City of Jersey Village

# Wall Street Storm Sewer System Study

Dannenbaum Engineering Corporation

## December 18, 2017


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DANNENBAUM

In association with

Kuo & Associates, Inc.
CONSULTING ENGINEERS - SURVEYORS

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# Executive Summary

For several years, repetitive flooding issues along the White Oak Bayou channel have adversely affected the City of Jersey Village. As a result of this recurring issue, Jersey Village contracted Dannenbaum Engineering Corporation (DEC) to develop a Long-term Flood Recovery Plan for the City. The Long-term Flood Recovery Plan included several solutions to help alleviate flooding within the City. One of these solutions was to redesign the existing storm sewer system in the Wall Street Neighborhood. The purpose of this study was to perform an in-depth analysis of the existing Wall Street storm sewer system and recommend a cost-effective solution to improve mobility and reduce ponding for more frequent storm events.

The project area is a total of 79.4 acres and is located in the City of Jersey Village along the E127-00-00 tributary within the White Oak Bayou Watershed. The primary objectives of the study include the following:

- Conduct a survey of the existing storm sewer system
- Perform a field visit to identify potential flooding sources and problem areas
- Review public comments from Jersey Village Long-term Flood Recovery Plan
- Complete a Hydrologic and Hydraulic Study using the Rational Method and the Clark Unit Hydrograph Method for peak flows and hydrograph generation
- Use XP-STORM for conveyance and storm sewer routing
- Mitigate peak flow increases to E127-00-00 with Golf Course detention
- Prepare an Engineer's Estimate for construction costs
- Set up a Construction Phasing Plan

The existing land use is entirely residential. The storm sewer survey performed by Kuo and Associates revealed 37 existing inlets, 23 manholes and showed four existing outfalls: one discharging into E100-00-00 and three discharging into E127-00-00. The survey showed four separate drainage systems within the Wall Street Neighborhood: System A, System B, System C and System D. There were three different types of existing inlets: 'BB' inlets, 'C-2' inlets and grate inlets. Typical pipe sizes included 24", 30" and 36" reinforced concrete pipe (RCP).

The drainage areas were delineated with a combination of topographic survey data and LiDAR data. The Rational Method was utilized to calculate the peak flows for the 2-yr, 5-yr, 10-yr and 100-yr storm events. The Clark Unit Hydrograph Method was used to generate the hydrographs in HEC-HMS. After the hydrographs were developed, XP-STORM was used to build a hydraulic model. The existing conditions model pinpointed several areas of severe ponding in the neighborhood for each of the storm frequencies. The severity of the flooding for each storm frequency was attributed to two factors: the existing storm sewer system was under capacity and did not have enough inlets and the significant amount of sheet flow entering the neighborhood from the golf course for each storm event.

The proposed improvements to the Wall Street Neighborhood storm sewer system included designing additional inlets, increasing the size of existing inlets and removing and replacing existing storm sewer with varying pipe sizes. System B and System D in were connected to provide an additional outfall for System B. Also, the existing outfall for System D was modified to increase capacity and another outfall was added to System C to decrease ponding present at the intersection of Wall St and Crawford St. These improvements were modeled in XP-STORM and the results showed impacts to the E127-00-00 tributary. Due to the high level of sheet flow entering Wall St from the adjacent golf course, an intermediary berm design was proposed to help intercept flow for a 2-yr and 5-yr storm event. The intermediary berm design would provide temporary relief from the golf course sheet flow while the proposed storm sewer improvements are being implemented and serve as Phase 1 for the final berm design.

The final design of the proposed berm was added around the Jersey Meadow Golf Course to convert the golf course into a multi-use facility to provide detention for the Wall Street Neighborhood improvements. Additionally, the final design of the berm prevented sheet flow from entering the neighborhood from the golf course for the 2-yr, 5-yr, 10-yr and 100-yr storm event. The proposed berm was part of the Long-term Flood Recovery Plan to help mitigate flooding issues within Jersey Village, as well as detain for the proposed improvements.

**Detention Summary Table**

| **Wall Street Storm Sewer System Study** | | |
|---|---|---|
| Detention Basin Drainage Area | 133.6 | acres |
| Detention Storage Rate | 1.75 | acre-ft/acre |
| Detention Storage Required | 43.7 | acre-ft |
| Detention Storage Provided | 105.37 | acre-ft |
| | **10% (10-yr)** | **1% (100-yr)** |
| Design Water Surface Elevation (ft) | 105.92 | 106.85 |
| Maximum Allowable Outflow (cfs) | 203 | 993 |
| Maximum Outflow Provided (cfs) | 156 | 920 |

The preliminary construction cost estimate is approximately $5,478,904 and the construction phasing plan was split into three phases. The first phase is to construct System B along Wall St and the second phase constructs the remainder of System B. The construction of System A and System C improvements is during the third phase.

# 1. Introduction

## 1.1. General

Flooding issues along the White Oak Bayou channel have repeatedly affected the City of Jersey Village for several years. After the April 18, 2016 (Tax Day) flood, the City decided to develop the Jersey Village Long-term Flood Recovery Plan to alleviate bayou flooding from the main channel (E100-00-00) and connecting tributaries running through Jersey Village. In addition to bayou flooding, numerous residents have complained about severe street ponding along Wall Street and neighboring streets during small and large storm events. Dannenbaum Engineering Corporation (DEC) was contracted by the City to complete the Wall Street Storm Sewer Study. The purpose of this study was to perform an in-depth analysis of the existing Wall Street storm sewer system and recommend a cost-effective and implementable solution to improve mobility and reduce ponding for more frequent storm events.

According to existing data and eyewitness accounts, Wall Street floods due to a lack of conveyance in the storm sewer system and significant sheet flow from the Jersey Meadow Golf Course. The existing storm sewer system contains undersized pipes as well as a lack of inlets along the Wall Street system, which contributes to an increase in flooding during higher frequency events. The 5-yr water surface elevation (WSE) in E127-00-00 was determined to be lower than the centerline of the road after being compared to the elevation of the street. This result implies that the system can be improved for more frequent storm events, such as 2-yr and 5-yr storm events. Flooding in larger events cannot be alleviated from increased storm sewer capacity due to the high WSE occurring in the E127-00-00 tributary. Therefore, the goal of the study was to propose a new Wall Street Storm Sewer System with increased capacity to accommodate more frequent storm events.

## 1.2. Scope of Work

The scope of work for this study is as follows:

1. Conduct a survey of existing storm sewer pipes, manholes, inlets and outfalls to the Bayou Channels.
2. Perform a field visit to identify problem areas and potential flooding sources.
3. Review public comments from the Jersey Village Long-Term Flood Recovery Plan.
4. Complete a Hydrologic and Hydraulic Study using the Rational Method and the Clark Unit Hydrograph Method for peak flows and hydrograph generation. Use XP-STORM for conveyance and storm sewer routing.
   - 4.1. Determine existing drainage areas and land use
   - 4.2. Develop existing hydrology
   - 4.3. Build existing XP-STORM model
   - 4.4. Perform level of service analysis for existing conveyance system
   - 4.5. Determine ponding areas
   - 4.6. Define design criteria for hydraulic grade line (HGL) of proposed conditions
   - 4.7. Design storm sewer size and number of inlets using XP-STORM

4.8. Design drainage outfalls at E100-00-00 and/or E127-00-00
4.9. Select recommended alternative from proposed analysis
4.10. Mitigate peak flow increases to tributary E127-00-00 with Golf Course detention
5. Prepare an Engineer's Estimate for construction costs of solution.
6. Set up a Construction Phasing Plan.
7. Develop Preliminary System Diagrams for selected conveyance alternative.

# 2. Data Collection

## 2.1. Topographic Survey

One of the most important elements of the data collection process was completion of the storm sewer survey by Kuo & Associates, Inc. Data was collected for the storm sewer system along Wall Street, Carlsbad Street, Crawford Street, Tahoe Drive and Capri Drive. The survey identified four separate drainage systems within the Wall Street Neighborhood. **Table 2.1A** provides a summary of the existing conditions according to the survey performed.

**Table 2.1A – Storm Sewer Survey Summary Table**

| Drainage System | Total Number of Inlets | | | Total # of Manholes | Total Amount of Storm Pipe | | | Outfall Pipe Size | Outfall Channel |
|---|---|---|---|---|---|---|---|---|---|
| | BB | C | Grate | | 24" | 30" | 36" | | |
| A | 4 | 2 | 0 | 6 | 552 | 525 | - | 50' - 30" CMP | E100-00-00 |
| B | 19 | 0 | 0 | 11 | 736 | 1,148 | 380 | 185' - 42" CMP | E127-00-00 |
| C | 5 | 0 | 1 | 3 | 429 | 61 | - | 210' - 30" CMP | E127-00-00 |
| D | 2 | 1 | 3 | 3 | 141 | 161 | - | 28' - 36" CMP | E127-00-00 |

The complete survey is located in **Appendix A**.

## 2.2. Field Visit

An initial field visit was conducted to further classify the elements in the existing system and any potential problem area locations. During this field visit, the small size and scarcity of the existing inlets was noted. This visit helped further the assumption that the amount of inlets and the inlet capacity would need to be increased in the proposed system.

A second field visit was performed to identify potential outfall locations for the proposed system. For existing Drainage System A, an empty lot is located near the current outfall location. If the outfall size needs to increase, there would be enough clearance to do so through this area. Due to the close proximity of the houses along Wall St, there was only one space that had enough clearance for potential maintenance in the future. Therefore, only one potential location was identified along Wall St for Existing Drainage System C and Existing Drainage System B would tie into the outfall for Existing Drainage System D. The outfall for System D is located at the East end of Wall St and had sufficient clearance for a larger outfall pipe if needed.

### 2.3. Citizen Commentary

Throughout the Jersey Village Long-term Flood Recovery Plan, a high level of communication was kept with the residents of Jersey Village. There were several opportunities for the residents of Jersey Village to submit their comments or concerns including attending a public meeting, filling out and submitting comment cards or responding to the questionnaire distributed to all Jersey Village residents. Numerous residents took advantage of these opportunities to express their concern about the Wall Street neighborhood drainage system. It was made clear that the existing design of Wall Street was inadequate for storm events of a lower magnitude through the collection of public comments. Numerous residents relayed personal stories of the street flooding on several occasions to the point where the residents were unable to drive. These stories extended beyond the Tax Day Flood, which occurred on April 18th, 2016.

In addition to amplifying the concern surrounding street flooding along Wall Street, public comments helped identify problem areas present in the neighborhood. Several residents have complained about the storm sewer system backing up from E127-00-00 and seeing water exiting the inlets instead of entering them.

## 3. Existing Conditions

### 3.1. Location and Topography

The Wall Street Neighborhood has a total project area of 79.5 acres and is located in the City of Jersey Village along the E127-00-00 tributary within the White Oak Bayou watershed (See **Exhibit 1**). The topography of the Wall Street Neighborhood is relatively flat and is shown in **Exhibit 2**. Delineation of the existing drainage areas is based on the topography, parcel boundaries and road elevations and can be found in **Exhibit 3**.

### 3.2. Land Use

The Wall Street Neighborhood is a residential community, so the land use for the entire project area was assumed to be single-family homes on small lots.

### 3.3. HCFCD Facilities and Unit Numbers

There are four outfalls to Harris County Flood Control District (HCFCD) facilities within the Wall Street Neighborhood. Wall Street and Crawford Street both have outfalls to HCFCD facilities. Wall Street has three outfalls to E127-00-00 and Crawford Street has one outfall to E100-00-00. All three outfalls along Wall Street are located on the South side of Wall Street and the last outfall is on the North side of Crawford Street. E127-00-00 runs parallel to Wall Street for approximately 0.57 miles (3,035 feet).

### 3.4. Right-of-Way

The right-of-way (ROW) for all streets within the Wall Street Neighborhood is 60’ wide. These roads are maintained and owned by the City of Jersey Village. In addition to the existing transportation ROW, HCFCD maintains the drainage easement for E100-00-00 and E127-00-00. The easement for E100-00-00 where an existing outfall is located is

approximately 150' wide. The easement for E127-00-00 along the project area length ranges from 100' wide to 150' wide. **Exhibit 2** shows the ROW limits.

### 3.5. Pipelines and Utilities

The project area contains several different types of utilities, both public and private. The public utilities include water lines, sanitary sewer and storm sewer and are owned and maintained by the City of Jersey Village. The private utility within the project limits is a crude oil pipeline across the Wall Street Neighborhood. The pipeline is shown in **Exhibit 2** and runs from east to west under Tahoe St. It is owned and operated by Teppco Partners.

## 4. Hydrology and Hydraulics

### 4.1. Analysis Objective

The drainage impact study was performed in compliance with the City of Jersey Village *Code of Ordinances*, the 2010 Harris County Flood Control District *Policy, Criteria and Procedure Manual (*HCFCD PCPM) and the 2009 *Hydrology and Hydraulics Manual*. The analysis objectives included analyzing the existing conditions and designing a proposed system with the 2-yr hydraulic grade line (HGL) below the gutter line and maintaining the proposed HGL at or below the top of curb (TOC) for the 5-yr storm. The proposed system was designed with no impact to E100-00-00 and E127-00-00, which requires mitigation through the anticipated Jersey Meadow Golf Course multi-use facility. Hydrologic and hydraulic analyses were completed in order to meet these requirements for the proposed Wall Street Neighborhood storm sewer system.

### 4.2. Hydrologic Methodology

The City of Jersey Village is a part of the White Oak Bayou Watershed (WOB) in Harris County, Texas. The main WOB channel, E100-00-00, runs directly through Jersey Village along with two tributaries, E127-00-00 and E135-00-00. In this study, the topographic survey revealed four separate drainage systems in the Wall Street Neighborhood. One of these drainage systems outfalls into E100-00-00 and the other three systems outfall into E127-00-00.

The drainage areas were determined using a combination of survey data obtained by Kuo and Associates, Inc. and 2008 LiDAR data provided by Harris County Flood Control District (HCFCD). The total area contributing to the Wall Street storm sewer system was determined using the ArcHydro toolbox in ArcGIS along with the LiDAR data. The detailed drainage areas were found by breaking apart the overall ArcHydro drainage area based on the existing inlets and the street topography shown in the survey data.

After the detailed drainage areas were determined, the rational method was employed to calculate the peak flows ($Q_P$) for 2-yr, 5-yr, 10-yr and 100-yr events:

$$Q_P = CIA$$

The existing land use for each drainage area was residential and all lot sizes were assumed greater than 2 lots/acre, but less than 4 lots/acre. Following the land use criteria listed in the *Jersey Village Code*, the run-off coefficient (C) was set to 0.5 for each drainage area. The time of concentration was determined using the following equation from the *Jersey Village Code*:

$$t_c = \frac{D}{60v} + 10$$

Where, $t_c$ = Time of Concentration, min
D = Flow Distance, feet
v = Flow Velocity, feet/sec

Survey and contour data was used to determine the flow path through each drainage area, which was equivalent to the flow distance. Each drainage area had a flow path through storm gutters and storm sewer pipes. The velocity for the storm gutter paths were found in Table 14-8 in the *Jersey Village Code*, which are based on the slope of the gutter. The velocity in the storm pipe was calculated using Manning's Formula:

$$V = \frac{1.486}{n} * R^{-(2/3)} * \sqrt{S}$$

Where, R = Hydraulic Radius, $\frac{A_w}{P_w}$ , feet
S = Slope of Hydraulic Gradient, feet/foot
n = Coefficient of Roughness

When calculating the hydraulic radius, the pipe was assumed to be flowing at full capacity. The slope of the pipe was taken from the survey data and the coefficient of roughness was determined based on the material of the pipe noted in the survey.

The average rainfall intensity (I) was calculated using the following formula:

$$I = \frac{b}{(t_c + d)^e}$$

This formula uses intensity parameters (b, d, e) that are listed in the *JV Code*. The *JV Code* only lists the 3-yr, 5-yr, 10-yr, 25-yr and 50-yr intensity parameters, so the given parameters were graphed and a trendline was generated to interpolate the 2-yr and 100-yr values.

The hydrographs for each drainage area were generated using the Clark Unit Hydrograph method in HEC-HMS. See **Appendix B** for all existing hydrologic models and detailed calculations.

## 4.3. Hydraulic Methodology

After the hydrographs were determined for each drainage area, the Wall Street storm sewer system was modeled in XP-STORM 2016, a program designed to simulate the dynamic behavior of storm sewer systems over a set period of time. The geometry of the model was determined utilizing the acquired survey data. The survey performed by Kuo & Associates, Inc. revealed four separate drainage systems within the Wall Street neighborhood.

The hydrographs found using the Clark Unit Hydrograph Method were input at the appropriate nodes and an outfall was modeled for each individual drainage system. Drainage system 'A' was located in the northern part of the neighborhood along Crawford Street, with the outfall by E100-00-00. System 'B' was the largest drainage system with inlets along Tahoe Drive, Capri Drive, Carlsbad Street and part of Wall Street. The outfall for system 'B' was located by E127-00-00 parallel to the intersection of Carlsbad Street and Wall Street. System 'C' was located along the western portion of Crawford St and discharged into E127-00-00 adjacent to the Crawford and Wall St intersection. Drainage system 'D' is located at the eastern part of the neighborhood where Wall St intersects with Senate Avenue. The outfall for System 'D' is located slightly upstream of the Senate Avenue bridge along E127-00-00.

Three types of inlets were present in existing conditions: 'BB' inlets, 'C' inlets and grate inlets. After analyzing survey and LiDAR data, it was assumed that all existing inlets were sag inlets. These inlets were modeled in XP-STORM using the maximum capacity of the inlet. The inlet capacities for the 'BB' and 'C' inlets were obtained from the City of Houston Infrastructure Design Manual. For a 'BB' inlet with a grate, the standard inlet capacity was doubled and a clogging factor was applied. The City of Jersey Village keeps their inlets well maintained so a clogging factor was not applied to a standard 'BB' and 'C' inlets without a grate. The capacity of the grate inlet was calculated with the use of the Federal Highway Administration (FHWA) Hydraulic Toolbox. A Curb and Gutter analysis was performed with the Hydraulic Toolbox using the topography of the existing road and the dimensions of the inlet. The intercepted flow value calculated in the program was used as the maximum capacity in the XP-STORM model. **Table 4.3A** summarizes the maximum inlet capacities used in the inlet analysis.

**Table 4.3A – Inlet Capacity Summary Table**

| Inlet Type | Maximum Capacity (cfs) |
|---|---|
| BB | 5.00 |
| BB [Grate] | 7.50 |
| C-2 | 10.00 |
| Grate | 5.19 |

The tail water for a 2-yr and 5-yr storm event was set to the top of pipe elevation, while a variable tail water was calculated for the 10-yr and 100-yr storm events. The variable tail water for each drainage system outfall was found using the water surface elevation (WSE)

from the Jersey Village Revised Existing Conditions HEC-RAS model and the channel flow from the White Oak Bayou Revised Existing Conditions HEC-HMS model. **Table 4.3B** displays the peak tail water elevation for each storm event. See **Appendix C** for the existing hydraulic models.

**Table 4.3B – Existing Tail Water Summary Table**

| Drainage System | Outfall | Area | Tail water Peak Elevation (ft) | | | |
|---|---|---|---|---|---|---|
| | | | Top of Pipe | | Variable Tail water | |
| | | (ac) | 2-yr | 5-yr | 10-yr | 100-yr |
| A | AOUT | 13.92 | 90.14 | 90.14 | 101.83 | 104.05 |
| B | BOUT | 41.4 | 91.08 | 91.08 | 101.35 | 103.41 |
| C | COUT | 19.83 | 95.86 | 95.86 | 102.4 | 104.17 |
| D | DOUT | 4.32 | 95.21 | 95.21 | 100.48 | 102.96 |
| Golf | GOUT | 133.6 | 103.75 | 103.75 | 104.498 | 105.72 |

## 4.4. Pre-Project Conditions

As stated in the previous section, the Wall Street Neighborhood has four separate drainage systems as shown in **Exhibit 4**. The project has four outfalls, one for each drainage system, as described below. In addition to the existing drainage system, the adjacent Jersey Meadow Golf Course contributes a significant amount of flow to the Wall Street Neighborhood.

***E100-00-00, System A***

System A is along the northeastern portion of Crawford Street, starting from the intersection of Crawford and Carlsbad Street. It extends to the end of Crawford St and outfalls into E100-00-00 through a 50’ long 36” corrugated metal pipe (CMP) located between two private residences. The system is composed of curb and gutter and underground storm sewer. Some negative flow is present at the outfall due to the high tail water elevation in the main channel but this does not extend to the rest of the system. The inlets are under capacity, which causes ponding at each low point in the road for each storm event. **Table 4.4A** shows the water surface elevations calculated in XP-STORM for each inlet and **Table 4.4B** shows the inlet capacity analysis. The 2-yr storm event was compared to the gutter line elevation, the 5-yr and 10-yr storm events were compared to the top of curb elevation (TOC) and the 100-yr storm event was compared to the right-of-way (ROW) ground elevations, or 0.5’ above TOC.

***E127-00-00, System B***

System B is the largest drainage system in the Wall Street Neighborhood. It is designed for Tahoe Street, Capri Drive, Carlsbad Street and the eastern portion of Wall Street, starting at the intersection of Wall St and Carlsbad St. Most of the system is made of curb and gutter and underground storm sewer. Severe ponding was shown throughout the entirety of System B for the 2-yr, 5-yr, 10-yr and 100-yr storm events. This ponding is due to the high tail water in the channel, undersized storm sewer pipes and inadequate inlet capacity. System B outfalls into E127-00-00 through a 42” CMP with a length of 185’

located between two private residences. **Table 4.4A** displays the WSE calculated in XP-STORM for Drainage System B and **Table 4.4B** shows the inlet capacity analysis.

***E127-00-00, System C***

System C extends along the southwestern portion of Crawford Street and the western half of Wall Street. The system outfalls into E127-00-00 with a 210' long 30" CMP located between two private residences. The system is made up of curb and gutter and underground storm sewer. Severe ponding is shown throughout this system with each storm frequency. This ponding could be attributed to the high tail water at the outfall, undersized pipes and inadequate inlet capacity. Additionally, System C is located next to the Jersey Meadow Golf Course facility. During all storm events, the overland flow from the golf course tops over the edge of the golf course and floods the western half of Wall Street by the intersection of Rio Grande Street and Wall Street. **Table 4.4A** displays the WSE calculated through XP-STORM and **Table 4.4B** displays the inlet capacity analysis.

***E127-00-00, System D***

System D is the smallest drainage system in the Wall Street Neighborhood. It is located in the eastern corner of Wall Street. The outfall is a 28' long 36" CMP that discharges into E127-00-00 along Senate Avenue. The system is made up of curb and gutter and underground storm sewer. The two inlets at the intersection of Wall Street and Senate Avenue experience severe ponding during the 5-yr, 10-yr and 100-yr storm events. This is due to inadequate inlet capacity, undersized pipes and a high tail water in the adjacent channel. **Table 4.4A** shows the WSE values calculated in XP-STORM and **Table 4.4B** displays the inlet capacity analysis.

***Jersey Meadow Golf Course***

In addition to an undersized storm sewer system, another contributor to the high levels of ponding within the Wall Street Neighborhood was a significant amount of runoff from the adjacent Jersey Meadow Golf Course. The golf course was treated as a separate drainage area and modeled in XP-STORM. It was assumed the golf course has two outfalls: the outfall pipe running from the lowest point of the golf course into the adjacent E127-00-00 tributary and the sheet flow that goes from the golf course into the Wall Street Neighborhood. **Table 4.4C** shows the total discharge from each outfall location.

**Table 4.4C – Golf Course Outfall Flows**

| Storm Frequency | Golf Course Outfall Pipe Flow (cfs) | Overland Flow from Golf Course to Wall St (cfs) |
|---|---|---|
| 2-yr | 11 | 114 |
| 5-yr | 37 | 117 |
| 10-yr | 36 | 206 |
| 100-yr | 36 | 314 |

During the Jersey Village Long-term Flood Recovery Plan, one of the recommended solutions included building a berm around Jersey Meadow Golf Course to convert it into a multi-use facility that functions as a golf course and a detention pond during higher

frequency storm events. The berm serves a dual-purpose of mitigating for the Jersey Village area and blocking the sheet flow from entering the Wall Street Neighborhood for the 2-yr, 5-yr, 10-yr and 100-yr storm events. To further quantify the total impact the runoff from the golf course had on Wall St, it was assumed the final golf course berm layout had been completed with no improvements to the Wall St storm sewer system. This model eliminated the sheet flow entering Wall St from the golf course for each storm frequency. The elimination of the golf course flows significantly lowered the water surface elevations (WSE) throughout the neighborhood. **Table 4.4D** shows the comparison of WSEs for existing conditions with and without the proposed golf course berm. **Table 4.4E** illustrates the total discharge in the E100-00-00 and E127-00-00 channels with and without the golf course berm in existing conditions.

**Table 4.4E – Existing vs Existing (Final Berm Layout) Outfall Impact Table**

| Outfall Name | Outfall Channel | Existing Discharge (cfs) | | | | Existing Discharge [w/Final Berm] (cfs) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| AOUT | E100-00-00 | 29 | 31 | 30 | 25 | 29 | 31 | 30 | 25 |
| BOUT | E127-00-00 | 81 | 88 | 76 | 559 | 81 | 88 | 49 | 291 |
| DOUT | E127-00-00 | 9 | 11 | 64 | 528 | 9 | 11 | 35 | 429 |
| COUT | E127-00-00 | 43 | 43 | 29 | 31 | 34 | 36 | 21 | 27 |
| GOUT | E127-00-00 | 11 | 37 | 36 | 36 | 44 | 55 | 61 | 72 |
| | Total | 174 | 209 | 234 | 1,180 | 198 | 220 | 195 | 845 |

Overall, the results showed a significant improvement on the Wall Street Neighborhood by eliminating the sheet flow from the adjacent golf course. Although the flooding throughout the neighborhood was considerably reduced, it did not completely remove the ponding present during the 2-yr and 5-yr storm events. In order to reduce the WSE below the gutter line for 2-yr and 5-yr storm events, improvements to the existing storm sewer system need to be implemented.

# 5. Proposed Conditions

## 5.1. Description

The proposed improvements to the Wall Street Neighborhood storm sewer system include designing additional inlets, increasing the size of the existing inlets and removing and replacing the existing storm sewer with reinforced concrete pipe (RCP) of varying sizes. Sheet flow patterns for both systems will be preserved and inlets will be kept at existing low points with additional on-grade inlets in select locations. **Exhibit 6** displays the proposed drainage area map**. Exhibit 7** shows the proposed drainage systems. Another possible alternative to implementing an entirely new system would be to leave the existing storm sewer system in place and install a parallel storm sewer system under the road. For this analysis, only the removal and replacement of existing pipes were

considered. **Tables 5.1A** and **5.1B** provide a brief summary of the proposed system attributes.

**Table 5.1A – Proposed Storm Sewer Summary Table**

| Drainage System | Total Number of Inlets | | | Total # of Manholes | Total Amount of Storm Pipe (RCP) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | BB | BB [Grate] | C-2 | | 24" | 30" | 36" | 42" | 48" | 54" | 60" |
| A | - | 2 | 4 | 6 | 317 | 598 | - | - | - | - | - |
| B | 10 | - | 23 | 24 | 598 | 2,058 | 1,032 | 543 | 90 | 380 | 1,185 |
| C | - | 2 | 7 | 10 | 187 | 1,857 | - | 61 | - | - | - |
| Total | 10 | 4 | 34 | 40 | 1,102 | 4,491 | 1,032 | 604 | 90 | 380 | 1,185 |

**Table 5.1B – Proposed Outfall Summary Table**

| Outfall | Outfall Pipe Size | Outfall Channel |
|---|---|---|
| AOUT | 50' - 30" CMP | E100-00-00 |
| BOUTa | 170' - 42" CMP | E127-00-00 |
| BOUTb | 50' - 48" RCP | E127-00-00 |
| COUTa | 210' - 30" CMP | E127-00-00 |
| COUTb | 190' - 36" RCP | E127-00-00 |

***System A***

The proposed inlet capacity in System A was increased for most of the existing inlets to reduce street ponding. Each of the existing 'BB' inlets had a removable metal plate along the street in front of the inlets, which could be replaced for a grate increase the capacity of the inlet. A couple of 'BB' inlets in System A had a grate added to increase the inlets capacity from 5 cfs to 7.5 cfs. Drainage areas A5 and A6 were split by adding a 'C-2' inlet to each area. Most of the existing underground storm sewer for System A will remain in place with the exception of diverting the western most drainage areas in System A into System B. The flow from these drainage areas was added to System B to avoid any impacts on E100-00-00 from improving the inlet capacity of the existing system. The outfall for drainage system A remained unchanged.

***System B***

In addition to the added drainage area from System A being routed to System B, System D was joined with System B with the combined outfall located at the existing outfall for System D. The existing outfall for System B was left in place. The proposed inlet capacity was increased for most of the exiting inlets to reduce street ponding. The existing 'BB' inlets were replaced with a 'C-2' inlet to increase capacity on the west half of Tahoe Dr, along Capri Dr and at the intersection of Wall St and Senate Ave. Additional inlets were added along Tahoe Dr, Capri Dr and Wall St. The proposed inlets can be seen in **Exhibit 7**. The underground storm sewer system along the east half of Tahoe Dr was kept the same as existing. The main trunk line for System B runs south down Carlsbad St from Tahoe Dr to Wall St and the east along Wall St to Senate Ave. The existing outfall for System D was increased to accommodate the increased flow from the combined system and larger inlet capacities.

***System C***

The proposed drainage areas contributing to System C were equivalent to the existing drainage areas. The inlet capacity was increased for a few inlets by replacing them with a 'C-2' inlet. 'C-2' inlets were added along Crawford St and Wall St. The underground storm sewer system pipe sizes were increased along Crawford St. An outfall was proposed between two private residences along Wall St in addition to the existing System C outfall. The increased pipe sizes, additional outfall and improved inlet capacity were proposed to decrease street ponding for each storm frequency. In addition to the storm sewer system improvements, it was assumed the proposed berm for the Jersey Meadow Golf Course was completed. In existing conditions, the golf course was shown to be contributing a significant amount of flow to the western portion of Wall St, but with the inclusion of the berm design, this flow was eliminated. The existing System C outfall was left in place and tied into the proposed system.

## 5.2. Hydrologic Analysis

For the proposed plan, the street elevations for the proposed conditions were assumed equal to the existing street elevations, which would make the flow patterns similar to existing conditions. The drainage areas were delineated based on the existing drainage areas and any additional inlets needed to accommodate overland flow not accounted for in existing conditions. The proposed drainage areas are shown in **Exhibit 5**. The Rational Method was used to calculate the peak flows for the 2-yr, 5-yr, 10-yr and 100-yr storm events. The hydrographs for each drainage area were generated using the Clark Unit Hydrograph method in HEC-HMS. See **Appendix D** for the proposed hydrologic calculations. **Table 5.2A** compares the peak flows for existing and proposed conditions.

## 5.3. Hydraulic Analysis

XP-STORM was used to design the proposed pipe sizes, to determine the level of street ponding, and to perform an impact and outfall analysis. The hydrographs delineated from the Clark Unit Hydrograph method were used as flow inputs at proposed inlet locations. The tail water assumptions for proposed conditions were the same as existing conditions. Overall, the water surface elevations along the entire system dropped and the amount of street ponding decreased due to the proposed improvements. The system was completely contained below the gutter line for the 2-yr event and dropped below the top of curb for most areas in the 5-yr event. Although the 10-yr storm even was not contained within the top of curb, there was still an average drop in water surface elevations of around 0.6' calculated. **Table 5.3A** shows the drop in water surface elevation for proposed conditions.

In addition to analyzing the WSE's, the discharge into the channel needed to be analyzed as well. Two types of flow into the channel were accounted for when modeling each outfall: discharge from the pipe and overland flow from the street into the channel. Overland flow was only present during the 100-yr storm event. **Table 5.3B** compares the total existing and unmitigated proposed peak flows at each outfall generated from XP-STORM.

**Table 5.3B – Unmitigated Outfall Impact Analysis Table (With Overland Flow)**

| Proposed Drainage System | Area (ac) | Outfall Name | Outfall Channel | Existing Discharge (cfs) | | | | Unmitigated Proposed Discharge (cfs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| A | 13.9 | AOUT | E100-00-00 | 29 | 31 | 30 | 25 | 20 | 23 | 27 | 25 |
| B | 45.7 | BOUTa | E127-00-00 | 81 | 88 | 76 | 559 | 89 | 94 | 47 | 485 |
| | | BOUTb | E127-00-00 | 9 | 11 | 64 | 528 | 20 | 33 | 115 | 638 |
| C | 19.8 | COUTa | E127-00-00 | 43 | 43 | 29 | 31 | 42 | 42 | 27 | 30 |
| | | COUTb | E127-00-00 | - | - | - | - | 33 | 33 | 32 | 49 |
| Golf | 133.6 | GOUT | E127-00-00 | 11 | 37 | 36 | 36 | 11 | 37 | 36 | 36 |
| | | | Total | 174 | 209 | 234 | 1,180 | 215 | 262 | 284 | 1,264 |

According to XP-STORM, there were impacts at the outfall to E100-00-00 and an increase in flow discharged into E127-00-00, so mitigation was required. The proposed Jersey Meadow Golf Course berm was assumed to provide the necessary mitigation for the channel impacts. In order to check the overall flow of the channel did not increase with the combined storm sewer improvements and the construction of the berm, the Jersey Meadow Golf Course berm was modeled in XP-STORM to simulate the proposed mitigated conditions.

**Exhibit 8** shows the XP-STORM proposed model layout. **Table 5.3C** compares the outfall flow totals for existing and mitigated proposed conditions and demonstrates a drop in total discharge for each tributary.

**Table 5.3C – Mitigated Outfall Impact Analysis Table (With Overland Flow)**

| Proposed Drainage System | Area (ac) | Outfall Name | Outfall Channel | Existing Discharge (cfs) | | | | Mitigated Proposed Discharge (cfs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| A | 13.9 | AOUT | E100-00-00 | 29 | 31 | 30 | 25 | 20 | 23 | 27 | 23 |
| B | 45.7 | BOUTa | E127-00-00 | 81 | 88 | 76 | 559 | 89 | 94 | 17 | 294 |
| | | BOUTb | E127-00-00 | 9 | 11 | 64 | 528 | 20 | 33 | 77 | 675 |
| C | 19.8 | COUTa | E127-00-00 | 43 | 43 | 29 | 31 | 24 | 27 | 15 | 22 |
| | | COUTb | E127-00-00 | - | - | - | - | 14 | 17 | 18 | 37 |
| Golf | 133.6 | GOUT | E127-00-00 | 11 | 37 | 36 | 36 | 17 | 23 | 25 | 28 |
| | | | Total | 174 | 209 | 234 | 1,180 | 183 | 217 | 180 | 1,078 |

According to XP-STORM, the adverse impacts of the proposed drainage system improvements were mitigated with the use of the Jersey Meadow Golf Course for detention. In addition to mitigating for impacts, the existing overland flow from the Jersey Meadow Golf Course was prevented from entering the Wall St system with the construction of the berm. See **Appendix E** for the proposed hydraulic models.

***Jersey Village Golf Course Berm (Intermediary Design)***

In addition to analyzing the effect of the completed berm design around Jersey Meadow Golf Course, another alternative was analyzed with a smaller berm design located at the southeast portion of the golf course. The design would be two separate berms: one located parallel to Rio Grande St and the other protecting the houses at the southeast portion of the golf course. There would be an opening in between the two berms to allow flow to go into E127-00-00. The intermediary design is shown on **Exhibit 9**.

The berm would intercept the sheet flow from the golf course for the 2-yr and 5-yr storm events. Flow will over top the berm for the 10-yr and 100-yr storm events. The intermediary design would not provide the necessary mitigation required for the proposed storm sewer improvements so it could not substitute for the final berm design. The intermediary berm design would serve as a temporary solution to relieve flooding in the Wall Street Neighborhood for the 2-yr and 5-yr storm events. If the intermediary design is constructed in conjunction with the proposed Wall St improvements, additional mitigation would be required for any impacts to E127-00-00. **Table 5.3D** shows the WSEs for the intermediary berm design with the final proposed storm improvements. **Table 5.3E** shows the outfall impact analysis for existing conditions with and without the intermediary berm design.

**Table 5.3E – Intermediary Berm Design Outfall Impact Table**

| Outfall Name | Outfall Channel | Existing Discharge (cfs) | | | | Existing Discharge [w/Intermediary Berm] (cfs) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| AOUT | E100-00-00 | 29 | 31 | 30 | 25 | 29 | 31 | 30 | 25 |
| BOUT | E127-00-00 | 81 | 88 | 76 | 559 | 81 | 88 | 49 | 496 |
| DOUT | E127-00-00 | 9 | 11 | 64 | 528 | 9 | 11 | 35 | 500 |
| COUT | E127-00-00 | 43 | 43 | 29 | 31 | 34 | 36 | 24 | 29 |
| GOUT | E127-00-00 | 11 | 37 | 36 | 36 | 42 | 55 | 79 | 87 |
| | Total | 174 | 209 | 234 | 1,180 | 195 | 220 | 216 | 1,137 |

The intermediary berm design was shown to significantly lower the WSEs for the 2-yr and 5-yr storm events. There were some reductions calculated for the 10-yr storm event. Overall, the existing conditions with the intermediary berm design did not impact E100-00-00 and E127-00-00.

## 5.4. Detention Layout

***Jersey Meadow Golf Course Berm (Final Design)***

The Jersey Meadow Golf Course is a 134-acre facility located west of the project area adjacent to Rio Grande Street. In the Jersey Village Long-term Flood Recovery Plan, one of the recommended solutions was to convert Jersey Meadow into a multi-use facility for mitigation while simultaneously operating as a golf course. The proposed design was to construct a berm up to 107.3 feet in the lower section of the golf course. The storage

capacity of the Jersey Meadow Golf Course with the proposed berm is approximately 138 ac-ft. **Table 5.4A** shows the storage capacity available in the golf course.

**Table 5.4A – Jersey Meadow Golf Course Storage Capacity**

| Elevation (ft) | Surface Area (ac) | Storage (ac-ft) |
|---|---|---|
| 101.1 | 0.00 | 0.00 |
| 102 | 0.61 | 0.27 |
| 103 | 2.06 | 1.49 |
| 104 | 5.97 | 4.91 |
| 105 | 19.57 | 16.83 |
| 106 | 50.13 | 51.43 |
| 107 | 76.59 | 114.88 |
| 107.3 | 82.81 | 138.83 |

The golf course berm offered several benefits including providing mitigation for impacts to the E127-00-00 tributary and preventing sheet flow from flooding the Wall St system from the golf course. A 24” restrictor was added to the golf course outfall pipe to decrease the discharge into the E127-00-00 tributary. **Exhibit 10** shows the final berm layout for the proposed Jersey Meadow Golf Course. **Table 5.4B** shows the WSE in the golf course for each storm frequency.

**Table 5.4B – Jersey Meadow Golf Course WSE**

| Storm Event | WSE (ft) |
|---|---|
| 2-yr | 105.22 |
| 5-yr | 105.37 |
| 10-yr | 105.80 |
| 100-yr | 106.75 |

### 5.5. Right-of-Way Requirements

Most of the proposed improvements are within the Jersey Village ROW. Some additional ROW will need to be purchased to provide 20 feet of clearance for future maintenance for the proposed outfall in System C in between two private residences. Improvements will also occur within HCFCD ROW.

# 6. Conclusion

## 6.1. Final Recommendations

The final proposed plan analyzed showed a significant decrease in the level of ponding present throughout the Wall St Neighborhood for every storm event. The water surface elevation was lowered below the gutter line for the 2-yr storm event and below the top of curb for the 5-yr storm event with the exception of one area. The existing streets were

determined to be good condition so only the areas with an improvement storm sewer system were estimated to be repaved. **Exhibit 11** shows a typical street section. The proposed storm sewer system improvements were shown to have impacts to the adjacent E127-00-00 tributary so mitigation was necessary.

The addition of a berm around the Jersey Meadow Golf Course was used as offsite mitigation. The golf course berm served a dual-purpose of containing the overland flow previously entering the Wall St system from the golf course and providing the necessary mitigation for the proposed improvements to the storm sewer system. In addition to the final design of the berm, an intermediary design was proposed to help alleviate flooding temporarily while the storm sewer improvements are being implemented. The intermediary design would not provide the necessary mitigation for the proposed storm sewer improvements; it would only intersect the sheet flow from the golf course for the 2-yr and 5-yr storm events. The intermediary design would also serve as Phase 1 for the final design of the berm.

## 6.2. Preliminary Cost Estimate

A preliminary cost estimate was prepared based on the proposed improvements. It was assumed that the pavement would be fully replaced in drainage improvement areas along Wall St, Capri Dr, Tahoe Dr and western Crawford St. Half of the pavement along Carlsbad St will have to be replaced for the proposed storm sewer improvements. This estimate does not include specific utility relocation costs but there is a general allowance included for that possibility. Additionally, the replacement of the existing water line, sanitary line and street lamps are not included in this cost estimate. The proposed plan included an additional outfall located between two private residences along Wall St. The property acquisition allowance was estimated based on the square footage required from each parcel and the Harris County Appraisal District's (HCAD) land value for each property. The total project cost was estimated at **$5,478,904**. The detailed estimate is located in **Table 6.2A**.

## 6.3. Construction Phasing Plan

The construction of the project was broken into three phases based on the proposed drainage systems and the areas that would provide the most benefits. Phase one includes the storm sewer improvements located in System B along Wall St and improving the eastern most outfall located at Senate Ave and Wall St. Phase two includes the construction of the rest of the System B improvements. Phase three involves the implementation of the improvements to System A and System C. **Exhibit 12** illustrates the proposed construction phasing plan.

## Table 4.4A - Existing Hydraulic Analysis Results

**Project Name:** Wall Street Storm Sewer Study
**Location:** Jersey Village, Texas

| Existing System ID | Inlet | Gutter (ft) | Top of Curb (TOC, ft) | FFE (ft) | Existing Water Surface El (ft) | | | | Existing WSE - FFE (ft) | | | | Exist WSE - Gutter El (ft) | Exist WSE - TOC El. (ft) | | Exist WSE - TOC + 0.5' (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| System A | A1 | 101.81 | 102.63 | 104.24 | 101.87 | 102.04 | 102.13 | 103.79 | -2.37 | -2.20 | -2.11 | -0.45 | 0.06 | -0.59 | -0.50 | 0.66 |
| | A2 | 101.73 | 102.6 | 104.24 | 101.86 | 102.04 | 102.13 | 103.79 | -2.38 | -2.20 | -2.11 | -0.45 | 0.13 | -0.56 | -0.47 | 0.69 |
| | A3 | 101.23 | 102.11 | 103.9 | 101.29 | 101.38 | 102.06 | 103.82 | -2.62 | -2.52 | -1.84 | -0.08 | 0.05 | -0.73 | -0.05 | 1.21 |
| | A4 | 101.02 | 101.82 | 103.9 | 101.28 | 101.38 | 102.06 | 103.82 | -2.62 | -2.52 | -1.84 | -0.08 | 0.26 | -0.44 | 0.24 | 1.50 |
| | A5 | 100.56 | 101.22 | 102.77 | 100.46 | 100.83 | 102.06 | 104.05 | -2.31 | -1.94 | -0.71 | 1.28 | -0.10 | -0.39 | 0.84 | 2.33 |
| | A6 | 100.42 | 101.18 | 102.77 | 100.44 | 100.83 | 102.06 | 104.05 | -2.33 | -1.94 | -0.71 | 1.28 | 0.02 | -0.35 | 0.88 | 2.37 |
| System B | B1 | 100.42 | 101.24 | 102.72 | 100.72 | 100.90 | 102.25 | 103.67 | -2.00 | -1.82 | -0.47 | 0.95 | 0.30 | -0.34 | 1.01 | 1.93 |
| | B2 | 100.34 | 101.23 | 102.72 | 100.72 | 100.90 | 102.25 | 103.67 | -2.00 | -1.82 | -0.47 | 0.95 | 0.38 | -0.33 | 1.02 | 1.94 |
| | B3 | 100.46 | 101.06 | 103.08 | 100.71 | 100.89 | 102.25 | 103.67 | -2.38 | -2.19 | -0.83 | 0.59 | 0.25 | -0.17 | 1.19 | 2.11 |
| | B4 | 100.37 | 101.16 | 103.08 | 100.71 | 100.89 | 102.25 | 103.67 | -2.38 | -2.19 | -0.83 | 0.59 | 0.33 | -0.27 | 1.09 | 2.01 |
| | B5 | 100.38 | 101.21 | 103.52 | 100.66 | 100.85 | 102.25 | 103.67 | -2.86 | -2.67 | -1.27 | 0.15 | 0.28 | -0.36 | 1.04 | 1.96 |
| | B6 | 100.39 | 101.13 | 103.52 | 100.66 | 100.85 | 102.25 | 103.67 | -2.86 | -2.67 | -1.27 | 0.15 | 0.27 | -0.28 | 1.12 | 2.04 |
| | B7 | 100.25 | 101.05 | 103.85 | 100.65 | 100.84 | 102.25 | 103.67 | -3.21 | -3.01 | -1.60 | -0.18 | 0.39 | -0.21 | 1.20 | 2.12 |
| | B8 | 100.29 | 101.13 | 103.85 | 100.65 | 100.84 | 102.25 | 103.67 | -3.21 | -3.01 | -1.60 | -0.18 | 0.35 | -0.29 | 1.12 | 2.04 |
| | B9 | 100.5 | 101.31 | 103.93 | 100.68 | 100.91 | 102.25 | 103.67 | -3.25 | -3.02 | -1.68 | -0.26 | 0.18 | -0.40 | 0.94 | 1.86 |
| | B10 | 100.56 | 101.32 | 103.93 | 100.67 | 100.91 | 102.25 | 103.67 | -3.26 | -3.02 | -1.68 | -0.26 | 0.11 | -0.41 | 0.93 | 1.85 |
| | B11 | 100.32 | 101.19 | 103.88 | 99.91 | 100.13 | 102.24 | 103.67 | -3.97 | -3.75 | -1.64 | -0.21 | -0.41 | -1.06 | 1.05 | 1.98 |
| | B12 | 100.37 | 101.2 | 103.88 | 99.90 | 100.13 | 102.24 | 103.67 | -3.98 | -3.75 | -1.64 | -0.21 | -0.47 | -1.07 | 1.04 | 1.97 |
| | B13 | 100.1 | 100.83 | 103.59 | 99.25 | 99.57 | 102.24 | 103.42 | -4.34 | -4.02 | -1.35 | -0.17 | -0.85 | -1.26 | 1.41 | 2.09 |
| | B14 | 100.45 | 101.22 | 103.59 | 99.22 | 99.54 | 102.24 | 103.42 | -4.37 | -4.05 | -1.35 | -0.17 | -1.23 | -1.68 | 1.02 | 1.70 |
| | B15 | 99.55 | 100.3 | 102.96 | 99.69 | 99.99 | 102.24 | 103.43 | -3.27 | -2.97 | -0.72 | 0.47 | 0.14 | -0.31 | 1.94 | 2.63 |
| | B16 | 99.57 | 100.32 | 102.96 | 99.68 | 99.99 | 102.24 | 103.43 | -3.28 | -2.97 | -0.72 | 0.47 | 0.11 | -0.33 | 1.92 | 2.61 |
| | B17 | 99.59 | 100.44 | 102.69 | 99.89 | 99.86 | 102.23 | 103.39 | -2.80 | -2.83 | -0.46 | 0.70 | 0.30 | -0.58 | 1.79 | 2.45 |
| | B18 | 99.84 | 100.33 | 102.69 | 99.61 | 99.40 | 102.23 | 103.39 | -3.08 | -3.29 | -0.46 | 0.70 | -0.23 | -0.93 | 1.90 | 2.56 |
| | B19 | 99.67 | 100.5 | 101.66 | 97.03 | 97.15 | 102.24 | 103.40 | -4.63 | -4.51 | 0.58 | 1.74 | -2.64 | -3.35 | 1.74 | 2.40 |
| System C | C1 | 101.46 | 102.24 | 105.16 | 102.80 | 102.76 | 103.28 | 103.67 | -2.36 | -2.40 | -1.88 | -1.49 | 1.34 | 0.52 | 1.04 | 0.93 |
| | C2 | 101.59 | 102.34 | 105.16 | 102.80 | 102.76 | 103.28 | 103.67 | -2.36 | -2.40 | -1.88 | -1.49 | 1.21 | 0.42 | 0.94 | 0.83 |
| | C3 | 101.79 | 102.55 | 104.78 | 102.80 | 102.76 | 103.36 | 103.84 | -1.98 | -2.02 | -1.42 | -0.94 | 1.01 | 0.21 | 0.81 | 0.79 |
| | C4 | 100 | 100.74 | 104.27 | 102.80 | 102.79 | 103.36 | 103.88 | -1.47 | -1.48 | -0.91 | -0.39 | 2.80 | 2.05 | 2.62 | 2.64 |
| | C5 | 100.02 | 100.8 | 104.27 | 102.80 | 102.78 | 103.36 | 103.88 | -1.47 | -1.49 | -0.91 | -0.39 | 2.78 | 1.98 | 2.56 | 2.58 |
| | C6 | 100.72 | 101.22 | 104.27 | 102.88 | 102.87 | 103.36 | 103.88 | -1.39 | -1.41 | -0.91 | -0.39 | 2.16 | 1.65 | 2.14 | 2.16 |
| System D | D1 | 98.95 | 99.78 | 101.58 | 96.55 | 96.64 | 102.20 | 103.16 | -5.03 | -4.94 | 0.62 | 1.58 | -2.40 | -3.14 | 2.42 | 2.88 |
| | D2 | 99.12 | 99.9 | 101.58 | 96.56 | 96.64 | 102.20 | 103.16 | -5.02 | -4.94 | 0.62 | 1.58 | -2.57 | -3.26 | 2.30 | 2.76 |
| | D3 | 103.62 | 104.62 | 101.58 | 99.55 | 99.57 | 100.67 | 102.86 | -2.03 | -2.01 | -0.91 | 1.28 | -4.07 | -5.05 | -3.95 | -2.27 |

## Table 4.4B - Existing Inlet Analysis Table

**Project Name:** Wall Street Storm Sewer Study
**Location:** Jersey Village, Texas

| Existing Drainage System | Existing Drainage Area | Area (ac) | Inlet Capacity (cfs) | Existing Peak Flow (cfs) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 2-yr | 5-yr | 10-yr | 100-yr |
| A | A1 | 2.53 | 5.00 | 5.6 | 6.49 | 7.59 | 10.51 |
| | A2 | 2.45 | 5.00 | 5.3 | 6.15 | 7.19 | 9.97 |
| | A3 | 1.52 | 5.00 | 3.88 | 4.49 | 5.23 | 7.2 |
| | A4 | 1.36 | 5.00 | 3.38 | 3.91 | 4.56 | 6.28 |
| | A5 | 2.55 | 10.00 | 5.53 | 6.41 | 7.5 | 10.39 |
| | A6 | 3.51 | 10.00 | 7.49 | 8.69 | 10.17 | 14.1 |
| B | B1 | 0.90 | 5.00 | 2.32 | 2.68 | 3.13 | 4.3 |
| | B2 | 0.88 | 5.00 | 2.22 | 2.57 | 3 | 4.12 |
| | B3 | 1.27 | 5.00 | 3.21 | 3.71 | 4.33 | 5.95 |
| | B4 | 0.90 | 5.00 | 2.15 | 2.49 | 2.9 | 4.01 |
| | B5 | 0.62 | 5.00 | 1.55 | 1.79 | 2.09 | 2.87 |
| | B6 | 0.68 | 5.00 | 1.67 | 1.94 | 2.26 | 3.11 |
| | B7 | 1.15 | 5.00 | 2.96 | 3.43 | 3.99 | 5.49 |
| | B8 | 0.73 | 5.00 | 1.8 | 2.08 | 2.43 | 3.35 |
| | B9 | 3.45 | 5.00 | 7.09 | 8.22 | 9.63 | 13.38 |
| | B10 | 2.17 | 5.00 | 4.95 | 5.73 | 6.7 | 9.26 |
| | B11 | 0.79 | 5.00 | 2.02 | 2.34 | 2.73 | 3.75 |
| | B12 | 0.58 | 5.00 | 1.41 | 1.63 | 1.9 | 2.62 |
| | B13 | 2.59 | 5.00 | 5.45 | 6.32 | 7.4 | 10.27 |
| | B14 | 3.81 | 5.00 | 7.04 | 8.18 | 9.61 | 13.41 |
| | B15 | 3.30 | 5.00 | 7.18 | 8.32 | 9.73 | 13.48 |
| | B16 | 3.11 | 5.00 | 6.44 | 7.48 | 8.76 | 12.16 |
| | B17 | 3.48 | 5.00 | 6.78 | 7.88 | 9.24 | 12.87 |
| | B18 | 5.72 | 5.00 | 12.46 | 14.44 | 16.89 | 23.41 |
| | B19 | 5.27 | 5.00 | 11.67 | 13.53 | 15.82 | 21.9 |
| C | C1 | 1.19 | 5.00 | 2.8 | 3.25 | 3.79 | 5.23 |
| | C2 | 1.24 | 5.00 | 2.82 | 3.26 | 3.81 | 5.27 |
| | C3 | 5.38 | 5.00 | 11.01 | 12.78 | 14.97 | 20.8 |
| | C4 | 1.18 | 5.00 | 2.9 | 3.36 | 3.91 | 5.39 |
| | C5 | 2.41 | 5.00 | 5.3 | 6.14 | 7.18 | 9.95 |
| | C6 | 8.43 | 5.19 | 15.23 | 17.71 | 20.81 | 29.08 |
| D | D1 | 1.02 | 7.50 | 2.28 | 2.64 | 3.09 | 4.28 |
| | D2 | 3.15 | 5.00 | 6.87 | 7.96 | 9.31 | 12.9 |
| | D3 | 0.15 | 10.00 | 0.47 | 0.55 | 0.63 | 0.86 |

Inlet Capacity < Existing Peak Flow

## Table 4.4D - Existing Hydraulic Analysis Results (With Final Berm Design)

**Project Name:** Wall Street Storm Sewer Study
**Location:** Jersey Village, Texas

| Existing System ID | Inlet | Gutter (ft) | Top of Curb (TOC, ft) | FFE (ft) | Existing Water Surface El (ft) | | | | Existing WSE (w/final berm) (ft) | | | | Existing (w/final berm) - Existing (ft) | | | | Existing (w/final berm) WSE - FFE (ft) | | | | Exist WSE - Gutter El (ft) | Exist WSE - TOC El. (ft) | | Exist WSE - TOC + 0.5' (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| System A | A1 | 101.81 | 102.63 | 104.24 | 101.87 | 102.04 | 102.13 | 103.79 | 101.87 | 102.04 | 102.13 | 103.72 | 0.00 | 0.00 | 0.00 | -0.07 | -2.37 | -2.20 | -2.11 | -0.52 | 0.06 | -0.59 | -0.50 | 0.59 |
| | A2 | 101.73 | 102.6 | 104.24 | 101.86 | 102.04 | 102.13 | 103.79 | 101.86 | 102.04 | 102.13 | 103.72 | 0.00 | 0.00 | 0.00 | -0.07 | -2.38 | -2.20 | -2.11 | -0.52 | 0.13 | -0.56 | -0.47 | 0.62 |
| | A3 | 101.23 | 102.11 | 103.9 | 101.29 | 101.38 | 102.06 | 103.82 | 101.29 | 101.38 | 101.96 | 103.76 | 0.00 | 0.00 | -0.09 | -0.06 | -2.62 | -2.52 | -1.94 | -0.14 | 0.05 | -0.73 | -0.15 | 1.15 |
| | A4 | 101.02 | 101.82 | 103.9 | 101.28 | 101.38 | 102.06 | 103.82 | 101.28 | 101.38 | 101.96 | 103.76 | 0.00 | 0.00 | -0.09 | -0.06 | -2.62 | -2.52 | -1.94 | -0.14 | 0.26 | -0.44 | 0.14 | 1.44 |
| | A5 | 100.56 | 101.22 | 102.77 | 100.46 | 100.83 | 102.06 | 104.05 | 100.46 | 100.83 | 101.96 | 104.05 | 0.00 | 0.00 | -0.09 | 0.00 | -2.31 | -1.94 | -0.81 | 1.28 | -0.10 | -0.39 | 0.74 | 2.33 |
| | A6 | 100.42 | 101.18 | 102.77 | 100.44 | 100.83 | 102.06 | 104.05 | 100.44 | 100.83 | 101.96 | 104.05 | 0.00 | 0.00 | -0.09 | 0.00 | -2.33 | -1.94 | -0.81 | 1.28 | 0.02 | -0.35 | 0.78 | 2.37 |
| System B | B1 | 100.42 | 101.24 | 102.72 | 100.72 | 100.90 | 102.25 | 103.67 | 100.72 | 100.90 | 101.54 | 103.22 | 0.00 | 0.00 | -0.71 | -0.45 | -2.00 | -1.82 | -1.18 | 0.50 | 0.30 | -0.34 | 0.30 | 1.48 |
| | B2 | 100.34 | 101.23 | 102.72 | 100.72 | 100.90 | 102.25 | 103.67 | 100.72 | 100.90 | 101.54 | 103.22 | 0.00 | 0.00 | -0.71 | -0.45 | -2.00 | -1.82 | -1.18 | 0.50 | 0.38 | -0.33 | 0.31 | 1.49 |
| | B3 | 100.46 | 101.06 | 103.08 | 100.71 | 100.89 | 102.25 | 103.67 | 100.71 | 100.89 | 101.54 | 103.22 | 0.00 | 0.00 | -0.71 | -0.45 | -2.38 | -2.19 | -1.54 | 0.14 | 0.25 | -0.17 | 0.48 | 1.66 |
| | B4 | 100.37 | 101.16 | 103.08 | 100.71 | 100.89 | 102.25 | 103.67 | 100.71 | 100.89 | 101.54 | 103.22 | 0.00 | 0.00 | -0.71 | -0.45 | -2.38 | -2.19 | -1.54 | 0.14 | 0.33 | -0.27 | 0.38 | 1.56 |
| | B5 | 100.38 | 101.21 | 103.52 | 100.66 | 100.85 | 102.25 | 103.67 | 100.66 | 100.85 | 101.54 | 103.22 | 0.00 | 0.00 | -0.71 | -0.45 | -2.86 | -2.67 | -1.98 | -0.30 | 0.28 | -0.36 | 0.33 | 1.51 |
| | B6 | 100.39 | 101.13 | 103.52 | 100.66 | 100.85 | 102.25 | 103.67 | 100.66 | 100.85 | 101.54 | 103.22 | 0.00 | 0.00 | -0.71 | -0.45 | -2.86 | -2.67 | -1.98 | -0.30 | 0.27 | -0.28 | 0.41 | 1.59 |
| | B7 | 100.25 | 101.05 | 103.85 | 100.65 | 100.84 | 102.25 | 103.67 | 100.65 | 100.84 | 101.54 | 103.22 | 0.00 | 0.00 | -0.71 | -0.46 | -3.21 | -3.01 | -2.31 | -0.63 | 0.39 | -0.21 | 0.49 | 1.67 |
| | B8 | 100.29 | 101.13 | 103.85 | 100.65 | 100.84 | 102.25 | 103.67 | 100.65 | 100.84 | 101.54 | 103.22 | 0.00 | 0.00 | -0.71 | -0.46 | -3.21 | -3.01 | -2.31 | -0.63 | 0.35 | -0.29 | 0.41 | 1.59 |
| | B9 | 100.5 | 101.31 | 103.93 | 100.68 | 100.91 | 102.25 | 103.67 | 100.68 | 100.91 | 101.54 | 103.21 | 0.00 | 0.00 | -0.71 | -0.46 | -3.25 | -3.02 | -2.39 | -0.72 | 0.18 | -0.40 | 0.23 | 1.40 |
| | B10 | 100.56 | 101.32 | 103.93 | 100.67 | 100.91 | 102.25 | 103.67 | 100.67 | 100.91 | 101.54 | 103.21 | 0.00 | 0.00 | -0.71 | -0.46 | -3.26 | -3.02 | -2.39 | -0.72 | 0.11 | -0.41 | 0.22 | 1.39 |
| | B11 | 100.32 | 101.19 | 103.88 | 99.91 | 100.13 | 102.24 | 103.67 | 99.91 | 100.13 | 101.52 | 103.21 | 0.00 | 0.00 | -0.72 | -0.46 | -3.97 | -3.75 | -2.36 | -0.67 | -0.41 | -1.06 | 0.33 | 1.52 |
| | B12 | 100.37 | 101.2 | 103.88 | 99.90 | 100.13 | 102.24 | 103.67 | 99.90 | 100.13 | 101.52 | 103.21 | 0.00 | 0.00 | -0.72 | -0.46 | -3.98 | -3.75 | -2.36 | -0.67 | -0.47 | -1.07 | 0.32 | 1.51 |
| | B13 | 100.1 | 100.83 | 103.59 | 99.25 | 99.57 | 102.24 | 103.42 | 99.25 | 99.57 | 101.52 | 103.18 | 0.00 | 0.00 | -0.72 | -0.24 | -4.34 | -4.02 | -2.07 | -0.41 | -0.85 | -1.26 | 0.69 | 1.85 |
| | B14 | 100.45 | 101.22 | 103.59 | 99.22 | 99.54 | 102.24 | 103.42 | 99.23 | 99.54 | 101.52 | 103.18 | 0.00 | 0.00 | -0.72 | -0.24 | -4.37 | -4.05 | -2.07 | -0.41 | -1.23 | -1.68 | 0.30 | 1.46 |
| | B15 | 99.55 | 100.3 | 102.96 | 99.69 | 99.99 | 102.24 | 103.43 | 99.69 | 99.99 | 101.52 | 103.18 | 0.00 | 0.00 | -0.72 | -0.25 | -3.27 | -2.97 | -1.44 | 0.22 | 0.14 | -0.31 | 1.22 | 2.38 |
| | B16 | 99.57 | 100.32 | 102.96 | 99.68 | 99.99 | 102.24 | 103.43 | 99.68 | 99.99 | 101.52 | 103.18 | 0.00 | 0.00 | -0.72 | -0.25 | -3.28 | -2.97 | -1.44 | 0.22 | 0.11 | -0.33 | 1.20 | 2.36 |
| | B17 | 99.59 | 100.44 | 102.69 | 99.89 | 99.86 | 102.23 | 103.39 | 97.60 | 97.76 | 101.41 | 103.17 | -2.29 | -2.10 | -0.83 | -0.22 | -5.09 | -4.93 | -1.28 | 0.48 | -1.99 | -2.68 | 0.97 | 2.23 |
| | B18 | 99.84 | 100.33 | 102.69 | 99.61 | 99.40 | 102.23 | 103.39 | 97.54 | 97.70 | 101.41 | 103.17 | -2.07 | -1.70 | -0.82 | -0.22 | -5.15 | -4.99 | -1.28 | 0.48 | -2.30 | -2.63 | 1.08 | 2.34 |
| | B19 | 99.67 | 100.5 | 101.66 | 97.03 | 97.15 | 102.24 | 103.40 | 97.03 | 97.15 | 101.41 | 103.18 | 0.00 | 0.00 | -0.82 | -0.23 | -4.63 | -4.51 | -0.25 | 1.52 | -2.64 | -3.35 | 0.91 | 2.18 |
| System C | C1 | 101.46 | 102.24 | 105.16 | 102.80 | 102.76 | 103.28 | 103.67 | 101.73 | 102.03 | 102.52 | 103.22 | -1.07 | -0.73 | -0.76 | -0.45 | -3.43 | -3.13 | -2.64 | -1.94 | 0.27 | -0.21 | 0.28 | 0.48 |
| | C2 | 101.59 | 102.34 | 105.16 | 102.80 | 102.76 | 103.28 | 103.67 | 101.73 | 102.03 | 102.52 | 103.22 | -1.07 | -0.73 | -0.76 | -0.45 | -3.43 | -3.13 | -2.64 | -1.94 | 0.14 | -0.31 | 0.18 | 0.38 |
| | C3 | 101.79 | 102.55 | 104.78 | 102.80 | 102.76 | 103.36 | 103.84 | 101.83 | 102.04 | 102.52 | 103.22 | -0.97 | -0.72 | -0.84 | -0.62 | -2.95 | -2.74 | -2.26 | -1.56 | 0.04 | -0.51 | -0.03 | 0.17 |
| | C4 | 100 | 100.74 | 104.27 | 102.80 | 102.79 | 103.36 | 103.88 | 100.45 | 100.83 | 102.63 | 103.22 | -2.36 | -1.96 | -0.74 | -0.65 | -3.82 | -3.44 | -1.64 | -1.05 | 0.45 | 0.09 | 1.89 | 1.98 |
| | C5 | 100.02 | 100.8 | 104.27 | 102.80 | 102.78 | 103.36 | 103.88 | 100.45 | 100.83 | 102.62 | 103.22 | -2.36 | -1.96 | -0.74 | -0.65 | -3.82 | -3.44 | -1.65 | -1.05 | 0.43 | 0.03 | 1.82 | 1.92 |
| | C6 | 100.72 | 101.22 | 104.27 | 102.88 | 102.87 | 103.36 | 103.88 | 100.38 | 100.80 | 102.70 | 103.22 | -2.50 | -2.07 | -0.67 | -0.66 | -3.89 | -3.47 | -1.57 | -1.05 | -0.34 | -0.42 | 1.48 | 1.50 |
| System D | D1 | 98.95 | 99.78 | 101.58 | 96.55 | 96.64 | 102.20 | 103.16 | 96.55 | 96.64 | 101.19 | 102.98 | 0.00 | 0.00 | -1.01 | -0.19 | -5.03 | -4.94 | -0.39 | 1.40 | -2.40 | -3.14 | 1.41 | 2.70 |
| | D2 | 99.12 | 99.9 | 101.58 | 96.56 | 96.64 | 102.20 | 103.16 | 96.56 | 96.64 | 101.19 | 102.98 | 0.00 | 0.00 | -1.01 | -0.19 | -5.02 | -4.94 | -0.39 | 1.40 | -2.57 | -3.26 | 1.29 | 2.58 |
| | D3 | 103.62 | 104.62 | 101.58 | 99.55 | 99.57 | 100.67 | 102.86 | 99.55 | 99.57 | 100.56 | 102.89 | 0.00 | 0.00 | -0.11 | 0.04 | -2.03 | -2.01 | -1.02 | 1.31 | -4.07 | -5.05 | -4.06 | -2.23 |

## Table 5.2A - Peak Flow Comparison Table

**Project Name:** Wall Street Storm Sewer Study
**Location:** Jersey Village, Texas

| Existing Drainage System | Existing Drainage Area | Proposed Drainage Area | Area (ac) | Existing Peak Flow (cfs) | | | | Proposed Peak Flow (cfs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| A | A1 | A1 | 2.53 | 5.6 | 6.49 | 7.59 | 10.51 | 5.6 | 6.49 | 7.59 | 10.51 |
| | A2 | A2 | 2.45 | 5.3 | 6.15 | 7.19 | 9.97 | 5.3 | 6.15 | 7.19 | 9.97 |
| | A3 | A3 | 1.52 | 3.88 | 4.49 | 5.23 | 7.2 | 3.88 | 4.49 | 5.23 | 7.2 |
| | A4 | A4 | 1.36 | 3.38 | 3.91 | 4.56 | 6.28 | 3.38 | 3.91 | 4.56 | 6.28 |
| | A5 | A5a | 1.69 | 5.53 | 6.41 | 7.5 | 10.39 | 3.66 | 4.25 | 4.97 | 6.89 |
| | | A5b | 0.86 | | | | | 1.86 | 2.16 | 2.53 | 3.5 |
| | A6 | A6a | 2.29 | 7.49 | 8.69 | 10.17 | 14.1 | 4.89 | 5.67 | 6.64 | 9.2 |
| | | A6b | 1.22 | | | | | 2.6 | 3.02 | 3.53 | 4.9 |
| B | B1 | B1 | 0.9 | 2.32 | 2.68 | 3.13 | 4.3 | 2.32 | 2.68 | 3.13 | 4.3 |
| | B2 | B2 | 0.88 | 2.22 | 2.57 | 3 | 4.12 | 2.22 | 2.57 | 3 | 4.12 |
| | B3 | B3 | 1.27 | 3.21 | 3.71 | 4.33 | 5.95 | 3.21 | 3.71 | 4.33 | 5.95 |
| | B4 | B4 | 0.9 | 2.15 | 2.49 | 2.9 | 4.01 | 2.15 | 2.49 | 2.9 | 4.01 |
| | B5 | B5 | 0.62 | 1.55 | 1.79 | 2.09 | 2.87 | 1.55 | 1.79 | 2.09 | 2.87 |
| | B6 | B6 | 0.68 | 1.67 | 1.94 | 2.26 | 3.11 | 1.67 | 1.94 | 2.26 | 3.11 |
| | B7 | B7 | 1.15 | 2.96 | 3.43 | 3.99 | 5.49 | 2.96 | 3.43 | 3.99 | 5.49 |
| | B8 | B8 | 0.73 | 1.8 | 2.08 | 2.43 | 3.35 | 1.8 | 2.08 | 2.43 | 3.35 |
| | B9 | B9a | 1.59 | 7.09 | 8.22 | 9.63 | 13.38 | 3.27 | 3.79 | 4.44 | 6.17 |
| | | B9b | 1.86 | | | | | 3.82 | 4.43 | 5.19 | 7.21 |
| | B10 | B10a | 0.87 | 4.95 | 5.73 | 6.7 | 9.26 | 1.98 | 2.3 | 2.69 | 3.71 |
| | | B10b | 1.3 | | | | | 2.96 | 3.43 | 4.01 | 5.55 |
| | B11 | B11 | 0.79 | 2.02 | 2.34 | 2.73 | 3.75 | 2.02 | 2.34 | 2.73 | 3.75 |
| | B12 | B12 | 0.58 | 1.41 | 1.63 | 1.9 | 2.62 | 1.41 | 1.63 | 1.9 | 2.62 |
| | B13 | B13a | 1.02 | 5.45 | 6.32 | 7.4 | 10.27 | 2.15 | 2.49 | 2.92 | 4.05 |
| | | B13b | 1.57 | | | | | 3.3 | 3.83 | 4.49 | 6.23 |
| | B14 | B14a | 1.78 | 7.04 | 8.18 | 9.61 | 13.41 | 3.29 | 3.82 | 4.49 | 6.27 |
| | | B14b | 2.03 | | | | | 3.75 | 4.36 | 5.12 | 7.15 |
| | B15 | B15a | 1.66 | 7.18 | 8.32 | 9.73 | 13.48 | 3.61 | 4.18 | 4.9 | 6.78 |
| | | B15b | 1.64 | | | | | 3.57 | 4.13 | 4.84 | 6.7 |
| | B16 | B16a | 1.44 | 6.44 | 7.48 | 8.76 | 12.16 | 2.98 | 3.46 | 4.05 | 5.63 |
| | | B16b | 1.67 | | | | | 3.46 | 4.02 | 4.7 | 6.53 |
| | B17 | B17a | 1.49 | 6.78 | 7.88 | 9.24 | 12.87 | 2.9 | 3.37 | 3.96 | 5.51 |
| | | B17b | 1.99 | | | | | 3.88 | 4.51 | 5.28 | 7.36 |
| | B18 | B18a | 2.62 | 12.46 | 14.44 | 16.89 | 23.41 | 5.71 | 6.61 | 7.74 | 10.72 |
| | | B18b | 3.1 | | | | | 6.75 | 7.83 | 9.16 | 12.68 |
| | B19 | B19a | 2.14 | 11.67 | 13.53 | 15.82 | 21.9 | 4.74 | 5.49 | 6.42 | 8.89 |
| | | B19b | 3.13 | | | | | 6.93 | 8.03 | 9.39 | 13 |
| C | C1 | C1 | 1.19 | 2.8 | 3.25 | 3.79 | 5.23 | 2.8 | 3.25 | 3.79 | 5.23 |
| | C2 | C2 | 1.24 | 2.82 | 3.26 | 3.81 | 5.27 | 2.82 | 3.26 | 3.81 | 5.27 |
| | C3 | C3a | 3.35 | 11.01 | 12.78 | 14.97 | 20.8 | 6.85 | 7.96 | 9.32 | 12.95 |
| | | C3b | 2.03 | | | | | 4.15 | 4.82 | 5.65 | 7.85 |
| | C4 | C4 | 1.18 | 2.9 | 3.36 | 3.91 | 5.39 | 2.9 | 3.36 | 3.91 | 5.39 |
| | C5 | C5 | 2.41 | 5.3 | 6.14 | 7.18 | 9.95 | 5.3 | 6.14 | 7.18 | 9.95 |
| | C6 | C6a | 3.53 | 15.23 | 17.71 | 20.81 | 29.08 | 6.38 | 7.42 | 8.71 | 12.18 |
| | | C6b | 3.6 | | | | | 6.5 | 7.56 | 8.89 | 12.42 |
| | | C6c | 1.3 | | | | | 2.35 | 2.73 | 3.21 | 4.48 |
| D | D1 | D1 | 1.02 | 2.28 | 2.64 | 3.09 | 4.28 | 2.28 | 2.64 | 3.09 | 4.28 |
| | D2 | D2 | 3.15 | 6.87 | 7.96 | 9.31 | 12.9 | 6.87 | 7.96 | 9.31 | 12.9 |
| | D3 | D3 | 0.15 | 0.47 | 0.55 | 0.63 | 0.86 | 0.47 | 0.55 | 0.63 | 0.86 |

## Table 5.3A - Proposed Hydraulic Analysis Results

**Project Name:** Wall Street Storm Sewer Study
**Location:** Jersey Village, Texas

| Proposed System ID | Inlet | Gutter (ft) | Top of Curb (TOC, ft) | FFE (ft) | Proposed (Unmitigated) Water Surface Elevation (ft) | | | | Proposed Water Surface Elevation (ft) | | | | Proposed WSE - Existing WSE | | | | Proposed WSE - FFE (ft) | | | | Prop WSE - Gutter El (ft) | Prop WSE - TOC El. (ft) | | Prop WSE - TOC + 0.5' (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| System A | A3 | 101.23 | 102.11 | 103.9 | 98.34 | 98.94 | 101.86 | 103.97 | 98.34 | 98.94 | 101.86 | 103.72 | -2.95 | -2.44 | -0.20 | -0.10 | -5.56 | -4.96 | -2.05 | -0.18 | -2.89 | -3.17 | -0.25 | 1.11 |
| | A4 | 101.02 | 101.82 | 103.9 | 98.31 | 98.93 | 101.86 | 103.97 | 98.31 | 98.93 | 101.86 | 103.72 | -2.97 | -2.45 | -0.20 | -0.10 | -5.59 | -4.97 | -2.05 | -0.18 | -2.71 | -2.89 | 0.04 | 1.40 |
| | A5a | 100.56 | 101.22 | 102.77 | 98.17 | 98.66 | 101.86 | 104.06 | 98.17 | 98.66 | 101.86 | 104.06 | -2.29 | -2.17 | -0.20 | 0.01 | -4.60 | -4.11 | -0.91 | 1.29 | -2.39 | -2.56 | 0.64 | 2.34 |
| | A6a | 100.42 | 101.18 | 102.77 | 98.18 | 98.65 | 101.86 | 104.06 | 98.18 | 98.65 | 101.86 | 104.06 | -2.26 | -2.18 | -0.20 | 0.01 | -4.59 | -4.12 | -0.91 | 1.29 | -2.24 | -2.53 | 0.67 | 2.38 |
| | A5b | 101.67 | 102.12 | 102.77 | 97.73 | 97.95 | 101.86 | 104.06 | 97.73 | 97.95 | 101.86 | 104.06 | - | - | - | - | -5.04 | -4.82 | -0.91 | 1.29 | -3.94 | -4.17 | -0.27 | 1.44 |
| | A6b | 101.47 | 102.03 | 102.77 | 97.73 | 97.95 | 101.86 | 104.06 | 97.73 | 97.95 | 101.86 | 104.06 | - | - | - | - | -5.04 | -4.82 | -0.91 | 1.29 | -3.74 | -4.08 | -0.17 | 1.53 |
| System B | A1 | 101.81 | 102.63 | 104.24 | 98.75 | 99.45 | 101.91 | 103.95 | 98.75 | 99.45 | 101.63 | 103.68 | -3.12 | -2.59 | -0.50 | -0.11 | -5.49 | -4.79 | -2.61 | -0.56 | -3.06 | -3.18 | -1.00 | 0.55 |
| | A2 | 101.73 | 102.6 | 104.24 | 98.76 | 99.47 | 101.92 | 103.95 | 98.76 | 99.47 | 101.65 | 103.68 | -3.10 | -2.57 | -0.48 | -0.11 | -5.48 | -4.77 | -2.59 | -0.56 | -2.97 | -3.13 | -0.95 | 0.58 |
| | B1 | 100.42 | 101.24 | 102.72 | 98.89 | 99.65 | 101.73 | 103.79 | 98.89 | 99.65 | 101.36 | 103.26 | -1.83 | -1.24 | -0.89 | -0.41 | -3.83 | -3.07 | -1.36 | 0.54 | -1.53 | -1.59 | 0.12 | 1.52 |
| | B2 | 100.34 | 101.23 | 102.72 | 98.89 | 99.65 | 101.73 | 103.79 | 98.89 | 99.65 | 101.36 | 103.26 | -1.84 | -1.25 | -0.89 | -0.41 | -3.83 | -3.07 | -1.36 | 0.54 | -1.45 | -1.58 | 0.13 | 1.53 |
| | B3 | 100.46 | 101.06 | 103.08 | 98.85 | 99.62 | 101.73 | 103.79 | 98.85 | 99.62 | 101.33 | 103.26 | -1.86 | -1.27 | -0.92 | -0.41 | -4.23 | -3.47 | -1.75 | 0.18 | -1.61 | -1.45 | 0.27 | 1.70 |
| | B4 | 100.37 | 101.16 | 103.08 | 98.84 | 99.61 | 101.73 | 103.79 | 98.84 | 99.61 | 101.33 | 103.26 | -1.86 | -1.28 | -0.92 | -0.41 | -4.24 | -3.47 | -1.75 | 0.18 | -1.53 | -1.55 | 0.17 | 1.60 |
| | B5 | 100.38 | 101.21 | 103.52 | 98.76 | 99.49 | 101.73 | 103.79 | 98.76 | 99.49 | 101.36 | 103.26 | -1.91 | -1.36 | -0.89 | -0.41 | -4.76 | -4.03 | -2.16 | -0.26 | -1.62 | -1.72 | 0.15 | 1.55 |
| | B6 | 100.39 | 101.13 | 103.52 | 98.76 | 99.49 | 101.73 | 103.79 | 98.76 | 99.49 | 101.36 | 103.26 | -1.91 | -1.36 | -0.89 | -0.41 | -4.76 | -4.03 | -2.16 | -0.26 | -1.63 | -1.64 | 0.23 | 1.63 |
| | B7 | 100.25 | 101.05 | 103.85 | 98.73 | 99.44 | 101.73 | 103.78 | 98.73 | 99.44 | 101.36 | 103.26 | -1.91 | -1.40 | -0.89 | -0.41 | -5.12 | -4.41 | -2.49 | -0.59 | -1.52 | -1.61 | 0.31 | 1.71 |
| | B8 | 100.29 | 101.13 | 103.85 | 98.73 | 99.44 | 101.73 | 103.78 | 98.73 | 99.44 | 101.36 | 103.26 | -1.91 | -1.40 | -0.89 | -0.41 | -5.12 | -4.41 | -2.49 | -0.59 | -1.56 | -1.69 | 0.23 | 1.63 |
| | B9a | 101.65 | 102.15 | 104.23 | 98.52 | 99.15 | 102.28 | 103.78 | 98.52 | 99.15 | 101.37 | 103.25 | - | - | - | - | -5.71 | -5.08 | -2.86 | -0.98 | -3.13 | -3.00 | -0.78 | 0.60 |
| | B10a | 101.73 | 102.23 | 104.23 | 98.51 | 99.14 | 102.28 | 103.78 | 98.51 | 99.14 | 101.36 | 103.25 | - | - | - | - | -5.72 | -5.09 | -2.87 | -0.98 | -3.22 | -3.09 | -0.87 | 0.52 |
| | B9b | 100.5 | 101.31 | 103.93 | 98.48 | 99.06 | 101.74 | 103.79 | 98.48 | 99.06 | 101.35 | 103.26 | -2.20 | -1.85 | -0.90 | -0.41 | -5.45 | -4.87 | -2.58 | -0.67 | -2.02 | -2.25 | 0.04 | 1.45 |
| | B10b | 100.56 | 101.32 | 103.93 | 98.47 | 99.06 | 101.74 | 103.79 | 98.47 | 99.06 | 101.35 | 103.26 | -2.21 | -1.86 | -0.90 | -0.41 | -5.46 | -4.87 | -2.58 | -0.67 | -2.09 | -2.26 | 0.03 | 1.44 |
| | B11 | 100.32 | 101.19 | 103.88 | 98.09 | 98.57 | 101.61 | 103.78 | 98.09 | 98.57 | 101.28 | 103.25 | -1.81 | -1.56 | -0.96 | -0.42 | -5.79 | -5.31 | -2.60 | -0.63 | -2.23 | -2.62 | 0.09 | 1.56 |
| | B12 | 100.37 | 101.2 | 103.88 | 98.09 | 98.57 | 101.61 | 103.78 | 98.09 | 98.57 | 101.28 | 103.25 | -1.81 | -1.56 | -0.96 | -0.42 | -5.79 | -5.31 | -2.60 | -0.63 | -2.28 | -2.63 | 0.08 | 1.55 |
| | B13a | 102.12 | 102.62 | 103.59 | 98.07 | 98.28 | 101.56 | 103.42 | 98.07 | 98.28 | 101.30 | 103.23 | - | - | - | - | -5.52 | -5.31 | -2.29 | -0.36 | -4.05 | -4.34 | -1.32 | 0.11 |
| | B14a | 102.16 | 102.66 | 103.59 | 98.07 | 98.28 | 101.56 | 103.42 | 98.07 | 98.28 | 101.30 | 103.23 | - | - | - | - | -5.52 | -5.31 | -2.30 | -0.36 | -4.09 | -4.38 | -1.36 | 0.07 |
| | B13b | 100.1 | 100.83 | 103.59 | 97.65 | 97.99 | 101.56 | 103.41 | 97.65 | 97.99 | 101.27 | 103.23 | -1.59 | -1.58 | -0.97 | -0.20 | -5.94 | -5.61 | -2.32 | -0.36 | -2.45 | -2.85 | 0.44 | 1.90 |
| | B14b | 100.45 | 101.22 | 103.59 | 97.69 | 98.00 | 101.56 | 103.41 | 97.69 | 98.00 | 101.27 | 103.23 | -1.53 | -1.55 | -0.97 | -0.20 | -5.90 | -5.59 | -2.32 | -0.36 | -2.76 | -3.22 | 0.05 | 1.51 |
| | B15a | 100.16 | 100.61 | 102.22 | 97.80 | 98.12 | 101.56 | 103.41 | 97.80 | 98.12 | 101.27 | 103.23 | - | - | - | - | -4.42 | -4.10 | -0.95 | 1.01 | -2.36 | -2.49 | 0.66 | 2.12 |
| | B16a | 100.18 | 100.68 | 102.22 | 97.80 | 98.12 | 101.56 | 103.41 | 97.80 | 98.12 | 101.27 | 103.23 | - | - | - | - | -4.42 | -4.10 | -0.95 | 1.01 | -2.38 | -2.56 | 0.59 | 2.05 |
| | B15b | 99.55 | 100.3 | 102.96 | 97.79 | 98.10 | 101.56 | 103.41 | 97.79 | 98.10 | 101.27 | 103.23 | -1.90 | -1.89 | -0.97 | -0.20 | -5.17 | -4.86 | -1.69 | 0.27 | -1.76 | -2.20 | 0.97 | 2.43 |
| | B16b | 99.57 | 100.32 | 102.96 | 97.79 | 98.10 | 101.56 | 103.41 | 97.79 | 98.09 | 101.27 | 103.23 | -1.89 | -1.89 | -0.97 | -0.20 | -5.18 | -4.87 | -1.69 | 0.27 | -1.79 | -2.23 | 0.95 | 2.41 |
| | B17a | 101.08 | 101.53 | 103.16 | 97.05 | 97.13 | 101.99 | 103.43 | 96.99 | 97.13 | 101.25 | 103.22 | - | - | - | - | -6.17 | -6.03 | -1.91 | 0.06 | -4.09 | -4.40 | -0.28 | 1.19 |
| | B18a | 100.99 | 101.48 | 103.16 | 97.05 | 97.12 | 101.99 | 103.43 | 96.99 | 97.12 | 101.25 | 103.22 | - | - | - | - | -6.17 | -6.04 | -1.91 | 0.06 | 0.01 | -0.21 | 0.85 | 1.24 |
| | B17b | 99.59 | 100.44 | 102.69 | 97.10 | 97.19 | 101.45 | 103.43 | 97.10 | 97.19 | 101.19 | 103.21 | -2.79 | -2.68 | -1.05 | -0.18 | -5.60 | -5.50 | -1.50 | 0.52 | -2.50 | -3.25 | 0.75 | 2.27 |
| | B18b | 99.84 | 100.33 | 102.69 | 97.01 | 97.11 | 101.45 | 103.43 | 97.01 | 97.11 | 101.20 | 103.21 | -2.60 | -2.29 | -1.04 | -0.18 | -5.68 | -5.58 | -1.49 | 0.52 | -2.83 | -3.22 | 0.87 | 2.38 |
| | B19a | 99.67 | 100.5 | 101.66 | 96.69 | 96.83 | 101.46 | 103.42 | 96.69 | 96.83 | 101.21 | 103.21 | -0.34 | -0.32 | -1.02 | -0.19 | -4.97 | -4.83 | -0.45 | 1.55 | -2.98 | -3.67 | 0.71 | 2.21 |
| | B19b | 99.74 | 100.24 | 101.66 | 96.68 | 96.81 | 101.46 | 103.42 | 96.68 | 96.81 | 101.21 | 103.21 | - | - | - | - | -4.98 | -4.85 | -0.45 | 1.55 | -3.06 | -3.43 | 0.97 | 2.47 |
| | D1 | 98.95 | 99.78 | 101.58 | 96.61 | 96.65 | 100.81 | 102.83 | 96.74 | 96.70 | 100.65 | 102.96 | 0.19 | 0.06 | -1.55 | -0.21 | -4.84 | -4.88 | -0.93 | 1.38 | -2.21 | -3.08 | 0.87 | 2.68 |
| | D2 | 99.12 | 99.9 | 101.58 | 96.61 | 96.65 | 100.81 | 102.83 | 96.64 | 96.65 | 100.65 | 102.96 | 0.09 | 0.01 | -1.55 | -0.21 | -4.94 | -4.93 | -0.93 | 1.38 | -2.48 | -3.25 | 0.75 | 2.56 |
| | D3 | 103.62 | 104.62 | 101.58 | 99.55 | 99.57 | 100.60 | 102.82 | 99.55 | 99.57 | 100.57 | 102.95 | 0.00 | 0.00 | -0.10 | 0.09 | -2.03 | -2.01 | -1.01 | 1.37 | -4.07 | -5.05 | -4.05 | -2.17 |

## Table 5.3A - Proposed Hydraulic Analysis Results

**Project Name:** Wall Street Storm Sewer Study
**Location:** Jersey Village, Texas

| Proposed System ID | Inlet | Gutter (ft) | Top of Curb (TOC, ft) | FFE (ft) | Proposed (Unmitigated) Water Surface Elevation (ft) | | | | Proposed Water Surface Elevation (ft) | | | | Proposed WSE - Existing WSE | | | | Proposed WSE - FFE (ft) | | | | Prop WSE - Gutter El (ft) | Prop WSE - TOC El. (ft) | | Prop WSE - TOC + 0.5' (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| System C | C1 | 101.46 | 102.24 | 105.16 | 102.61 | 102.56 | 103.36 | 103.90 | 99.74 | 99.79 | 102.48 | 103.27 | -3.05 | -2.97 | -0.79 | -0.40 | -5.42 | -5.37 | -2.68 | -1.89 | -1.72 | -2.45 | 0.24 | 0.53 |
| | C2 | 101.59 | 102.34 | 105.16 | 102.61 | 102.56 | 103.36 | 103.90 | 99.65 | 99.71 | 102.48 | 103.27 | -3.15 | -3.06 | -0.79 | -0.40 | -5.51 | -5.46 | -2.68 | -1.89 | -1.94 | -2.64 | 0.14 | 0.43 |
| | C3a | 101.79 | 102.55 | 104.78 | 102.62 | 102.57 | 103.44 | 104.04 | 100.03 | 100.12 | 102.52 | 103.27 | -2.77 | -2.64 | -0.84 | -0.58 | -4.75 | -4.66 | -2.26 | -1.51 | -1.76 | -2.43 | -0.03 | 0.22 |
| | C3b | 102.29 | 102.76 | 104.78 | 102.62 | 102.57 | 103.44 | 104.04 | 100.16 | 100.24 | 102.52 | 103.27 | - | - | - | - | -4.62 | -4.54 | -2.26 | -1.51 | -2.13 | -2.52 | -0.24 | 0.01 |
| | C4 | 100 | 100.74 | 104.27 | 102.73 | 102.69 | 103.55 | 104.58 | 97.90 | 98.59 | 102.57 | 103.27 | -4.90 | -4.20 | -0.80 | -0.60 | -6.37 | -5.68 | -1.71 | -1.00 | -2.10 | -2.15 | 1.83 | 2.03 |
| | C5 | 100.02 | 100.8 | 104.27 | 102.73 | 102.69 | 103.55 | 104.58 | 97.90 | 98.58 | 102.56 | 103.27 | -4.90 | -4.20 | -0.80 | -0.61 | -6.37 | -5.69 | -1.71 | -1.00 | -2.12 | -2.22 | 1.76 | 1.97 |
| | C6a | 102.11 | 102.68 | 104.34 | 102.89 | 102.89 | 103.47 | 104.43 | 97.99 | 98.68 | 102.59 | 103.30 | - | - | - | - | -6.35 | -5.66 | -1.75 | -1.04 | -4.12 | -4.00 | -0.09 | 0.12 |
| | C6b | 100.72 | 101.22 | 104.27 | 102.54 | 102.50 | 103.41 | 104.42 | 97.91 | 98.57 | 102.40 | 103.27 | -4.97 | -4.30 | -0.97 | -0.61 | -6.36 | -5.70 | -1.87 | -1.00 | -2.81 | -2.65 | 1.18 | 1.55 |
| | C6c | 100.77 | 101.27 | 103.63 | 102.49 | 102.44 | 103.25 | 103.62 | 97.71 | 98.22 | 102.40 | 103.26 | - | - | - | - | -5.92 | -5.41 | -1.23 | -0.37 | -3.06 | -3.05 | 1.13 | 1.49 |

## Table 5.3D - Existing Hydraulic Analysis Results (With Intermediary Berm Design)

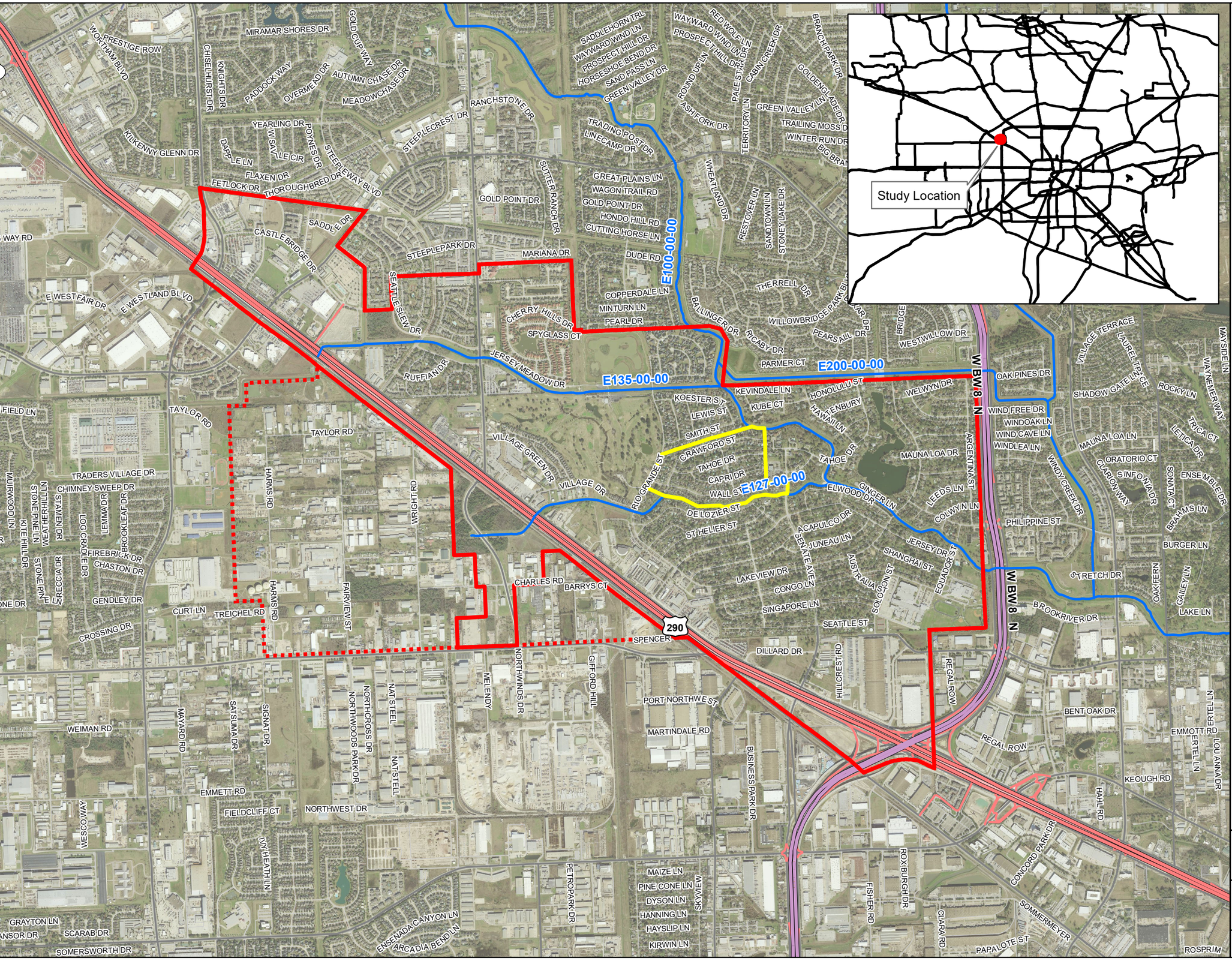
**Project Name:** Wall Street Storm Sewer Study
**Location:** Jersey Village, Texas

| Existing System ID | Inlet | Gutter (ft) | Top of Curb (TOC, ft) | FFE (ft) | Existing Water Surface El (ft) | | | | Existing WSE (w/intermediary berm) (ft) | | | | Existing (w/intermediary berm) - Existing (ft) | | | | Existing (w/intermediary berm) WSE - FFE (ft) | | | | Exist WSE - Gutter El (ft) | Exist WSE - TOC El. (ft) | | Exist WSE - TOC + 0.5' (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr | 2-yr | 5-yr | 10-yr | 100-yr |
| System A | A1 | 101.81 | 102.63 | 104.24 | 101.87 | 102.04 | 102.13 | 103.79 | 101.87 | 102.04 | 102.13 | 103.78 | 0.00 | 0.00 | 0.00 | -0.01 | -2.37 | -2.20 | -2.11 | -0.46 | 0.06 | -0.59 | -0.50 | 0.65 |
| | A2 | 101.73 | 102.6 | 104.24 | 101.86 | 102.04 | 102.13 | 103.79 | 101.86 | 102.04 | 102.13 | 103.78 | 0.00 | 0.00 | 0.00 | -0.01 | -2.38 | -2.20 | -2.11 | -0.46 | 0.13 | -0.56 | -0.47 | 0.68 |
| | A3 | 101.23 | 102.11 | 103.9 | 101.29 | 101.38 | 102.06 | 103.82 | 101.29 | 101.38 | 101.96 | 103.81 | 0.00 | 0.00 | -0.09 | -0.01 | -2.62 | -2.52 | -1.94 | -0.09 | 0.05 | -0.73 | -0.15 | 1.20 |
| | A4 | 101.02 | 101.82 | 103.9 | 101.28 | 101.38 | 102.06 | 103.82 | 101.28 | 101.38 | 101.96 | 103.81 | 0.00 | 0.00 | -0.09 | -0.01 | -2.62 | -2.52 | -1.94 | -0.09 | 0.26 | -0.44 | 0.14 | 1.49 |
| | A5 | 100.56 | 101.22 | 102.77 | 100.46 | 100.83 | 102.06 | 104.05 | 100.46 | 100.83 | 101.96 | 104.05 | 0.00 | 0.00 | -0.09 | 0.00 | -2.31 | -1.94 | -0.81 | 1.28 | -0.10 | -0.39 | 0.74 | 2.33 |
| | A6 | 100.42 | 101.18 | 102.77 | 100.44 | 100.83 | 102.06 | 104.05 | 100.44 | 100.83 | 101.96 | 104.05 | 0.00 | 0.00 | -0.09 | 0.00 | -2.33 | -1.94 | -0.81 | 1.28 | 0.02 | -0.35 | 0.78 | 2.37 |
| System B | B1 | 100.42 | 101.24 | 102.72 | 100.72 | 100.90 | 102.25 | 103.67 | 100.72 | 100.90 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -2.00 | -1.82 | -1.18 | 0.92 | 0.30 | -0.34 | 0.30 | 1.90 |
| | B2 | 100.34 | 101.23 | 102.72 | 100.72 | 100.90 | 102.25 | 103.67 | 100.72 | 100.90 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -2.00 | -1.82 | -1.18 | 0.92 | 0.38 | -0.33 | 0.31 | 1.91 |
| | B3 | 100.46 | 101.06 | 103.08 | 100.71 | 100.89 | 102.25 | 103.67 | 100.71 | 100.89 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -2.38 | -2.19 | -1.54 | 0.56 | 0.25 | -0.17 | 0.48 | 2.08 |
| | B4 | 100.37 | 101.16 | 103.08 | 100.71 | 100.89 | 102.25 | 103.67 | 100.71 | 100.89 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -2.38 | -2.19 | -1.54 | 0.56 | 0.33 | -0.27 | 0.38 | 1.98 |
| | B5 | 100.38 | 101.21 | 103.52 | 100.66 | 100.85 | 102.25 | 103.67 | 100.66 | 100.85 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -2.86 | -2.67 | -1.98 | 0.12 | 0.28 | -0.36 | 0.33 | 1.93 |
| | B6 | 100.39 | 101.13 | 103.52 | 100.66 | 100.85 | 102.25 | 103.67 | 100.66 | 100.85 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -2.86 | -2.67 | -1.98 | 0.12 | 0.27 | -0.28 | 0.41 | 2.01 |
| | B7 | 100.25 | 101.05 | 103.85 | 100.65 | 100.84 | 102.25 | 103.67 | 100.65 | 100.84 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -3.21 | -3.01 | -2.31 | -0.21 | 0.39 | -0.21 | 0.49 | 2.09 |
| | B8 | 100.29 | 101.13 | 103.85 | 100.65 | 100.84 | 102.25 | 103.67 | 100.65 | 100.84 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -3.21 | -3.01 | -2.31 | -0.21 | 0.35 | -0.29 | 0.41 | 2.01 |
| | B9 | 100.5 | 101.31 | 103.93 | 100.68 | 100.91 | 102.25 | 103.67 | 100.68 | 100.91 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -3.25 | -3.02 | -2.39 | -0.29 | 0.18 | -0.40 | 0.23 | 1.83 |
| | B10 | 100.56 | 101.32 | 103.93 | 100.67 | 100.91 | 102.25 | 103.67 | 100.67 | 100.91 | 101.54 | 103.64 | 0.00 | 0.00 | -0.71 | -0.03 | -3.26 | -3.02 | -2.39 | -0.29 | 0.11 | -0.41 | 0.22 | 1.82 |
| | B11 | 100.32 | 101.19 | 103.88 | 99.91 | 100.13 | 102.24 | 103.67 | 99.91 | 100.13 | 101.52 | 103.64 | 0.00 | 0.00 | -0.72 | -0.03 | -3.97 | -3.75 | -2.36 | -0.24 | -0.41 | -1.06 | 0.33 | 1.95 |
| | B12 | 100.37 | 101.2 | 103.88 | 99.90 | 100.13 | 102.24 | 103.67 | 99.90 | 100.13 | 101.52 | 103.64 | 0.00 | 0.00 | -0.72 | -0.03 | -3.98 | -3.75 | -2.36 | -0.24 | -0.47 | -1.07 | 0.32 | 1.94 |
| | B13 | 100.1 | 100.83 | 103.59 | 99.25 | 99.57 | 102.24 | 103.42 | 99.25 | 99.57 | 101.52 | 103.39 | 0.00 | 0.00 | -0.72 | -0.03 | -4.34 | -4.02 | -2.07 | -0.20 | -0.85 | -1.26 | 0.69 | 2.06 |
| | B14 | 100.45 | 101.22 | 103.59 | 99.22 | 99.54 | 102.24 | 103.42 | 99.23 | 99.54 | 101.52 | 103.39 | 0.00 | 0.00 | -0.72 | -0.03 | -4.37 | -4.05 | -2.07 | -0.20 | -1.23 | -1.68 | 0.30 | 1.67 |
| | B15 | 99.55 | 100.3 | 102.96 | 99.69 | 99.99 | 102.24 | 103.43 | 99.69 | 99.99 | 101.52 | 103.39 | 0.00 | 0.00 | -0.72 | -0.04 | -3.27 | -2.97 | -1.44 | 0.43 | 0.14 | -0.31 | 1.22 | 2.59 |
| | B16 | 99.57 | 100.32 | 102.96 | 99.68 | 99.99 | 102.24 | 103.43 | 99.68 | 99.99 | 101.52 | 103.39 | 0.00 | 0.00 | -0.72 | -0.04 | -3.28 | -2.97 | -1.44 | 0.43 | 0.11 | -0.33 | 1.20 | 2.57 |
| | B17 | 99.59 | 100.44 | 102.69 | 99.89 | 99.86 | 102.23 | 103.39 | 97.60 | 97.76 | 101.41 | 103.35 | -2.29 | -2.10 | -0.83 | -0.04 | -5.09 | -4.93 | -1.28 | 0.66 | -1.99 | -2.68 | 0.97 | 2.41 |
| | B18 | 99.84 | 100.33 | 102.69 | 99.61 | 99.40 | 102.23 | 103.39 | 97.54 | 97.70 | 101.41 | 103.35 | -2.07 | -1.70 | -0.82 | -0.04 | -5.15 | -4.99 | -1.28 | 0.66 | -2.30 | -2.63 | 1.08 | 2.52 |
| | B19 | 99.67 | 100.5 | 101.66 | 97.03 | 97.15 | 102.24 | 103.40 | 97.03 | 97.15 | 101.41 | 103.36 | 0.00 | 0.00 | -0.82 | -0.04 | -4.63 | -4.51 | -0.25 | 1.70 | -2.64 | -3.35 | 0.91 | 2.36 |
| System C | C1 | 101.46 | 102.24 | 105.16 | 102.80 | 102.76 | 103.28 | 103.67 | 101.73 | 102.03 | 102.52 | 103.63 | -1.07 | -0.73 | -0.76 | -0.03 | -3.43 | -3.13 | -2.64 | -1.53 | 0.27 | -0.21 | 0.28 | 0.89 |
| | C2 | 101.59 | 102.34 | 105.16 | 102.80 | 102.76 | 103.28 | 103.67 | 101.73 | 102.03 | 102.52 | 103.63 | -1.07 | -0.73 | -0.76 | -0.03 | -3.43 | -3.13 | -2.64 | -1.53 | 0.14 | -0.31 | 0.18 | 0.79 |
| | C3 | 101.79 | 102.55 | 104.78 | 102.80 | 102.76 | 103.36 | 103.84 | 101.83 | 102.04 | 102.52 | 103.83 | -0.97 | -0.72 | -0.84 | -0.02 | -2.95 | -2.74 | -2.26 | -0.95 | 0.04 | -0.51 | -0.03 | 0.78 |
| | C4 | 100 | 100.74 | 104.27 | 102.80 | 102.79 | 103.36 | 103.88 | 100.45 | 100.83 | 102.63 | 103.86 | -2.36 | -1.96 | -0.74 | -0.02 | -3.82 | -3.44 | -1.64 | -0.41 | 0.45 | 0.09 | 1.89 | 2.62 |
| | C5 | 100.02 | 100.8 | 104.27 | 102.80 | 102.78 | 103.36 | 103.88 | 100.45 | 100.83 | 102.62 | 103.86 | -2.36 | -1.96 | -0.74 | -0.02 | -3.82 | -3.44 | -1.65 | -0.41 | 0.43 | 0.03 | 1.82 | 2.56 |
| | C6 | 100.72 | 101.22 | 104.27 | 102.88 | 102.87 | 103.36 | 103.88 | 100.38 | 100.80 | 102.70 | 103.87 | -2.50 | -2.07 | -0.67 | -0.02 | -3.89 | -3.47 | -1.57 | -0.40 | -0.34 | -0.42 | 1.48 | 2.15 |
| System D | D1 | 98.95 | 99.78 | 101.58 | 96.55 | 96.64 | 102.20 | 103.16 | 96.55 | 96.64 | 101.19 | 103.13 | 0.00 | 0.00 | -1.01 | -0.03 | -5.03 | -4.94 | -0.39 | 1.55 | -2.40 | -3.14 | 1.41 | 2.85 |
| | D2 | 99.12 | 99.9 | 101.58 | 96.56 | 96.64 | 102.20 | 103.16 | 96.56 | 96.64 | 101.19 | 103.13 | 0.00 | 0.00 | -1.01 | -0.03 | -5.02 | -4.94 | -0.39 | 1.55 | -2.57 | -3.26 | 1.29 | 2.73 |
| | D3 | 103.62 | 104.62 | 101.58 | 99.55 | 99.57 | 100.67 | 102.86 | 99.55 | 99.57 | 100.56 | 102.85 | 0.00 | 0.00 | -0.11 | -0.01 | -2.03 | -2.01 | -1.02 | 1.27 | -4.07 | -5.05 | -4.06 | -2.27 |

**Table 6.2A - Construction Cost Estimate**

**Project Name:** Wall Street Storm Sewer Study
**Location:** Jersey Village, Texas

| SPEC NO | ITEM DESCRIPTION | UNIT | APPROX QUANTITIES | UNIT PRICE | TOTAL |
|---|---|---|---|---|---|
| | | | | | |
| 100 | TREE PREP & PROTECTION | EA | 100.00 | $150.00 | $15,000.00 |
| 104 | REMOVE CONC PAVEMENT | SY | 15,300.00 | $7.00 | $107,100.00 |
| 104 | REMOVE CONC DRIVEWAY | SY | 1,500.00 | $6.00 | $9,000.00 |
| 104 | REMOVE CONC SIDEWALK | SY | 100.00 | $6.00 | $600.00 |
| 160 | FURNISHING AND PLACING TOPSOIL (4") | SY | 4,900.00 | $1.00 | $4,900.00 |
| 162 | BLOCK SODDING | SY | 4,900.00 | $3.00 | $14,700.00 |
| 260 | LIME TRT (EXST MATL) (8") | SY | 16,500.00 | $4.00 | $66,000.00 |
| 260 | LIME (HYDRATED LIME (DRY) | TON | 380.00 | $160.00 | $60,800.00 |
| 360 | CONC PAV (JOINT REINF) | SY | 15,300.00 | $65.00 | $994,500.00 |
| 400 | STRUCT EXCAV | CY | 9,050.00 | $10.00 | $90,500.00 |
| 400 | CUT & RESTORE PAV | SY | 80.00 | $130.00 | $10,400.00 |
| 400 | CEM STABIL BKFL | CY | 6,031.00 | $41.00 | $247,271.00 |
| 402 | TRENCH EXCAVATION PROTECTION | LF | 7,060.00 | $2.00 | $14,120.00 |
| 432 | RIPRAP (STONE) | CY | 30.00 | $200.00 | $6,000.00 |
| 464 | RC PIPE (CL III) (24 IN) | LF | 670.00 | $70.00 | $46,900.00 |
| 464 | RC PIPE (CL III) (30 IN) | LF | 3,255.00 | $80.00 | $260,400.00 |
| 464 | RC PIPE (CL III) (36 IN) | LF | 1,040.00 | $90.00 | $93,600.00 |
| 464 | RC PIPE (CL III) (42 IN) | LF | 440.00 | $110.00 | $48,400.00 |
| 464 | RC PIPE (CL III) (48 IN) | LF | 90.00 | $130.00 | $11,700.00 |
| 464 | RC PIPE (CL III) (54 IN) | LF | 380.00 | $170.00 | $64,600.00 |
| 464 | RC PIPE (CL III) (60 IN) | LF | 1,185.00 | $190.00 | $225,150.00 |
| 465 | INLET (COMPL) (TY C) | EA | 33.00 | $3,300.00 | $108,900.00 |
| 465 | MANHOLE (COMPL) (≤ 42 IN) | EA | 22.00 | $3,500.00 | $77,000.00 |
| 465 | MANHOLE (COMPL) (> 42 IN) | EA | 6.00 | $4,000.00 | $24,000.00 |
| 476 | JAC BORE OR TUN (30 IN) (RC) (CL IV) | LF | 150.00 | $595.00 | $89,250.00 |
| 496 | REMOVE STR (PIPE) (ALL SIZES) | LF | 2,050.00 | $25.00 | $51,250.00 |
| 496 | REMOVE STR (INLET) | EA | 11.00 | $800.00 | $8,800.00 |
| 496 | REMOVE STR (MANHOLE) | EA | 13.00 | $800.00 | $10,400.00 |
| 500 | MOBILIZATION [10 percent] | LS | 1.00 | $299,519.10 | $299,519.10 |
| 502 | BARRICADES, SIGNS, AND TRAFFIC HANDLING | MO | 12.00 | $5,000.00 | $60,000.00 |
| 506 | SWPPP | LS | 1.00 | $10,000.00 | $10,000.00 |
| 529 | CONC CURB (MONO) (TY II) | LF | 9,500.00 | $5.00 | $47,500.00 |
| 530 | DRIVEWAYS (CONC) | SY | 1,500.00 | $65.00 | $97,500.00 |
| 531 | CONC SIDEWALK | SY | 100.00 | $40.00 | $4,000.00 |
| 531 | CURB RAMPS | EA | 8.00 | $1,400.00 | $11,200.00 |
| 636 | SIGNS & SUPPORTS | EA | 15.00 | $250.00 | $3,750.00 |
| | | | | | |
| | SUBTOTAL | | | | $3,294,710.10 |
| | CONSTRUTION CONTINGENCY [25%] | LS | 1.00 | $823,677.53 | $823,677.53 |
| | SUBTOTAL | | | | $4,118,387.63 |
| | | | | | |
| | UTILITY RELOCATION ALLOWANCE | LS | 1.00 | $100,000.00 | $100,000.00 |
| | PROPERTY ACQUISITION ALLOWANCE | LS | 1.00 | $25,000.00 | $25,000.00 |
| | ENGINEERING FEES [15%] | LS | 1.00 | $617,758.14 | $617,758.14 |
| | SUBCONSULTANTS FEES [8%] | LS | 1.00 | $329,471.01 | $329,471.01 |
| | CONSTRUCTION MANAGEMENT FEES [7%] | LS | 1.00 | $288,287.13 | $288,287.13 |
| | | | ESTIMATED PROJECT TOTAL | | $5,478,903.91 |




## Legend

- Project Study Area
- Stream Network
- Jersey Village Limits
- ETJ

**DANNENBAUM**

N

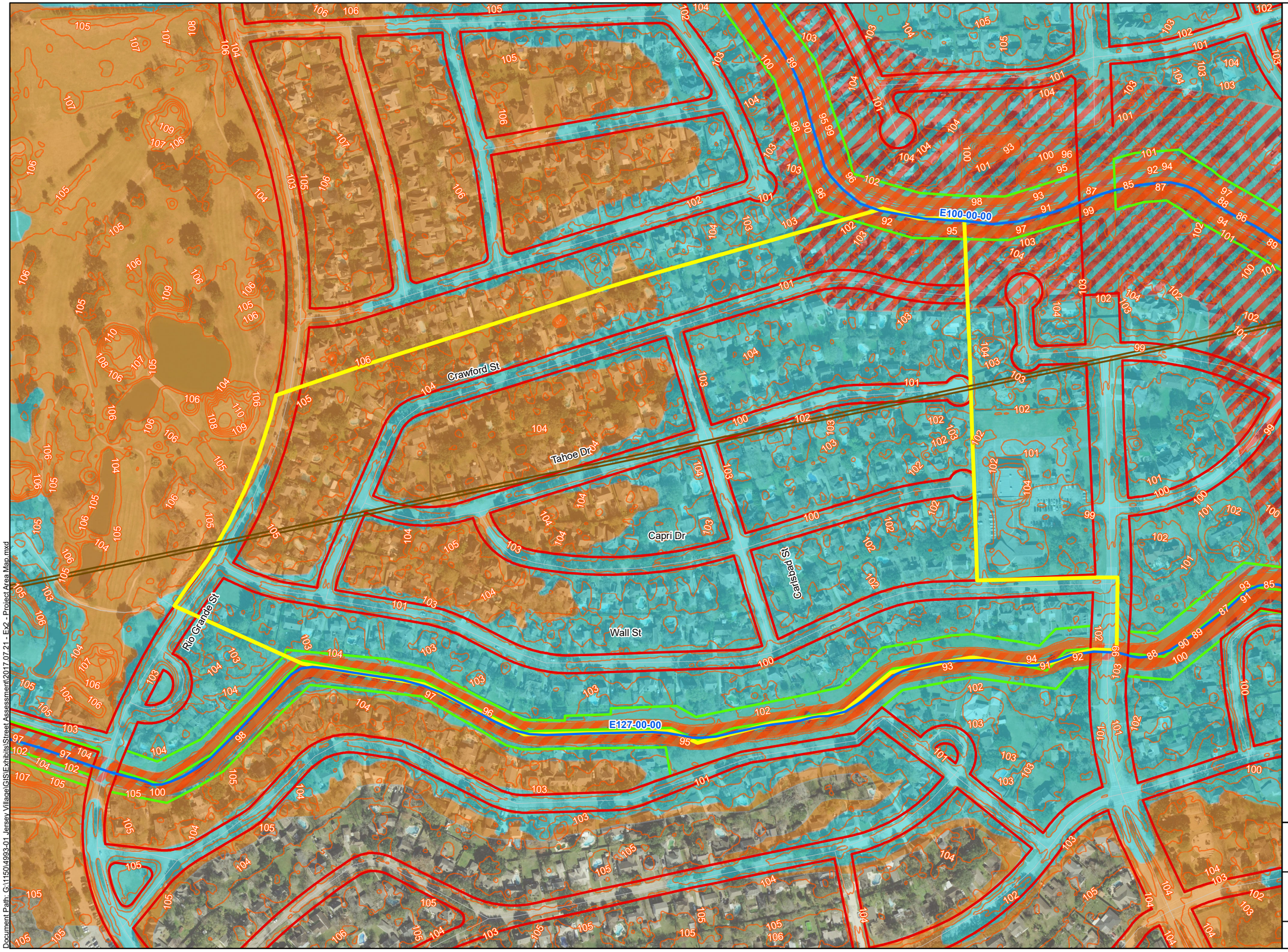
0 2,000 4,000 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 1**
Vicinity Map

1 in. = 2,000 ft | December 2017

Document Path: G:\11500\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.07.21 - Ex1 - Vicinity Map.mxd




## Legend

- Project Study Area
- HCFCD JV Easements
- HCAD Right-of-Way
- Oil & Gas Pipeline
- Elevation Contour (1 ft)
- Stream Network

**Effective FEMA Floodplain**

- AE
- AE, Floodway
- X, 0.2 Pct Annual Chance Flood Hazard

**DANNENBAUM**

N

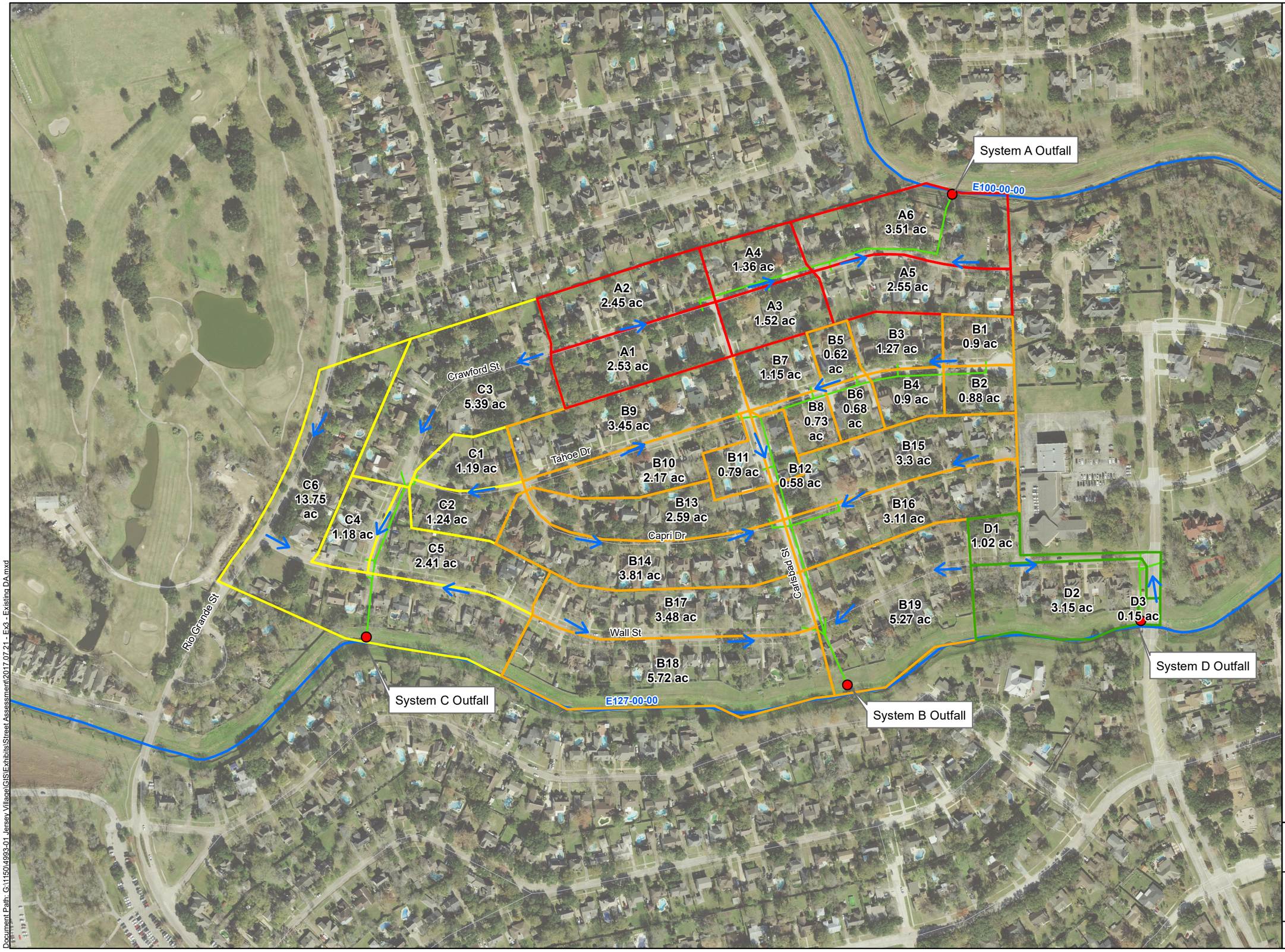
0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 2**
Project Area Map

1 in. = 300 ft | December, 2017

Document Path: G:\115015\04993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.07.21 - Ex2 - Project Area Map.mxd




## Legend

- Existing Outfall
- Existing Storm Sewer
- Stream Network

**Existing Drainage Areas**

**Drainage System**

- System A
- System B
- System C
- System D

**DANNENBAUM**

N

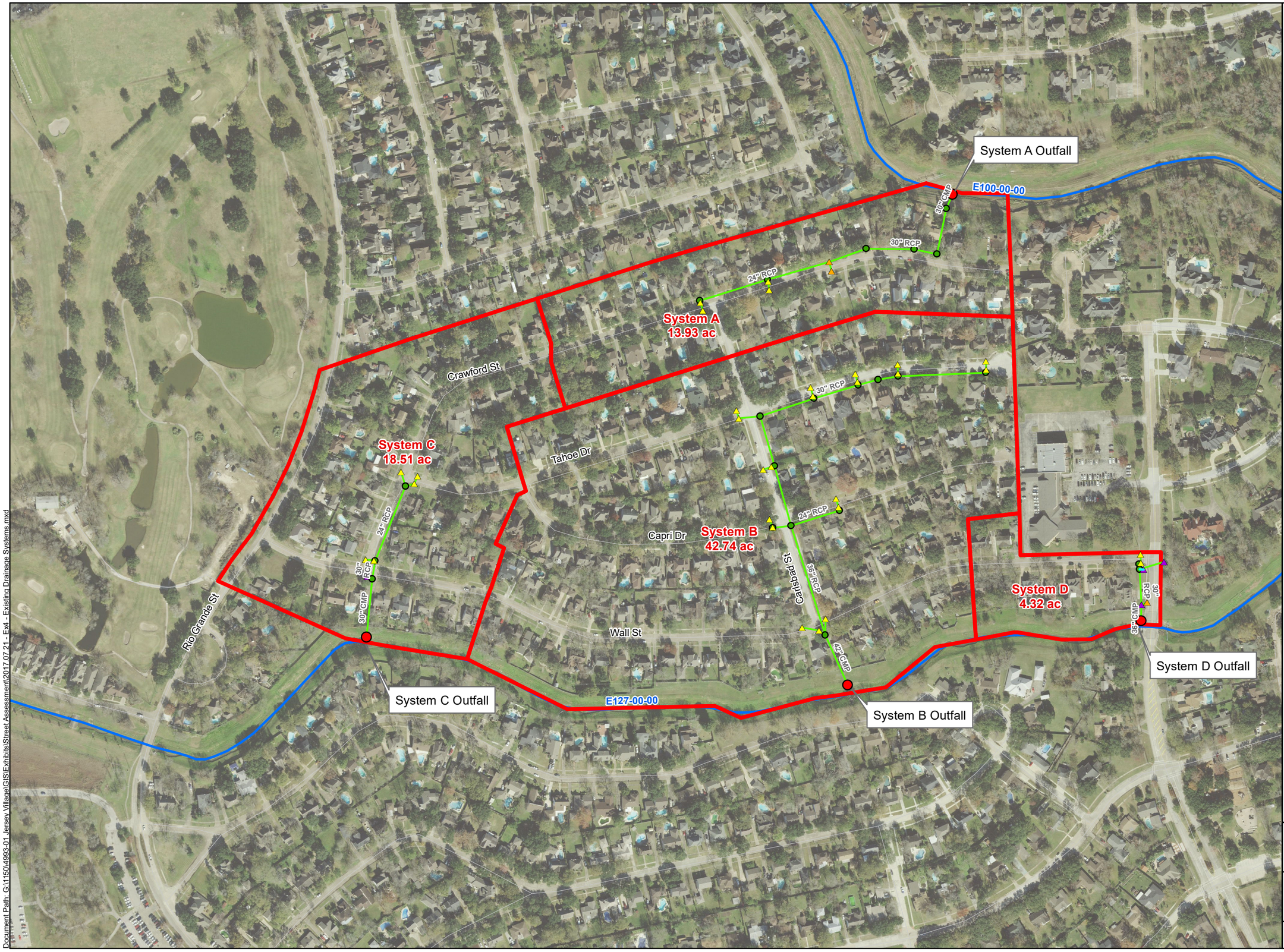
0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 3**
Existing Drainage Areas

1 in. = 300 ft | December, 2017

Document Path: G:\1150\04993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.07.21 - Ex3 - Existing DA.mxd




## Legend

- Existing Storm Sewer
- Stream Network
- Existing Drainage Systems

**Existing Drainage Structure Type**

- "BB" Inlet
- "C-2" Inlet
- Grate Inlet
- Manhole
- Outfall

DANNENBAUM

N

0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 4**
Existing Drainage Systems

1 in. = 300 ft | December, 2017

Document Path: G:\1150\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.07.21 - Ex4 - Existing Drainage Systems.mxd

Ponding Depths
Tahoe Dr & Carlsbad St

WSE (2-yr) = 0.18 ft
WSE (5-yr) = 0.41 ft
WSE (10-yr) = 1.75 ft
WSE (100-yr) = 3.17 ft

Ponding Depths
Crawford St & Tahoe Dr

WSE (2-yr) = 1.34 ft
WSE (5-yr) = 1.30 ft
WSE (10-yr) = 1.82 ft
WSE (100-yr) = 2.21 ft

E100-00-00

SystemA
13.93 ac

SystemC
18.51 ac

SystemB
42.74 ac

SystemD
4.32 ac

E127-00-00

Ponding Depths
Wall St & Crawford St

WSE (2-yr) = 2.16 ft
WSE (5-yr) = 2.15 ft
WSE (10-yr) = 2.64 ft
WSE (100-yr) = 3.16 ft

Ponding Depths
Wall St & Carlsbad St

WSE (2-yr) = 0.30 ft
WSE (5-yr) = 0.27 ft
WSE (10-yr) = 2.64 ft
WSE (100-yr) = 3.80 ft

## Legend

- Existing Nodes
- Existing Links
- Stream Network
- Existing Drainage Systems

DANNENBAUM

N

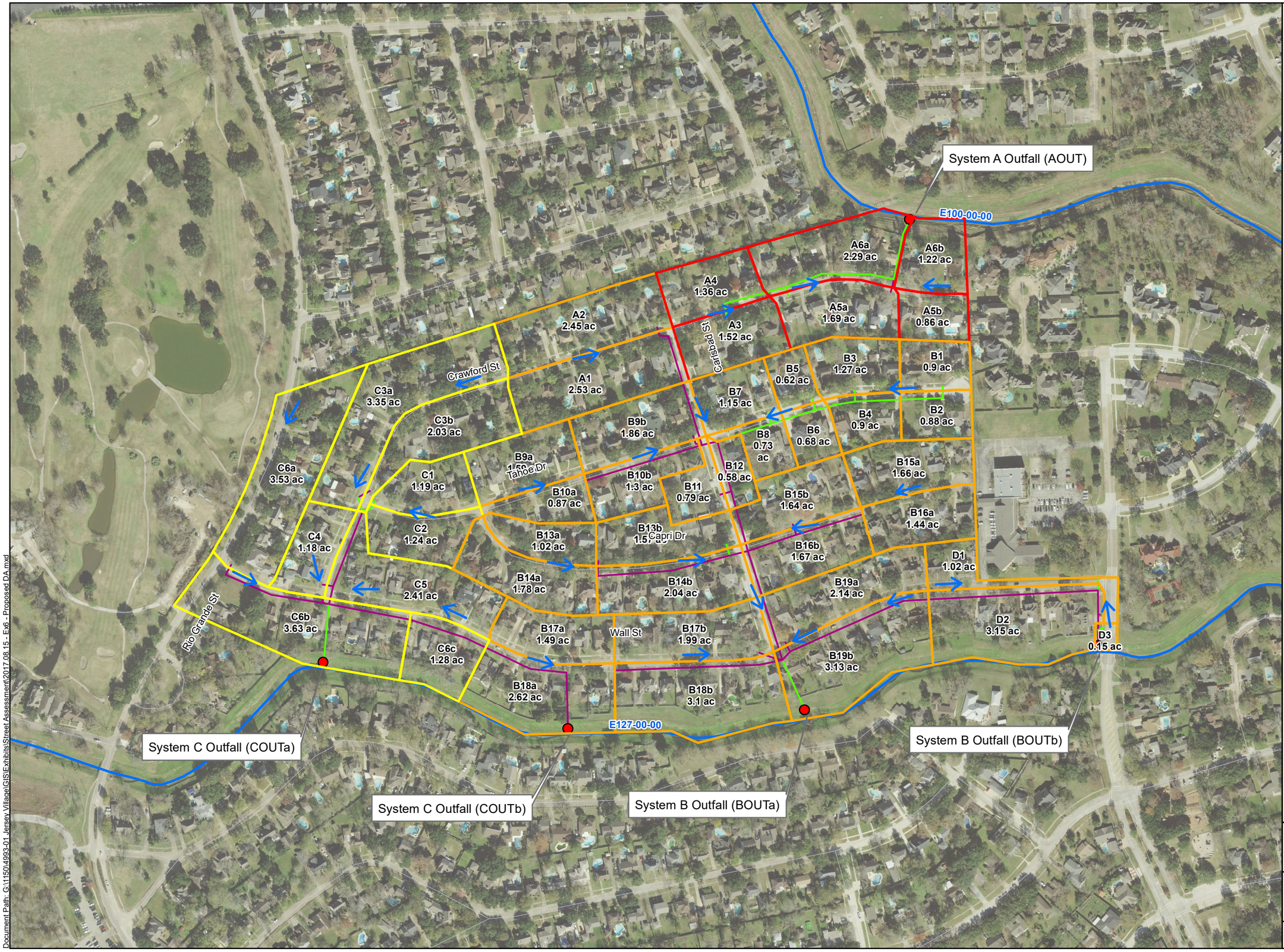
0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 5**
Existing XP-STORM Layout

1 in. = 300 ft | December 2017

Document Path: G:\1150\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.07.21 - Ex5 - Existing SWMM.mxd




## Legend

- Proposed Outfall
- Stream Network

**Proposed Storm Sewer**

- Existing
- Proposed

**Proposed Drainage Areas**

**Drainage System**

- System A
- System B
- System C

DANNENBAUM

N

0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 6**
Proposed Drainage Areas

1 in. = 300 ft | December 2017

Document Path: G:\1150\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.08.15 - Ex6 - Proposed DA.mxd


## Legend

- Proposed Drainage Systems
- Stream Network

**Proposed Storm Sewer**

- Existing
- Proposed

**Proposed Structure Type**

- Existing "BB" Inlet
- Existing "BB" w/grate
- Existing "C-2" Inlet
- Proposed "C-2" Inlet
- Manhole
- Outfall

DANNENBAUM

N

0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 7**
Proposed Drainage Systems

1 in. = 300 ft | December 2017

Document Path: G:\11150\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.08.15 - Ex7 - Prop. Drainage Systems.mxd

Ponding Depths
Tahoe Dr & Carlsbad St

WSE (2-yr) = 0 ft
WSE (5-yr) = 0 ft
WSE (10-yr) = 1.17 ft
WSE (100-yr) = 3.13 ft

Ponding Depths
Crawford St & Tahoe Dr

WSE (2-yr) = 0 ft
WSE (5-yr) = 0 ft
WSE (10-yr) = 1.02 ft
WSE (100-yr) = 1.81 ft

E100-00-00

System A
8.95 ac

System C
19.86 ac

System B
50.67 ac

E127-00-00

Ponding Depths
Wall St & Crawford St

WSE (2-yr) = 0 ft
WSE (5-yr) = 0 ft
WSE (10-yr) = 1.68 ft
WSE (100-yr) = 2.55 ft

Ponding Depths
Wall St & Carlsbad St

WSE (2-yr) = 0 ft
WSE (5-yr) = 0 ft
WSE (10-yr) = 1.60 ft
WSE (100-yr) = 3.62 ft

## Legend

- Proposed Nodes
- Proposed Links
- Stream Network
- Proposed Drainage Systems

**DANNENBAUM**

N

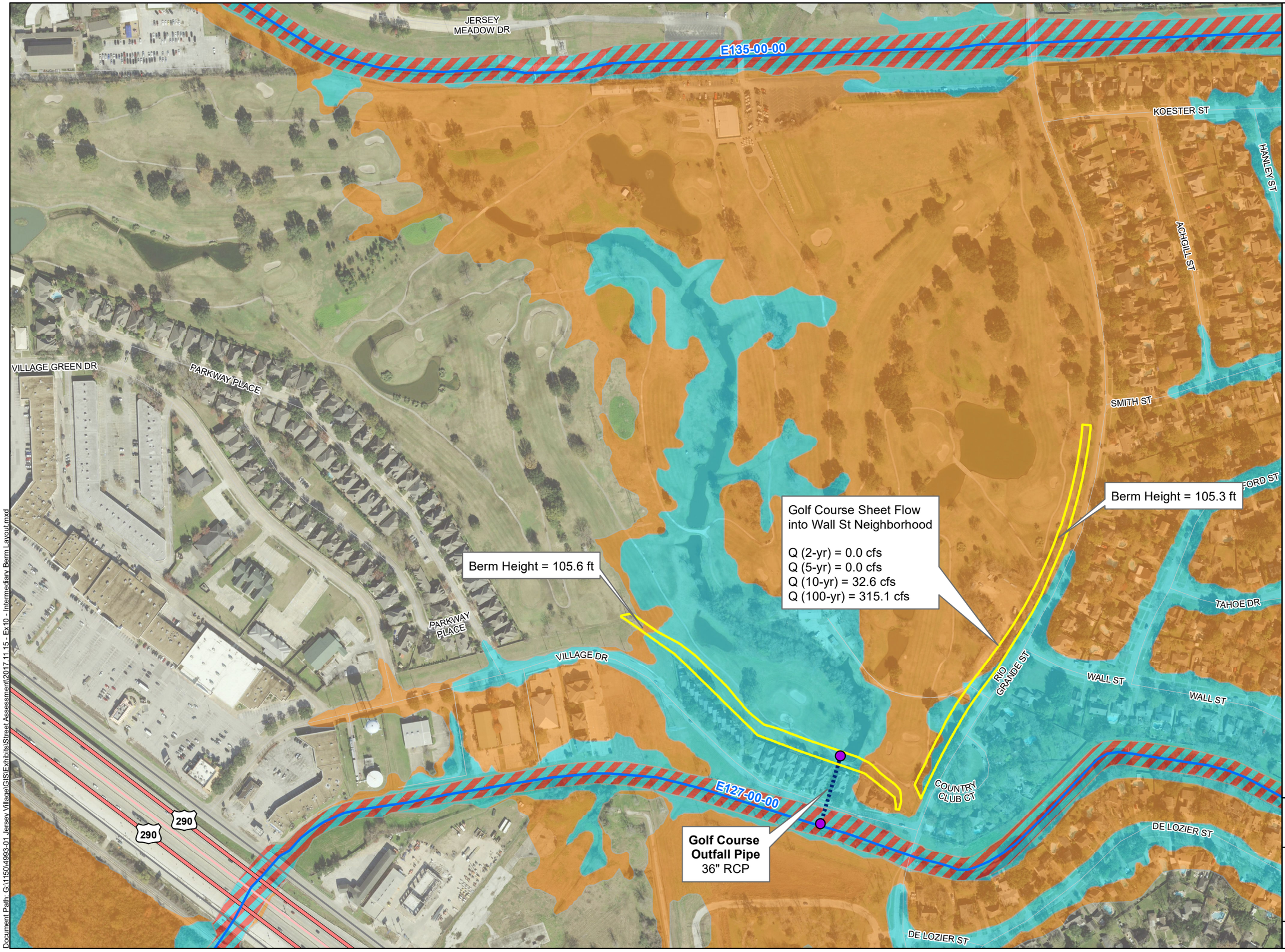
0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 8**
Proposed XP-STORM Layout

1 in. = 300 ft | December 2017

Document Path: G:\1150\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.08.21 - Ex8 - Proposed SWMM.mxd




## Legend

- Golf Course Outlets
- Intermediary Berm
- Golf Course Outfall
- Stream Network

**Effective FEMA Floodplain**

- AE
- AE, Floodway
- X, 0.2 Pct Annual Chance Flood Hazard

**DANNENBAUM**

N

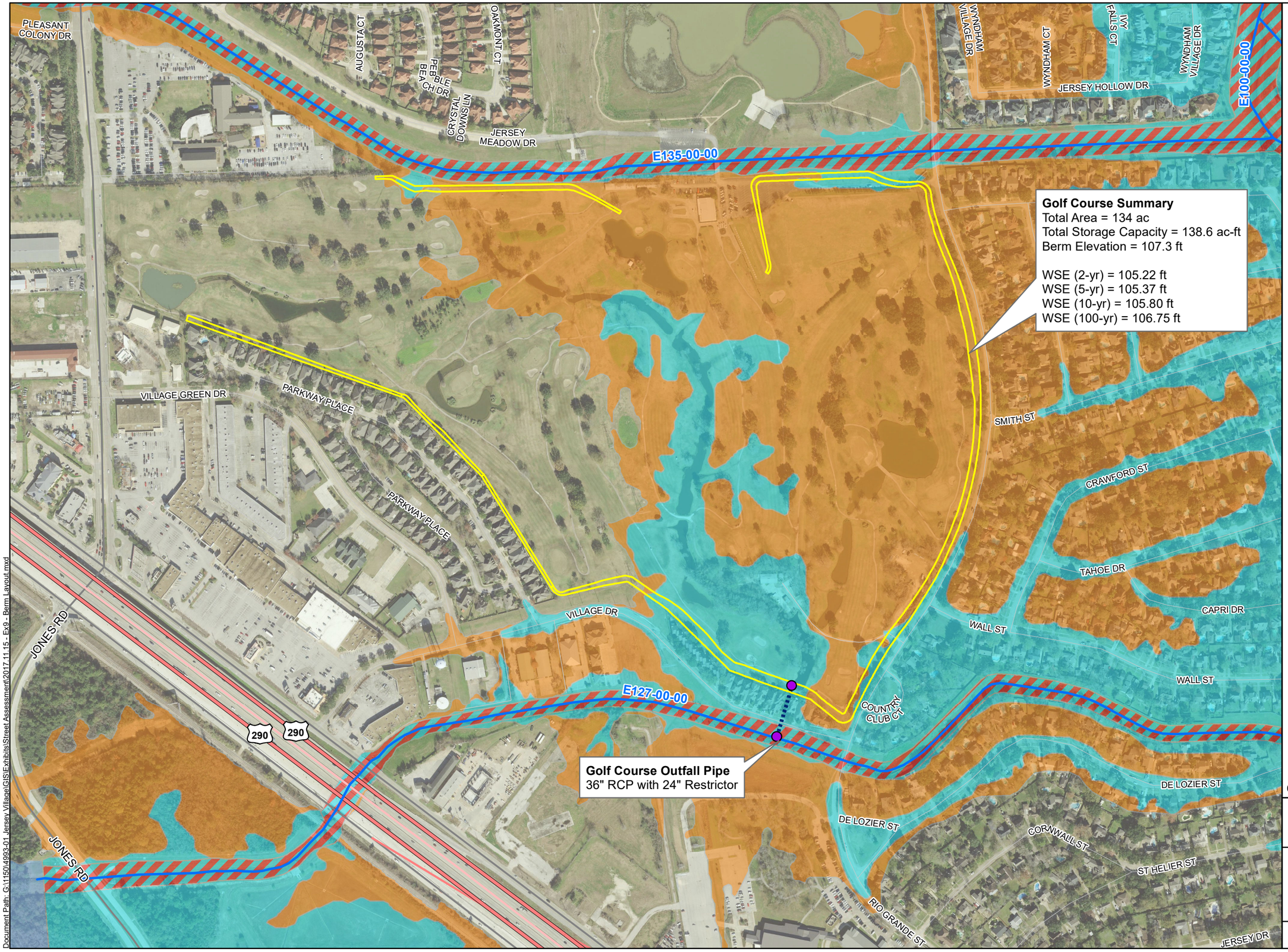
0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 9**
Intermediary Golf Course Berm Layout

1 in. = 300 ft | December 2017

Document Path: G:\1150\04993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.11.15 - Ex10 - Intermediary Berm Layout.mxd




## Legend

- Golf Course Outlets
- Proposed Berm Layout
- Golf Course Outfall
- Stream Network

**Effective FEMA Floodplain**

- A
- AE
- AE, Floodway
- X, 0.2 Pct Annual Chance Flood Hazard

**DANNENBAUM**

N

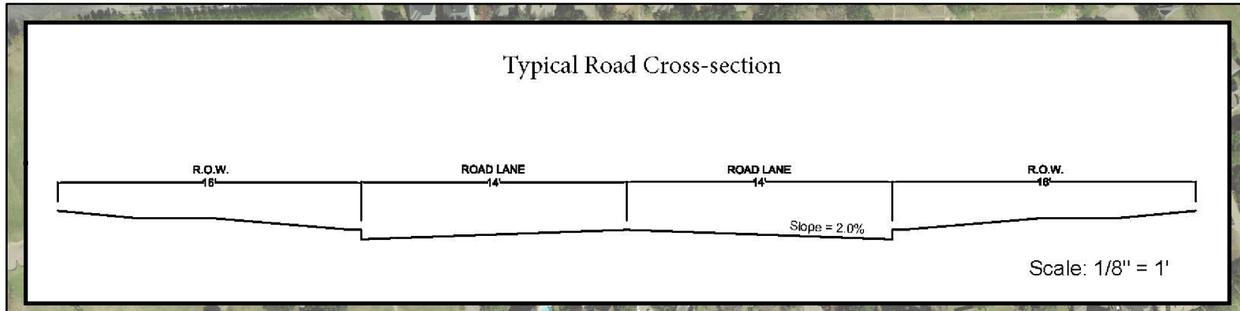
0 400 800 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 10**
**Final** Golf Course
Berm Layout

1 in. = 400 ft | December 2017

Document Path: G:\11150\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.11.15 - Ex9 - Berm Layout.mxd




E100-00-00

System A
8.95 ac

Crawford St

Tahoe Dr

System C
19.86 ac

System B
50.67 ac

Capri Dr

Carlsbad St

Rio Grande St

Wall St

E127-00-00

## Legend

- Proposed Drainage Systems
- Stream Network

**Possible Street Repaving**

- Fully Repaved
- Half Repaved
- No Repaving

DANNENBAUM

N

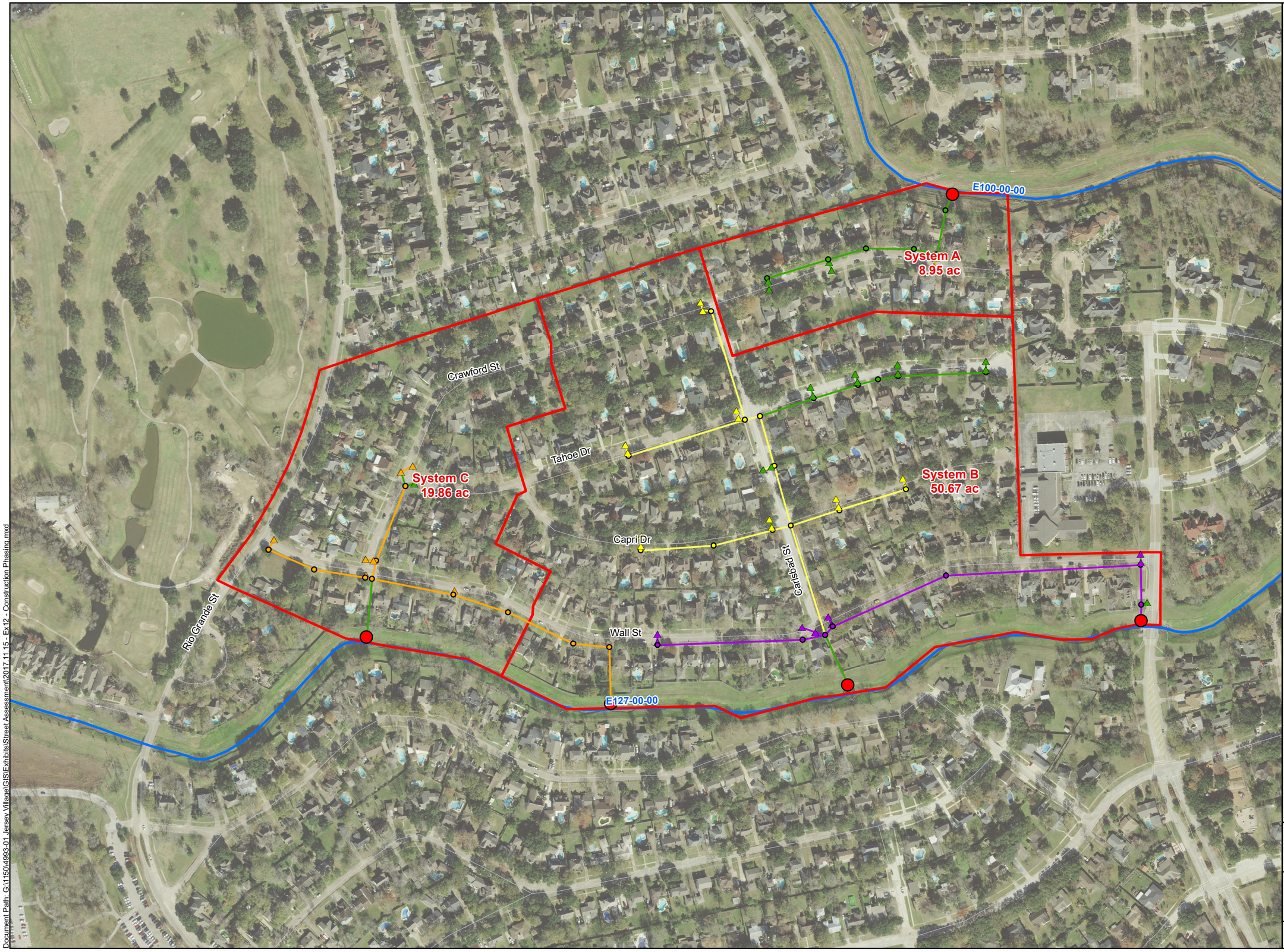
0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 11**
Proposed Street Repaving and Typical Road Cross-section

1 in. = 300 ft | December 2017

Document Path: G:\11150\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.11.15 - Ex11 - Proposed Paving.mxd




## Legend

- Proposed Drainage Systems
- Stream Network

**Construction Phase**

- Existing
- Phase 1
- Phase 2
- Phase 3

**Structure Phase**

- Existing Inlet
- Existing Manhole
- Phase 1 Inlet
- Phase 1 Manhole
- Phase 2 Inlet
- Phase 2 Manhole
- Phase 3 Inlet
- Phase 3 Manhole
- Outfall

**DANNENBAUM**

N

0 300 600 Ft

**City of Jersey Village**
**Wall Street Storm Sewer Study**

**Exhibit 12**
Construction Phasing plan

1 in. = 300 ft | December, 2017

Document Path: G:\1150\4993-01 Jersey Village\GIS\Exhibits\Street Assessment\2017.11.15 - Ex12 - Construction Phasing.mxd