74 | 19.60 | 19.81 | 27.78 | 16.63 |
| Average Observed ft NAVD88 | 11.03 | 10.78 | 8.61 | 19.90 | 19.71 | 19.68 | 27.81 | 16.65 |
| Mean Error (ME) ft | 0.26 | 0.41 | 0.46 | 0.16 | 0.03 | 0.13 | 0.03 | 0.07 |
| Mean Absolute Error (MAE) ft | 0.56 | 0.83 | 0.90 | 0.22 | 0.25 | 0.19 | 0.07 | 0.12 |
| Root Mean Square Error (RMSE) ft | 0.77 | 1.06 | 1.15 | 0.32 | 0.35 | 0.23 | 0.09 | 0.17 |
| Standard Deviation (SD) (Observed) ft | 2.21 | 2.57 | 2.62 | 0.48 | 0.79 | 0.71 | 0.12 | 0.23 |
| 1/2 Standard Deviation (SD) (Observed) ft | 1.10 | 1.29 | 1.31 | 0.24 | 0.40 | 0.35 | 0.06 | 0.11 |

Charts comparing the calibration simulation time series results to gage data, as well as the results of the SLC model are included in **Appendix C**. A review of the comparison charts at all gage locations suggested good correlation between the gage and model results. Nodes used for the calibration analysis are included in each chart, with the exception of Location 5. The time series data for Location 5 was taken from a node in the 2D mesh which is depicted in **Figure 3**.

The initial stage for at least one location was identified as being notably different than the observed data (Location 4). While the initial stage is off, it does not affect the overall calibration results which show good correlation with the gage data.

Two of the 3 locations at which model results vary the greatest from observed information, namely Station 2 – KEHL-T and Station 3 – Imperial, are in areas draining to and through some heavily vegetated stream sections and culvert connections. The Manning's values used in the model for that area appear reasonable for the condition, however, it is possible that some downed trees or other debris could have collected in that general area during the storm which would tend to increase stages beyond that predicted by the model. Further research, including conversations with County work crews, may provide more information to allow adjustments to the model during future project phases.

### 3.2.2 Continuous Simulation

A continuous simulation was performed on the calibrated existing conditions model over a 5-year period between January 1, 2013, and December 31, 2017. The results of this simulation were submitted to Kimley-Horn for review by their environmental team to determine wetland hydroperiods. Initial stages for this model were set based on the DEM elevations, with the system's wetland stages stabilizing after the first few storm events. The results of this continuous simulation and hydroperiod evaluation were also used to study the impacts of the selected design alternatives. This analysis is further discussed in **Section 4.4**.

### 3.2.3 Design Storms

The calibrated existing conditions model was also used to simulate four discrete design storms; these storms are listed in **Table 3.3**. A rainfall file was established for each of the design storms listed in **Table 3.3** using their stated distributions and rainfall depths. Each rainfall file also includes a Mean Annual rainfall event (4.69-inches / 24 hours, FLMOD distribution) that occurs approximately 7-days before the design storm rainfall event. Rainfall data were assembled this way to allow for a 6-day recovery period without rainfall before the design storm event which allows for proper representation of soil storage and initial conditions for the design storm event. Rainfall data for each design storm is included in the model files in the electronic deliverable provided with this memorandum.

**Table 3.3 – Design Storm Rainfall Data**

| Recurrence Interval | Duration | Source | Distribution | Rainfall Depth (in) |
|---|---|---|---|---|
| 1-Year | 24-Hour | NOAA Atlas 14 | FLMOD | 3.94 |
| 5-Year | 24-Hour | NOAA Atlas 14 | FLMOD | 6.02 |
| 25-Year | 72-Hour | NOAA Atlas 14 | SFWMD-72 | 11.20 |
| 100-Year | 72-Hour | NOAA Atlas 14 | SFWMD-72 | 14.90 |

**Note: Rainfall depths provided in this table reflect the design storm only, and do not include the depth of the Mean Annual event that precedes each design storm.*

A "hot start" was used to set initial conditions for design storm simulations. The selected hot start time was based on a point in the calibration simulation results (August 24, Hour 12) just before the Invest 92L storm event. Elevations at this time were considered representative of typical wet season water elevations throughout the system.

# Design Alternative Analysis

Section

4

## 4.1 Introduction

The County's primary goal for the Larry Kiker and Hidden Cypress Preserve (LKP) is to create a multifunctional facility that provides improvements to downstream community flooding conditions and water quality, while also providing recreational benefits, as discussed in **Section 1**. According to the SOW for the current project, as outlined in Section 7.3.1, it was expected that the client would provide projects to be incorporated into the model. However, no projects were provided. Instead, Kimley-Horn identified project goals with the County and prepared preliminary conceptual site layouts; SAI has been responsible for developing design concepts to address the goals and develop models for the design elements related to stormwater management. The stormwater management goals conveyed to SAI were as follows:

1- Maximize flood storage within the LKP property and wetlands east of I-75.
2- Mitigate flooding in the communities west and south of LKP.
3- Avoid adverse impact to neighboring communities.
4- Improve hydroperiods for the wetlands east of I-75 to resemble a more natural hydroperiod.

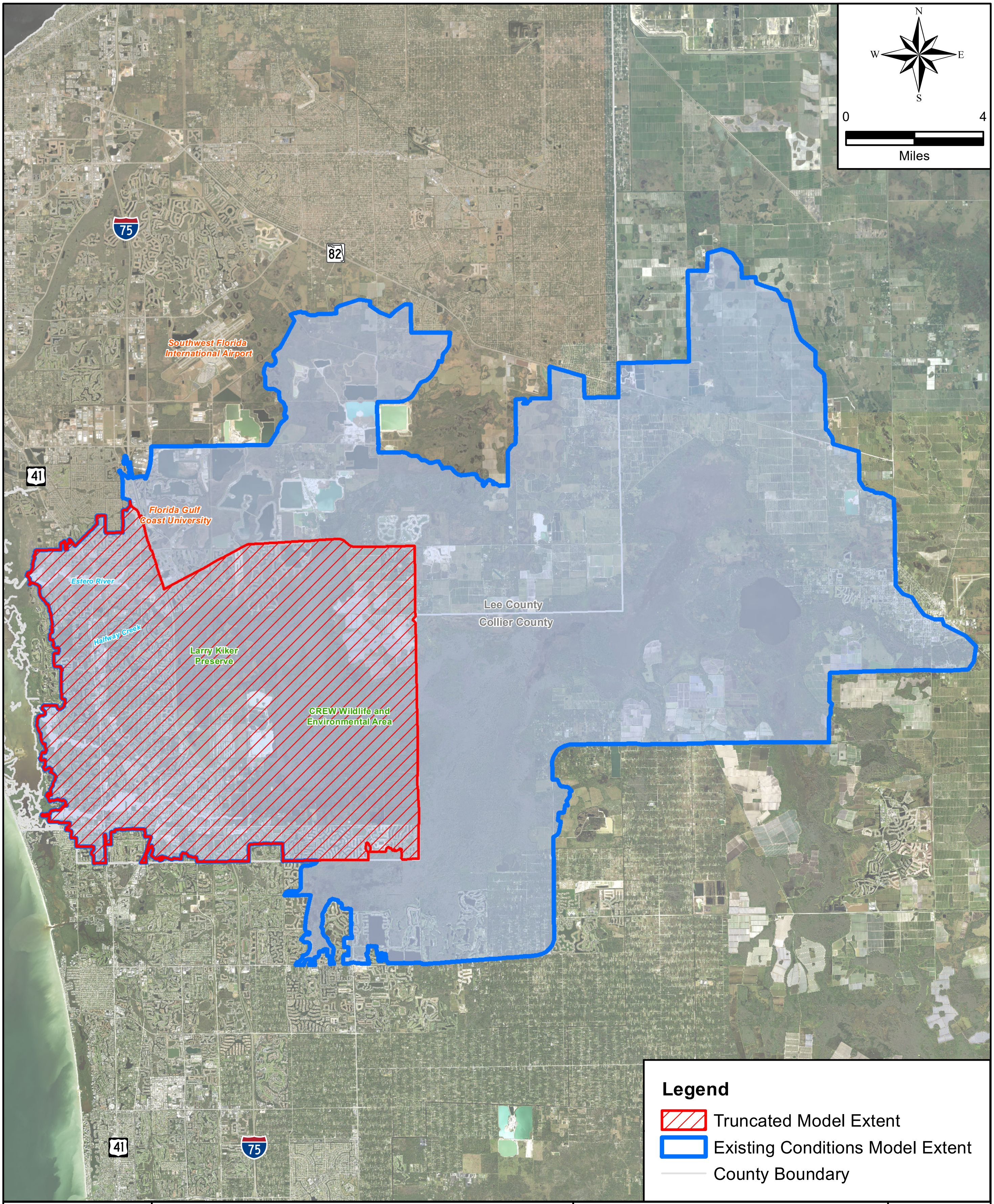
The design alternative development process occurred in two phases; first, the conceptual design alternatives were developed, then the final, refined design alternatives were prepared. The final existing conditions LKP model, discussed in **Section 3**, was used to analyze design concepts for the LKP property. It should be noted that SAI truncated the LKP model before beginning the conceptual design analyses so that iterative model simulations could be performed more quickly. The truncated model extents, compared to the full model, are shown in **Figure 4.1**.

The conceptual design alternatives were developed based on preliminary layouts provided by Kimley-Horn. The preliminary layouts divided the LKP property into several wetland cells with conveyance between the cells to let water flow through and out of the property. Control elevations were also assigned to each cell. The preliminary conceptual layout provided to SAI is presented in **Figure 4.2**. In addition to the LKP cells, both the preliminary design alternatives and refined alternatives included a perimeter berm east of I-75. The berm development is planned to occur in three phases: Phase 1 on the west and south sides of the LKP cells, Phase 2 on the north and east sides of the Bonita Grande Mine, and Phase 3 on the south side of the mine and north of the Kehl Canal. The berms are illustrated in **Figure 4.3.**

SAI initially prepared conceptual design alternatives based on the preliminary layouts provided by Kimley-Horn. Additional design alternatives were developed based on discussions with Kimley-Horn about the layouts and results of the previously developed alternatives. It should be noted that some of these alternatives were designed to observe the behavior of the model and were not intended for construction. Additionally, certain model adjustments between alternatives were minor and aimed at addressing specific issues. They have been included in this report for future reference. A total of 19 conceptual level design alternatives were developed as part of this project; a brief summary of each is included below.

- **Design Alternative 1:** The preliminary LKP exterior cell layout was incorporated into the model. No connections were added to or from the surrounding wetland areas. This alternative simulated a condition that would isolate the LKP property to determine the impacts on the surrounding wetland system and communities.
- **Design Alternative 2:** This alternative built upon Design Alternative 1 by allowing flow into and out of the LKP property. This design would emulate a condition that allows free flow between the interior cells.
- **Design Alternative 3:** Like Design Alternative 2, this alternative allows flow into and out of the LKP project site; however, this alternative considers defined cell boundaries, as shown in **Figure 4.2**. This alternative also proposes a berm on the east side of I-75, north of the LKP cells up to the Stoneybrook community, diverting flow away from the Estero River and towards Halfway Creek.

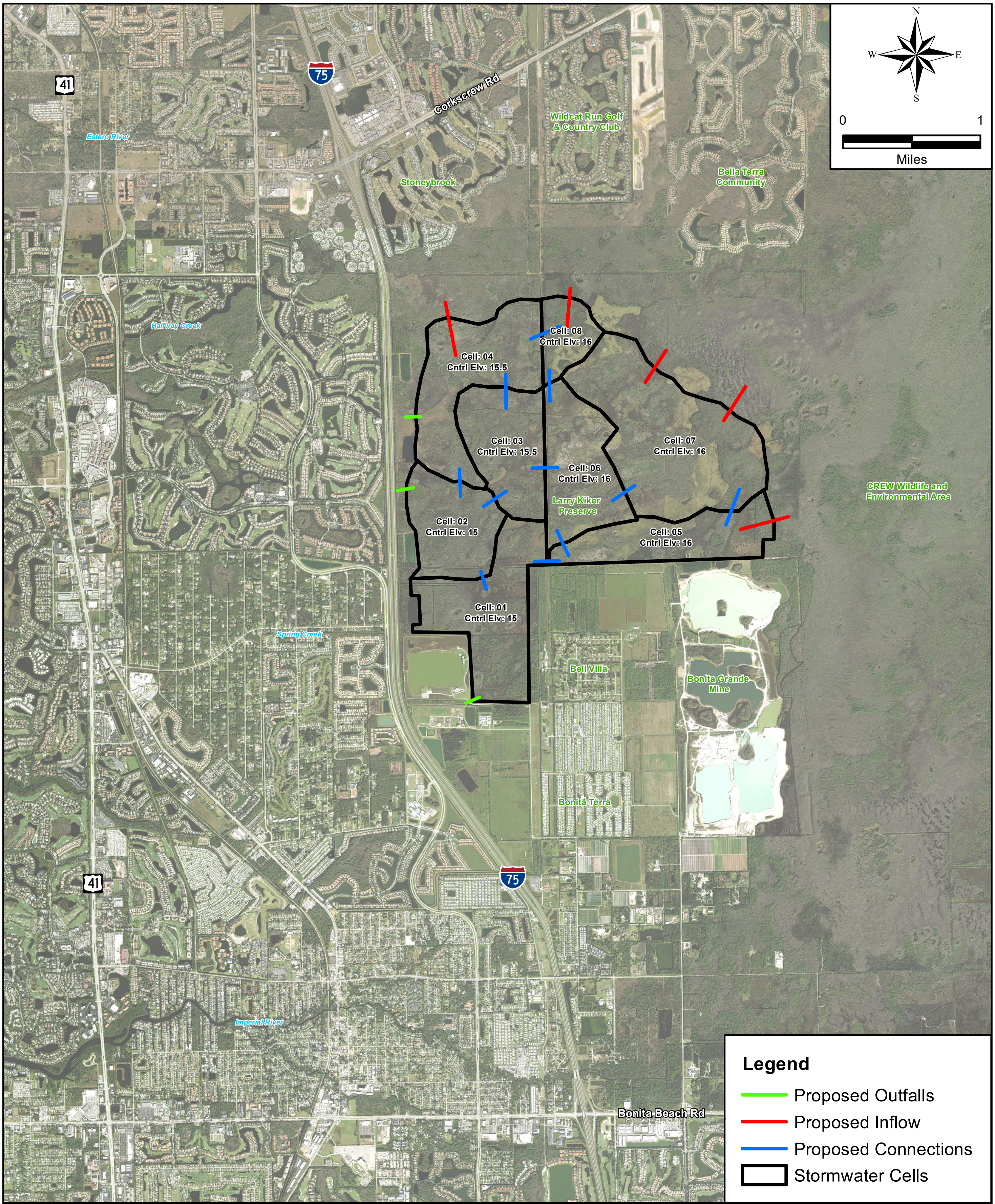
INSERT FIGURE 4.1



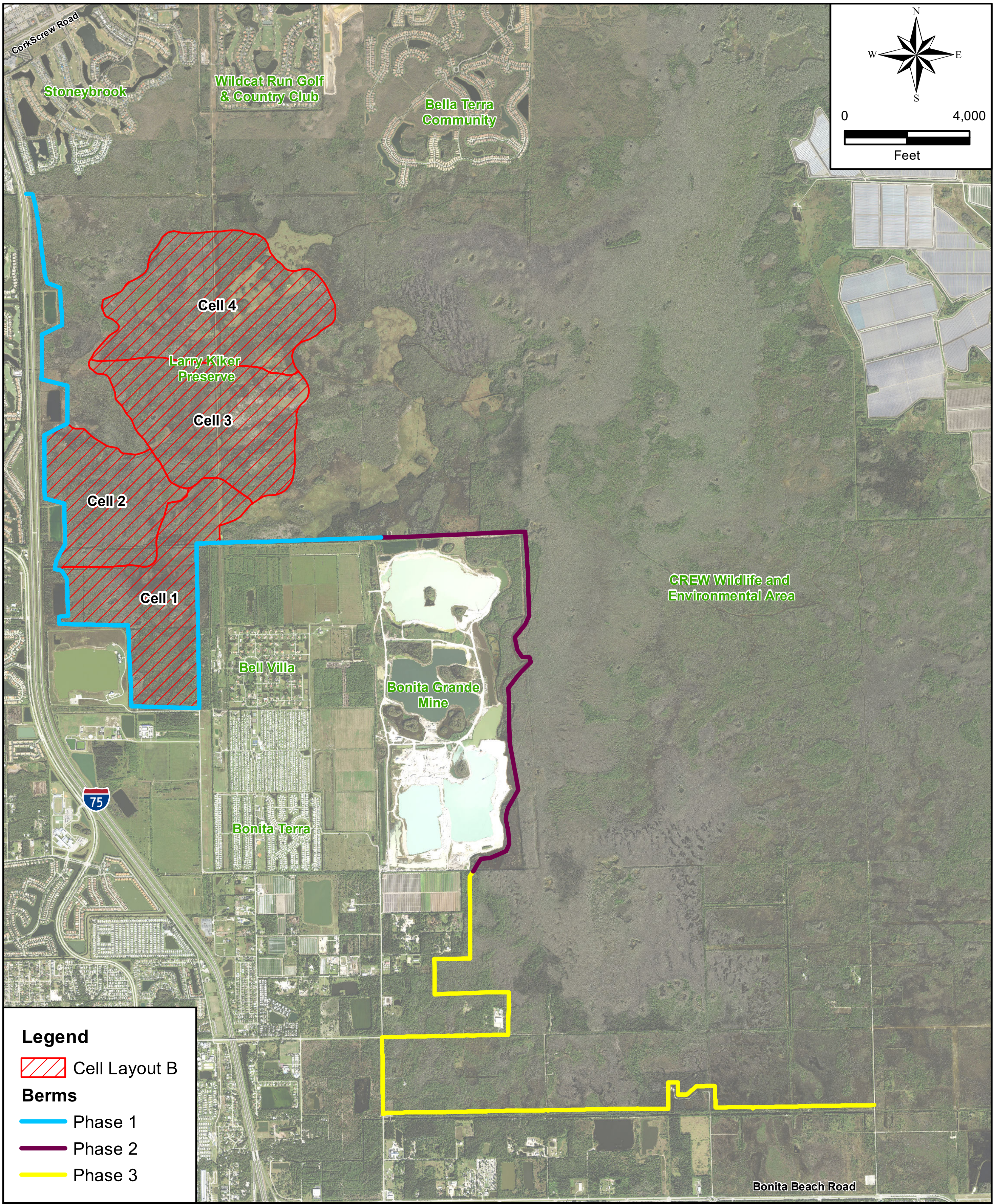

LARRY KIKER PRESERVE

TRUNCATED MODEL LIMITS

FIGURE: 4.1




| | | | |
|---|---|---|---|
| SAI | LARRY KIKER PRESERVE | PRELIMINARY CONCEPT LAYOUT | FIGURE: 4.2 |




| SAI | LARRY KIKER PRESERVE | FINAL CELLS AND BERM CONFIGURATION | FIGURE: 4.3 |
|---|---|---|---|

- **Design Alternative 4:** This alternative incorporates all the improvements considered in Design Alternative 3 and includes the installation of additional pipes into the LKP cells at the north end. Additionally, flap gates were considered on some of the pipes into the LKP wetlands to increase the storage capacity onsite.
- **Design Alternative 5:** Design Alternative 5 shares most of the improvements from Design Alternative 4, with two notable exceptions. In this design alternative, there are no pipes for the west cells towards I-75. Additionally, one of the flap gates proposed in Design Alternative 4 was removed in this alternative. Consequently, flow is permitted into LKP cells from the north and east, and the only permitted outflow is through a single pipe on the east side of the property (Cell 07, refer to **Figure 4.2**).
- **Design Alternative 5-2:** This alternative incorporates all the improvements from Design Alternative 5, while raising the proposed berm to a higher elevation.
- **Design Alternative 5-3:** This alternative encompasses all improvements from Design Alternative 5-2, except for one key difference: all east and northeast pipes have flap gates and allow positive flow into the cells. No flow is allowed outside of the LKP property under this design condition.
- **Design Alternative 5-4:** This alternative incorporates all improvements from Design Alternative 5-3. In this variation, the outflow from the Stonybrook community has been rerouted to the west using a pipe connection. This was considered in an effort to prevent flood stage increases in the community north of LKP.
- **Design Alternative 6:** This alternative includes all enhancements from Design Alternative 5-3 while extending the proposed berm to the northeast. The longer berm was considered in an attempt to address flood stage increases that were observed in the Stonybrook community under all of Design Alternative 5's variations.
- **Design Alternative 7:** Design Alternative 3 served as the base condition for this design alternative concept. A linear pond was designed to be constructed around the northern half of the LKP project site. This pond would facilitate the flow from the wetland into the cells and reduce adverse impacts upstream. It is worth noting that Alternative 7 was specifically designed as a test scenario at the request of SAI to assess the effects of improving the circulation of stormwater around LKP cells on downstream flood stages in the Estero River and Halfway Creek areas.
- **Design Alternative 8:** This alternative incorporates all the improvements proposed in Design Alternative 7 while considering additional perimeter berm. A portion of the southern perimeter berm that was proposed in the *Sothern Lee County Mitigation Plan, ICPR4 Modeling of East of I-75 Overland Collection Drainageway Concept Project and Crew-Flint Pen Hydrologic Restoration Concept – Final Report* (Streamline Technologies, 2020) was included in this design. The berm would extend from the southeast corner of the Preserve (Cell 05) and continue south along the eastern side of Bonita Grande Mine.
- **Design Alternative 9:** Design Alternative 9 includes all the improvements from Design Alternative 3 with the inclusion of the first-phase southern berm, as in Design Alternative 8.
- **Design Alternative 5-2a:** This alternative incorporates all improvements from Design Alternative 5-2 and expands upon the proposed berm. The berm would be extended to both to the north and south and be raised to prevent all flow over the berm during simulated storm events. This proposed berm condition would restrict all flow from the north of LKP from flowing west towards I-75, thus reducing flood stages in the Estero River and Halfway Creek.
- **Design Alternative 5-2b:** This alternative encompasses all improvements from Design Alternative 5-2a but proposes an even longer berm. The berm would be extended to the south, mirroring the full B1 alignment from the 2020 Streamline Technologies report (refer to **Appendix A.1**). The berm would be constructed so that no flow would be permitted over the berm under this design condition.

- **Design Alternative 5-2c:** This alternative adopts all improvements proposed in Design Alternative 5-2b with some modifications to the proposed berm alignment. Existing pipe connections on the south side of the LKP property would also be removed in this alternative, severing the connection to the south. The design adjustments proposed in this alternative aimed to mitigate adverse impacts to the communities and mine south of the LKP property.
- **Design Alternative 5-2d:** This alternative incorporates all improvements from Design Alternative 5-2b. The existing pipes that were removed in Design Alternative 5-2c would also be removed in this alternative.

The results of the aforementioned 15 preliminary design alternatives were shared with the County to gather their feedback. In response, the County suggested examining three additional preliminary design alternatives as follows:

- **Design Alternative 5-2d (Full Berm B1):** This alternative adopts all improvements from Design Alternative 5-2d with adjustments to the berm alignment. The proposed layout revises the berm alignment to better adhere to the original B1 berm (refer to **Appendix A.1** for original berm alignment details).
- **Design Alternative 5-2d (Full Berm B2):** This alternative also follows Design Alternative 5-2d, with revisions to the berm alignment. The berm would adhere to the original B2 alignment discussed in the 2020 Streamline Technologies report (**Appendix A.1**).
- **Design Alternative 5-2d (Short Berm B1):** This alternative again incorporates all improvements from Design Alternative 5-2d with changes to the berm alignment. A shortened version of the B1 Berm Alignment was proposed and incorporated into this design alternative.

The conceptual design alternatives, accompanied by a short memo by Kimley-Horn (**Appendix A.5**), were submitted for review and input by the County prior to beginning design refinements. The County elected to move forward with refinements to the Design Alternative 5-2d concepts. Six refinement scenarios were prepared as part of the design refinement effort. The refinements focused on three main components: 1) cell layout, 2) water management features, and 3) berm configuration. It should be noted that the cell layouts used in the conceptual design alternatives were revised for the final design refinements and only 1 cell layout was ultimately considered. The final cell layouts and berm configuration scenarios are depicted in **Figure 4.3**. A summary of the final refined designs is included below, and a summary table is presented in **Table 4.1**. Also, **Figures 4.4** and **4.5** represent improvements for phase 3 of final design alternatives A and B, respectively.

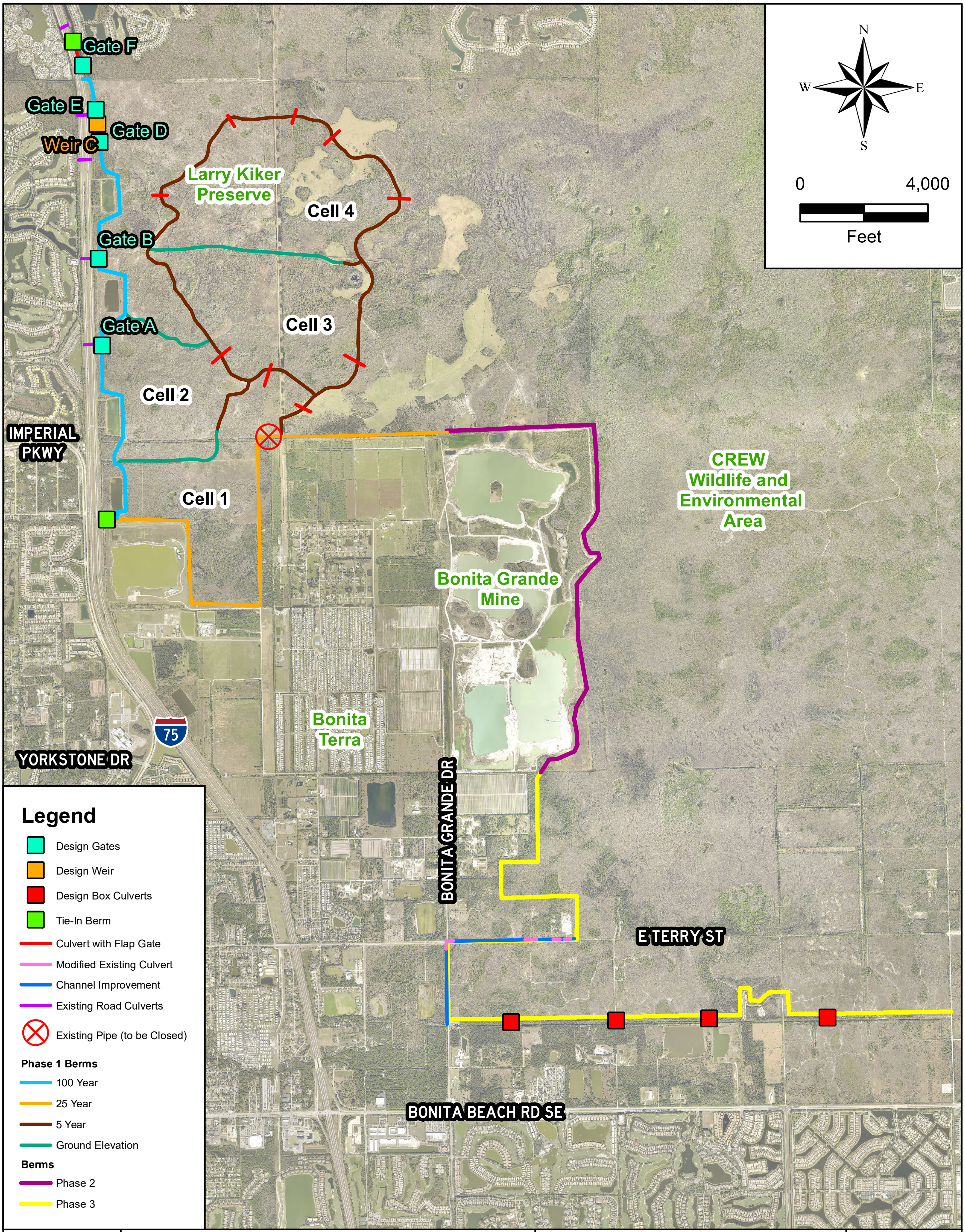
- **Design Alternative Final 1A (DAF-1A):** This alternative includes Phase 1 of the berm and Scenario A of the water management features. This combination of design features results in the shortest berm length that runs along I-75 and along the south side of LKP, ending at the mine. The berm and cell boundaries were designed at the "low" elevation condition. Given that the berms representing the cells function as roads and trails, their low elevation implies that for storms exceeding a certain threshold, some roads and trails may become impassable and will need to be closed. The threshold for different segments of the berms varies and will be explained later. Several control structures, operable gates and weirs are proposed on the westernmost berm. These structures will control the outflow towards I-75 and mitigate flooding concerns downstream.
- **Design Alternative Final 2A (DAF-2A):** The Phase 2 berm configuration was included with this design alternative at the same low elevation associated with Scenario A. The Phase 2 berm is longer than Phase 1; it extends further east past the Bonita Grande Mine and continues south until reaching the southern end of the mine.
- **Design Alternative Final 3A (DAF-3A):** The Phase 3 berm alternative represents the longest berm configuration which is a shortened version of the B1 Berm alignment presented in the 2020 Streamline Technologies report (**Appendix A.1**). The berm continues south, past the Phase 2

limits, and then west running parallel to the Kehl Canal with box culverts to allow flow to the south. This alternative is also included in the Scenario A, low elevation condition.

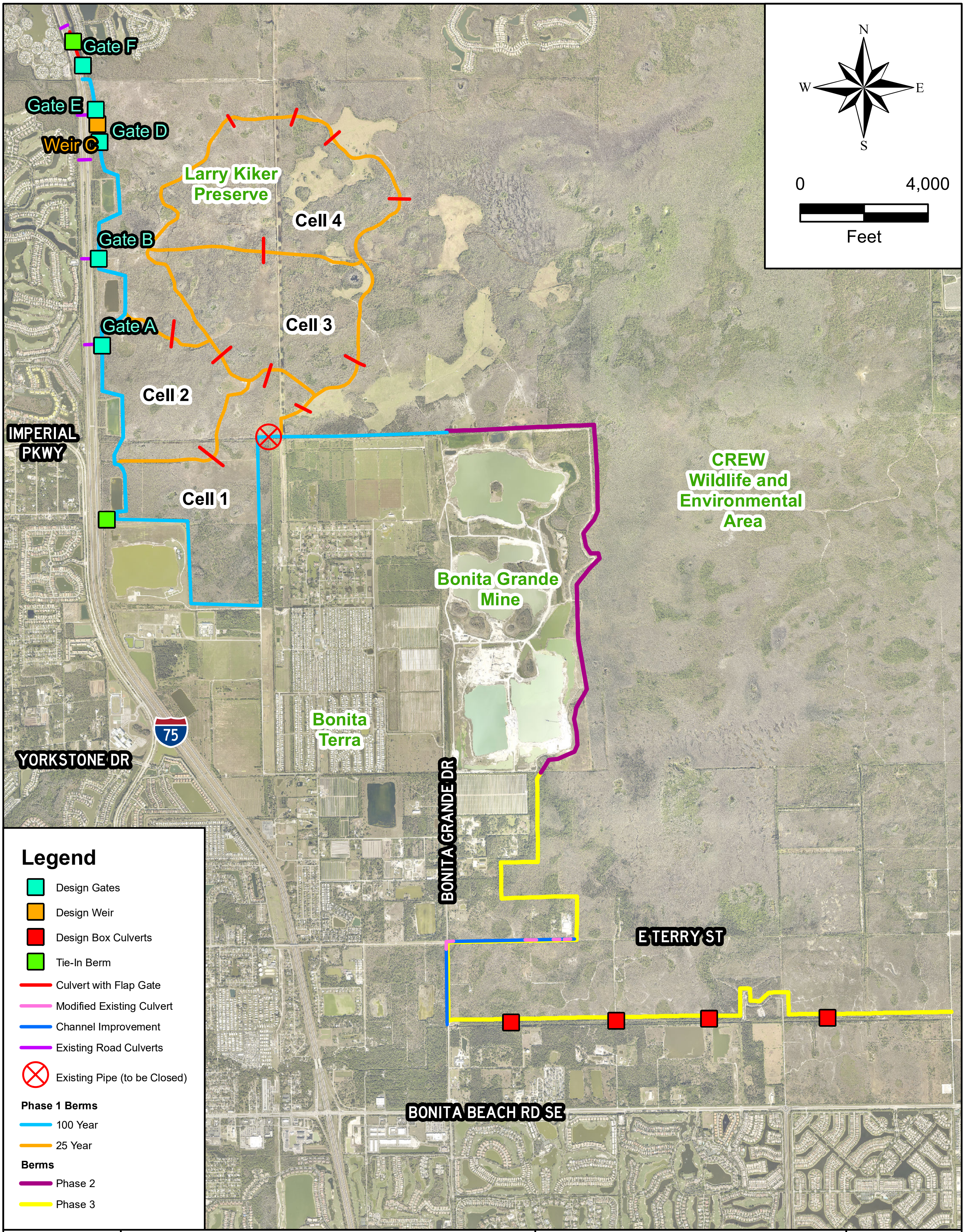
- **Design Alternative Final 1B (DAF-1B):** DAF-1B utilizes similar design components as DAF-1A; however, the "high" elevation berm scenario (Scenario B) was implemented. All other design components from DAF-1A remained but were optimized for this design condition.
- **Design Alternative Final 2B (DAF-2B):** This alternative includes all improvements from the DAF-1B design alternative berm, however, it was configured in the longer Phase 2 layout.
- **Design Alternative Final 3B (DAF-3B):** This alternative has all improvements from DAF-2B with the Phase 3 berm alignment instead of Phase 2. Similar to DAF-3A, box culverts were designed to allow water out of the wetland to the south towards Kehl Canal.

**Table 4.1 – Refined Design Alternatives**

| Alternative | Cell Layout | Water Management | Berm Scenario |
|---|---|---|---|
| **1A** | Layout B | Low Design Elevations; Control structures under I-75 | Phase 1 only |
| **2A** | Layout B | Low Design Elevations; Control structures under I-75 | Phase 2 (Phase 1 plus Bonita Grande Mine berm) |
| **3A** | Layout B | Low Design Elevations; Control structures under I-75 and north of Kehl Canal | Phase 3 (Full Berm - Short B1) |
| **1B** | Layout B | High Design Elevations; Control structures under I-75 | Phase 1 only |
| **2B** | Layout B | High Design Elevations; Control structures under I-75 | Phase 2 (Phase 1 plus Bonita Grande Mine berm) |
| **3B** | Layout B | High Design Elevations; Control structures under I-75 and north of Kehl Canal | Phase 3 (Full Berm - Short B1) |




| SAI | LARRY KIKER PRESERVE | DESIGN ALTERNATIVE DAF-3A | FIGURE: 4.4 |
|---|---|---|---|

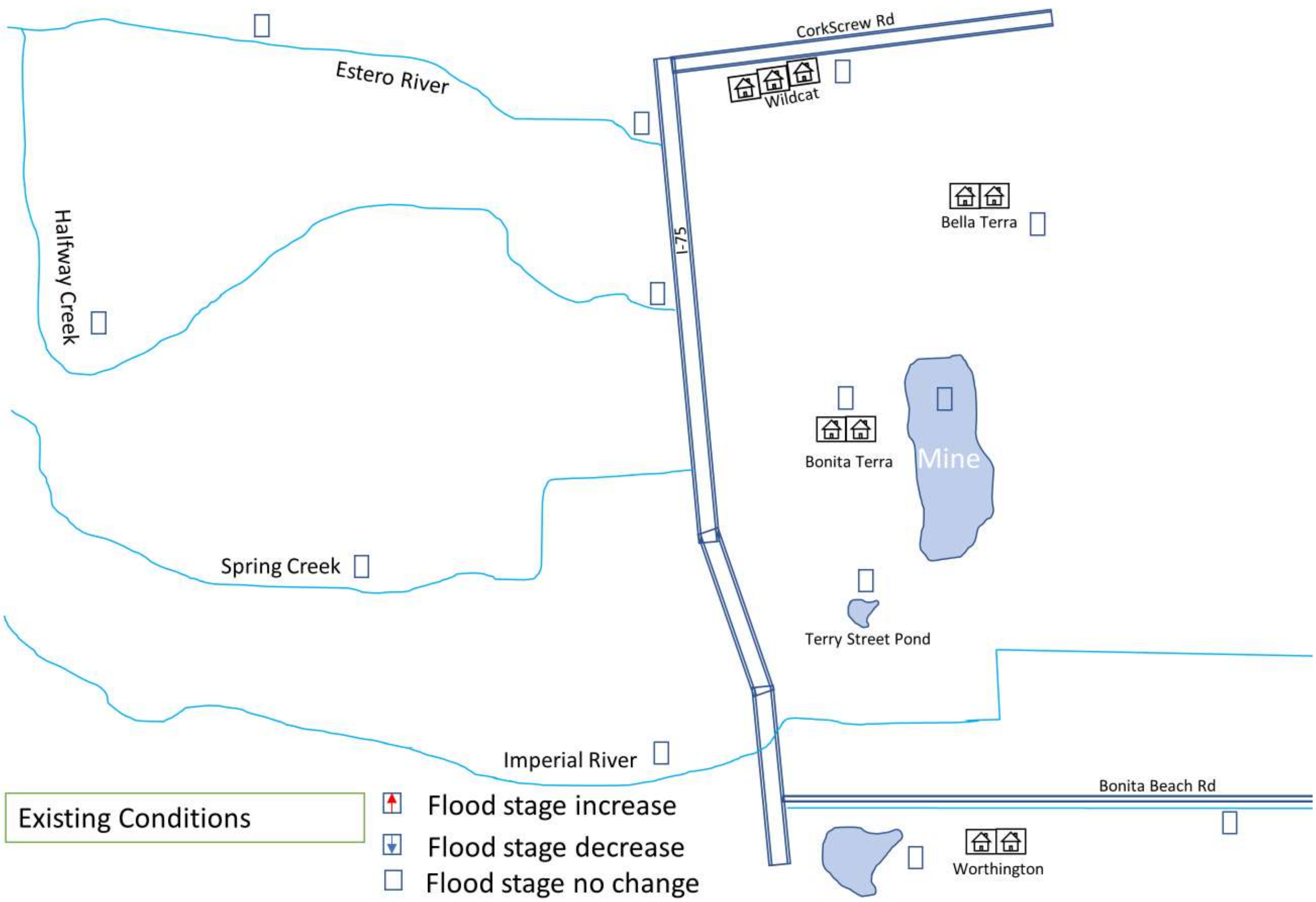



| | | | |
|---|---|---|---|
| SAI | LARRY KIKER PRESERVE | DESIGN ALTERNATIVE DAF-3B | FIGURE: 4.5 |

### 4.2 Conceptual Design Alternatives

This section discusses, in detail, the 19 conceptual level design alternatives that were analyzed for the project. The conceptual design alternatives focused on improvements within the LKP property and analyzed results throughout the surrounding areas and downstream creeks and rivers. **Figure 4.6** shows a schematic of the existing conditions layout and key results analysis points. It should be noted that the conceptual design alternatives were only simulated for the 25-year and 100-year, 72-hour storm events.

**Figure 4.6 – Schematic of Existing Conditions LKP Model**




#### 4.2.1 Design Alternative 1

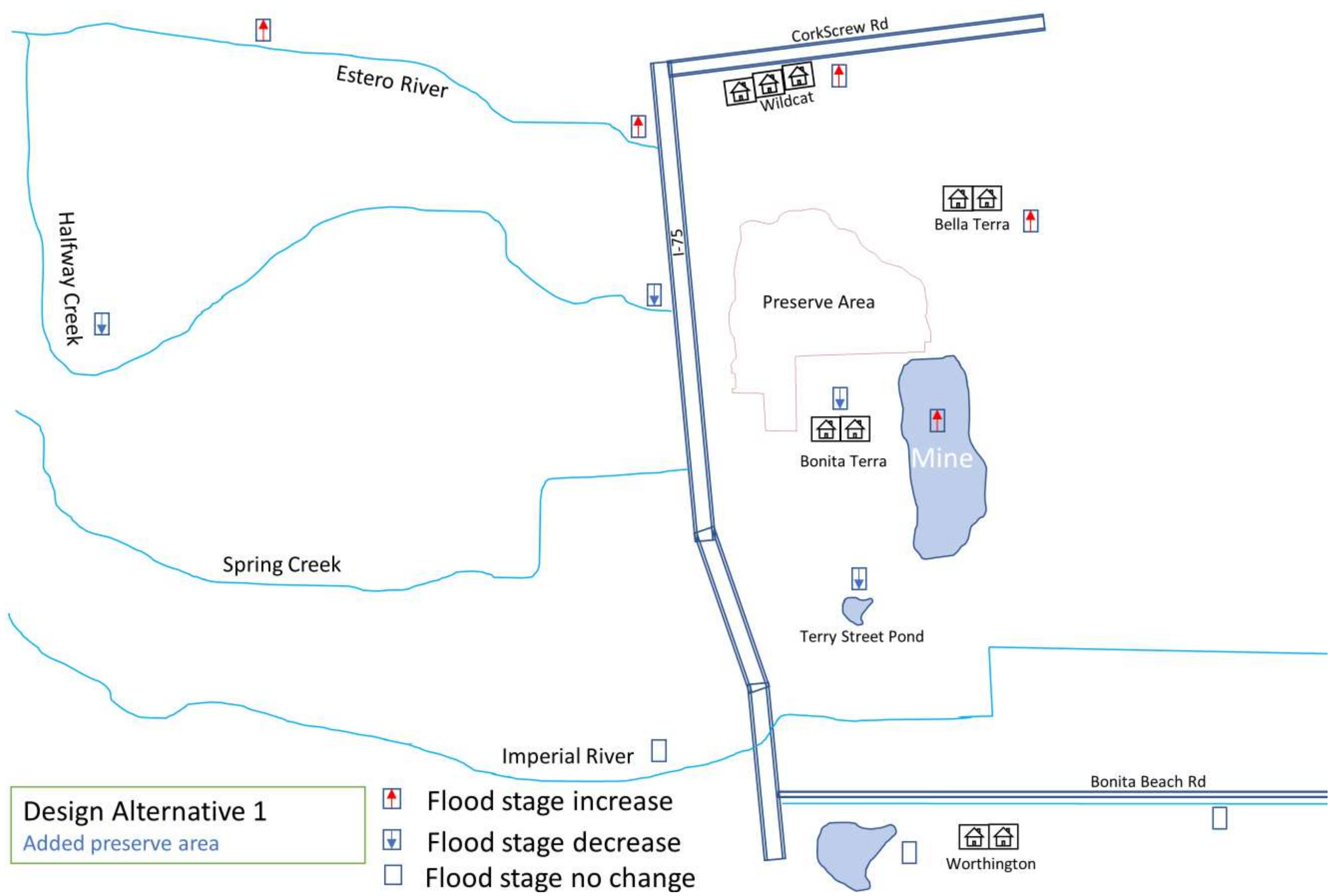
Design Alternative 1 (DA1) aims to capture local runoff within the LKP cells situated on the east side of I-75 while isolating the property from the surrounding wetlands. This alternative was considered to determine the impacts of the proposed LKP project without modifying the existing stormwater conveyance features.

The existing conditions LKP Model models the Preserve with a 2D overland flow mesh. The design conditions were modeled using an exclusion polygon over the LKP limits. The area within the exclusion polygon is excluded (i.e., blocked) in the 2D mesh. Runoff generated within the LKP was modeled as traditional 1D subbasins was a storage node. No hydraulic connections into or out of the Preserve were included. **Figure 4.7** shows a schematic of the DA1 proposed conditions.

Adding and isolating the proposed LKP project has several notable effects. The project blocks natural flows from the surrounding wetland towards Halfway Creek, resulting in a decreased flood stage within the creek. Flow that is diverted away from Halfway Creek proceeds northward which causes an increase in the flood stages in the Estero River. Decreases in flood stages were noted within the communities west and south of Bonita Grande Mine because the LKP project blocks a portion of the flow to the south. The communities located north and east of the LKP are estimated to experience an increase in flood stage due to this design alternative.

These key locations are depicted in **Figure 4.7** along with a summary of the changes in model results, compared to existing conditions, for the 25-year and 100-year, 72-hour storm events. Each key location was designated as one of three conditions: 1) Flood Stage Increase – at least one of the two storms resulted in a flood stage increase; 2) Flood Stage Decrease – both storms resulted in decreases in node maximum stage; 3) No Change – no change in node maximum stage results for at least one storm, and no maximum stage increases. The flood stage inside the LKP reached 16.62-feet NAVD88 during the 100-year, 72-hour event, this is almost the same flood stage for this area in the LKP Model. A node maximum stage comparison table is included in **Appendix D.1**, which compares the DA1 results for the 25 and 100-year storm events to the LKP Model. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.7 – Design Alternative 1 Schematic and Flood Stage Comparison**



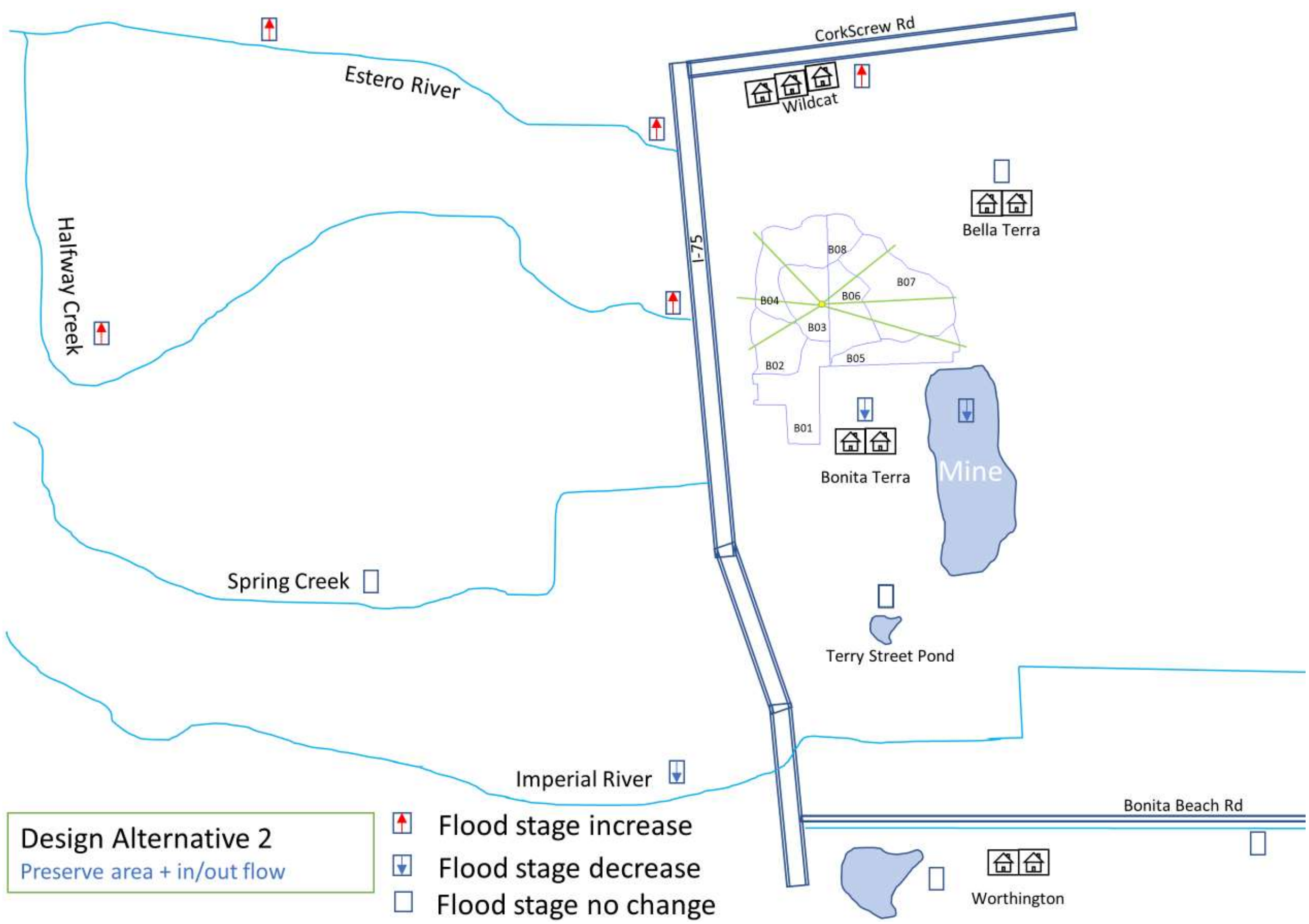

### 4.2.2 Design Alternative 2

Design Alternative 2 (DA2) builds upon DA1 by considering the impacts of allowing flow through the property. The primary goal of this alternative was to mitigate the flood stage increases observed when blocking the flow path in DA1.

Culverts were added on the upstream (eastern) and downstream (western) ends of the proposed LKP property and free flow was assumed between the internal cell boundaries. Three 8x17-feet box culverts were placed on the eastern cells, which primarily allow flow into the Preserve. Three box culverts of the same dimensions were also added on the western cells to allow flow out of the Preserve. A layout of the proposed alternative is presented in **Figure 4.8**.

Compared to DA1, DA2 directs more flow to the west and north and flow to the south is further impeded. Flood stages in both the Estero River and Halfway Creek, as well as the community north of LKP, are estimated to increase during the 25 and 100-year storm events. Flood stages in the mine and community south of the Preserve, however, are estimated to experience decreases. The flood stage increase observed in DA1 for the Bella Terra community was resolved in DA2. **Figure 4.8** presents a summary of the changes in model results, compared to existing conditions, for the 25-year and 100-year, 72-hour storm events. The flood stage in the LKP during the 100-year 72-hour event reached 16.98-feet NAVD88, about 4-inches higher than the average flood stage for this area in the existing condition model. A node maximum stage comparison table is included in **Appendix D.2**, which compares the DA2 results for the 25 and 100-year storm events to the LKP Model. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.8 – Design Alternative 2 Schematic and Flood Stage Comparison**




### 4.2.3 Design Alternative 3

Design Alternative 3 (DA3) focused on optimizing the culvert sizes throughout the property. The primary objective of this alternative was to address the flood stage increases observed in DA2 within the Estero River, Halfway Creek, and community north of LKP.

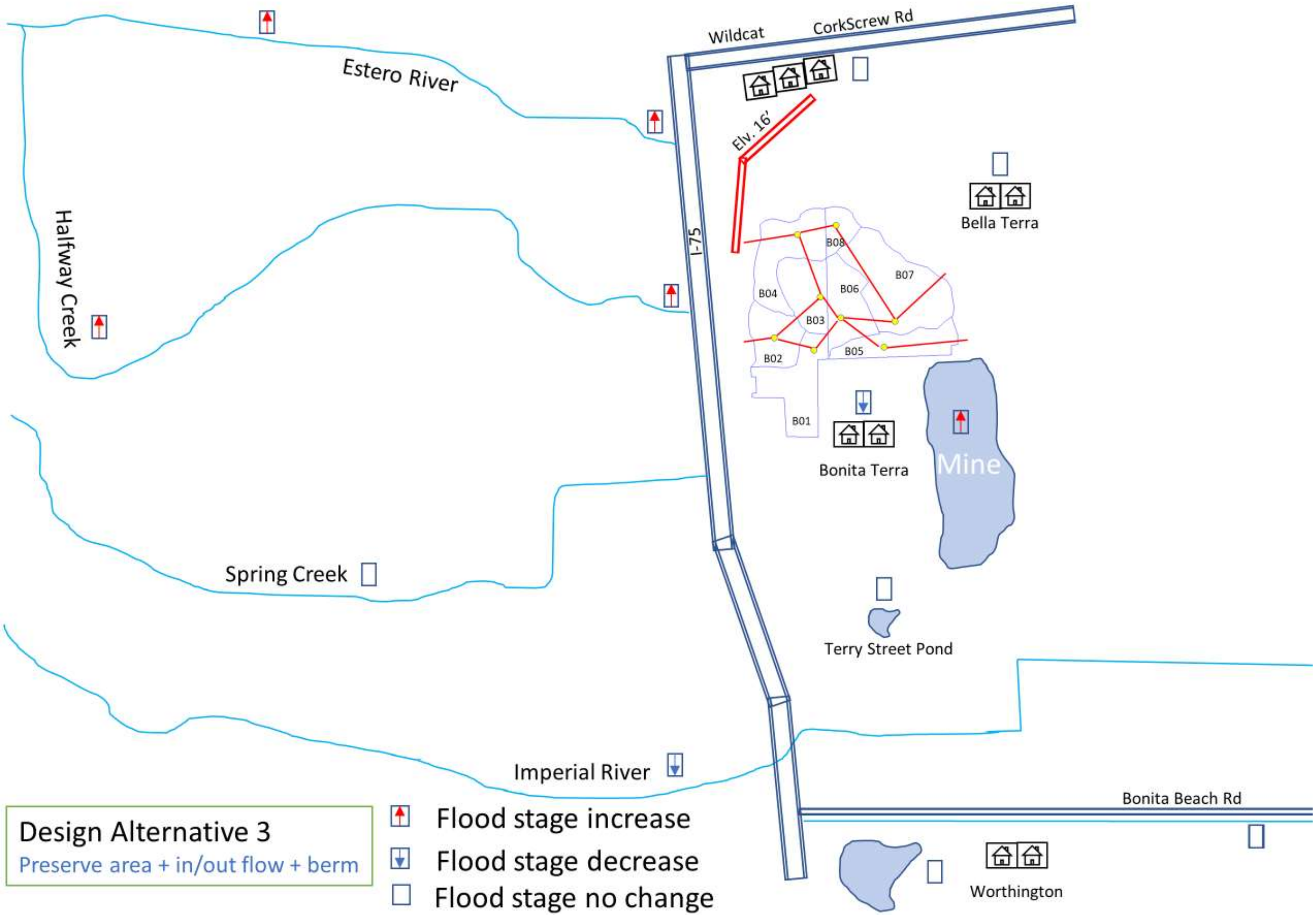
The DA1 Model, which modeled the LKP property as an exclusion area, was used as the foundation model for this alternative. The LKP property was divided into 8 distinct cells based on the layout provided by Kimley-Horn (refer to **Figure 4.2**). Each cell was modeled using a 1D subbasin with pipe links allowing flow through the Preserve. The hydraulic connections between the cells and wetland were provided using the following culverts:

- From Wetland to Cell B05: 50 linear feet (LF) ~ 4x10-feet concrete box culvert (CBC), invert at elevation 8-feet (NAVD88)
- From Wetland to Cell B07: 50 LF ~ 4x10-feet CBC, invert at elevation 8-feet (NAVD88)
- From Cell B02 to Wetland: Five 80 LF ~ 36-inch reinforced concrete pipe (RCP), invert at elevation 8-feet (NAVD88)
- From Cell B04 to Wetland: Five 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)
- From Cell B05 to Cell B06: Five 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)
- From Cell B07 to Cell B06: 50 LF ~ 4x10-feet CBC, invert at elevation 8-feet (NAVD88)
- From Cell B07 to Cell B08: Five 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)
- From Cell B06 to Cell B01: Three 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)
- From Cell B06 to Cell B03: Five 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)
- From Cell B08 to Cell B04: Five 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)
- From Cell B01 to Cell B02: Three 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)
- From Cell B03 to Cell B02: Five 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)
- From Cell B03 to Cell B04: Five 80 LF ~ 36-inch RCP, invert at elevation 8-feet (NAVD88)

DA3 also involved constructing a berm east of I-75 and northwest of the LKP, with a top elevation of 16-feet NAVD88. The berm begins at the south end of the Stoneybrook community and continues south for approximately 3,800-feet. The proposed berm effectively blocks the flow from the wetland to Estero River, with only a narrow path between the Preserve and berm. This passage allows flow from the wetland to reach Halfway Creek in a more controlled manner. A schematic of the proposed conditions for DA3 is presented in **Figure 4.9**.

DA3 resolved the flood stage increases observed in the Stoneybrook and Bella Terra communities to the north of LKP. However, more water was diverted to the south under this design condition resulting in increased flood stages within the Bonita Grande Mine. Additionally, flood stage increases were also noted within the Estero River and Halfway Creek, compared to existing conditions. Flood stages are still expected to increase downstream of the berm because the water elevation in the wetland is above the proposed berm elevation (16-feet NAVD88) in both the 25 and 100-year storm events. A summary of the changes in flood stage, compared to existing conditions, is presented in **Figure 4.9**. Flood stages within the Preserve for the 100-year, 72-hour event reached 17.0-feet NAVD88, approximately 5-inches higher than the average flood stage under existing conditions in this area. A detailed comparison of the maximum stage results for the existing conditions LKP Model and DA3 Model for the 25-year and 100-year, 72-hour storms is included in **Appendix D.3**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.9 – Design Alternative 3 Schematic and Flood Stage Comparison**

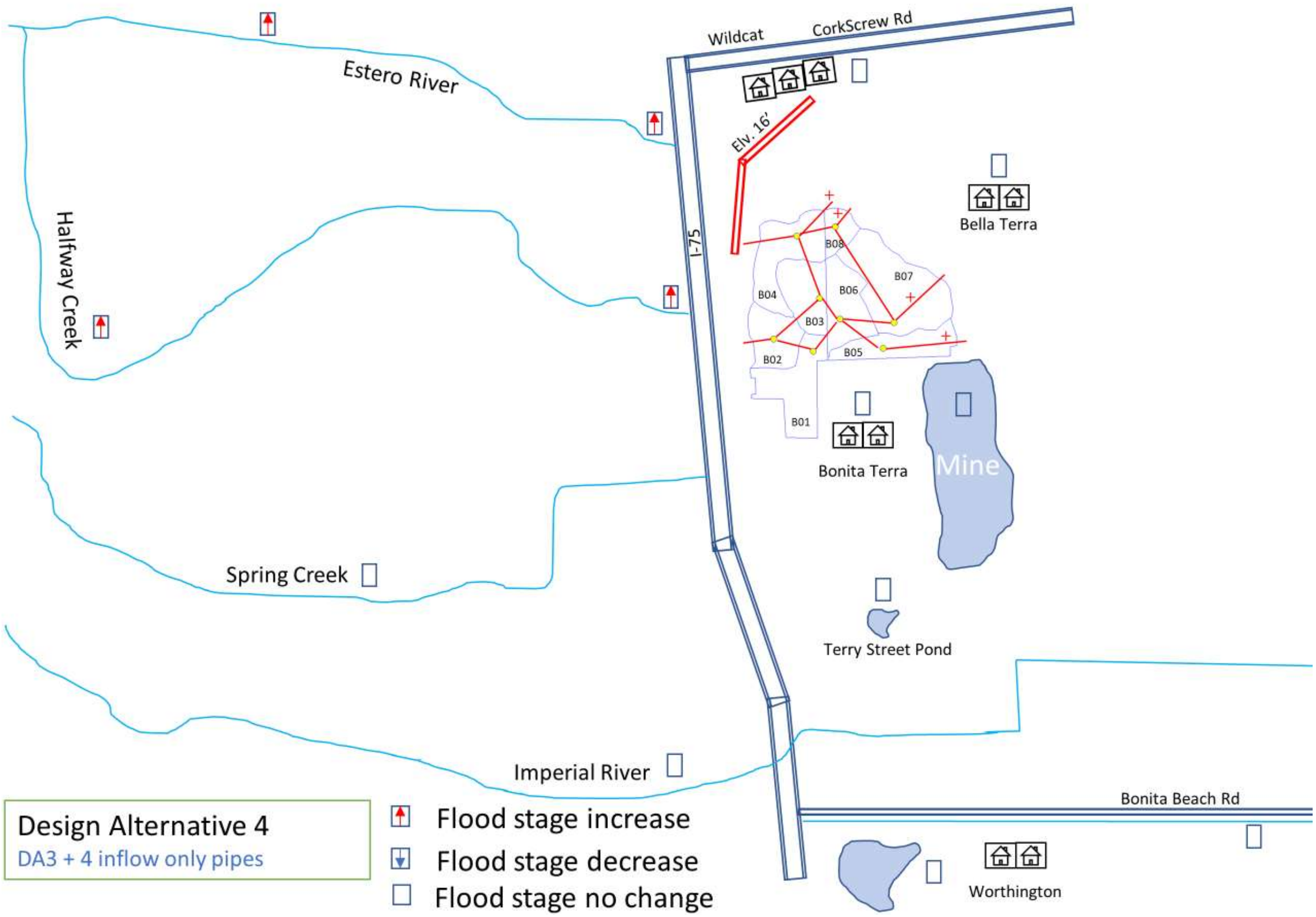



### 4.2.4 Design Alternative 4

Design Alternative 4 (DA4) aims to optimize storage capacity within the LKP property and cells while addressing the flood stage increases previously observed within Estero River and Halfway Creek in DA3. This alternative builds upon the DA3 layout and culverts, which were optimized as part of DA3. Increased storage was achieved by installing flap gates on the upstream (eastern) end of the Preserve which allows flow in without allowing flow out. Two additional culverts were added at the north end of the property to allow flow from the wetland into cells 08 and 04. The proposed pipes are both 4x8-feet CBCs at elevation 8.0-feet NAVD88. The schematic for this design alternative is shown in **Figure 4.10**.

DA4 shows no adverse impacts on the upstream (east) side of I-75, which is an improvement compared to the other alternatives considered thus far. Flood stages in Halfway Creek and Estero River are estimated to increase under this design condition, these flood stage increases are consistent with the increases observed in DA3. There were no flood stage decreases noted in the project vicinity. **Figure 4.10** includes a summary of the flood stage changes, compared to existing conditions, for this design alternative. The flood stage within LKP reached 17.2-feet NAVD88 in the 100-year, 72-hour storm event, which is approximately 7-inches higher than the average flood stage in the existing condition model for this area. For a detailed comparison of the maximum stages between existing conditions and DA4 during the 25-year and 100-year, 72-hour storm events, please refer to **Appendix D.4**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.10 – Design Alternative 4 Schematic and Flood Stage Comparison**




### 4.2.5 Design Alternative 5

Design Alternative 5 (DA5) is similar to DA4 since it also focuses on maximizing stormwater storage within the proposed LKP cells. This alternative proposes design components that would mitigate the flood stage increases that were estimated under DA4 conditions.

The DA4 Model was used as the base model for the DA5 Model. Flap gates were utilized to increase storage on the LKP property, like in DA4, by preventing flow out of the community. All the pipes connecting from the wetland to the east and north have flap gates in this alternative. Storage capacity was also maximized by removing the two outfall pipes proposed in DA3 and DA4 on the downstream (west) end of the Preserve. Below is a list of connections between the cells and wetland, as well as between the cells, these proposed connections are also presented in **Figure 4.11**. Note – all proposed culverts are modeled at elevation 8.0-feet NAVD88.

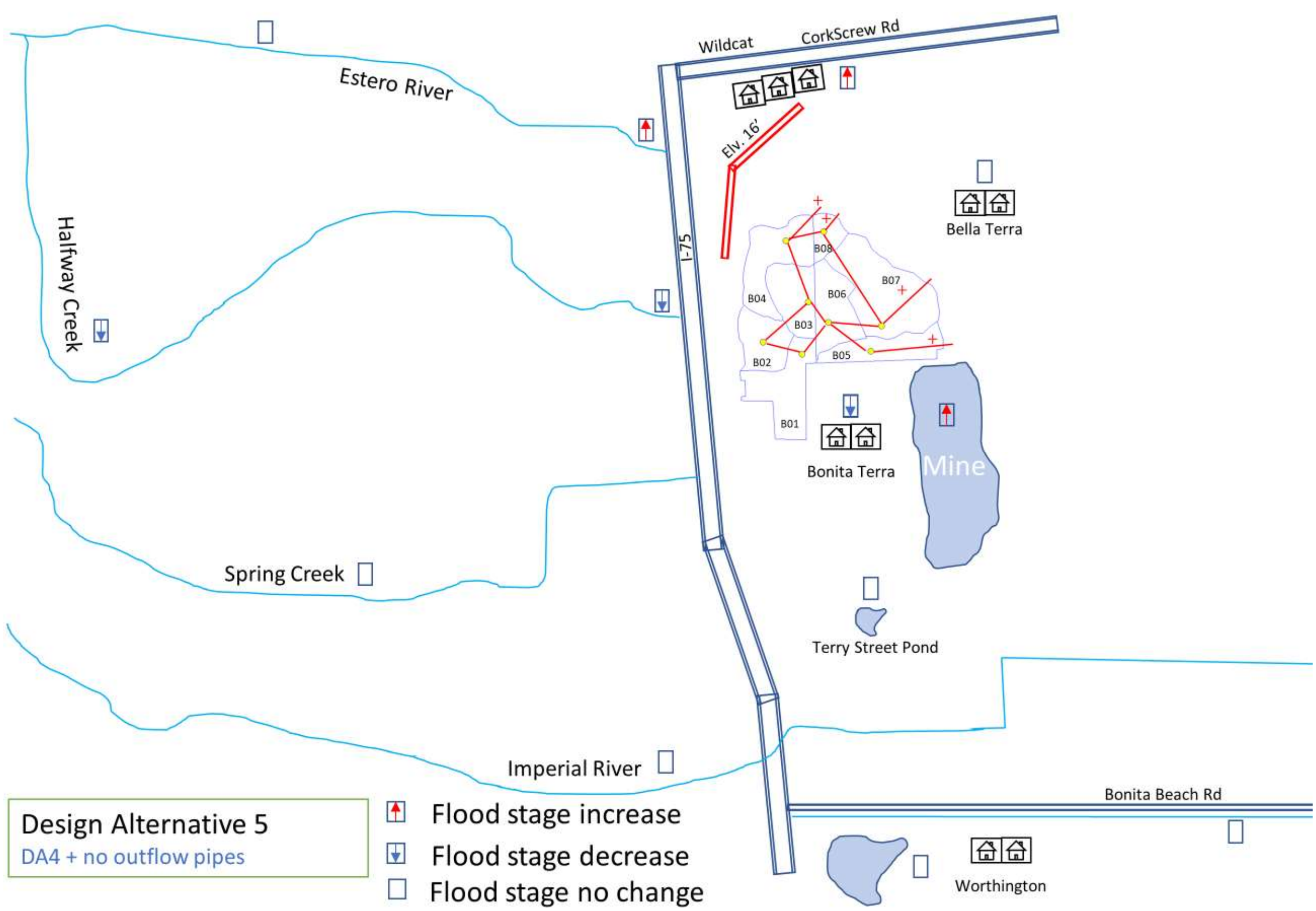
- From Wetland to Cell B05: 50 LF ~ 4x10-feet CBC, with flap gate upstream
- From Wetland to Cell B07: 50 LF ~ 4x10-feet CBC, with flap gate upstream
- From Wetland to Cell B08: 50 LF ~ 4x8-feet CBC, with flap gate upstream
- From Wetland to Cell B04: 50 LF ~ 4x8-feet CBC, with flap gate upstream
- From Cell B05 to Cell B06: Five 80 LF ~ 36-inch RCP
- From Cell B07 to Cell B06: 50 LF ~ 4x10-feet CBC
- From Cell B07 to Cell B08: Five 80 LF ~ 36-inch RCP
- From Cell B06 to Cell B01: Three 80 LF ~ 36-inch RCP
- From Cell B06 to Cell B03: Five 80 LF ~ 36-inch RCP
- From Cell B08 to Cell B04: Five 80 LF ~ 36-inch RCP

- From Cell B01 to Cell B02: Three 80 LF ~ 36-inch RCP
- From Cell B03 to Cell B02: Five 80 LF ~ 36-inch RCP
- From Cell B03 to Cell B04: Five 80 LF ~ 36-inch RCP

**Figure 4.11** illustrates the schematic of DA5 and showcases the flood stage changes between the existing conditions model and DA5 for the 25-year and 100-year, 72-hour storm events. The flood stage increase observed within Halfway Creek in DA4 has been resolved in DA5. The Estero River is estimated to still experience flood stage increases in this alternative, but the increases are limited to just downstream of I-75; the river is even estimated to see reductions in flood stage further downstream. Flood stages are also estimated to increase within the Stoneybrook community and in the Bonita Grande Mine under DA5 conditions.

Flood stages in the LKP property further increased compared to DA4 due to the removal of the western outflow pipes. During the 100-year, 72-hour storm event the flood stage reached 17.5-feet NAVD88, which is approximately 10-inches higher than the average flood elevation across the LKP property under existing conditions. A node maximum stage comparison table for the 25 and 100-year, 72-hour storm events is included in **Appendix D.5**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.11 – Design Alternative 5 Schematic and Flood Stage Comparison**

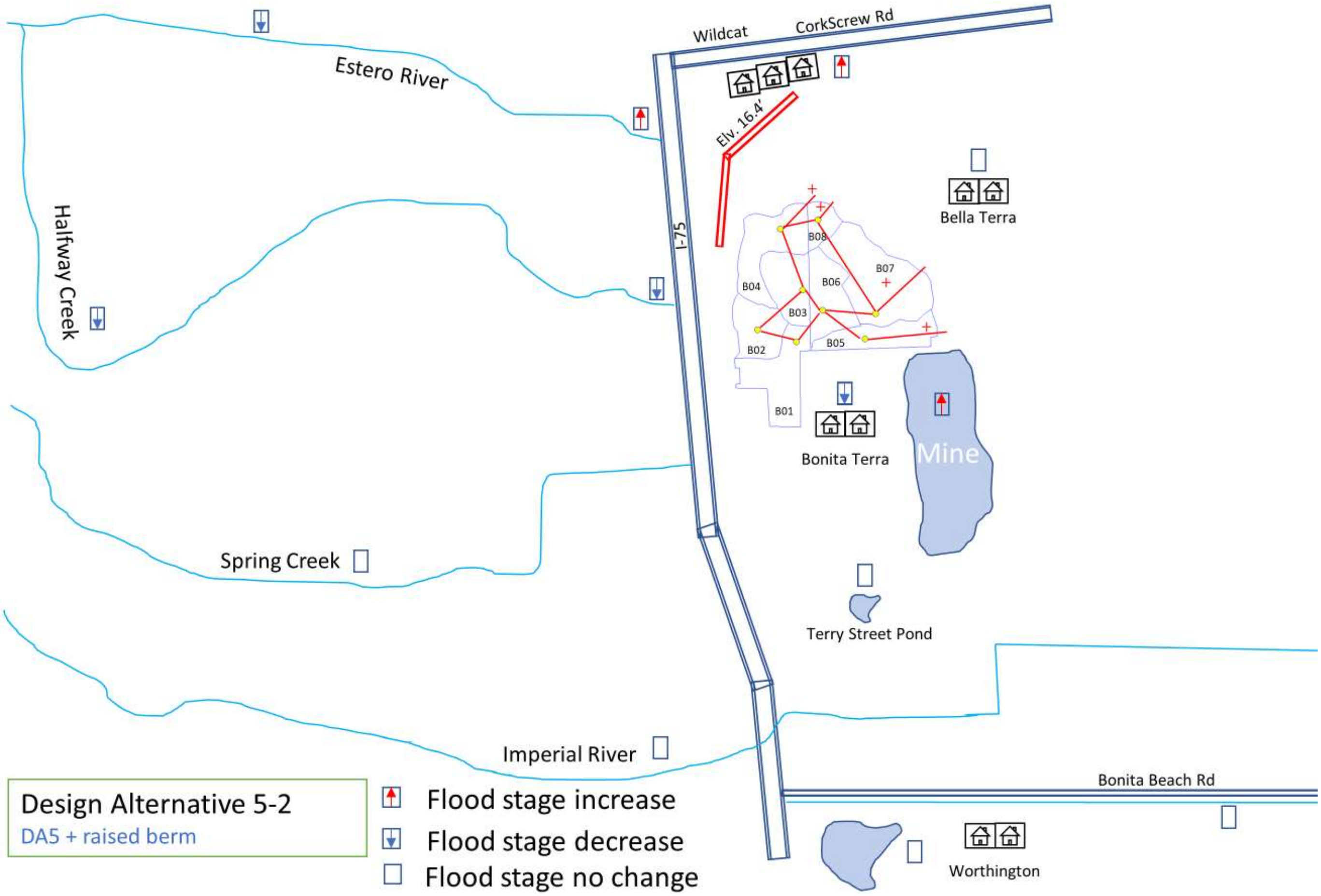



### 4.2.6 Design Alternative 5-2

Design Alternative 5-2 (DA5-2) aims to improve upon DA5 by resolving the flood stage increase observed at the upstream end of the Estero River. The DA5 Model was used as the base model for this design alternative and only the proposed berm elevation was revised. The berm was raised from 16-feet NAVD88 to 16.4-feet NAVD88.

Raising the berm elevation did not result in any significant differences in model results, as shown in **Figure 4.12**. The flood stages within the LKP cells were also consistent with DA5. Node maximum stages for DA5-2 are compared to existing conditions in **Appendix D.6**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

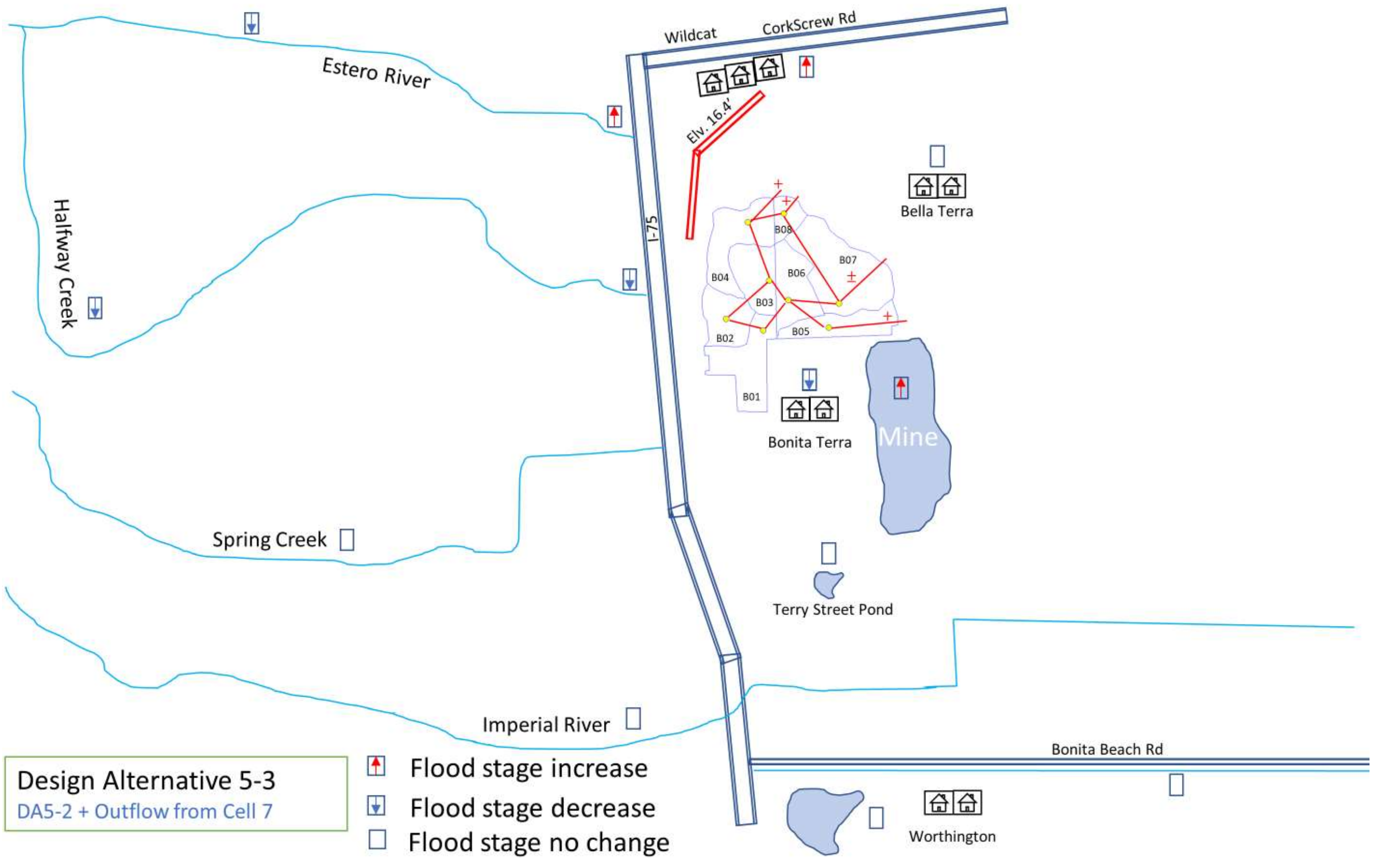
**Figure 4.12 – Design Alternative 5-2 Schematic and Flood Stage Comparison**




### 4.2.7 Design Alternative 5-3

Design Alternative 5-3 (DA5-3) is a variation of DA5-2 with a minor change allowing both positive and negative flow between the wetland and Cell B07. No significant changes in flood stages were observed in DA5-3 compared to DA5-2. **Figure 4.13** displays the schematic of DA5-3 and presents the flood stage changes between the existing conditions LKP Model and DA5-3 Model for the 25 and 100-year 72-hour events. The flood stage within LKP cells also remained consistent with DA5-2. A detailed comparison of node maximum stages is included in **Appendix D.7** for the 25 and 100-year, 72-hour storm events. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.13 – Design Alternative 5-3 Schematic and Flood Stage Comparison**

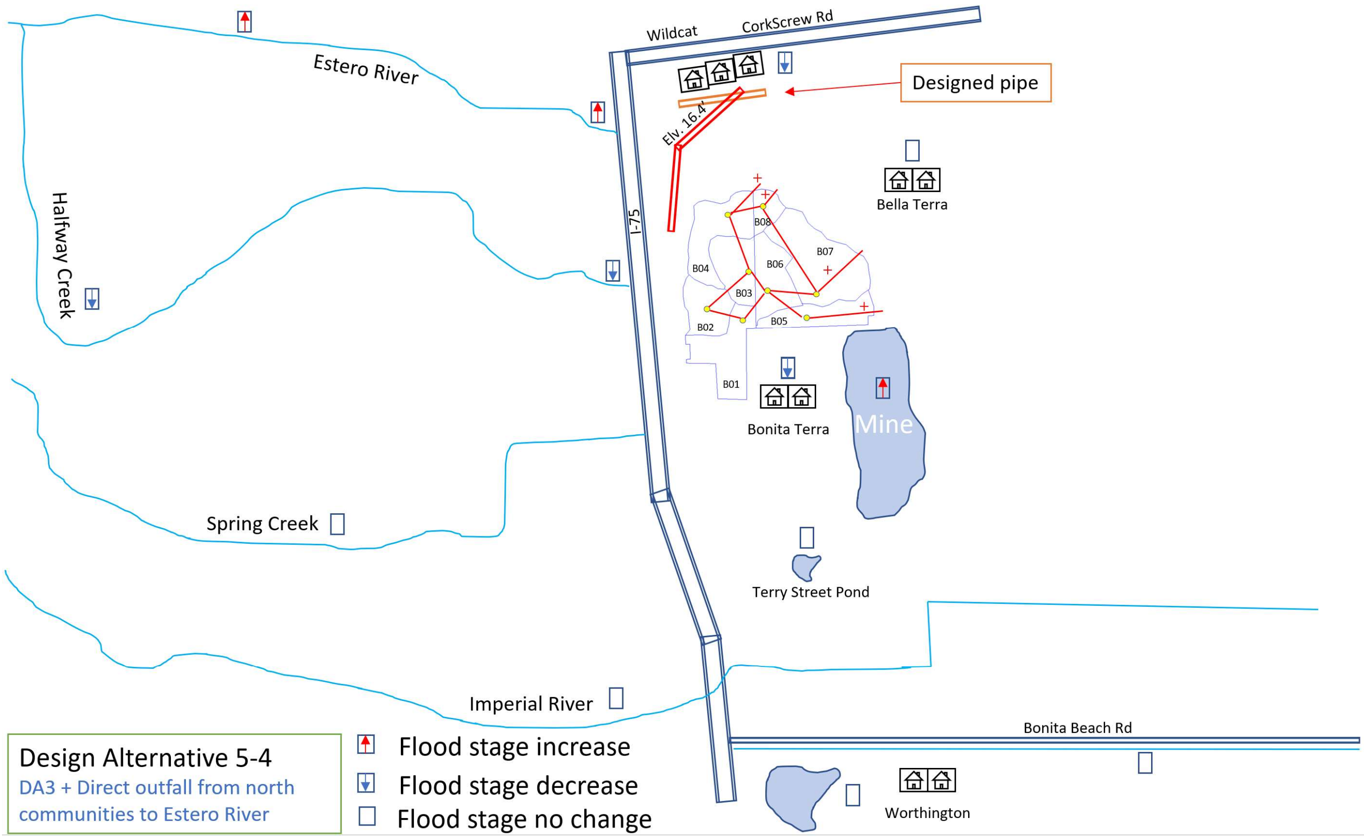



### 4.2.8 Design Alternative 5-4

Design Alternative 5-4 (DA5-4) focused on addressing the flood stage increases in the Stoneybrook Community, which is located to the north of LKP. The DA5-4 Model was developed based on the DA5-3 Model. In this alternative the outflow from the northern communities was diverted to the west of the proposed berm using a pipe connection. The lower tailwater elevation on the west side of the proposed berm reduces the potential for backflow into the northern communities.

**Figure 4.14** displays the schematic of DA5-4 and illustrates the flood stage changes between the existing condition model and DA5-4 for the 25 and 100-year, 72-hour storm events. Rerouting the outfall for the Stoneybrook community did mitigate the flood stage increases in the community that were observed in the previous iterations of DA5. However, this improvement has resulted in flood stage increases in the downstream segments of Estero River, which was not observed in the previous iterations. No other significant changes in results were noted compared to DA5-3. **Appendix D.8** includes a detailed comparison of the maximum stages for the existing condition model and the DA5-4 condition, considering the 25 and 100-year, 72-hour storms events. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.14 – Design Alternative 5-4 Schematic and Flood Stage Comparison**

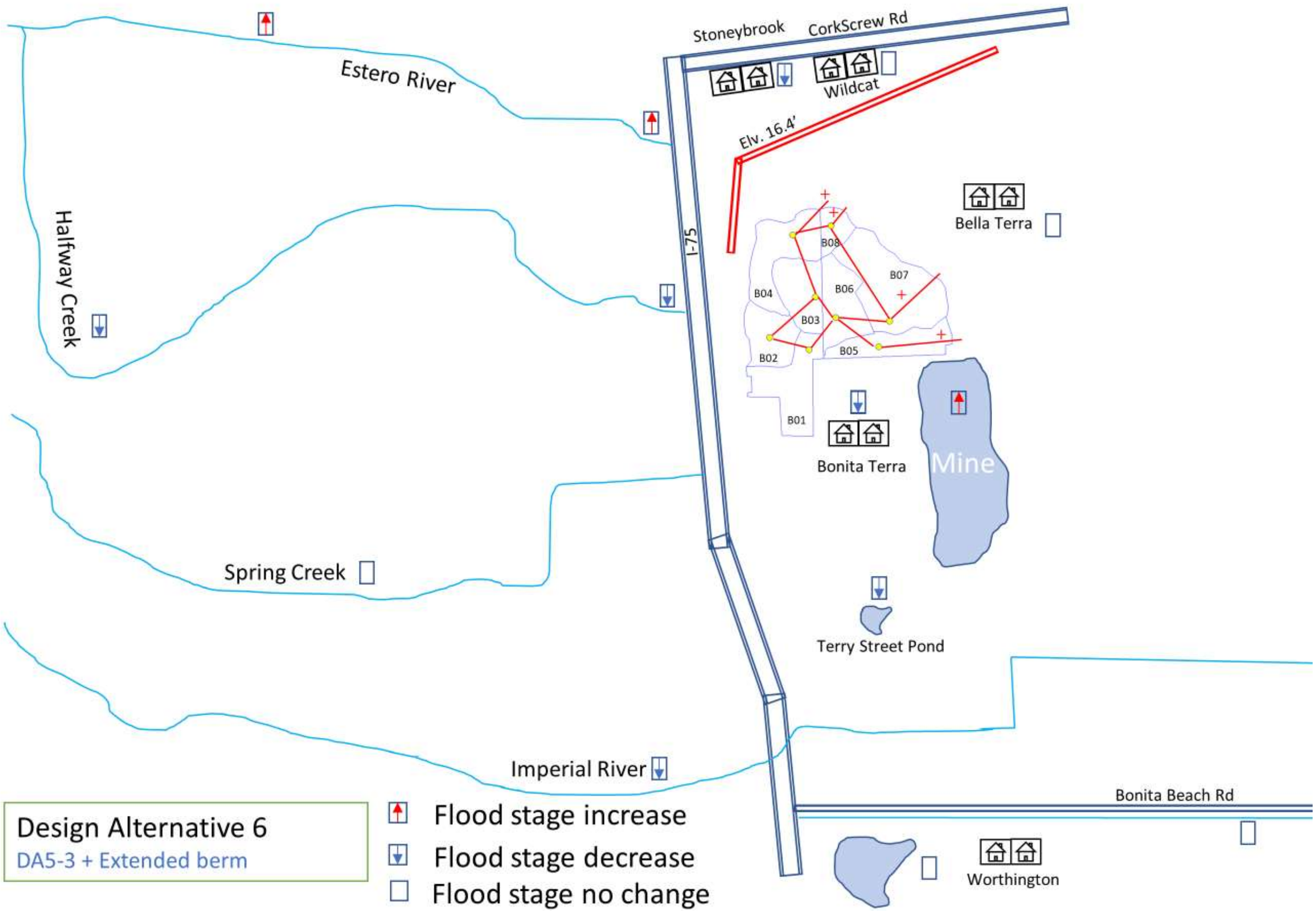



### 4.2.9 Design Alternative 6

This design alternative was developed based on the DA5-3, with a goal of mitigating the estimated flood stage increases. Design Alternative 6 (DA6) proposes extending the proposed berm to the northeast, providing the communities to the north with full separation from the LKP property. The berm elevation was designed at 16.4-feet NAVD88. The proposed berm alignment is depicted in **Figure 4.15**.

This alternative offers similar levels of flood reduction and stage increases as estimated in DA5-4, which also considered disconnecting Stoneybrook community from the LKP property. A summary of this design's maximum stage results, compared to existing conditions for the 25 and 100-year storms, is shown in **Figure 4.15**. A complete node maximum stage comparison table is also included in **Appendix D.9**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.15 – Design Alternative 6 Schematic and Flood Stage Comparison**

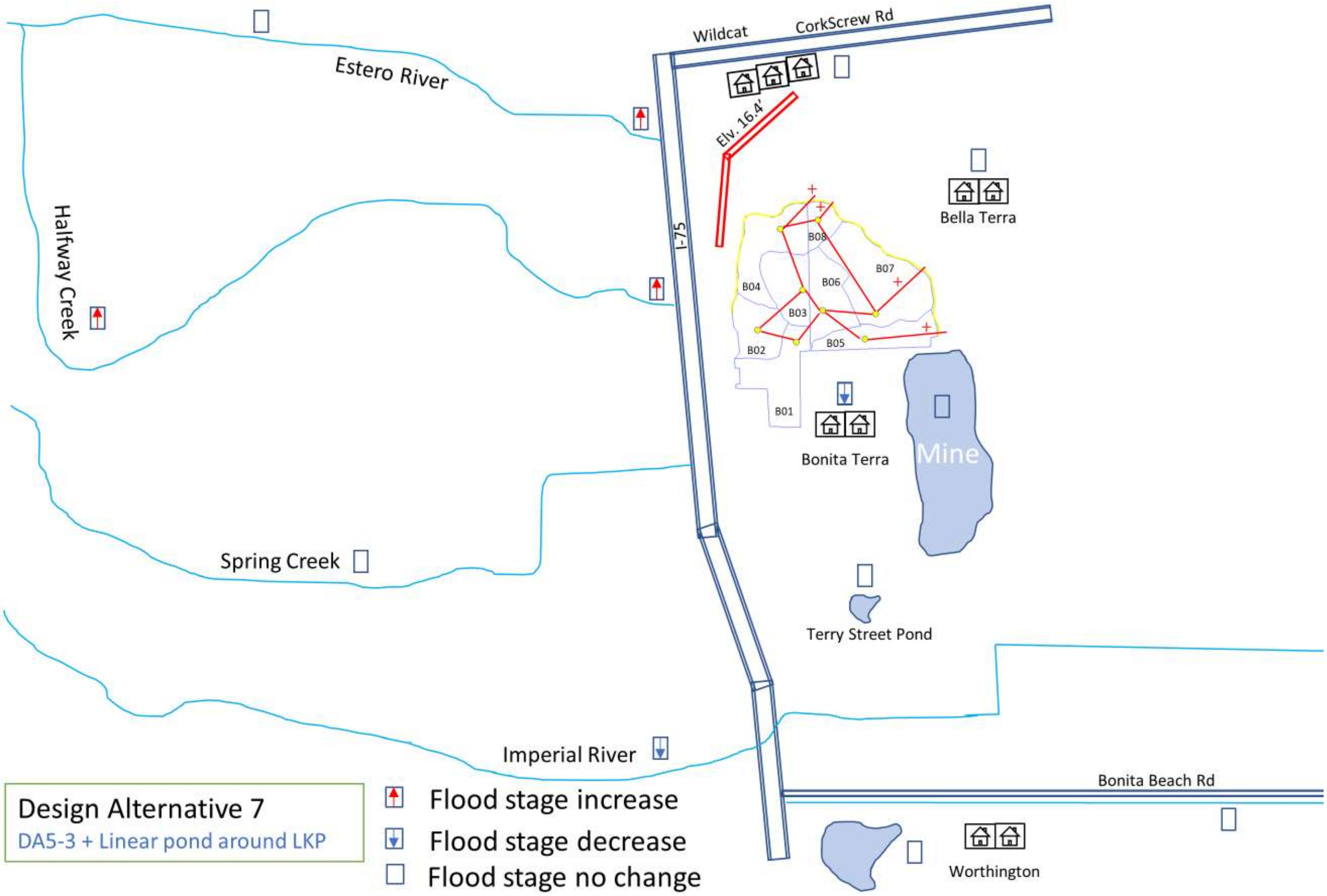



### 4.2.10 Design Alternative 7

The goal of Design Alternative 7 (DA7) is to achieve a balance between flood stages in Estero River and Halfway Creek. In previous design alternatives, starting from DA5-3, flood stage increases were observed in the Estero River while Halfway Creek experienced decreases in flood stage. A linear pond surrounding the LKP cells was introduced to address the uneven flow distribution. The proposed pond covers the entire northern and eastern property boundary as well as the northern half of the western boundary, as shown in **Figure 4.16**. The goal of the pond was to collect flow from around the wetlands around the Preserve and direct it to the proposed inflow pipes to LKP. As we mentioned Alternative 7 was specifically designed as a test scenario at the request of SAI to assess the effects of improving the circulation of stormwater around LKP cells on downstream flood stages in the Estero River and Halfway Creek.

This design concept did not achieve the desired goal. Halfway Creek and Estero River peak stages are estimated to increase in DA7. This occurred because the proposed linear pond redirected a portion of the runoff that previously flowed south to the eastern inflow pipes. Flood stage increases in the Bonita Grande Mine, which is located to the south of LKP, were resolved due to the redirected flow. **Figure 4.16** highlights the flood stage changes between the existing conditions and DA7 for the 25 and 100-year events. For a detailed comparison of the maximum stages between the existing condition and the DA7 condition, please refer to **Appendix D.10**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.16 – Design Alternative 7 Schematic and Flood Stage Comparison**

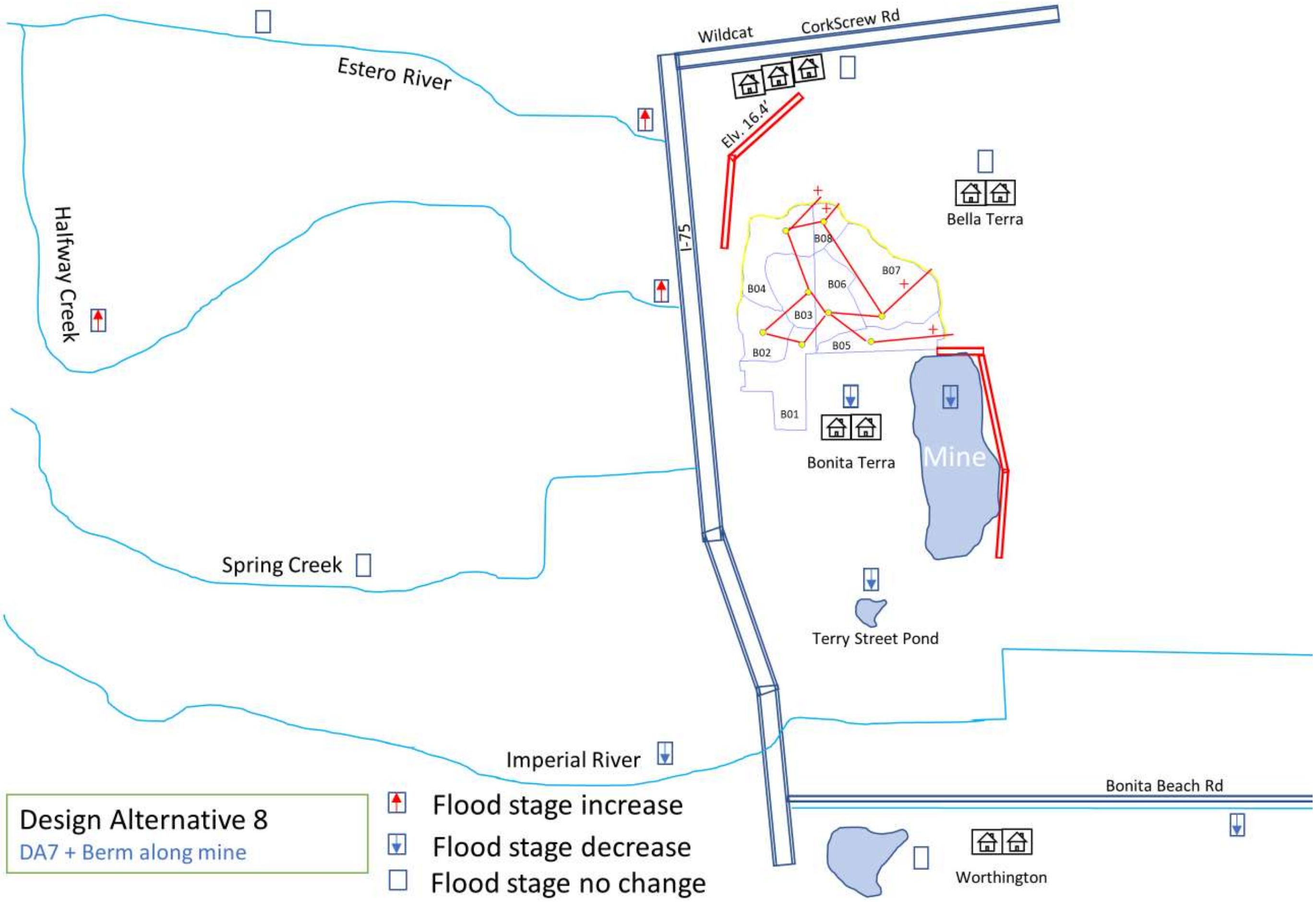



### 4.2.11 Design Alternative 8

Design Alternative 8 (DA8) expands upon DA7 by adding a berm to protect Bonita Grande Mine. The proposed berm would begin at the southeastern corner of the LKP cell boundaries and continue along the northern and eastern side of the mine, as shown in **Figure 4.17**. The berm was designed to be constructed at elevation 20.0-feet NAVD88 which restricts flow during all simulated storm events.

The construction of this extended berm resulted in decreased flood stages in the communities south of LKP, the Bonita Grande Mine, the Imperial River, and the canal along Bonita Beach Road. **Figure 4.17** shows the estimated flood stage decreases, compared to existing conditions, associated with this alternative. The flood stage increases in Halfway Creek and Estero River, which are estimated in most of the design concepts considered thus far, are still estimated in this design condition. A node maximum stage comparison table for the 25 and 100-year storms is included in **Appendix D.11**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.17 – Design Alternative 8 Schematic and Flood Stage Comparison**

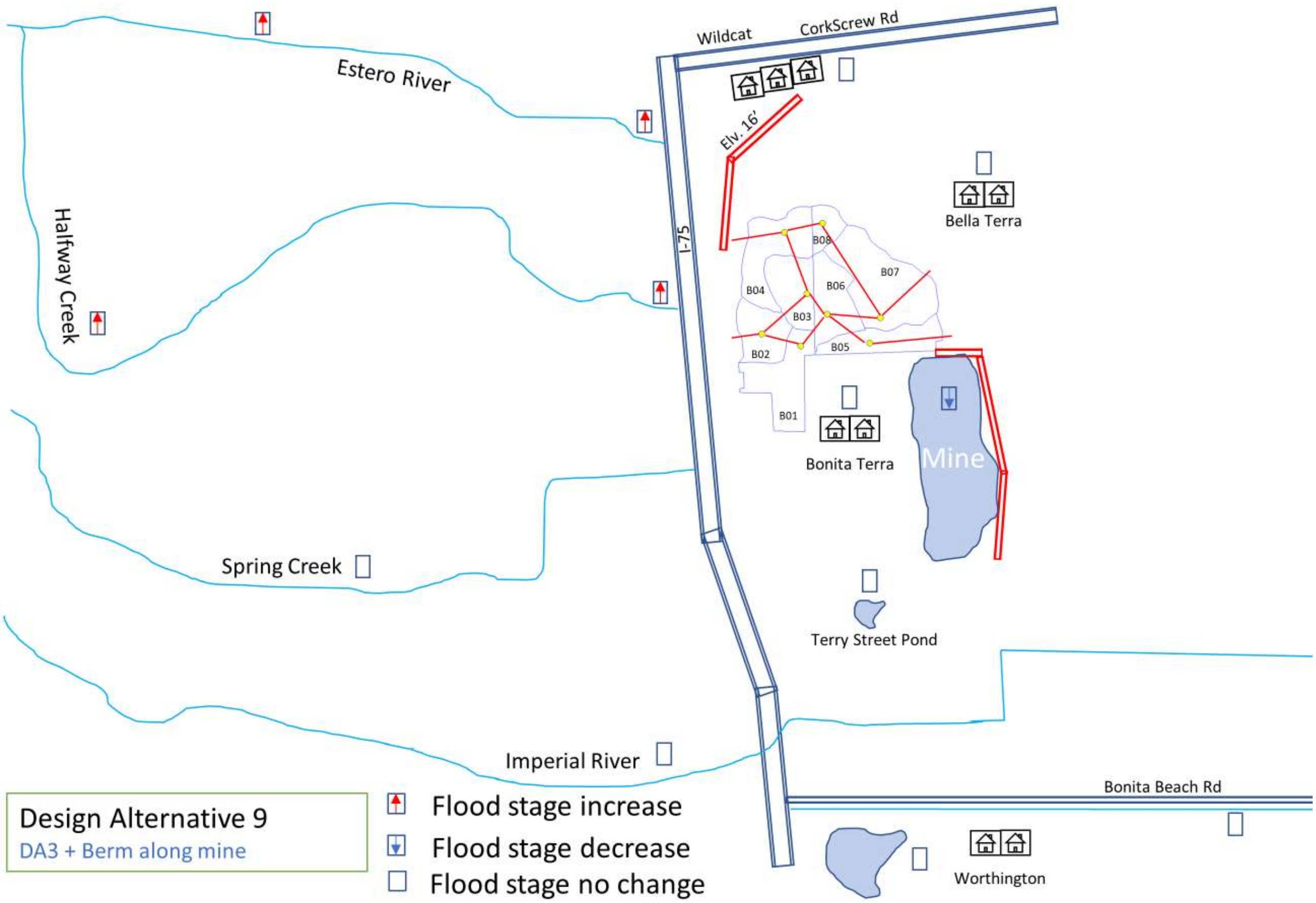



### 4.2.12 Design Alternative 9

The DA3 Model was used to develop DA9. This alternative, however, includes the extended berm that was proposed in DA8 to protect Bonita Grande Mine. This berm will also have an elevation of 20.0-feet NAVD88.

This design condition results in lowered flood stages in the Bonita Grande Mine. No other significant flood stage changes were noted on the east side of I-75. The flood stages in Halfway Creek and Estero River are estimated to experience flood stage increases in DA9. **Figure 4.18** depicts the schematic of the DA9, as well as the flood stage changes between existing conditions and DA9 for the 25 and 100-year, 72-hour storm events. **Appendix D.12** presents a comparison of the maximum stage results for existing conditions and DA9. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.18 – Design Alternative 9 Schematic and Flood Stage Comparison**

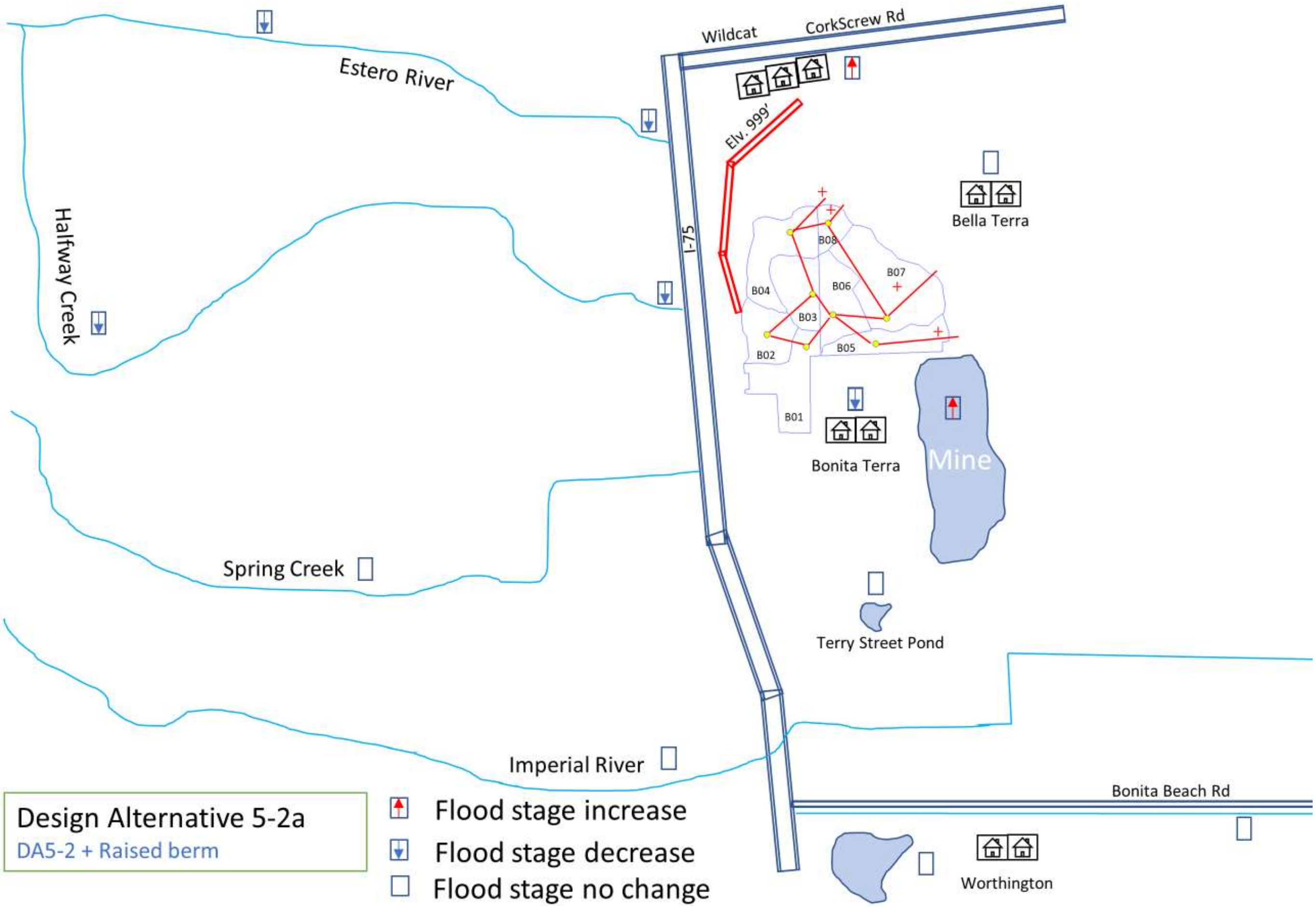



### 4.2.13 Design Alternative 5-2a

Design Alternative 5-2a (DA5-2a) was developed to assess the capacity of the wetlands east of I-75 to effectively store stormwater during extreme rainfall events. This alternative expands upon DA5-2, and the DA5-2 Model was used as the base condition for DA5-2a. The proposed berm has been expanded southward, connected to LKP cells, and raised to an elevation of 999- , ensuring that there is no flow towards the west of I-75.. These alterations essentially sever the western flow way and forces all water to remain in the wetland and LKP or flow to the southern outfall. The proposed berm alignment and design layout for this alternative is presented in **Figure 4.19**.

The extended berm resulted in flood stage decreases in both Halfway Creek and the Estero River, as shown in **Figure 4.19**. No flood stage increases were noted west of I-75 under this design condition. Flood stage increases were noted east of I-75 in the Stoneybrook community and in the Bonita Grande Mine due to the severed outfall to the west. The berm also resulted in increased stages inside the LKP cells. The maximum stage increased to 17.6-feet NAVD88; an approximately 12-inch increase compared to existing conditions. Flood stages in the community south of LKP are estimated to see reductions in flood stage under this design condition. A complete maximum stage comparison table is included in **Appendix D.13** for the 25 and 100-year storms. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.19 – Design Alternative 5-2a Schematic and Flood Stage Comparison**



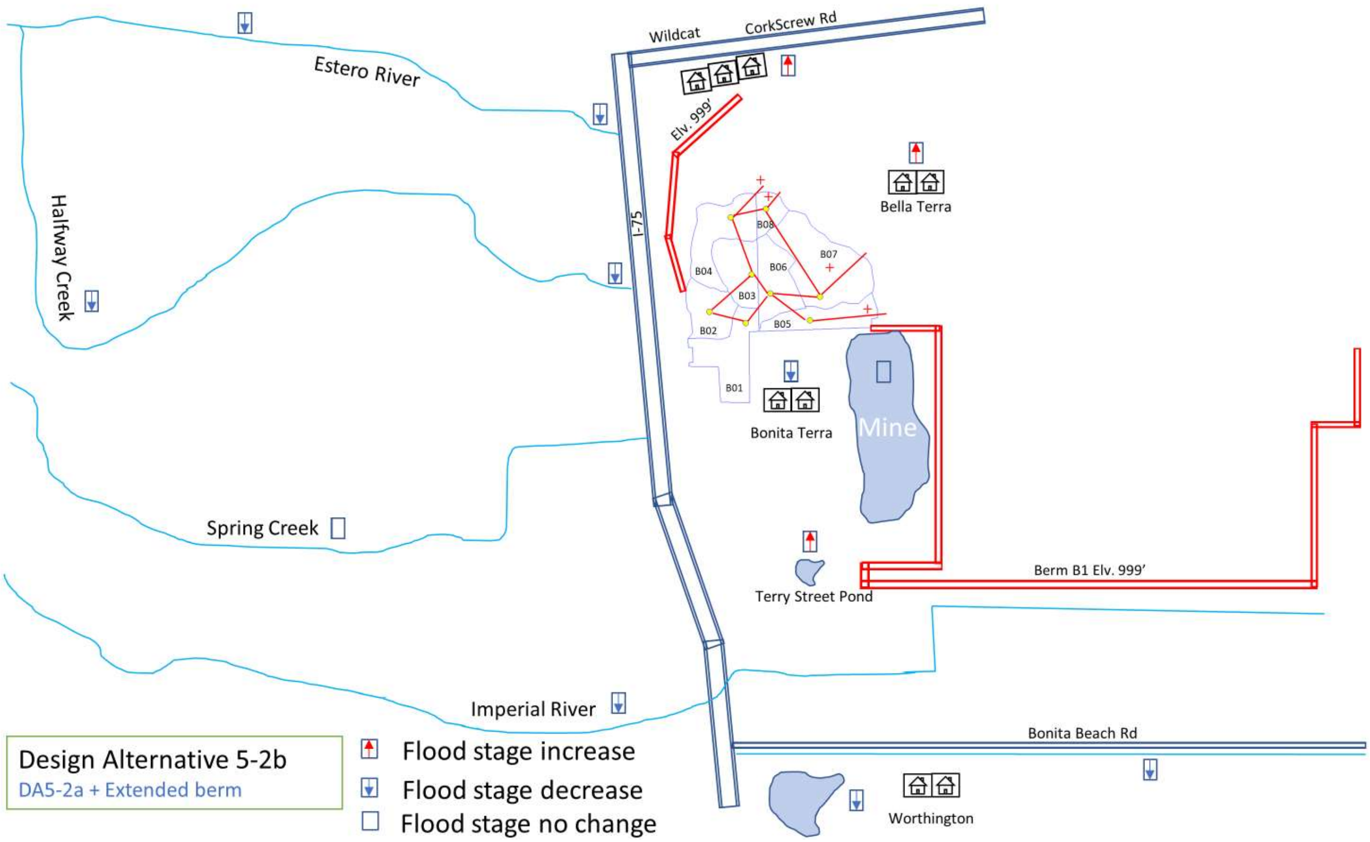

### 4.2.14 Design Alternative 5-2b

Design Alternative 5-2b (DA5-2b) considered the option of isolating the LKP property and surrounding wetlands with a berm following a similar alignment as the B1 berm from the 2020 Streamline Technologies report (refer to **Appendix A.1**). This alternative builds upon DA5-2a, which includes the extended berm that severs flow to the west. The berm proposed in this alternative begins at the southeastern corner of the LKP, running along the Bonita Grande Mine, until reaching the Kehl canal where it continues east, and eventually turns north. The layout of the berm in this alternative is presented in **Figure 4.20**. The proposed berm south of LKP was modeled at elevation 999-feet, which restricts all flow over the berm.

This alternative resulted in decreased flood stages in most areas west of I-75 (i.e., Estero River, Halfway Creek, and Imperial River). Flood stage decreases were also noted along Bonita Beach Road, as well as the communities to the south. These locations, which are highlighted in **Figure 4.20**, are all located downstream of the proposed berm which blocks flow from leaving the wetland. Flood stages in the communities north and east of the proposed berms (Stoneybrook, Wildcat Run, and Bella Terra) are estimated to experience an increase in flooding under design conditions. A summary of the peak stage comparisons at key points around the project is included in **Figure 4.20**. There is one community located downstream (west) of the proposed berm and southwest of the Bonita Grande Mine, which is estimated to experience an increase in maximum stage under design conditions. This increase is observed in the smaller storm events (25-year and smaller) because the existing outfall path to the Kehl Canal is blocked by the B1 berm alignment.

This alternative resulted in the largest increase in flood stage inside of LKP. The maximum stage in the cells was estimated to be 18.4-feet NAVD88, which is approximately 21-inches higher than the average maximum stage in existing conditions. A comparison of all the node maximum stage results is included in **Appendix D.14** for the 25 and 100-year, 72-hour storm events. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.20 – Design Alternative 5-2b Schematic and Flood Stage Comparison**

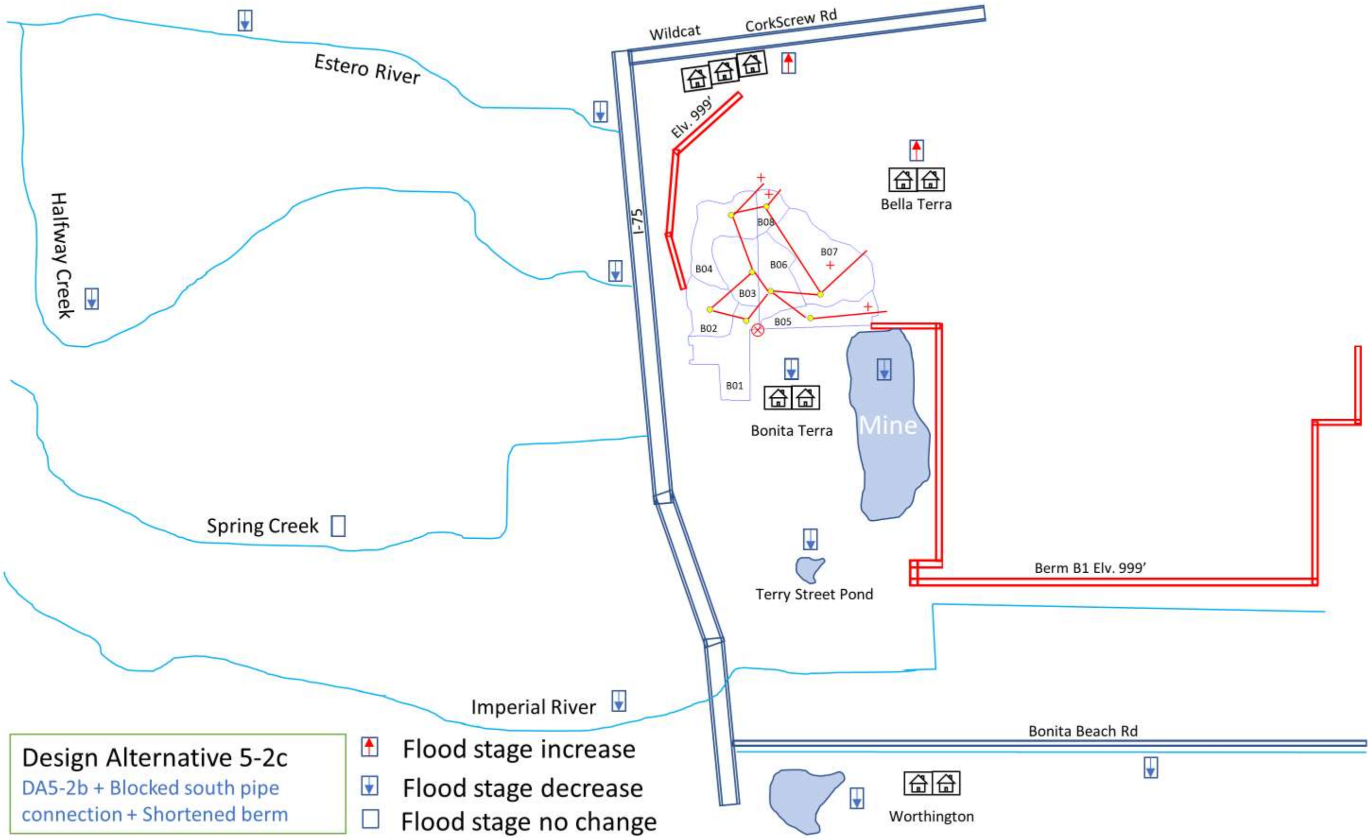



### 4.2.15 Design Alternative 5-2c

The goal of Design Alternative 5-2c (DA5-2c) was to address the flood stage increases affecting the communities located to the west of the proposed berm expansion from DA5-2b and to the south of Bonita Grande Mine. The DA5-2b Model was used as the foundation model for this design alternative. The B1 berm alignment was revised along the southern edge of the mine, near the intersection of E Terry Street and Bonita Grande Drive. The original north-south berm along Bonita Grande Drive was shifted approximately 5,000 feet to the east, and subsequently, modifying the east-west berm along E Terry Street to align with the new north-south berm (refer to **Figure 4.21**). This revision restores a similar flow pattern to existing conditions by allowing local flow to overtop E Terry Street and reach the Kehl Canal. Additionally, two existing culverts along the southern LKP cells were blocked, effectively isolating LKP from the southern communities.

This design alternative achieved the goal of reducing flood stages in the communities south of the Preserve. The flood stages at all locations downstream of LKP are estimated to see reductions or no change, compared to existing conditions. No notable changes were observed upstream of the proposed berm, compared to DA5-2b. **Figure 4.21** presents a comparison of flood stage results to existing conditions for key locations around the project. The flood stage in LKP was estimated to be approximately 18.1-feet NAVD88 during the 100-year, 72-hour storm event, which is approximately 18-inches higher than existing conditions. A maximum stage comparison between existing and proposed conditions for the 25 and 100-year, 72-hour storm events is included in **Appendix D.15**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.21 – Design Alternative 5-2c Schematic and Flood Stage Comparison**

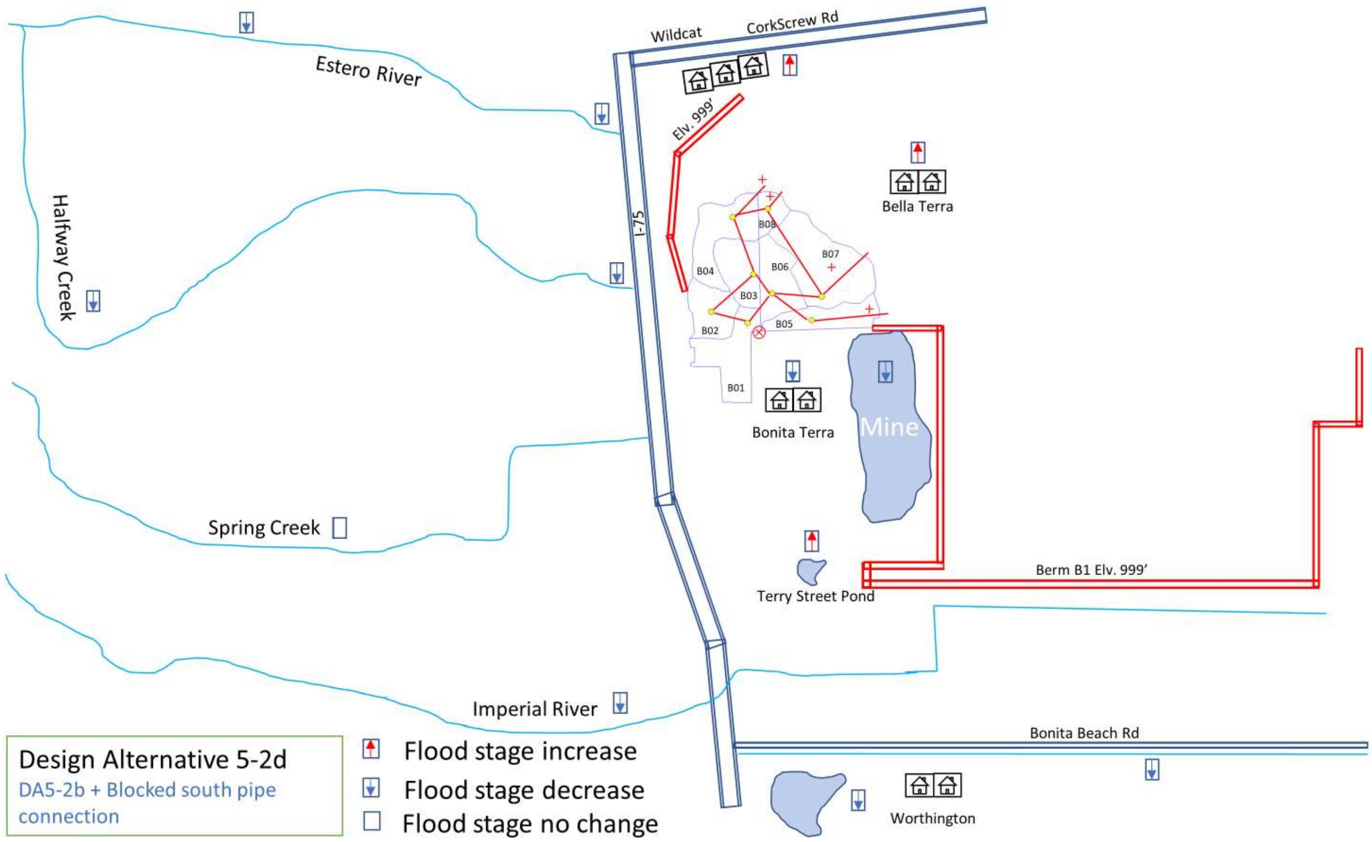



### 4.2.16 Design Alternative 5-2d

The County conveyed that they would prefer to stay with the original B1 berm which extends to the intersection of E Terry Street and Bonita Grande Drive. Design Alternative 5-2d (DA5-2d) reverted the berm back to its original alignment. The DA5-2d Model was developed using the DA5-2b Model as the base condition. DA5-2d modifies DA5-2b by blocking the two existing pipe connections from Cell B01 to the south.

This design alternative estimates similar results to DA5-2b; the same locations that were estimated to have flood stage increases or decreases are the same in both alternatives. A summary of the flood stage changes in key locations around the project area, compared to existing conditions, is presented in **Figure 4.22**. The flood stages in the LKP cells consequently raised to 18.5-feet NAVD88, approximately two inches half higher than DA5-2b, because the existing pipe connections from LKP were blocked. No significant improvements were observed south of LKP because the existing outfall path to the Kehl Canal remains blocked by the B1 berm alignment. A comparison of node max stage results for existing conditions and DA5-2d are presented in **Appendix D.16**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.22 – Design Alternative 5-2d Schematic and Flood Stage Comparison**

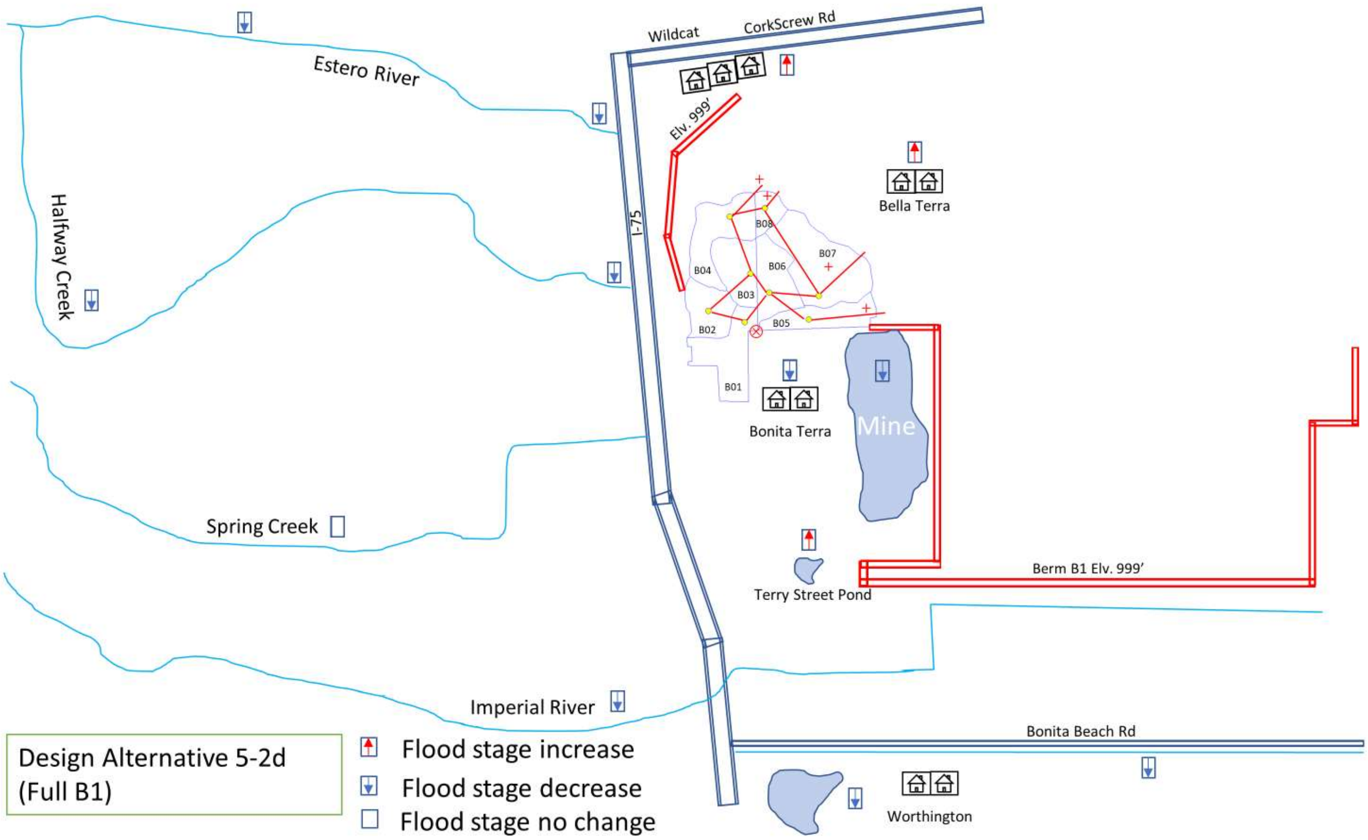



### 4.2.17 Design Alternative 5-2d Full B1 Berm

The County and project team considered all the conceptual design alternatives developed thus far and selected DA5-2d as the base concept to test various berm alignments. Design Alternative 5-2d Full B1 Berm (DA5-2d-FB1) was developed by incorporating all the improvements made in DA5-2d while incorporating the full B1 berm alignment proposed in the 2020 Streamline Technologies report (refer to Appendix A.1). It should be noted that hydraulically, this design alternative is consistent with design alternative 5-2d. However, from a modeling standpoint, minor adjustments were made to the berm to ensure full alignment with the B1 berm proposed by Streamline.

Model results for the DA5-2d Full B1 design condition are fairly consistent with results from DA5-2d, which had a similar berm alignment. **Figure 4.23** presents a schematic of DA5-2d-FB1, showcasing the changes in flood stage between the existing condition LKP Model and DA5-2d-FB1 Full Model for the 25 and 100-year, 72-hour storm events. Flood stages in Halfway Creek, Estero River, and Imperial River are all estimated to decrease in this alternative, as well as flood stages along Bonita Beach Road. Flood stages upstream of the proposed berm are estimated to increase slightly, including in the residential communities south of Corkscrew Road. The community southwest of the Bonita Grande Mine is also estimated to experience flood stage increases due to the blocked outfall path, as discussed in **Section 4.2.16**. A detailed comparison of the maximum flood stage elevations is included in **Appendix D.17**. This table provides a comprehensive overview of stage differences between the existing condition LKP Model and the DA5-2d-FB1 Model, for the 25 and 100-year, 72-hour storm events. Also, the stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.23 – Design Alternative 5-2d Full B1 Berm Schematic and Flood Stage Comparison**

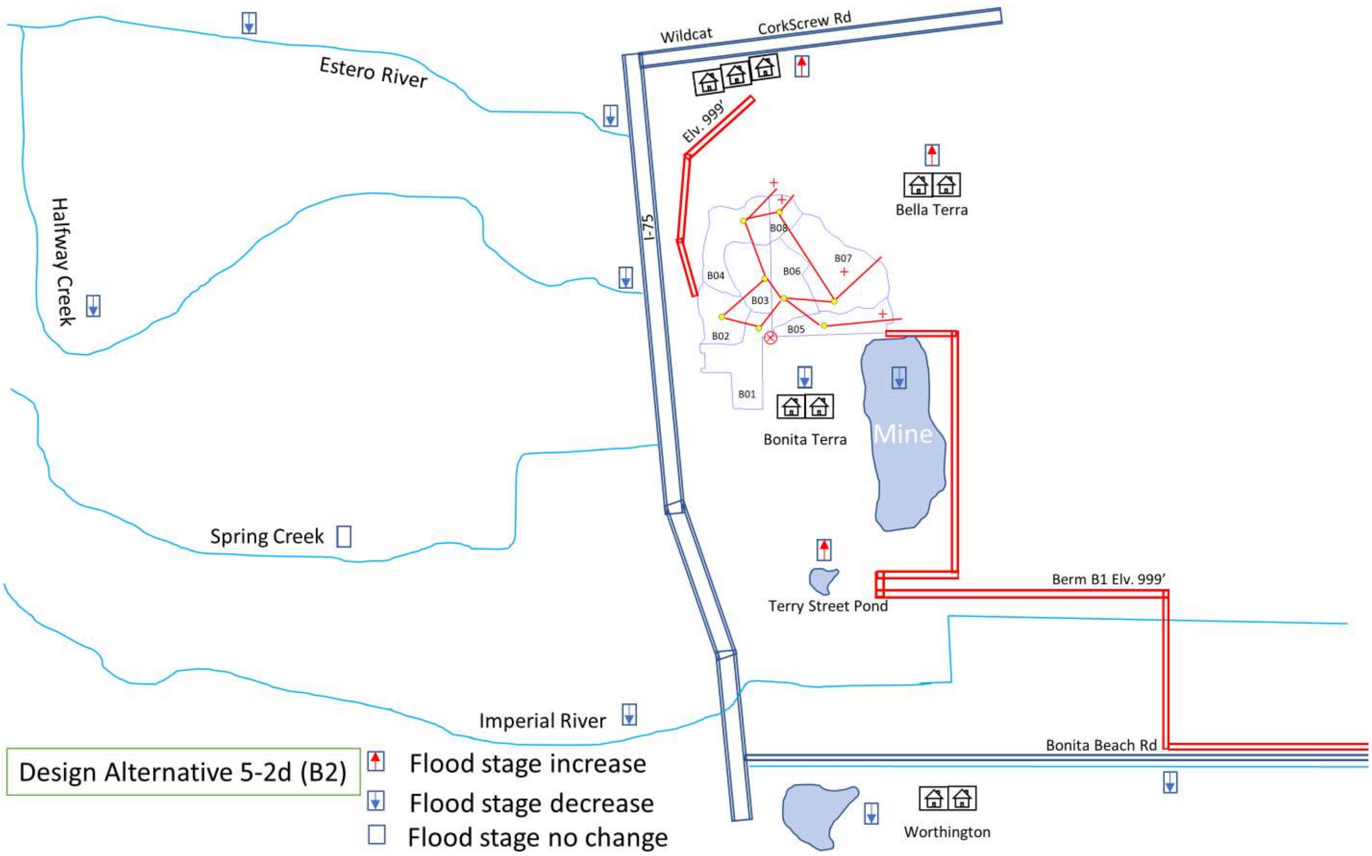



### 4.2.18 Design Alternative 5-2d B2 Berm

Design Alternative 5-2d B2 Berm (DA5-2d-B2) was built upon DA5-2d while incorporating the B2 berm alignment that was presented in the 2020 Streamline Technologies report (refer to **Appendix A.1**). The B2 berm alignment brings the berm south (instead of north), passing the Kehl Canal and ultimately running parallel to the north side of Bonita Beach Road. The B2 berm alignment, and DA5-2d-B2 layout, are presented in **Figure 4.24**.

The B2 berm alignment resulted in similar flood stages when compared to the full B1 alignment. **Figure 4.24** presents a summary of the maximum stage results compared to existing conditions for key locations around the project. DA5-2d-B2 is estimated to experience flood stage increases and decreases at the same locations predicted in DA5-2d-FB1. It should be noted however that the magnitude in flood stage changes in not the same between the two alternatives. The flood stage increase estimated in the Bella Terra community is higher than DA5-2d-FB1 and the flood stage within Imperial River is estimated to experience a more significant drop when compared. **Appendix D.18** presents a maximum stage comparison between the existing conditions LKP Model and DA5-2d-B2 Model. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.24 – Design Alternative 5-2d B2 Berm Schematic and Flood Stage Comparison**

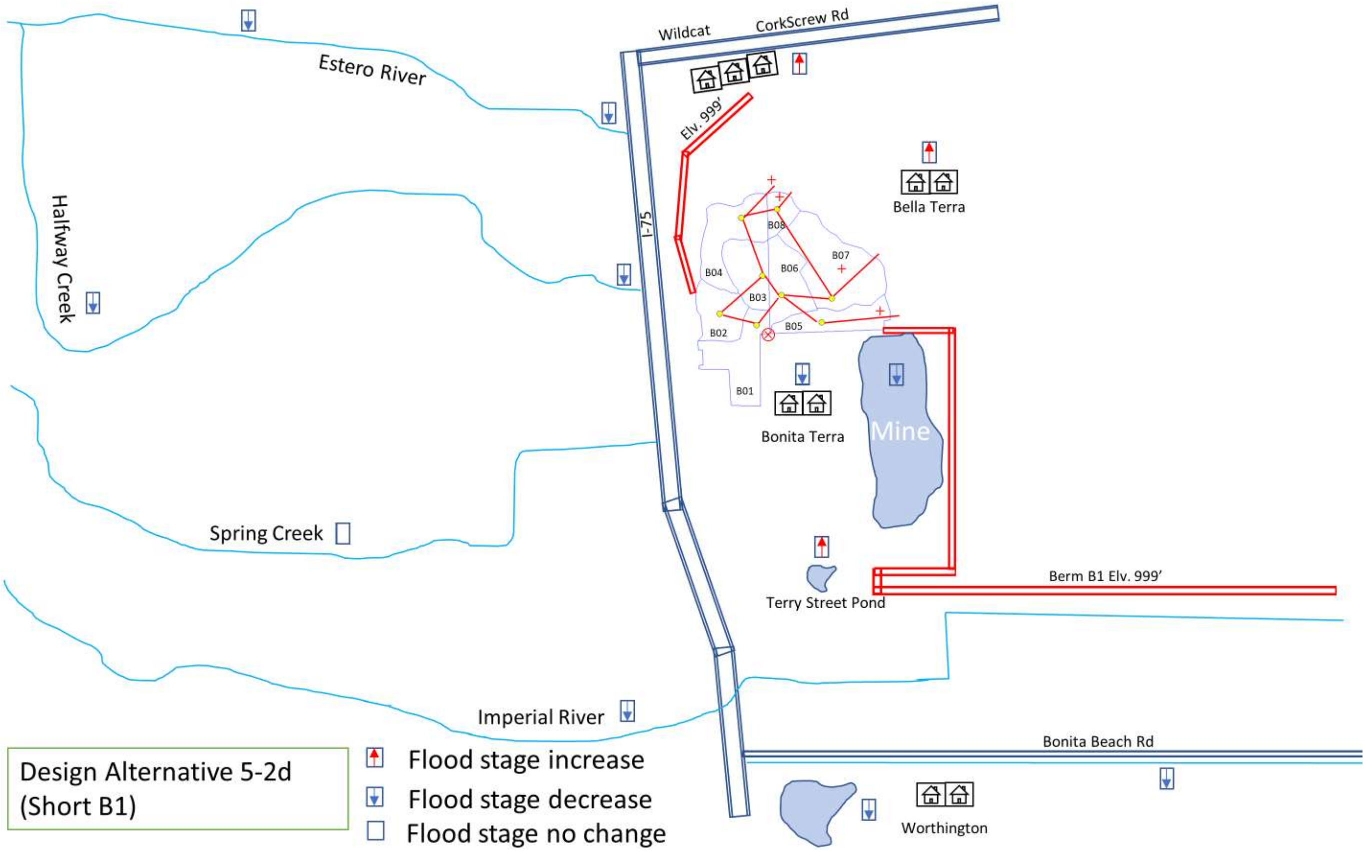



### 4.2.19 Design Alternative 5-2d B1 Short Berm

Design Alternative 5-2d B1 Short Berm (DA5-2d-SHB1) considered the DA5-2d condition with a shortened B1 berm alignment. The proposed berm would be consistent with the DA5-2d-FB1 berm alignment, starting at the north end, continuing until running parallel with the Kehl Canal. The berm would be shortened at the eastern-most end before turning north, as depicted in **Figure 4.25**. The berm in this design alternative would be constructed at an elevation that would prevent flow for all design storm events, like proposed in all DA5-2d scenarios.

The changes in flood stage associated with this alternative were similar to the other berm scenarios considered (Full B1 and B2). **Figure 4.25** illustrates a summary of the flood stage changes, compared to existing conditions, for key locations in the project area. Flood stages in DA5-2d-SHB1 were fairly consistent with DA5-2d-FB1, as can be observed in **Appendix D.19**. The stage difference between this design alternative and the existing condition at key locations is presented in **Table 4.2** at the end of this section.

**Figure 4.25 – Design Alternative 5-2d Short B1 Berm Schematic and Flood Stage Comparison**




### 4.2.20 Conclusion of Conceptual Design Alternatives

Analyzing the three conceptual berm alignment scenarios and model results reveals the following:

1- DA5-2d-B2 has the highest flood stages within LKP cells. It should be noted that flood stage differences within LKP were close (within an inch) between the different berm alignments, so this was not considered a consequential evaluation metric.
2- Flood stage increases in the Bella Terra community for all three design alternatives are relatively close, with DA5-2d-FB1 having the smallest increase.
3- Flood stage decreases west of I-75 are consistent across the conveyance ways for all design alternatives, with one exception. Flood stages in the Imperial River experience a greater drop in DA5-2d-B2 because the Kehl Canal would be fully disconnected. The flood stage decrease for Imperial River remains the same for DA5-2d-FB1 and DA5-2d-SHB1.

**Table 4.2** illustrates the differences between various conceptual design alternatives and the existing conditions model. It's important to note that this table presents the maximum differences observed for the 25-year, 72-hour storm and the 100-year, 72-hour storm.

**Table 4.2 Stage Difference between Design Alternative and Existing Condition (inch)**

| Design Alternative Name | Bonita Beach Road channel | Estero River D/S | Estero River-Middle | Estero River U/S | Halfway Creek D/S | Halfway Creek U/S | Bonita Terra | Imperial River | Bonita Grande Mine | Terry Street Pond | Spring Creek | Bella Terra | Wildcat Run Golf & Country Club | Worthington Country Club | LKP Cells |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BB-050 | ERSB-N24 | ERSB-N33 | ERSB-N45 | HC-N62 | HC-N94 | LMK_00025 | NE0115 | NE0279 | NE0285 | NG0090 | SLT-BelTerr010 | SLT-WildCat005 | WORTH-01 | *** |
| DA1 | 0 | 4 | 4 | 4 | -2 | -3 | -2 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 0 |
| DA2 | 0 | 3 | 3 | 3 | 1 | 2 | -1 | -1 | -1 | 0 | 0 | 0 | 1 | 0 | 4 |
| DA3 | 0 | 1 | 2 | 1 | 1 | 2 | -1 | -1 | 1 | 0 | 0 | 0 | 0 | 0 | 5 |
| DA4 | 0 | 1 | 2 | 1 | 2 | 2 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| DA5 | 0 | 0 | 2 | 2 | -2 | -3 | -1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 10 |
| DA5-2 | 0 | -1 | 0 | 1 | -2 | -3 | -1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 10 |
| DA5-3 | 0 | -1 | 0 | 1 | -2 | -3 | -1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 10 |
| DA5-4 | 0 | 1 | 3 | 4 | -2 | -2 | -1 | 0 | 1 | 0 | 0 | 0 | -1 | 0 | 10 |
| DA6 | 0 | 2 | 3 | 5 | -1 | -1 | -1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| DA7 | 0 | 0 | 0 | 2 | 4 | 5 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| DA8 | -1 | 0 | 0 | 3 | 4 | 5 | -1 | -2 | -3 | -1 | 0 | 0 | 0 | 0 | 7 |
| DA9 | 0 | 1 | 2 | 2 | 2 | 2 | -1 | -2 | -2 | -1 | 0 | 0 | 0 | 0 | 6 |
| DA5-2a | 0 | -2 | -2 | -5 | -3 | -4 | -1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 12 |
| DA5-2b | -8 | -2 | -2 | -5 | -3 | -4 | -1 | -16 | -2 | 3 | 0 | 2 | 4 | -1 | 21 |
| DA5-2c | -5 | -2 | -2 | -5 | -3 | -4 | -3 | -12 | -4 | -2 | 0 | 3 | 2 | 0 | 18 |
| DA5-2d | -8 | -2 | -2 | -5 | -3 | -4 | -3 | -16 | -2 | 2 | 0 | 2 | 5 | -1 | 23 |
| DA5-2d (FullB1) | -8 | -2 | -2 | -5 | -3 | -4 | -3 | -16 | -3 | 2 | 0 | 2 | 5 | -1 | 23 |
| DA5-2d(B2) | -10 | -2 | -2 | -5 | -3 | -4 | -3 | -20 | -3 | 2 | 0 | 3 | 6 | -1 | 24 |
| DA5-2d (ShortB1) | -8 | -2 | -2 | -5 | -3 | -4 | -3 | -16 | -3 | 2 | 0 | 3 | 6 | -1 | 23 |

*** Note: LKP cells were modeled in 2D for the existing condition model and in 1D for the design conditions. In this table, the 1D interface node SLT-12100 is used for the existing condition, while node N06 are utilized for design alternatives.

### 4.3 Refined Design Alternatives

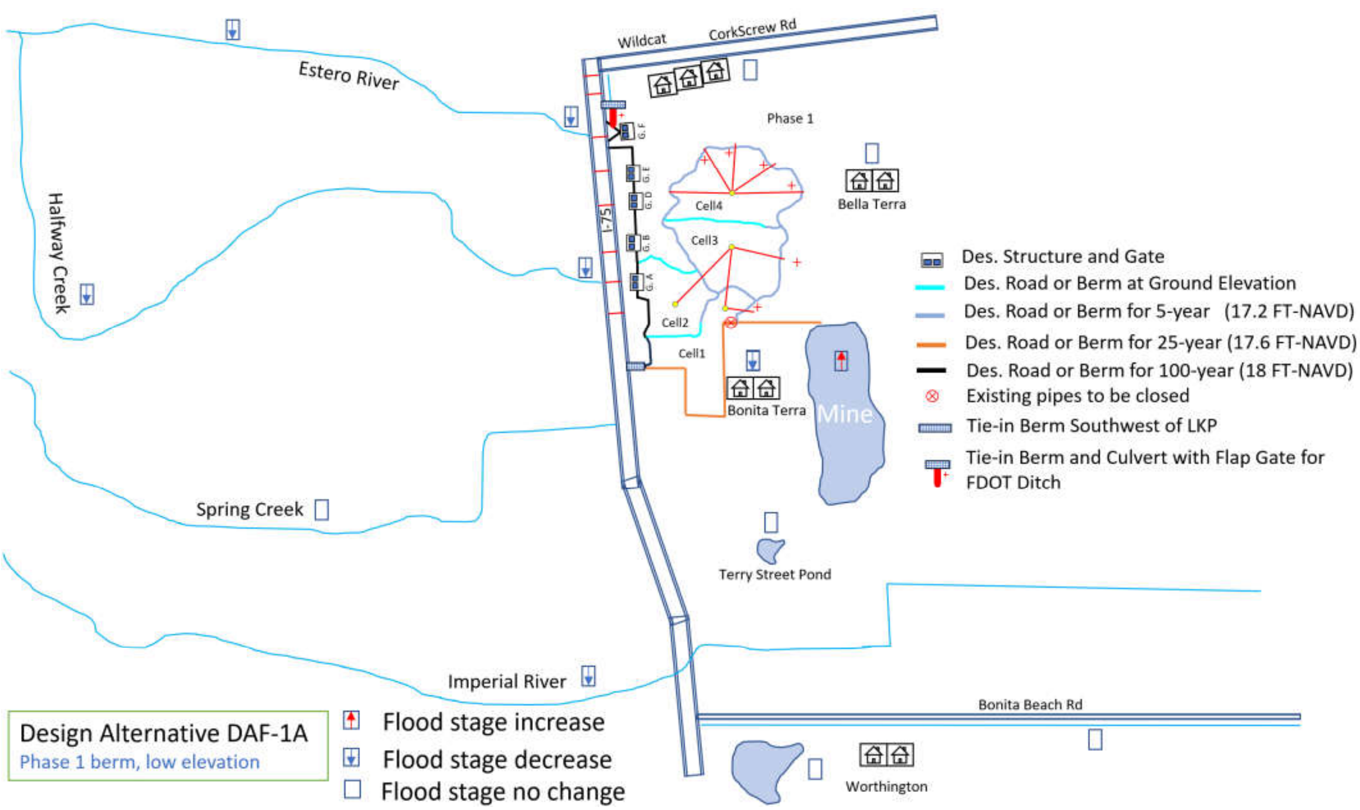
Six refinement scenarios were developed and conveyed to SAI for design refinement, modeling, and results analysis. **Table 4.1** classifies the six design alternatives into two groups: Group A (Low Design Elevation) and Group B (High Design Elevation). Each group is designed to manage various storm events, with Group A typically featuring lower top-of-berm or top-of-road elevations, resulting in the closure of LKP roads and trails during larger storms. Both Group A and Group B consist of three design alternatives, each based on different phases of the B1 perimeter berm development (see **Figure 4.3, 4.4 & 4.5**). The various designs are named to represent major features of a design. For example, Design Alternative 1A incorporates Phase 1 of the berm, while Design Alternative 2A includes both Phase 1 and Phase 2.

The refined design alternatives were simulated using the full LKP Model, rather than the truncated model used in the conceptual design models described previously. All four design storms (1-year and 5-year 24-hour storms, and 25-year and 100-year 72-hour storms) were simulated for results review. This section discusses the six refined design alternatives in detail.

#### 4.3.1 Design Alternative Final 1A

Design Alternative Final 1A (DAF-1A) focuses on the LKP cells and the perimeter berm extending from Stonybrook Community to the northwest corner of the Bonita Grande Mine, refer to **Figure 4.26** for a design layout. This design alternative utilizes the revised set of LKP cells (shown in **Figure 4.3**), and features roads and trails engineered to withstand lower storm intensities.

**Figure 4.26 – Design Alternative Final 1A Schematic and Flood Stage Comparison**




The elevation of the LKP roads and trails vary for different segments; portions of the roads are either based on ground elevation, 5-year storm, or 25-year storm events. The road or berm alignment and proposed elevations are depicted in **Figure 4.26**. The entire perimeter berm was originally designed for the 25-year storm elevation; however, the lower berm condition for the segment parallel to I-75 resulted in increased flood stages downstream (westward) during the 100-year storm event. Consequently, the berm design was revised to raise the portion of the berm parallel to I-75 to the 100-year storm elevation.

A series of culverts situated beneath different LKP cells, as shown in **Figure 4.26**, facilitate a flow connection between the LKP cells and surrounding wetlands. No pipe connections were provided along cells that have a segment of the cell boundary (e.g., trails or roadways) at the existing ground elevation. It was assumed that free flow will occur over these portions of the cell boundary. Pipes connecting to the wetland on the north and east sides of the LKP cells are equipped with flap gates to enable flow into the cells while preventing outflow. Hydraulic connections between the cells and wetland were designed with the following culverts, each of which was designed to be constructed at an elevation of 8-feet NAVD88.

- From Wetland to Cell # 1: 50 LF, 4x10-feet CBC. This culvert has a flap gate upstream.
- From Wetland to Cell # 3: 50 LF, 4x10-feet CBC. This culvert has a flap gate upstream.
- From Wetland to Cell # 4: 4~ 50 LF, 4x10-feet CBC. These culverts have flap gates upstream.
- From Cell # 4 to Wetland: 50 LF, 4x10-feet CBC.
- From Cell # 3 to Cell # 1: 3~ 50 LF, 36-inch RCP.
- From Cell # 3 to Cell # 2: 5~ 50 LF, 36-inch RCP.

The preliminary model results showed that the perimeter berm running parallel to I-75 completely obstructs flow for storms of 100-year frequency or lower. This obstruction led to an increase in flood stages in the communities east (upstream) of I-75. Also, based on the preliminary model results the recovery time for the flood stage hydrograph was also prolonged, posing a potential flood risk after successive storms. A series of operable gates and weirs have been designed along the I-75 berm to allow outflow in a controlled manner. The gates were included in the design to retain stormwater east of I-75 during the storm and release it gradually afterward without causing an increase in flood stage west of I-75 or exacerbating flooding conditions for communities east of I-75. Using the project goal of maximizing storage east of I-75 without causing negative effects to the communities east of I-75 and reducing flood stages west of I-75, SAI conducted several iterations to estimate the optimum gate size and operational schedule. Additionally, the gate inverts were set to maintain the seasonal high water elevation for LKP around elevation 14.5 FT-NAVD. The structures and recommended gate operations are described below, the location of each structure is depicted in **Figure 4.26**.

**Structures and Gates at Location A**: One operational gate has been designed with a 2-feet high by 2.5-feet wide rectangular opening at an elevation of 14.5-feet NAVD88. The weir was closed at the start of the storm, partially opened 92 hours after the storm (approximately 4 days), and fully opened after 128 hours (approximately 5 days).

**Structures and Gates at Location B**: Two sets of operable gates and one structural weir have been designed at this location. The first gate consists of three 2-feet wide by 3-feet high rectangular openings with an invert elevation of 13.5-feet NAVD88. These weirs will be closed at the start of the storm, partially opened 92 hours after the storm, and fully opened after 128 hours, consistent with the gate operation at Location A. The second set of operable gates was designed to expedite the recovery process and mitigate the flood risk after successive storms. The recovery gates consist of three 1-foot high by 6-feet wide rectangular openings with an invert elevation of 13.5-feet NAVD88. The recovery gates will be closed at the beginning of the storm and remain closed for up to 13-days after the storm event; the gates can then be opened to facilitate storm recovery if needed. Finally, a 40-feet wide rectangular weir was designed at 16.6-feet NAVD88.

**Structures and Gates at Location D**: One operational gate has been designed at this location with a 1-foot high by 6-feet wide rectangular opening at 11-feet NAVD88. This weir will be closed at the start of the storm and fully opened after 92 hours.

**Structures and Gates at Location E**: Two operable gates and one structural weir have been designed at this location. The first gate is a 1-foot high by 6-feet wide rectangular opening at 11-feet NAVD88, that will be closed at the start of the storm and fully opened after 92 hours. The second gate is another recovery gate, similar to the one included at Location B. This recovery gate is a 1-foot high by 6-feet wide rectangular opening at 11-feet NAVD88. The recovery gate is closed at the start of the storm and opened after 13-days to allow for additional system recovery. A 40-feet wide rectangular weir at an elevation of 16.6-feet NAVD88 would also be included at this location.

**Structures and Gates at Location F**: For this location, one operational gate and one structural weir have been designed. The gate is a 1-foot high by 6-feet wide rectangular opening with an invert elevation of 11-feet NAVD88. The gate will be closed at the start of the storm and fully opened after 92 hours. A 40-feet wide rectangular weir is also proposed with an invert elevation of 16.6-feet NAVD88.

**Other improvements for DAF-1A:**

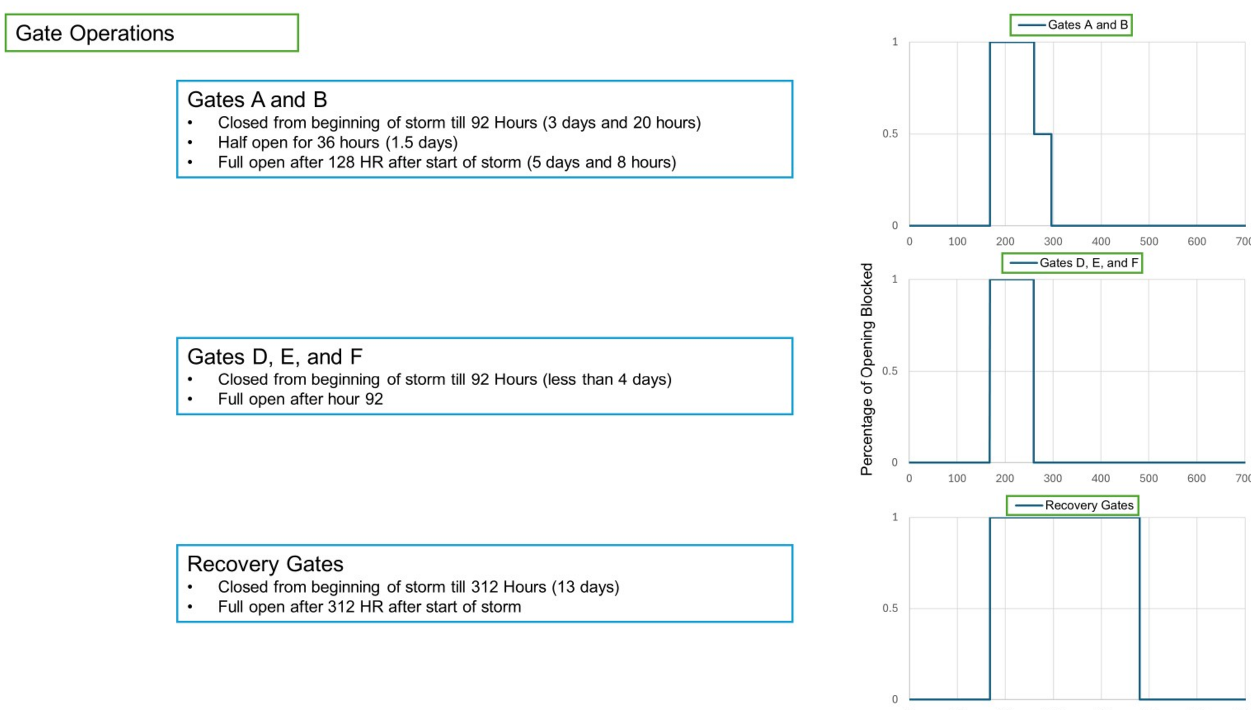
1-Initial results from DAF-1A indicate that during significant storms, a portion of stored stormwater upstream of Gate F (upstream of the Estero River) flows northward through the FDOT ditch and culverts under I-75, resulting in flood stage increases for communities northwest of I-75. A berm was added downstream of the ditch, as shown in **Figure 4.26**, to prevent the estimated rises in the FDOT system. A 24-inch RCP that is fitted with a flap gate is proposed to connect the FDOT ditch to the existing outfall pipe crossing I-75 towards the Estero River. This berm and flap gate culvert facilitates southward flow during smaller storms and prevents flow reversal during larger storms.

2-Preliminary model results for DAF-1A revealed that during major storms, runoff discharged from Gates A and B flows southward, reaching Liberty Crossing Road. While this flow does not significantly impact flood stages, it does notably increase recovery time. To address this, Phase 1 of the designed berm is connected to I-75, preventing runoff from flowing southward.

3-Two existing pipes connecting LKP Cell #1 to the southern community have been closed off to prevent flow from the LKP cells towards the south.

A summary of the gate operational recommendations is included in **Figure 4.27**.

**Figure 4.27 – Proposed Gate Operation Procedures**




Hydraulic Performance: The design condition associated with DAF-1A effectively retains stormwater within the wetland during storms and gradually releases it afterward through the designed gates. A reduction in the maximum stage is estimated for the Estero River and Halfway Creek due to the proposed berm along I-75 and the gate operations. Additionally, there is a slight decrease in flood stage estimated within the Imperial River. This decrease in maximum stage is attributed to the additional storage within LKP cells, which prevents flow southward. The only adverse effect of this design alternative is an increase in flood stage within the Bonita Grande Mine, since Phase 1 of the design refinements lacks a protective berm for the site. A summary of flood stage changes, compared to existing conditions, is presented in **Figure 4.26** and in **Table 4.3**, for key locations around the project area. Flood stages inside the LKP cells during the 100-year, 72-hour storm event reached 17.4-feet NAVD88, approximately 1-foot higher than the average flood stage in this area under existing conditions.

**Appendix E.1** provides a comparison of the maximum stages for the existing conditions LKP Model and the DAF-1A Model. It should be noted that the flood stage increases mainly occurred within the wetland east of I-75 and is not limited to Lee County property. This discrepancy is expected to occur in all modeled design scenarios, although it may occur at different nodes.

**Table 4.3 – Design Alternative Final 1A Node Maximum Stage Comparison**

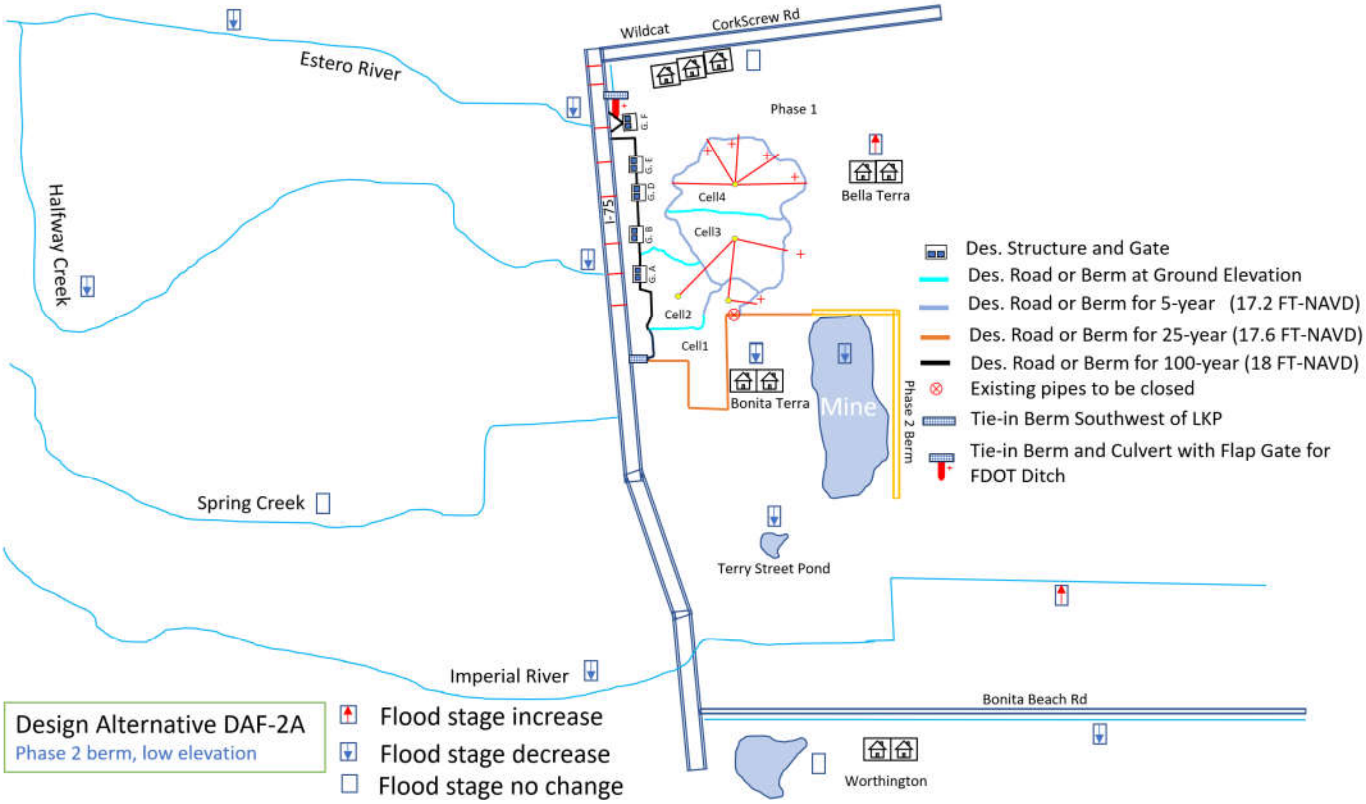
| Node ID | Location | 25-Year 72-Hour | | | 100-Year 72-Hour | | |
|---|---|---|---|---|---|---|---|
| | | EX Stage (ft, NAVD) | DAF-1A (ft, NAVD) | DA - EX (in) | EX Stage (ft, NAVD) | DAF-1A (ft, NAVD) | DA – EX (in) |
| BB-050 | Bonita Beach Road channel | 13.4 | 13.4 | 0 | 13.9 | 13.8 | -1 |
| ERSB-N24 | Estero River D/S | 12.0 | 11.6 | -5 | 13.2 | 12.9 | -4 |
| ERSB-N33 | Estero River-Middle | 14.1 | 13.9 | -2 | 14.5 | 14.2 | -3 |
| ERSB-N45 | Estero River U/S | 15.5 | 14.8 | -8 | 16.0 | 15.3 | -8 |
| HC-N62 | Halfway Creek D/S | 14.3 | 14.1 | -3 | 14.9 | 14.6 | -4 |
| HC-N94 | Halfway Creek U/S | 14.6 | 14.3 | -4 | 15.3 | 14.9 | -5 |
| LMK_00025 | Bonita Terra | 14.4 | 14.3 | -2 | 14.7 | 14.4 | -4 |
| NE0115 | Imperial River | 10.6 | 10.6 | -1 | 11.7 | 11.6 | -1 |
| NE0285 | Terry Street Pond | 14.3 | 14.3 | 0 | 14.8 | 14.6 | -2 |
| NG0090 | Spring Creek | 5.0 | 5.0 | 0 | 5.6 | 5.6 | 0 |
| NE0279 | Bonita Grande Mine | 16.4 | 16.4 | 0 | 16.6 | 16.7 | 1 |
| SLT-BelTerr010 | Bella Terra | 18.2 | 18.2 | 0 | 18.7 | 18.7 | 0 |
| SLT-WildCat005 | Wildcat Run Golf & Country Club | 17.9 | 17.9 | 0 | 18.3 | 18.3 | 0 |
| WORTH-01 | Worthington Country Club | 13.8 | 13.8 | 0 | 14.6 | 14.6 | 0 |

Additional Considerations: The only estimated flood stage increase in this alternative is within the Bonita Grande Mine. SAI prepared an exploratory design model scenario to assess whether extending the berm to protect the mine would be beneficial. The Phase 1 berm was extended to the northeast corner of the mine for this scenario based on a portion of the berm alignment in Phase 2. The results indicated that incorporating this part of the Phase 2 berm that covers the northern side of the Bonita Grande Mine would resolve the flood stage increase at the mine. This scenario would need further analysis during the final design phase of the project if selected by the County.

### 4.3.2 Design Alternative Final 2A

Design Alternative Final 2A (DAF-2A) includes the same water management features as DAF-1A but considers the Phase 2 berm condition which extends the berm along the northern and eastern sides of the Bonita Grande Mine. **Figure 4.28** presents the Phase 2 berm alignment as well as the final design condition for DAF-2A. The Phase 2 extended portion of the berm was designed to the 100-year storm elevation, which prevents flow across the berm in all simulated storm events. No other changes are proposed to the DAF-1A design condition.

**Figure 4.28 – Design Alternative Final 2A Schematic and Flood Stage Comparison**




<u>Hydraulic Performance:</u> The addition of the Phase 2 berm to the design scenario protects and lowers flood stages in the southern communities and the Bonita Grande Mine, which is an improvement compared to DAF-1A. The extended berm prevented flows from the north and east from getting into and past the mine, resulting in some flood stage increases upstream of the berm. The Bella Terra community is estimated to experience a 1-inch flood stage increase in the larger (25-year and 100-year) storm events, which already estimate roadway flooding in existing conditions. The Phase 2 berm alters the southern outflow pattern by diverting flow further east, where no berm is proposed. The additional flow to the east (and then south) results in increased flood stages in the Kehl Canal. Nevertheless, flood stages downstream of LKP in the Estero River, Halfway Creek, and Imperial River are estimated to decrease under design conditions. A summary of the changes in flood stage compared to existing conditions at key locations around the project is presented in **Figure 4.28** and **Table 4.4**.

The flood stage within the LKP cells reached 17.5-feet NAVD88 during the 100-year, 72-hour storm event, 13-inches higher than the average flood stage in existing conditions. The estimated flood stages in LKP are slightly higher in this alternative than in DAF-1A, given the further restricted outfall to the south. **Appendix E.2** includes a node maximum stage comparison table for DAF-2A compared to existing conditions, for all simulated storm events.

**Table 4.4 – Design Alternative Final 2A Node Maximum Stage Comparison**

| Node ID | Location | 25-Year 72-Hour | | | 100-Year 72-Hour | | |
|---|---|---|---|---|---|---|---|
| | | EX Stage (ft, NAVD) | DAF-2A (ft, NAVD) | DA - EX (in) | EX Stage (ft, NAVD) | DAF-2A (ft, NAVD) | DA – EX (in) |
| BB-050 | Bonita Beach Road channel | 13.4 | 13.3 | -1 | 13.9 | 13.7 | -2 |
| ERSB-N24 | Estero River D/S | 12.0 | 11.6 | -5 | 13.2 | 12.9 | -4 |
| ERSB-N33 | Estero River-Middle | 14.1 | 13.9 | -2 | 14.5 | 14.2 | -3 |
| ERSB-N45 | Estero River U/S | 15.5 | 14.9 | -6 | 16.0 | 15.4 | -8 |
| HC-N62 | Halfway Creek D/S | 14.3 | 14.1 | -3 | 14.9 | 14.6 | -3 |
| HC-N94 | Halfway Creek U/S | 14.6 | 14.3 | -4 | 15.3 | 14.9 | -4 |
| LMK_00025 | Bonita Terra | 14.4 | 14.2 | -2 | 14.7 | 14.4 | -4 |
| NE0115 | Imperial River | 10.6 | 10.4 | -3 | 11.7 | 11.4 | -4 |
| NE0285 | Terry Street Pond | 14.3 | 14.2 | -2 | 14.8 | 14.4 | -4 |
| NG0090 | Spring Creek | 5.0 | 5.0 | 0 | 5.6 | 5.6 | 0 |
| NE0279 | Bonita Grande Mine | 16.4 | 16.1 | -4 | 16.6 | 16.3 | -4 |
| SLT-BelTerr010 | Bella Terra | 18.2 | 18.3 | 1 | 18.7 | 18.8 | 1 |
| SLT-WildCat005 | Wildcat Run Golf & Country Club | 17.9 | 17.9 | 0 | 18.3 | 18.3 | 0 |
| WORTH-01 | Worthington Country Club | 13.8 | 13.8 | 0 | 14.6 | 14.6 | 0 |

Additional Considerations: The full Phase 2 berm results in a 1-inch increase in flood stage for the 25 and 100-year storm events within the Bella Terra community. This community is expected to experience roadway inundation during the 25-year storm and greater under existing conditions so increases in flood stage results will likely exacerbate flooding conditions. Two different exploratory design concepts were formulated to determine if there were options to lower flood stages in Bella Terra with the Phase 2 berm alignment. The first concept involved adding a control structure from the north (upstream) side of the berm into the Bonita Grande Mine. This would utilize the additional mine storage resulting from the estimated reductions in maximum stage. The second concept involved constructing a perimeter channel along the Phase 2 portion of the proposed berm. The channel would catch and direct flow to the south, rather than staging up upstream of the berm. Model results for these two potential solutions showed improvements in Bella Terra's flood stages, suggesting that this design condition is feasible and warrants further study. It is recommended that additional studies are conducted if the County elects to move forward with this design alternative.

### 4.3.3 Design Alternative Final 3A

Design Alternative Final 3A (DAF-3A) introduces the Phase 3 berm to the DAF-2A design condition. The Phase 3 berm continues south and west from the terminus of the Phase 2 berm, until turning east and running parallel to the Kehl Canal. The Phase 3 berm alignment is shown in **Figure 4.3 and Figure 4.4**.

The existing conditions flow patterns during smaller storm events from areas south of the mine suggests that local runoff flows parallel to Bonita Grande Drive, from north to south, overtopping E Terry Street and discharging into Kehl Canal. Initial DAF-3A Model results indicate that the Phase 3 berm blocks the existing flow patterns, raising flood stages north of E Terry Street. Enhancing the existing ditches and culvert crossings allowed local runoff a positive outfall towards the Kehl Canal, mitigating the flood stage increases initially estimated for the smaller storm events. This enhancement encompasses the following channels and culverts:

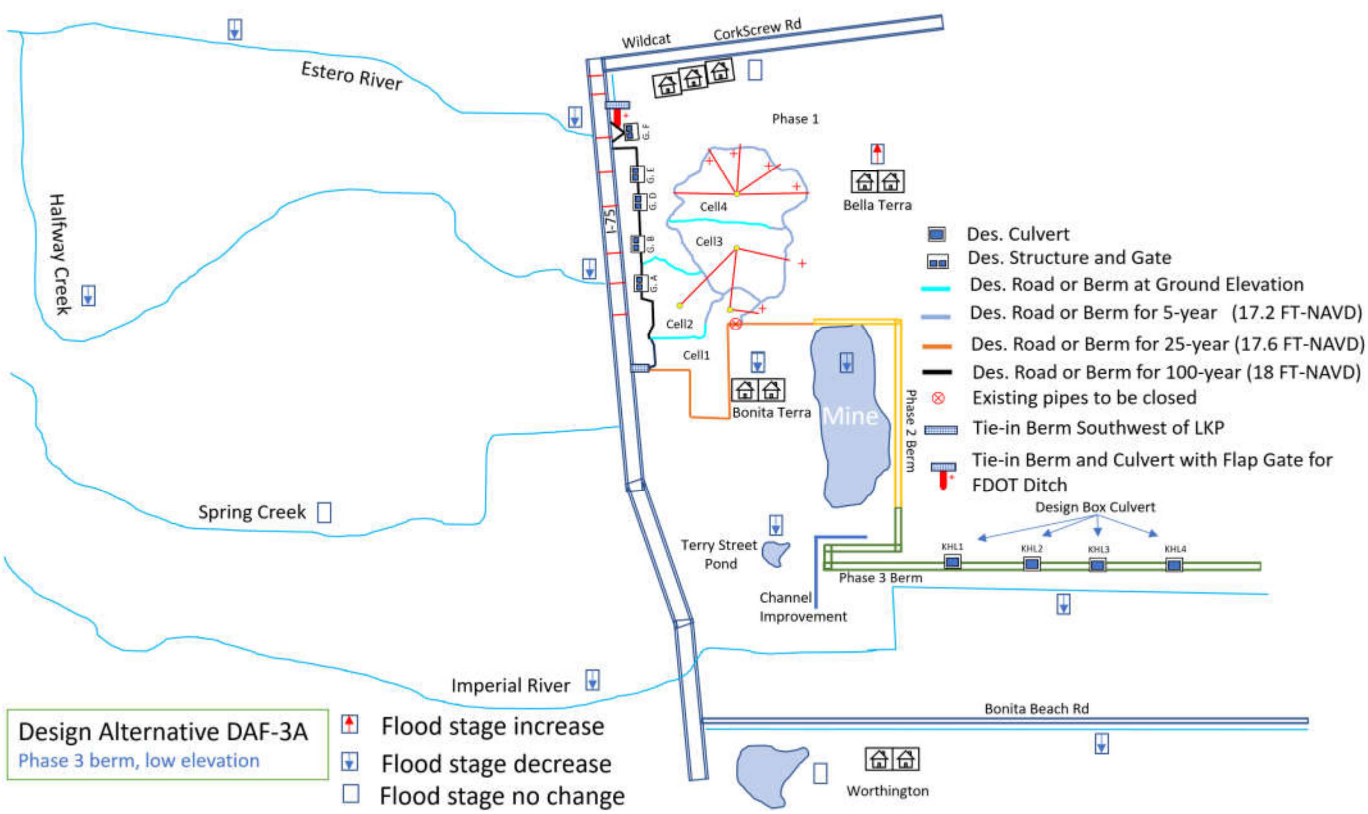
- The existing ditch located along the north side of E Terry Street extending from Bonita Grande Drive to 13731 E Terry Street (approximately 3,810 LF) would be excavated to have a 2-foot bottom width and side slope of 3H:3V. Several driveway crossings exist along this ditch that would require pipe upgrades; these crossings would each be upgraded to 29-inch by 45-inch

ERCPs at inverts of 11-feet NAVD88. At the east end of the ditch, a 36-inch RCP with a flap gate is proposed to allow local runoff to flow east into the wetland area while preventing backflow from the wetland from entering the ditch system during large storm events.

- The existing culvert crossing under E Terry Street on the east side of Bonita Grande Drive, would be removed, as this road would act as part of the Phase 3 berm under this design.
- The existing Bonita Grande Drive culvert crossing would be upgraded to a 29-inch by 45-inch ERCP and constructed at elevation 11-feet NAVD88, allowing flow to continue west.
- The existing culvert crossing E Terry Street, west of Bonita Grande Drive, would be upgraded to a 4-feet by 5-feet CBC at 10-feet NAVD88.
- The roadside ditch that runs along the west side of Bonita Grande Drive from the intersection of E Terry Street to the Kehl Canal (approximately 1,565 LF) would also be excavated to have a 2-foot bottom width and side slope 3H:3V to improve conveyance.

Constructing the Phase 3 berm completely blocks off the southern flow connection to the Kehl Canal which would result in significant increases in flooding conditions north of the berm. The culverts were designed to allow flow back to Kehl Canal, reduce flood stages upstream in the CREW Wildlife and Environmental Area, and allow recovery to the upstream system. The final design included four sets of 4-feet by 6-feet CBCs at 8-feet NAVD88, as shown in **Figure 4.29**.

**Figure 4.29 – Design Alternative Final 3A Schematic and Flood Stage Comparison**




<u>Hydraulic Performance:</u> Constructing the Phase 3 berm results in reduced flood stages at almost all key locations downstream of the proposed berm. The Kehl Canal, which was estimated to experience a flood stage increase in DAF-2A, is now estimated to see reductions in flood stage. The Bella Terra community is estimated to experience a 1-inch increase in flood stage during the 25 and 100- year storm events, similar to DAF-2A. The flood stage increase in Bella Terra is due to the restricted outflow from the Phase 2 and 3 berms. It is believed that these increases can be addressed in a similar way as considered in DAF-2A (refer to the Additional Considerations in **Section 4.3.2**). No other significant flood stage increases

were noted under this design condition. A summary of the changes in flood stage, compared to existing conditions, is presented in **Figure 4.29** and **Table 4.5**.

The flood stage inside LKP during the 100-year 72-hour event was estimated to reach 17.5-feet NAVD88, which is consistent with DAF-2A and 13-inches higher than the average flood stage in the existing condition LKP Model. **Appendix E.3** includes a node maximum stage comparison table for DAF-2A compared to existing conditions, for all simulated storm events.

**Table 4.5 – Design Alternative Final 3A Node Maximum Stage Comparison**

| Node ID | Location | 25-Year 72-Hour | | | 100-Year 72-Hour | | |
|---|---|---|---|---|---|---|---|
| | | EX Stage (ft, NAVD) | DAF-3A (ft, NAVD) | DA - EX (in) | EX Stage (ft, NAVD) | DAF-3A (ft, NAVD) | DA – EX (in) |
| BB-050 | Bonita Beach Road channel | 13.4 | 13.2 | -2 | 13.9 | 13.6 | -3 |
| ERSB-N24 | Estero River D/S | 12.0 | 11.6 | -5 | 13.2 | 12.9 | -3 |
| ERSB-N33 | Estero River-Middle | 14.1 | 13.9 | -2 | 14.5 | 14.2 | -3 |
| ERSB-N45 | Estero River U/S | 15.5 | 15.0 | -5 | 16.0 | 15.4 | -8 |
| HC-N62 | Halfway Creek D/S | 14.3 | 14.1 | -3 | 14.9 | 14.6 | -3 |
| HC-N94 | Halfway Creek U/S | 14.6 | 14.3 | -4 | 15.3 | 14.9 | -4 |
| LMK_00025 | Bonita Terra | 14.4 | 14.2 | -2 | 14.7 | 14.4 | -4 |
| NE0115 | Imperial River | 10.6 | 10.2 | -6 | 11.7 | 10.9 | -10 |
| NE0285 | Terry Street Pond | 14.3 | 14.0 | -4 | 14.8 | 14.3 | -5 |
| NG0090 | Spring Creek | 5.0 | 5.0 | 0 | 5.6 | 5.6 | 0 |
| NE0279 | Bonita Grande Mine | 16.4 | 16.0 | -5 | 16.6 | 16.2 | -5 |
| SLT-BelTerr010 | Bella Terra | 18.2 | 18.3 | 1 | 18.7 | 18.8 | 1 |
| SLT-WildCat005 | Wildcat Run Golf & Country Club | 17.9 | 17.9 | 0 | 18.3 | 18.3 | 0 |
| WORTH-01 | Worthington Country Club | 13.8 | 13.8 | 0 | 14.6 | 14.6 | 0 |

Additional Considerations: The CBCs proposed under the Phase 3 berm providing an outfall to the Kehl Canal were optimized to minimize flood increases in the properties upstream. The County indicated that portions of the CREW Wildlife and Environmental Area could potentially benefit from additional water and increased peak stages during storm events. SAI prepared several iterations of the Phase 3 berm culverts before the final design condition was determined. One option considered was use of operable gate structures, similar to those proposed along I-75. This option was abandoned because it increased flood stages within farmlands in the CREW area. The County may elect to explore gated or other outfall structures along the Phase 3 berm during a future project phase to provide additional benefit to the CREW area and considering impacts to farmland in the area.

### 4.3.4 Design Alternative Final 1B

Design Alternative Final 1B (DAF-1B) reconsiders the Phase 1 berm alignment, as shown in **Figure 4.3**, that was included in DAF-1A. The berm in DAF-1B, however, would be raised to the Scenario B, high elevation condition. The roadways and trails along the LKP cell boundaries would be elevated to the 25-year, 72-hour storm elevation. The entirety of the Phase 1 berm would be at the 100-year, 72-hour storm event flood stage (18.0-feet, NAVD88), which prevents flow in all simulated design storms.

A series of culverts between the proposed cells facilitate a connection between the LKP facility and surrounding wetlands. The location of the proposed pipe connections in this alternative are depicted in **Figure 4.30**. Scenario B, unlike Scenario A, assumes flow between cells is restricted through the 25-year storm event; therefore, pipe connections were provided between all internal cell boundaries. Pipes along the northern and eastern edge of the LKP cells would all be installed with flap gates to prevent reverse flow from LKP into the wetland. Only one outfall pipe is provided from the cells to the wetland upstream of the proposed berm, this pipe is located at the south end of the project from Cell 2 to the north. The proposed hydraulic connections between the cells and wetland are listed below, all connections were designed at an elevation of 8.0-feet NAVD88.

- From Wetland to Cell # 1: 50 LF, 4x10-feet CBC. This culvert has a flap gate upstream.
- From Wetland to Cell # 3: 50 LF, 4x10-feet CBC. This culvert has a flap gate upstream.
- From Wetland to Cell # 4: 4~ 50 LF, 4x10-feet CBC. These culverts have flap gate upstream.
- From Cell # 3 to Cell # 1: 3~ 50 LF, 36-inch RCP.
- From Cell # 3 to Cell # 2: 5~ 50 LF, 36-inch RCP.
- From Cell # 1 to Cell # 2: 3~ 50 LF, 36-inch RCP.
- From Cell # 2 to Wetland: 5~ 50 LF, 36-inch RCP.

The perimeter berm completely obstructs flow for storms of 100-year frequency or lower leading to an increase in flood stage levels in communities situated east of I-75. Moreover, the recovery time for the flood stage hydrograph will be significantly prolonged, posing a potential flood risk during successive storm events. A series of gates and weirs were designed along the Phase 1 berm parallel to I-75, similar to Scenario A. Using the project goal of maximizing storage east of I-75 without causing negative effects to the communities east of I-75 and reducing flood stages west of I-75, SAI conducted several iterations to estimate the optimum gate size, operational tables. Additionally, the gate inverts were set to maintain the seasonal high water elevation for LKP around elevation 14.5 FT-NAVD. The gate operation procedures are consistent with those proposed in Scenario A and shown in **Figure 4.27**. The proposed structure locations are depicted in the **Figure 4.30** schematic, and the details of the proposed structures are included below.

**Structures and Gates at Location A**: One operational gate with a 2-feet high by 2.5-feet wide rectangular opening at 14.5-feet NAVD was designed at this location. The weir will be closed at the start of the storm, partially opened 92 hours after the storm, and fully opened after 128 hours. This gate allows for stormwater detention east of I-75 during the storm and controlled release afterward, without causing adverse effects upstream or downstream of LKP.

**Structures and Gates at Location B**: Two sets of operable gates and one structural weir were designed at this location, which is located just upstream of Halfway Creek. The first set of gates consists of three 2-feet high by 3-feet wide rectangular opening at 13.5-feet NAVD88. These gates will be closed at the start of the storm, partially opened 92 hours after the storm, and fully opened after 128 hours. These gates allow for stormwater detention east of I-75 during the storm and controlled release afterward, without causing adverse effects upstream or downstream of LKP. The second set of gates was designed to expedite the recovery process and mitigate the flood risk associated with successive storms. These recovery gates consist of three 1-foot high by 6-feet wide rectangular weirs with an invert elevation of 13.5-feet NAVD88. The recovery gates will be closed at the beginning of the storm and remain closed for up to 13 days. After the 13-day period, the recovery gates may be opened to facilitate the storm recovery process. A 40-feet wide rectangular weir with an invert elevation of 16.6-feet NAVD88 would also be included on the structure.

**Structures and Gates at Location C**: An additional weir structure was determined to be necessary in design Scenario B; this weir was designed at Location C. The weir was designed to be 40-feet wide at 16.6-feet NAVD88.

**Structures and Gates at Location D**: A 1-foot high by 6-feet wide rectangular opening 11-feet NAVD88 with an operable gate was designed at Location D. This gate will be closed at the start of the storm and fully opened after 92 hours. This gate allows for stormwater detention east of I-75 during the storm and controlled release afterward, without causing adverse effects upstream or downstream of LKP.

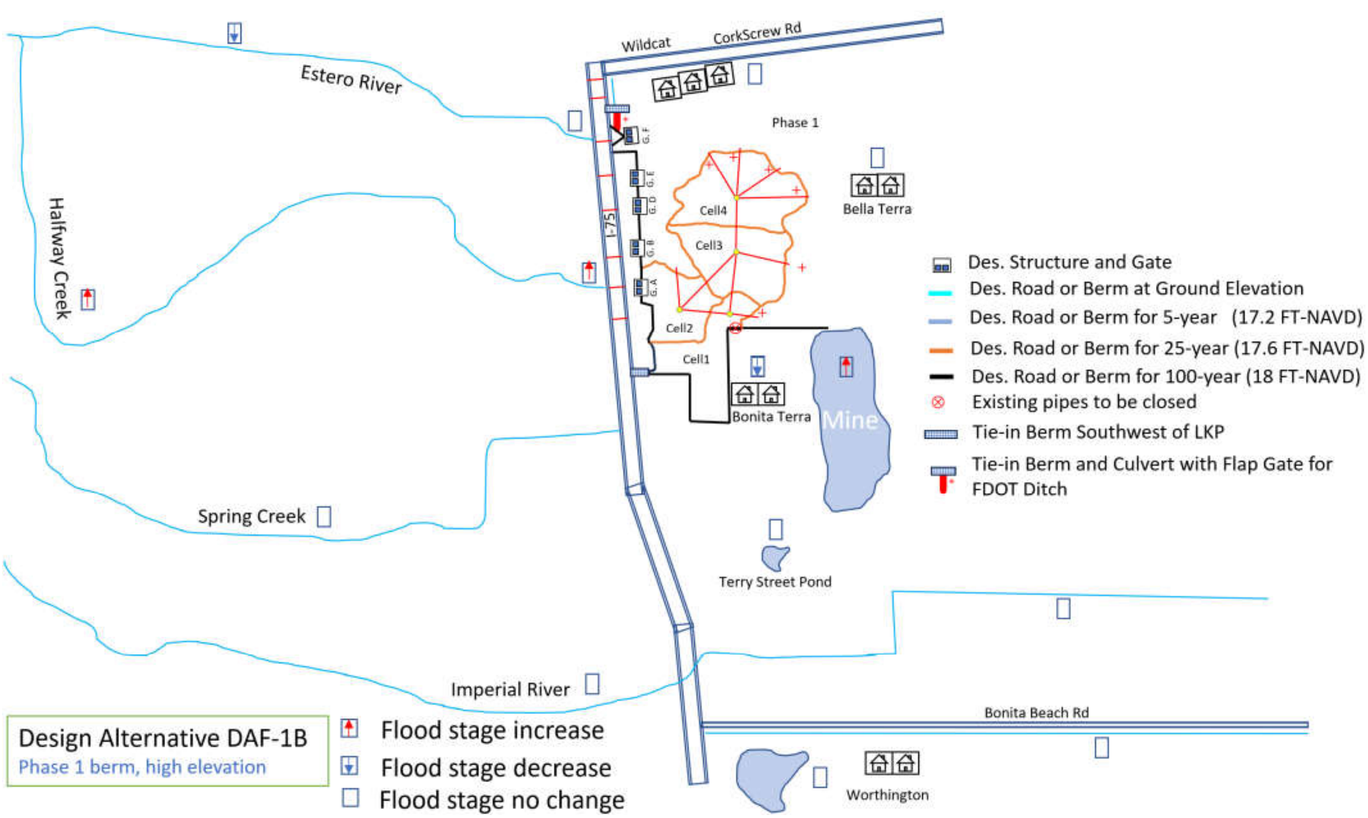
**Structures and Gates at Location E**: Two operable gates and one structural weir have been designed at this location. The first gate is a 1-foot high by 6-feet wide rectangular weir with an invert elevation of 11-feet NAVD88. The gate is closed at the start of the storm and fully opened after 92 hours. This gate allows for stormwater detention east of I-75 during the storm and controlled release afterward, without causing adverse effects upstream or downstream of LKP. A recovery gate was also included at Location E; the gate is a 1-foot wide by 6-feet wide rectangular opening at 11-feet NAVD88. This gate will be closed at the beginning of the storm and remain closed for up to 13 days. The recovery gate would then be opened to facilitate the storm recovery process. A 40-feet wide rectangular weir with at 16.6-feet NAVD88 would also be included on this structure.

**Structures and Gates at Location F**: One operational gate and one structural weir have been designed at this location. The gate is a 1-foot wide by 6-feet high rectangular opening with at 11-feet NAVD88. This gate would be closed at the start of the storm and fully opened after 92 hours. This gate allows for stormwater detention east of I-75 during the storm and controlled release afterward, without causing adverse effects upstream or downstream of LKP. A 40-feet wide rectangular weir with an invert elevation of 16.6-feet NAVD88 would also be constructed at this location.

The berm around the FDOT ditch north of Location F that was proposed in Scenario A would also be recommended in Scenario B to avoid increased stages in the FDOT ditch. The same outfall pipe with flap gate would be installed under the berm to allow the FDOT runoff to bypass the proposed berm system for LKP. In addition, the two existing pipes connecting LKP Cell #1 to the southern community have been closed off, following the same approach as explained for Alternative 1A. Furthermore, the berm southwest of LKP is connected to I-75 to prevent discharged flow from Gates A and B from flowing south and reaching Liberty Crossing road.

While the primary objective of Alternative B is to elevate roads and trails for LKP to improve operability during the wet season, it also has the potential to increase floodwater storage within LKP cells. Therefore, SAI analyzed the feasibility of adding control structures and gates within the cells to optimize on-site storage. Model results indicated that these control structures caused increased flooding conditions in the communities upstream of the Preserve, compared to the culvert connections recommended in the final design. These preliminary concepts were therefore abandoned. Also, initial stages were changed to be consistent throughout the Preserve so control structures internally were no longer necessary.

**Figure 4.30 – Design Alternative Final 1B Schematic and Flood Stage Comparison**



Hydraulic Performance: Model results for the DAF-1B condition are fairly consistent with DAF-1A. Flood stage decreases are estimated for most of the key locations analyzed in the project area. The only notable flood stage increased occurred within the Bonita Grande Mine, where flood stages are estimated to increase by up to 5-inches during larger storm events. A summary of the design conditions results at the key locations around the project are included in **Figure 4.30** and **Table 4.6**.

Flood stages within the LKP cells reached up to 17.4-feet NAVD88 during the 100-year, 72-hour storm event, approximately 12-inches higher than the average flood under existing conditions. A complete comparison of node maximum stage results for all simulated design storms is included in **Appendix E.4**.

**Table 4.6 – Design Alternative Final 1B Node Maximum Stage Comparison**

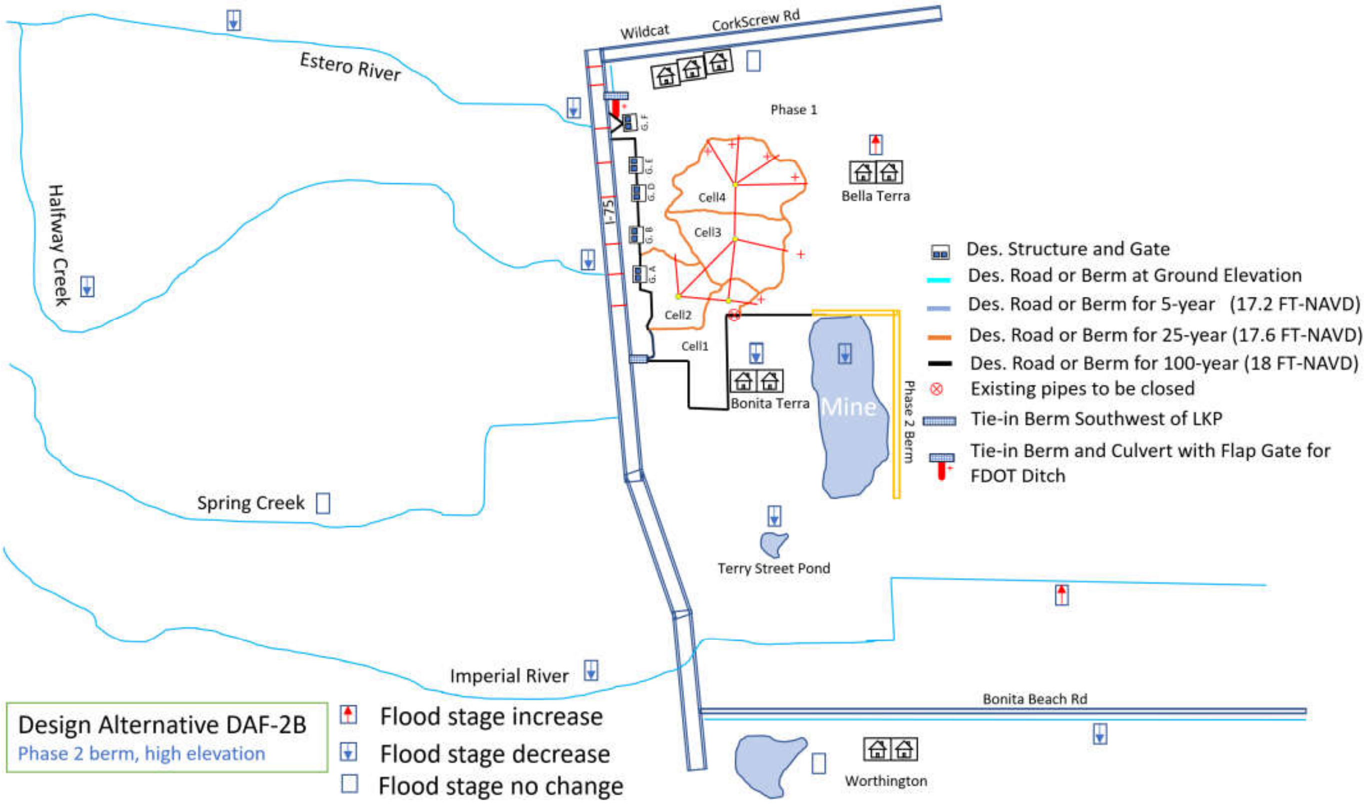
| Node ID | Location | 25-Year 72-Hour | | | 100-Year 72-Hour | | |
|---|---|---|---|---|---|---|---|
| | | EX Stage (ft, NAVD) | DAF-1B (ft, NAVD) | DA - EX (in) | EX Stage (ft, NAVD) | DAF-1B (ft, NAVD) | DA – EX (in) |
| BB-050 | Bonita Beach Road channel | 13.4 | 13.4 | 0 | 13.9 | 13.8 | 0 |
| ERSB-N24 | Estero River D/S | 12.0 | 11.6 | -5 | 13.2 | 12.9 | -4 |
| ERSB-N33 | Estero River-Middle | 14.1 | 13.9 | -2 | 14.5 | 14.2 | -3 |
| ERSB-N45 | Estero River U/S | 15.5 | 14.8 | -8 | 16.0 | 15.4 | -8 |
| HC-N62 | Halfway Creek D/S | 14.3 | 14.1 | -3 | 14.9 | 14.6 | -3 |
| HC-N94 | Halfway Creek U/S | 14.6 | 14.3 | -4 | 15.3 | 14.9 | -4 |
| LMK_00025 | Bonita Terra | 14.4 | 14.3 | -2 | 14.7 | 14.4 | -4 |
| NE0115 | Imperial River | 10.6 | 10.6 | 0 | 11.7 | 11.6 | -1 |
| NE0285 | Terry Street Pond | 14.3 | 14.3 | 0 | 14.8 | 14.6 | -2 |
| NG0090 | Spring Creek | 5.0 | 5.0 | 0 | 5.6 | 5.6 | 0 |
| NE0279 | Bonita Grande Mine | 16.4 | 16.4 | 0 | 16.6 | 16.7 | 1 |
| SLT-BelTerr010 | Bella Terra | 18.2 | 18.2 | 0 | 18.7 | 18.7 | 0 |
| SLT-WildCat005 | Wildcat Run Golf & Country Club | 17.9 | 17.9 | 0 | 18.3 | 18.3 | 0 |
| WORTH-01 | Worthington Country Club | 13.8 | 13.8 | 0 | 14.6 | 14.6 | 0 |

Additional Considerations: The flood stage increases reported within the Bonita Grande Mine are due to the Phase 1 berm which is the shortest berm alignment, like in DAF-1A. The shortened Phase 2 berm, which was discussed in the Additional Considerations in **Section 4.3.1**, would also be recommended for further evaluation if this design is selected by the County. It should also be noted that the increases in flood stages are not limited to property owned by Lee County, but also affects other private and public properties.

### 4.3.5 Design Alternative Final 2B

Design Alternative Final 2B (DAF-2B) includes the Phase 2 berm alignment (discussed in **Section 4.3.2**) and the Scenario B water management features (discussed in **Section 4.3.4**). This design alternative built upon the design components developed for DAF-1B. The proposed berm alignment and top elevation are depicted in **Figure 4.31**. The entire perimeter berm, in the Scenario B condition, would be constructed to the 100-year, 72-hour peak stage (18.0-feet NAVD88) to prevent flow during all simulated design storm events.

**Figure 4.31 – Design Alternative Final 2B Schematic and Flood Stage Comparison**




Hydraulic Performance: The Scenario B water management features resulted in similar peak stage results as Scenario A, when comparing DAF-2A and DAF-2B. Flood stages downstream (south and west) of the perimeter berm were estimated to experience decreases in flood stage compared to existing conditions. The flood stage increases that were estimated in the Bonita Grande Mine in DAF-1B have been mitigated, and flood stages are expected to reduce by up to 8-inches. Flood stages downstream of the berm are estimated to decrease because the berm restricts flow along the natural flow path. As a result, flood stages are expected to increase within the Bella Terra community and portions of the Kehl Canal. It should be noted that the flood stage increase that is estimated in the Kehl Canal is localized and does not impact downstream portions of the canal or the Imperial River. A summary of flood stage results is presented in **Figure 4.31** and **Table 4.7**.

Flood stages within the LKP facility reached 17.8-feet NAVD88 during the 100-year, 72-hour storm event, 17-inches higher than the average flood stage in existing conditions. A complete comparison of node maximum stage results for all simulated design storms is included in **Appendix E.5**.

**Table 4.7 – Design Alternative Final 2B Node Maximum Stage Comparison**

| Node ID | Location | 25-Year 72-Hour | | | 100-Year 72-Hour | | |
|---|---|---|---|---|---|---|---|
| | | EX Stage (ft, NAVD) | DAF-2B (ft, NAVD) | DA - EX (in) | EX Stage (ft, NAVD) | DAF-2B (ft, NAVD) | DA – EX (in) |
| BB-050 | Bonita Beach Road channel | 13.4 | 13.3 | -1 | 13.9 | 13.7 | -2 |
| ERSB-N24 | Estero River D/S | 12.0 | 11.6 | -5 | 13.2 | 12.9 | -3 |
| ERSB-N33 | Estero River-Middle | 14.1 | 13.9 | -2 | 14.5 | 14.2 | -3 |
| ERSB-N45 | Estero River U/S | 15.5 | 14.8 | -8 | 16.0 | 15.6 | -5 |
| HC-N62 | Halfway Creek D/S | 14.3 | 14.1 | -3 | 14.9 | 14.6 | -3 |
| HC-N94 | Halfway Creek U/S | 14.6 | 14.3 | -4 | 15.3 | 14.9 | -4 |
| LMK_00025 | Bonita Terra | 14.4 | 14.2 | -2 | 14.7 | 14.4 | -4 |
| NE0115 | Imperial River | 10.6 | 10.4 | -3 | 11.7 | 11.4 | -4 |
| NE0285 | Terry Street Pond | 14.3 | 14.2 | -2 | 14.8 | 14.4 | -4 |
| NG0090 | Spring Creek | 5.0 | 5.0 | 0 | 5.6 | 5.6 | 0 |
| NE0279 | Bonita Grande Mine | 16.4 | 16.1 | -4 | 16.6 | 16.3 | -4 |
| SLT-BelTerr010 | Bella Terra | 18.2 | 18.3 | 1 | 18.7 | 18.8 | 1 |
| SLT-WildCat005 | Wildcat Run Golf & Country Club | 17.9 | 17.9 | 0 | 18.3 | 18.4 | 0 |
| WORTH-01 | Worthington Country Club | 13.8 | 13.8 | 0 | 14.6 | 14.6 | 0 |

Additional Considerations: The 1-inch flood stage increase estimated in Bella Terra was also estimated in DAF-2A. It is believed that adding a controlled outfall from the wetland, north of the proposed berm, to the Bonita Grande Mine would mitigate the estimated flood stage increase. This would require additional study in a future project phase if the County elected to move forward with the design. For more details, please refer to the Additional Considerations in **Section 4.3.2**.

### 4.3.6 Design Alternative Final 3B

Design Alternative Final 3B (DAF-3B) includes the Phase 3 berm alignment (discussed in **Section 4.3.3**), which includes several additional culverts and ditch modifications, and the Scenario B water management features (discussed in **Section 4.3.4**). The Phase 3 berm would be constructed at the 100-year elevation (18.0-feet NAVD88) like the remainder of the perimeter berm. **Figure 4.32** presents the proposed layout for DAF-3B.

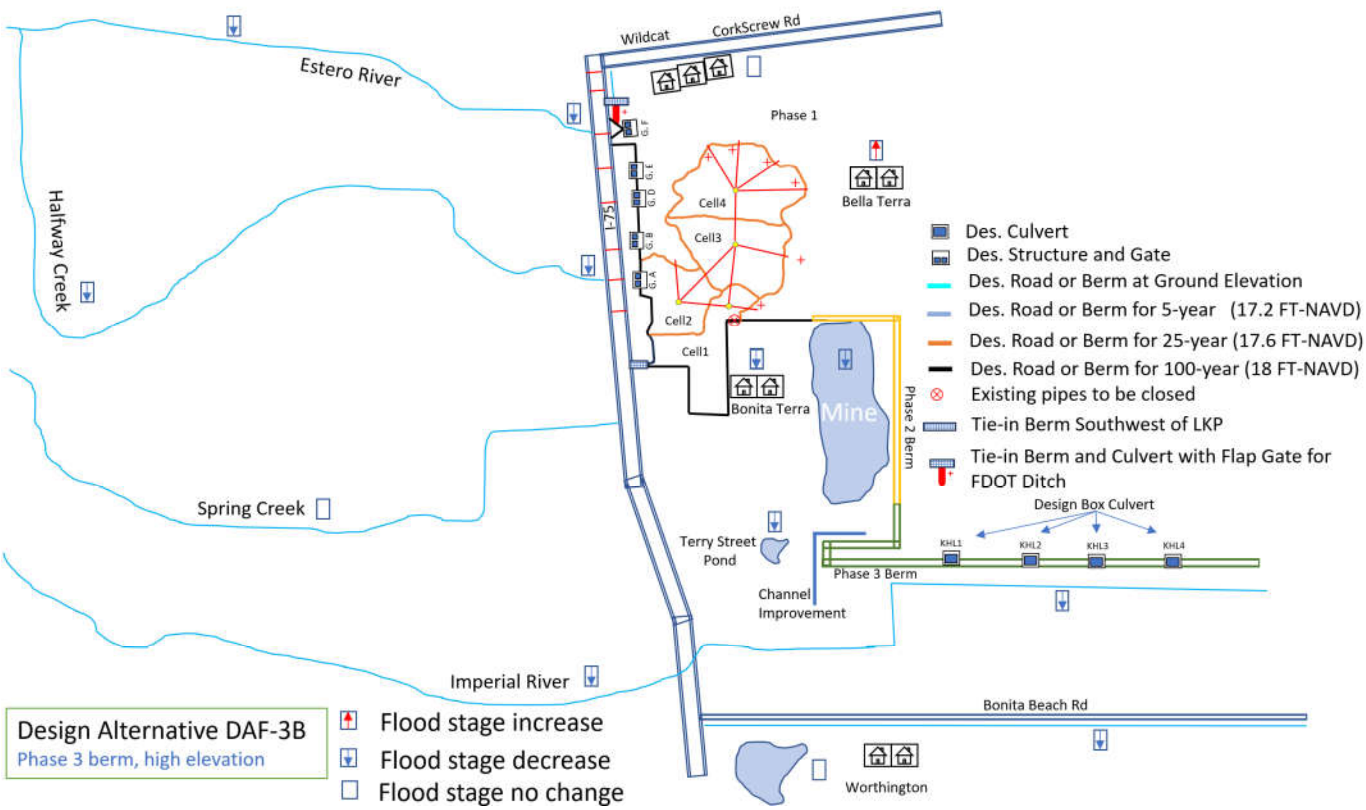
The existing conditions flow patterns during smaller storm events from areas south of the mine suggests that local runoff flows parallel to Bonita Grande Drive, from north to south, overtopping E Terry Street and discharging into Kehl Canal. Initial DAF-3A Model results indicate that the Phase 3 berm blocks the existing flow patterns, raising flood stages north of E Terry Street. Enhancing the existing ditches and culvert crossings allowed local runoff a positive outfall towards the Kehl Canal, mitigating the flood stage increases initially estimated during the smaller storm events. This enhancement encompasses the following channels and culverts:

- The existing ditch located along the north side of E Terry Street extending from Bonita Grande Drive to 13731 E Terry Street (approximately 3,810 LF) would be excavated to have a 2-foot bottom width and side slope of 3H:3V. Several driveway crossings exist along this ditch that would require pipe upgrades; these crossings would each be upgraded to 29-inch by 45-inch ERCPs at inverts of 11-feet NAVD88. At the east end of the ditch, a 36-inch RCP with a flap gate is proposed to allow local runoff to flow east into the wetland area while preventing backflow from the wetland from entering the ditch system during large storm events.
- The existing culvert crossing under E Terry Street on the east side of Bonita Grande Drive, would be removed, as the road would act as part of the Phase 3 berm under this design.

- The existing Bonita Grande Drive culvert crossing would be upgraded to a 29-inch by 45-inch ERCP and constructed at elevation 11-feet NAVD88, allowing flow to continue west.
- The existing culvert crossing E Terry Street, west of Bonita Grande Drive, would be upgraded to a 4-feet by 5-feet CBC at 10-feet NAVD88.
- The roadside ditch that runs along the west side of Bonita Grande Drive from the intersection of E Terry Street to the Kehl Canal (approximately 1,565 LF) would also be excavated to have a 2-foot bottom width and side slope 3H:3V to improve conveyance.

Constructing the Phase 3 berm completely blocks off the southern flow connection to the Kehl Canal which would result in significant increases in flooding conditions north of the berm. The culverts were designed to allow flow back to Kehl Canal, reduce flood stages upstream in the Corkscrew Regional Ecosystem Watershed (CREW) Wildlife and Environmental Area, and allow recovery in the upstream system. The final design included four sets of 4-feet by 6-feet CBCs at 8-feet NAVD88, as shown in **Figure 4.32**.

**Figure 4.32 – Design Alternative Final 3B Schematic and Flood Stage Comparison**




Hydraulic Performance: DAF-3B has similar results to DAF-3A. All estimated flood stages downstream of the berm are expected to decrease, while the Bella Terra community is expected to see an increase. A summary of the DAF-3B results, compared to existing conditions, is presented in **Figure 4.32** and **Table 4.8**.

Flood stages within the LKP facility reached 17.9-feet NAVD88 during the 100-year, 72-hour storm event, 18-inches higher than the average flood stage in existing conditions. A complete comparison of node maximum stage results for all simulated design storms is included in **Appendix E.6**. This design alternative offers the most significant reductions in flood stage, but also results in the largest increases in flood stage compared to existing conditions.

**Table 4.8 – Design Alternative Final 3B Node Maximum Stage Comparison**

| Node ID | Location | 25-Year 72-Hour | | | 100-Year 72-Hour | | |
|---|---|---|---|---|---|---|---|
| | | EX Stage (ft, NAVD) | DAF-2B (ft, NAVD) | DA - EX (in) | EX Stage (ft, NAVD) | DAF-2B (ft, NAVD) | DA – EX (in) |
| BB-050 | Bonita Beach Road channel | 13.4 | 13.2 | -2 | 13.9 | 13.6 | -3 |
| ERSB-N24 | Estero River D/S | 12.0 | 11.6 | -5 | 13.2 | 12.9 | -3 |
| ERSB-N33 | Estero River-Middle | 14.1 | 13.9 | -2 | 14.5 | 14.2 | -3 |
| ERSB-N45 | Estero River U/S | 15.5 | 14.8 | -7 | 16.0 | 15.7 | -3 |
| HC-N62 | Halfway Creek D/S | 14.3 | 14.1 | -3 | 14.9 | 14.6 | -3 |
| HC-N94 | Halfway Creek U/S | 14.6 | 14.3 | -4 | 15.3 | 14.9 | -4 |
| LMK_00025 | Bonita Terra | 14.4 | 14.2 | -2 | 14.7 | 14.4 | -4 |
| NE0115 | Imperial River | 10.6 | 10.2 | -6 | 11.7 | 10.9 | -10 |
| NE0285 | Terry Street Pond | 14.3 | 14.0 | -4 | 14.8 | 14.3 | -5 |
| NG0090 | Spring Creek | 5.0 | 5.0 | 0 | 5.6 | 5.6 | 0 |
| NE0279 | Bonita Grande Mine | 16.4 | 16.0 | -5 | 16.6 | 16.2 | -5 |
| SLT-BelTerr010 | Bella Terra | 18.2 | 18.3 | 1 | 18.7 | 18.8 | 2 |
| SLT-WildCat005 | Wildcat Run Golf & Country Club | 17.9 | 17.9 | 0 | 18.3 | 18.4 | 0 |
| WORTH-01 | Worthington Country Club | 13.8 | 13.8 | 0 | 14.6 | 14.6 | 0 |

Additional Considerations: The Bella Terra flood stage increase that was estimated in DAF-3A was also estimated in DAF-3B, but with slightly deeper flooding seen during the 100-year event. The controlled outfall to the Bonita Grande Mine that was discussed in the Phase 2 and DAF-3A designs would also be recommended for further evaluation in this alternative to alleviate the flood stage increase in Bella Terra. For additional information refer to the Additional Considerations discussion in **Section 4.3.2**. The outfall culverts recommended in DAF-3A were also used in DAF-3B which means they were optimized for flood protection and control during the wet season. The outfall culvert design could be modified, as suggested in DAF-3A (refer to **Section 4.3.3**), to include gated controls that would allow the County to achieve various goals for the wetlands upstream. Additional studies would be required to determine appropriate outfall sizes and operation procedures to achieve goals other than flood protection.

### 4.3.7 Conclusion

The Phase 3 berm alignment was determined to provide the greatest flood stage improvements downstream, while having comparable results in the upstream communities, compared to the other berm phases. Additionally, the Phase 3 berm allows for the most control of the wetland system which may be beneficial to the County depending on the various goals of the project. Scenario A, low elevation berm conditions, showed more improvement in flood stages west of I-75 and less increase in flood stages in the Bella Terra community, compared to Scenario B, high elevation berm conditions.

Stage hydrographs were prepared comparing the results of the Scenario A and B design conditions for the Phase 3 berm; these hydrographs are included in **Appendix E.7**. Hydrographs show improvements in the duration of flooding at many locations downstream of the proposed berm (i.e., west of I-75 and south of LKP) with reductions ranging from 10 hours to 5 days. The wetland hydrographs show notably higher stages after the storm event, compared to existing conditions, suggesting that the wetland storage has increased under design conditions.

DAF-3A and DAF-3B offer similar improvements in flooding results. DAF-3A provided slightly more improvement in flood stage west of I-75, while requiring less material since the berm would be constructed to a lower elevation. DAF-3B provides better protection for the facility roads and trails, allowing better access to maintenance staff during storm events, and opening to the public sooner after the storm event.

In addition, DAF-3B provides more storage within the LKP cells (Refer to **Table 4.9**). DAF-3A was selected for further evaluation of the wetland hydroperiods, since this alternative estimates the most beneficial flood stage results.

**Table 4.9- Stage Difference between Final Design Alternative and Existing Condition (inch)**

| Design Alternative | Cell #1 | Cell #2 | Cell #3 | Cell #4 |
|---|---|---|---|---|
| DAF-1A | 21 | 17 | 11 | 7 |
| DAF-2A | 22 | 19 | 14 | 10 |
| DAF-3A | 23 | 20 | 15 | 10 |
| DBF-1B | 20 | 15 | 11 | 8 |
| DBF-2B | 26 | 21 | 16 | 11 |
| DBF-3B | 27 | 22 | 17 | 12 |

## 4.4 Wetland Hydroperiods

The final design alternatives are reliant on the perimeter berm (Phases 1 – 3, as applicable) which impacts the hydroperiod of the eastern wetlands, including CREW Wildlife and Environmental Area. A continuous simulation was conducted over a 5-year period from 2013 to 2017 in order to evaluate the wetlands in and around LKP and their hydroperiods. The selected 5-year period included both wet and dry periods, as well as large storm events like Hurricane Irma and Invest 92L. The continuous simulation was only conducted for the existing conditions LKP Model and the DAF-3A Model, which was the design alternative selected for further evaluation.

The proposed operable gates crossing the berm along I-75 were primarily designed to regulate stormwater flood stages and hydrograph recovery for nodes east of I-75 during the wet period. As a result, these operational gates were not optimized to improve the hydroperiod during dry periods. Despite this, the results reveal significant hydroperiod improvements at some of the analyzed locations. Additional wetland hydroperiod improvements could be provided if the major outfall structures along the perimeter berm were gated and operated to optimize the water levels during dry periods. This includes gates along the four CBCs proposed along the Phase 3 berm which were designed to be fully open during the wet season. Studies could be performed to determine a gate operation schedule that could further enhance wetland hydroperiods. **Figure 4.33** illustrates the locations of the six wetlands at which hydroperiod results were reviewed. These locations were designated by the Kimley-Horn environmental team. An important observation from the continuous simulation results was that the hydroperiod for the design condition exhibited more significant changes on the eastern and southwestern sides of LKP compared to the northern and northwestern sides. Further review suggests that the eastern and southwestern areas of LKP have lower elevations than the northwestern side. As the control elevation is raised, it primarily impacts the lower elevation areas rather than the higher elevation ones.

**Figure 4.33 – Locations of Wetland Hydroperiod Evaluation**

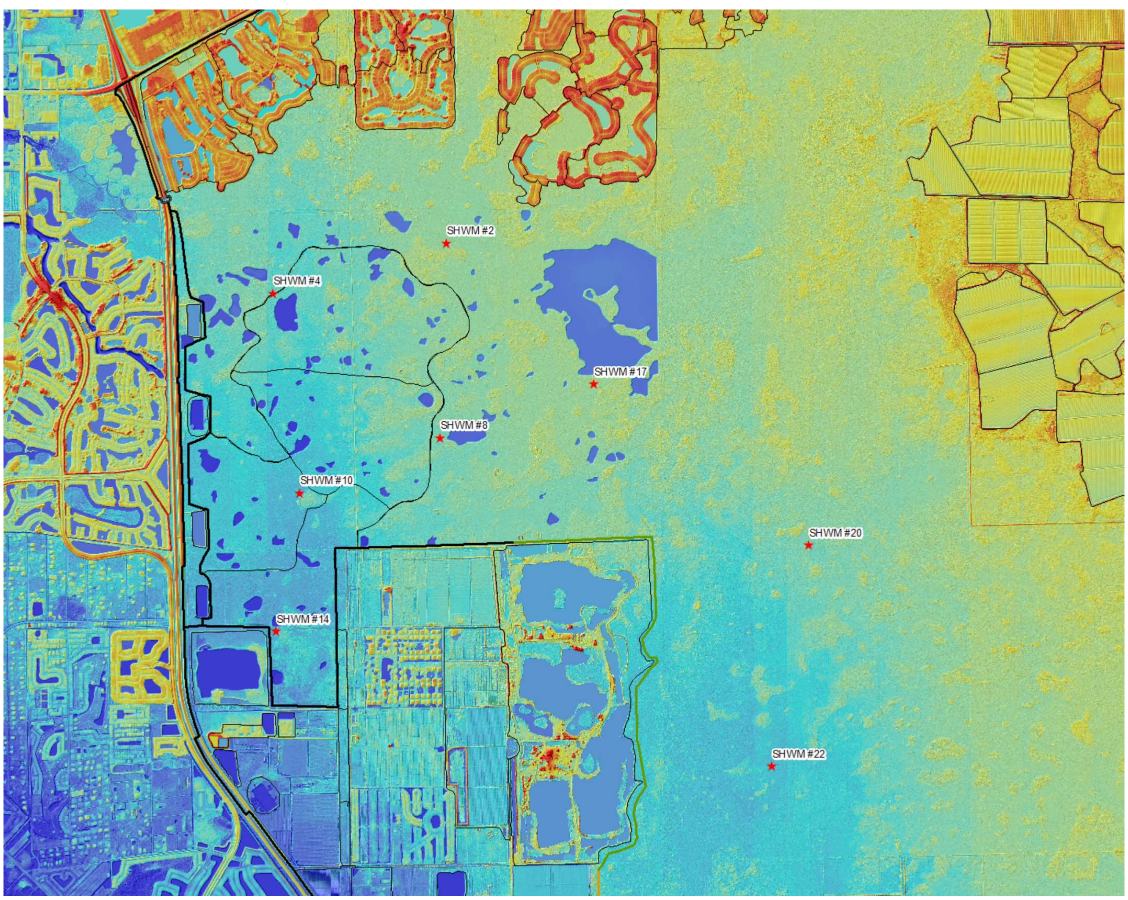
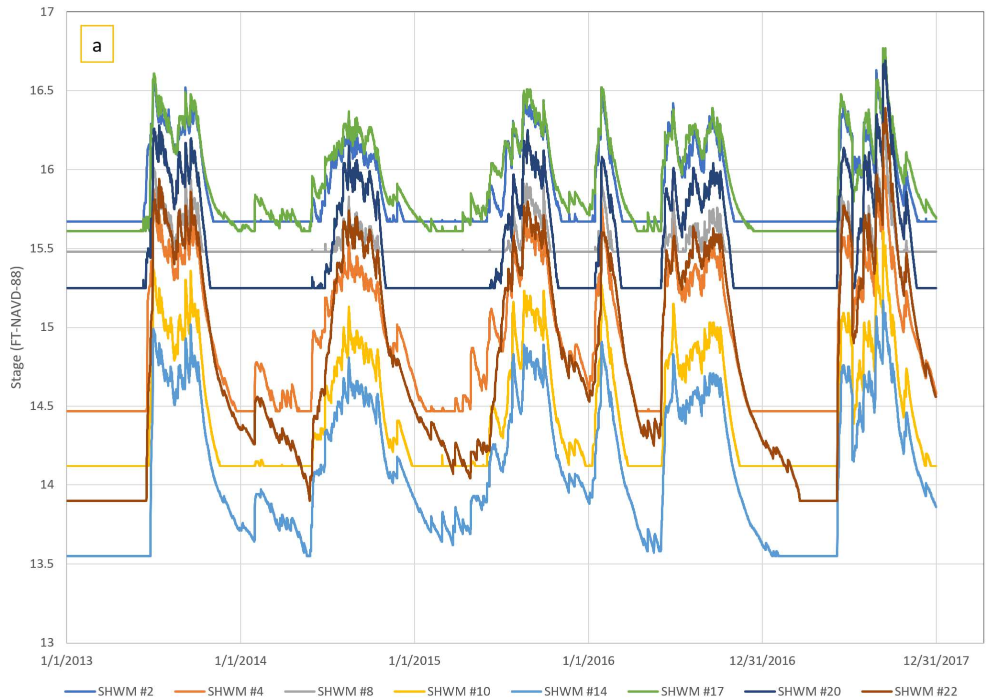
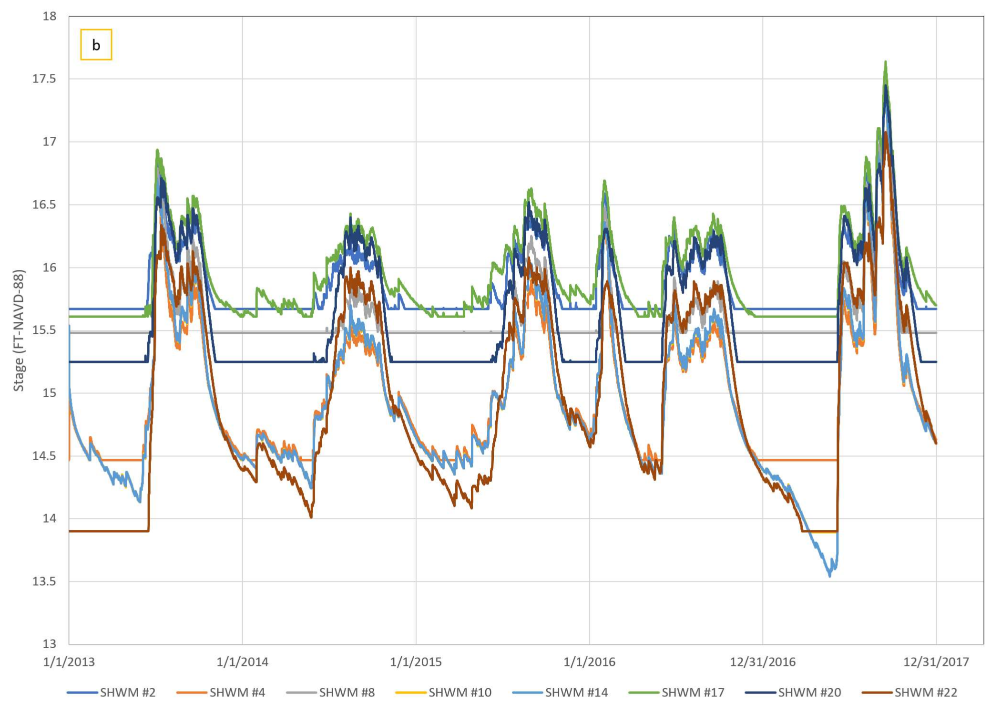


**Figure 4.34 – 5-Year Continuous Simulation Flood Hydrographs for a) Existing and b) DAF-3A**



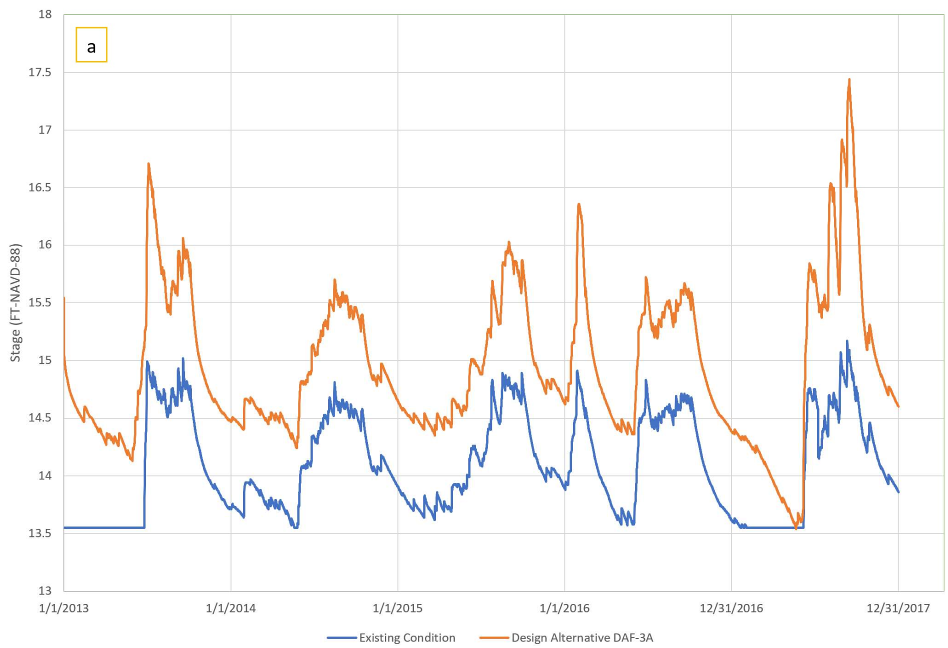

**Figures 4.34a** and **4.34b** depict the 5-year flood hydrographs at the six wetland analysis locations for existing and design conditions, respectively. These graphs show that the range of stage fluctuation (i.e., the difference between maximum and minimum stage over the simulation period) for each location increases after implementation of DAF-3A. This suggests that the wetland system experiences deeper inundation during the wet periods. There is also a decrease in the variation of flood stage between the different locations under DAF-3A conditions. The design condition hydrographs (**Figure 4.34b)** are much closer together in elevation, especially during wet periods, compared to those in existing conditions (**Figure**

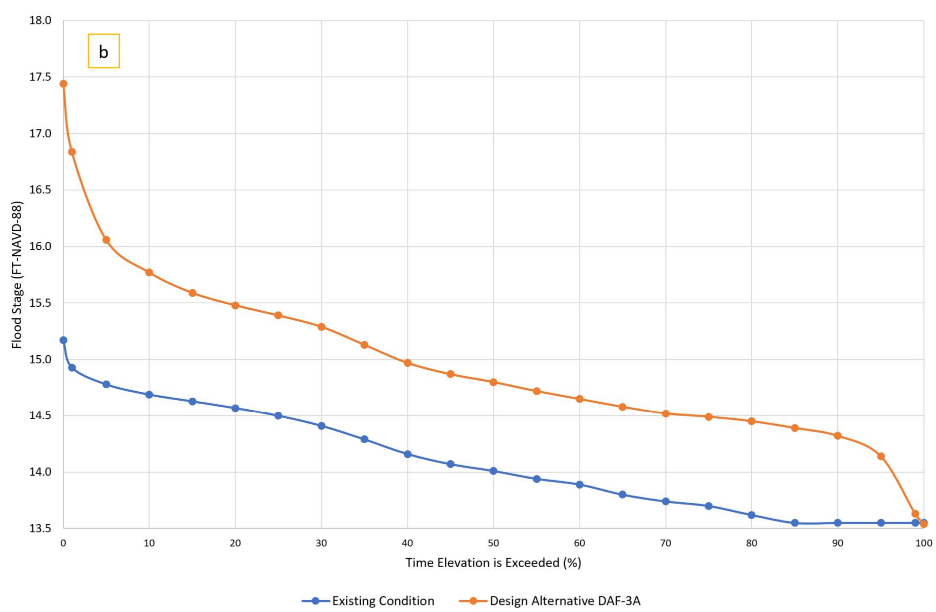
**4.34a**). This is due to the proposed berm east of I-75 and the new control elevation, which significantly backs stormwater up in the wetland promoting more interaction between the wetland areas.

### 4.4.1 Wetland Evaluation Point SHWM # 14

**Figure 4.35a** displays the stage hydrographs for both the existing and DAF-3A conditions at location SHWM #14. This graph shows that flood stages increase during both wet and dry periods under design conditions. The hydroperiod is also expanded with elongated wet periods and shortened or eliminated dry periods. **Figure 4.35b** provides a graph of the exceedance probability using the five years of simulation data at SHWM #14. This figure illustrates the percentage of time when the simulated flood stage exceeds a certain elevation. For example, based on **Figure 4.35b**, the flood stage at SHWM #14 is above 14.0-feet NAVD88 for 50% of the time (or 2.5 years) in the existing conditions model, whereas the flood stage is estimated to be above 14.8-feet NAVD88 in the design condition.

**Figure 4.35 – SHWM #14 Hydroperiod Analysis a) Continuous Simulation Hydrographs b) Exceedance Probability**

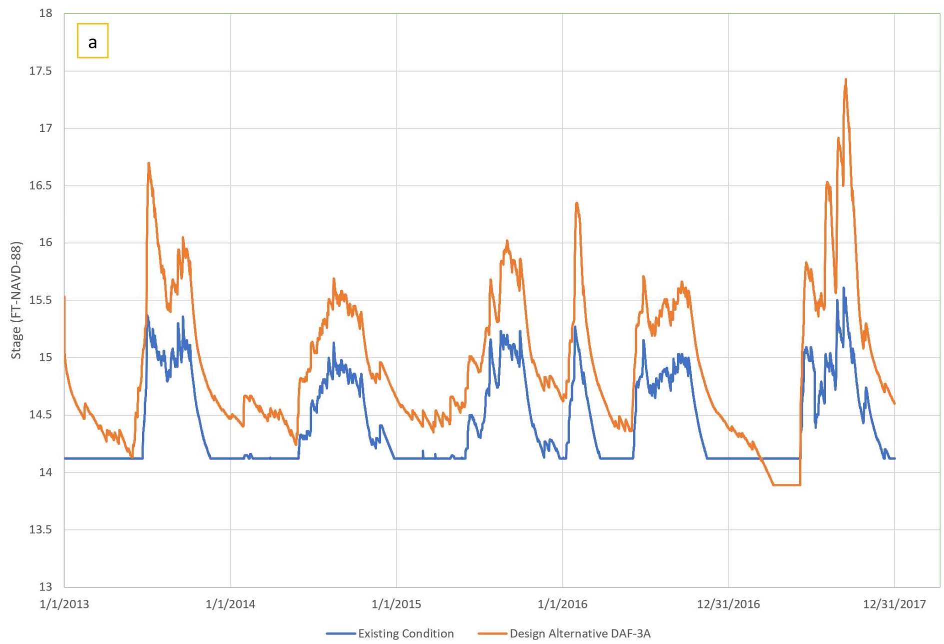


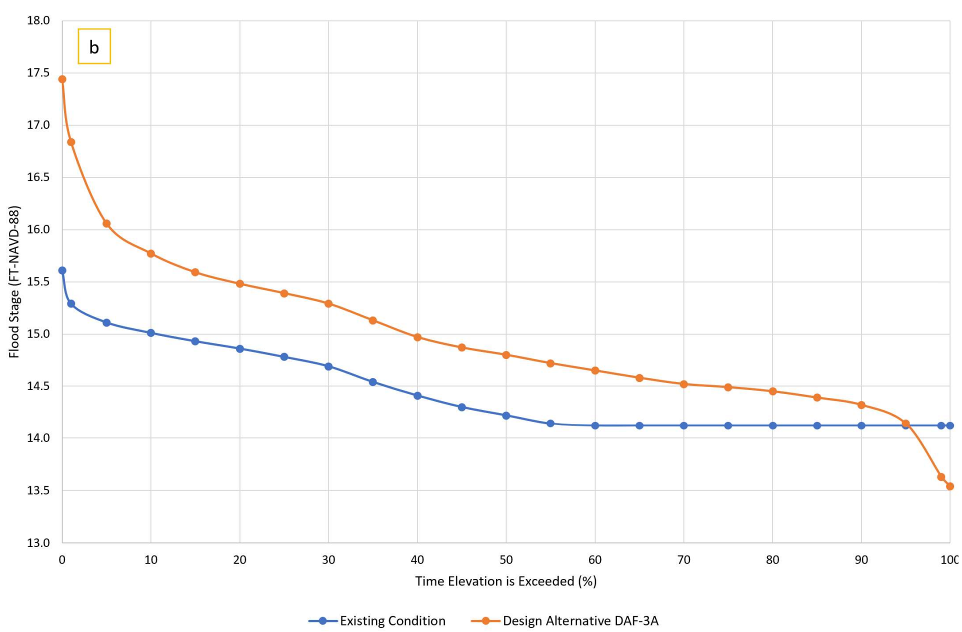



### 4.4.2 Wetland Evaluation Point SHWM # 10:

**Figure 4.36a** displays the 5-year continuous simulation stage hydrographs for both existing and DAF-3A conditions at SHWM #10. Flood stages generally increase for both wet and dry periods in the design condition, with only exception. There is a noticeable drop in stage during 2017 that can be observed in **Figure 4.36a**. This stage drop is attributed to the gates along the I-75 berm remaining open throughout the dry period. Optimizing the gate operation procedures during dry periods would address this issue and should be studied during future project phases. **Figure 4.36b** presents the exceedance probability using 5-years of simulation data at SHWM #10. This figure also shows the hydroperiod has mostly increased, with the small exception during a dry period.

**Figure 4.36 – SHWM#10 Hydroperiod Analysis a) Continuous Simulation Hydrographs b) Exceedance Probability**

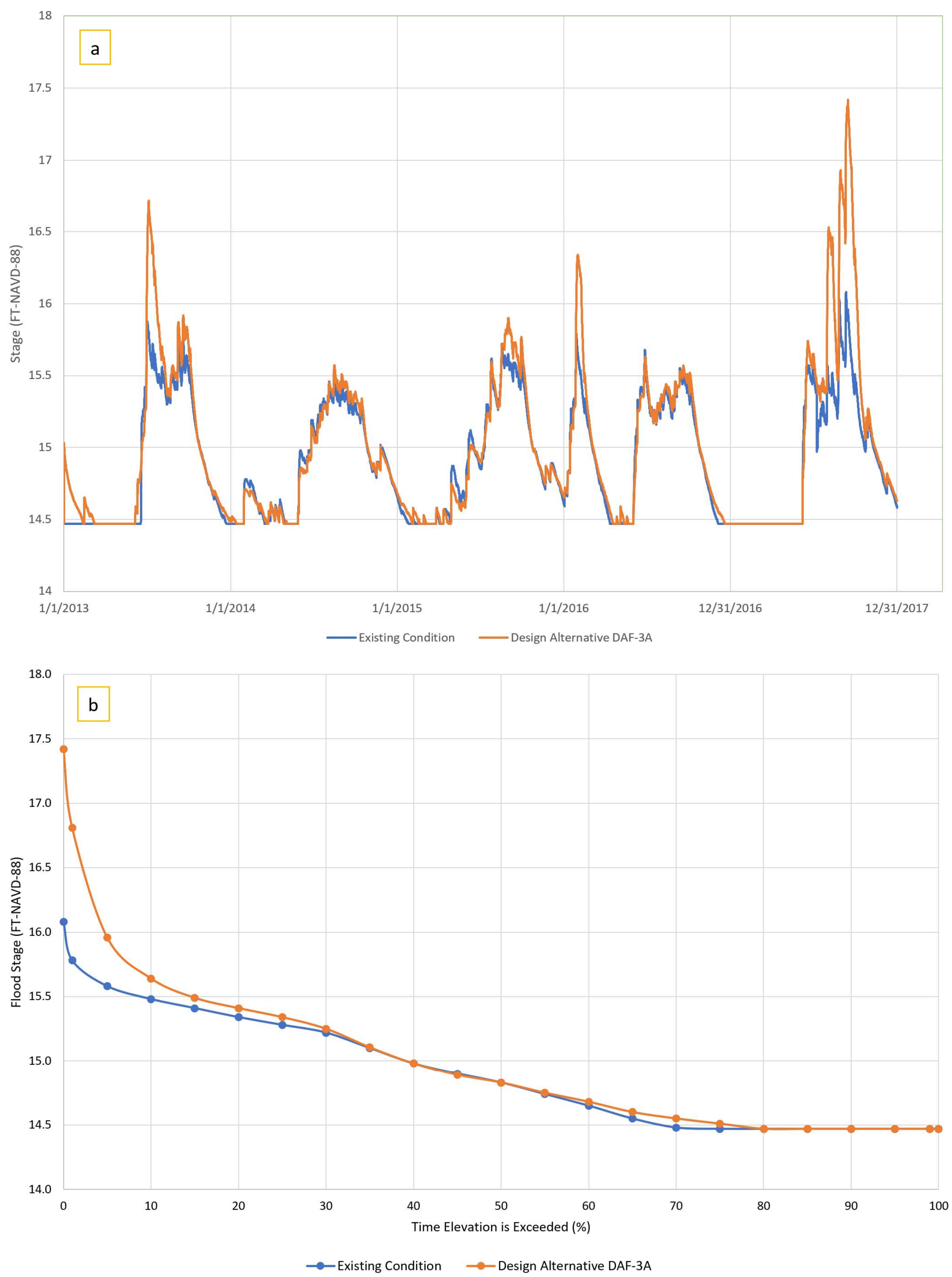


### 4.4.3 Wetland Evaluation Point # 4:

**Figure 4.37a** displays the 5-year continuous simulation stage hydrographs for both existing and DAF-3A conditions at SHWM # 4. A review of this figure shows that flood stages increase during wet periods and show some small increases during dry periods. Dry periods are still expected at this location under design conditions, although most dry periods are expected to shorten. Additional improvements to the hydroperiod (i.e., shortened dry periods) at this location may be achieved by optimizing gate operations during dry periods, as recommended in **Section 4.4.2**. In **Figure 4.37b**, the exceedance probability using 5-years of simulation data is presented for location SHWM #4. This figure shows that the hydroperiod remains unchanged for approximately 70% of the time. Additional improvements to the hydroperiod may be achieved by optimizing gate operations during dry periods.

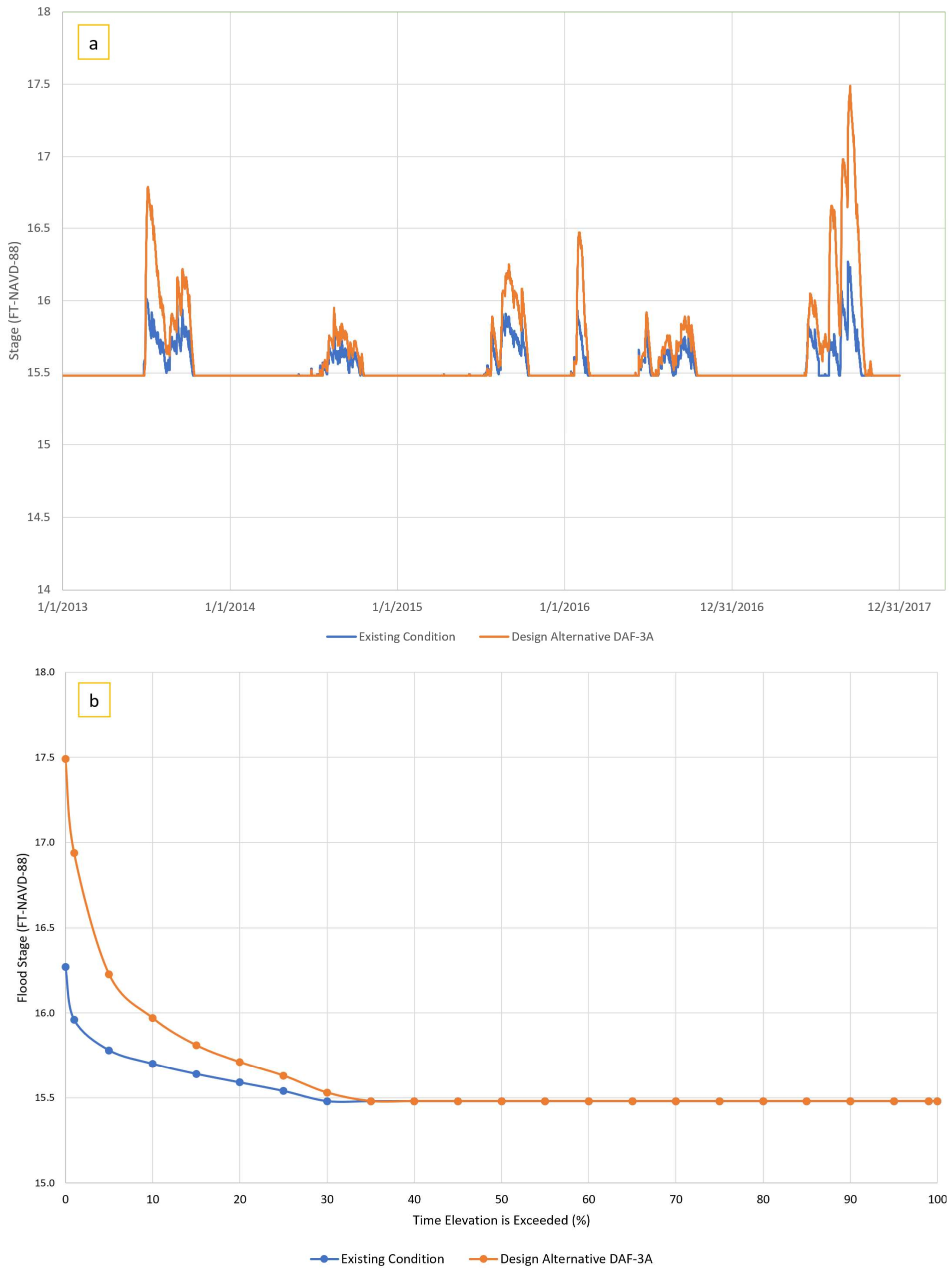
**Figure 4.37 – SHWM #4 Hydroperiod Analysis a) Continuous Simulation Hydrographs b) Exceedance Probability**



### 4.4.4 Wetland Evaluation Point SHWM # 8:

**Figure 4-38a** displays the 5-year continuous simulation stage hydrographs for both existing and DAF-3A conditions at SHWM # 8. The hydrograph shows that flood stages increase during wet periods and shows almost no change for dry periods in the design condition. Therefore, dry periods are still expected in this location under design conditions. Additional improvements to the hydroperiod (i.e., shortened dry periods) at this location may be achieved by optimizing gate operations during dry periods. The exceedance probability using 5-years of simulation data is presented for location SHWM #8 in **Figure 4.38b**. The hydroperiod remains unchanged for approximately 70% of the time according to the exceedance probability chart. Improving the hydroperiod may be achieved by optimizing gate operations during dry periods.

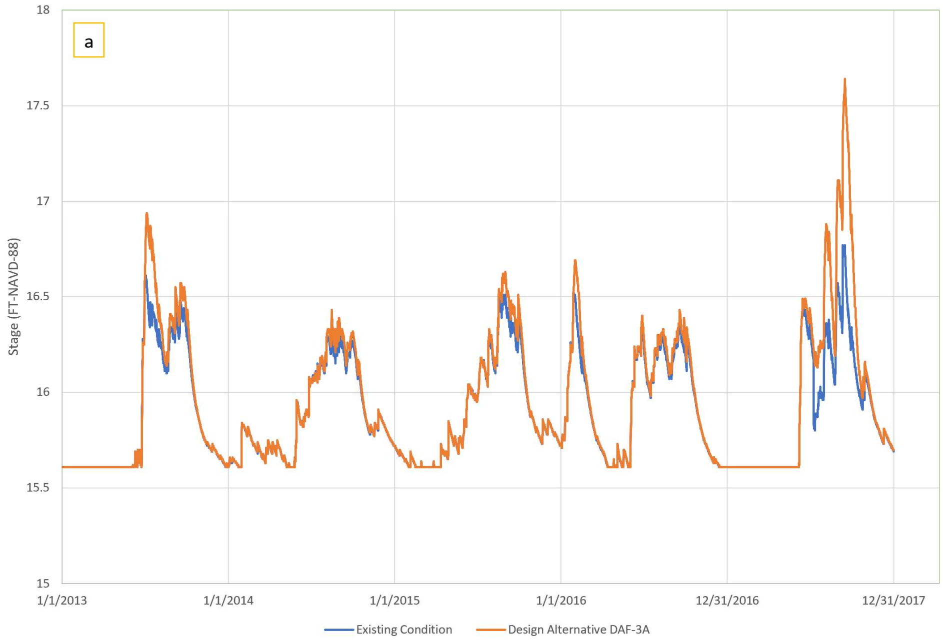
**Figure 4.38 – SHWM #8 Hydroperiod Analysis a) Continuous Simulation Hydrographs b) Exceedance Probability**

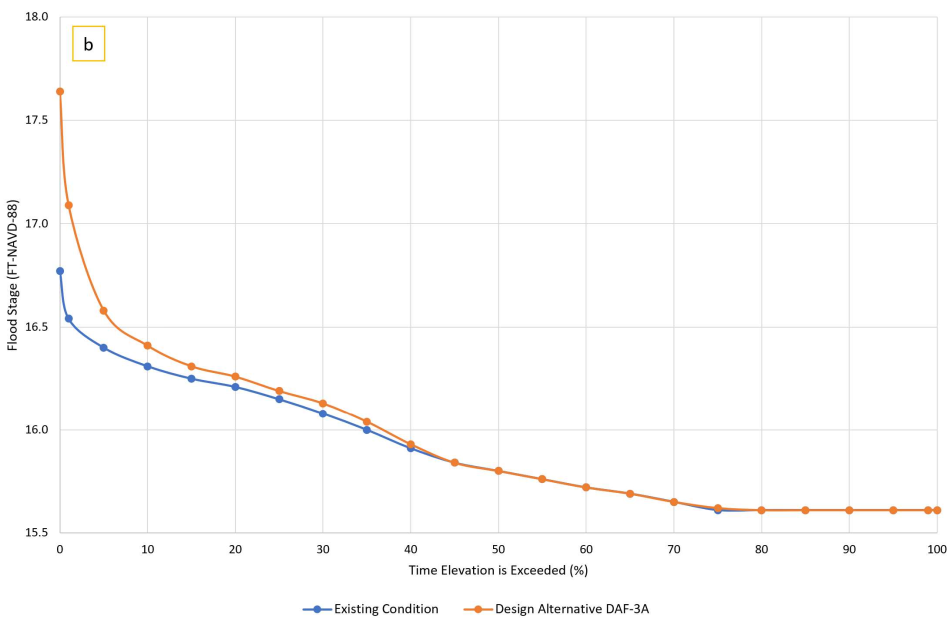


### 4.4.5 Wetland Evaluation Point SHWM # 17:

**Figure 4.39a** displays the 5-year continuous simulation stage hydrographs for both existing and DAF-3A conditions at SHWM #17. Flood stages are estimated to increase during wet periods, as shown in hydrograph comparison, and show almost no change during dry periods. Therefore, dry periods are still expected in this location under design conditions. Additional improvements to the hydroperiod may be achieved by optimizing gate operation during dry periods to hold more water in the wetland. The exceedance probability using 5-years of simulation data is presented for location SHWM #17 in **Figure 4.39b**. The hydroperiod at this location remains unchanged for approximately 70% of the simulated time, according to the exceedance probability chart.

**Figure 4.39 – SHWM #17 Hydroperiod Analysis a) Continuous Simulation Hydrographs b) Exceedance Probability**

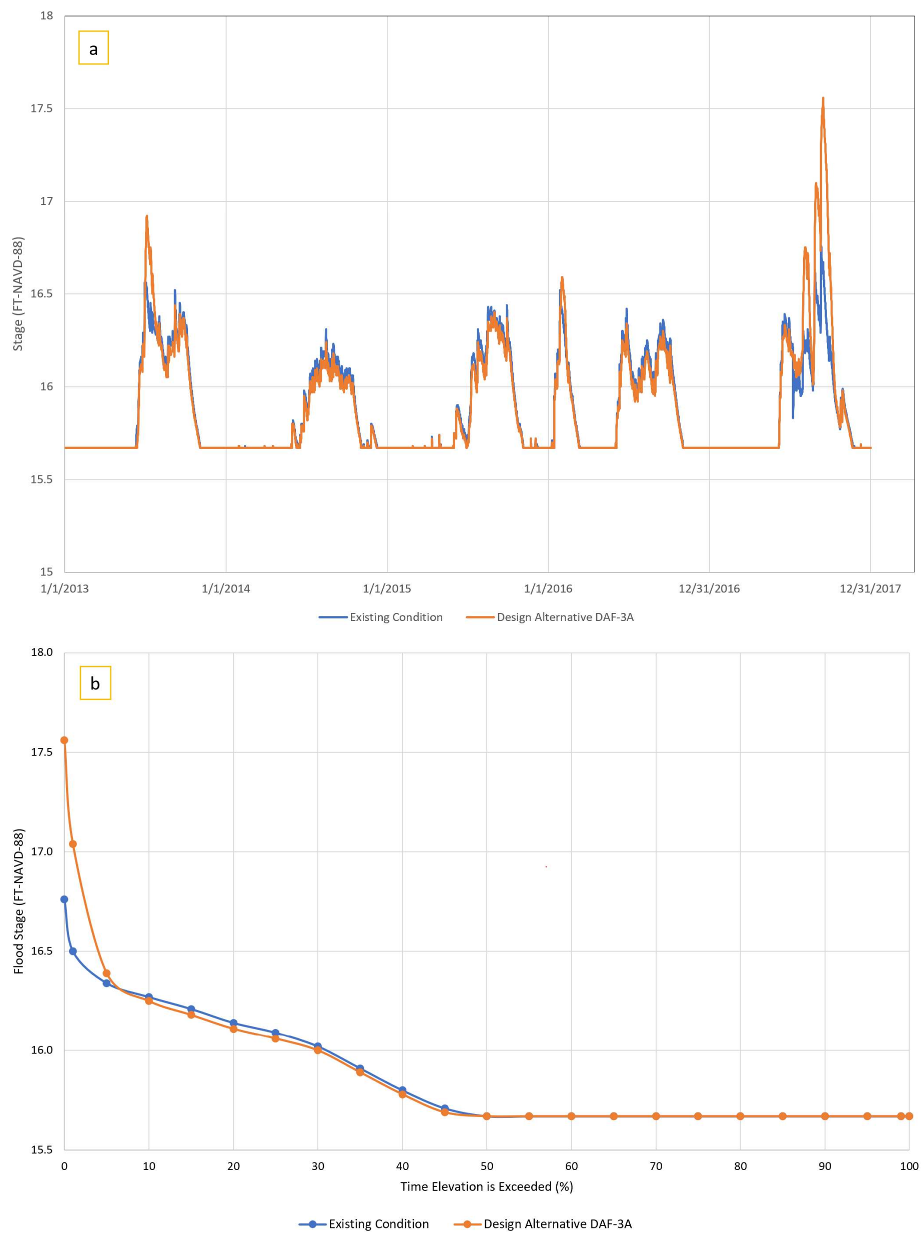


### 4.4.6 Wetland Evaluation Point SHWM # 2:

**Figure 4.40a** displays the 5-year continuous simulation stage hydrographs for both existing and DAF-3A conditions at SHWM #2. This hydrograph comparison shows only minor changes in flood stages for both wet and dry periods, suggesting minimal improvement in the wetland's hydroperiod at this location. It's important to highlight that this point is located the farthest north and east and is at a higher elevation compared to the other wetland evaluation points. The changes in flood stage results observed at this point are less significant because the design modifications have less impact at this location. Optimizing operational gates during the dry period may still yield some hydroperiod improvement at this location, despite the distance from the design, however, significant changes are not likely to occur. The exceedance probability using 5-years of simulation data is presented for location SHWM #2 in **Figure 4.40b**. Similarly, this figure indicates minor changes for the majority of the time.

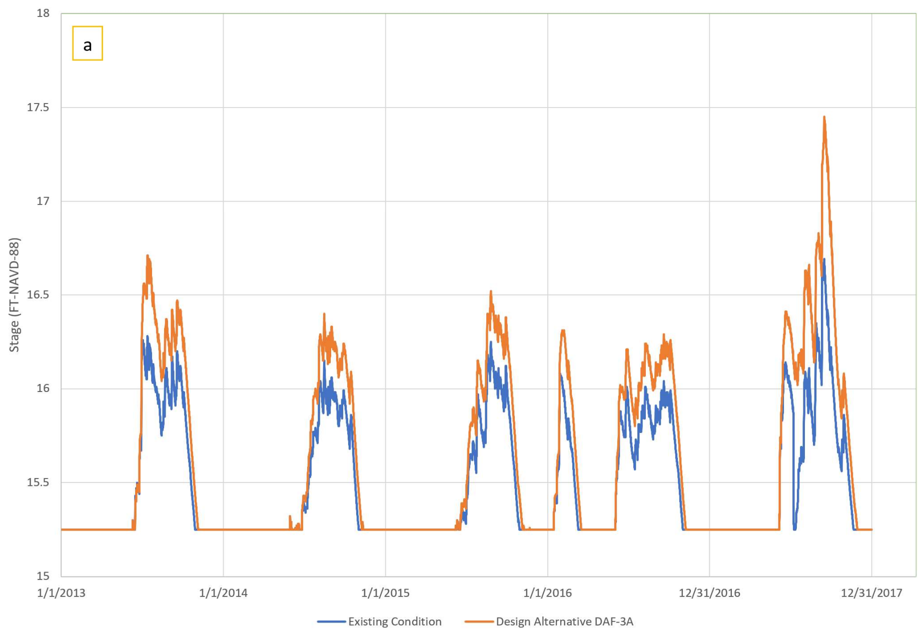
**Figure 4.40 – SHWM # 2 Hydroperiod Analysis a) Continuous Simulation Hydrographs b) Exceedance Probability**

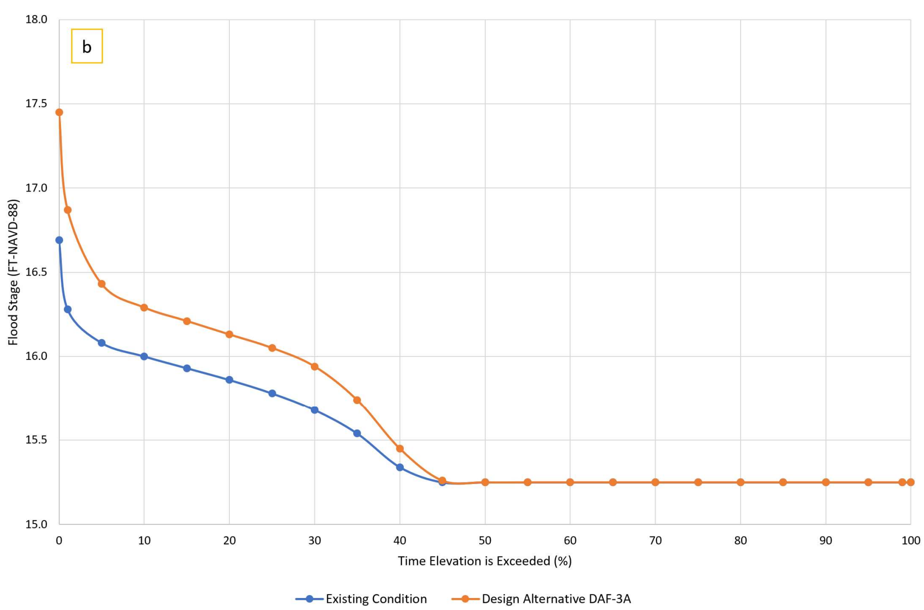


### 4.4.7 Wetland Evaluation Point SHWM # 20:

**Figure 4.41a** displays the 5-year continuous simulation stage hydrographs for both existing and DAF-3A conditions at SHWM #20. Flood stages are estimated to increase during wet periods, as shown in hydrograph comparison, and show almost no change during dry periods. Therefore, dry periods are still expected in this location under design conditions. As this location is influenced by the berm and related culverts north of Kehl Canal, additional improvement to the hydroperiod may be attained by substituting the design culverts with gates. These gates could then be operated during dry periods to retain more water in the wetland. The exceedance probability using 5-years of simulation data is presented for location SHWM #20 in **Figure 4.41b**. The hydroperiod at this location remains unchanged for approximately 70% of the simulated time, according to the exceedance probability chart.

**Figure 4.41 – SHWM # 20 Hydroperiod Analysis a) Continuous Simulation Hydrographs b) Exceedance Probability**

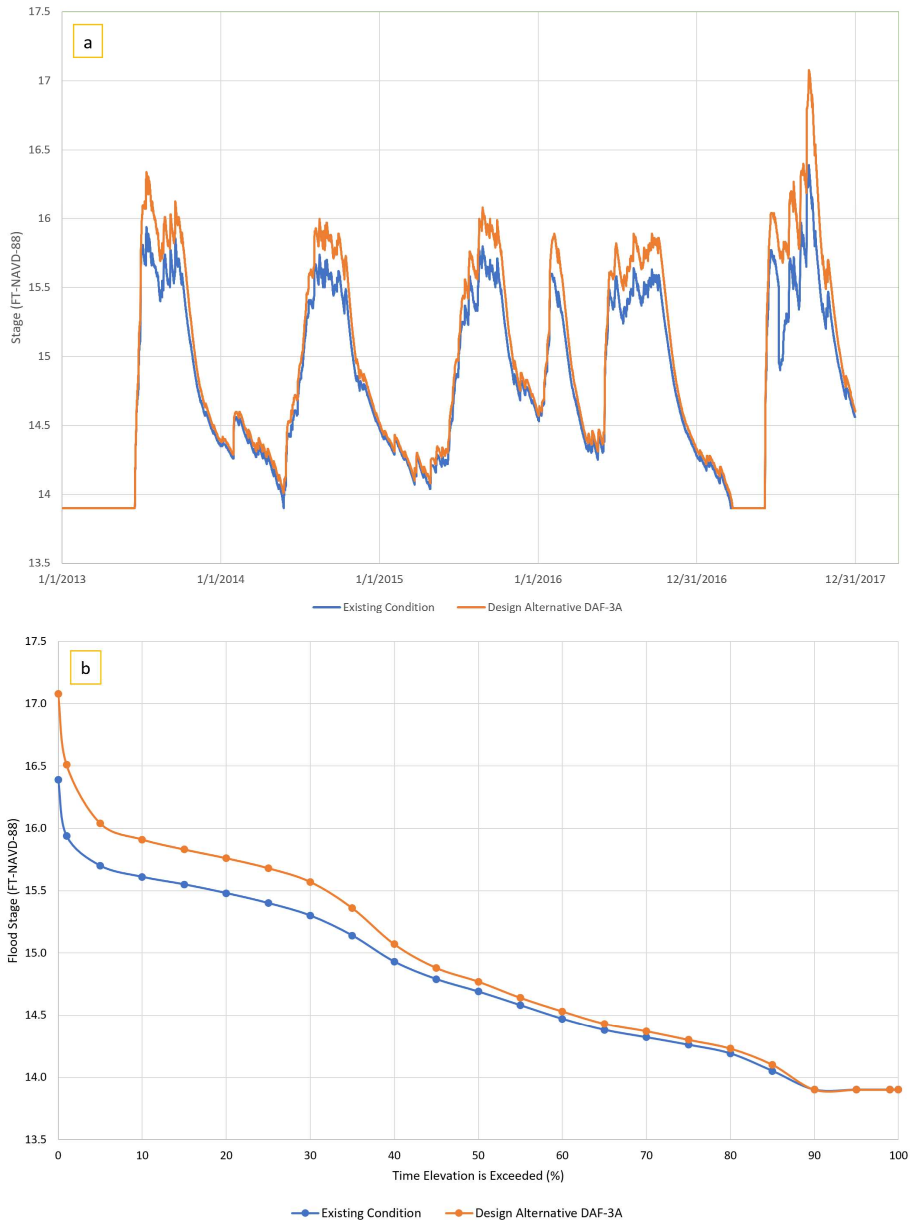


### 4.4.8 Wetland Evaluation Point SHWM # 22:

**Figure 4.42a** displays the 5-year continuous simulation stage hydrographs for both existing and DAF-3A conditions at SHWM #22. Flood stages are estimated to increase during wet periods, as shown in hydrograph comparison, and show almost no change during dry periods. Therefore, dry periods are still expected in this location under design conditions. As this location is influenced by the berm and related culverts north of Kehl Canal, additional improvement to the hydroperiod may be attained by substituting the design culverts with gates. These gates could then be operated during dry periods to retain more water in the wetland. The exceedance probability using 5-years of simulation data is presented for location SHWM #22 in **Figure 4.42b**. The hydroperiod at this location remains unchanged for approximately 70% of the simulated time, according to the exceedance probability chart.

**Figure 4.42 – SHWM # 22 Hydroperiod Analysis a) Continuous Simulation Hydrographs b) Exceedance Probability**



### 4.4.9 Conclusion:

The evaluation of wetland hydroperiods has provided valuable insights into the potential impacts and opportunities for improvement from the project. Through continuous simulations over a 5-year period, including various wet and dry periods and significant storm events, the effects of proposed design modifications were assessed. While the primary focus of the proposed operable gates along the berm along I-75 was to regulate flood stages during wet periods, significant hydroperiod improvements were observed at analyzed locations. However, it was noted that the eastern and southwestern sides of the project area experienced more significant changes in hydroperiod compared to the northern and northwestern sides, attributed to differences in elevation.

Further analysis at specific wetland evaluation points revealed varying degrees of impact from the design modifications. While some locations experienced notable improvements in hydroperiod, others showed minimal changes. Optimizing gate operations during dry periods emerged as a potential strategy to address remaining challenges and further enhance hydroperiods, particularly in locations where the design modifications had less impact. Also, additional improvements to the hydroperiod may be attained by substituting the design culverts for the berm north of Kehl Canal with operable gates. These gates would operate during dry periods to retain more water in the wetland.

Finally, while a number of changes in hydroperiod are described above and other opportunities to further refine the design may be possible, any future changes must be made in coordination with the project environmental team to fine tune the final project design and gate operation schedules.