



Friday, January 29, 2021

Commissioner Adrian Garcia  
Harris County Precinct 2  
1001 Preston, Suite 924  
Houston, Texas 77002

Subject: 2021 Partnership Project Applications  
Application 1 – College Park Subdivision neighborhood drainage improvements  
Application 2 – Deer Park Gardens – Phase 1 neighborhood drainage improvements

Commissioner Garcia,

Last year, your Office initiated the Precinct 2 Partnership Projects in an effort to work collaboratively with municipalities to identify potential Capital Improvement Projects and maintenance projects that benefit the constituents of Precinct 2. We look forward to participation with your office this year and thank you for last year's funding effort which Deer Park was the fortunate recipient of (2) 2020 Partnership Project awards for drainage:

1. Heritage Addition \$2,047,461

The Heritage Addition subdivision neighborhood contains 307-homes as well as an Elementary school. This drainage project started in August 2020 and will be completed by July 2021.

2. Delo-Elaine / Deer Park Manor \$1,005,985

The Delo-Elaine / Deer Park Manor neighborhoods contain 188-homes. This project will start in the next 90-days and be completed by early 2022.

Putting your Office's participation funding to work last year has meant that the nearly 500-homes in these areas, will now be protected during 100-year rain events. Your Office's assistance with these drainage projects is advertised on the project site and frequently brought to the attention of residents, City Council and Staff, as well as published in our local quarterly publication "The Deer Park Messenger".

We appreciate your past assistance and look forward to your participation with the (2) Subject drainage projects as we look to further strengthen Deer Park against future rain events. Your consideration in the matter is greatly appreciated and any assistance you could provide will be used to the benefit of Precinct 2 constituents.

Please feel free to contact me if you have questions or need any additional information.

Sincerely,

Adam Ballesteros, P.E.  
City of Deer Park  
City Engineer

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**ADRIAN  
GARCIA**  
COMMISSIONER

## Partnership Project Request Form

Requesting Agency Information	
<b>Requesting Agency</b>	City of Deer Park
Requesting Agency POC	
<b>First Name</b>	Jerry
<b>Last Name</b>	Mouton
<b>Title</b>	Mayor
<b>Phone Number</b>	(281) 479-2394
<b>Email Address</b>	c/o Mr. Gary Jackson ( Assistant City Manager) – gjackson@deerparktx.org
<b>Physical Address</b>	710 E. San Augustine, Deer Park, TX 77536

Request Summary	
<b>Project Type (Circle One)</b>	Street <u>Drainage</u> , Sidewalk, Traffic Improvements, Parks, Planning Studies, Others
<b>Estimated Project Cost</b>	\$6,068,261.78
<b>Funding Commitment by Requesting Entity</b>	50%
<b>Funding Requested From Precinct 2</b>	50%
<b>Alternative Requests from Precinct 2 other than funding</b>	N/A
<b>Other Funding Source/Funding Partners</b>	N/A
<b>Proposed Project Start Date</b>	Q4 2021

Project Information Data
<b>A. Project Description</b>
<p>The College Park subdivision neighborhoods (“College Park”) have experienced flooding during several recent storm events. As such, the City of Deer Park tasked CobbFendley to study and develop a Preliminary Engineering Drainage Report 01 (“Report”) which is attached as Exhibit A. The report studied College Park’s present-day storm sewer system, overland sheet flow patterns, overall drainage system functionality and to identify problems and areas of concern. The Report was completed in 2020 and offers flood mitigation recommendations for the purposes of this Partnership submittal, project design, contractor bidding, easement acquisition and construction of flood mitigation infrastructure. The Report included alternative proposed designs and recommendations, which would alleviate flooding within the neighborhood, for storm events up to and including the 100-year rainfall events. The Report recommends improvements that will lower College Park water surface elevations without increases in flow to the adjacent receiving stream Willow Spring Bayou B112-00-00. Report recommendations include improvements to the storm sewer system within College Park, easement acquisition and a new detention pond located on vacant property inside the Grand View Funeral Home property (Memorial Park / Bethany Cemetery), or a nearby vacant lot, with both locations near the intersection of Luella Avenue and Spencer Highway. Upon review of the CobbFendley Report and acceptance by the City of Deer Park, CobbFendley will design construction plans, specifications and estimates. The benefits of this project have been presented to City of Deer Park Council at several meetings with Council and members of the affected public being very receptive to the project.</p>

**B. Funding Commitment and Agency Priority**

PROJECT FUNDING COMMITMENT AND AGENCY PRIORITY										
Rank	Project	PER			PS&E			Funding available from Deer Park?	Construction	
		Started	Submitted	Approved	Started	Submitted	Approved		Started	% Complete
1	College Park	YES	YES	YES	NO	-	-	YES	NO	N/A
2	Deer Park Gardens - Phase 1	YES	YES	YES	YES	-	-	YES	NO	N/A

**C. Master Plan Element**

City of Deer Park contracted with Klotz Associates, Inc. in 2009 to obtain a Citywide Drainage Masterplan (“Masterplan”). The Masterplan was created in 2009 and created to identify potential problem areas associated with drainage networks within the City limits and provide general recommendations for necessary improvements to storm sewer systems and/or drainage channels. Upon completion of the Masterplan, it was approved and formally adopted by the Deer Park City Council. An executive summary from the Masterplan is included with this submittal as Exhibit C. and identified College Park as an area of necessary potential improvement. The Masterplan, the Report and repetitive losses resulting from recent storms, assisted Deer Park in identifying the College Park area as a high priority project with a feasible economical cost benefit within the City’s fiscal budget. Because of this, the City has started the process to begin allocating resources to perform recommendations outlined in the Report. College Park’s drainage improvements project has no connection to any County or HCFCD identified projects.

**D. Flooding Threat/Safety/ Traffic Improvement**

This project will address flooding problems identified within College Park, which contains 234-homes, of which 71-homes have reported repetitive flood losses, as shown in Exhibit D. The Report conducted XP-SWMM existing condition analysis modeling (modeling dataset available upon request) and revealed 158-parcels affected by 100-year rainfall events. This neighborhood is not located within the regulatory FEMA 100- or 500-year floodplains. Based upon the recommended improvements for these neighborhoods, the recommended storm sewer and detention pond improvements will provide the minimum 2-year conveyance capacity as well as alleviate structural flooding in the 100-year rainfall event.

**E. Level of Protection/Level of Service/ Connectivity**

The Report conducted XP-SWMM existing condition analysis modeling and revealed 158-parcels affected by 100-year rainfall events with inundation by water surface elevations exceeding the ROW. Report recommendations allow for the proposed storm sewer system improvements to convey Atlas-14 based rainfall events, with water surface elevations remaining at or below the gutter line, and maintaining water surface elevations to within the ROW, to 2- and 100-year rainfall events, respectively. Changes in 100-year rainfall event inundation between existing and proposed conditions are shown in the Report based on the selected mitigation alternative. All (3) mitigation alternatives maintain water surface elevations to within the ROW. Impacts resulting from the increased conveyance capacity is mitigated by a detention pond with 16.6-acre-feet of capacity at the location described in the Project Description.

**F. Area Benefited**

College Park contains 234-homes constructed in the late-1960s. Flooding concerns have been reported since these homes were originally built and grown worse over time. There are 71-homes currently identified with reported flood losses, with most being repetitive flood losses from separate rainfall events. Proposed improvements from the Report are intended to allow for passable roadways, and alleviate flooding from all homes within the neighborhood in the 2- and 100-year rainfall events, respectively. The Report recommendations require a detention pond to mitigate project impacts. Dependent on easement acquisition, the size of the detention pond could be expanded to utilize the entire property, and realized additional benefits downstream of College Park.

***G. Ancillary Benefit***

**Safety:** Reduction of water surface elevations within the neighborhood can aid in prevention of drowning/loss of life.

**Water Conservation/recharge opportunities:** This project can provide an additional benefit of water conservation and recharge by allowing storage of water within the detention pond. The pond configuration could easily be modified to include a wet bottom. This stored water will allow for additional infiltration over time into the groundwater as well as a potential location for immediate need water during fire emergencies in an event where the City waterlines failed.

**Water quality Implications:** Construction of the detention facility associated with this project will allow the storm water to be managed. Trash racks located near the pond outfall will also remove debris that would have otherwise been conveyed directly to the receiving streams.

**Vegetation and wildlife:** this project will have no impacts on vegetation or wildlife since the improvements are being performed in a fully developed neighborhood. The location where the detention pond is to be located is currently grass and can remain grass once the pond is constructed. The pond can also serve as a source of habitat or water source due to its adjacency to the prairieland preserve.

**Multiple-use features:** The detention pond can also serve for recreational facilities – if the pond is constructed as a dry bottom pond, the bottom can be utilized by the adjacent prairieland preserve; if the pond is constructed as a wet-bottom pond, it can provided fishing, kayaking, or paddle boarding opportunities as well.

**Transportation:** Because the storm sewer improvements are being performed in a residential area, transportation will be greatly improved allowing for better flow of traffic during the more frequent rainfall events. Similarly, the improvements will also allow for pedestrian and bicycle traffic as well.

***H. Level of Partner Participation***

The City of Deer Park is prepared to contribute fifty-percent (50%) of the overall costs associated with this project. Funding for the City’s portion of the project will be obtained through direct agency funding from the City of Deer Park. The CobbFendley Report has been completed and construction plans will be developed based on recommendations within the report. The City hopes to start construction of this project in mid- to late-2021.

***I. Operations and Maintenance Cost to Harris County***

Because this project is being performed within developed neighborhoods, required maintenance of the drainage system is minimal at best. The City of Deer Park will provide all future operation and maintenance of the storm sewer system, and provide maintenance and mowing associated with any future detention pond. Therefore, it will not be necessary for Harris County Precinct 2, Harris County Flood Control District or any other entity, other than the City of Deer Park itself, to bear the future cost of perpetual operation and maintenance for this infrastructure.

We appreciate your consideration of this project and any assistance you could provide would be greatly appreciated. Please feel free to contact me if you have questions or need any additional information.

Signature of the Applicant/Applicants Agent:



Name and Title:  
R. Adam Ballesteros, P.E.  
City of Deer Park  
City Engineer

Date:  
Friday, January 29, 2021



**ADRIAN  
GARCIA**  
COMMISSIONER

## Partnership Project Request Form

Requesting Agency Information	
<b>Requesting Agency</b>	City of Deer Park
Requesting Agency POC	
<b>First Name</b>	Jerry
<b>Last Name</b>	Mouton
<b>Title</b>	Mayor
<b>Phone Number</b>	(281) 479-2394
<b>Email Address</b>	c/o Mr. Gary Jackson ( Assistant City Manager) – gjackson@deerparktx.org
<b>Physical Address</b>	710 E. San Augustine, Deer Park, TX 77536

Request Summary	
<b>Project Type (Circle One)</b>	Street <u>Drainage</u> , Sidewalk, Traffic Improvements, Parks, Planning Studies, Others
<b>Estimated Project Cost</b>	\$436,856.40
<b>Funding Commitment by Requesting Entity</b>	50%
<b>Funding Requested From Precinct 2</b>	50%
<b>Alternative Requests from Precinct 2 other than funding</b>	N/A
<b>Other Funding Source/Funding Partners</b>	N/A
<b>Proposed Project Start Date</b>	Q2 2021

Project Information Data
<b>A. Project Description</b>
<p>The Deer Park Gardens – Phase 1 subdivision neighborhood (“Deer Park Gardens”) have experienced flooding during several recent storm events. As such, the City of Deer Park tasked CobbFendley to study and develop a Preliminary Engineering Drainage Report 02 (“Report”) which is attached as Exhibit B. The report studied Deer Park Gardens’s present-day storm sewer system, overland sheet flow patterns, overall drainage system functionality and to identify problems and areas of concern. The Report was completed in 2020 and offers flood mitigation recommendations for the purposes of this Partnership submittal, project design, contractor bidding, easement acquisition and construction of flood mitigation infrastructure. The Report included alternative proposed designs and recommendations, which would alleviate flooding within the neighborhood, for storm events up to and including the 100-year rainfall events. The Report recommends improvements that will lower Deer Park Gardens water surface elevations without increases in flow to the adjacent receiving stream Patrick’s Bayou G104-00-00, once detention is acquired. Report recommendations include improvements to the storm sewer system within Deer Park Gardens, easement acquisition and a new detention pond to be determined. Upon review of the CobbFendley Report and acceptance by the City of Deer Park, CobbFendley will design construction plans, specifications and estimates. The benefits of this project have been presented to City of Deer Park Council at several meetings with Council and members of the affected public being very receptive to the project. This Partnership Project Request form is for Phase 1 of a multiphase project to perform storm sewer improvements and other flood mitigation measures in the Deer Park Gardens subdivision neighborhoods.</p>

**B. Funding Commitment and Agency Priority**

<b>PROJECT FUNDING COMMITMENT AND AGENCY PRIORITY</b>										
<b>Rank</b>	<b>Project</b>	<b>PER</b>			<b>PS&amp;E</b>			<b>Funding available from Deer Park?</b>	<b>Construction</b>	
		<b>Started</b>	<b>Submitted</b>	<b>Approved</b>	<b>Started</b>	<b>Submitted</b>	<b>Approved</b>		<b>Started</b>	<b>% Complete</b>
1	College Park	YES	YES	YES	NO	-	-	YES	NO	N/A
2	Deer Park Gardens - Phase 1	YES	YES	YES	YES	-	-	YES	NO	N/A

**C. Master Plan Element**

City of Deer Park contracted with Klotz Associates, Inc. in 2009 to obtain a Citywide Drainage Masterplan (“Masterplan”). The Masterplan was created in 2009 and created to identify potential problem areas associated with drainage networks within the City limits and provide general recommendations for necessary improvements to storm sewer systems and/or drainage channels. Upon completion of the Masterplan, it was approved and formally adopted by the Deer Park City Council. An executive summary from the Masterplan is included with this submittal as Exhibit C. and identified Deer Park Gardens as an area of necessary potential improvement. The Masterplan, the Report and repetitive losses resulting from recent storms, assisted Deer Park in identifying the Deer Park Gardens area as a high priority project with a feasible economical cost benefit within the City’s fiscal budget. Because of this, the City has started the process to begin allocating resources to perform recommendations outlined in the Report. Deer Park Gardens’s drainage improvements project has no connection to any County or HCFCID identified projects.

**D. Flooding Threat/Safety/ Traffic Improvement**

This project will address flooding problems identified within Deer Park Gardens along Norwood Street where homes have reported repetitive flood losses, as shown in Exhibit D. The Report conducted XP-SWMM existing condition analysis modeling (modeling dataset available upon request) and revealed parcels affected by 100-year rainfall events. Norwood Street improvements are located within the regulatory FEMA 500-year floodplain. Based upon the recommended Phase 1 storm sewer improvements for this neighborhood, some relief will be provided while additional Phases of the multiphase approach are executed to provide detention and perform other flood mitigation improvements.

**E. Level of Protection/Level of Service/ Connectivity**

The Report conducted XP-SWMM existing condition analysis modeling and revealed parcels affected by 100-year rainfall events with inundation by water surface elevations exceeding the ROW. Report recommendations allow for the proposed storm sewer system improvements to convey Atlas-14 based rainfall events, with water surface elevations remaining at or below the gutter line, and maintaining water surface elevations to within the ROW, to 2- and 100-year rainfall events, respectively. Changes in 100-year rainfall event inundation between existing and proposed conditions are shown in the Report based on the selected mitigation alternative. The overall project with all Phases will maintain water surface elevations to within the ROW. Impacts resulting from the increased conveyance capacity will eventually be mitigated by a detention pond requiring 38-acre-feet of capacity in the Deer Park Gardens area.

**F. Area Benefited**

Deer Park Gardens contains homes constructed in the late-1950s. Flooding concerns have been reported since these homes were originally built and grown worse over time. Homes currently identified with reported flood losses, also experience repetitive flood losses from separate rainfall events. Proposed improvements from the Report are intended to allow for passable roadways, and alleviate flooding from all homes within the neighborhood in the in the 2- and 100-year rainfall events, respectively, upon completion of all construction Phases. The Report recommendations require a detention pond to eventually be constructed to mitigate project impacts. Dependent on easement acquisition, the size of the detention pond could be expanded to utilize to realize additional benefits both up- and downstream of Deer Park Gardens.

***G. Ancillary Benefit***

**Safety:** Reduction of water surface elevations within the neighborhood can aid in prevention of drowning/loss of life.

**Water Conservation/recharge opportunities:** This project can provide an additional benefit of water conservation and recharge by allowing storage of water within the detention pond. The pond configuration could easily be modified to include a wet bottom. This stored water will allow for additional infiltration over time into the groundwater as well as a potential location for immediate need water during fire emergencies in an event where the City waterlines failed.

**Water quality Implications:** Construction of the detention facility associated with this project will allow the storm water to be managed. Trash racks located near the pond outfall will also remove debris that would have otherwise been conveyed directly to the receiving streams.

**Vegetation and wildlife:** this project will have no impacts on vegetation or wildlife since the improvements are being performed in a fully developed neighborhood. The location where the detention pond is to be located is currently grass and can remain grass once the pond is constructed. The pond can also serve as a source of habitat or water source due to its adjacency to the prairieland preserve.

**Multiple-use features:** The detention pond can also serve for recreational facilities – if the pond is constructed as a dry bottom pond, the bottom can be utilized by the adjacent prairieland preserve; if the pond is constructed as a wet-bottom pond, it can provided fishing, kayaking, or paddle boarding opportunities as well.

**Transportation:** Because the storm sewer improvements are being performed in a residential area, transportation will be greatly improved allowing for better flow of traffic during the more frequent rainfall events. Similarly, the improvements will also allow for pedestrian and bicycle traffic as well.

***H. Level of Partner Participation***

The City of Deer Park is prepared to contribute fifty-percent (50%) of the overall costs associated with this project. Funding for the City’s portion of the project will be obtained through direct agency funding from the City of Deer Park. The CobbFendley Report has been completed and construction plans are being developed based on recommendations within the report. The City hopes to start construction of Phase 1 of this project in mid-2021.

***I. Operations and Maintenance Cost to Harris County***

Because this project is being performed within developed neighborhoods, required maintenance of the drainage system is minimal at best. The City of Deer Park will provide all future operation and maintenance of the storm sewer system, and provide maintenance and mowing associated with any future detention pond. Therefore, it will not be necessary for Harris County Precinct 2, Harris County Flood Control District or any other entity, other than the City of Deer Park itself, to bear the future cost of perpetual operation and maintenance for this infrastructure.

We appreciate your consideration of this project and any assistance you could provide would be greatly appreciated. Please feel free to contact me if you have questions or need any additional information.

Signature of the Applicant/Applicants Agent:



Name and Title:

R. Adam Ballesteros, P.E.  
City of Deer Park  
City Engineer

Date:

Friday, January 29, 2021

# **EXHIBIT A**

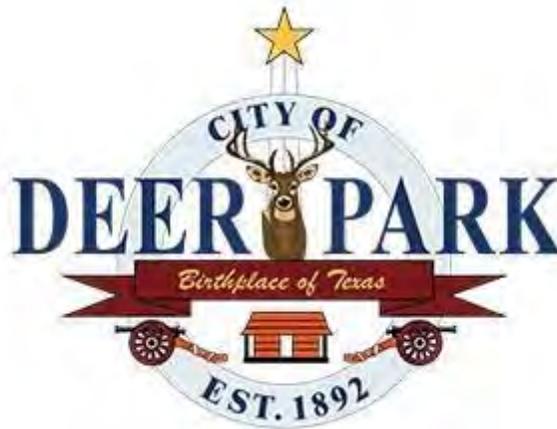
## **“REPORT 01” 01 – College Park**

Preliminary Engineering Report for College Park Drainage Improvements  
CobbFendley  
January 2021

# PRELIMINARY ENGINEERING REPORT FOR College Park Drainage Improvements

**CITY OF DEER PARK, TEXAS**

CobbFendley Project No. 1813-004



January 2021



Submitted By:

 **CobbFendley**  
Texas Registration No. 274

Civil Engineering ♦ Construction Management ♦ GIS/CADD ♦ Land Development ♦ Land Surveying  
Municipal ♦ Right-of-Way ♦ Site Development ♦ Subsurface Utility Engineering  
Hydraulics/Hydrology ♦ Telecommunications ♦ Transportation ♦ Utility Coordination

13430 Northwest Freeway, Suite 1100 | Houston, Texas 77040 | Voice 713.462.3242 | Fax 713.462.3262 | [www.cobbfendley.com](http://www.cobbfendley.com)

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F. Conclusions .....	9

## EXHIBITS

1. Vicinity Map
2. Project Location
3. FEMA Floodplain Map
4. Drainage Area Map
5. Existing Storm Sewer Map
6. LiDAR Map
7. Existing Condition 100-Year Ponding Map
8. Overland Sheetflow Map
9. Proposed Alternative 1 Layout
10. Alternative 1 100-Year Ponding Map
11. Proposed Alternative 2 Layout
12. Alternative 2 100-Year Ponding Map
13. Proposed Alternative 3 Layout
14. Alternative 3 100-Year Ponding Map

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## TABLES

1. Green & Ampt Loss Parameters
2. Existing Condition Hydrologic Calculations
3. Total Existing Condition Flow
4. Alternative 1 – Detailed Cost Estimate
5. Alternative 2 – Detailed Cost Estimate
6. Total Proposed Condition Flow Comparison

## APPENDICES

- A. College Park Existing Drainage Plans
- B. Detailed Hydrologic Calculations
- C. 2-Year XP-Storm Output
- D. 100-Year XP-Storm Output

## Executive Summary

The City of Deer Park (City) contracted with Cobb, Fendley & Associates, Inc. to develop a Preliminary Engineering Drainage Report for the College Park Subdivision located in the southern portion of the City, see Exhibit 1 – Vicinity Map. The College Park Subdivision is bound by Spencer Highway on the south, E Lambuth Ln on the North, HCFCD Unit #B112-03-01 on the west, and Willowspring Creek (HCFCD Unit #B112-00-00) on the east. The project areas are comprised of single-family homes with concrete sidewalks and curb and gutter storm sewer systems.

There are five (5) storm sewer systems within College Park that convey flow from the neighborhood to B112-03-01, which borders the neighborhood on the western side. The storm sewer within College Park does not have capacity for the 2-year storm event, and there are no adequate paths for extreme event overland sheetflow.

Three alternatives were considered and analyzed as solutions to the drainage deficiencies within the neighborhood. Due to depth constraints, it was determined that the existing storm sewer layout and outfall locations would need to be modified in the proposed condition to provide adequate cover for the proposed storm sewer pipes. The proposed alternatives involve collecting all storm sewers within the neighborhood in a single trunkline along Luella and routing flow to Willowspring Creek. A detention pond is recommended in all alternatives for mitigation of flow and water surface elevation impacts in Willowspring Creek.

The recommended alternative for improvements to these neighborhoods is Alternative 1. This alternative includes increasing storm sewer and inlet conveyance capacity to eliminate ponding in the 2-year event and limit ponding in the 100-year event to the remain within the Right-of-Way. Flow from the east-west streets will be collected in a trunkline along Luella Ave which will continue west along the southern border of the neighborhood, draining through a proposed 16.61 acre-foot detention pond where water will be stored for a controlled release into Willowspring Creek approximately 1,570-ft north of Spencer Highway. In all locations, where possible, the proposed pavement would remain the same width as the existing pavement, resulting in no change in impervious cover. The proposed detention pond provides the mitigation necessary to offset the increase in conveyance. Note that this alternative is dependent on obtaining a drainage easement / purchasing property from the cemetery. The total estimated cost associated with constructing Alternative 1 improvements is \$4,717,512, which does not include cost of land acquisition or easements.

Should the required land acquisition and easements for Alternative 1 prove infeasible to obtain, Alternative 2 is also a viable alternate option.

## A. Study Area Location and Description

The City of Deer Park (City) contracted with Cobb, Fendley & Associates, Inc. to develop a Preliminary Engineering Drainage Report for the College Park Subdivision located in the southern portion of the City, see Exhibit 1 – Vicinity Map. The College Park Subdivision is bound by Spencer Highway on the south, E Lambuth Ln on the North, HCFCD Unit #B112-03-01 on the west, and Willowspring Creek (HCFCD Unit #B112-00-00) on the east.

The project area is comprised of single-family homes with concrete sidewalks and a curb and gutter storm sewer system. The storm sewer within the project area serves 161 residential properties and 7 commercial properties. 56 properties reported flooding during Tropical Storm Allison and 9 properties reported flooding during Hurricane Harvey.

## B. Scope of Work

The purpose of this study is to review and evaluate the present-day condition of the drainage system servicing the project area to identify problems and areas of concern. Specific tasks include:

- Determine overland sheetflow parameters
- Identify outfall locations
- Determine drainage area boundaries
- Perform hydrologic calculations for the existing condition
- Perform an existing condition storm sewer capacity analysis
- Determine locations of the existing drainage system in which improvements can be made
- Analyze potential alternative solutions to mitigate impacts which may result from increased conveyance capacity or increased impervious cover as part of the recommended improvements

## C. Methodology

The Rational Method was used to determine peak flows for both the existing and proposed condition. Drainage areas were delineated using Harris County 2018 LiDAR and plan sets of the existing drainage infrastructure. Runoff coefficient “C” values were determined for each drainage area based on land use and the equation for Time of Concentration (Eq. 1) found in the City of Houston Infrastructure Design Manual (July 2019).

Eq. 1  $TC = 10 * A^{0.1761} + 15$

Where:

TC = Time of concentration (minutes)

A = Area (acres)

The Clark Unit Hydrograph Method was used to compute the runoff hydrographs within XP-Storm. The Clark Unit Hydrograph Method requires a drainage area, time of concentration (Tc), and a storage value (R) to compute a runoff hydrograph. The storage parameter (R) was determined by adjusting the value until the resulting peak discharge matched the computed runoff from the Rational Method. The loss parameters were input into XP-Storm using the Green & Ampt loss method parameters provided in **Table 1** below, which were obtained from the B112B Subbasin from the Armand Bayou FEMA Effective HEC-HMS model.

**Table 1: Green & Ampt Loss Parameters**

Initial Loss (in)	Moisture Deficit	Suction (in)	Conductivity (in/hr)
0.1	0.385	12.45	0.024

An inlet-level XP-Storm (v. 2016.1) model was created to analyze the existing drainage system. The drainage system was evaluated based upon its ability to convey the design 2-year rainfall utilizing top of pipe as the boundary condition for tailwater. The 100-year rainfall event was also analyzed to determine the performance of the system in extreme rainfall events. The existing condition 100-year model tailwater condition was set at the top of the concrete-lined section of the channel at each outfall location. The FEMA Effective base flood elevation within Willowspring Creek (B112-00-00) at the outfall locations were used to determine the tailwater for the proposed condition 100-year models.

## D. Existing Condition Drainage Analysis

### 1. Hydrology

The project area is located within the Armand Bayou Watershed and is situated outside the 100-year FEMA floodplain, see Exhibit 3 – FEMA Floodplain Map. Drainage areas were delineated using 2008 LiDAR, 2018 Google Earth imagery, and existing plan sets, see Exhibit 4 for an existing condition drainage area map of the project area. The rational method was used to determine peak flows from each drainage area, according to the City of Houston Infrastructure Design

Manual (July 2019). The time of concentration formula mentioned in Section C of this report was used to calculate time of concentration for each drainage area to determine the rainfall intensity. **Table 2** shows the existing condition hydrologic calculations for each drainage area.

**Table 2: Existing Condition Hydrologic Calculations**

Drainage Area Name	Area (ac)	C-Value	Tc (min)	Intensity (in/hr)		Peak Flow (cfs)	
				2-year	100-year	2-year	100-year
A-1	2.47	0.55	26.73	3.30	6.82	4.49	9.27
A-2	3.36	0.55	27.38	3.26	6.75	6.03	12.48
A-3	0.35	0.55	23.31	3.54	7.20	0.68	1.39
A-4	0.17	0.55	22.32	3.62	7.33	0.34	0.68
A-5	0.51	0.55	23.88	3.50	7.14	0.98	2.00
B-1	3.35	0.55	27.37	3.26	6.75	6.01	12.44
B-2	2.8	0.55	26.99	3.29	6.79	5.06	10.46
C-1	2.59	0.55	26.82	3.30	6.81	4.70	9.70
C-2	3.73	0.55	27.61	3.25	6.73	6.66	13.80
C-3	2.17	0.55	26.46	3.32	6.85	3.96	8.17
D-1	2.6	0.55	26.83	3.30	6.81	4.71	9.74
D-2	3.55	0.55	27.50	3.26	6.74	6.36	13.16
D-3	0.93	0.55	24.87	3.43	7.02	1.75	3.59
E-1	3.1	0.55	27.20	3.27	6.77	5.58	11.54
E-2	3.06	0.55	27.18	3.28	6.77	5.51	11.40
E-3	1.42	0.8	25.64	3.38	6.94	3.83	7.88
E-4	1.76	0.8	26.05	3.35	6.89	4.71	9.71
E-5	0.92	0.55	24.85	3.43	7.02	1.74	3.55

2. Hydraulics

The existing drainage systems servicing the project areas are primarily comprised of concrete curb and gutter streets with inlets and underground storm sewer pipes within the neighborhoods. There are five (5) storm sewer systems within College Park that convey flow from the neighborhood to B112-03-01, which borders the neighborhood on the western side. The existing sheet flow for this area drains east to Willowspring Creek (B112-00-00). In the existing condition, there are inadequate overland flow paths to allow ponded water to drain to B112-03-01 on the west or east to Willowspring Creek. See Exhibit 5 for an existing storm sewer map for the subdivision and Exhibit 6 – LiDAR Map.

The existing storm sewer systems are comprised of reinforced concrete pipe (RCP) and arch-shaped corrugated metal pipe (CMP). RCP pipes range in size from 18" to 24". The arch CMP pipes range in size from 13" x 22" to 18" x 29". The inlets along Luella Avenue are primarily Type-C inlets and are located at the intersections of roadways, while the inlets along the east-west streets are primarily Type-BB inlets and are located at sags in the roadways. See Exhibit 5 for an existing condition storm sewer layout map. Information for the existing storm sewer within the subdivision was obtained from plan sets provided by the City of Deer Park. These plans are included in Appendix A.

The boundary condition at each outfall was set to the top-of-pipe elevation for the 2-year analysis, and was set to the Effective 100-year base flood elevation (BFE), which was interpolated upstream along B112-03-00 and B112-03-01 based on the slope of the channel bed to approximate the BFE at each outfall location.

The XP-Storm analysis determined the existing storm sewer pipes and inlets within College Park were inadequately sized to convey the 2-year storm event. Additionally, the 100-year analysis shows a concerning amount of ponding along the east-west streets, see Exhibit 6 – Existing Condition 100-Year Ponding Map. The hydrologic calculations and XP-SWMM results for the existing condition and proposed alternatives can be found in Appendices B (Detailed Hydrologic Calculations), C (2-year storm event models), and D (100-year storm event models). The total existing condition flow (calculated by summing the outfall hydrographs from each of the 5 existing systems) for the 2-year and 100-year events is summarized in **Table 3**, below.

**Table 3: Total Existing Condition Flow**

<b>2-Year Flow (cfs)</b>	<b>100-Year Flow (cfs)</b>
50.59	63.24

In addition to the undersized storm sewer within the College park subdivision, it was also determined that one of the primary factors leading to inundation within the neighborhood is inadequate paths for overland sheet flow. Exhibit 7 shows the overland sheet flow patterns and the resulting ponding depth before overland flow can occur. In the existing condition, overland flow travels between homes along Dartmouth Lane and Princeton Lane. This path correlates with reported repeat flooding complaints.

## E. Proposed Alternatives

Due to depth constraints, it was determined that the existing storm sewer layout and outfall locations would need to be modified in the proposed condition to provide adequate cover for the proposed storm sewer pipes. The proposed alternatives involve collecting all storm sewers within the neighborhood in a single trunkline along Luella and routing flow to

Willowspring Creek. The five existing outfall pipes into B112-03-01 will be plugged and abandoned in place.

The proposed condition drainage areas, hydrologic parameters, and computed runoff rates reflect that of the existing condition except for areas proposed for detention basin sites. Detailed hydrologic calculations, including those for the proposed drainage areas associated with the detention facilities, are located in Appendix B. Each of the alternatives were analyzed using XP-Storm with similar boundary conditions as the existing condition analysis for comparison.

## 1. Alternative 1

Alternative 1 includes replacing all storm sewer within the project area with RCP storm sewer sized to convey the 2-year event. Flow from the east-west streets will be collected in a trunkline along Luella Ave which will continue west along E Rutgers Ln, draining to a proposed linear detention pond where water will be stored for a controlled release into Willowspring Creek.

Inlets and storm sewer within the project area were upsized to provide adequate capacity to keep 100-year ponding within the ROW. The proposed storm sewer ranges in size from 24" to 84", and proposed inlets range in size from Type C to Type C-2.

The proposed detention facility will be a 1,060-ft linear pond that is approximately 10-feet deep with 3H:1V side slopes, providing approximately 18 acre-ft of storage. The pond will drain to Willowspring Creek via a 42" RCP, outfalling approximately 1,570-ft north of Spencer Highway, see Exhibit 9 – Proposed Alternative 1 Layout.

A drainage easement will be required between 1217 E Rutgers Ln and 1221 E Rutgers Ln. Further investigation is required to determine whether there is enough space between homes to construct the proposed storm sewer. The proposed detention pond will require acquisition of 2.76 acres of undeveloped land from the Grand View Memorial Park cemetery. This only includes a 30-foot maintenance berm along the western edge of the pond. The total estimated cost for Alternative 1 is \$4,717,512, which includes storm sewer, detention, necessary pavement replacement, but does NOT include land acquisition for the detention site. This alternative is dependent on obtaining a drainage easement / purchasing property from the cemetery. A complete cost breakdown can be seen in Table 4 – Alternative 1 Detailed Cost.

Alternative 1 provides adequate capacity to convey the 100-year event within the ROW and utilizes 16.61 acre-feet of storage in the proposed pond, see Exhibit 10 – Alternative 1 100-Year Ponding Map.

## 2. Alternative 2

Alternative 2 includes replacing all storm sewer within the project area with RCP storm sewer sized to convey the 2-year event. Flow from the east-west streets will be collected in a trunkline along Luella Ave which will continue west along the southern border of the neighborhood, draining through a proposed detention pond where water will be stored for a controlled release into Willowspring Creek approximately 675-ft north of Spencer Highway, see Exhibit 11 – Proposed Alternative 2 Layout.

Inlets and storm sewer within the project area were upsized to provide adequate capacity to keep 100-year ponding within the ROW. The proposed storm sewer ranges in size from 24" to 72", and proposed inlets range in size from Type C to Type C-2.

The proposed detention facility will be a 12-ft deep pond with 4H:1V side slopes and a 30-foot maintenance berm, providing 12.18 acre-ft of storage. The pond will drain through a 42" RCP with a 41" restrictor, which will route flow through the Grandview Memorial Park cemetery beneath the existing road, outfalling into Willowspring Creek. A drainage easement will be required along the southern boundary of the neighborhood and through Grand View Memorial Park, and the proposed detention pond will require acquisition of 2.4 acres of land. The total estimated paving and drainage cost for Alternative 2 is \$4,548,805, which includes storm sewer, detention, necessary pavement replacement, but does NOT include land acquisition for the detention site or the cost of obtaining an easement through the cemetery. A complete cost breakdown can be seen in Table 5 – Alternative 2 Detailed Cost.

Alternative 2 provides adequate capacity to convey the 100-year event within the ROW and utilizes 10.88 acre-feet of storage in the proposed pond, see Exhibit 12 – Alternative 2 100-Year Ponding Map.

## 3. Alternative 3

Alternative 3 includes replacing all storm sewer within the project area with RCP storm sewer sized to convey the 2-year event. Flow from the east-west streets will be collected in a trunkline along Luella Ave which will continue south to Spencer Highway and flow east to Willowspring Creek. A proposed detention pond will be situated south of the neighborhood where water will be stored for a controlled release into Willowspring Creek, see Exhibit 13 – Proposed Alternative 3 Layout.

Inlets and storm sewer within the project area were upsized to provide adequate capacity to keep 100-year ponding within the ROW. The proposed storm sewer ranges in size from 24" to 72", and proposed inlets range in size from Type C to Type C-2.

The proposed detention facility will be a 14-ft deep pond with 4H:1V side slopes and a 30-foot maintenance berm, providing 13.77 acre-ft of storage. Downstream of the

detention pond the trunkline will be reduced to a 48" RCP, which will route flow along Spencer Highway, outfalling into Willowspring Creek.

Alternative 3 provides adequate capacity to convey the 100-year event within the ROW and utilizes 12.56 acre-feet of storage in the proposed pond, see Exhibit 14 – Alternative 3 100-Year Ponding Map.

This alternative may be infeasible due to the number of utilities within the Spencer Highway right-of-way which may require relocation.

All three alternatives provide sufficient mitigation volume to offset increased conveyance to Willowspring Creek. See **Table 6**, below, for a comparison of the proposed flow with that of the existing condition. The corresponding XP-Storm output tables for 2-year and 100-year analyses of the proposed alternatives are presented in Appendix C and Appendix D.

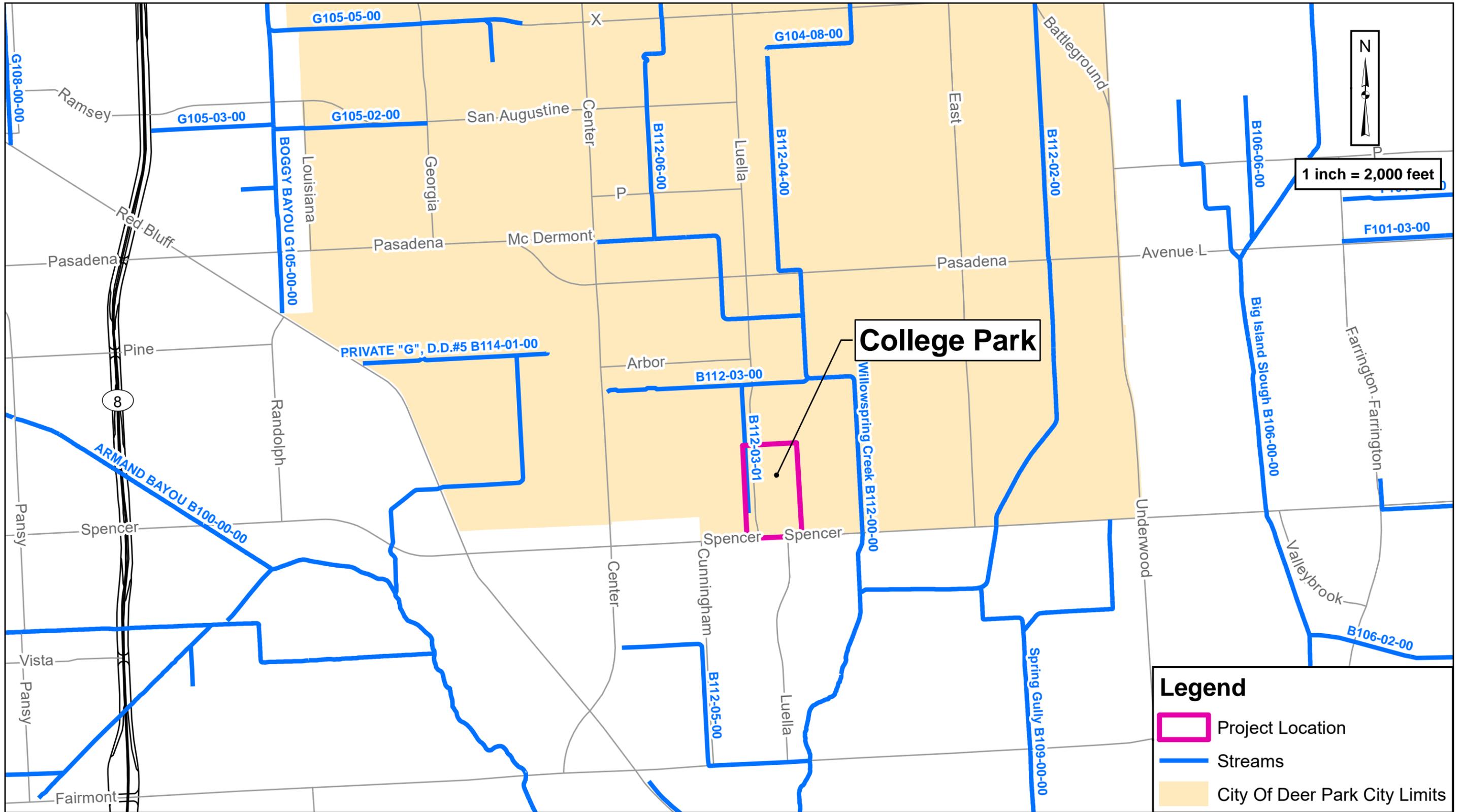
**Table 6: Total Proposed Condition Flow Comparison**

	<b>2-Year Flow (cfs)</b>	<b>100-Year Flow (cfs)</b>
<b>Existing Condition</b>	50.59	63.24
<b>Proposed Alt. 1</b>	18.97	59.66
<b>Proposed Alt. 2</b>	35.74	60.53
<b>Proposed Alt. 3</b>	15.01	58.33

## F. Conclusions

After analyzing all the data collected, we have determined:

- The majority of the storm sewer within College Park is undersized for the 2-year storm event or does not meet the minimum size requirements established by criteria.
- The topography is generally graded west to east, toward Willowspring Creek. The primary cause of extreme event flooding/ponding within College Park is due to inadequate overland sheetflow routes.
- Due to depth constraints, it was determined that the existing storm sewer layout and outfall locations would need to be reconfigured in the proposed condition to provide adequate cover for the larger pipe sizes required in the proposed condition.
- The presented alternatives recommend collecting the existing storm sewer systems into a single trunkline, upsizing the storm sewer and inlets to convey the 2-year storm event and keep the 100-year extreme event ponding from exceeding the ROW, constructing a detention pond adjacent to the College Park neighborhood, and reconfiguring the system to outfall east to Willowspring Creek (HCFCD Unit B#112-00-00).
- The recommended alternative for improvements to these neighborhoods is Alternative 1. This alternative includes increasing storm sewer and inlet conveyance capacity to eliminate ponding in the 2-year event and limit ponding in the 100-year event to the remain within the Right-of-Way. Flow from the east-west streets will be collected in a trunkline along Luella Ave which will continue west along the southern border of the neighborhood, draining through a proposed 16.61 acre-foot detention pond where water will be stored for a controlled release into Willowspring Creek approximately 1,570-ft north of Spencer Highway. This alternative is dependent on obtaining a drainage easement / purchasing property from the cemetery. The total estimated cost associated with the Alternative 1 improvements is \$4,717,512, which does NOT include cost of land acquisition or easements. This alternative provides benefit to 163 properties.
- Should the required land acquisition and easements for Alternative 1 prove infeasible to obtain, Alternative 2 would then become the recommended alternate option.



**College Park**

1 inch = 2,000 feet

**Legend**

- Project Location
- Streams
- City Of Deer Park City Limits

**CobbFendley**  
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 Houston, Texas 77040  
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 www.cobbfendley.com

**City of Deer Park - College Park  
 Vicinity Map**

Date: July 2019

EXHIBIT 1



1 inch = 500 feet

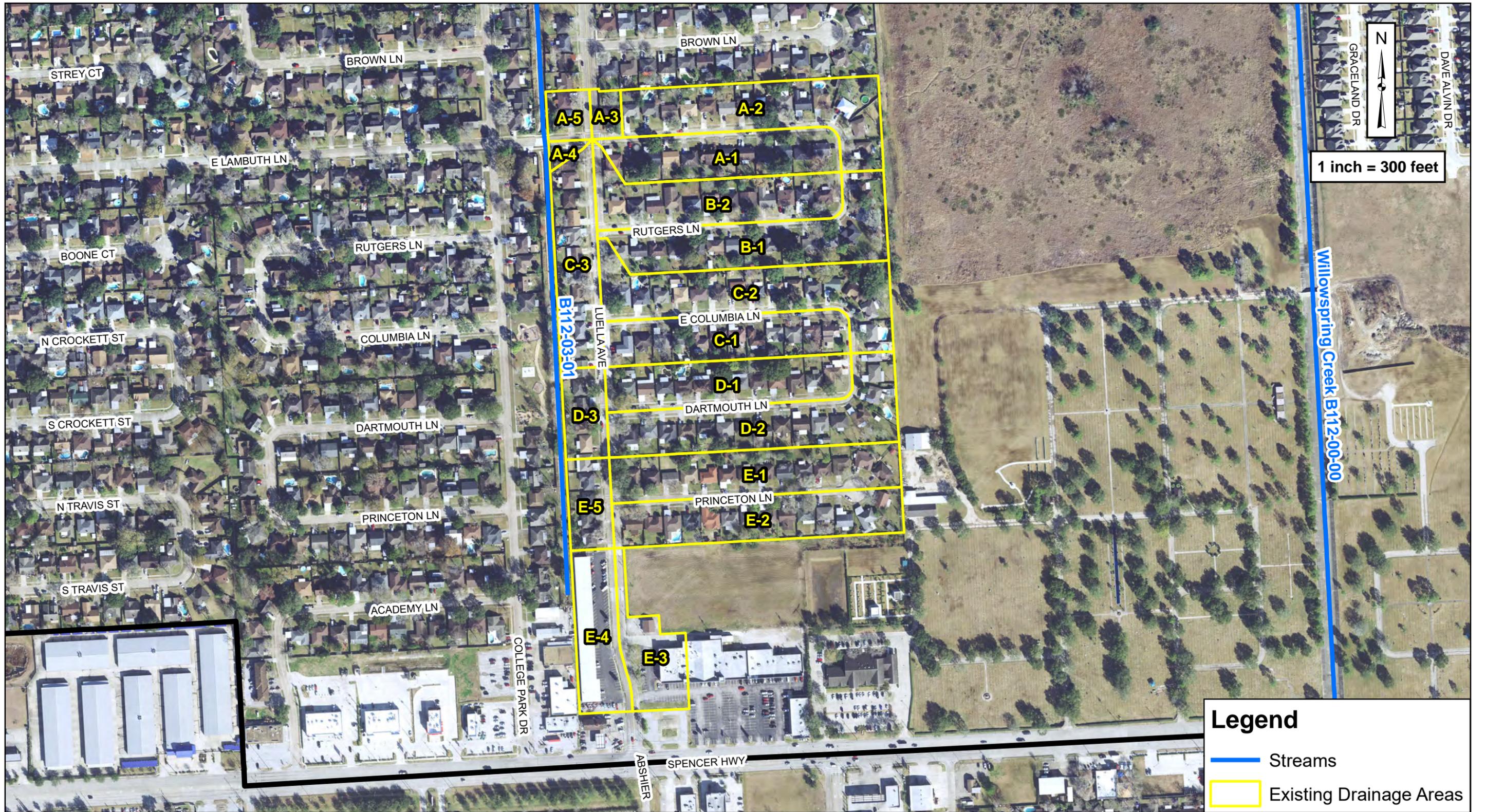
**CobbFendley**  
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 Houston, Texas 77040  
 713.462.3242 | fax 713.462.3262  
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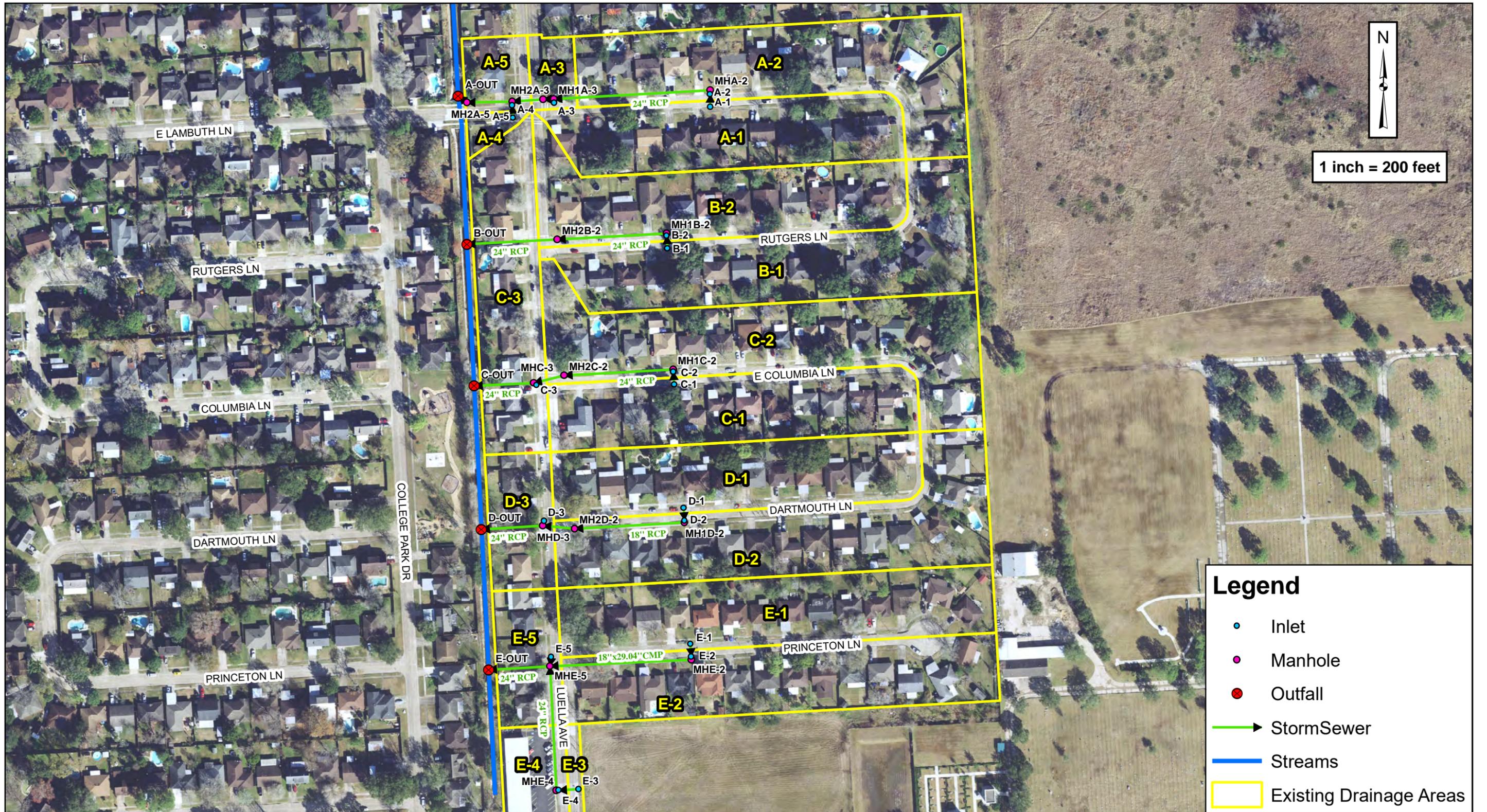
**City of Deer Park - College Park  
 Project Location Map**

Date: July 2019

EXHIBIT 2







1 inch = 200 feet

**Legend**

- Inlet
- Manhole
- Outfall
- StormSewer
- Streams
- Existing Drainage Areas

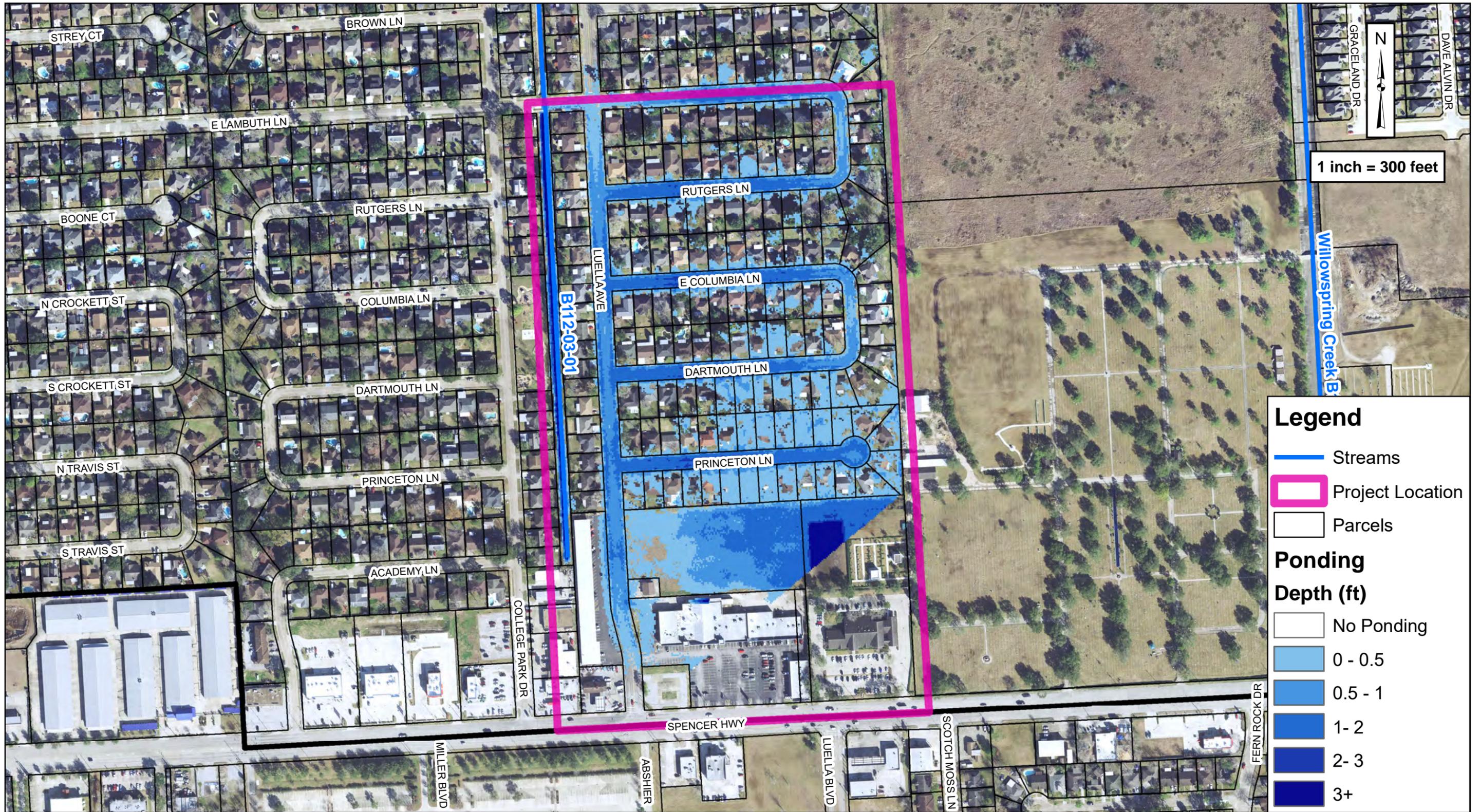
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**City of Deer Park - College Park  
 Existing Storm Sewer Map**

Date: July 2019

EXHIBIT 5





**Legend**

- Streams
- Project Location
- Parcels

**Ponding Depth (ft)**

- No Ponding
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 +

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**City of Deer Park - College Park  
 Existing 100-Year Ponding Map**

Date: July 2019

EXHIBIT 7



**Legend**

- Overland Flow Paths
- Project Location
- Parcels

**Ponding Depth (ft)**

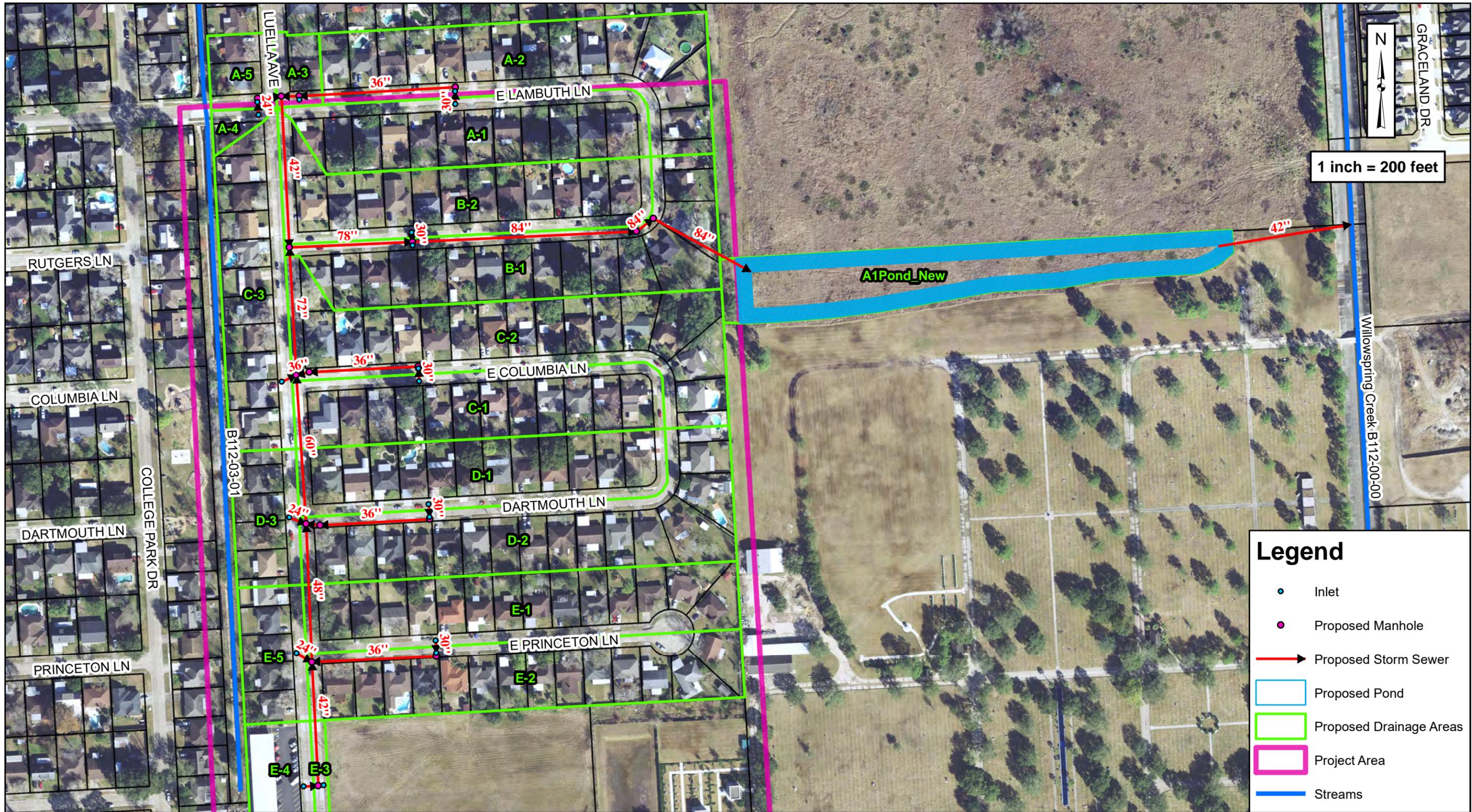
- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2+

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**City of Deer Park - College Park  
 Overland Sheetflow Map**

Date: July 2019

EXHIBIT 8



### Legend

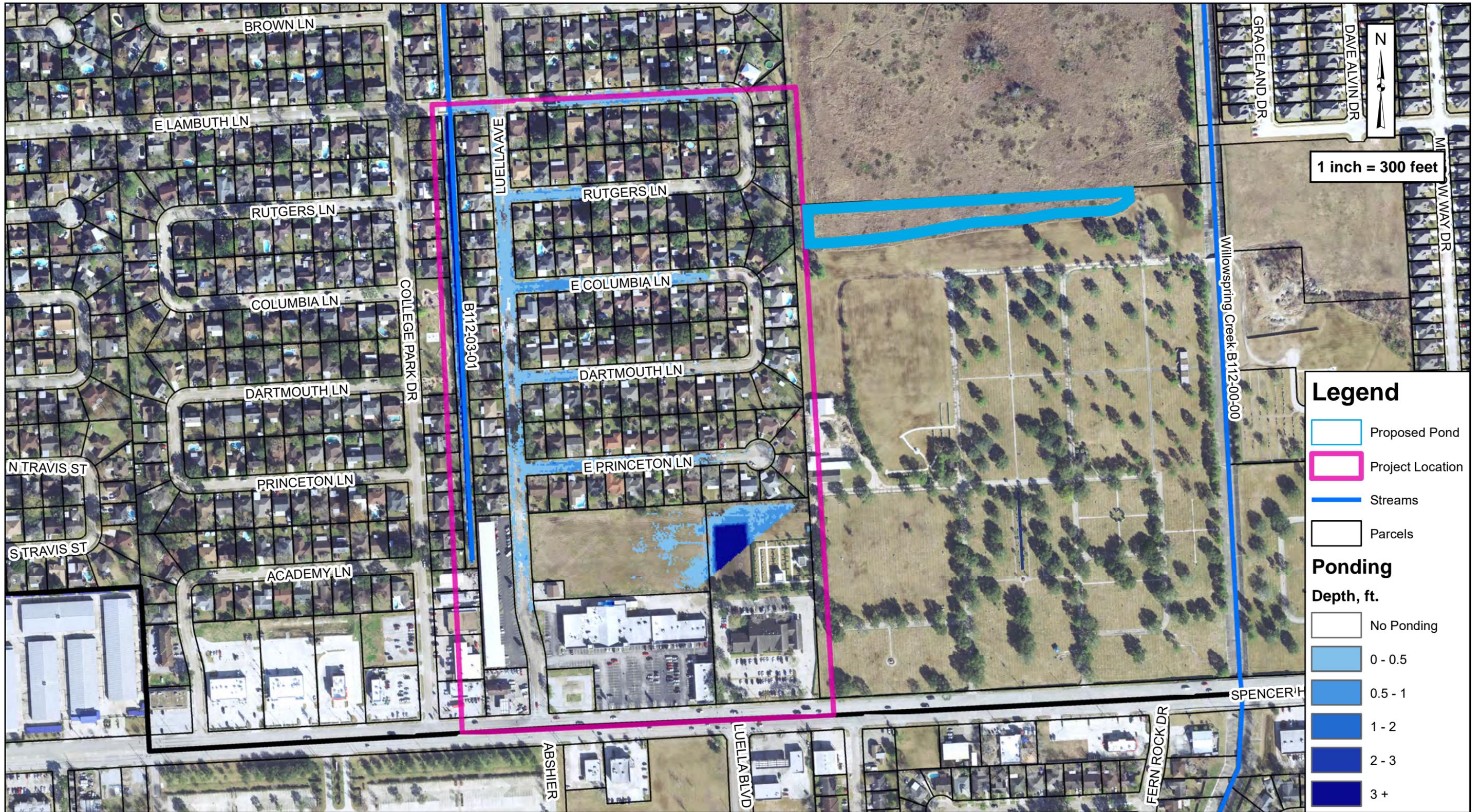
- Inlet
- Proposed Manhole
- Proposed Storm Sewer
- Proposed Pond
- Proposed Drainage Areas
- Project Area
- Streams

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**City of Deer Park - College Park  
 Proposed Alternative 1 Layout**

Date: January 2021

EXHIBIT 9



**Legend**

- Proposed Pond
- Project Location
- Streams
- Parcels

**Ponding**

Depth, ft.

- No Ponding
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 +

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**City of Deer Park - College Park  
 100-Year Ponding Map - Alternative 1**

Date: January 2021

EXHIBIT 10



### Legend

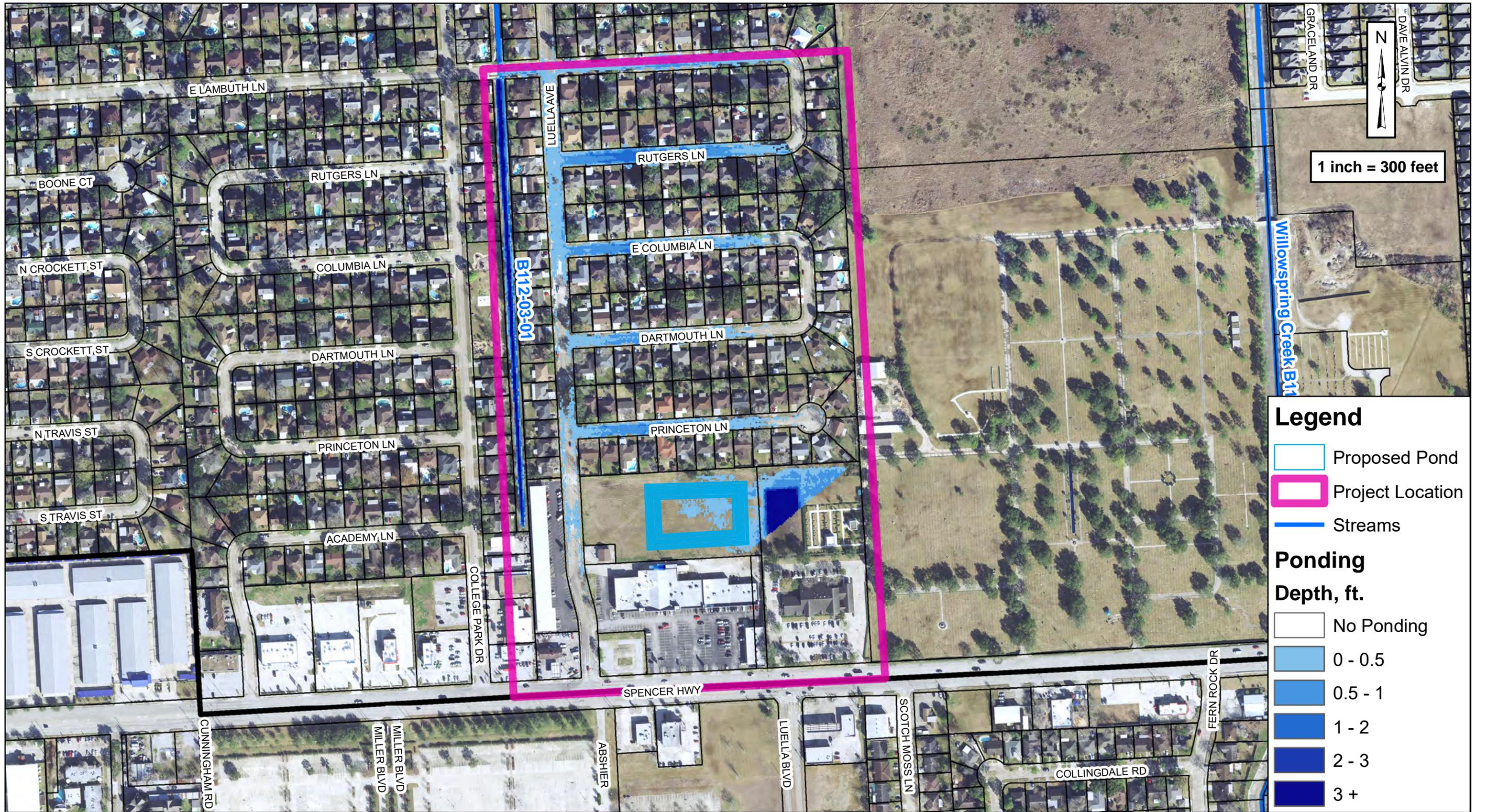
- Inlet
- Proposed Manholes
- Proposed Storm Sewer
- Proposed Pond
- Proposed Drainage Areas
- Project Location
- Streams

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**City of Deer Park - College Park  
 Proposed Alternative 2 Layout**

Date: July 2019

EXHIBIT 11

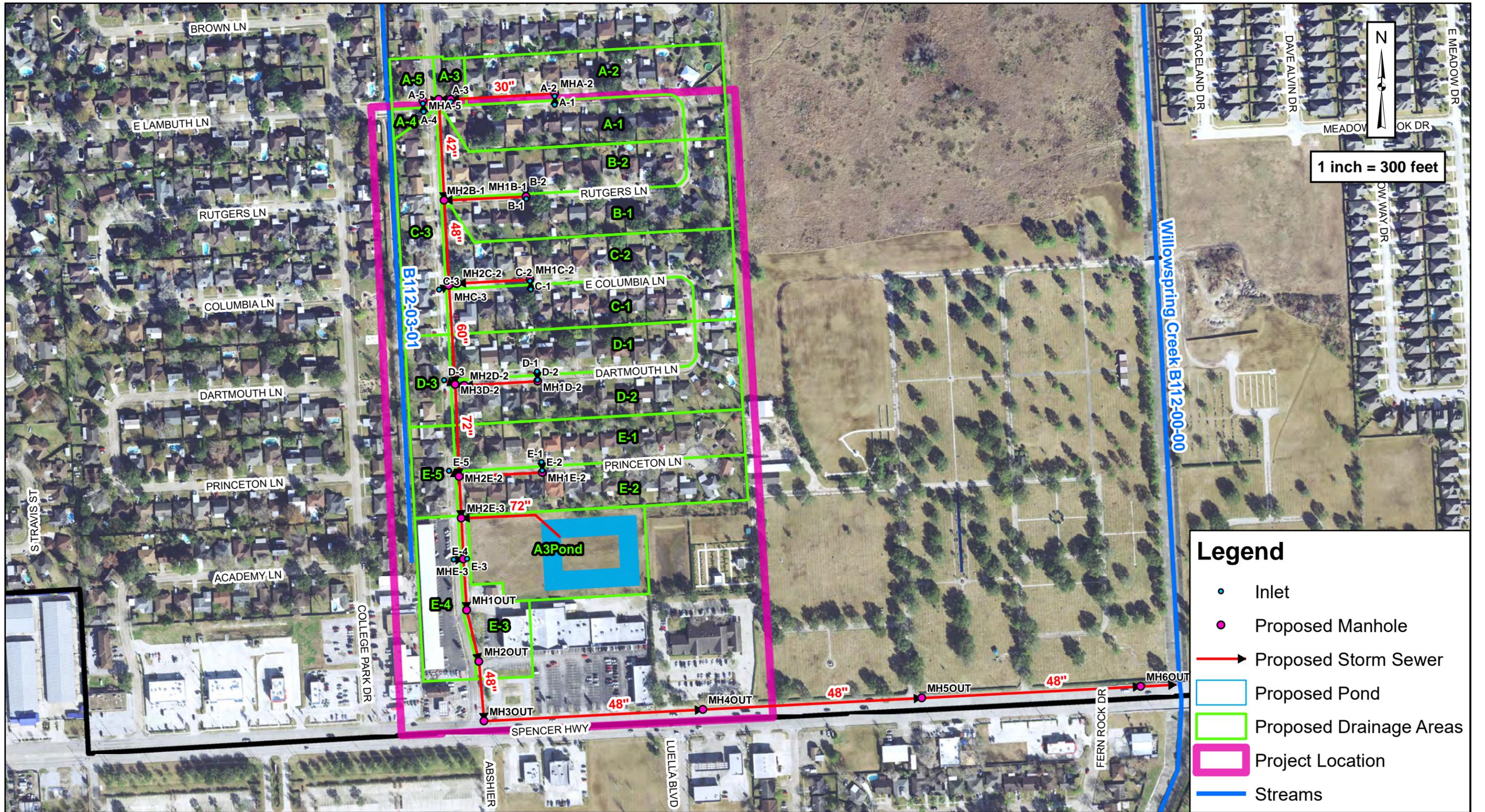


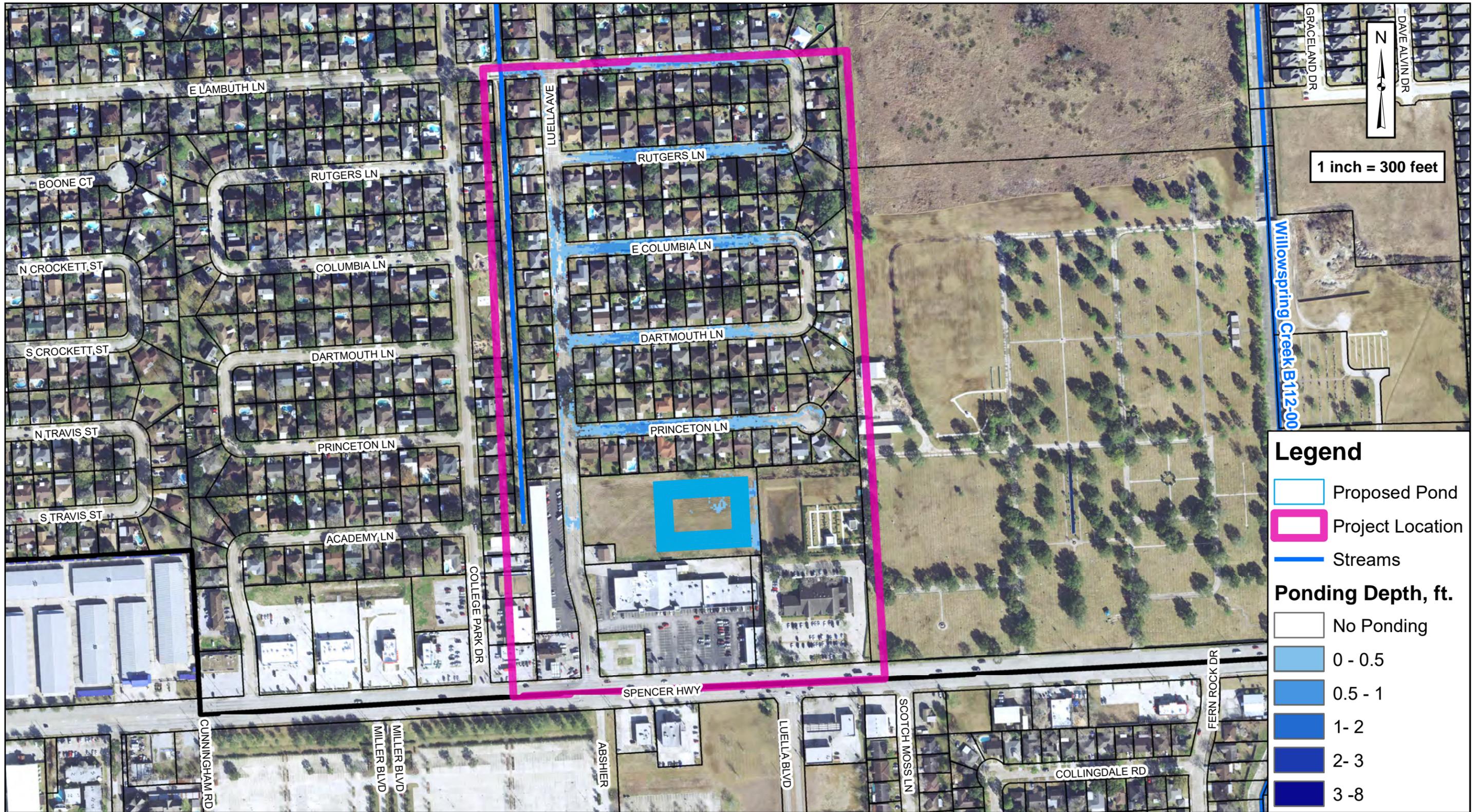
**Legend**

- Proposed Pond
- Project Location
- Streams

**Ponding Depth, ft.**

- No Ponding
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 +





**Legend**

- Proposed Pond
- Project Location
- Streams

**Ponding Depth, ft.**

- No Ponding
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 8

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**City of Deer Park - College Park  
 100-Year Ponding Map - Alternative 3**

Date: July 2019

EXHIBIT 14

**Table 4: Alternative 1 - Detailed Cost Estimate**

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
<b>GENERAL</b>				
<b>GENERAL ITEMS</b>				
MOBILIZATION (5%)	LS	1	\$ 240,000.00	\$ 240,000.00
TRAFFIC CONTROL (5%)	LS	1	\$ 240,000.00	\$ 240,000.00
<b>GENERAL SUB-TOTAL</b>				\$ 480,000.00
<b>PAVING</b>				
<b>PAVING REMOVAL ITEMS</b>				
REMOVE AND DISPOSE OF EXISTING PAVEMENT AND CURB - ASSUMES ALL CONCRETE PAVEMENT THICKNESS WITH OR WITHOUT ASPHALT OVERLAY	SY	11,490	\$ 7.00	\$ 80,429.61
REMOVE AND DISPOSE OF EXISTING DRIVEWAYS AND SIDEWALKS	SY	3,590	\$ 5.00	\$ 17,950.00
<b>PAVING ITEMS</b>				
6" REINFORCED CONCRETE PAVEMENT (COMPLETE IN PLACE)	SY	11,490	\$ 52.00	\$ 597,477.11
LIME STABILIZED SUBGRADE, 6" THICK	SY	12,311	\$ 8.00	\$ 98,485.24
LIME (6%, 7% BY WEIGHT)	TON	194	\$ 200.00	\$ 38,778.56
6" CONCRETE CURB	LF	3,162	\$ 5.00	\$ 15,807.50
6" CONCRETE FOR DRIVEWAYS	SF	16,503	\$ 10.00	\$ 165,025.00
4 1/2" CONCRETE FOR SIDEWALKS	SF	15,808	\$ 8.00	\$ 126,460.00
<b>PAVING SUB-TOTAL</b>				\$ 1,140,413.02
<b>ADD 15% FOR CONTINGENT ITEMS</b>				\$ 171,061.95
<b>PAVING TOTAL</b>				\$ 1,311,474.98
<b>DRAINAGE</b>				
<b>STORM SEWER REMOVAL ITEMS</b>				
REMOVE STORM SEWER PIPE (ALL TYPES)	LF	2,811	\$ 20.00	\$ 56,220.00
REMOVE INLETS (ALL TYPES)	EA	18	\$ 500.00	\$ 9,000.00
REMOVE MANHOLES (ALL TYPES, ALL DEPTHS)	EA	15	\$ 500.00	\$ 7,500.00
<b>STORM SEWER ITEMS</b>				
CURB INLETS (ALL TYPES)	EA	18	\$ 3,500.00	\$ 63,000.00
MANHOLES (FOR 42" DIA. PIPE OR SMALLER) (ALL TYPES)	EA	10	\$ 4,200.00	\$ 42,000.00
MANHOLES (FOR 48" TO 72" DIA. PIPE) (ALL TYPES)	EA	3	\$ 6,000.00	\$ 18,000.00
MANHOLES (FOR 78" DIA. PIPE AND LARGER) (ALL TYPES)	EA	4	\$ 15,000.00	\$ 60,000.00
24-INCH RCP	LF	203	\$ 120.00	\$ 24,360.00
30-INCH RCP	LF	202	\$ 140.00	\$ 28,280.00
36-INCH RCP	LF	1,161	\$ 190.00	\$ 220,590.00
42-INCH RCP	LF	872	\$ 240.00	\$ 209,280.00
48-INCH RCP	LF	294	\$ 290.00	\$ 85,260.00
60-INCH RCP	LF	317	\$ 400.00	\$ 126,800.00
72-INCH RCP	LF	272	\$ 550.00	\$ 149,600.00
78-INCH RCP	LF	262	\$ 700.00	\$ 183,400.00
84-INCH RCP	LF	759	\$ 800.00	\$ 607,200.00
TRENCH SAFETY SYSTEM	LF	3,937	\$ 2.00	\$ 7,874.00
<b>DETENTION</b>				
DETENTION POND (DRY)	AC-FT	18.00	\$ 30,000.00	\$ 540,000.00
<b>STORM SEWER SUB-TOTAL</b>				\$ 2,438,364.00
<b>ADD 20% FOR CONTINGENT ITEMS</b>				\$ 487,672.80
<b>STORM SEWER TOTAL</b>				\$ 2,926,036.80
<b>ESTIMATED TOTAL PROJECT COST</b>				\$ 4,717,511.78

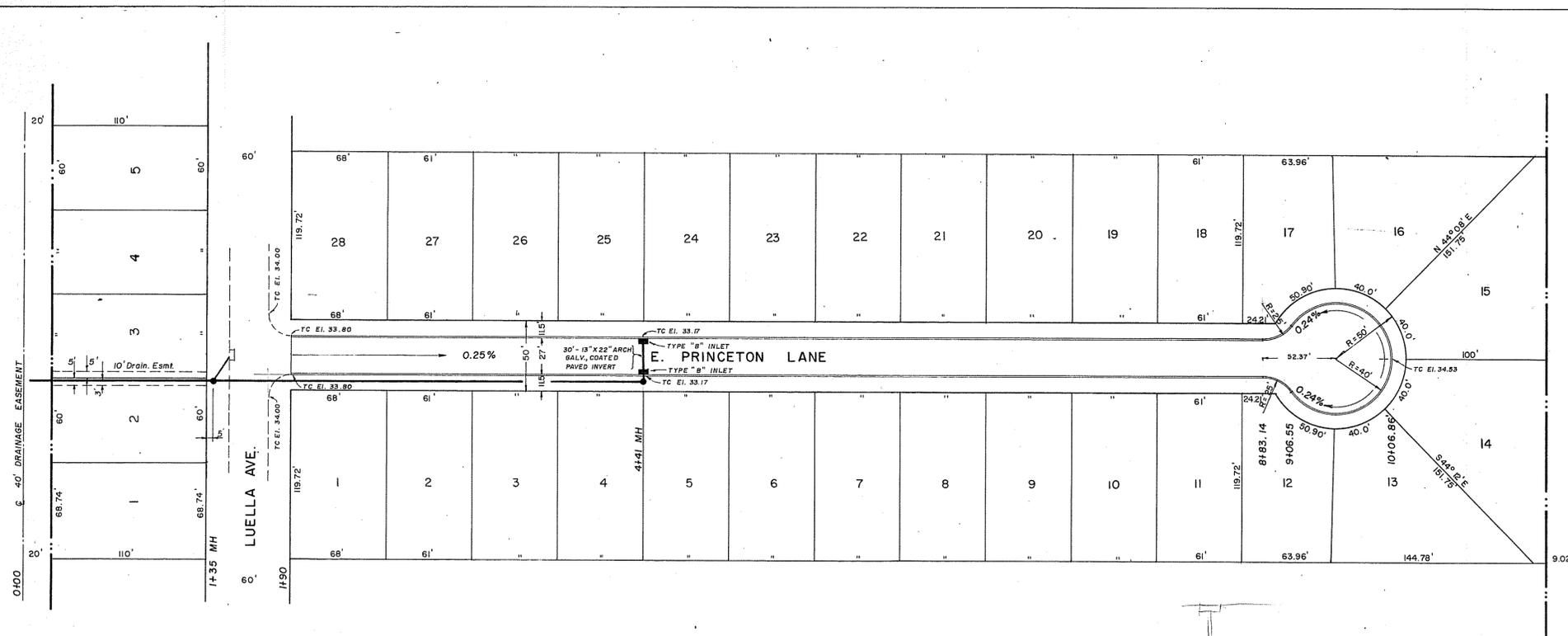
**Table 5: Alternative 2 - Detailed Cost Estimate**

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
<b>GENERAL</b>				
<b>GENERAL ITEMS</b>				
MOBILIZATION (5%)	LS	1	\$ 240,000.00	\$ 240,000.00
TRAFFIC CONTROL (5%)	LS	1	\$ 240,000.00	\$ 240,000.00
<b>GENERAL SUB-TOTAL</b>				\$ 480,000.00
<b>PAVING</b>				
<b>PAVING REMOVAL ITEMS</b>				
REMOVE AND DISPOSE OF EXISTING PAVEMENT AND CURB - ASSUMES ALL CONCRETE PAVEMENT THICKNESS WITH OR WITHOUT ASPHALT OVERLAY	SY	11,726	\$ 7.00	\$ 82,078.53
REMOVE AND DISPOSE OF EXISTING DRIVEWAYS AND SIDEWALKS	SY	3,644	\$ 5.00	\$ 18,220.22
<b>PAVING ITEMS</b>				
6" REINFORCED CONCRETE PAVEMENT (COMPLETE IN PLACE)	SY	11,726	\$ 52.00	\$ 609,726.23
LIME STABILIZED SUBGRADE, 6" THICK	SY	12,563	\$ 8.00	\$ 100,504.32
LIME (6%, 7% BY WEIGHT)	TON	198	\$ 200.00	\$ 39,573.58
6" CONCRETE CURB	LF	3,279	\$ 5.00	\$ 16,396.40
6" CONCRETE FOR DRIVEWAYS	SF	16,400	\$ 10.00	\$ 164,000.00
4 1/2" CONCRETE FOR SIDEWALKS	SF	16,396	\$ 8.00	\$ 131,171.20
<b>PAVING SUB-TOTAL</b>				\$ 1,161,670.49
<b>ADD 15% FOR CONTINGENT ITEMS</b>				\$ 174,250.57
<b>PAVING TOTAL</b>				\$ 1,335,921.06
<b>DRAINAGE</b>				
<b>STORM SEWER REMOVAL ITEMS</b>				
REMOVE STORM SEWER PIPE (ALL TYPES)	LF	2,811	\$ 20.00	\$ 56,220.00
REMOVE INLETS (ALL TYPES)	EA	18	\$ 500.00	\$ 9,000.00
REMOVE MANHOLES (ALL TYPES, ALL DEPTHS)	EA	15	\$ 500.00	\$ 7,500.00
<b>STORM SEWER ITEMS</b>				
CURB INLETS (ALL TYPES)	EA	18	\$ 3,500.00	\$ 63,000.00
MANHOLES (FOR 42" DIA. PIPE OR SMALLER) (ALL TYPES)	EA	16	\$ 4,200.00	\$ 67,200.00
MANHOLES (FOR 48" TO 72" DIA. PIPE) (ALL TYPES)	EA	5	\$ 6,000.00	\$ 30,000.00
24-INCH RCP	LF	300	\$ 120.00	\$ 36,000.00
30-INCH RCP	LF	476	\$ 140.00	\$ 66,640.00
36-INCH RCP	LF	1,052	\$ 190.00	\$ 199,880.00
42-INCH RCP	LF	2,248	\$ 240.00	\$ 539,520.00
48-INCH RCP	LF	271	\$ 290.00	\$ 78,590.00
60-INCH RCP	LF	317	\$ 550.00	\$ 174,223.50
72-INCH RCP	LF	727	\$ 800.00	\$ 581,600.00
TRENCH SAFETY SYSTEM	LF	1,315	\$ 2.00	\$ 2,629.54
<b>DETENTION</b>				
DETENTION POND (DRY)	AC-FT	12.18	\$ 30,000.00	\$ 365,400.00
<b>STORM SEWER SUB-TOTAL</b>				\$ 2,277,403.04
<b>ADD 20% FOR CONTINGENT ITEMS</b>				\$ 455,480.61
<b>STORM SEWER TOTAL</b>				\$ 2,732,883.65
<b>ESTIMATED TOTAL PROJECT COST</b>				\$ 4,548,804.71

## **APPENDIX A**

### **College Park Existing Drainage Plans**

**PLAN**  
 SURVIVOR  
 NOTE BOOK  
 CHAINS CHECKED  
 ALIGNMENT CHECKED  
 RT. OF WAY CHECKED  
 No. \_\_\_\_\_  
 BY \_\_\_\_\_  
 DATE \_\_\_\_\_

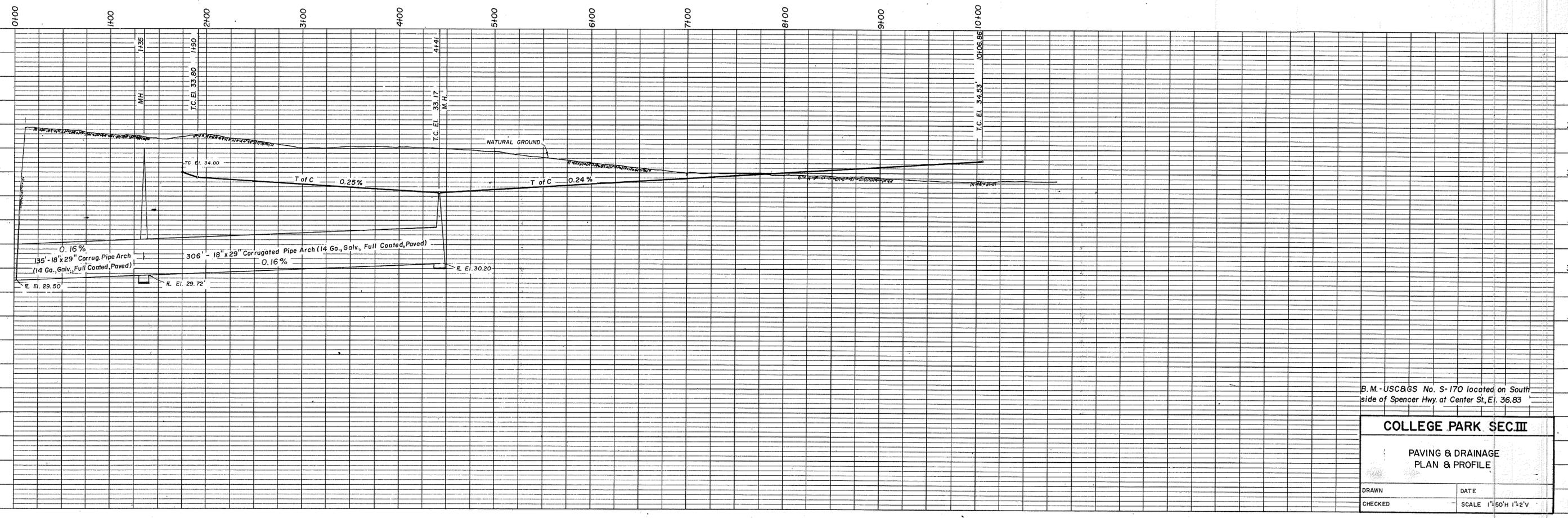


Approved: \_\_\_\_\_  
 Chairman, Planning and Zoning Commission  
 City of Deer Park, Texas

Approved: \_\_\_\_\_  
 City Engineer  
 City of Deer Park, Texas

All Construction to be in accordance with City  
 of Deer Park Specifications

**PROFILE**  
 SURVIVOR  
 NOTE BOOK  
 CHAINS CHECKED  
 ELEVATIONS CHECKED  
 No. \_\_\_\_\_  
 BY \_\_\_\_\_  
 DATE \_\_\_\_\_



B.M. - USC&GS No. S-170 located on South  
 side of Spencer Hwy. at Center St., El. 36.83

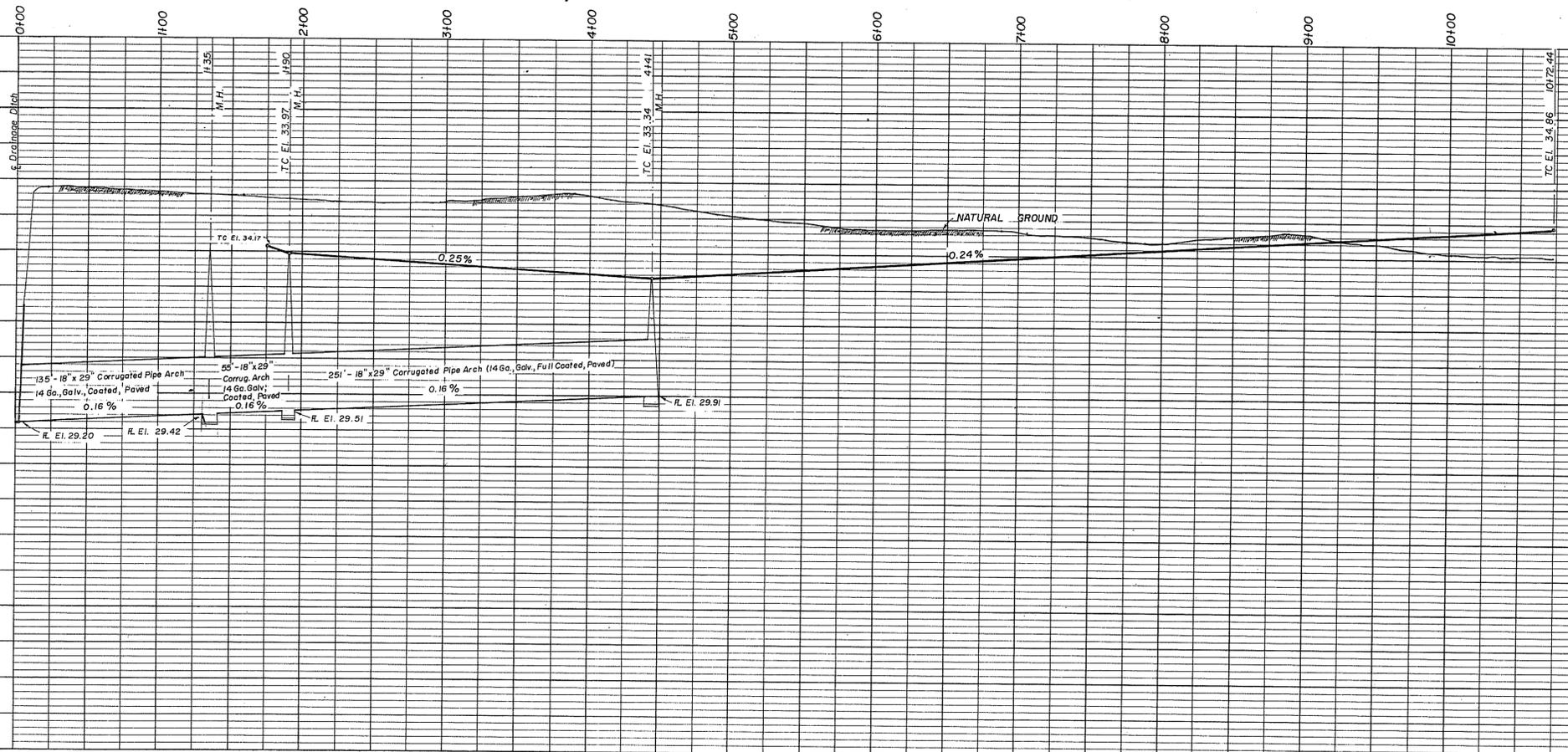
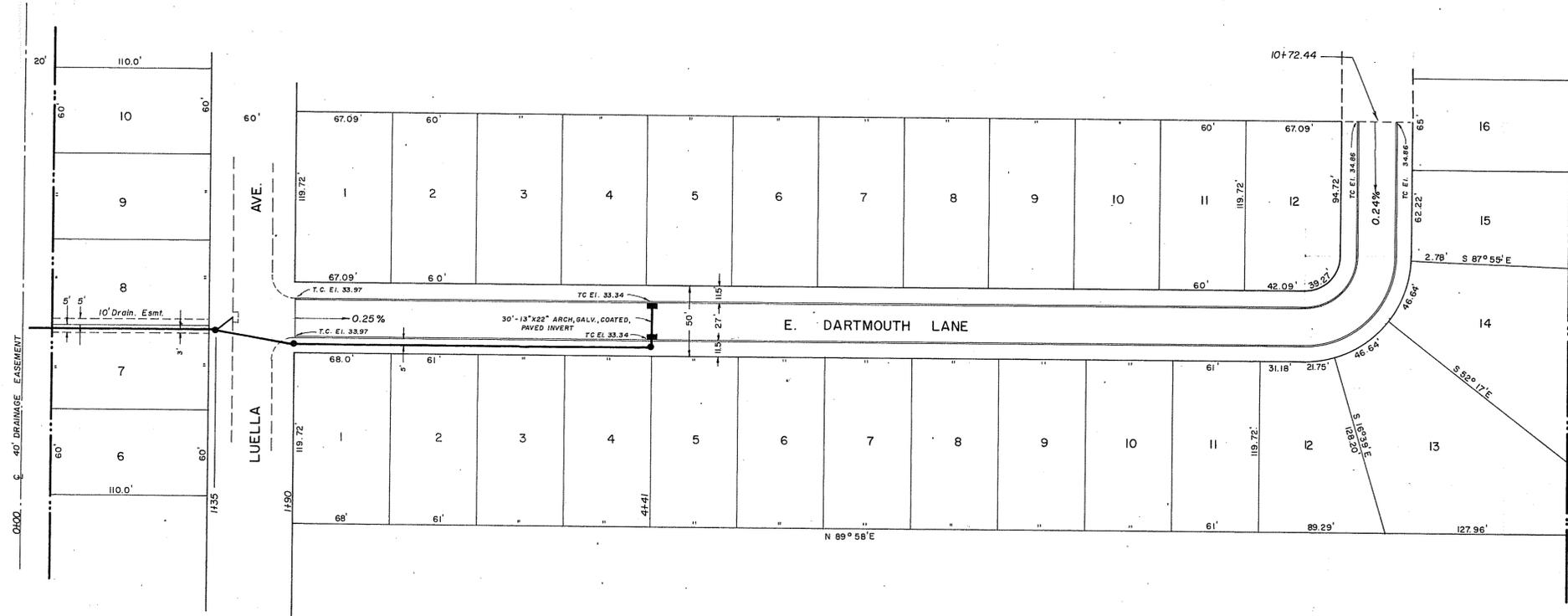
**COLLEGE PARK SEC. III**

PAVING & DRAINAGE  
 PLAN & PROFILE

DRAWN	DATE
CHECKED	SCALE 1"=50'H 1/2"=1'V

**PLAN**  
 SURVEYED  
 PLOTTED  
 NOTE BOOK  
 ALIGNMENT CHECKED  
 REF. OF WAY CHECKED  
 No. \_\_\_\_\_  
 BY \_\_\_\_\_

**PROFILE**  
 SURVEYED  
 PLOTTED  
 NOTE BOOK  
 B. M.'S. NOTED  
 STRUCTURE NOTATIONS CHECKED  
 No. \_\_\_\_\_  
 BY \_\_\_\_\_



Approved: \_\_\_\_\_  
 Chairman, Planning and Zoning Commission  
 City of Deer Park, Texas

Approved: \_\_\_\_\_  
 City Engineer  
 City of Deer Park, Texas

B.M. -USC&GS No. S-170 located on South side  
 Spencer Hwy. at Center St. El. 36.83'

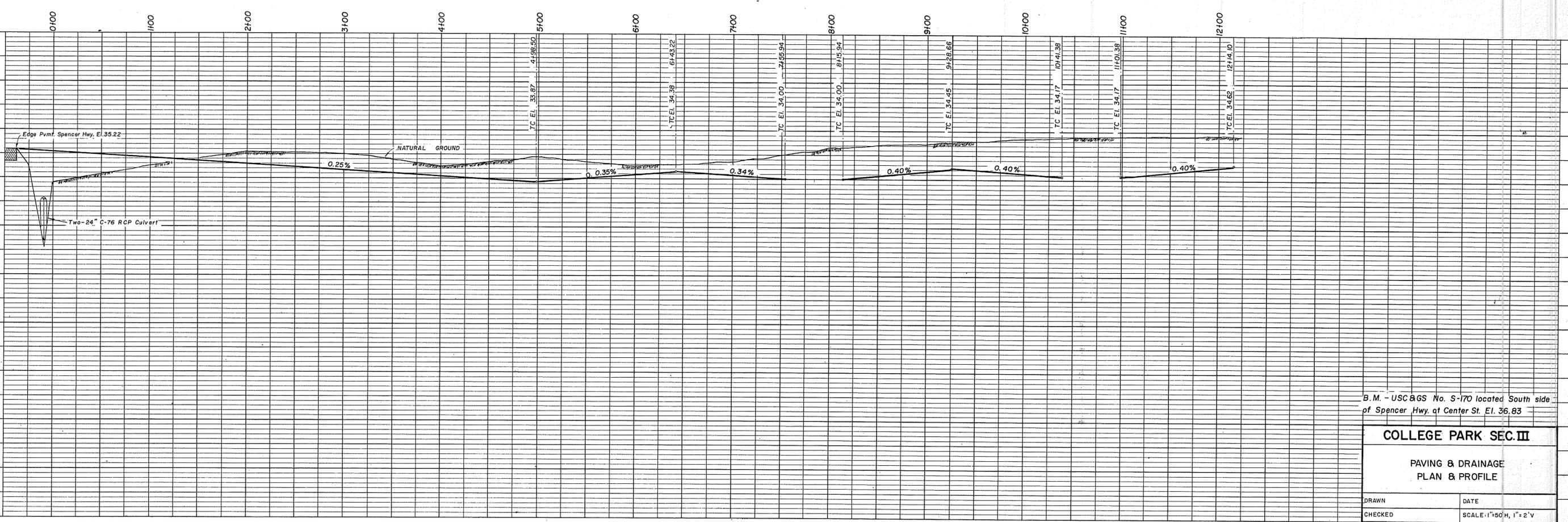
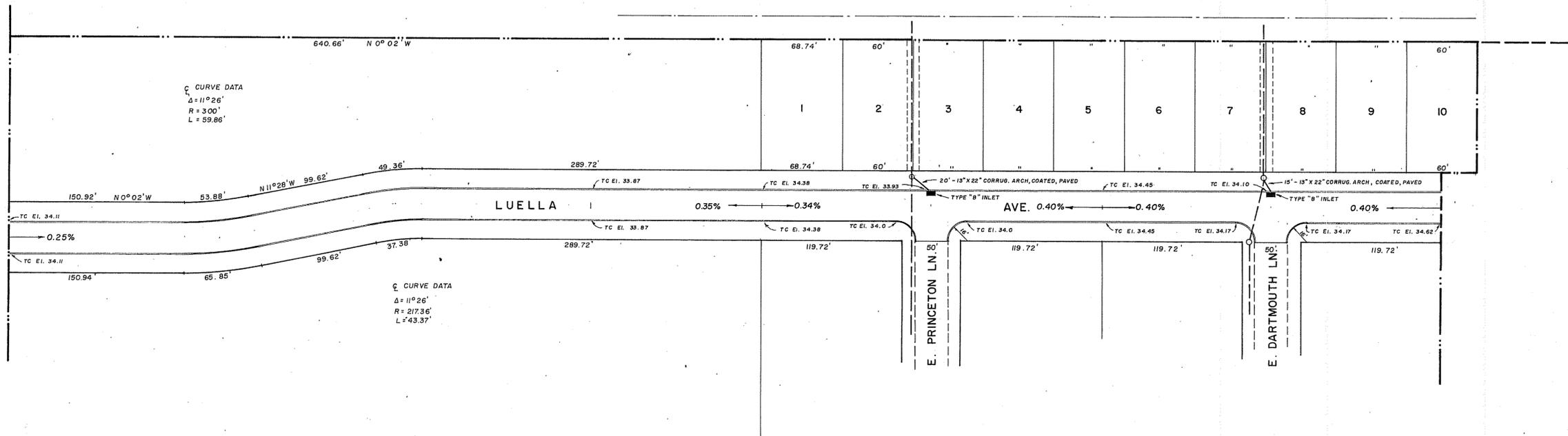
**COLLEGE PARK SEC. III**

**PAVING & DRAINAGE  
 PLAN & PROFILE**

DRAWN Ballard  
 CHECKED \_\_\_\_\_  
 DATE \_\_\_\_\_  
 SCALE 1"=50'H 1/2"=1' V

**PLAN**  
 SURVEYED BY \_\_\_\_\_  
 PLOTTED BY \_\_\_\_\_  
 ALIGNMENT CHECKED BY \_\_\_\_\_  
 NO. OF WAY CHECKED BY \_\_\_\_\_  
 NOTE BOOK No. \_\_\_\_\_

**PROFILE**  
 SURVEYED BY \_\_\_\_\_  
 PLOTTED BY \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_  
 NO. OF NOTES BY \_\_\_\_\_  
 STRUCTURE NOTATIONS CHECKED BY \_\_\_\_\_  
 NOTE BOOK No. \_\_\_\_\_



Approved: \_\_\_\_\_  
 Chairman, Planning and Zoning Commission  
 City of Deer Park, Texas

Approved: \_\_\_\_\_  
 City Engineer  
 City of Deer Park, Texas

B. M. - USC & GS No. S-170 located South side of Spencer Hwy. at Center St. El. 36.83

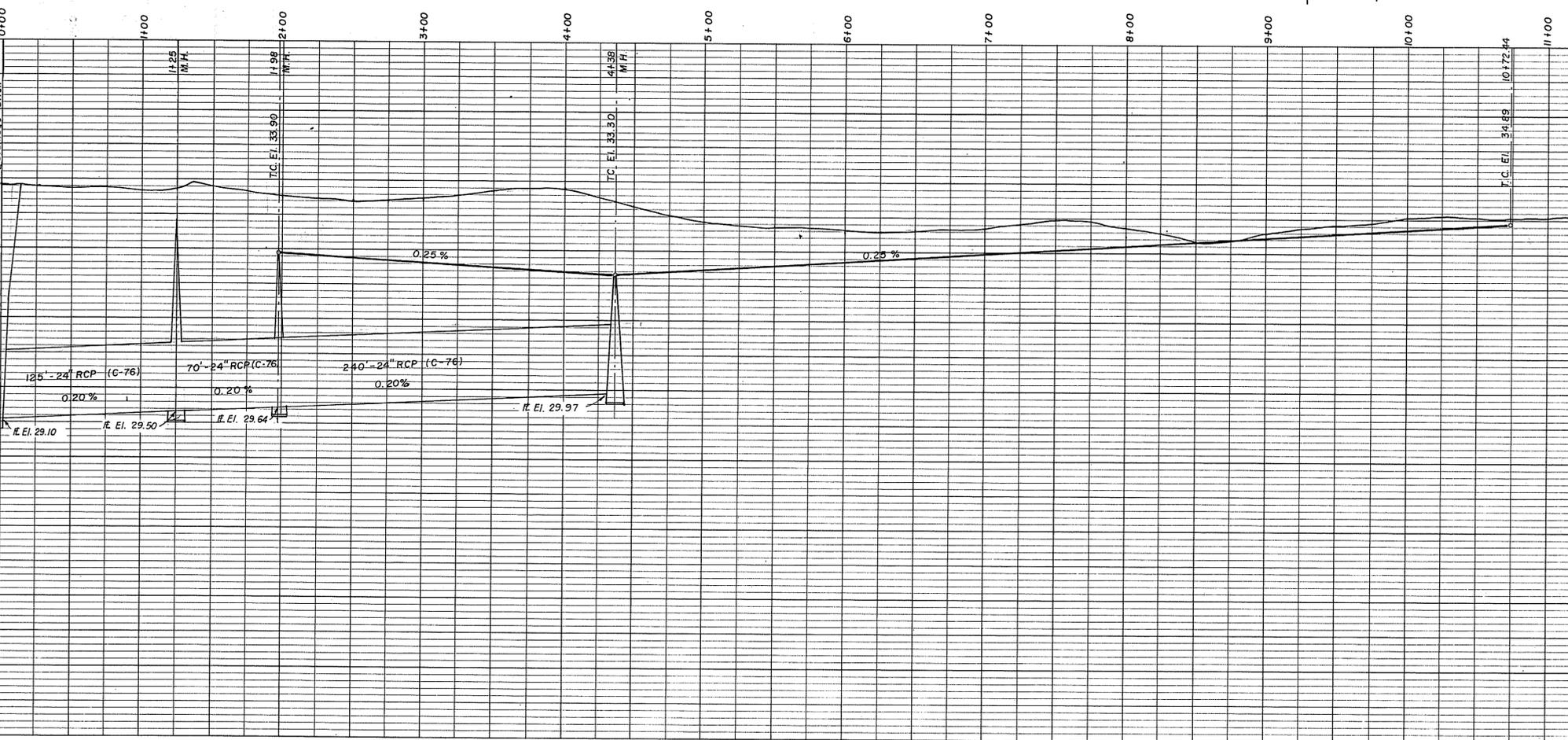
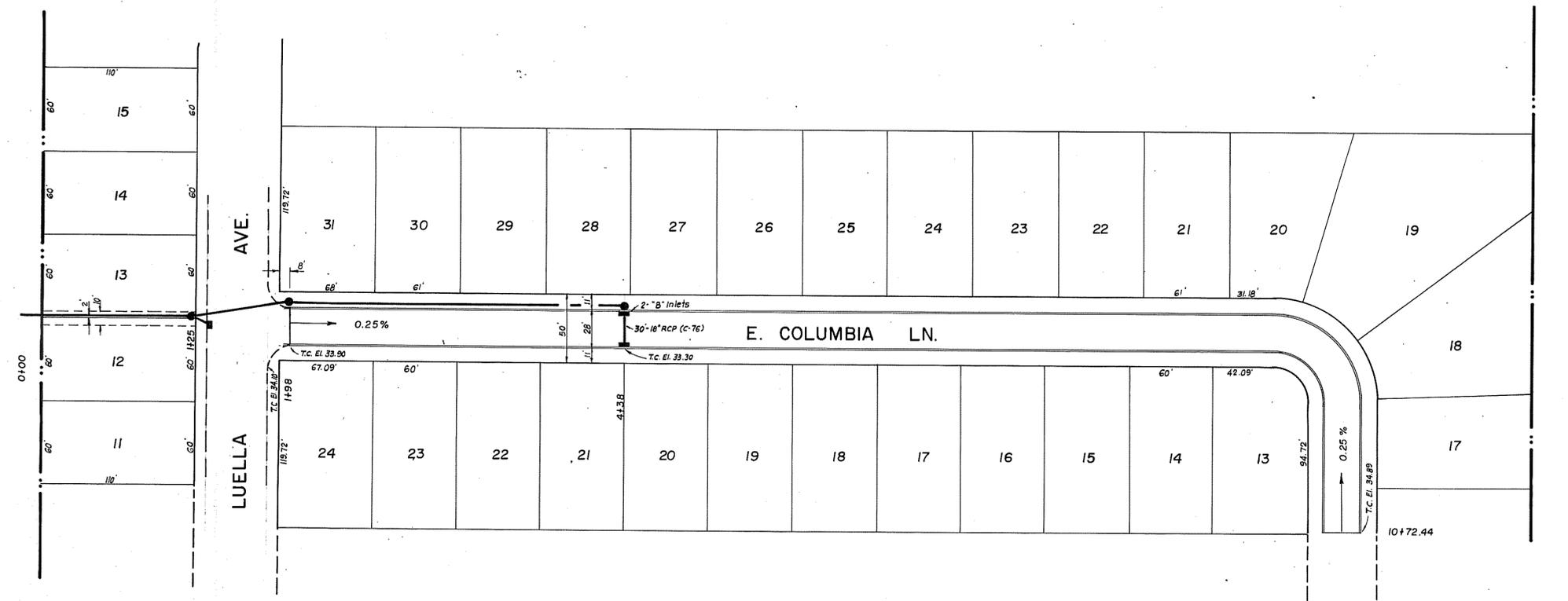
**COLLEGE PARK SEC. III**

**PAVING & DRAINAGE  
 PLAN & PROFILE**

DRAWN	DATE
CHECKED	SCALE: 1"=50'H, 1"=2'V

PLAN  
 SURVEYED, PLOTTED, CHECKED, BY, DATE  
 NOTE BOOK, ALIGNMENT CHECKED, RI, OF WAY CHECKED, No.

PROFILE  
 SURVEYED, PLOTTED, CHECKED, BY, DATE  
 NOTE BOOK, B.M.'S NOTED, STRUCTURE NOTATIONS CHECKED, No.



Approved: \_\_\_\_\_  
 Chairman, Planning & Zoning Commission  
 City of Deer Park, Texas

Approved: *Robert M. Milnes*  
 City Engineer  
 City of Deer Park, Texas

ALL CONSTRUCTION TO CONFORM TO CITY OF  
 DEER PARK ORDINANCES AND REGULATIONS

B.M. - USCGS No. S-170 located South side of  
 Spencer Highway at Center St. El. 36.83

COLLEGE PARK SEC. V  
 PAVING & DRAINAGE  
 PLAN & PROFILE  
 DRAWN *Ballard* DATE: Feb, 1965  
 CHECKED SCALE: 1" = 50' H, 1" = 2' V



## **APPENDIX B**

### **Detailed Hydrologic Calculations**

**Appendix B**  
**Detailed Hydrologic Calculations**

DA Name	Area (ac)	% Imp	C - Value	Tc (min)	Intensity (in/hr)		Peak Flow (cfs)	
					2-year	100-year	2-year	100-year
A-1	2.47	58.33	0.55	26.73	3.29	6.82	4.47	9.27
A-2	3.36	58.33	0.55	27.38	3.25	6.75	6.01	12.48
A-3	0.35	58.33	0.55	23.31	3.53	7.20	0.68	1.39
A-4	0.17	58.33	0.55	22.32	3.60	7.33	0.34	0.68
A-5	0.51	58.33	0.55	23.88	3.49	7.14	0.98	2.00
B-1	3.35	58.33	0.55	27.37	3.25	6.75	5.99	12.44
B-2	2.8	58.33	0.55	26.99	3.28	6.79	5.04	10.46
C-1	2.59	58.33	0.55	26.82	3.29	6.81	4.68	9.70
C-2	3.73	58.33	0.55	27.61	3.24	6.73	6.64	13.80
C-3	2.17	58.33	0.55	26.46	3.31	6.85	3.95	8.17
D-1	2.6	58.33	0.55	26.83	3.29	6.81	4.70	9.74
D-2	3.55	58.33	0.55	27.50	3.24	6.74	6.33	13.16
D-3	0.93	58.33	0.55	24.87	3.42	7.02	1.75	3.59
E-1	3.1	58.33	0.55	27.20	3.26	6.77	5.56	11.54
E-2	3.06	58.33	0.55	27.18	3.26	6.77	5.49	11.40
E-3	1.42	100.00	0.80	25.64	3.36	6.94	3.82	7.88
E-4	1.76	100.00	0.80	26.05	3.34	6.89	4.70	9.71
E-5	0.92	58.33	0.55	24.85	3.42	7.02	1.73	3.55
<b>Added Proposed Areas:</b>								
A1Pond	2.76	100.00	0.80	26.96	3.28	6.80	7.24	15.01
A2Pond	3.51	43.33	0.46	27.47	3.25	6.74	5.24	10.89
A3Pond	3.51	43.33	0.46	27.47	3.25	6.74	5.24	10.89

**APPENDIX C**

**2-Year XP-Storm Outputs**

**DATA OMITTED FOR  
DOCUMENT BREVITY**

**DATA AVAILABLE UPON  
REQUEST FROM:**

**CITY OF DEER PARK**

**ENGINEERING  
DEPARTMENT**

**APPENDIX D**

**100-Year XP-Storm Outputs**

**DATA OMITTED FOR  
DOCUMENT BREVITY**

**DATA AVAILABLE UPON  
REQUEST FROM:**

**CITY OF DEER PARK**

**ENGINEERING  
DEPARTMENT**

# **EXHIBIT B**

## **“REPORT 02” 02 – Deer Park Gardens**

Preliminary Engineering Report for Deer Park Gardens Drainage Improvements  
CobbFendley  
January 2021



**E. 8TH STREET**

PROP. 54" RCP

PROP. 36" RCP

NEW INLETS

**NORWOOD STREET**

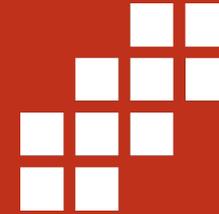
**MARTHA STREET**

Peggy St

Luella Ave

**DEER PARK GARDENS  
PHASE 1  
PROJECT LOCATION**

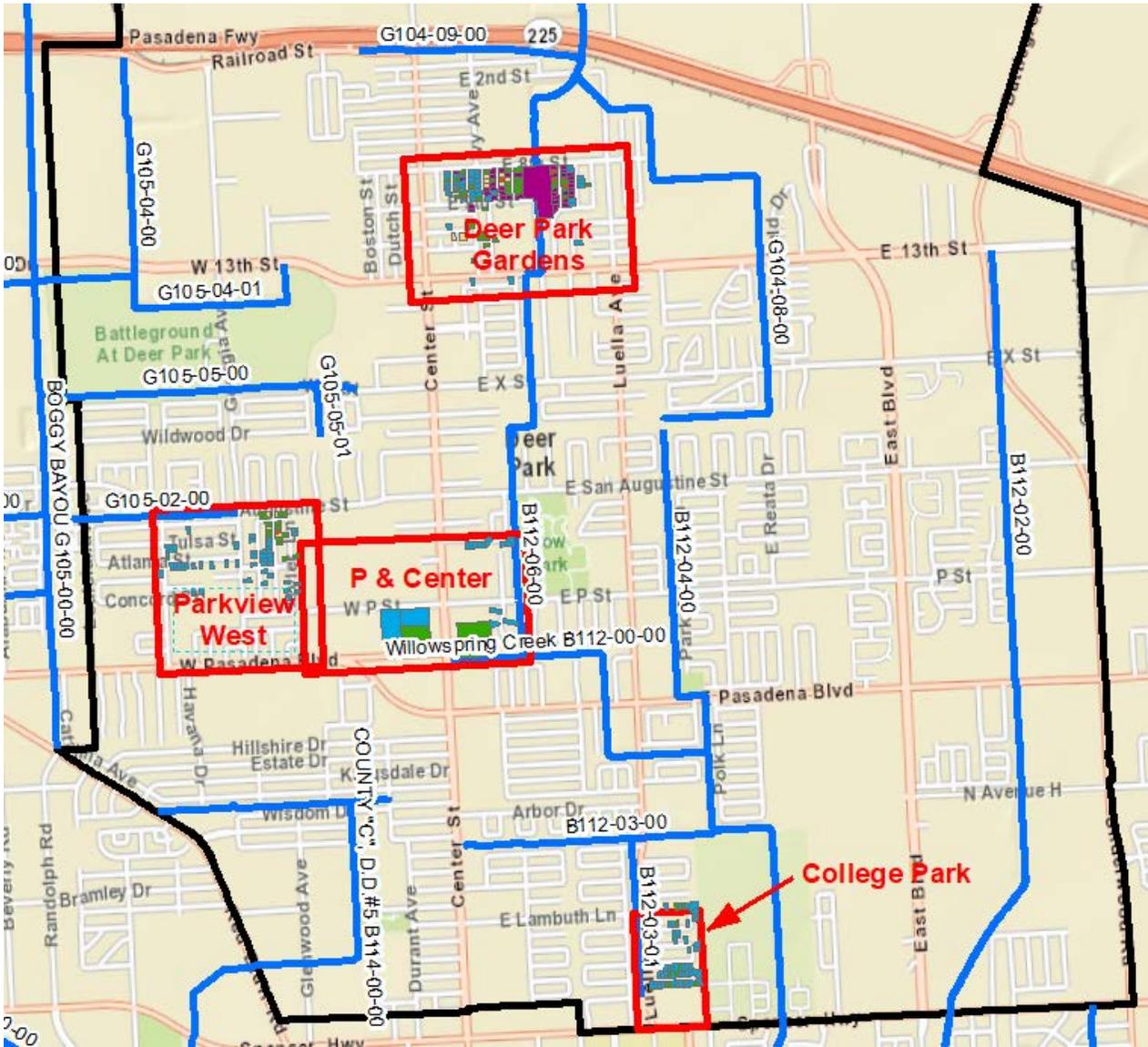
# DEER PARK



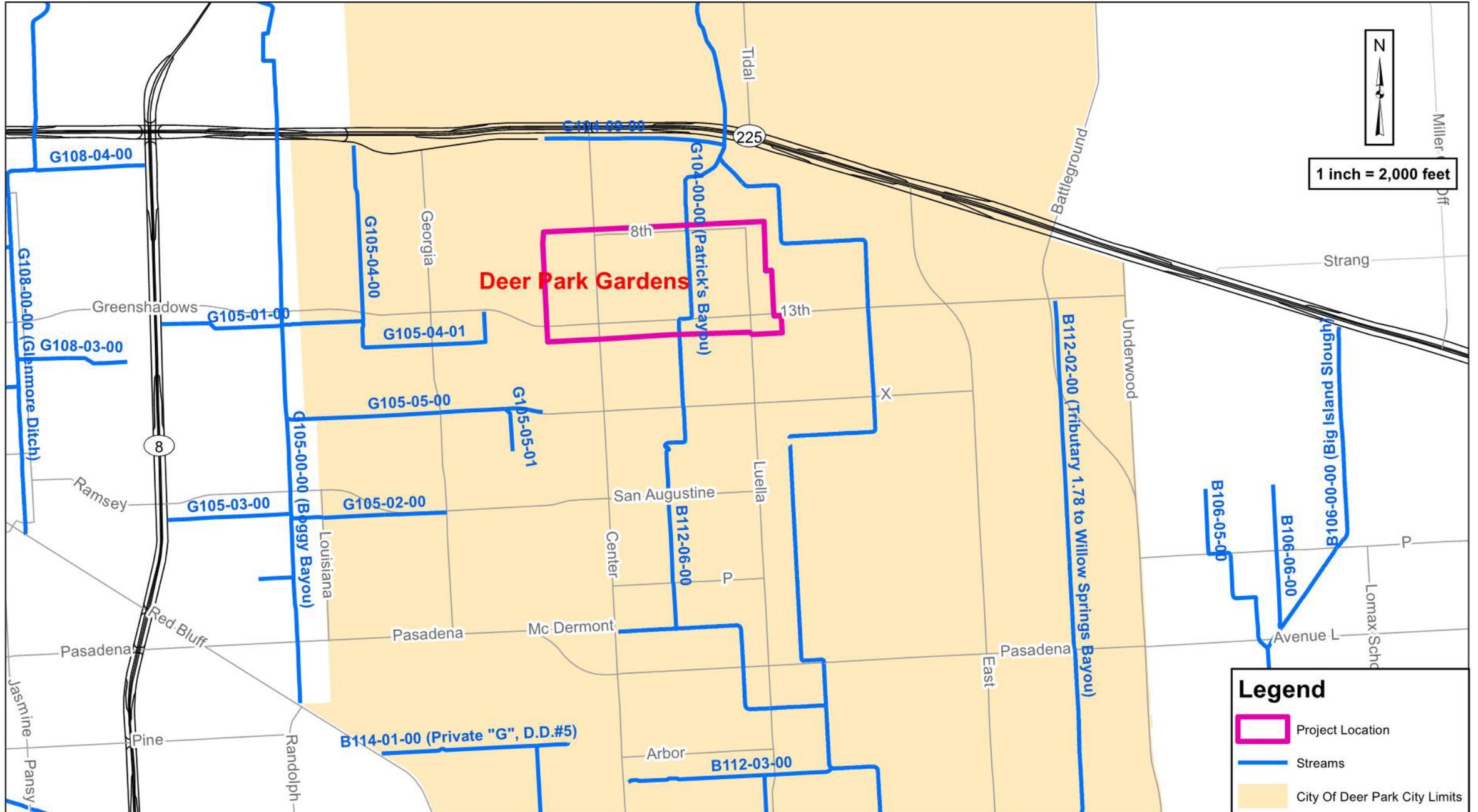
October 1, 2019

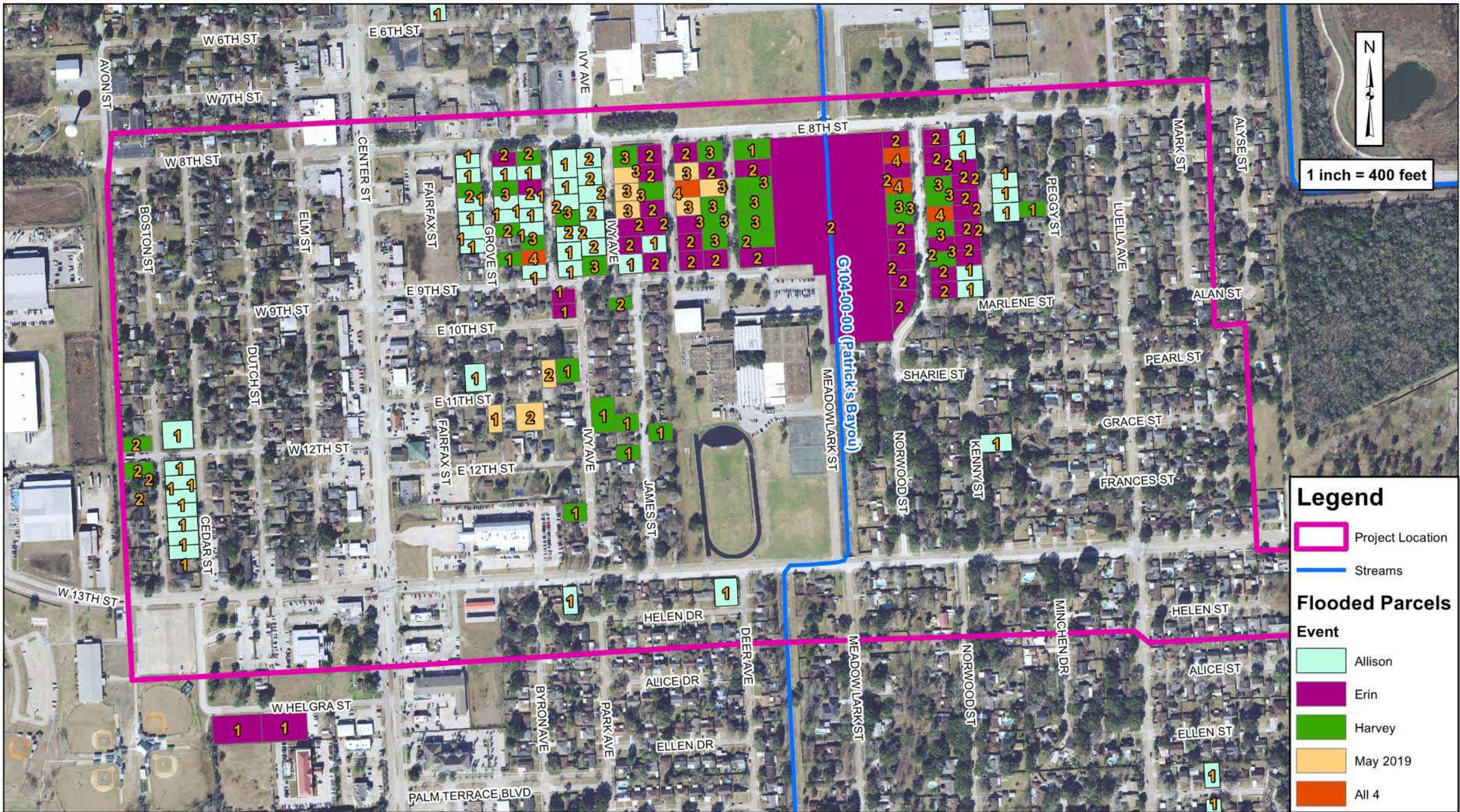
 CobbFendley

# Area Overview



# Deer Park Gardens





1 inch = 400 feet

**Legend**

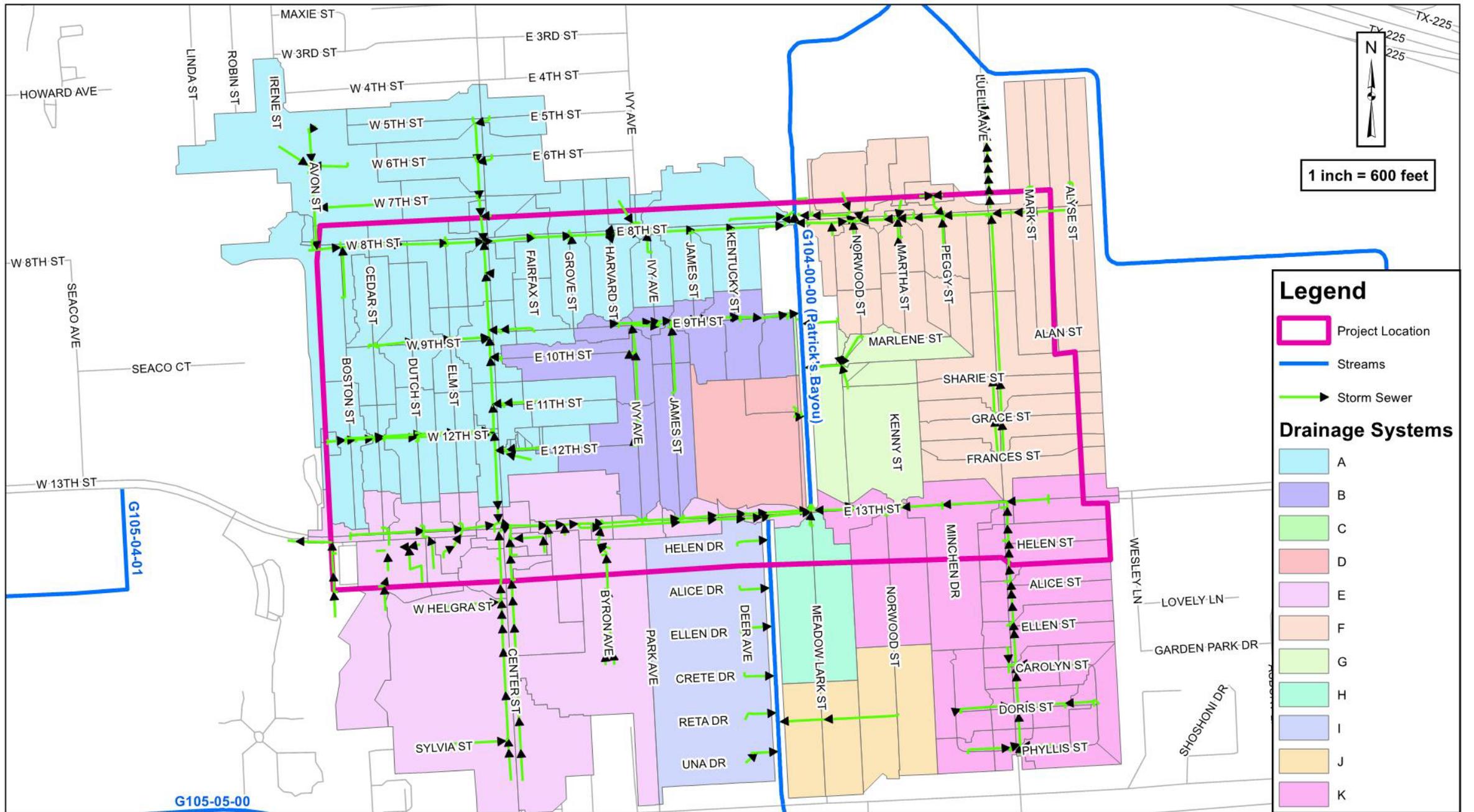
- Project Location
- Streams

**Flooded Parcels**

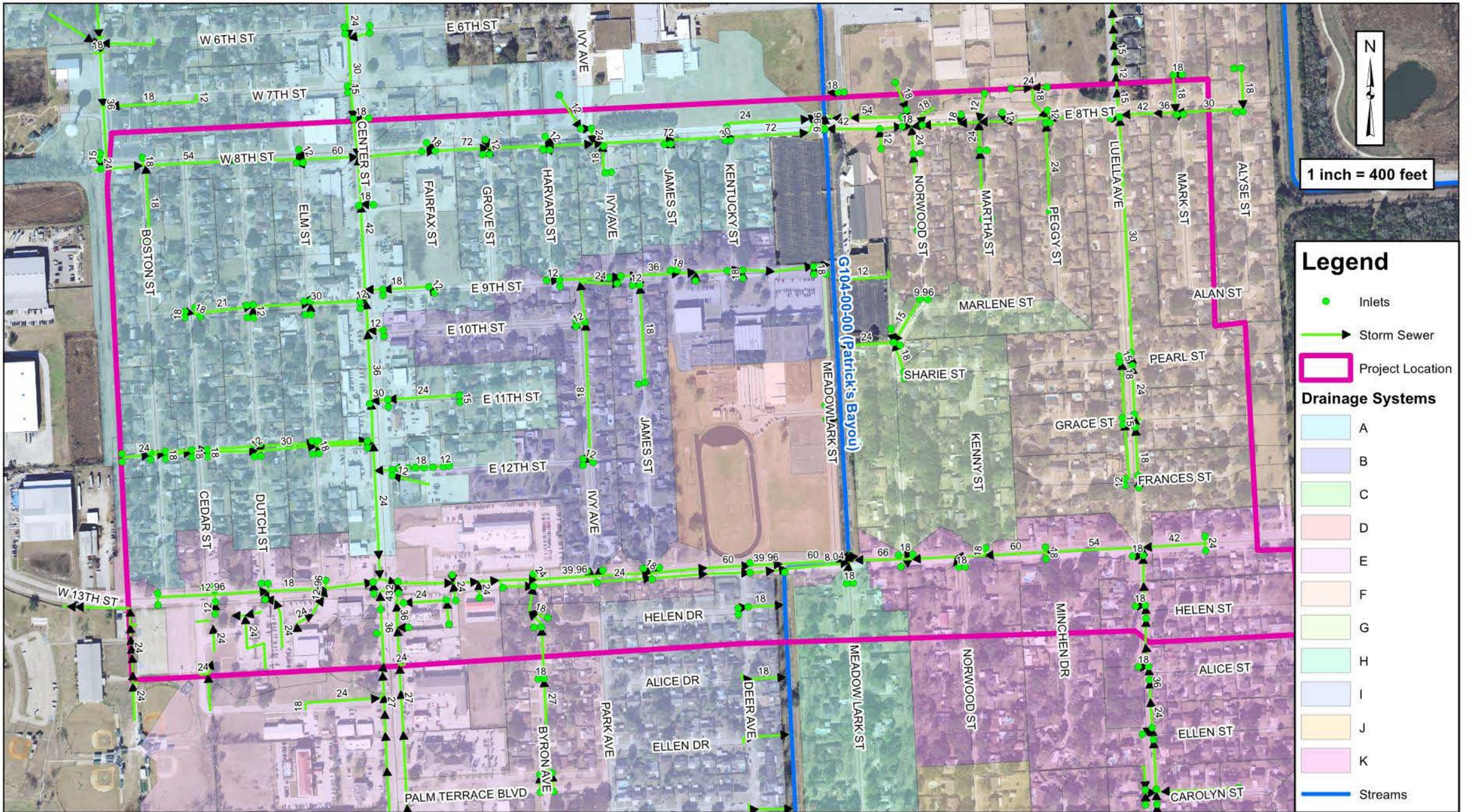
**Event**

- Allison
- Erin
- Harvey
- May 2019
- All 4





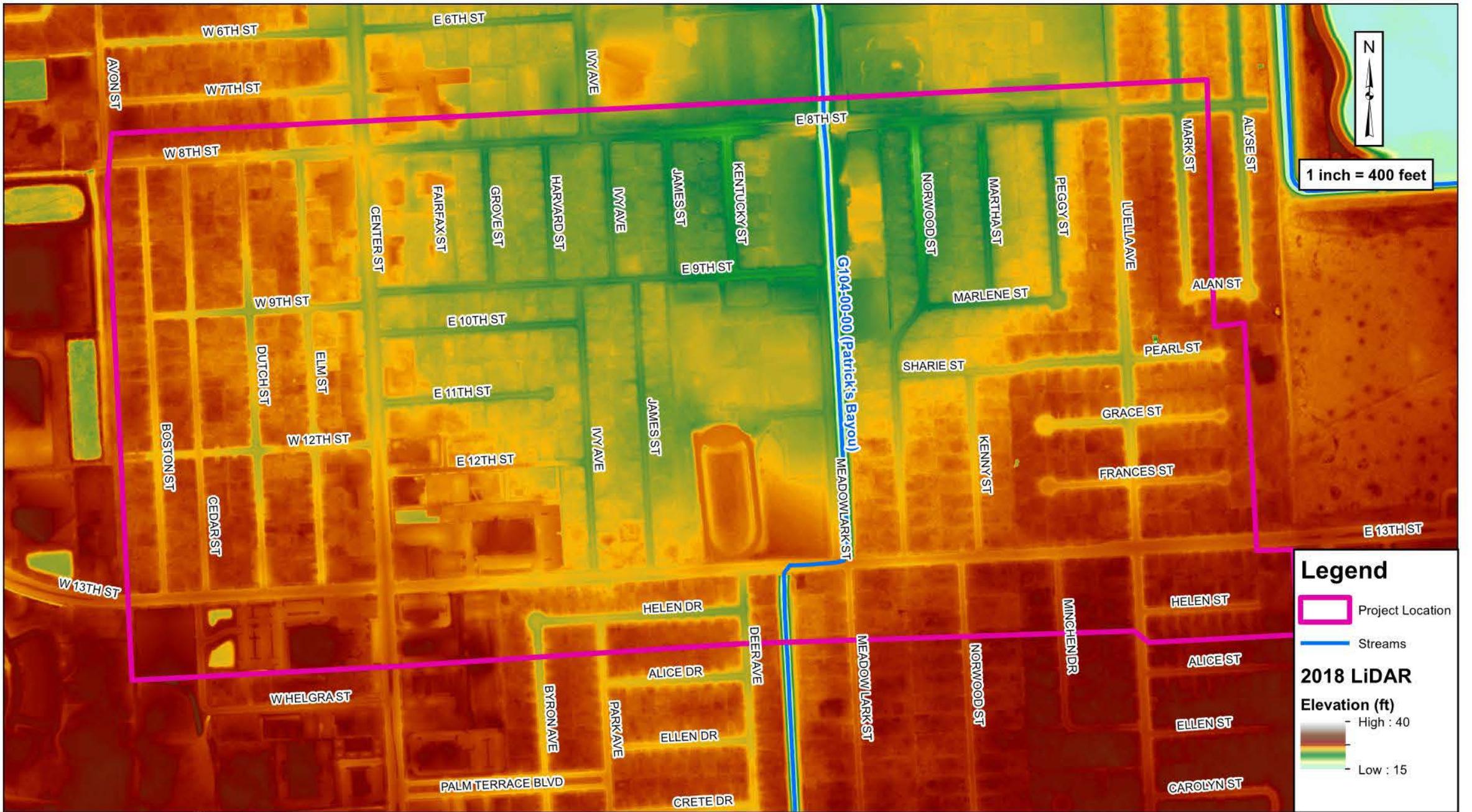
City of Deer Park - Deer Park Gardens  
Drainage Area Map

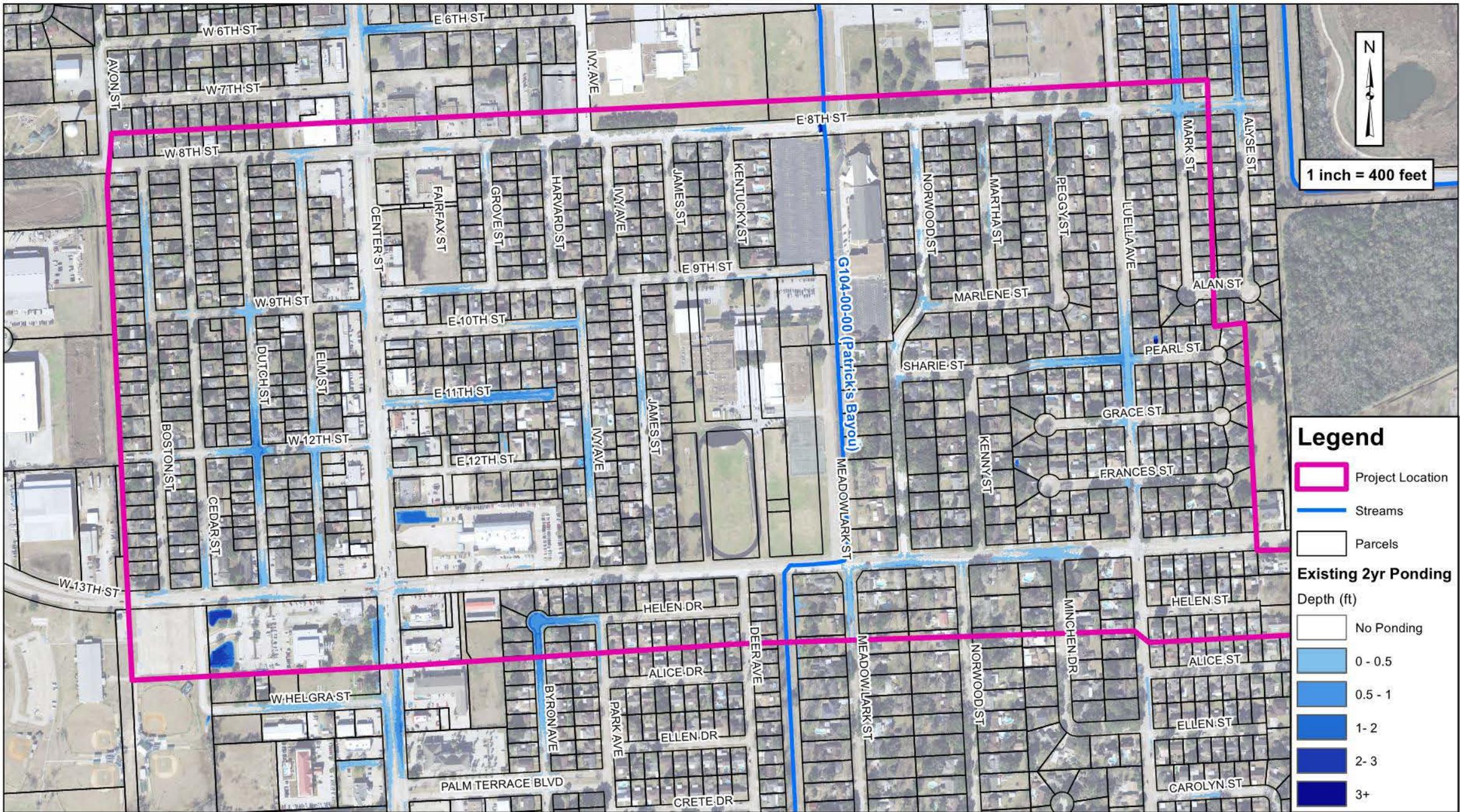


1 inch = 400 feet

### Legend

- Inlets
  - ▶ Storm Sewer
  - Project Location
- Drainage Systems**
- A
  - B
  - C
  - D
  - E
  - F
  - G
  - H
  - I
  - J
  - K
  - Streams





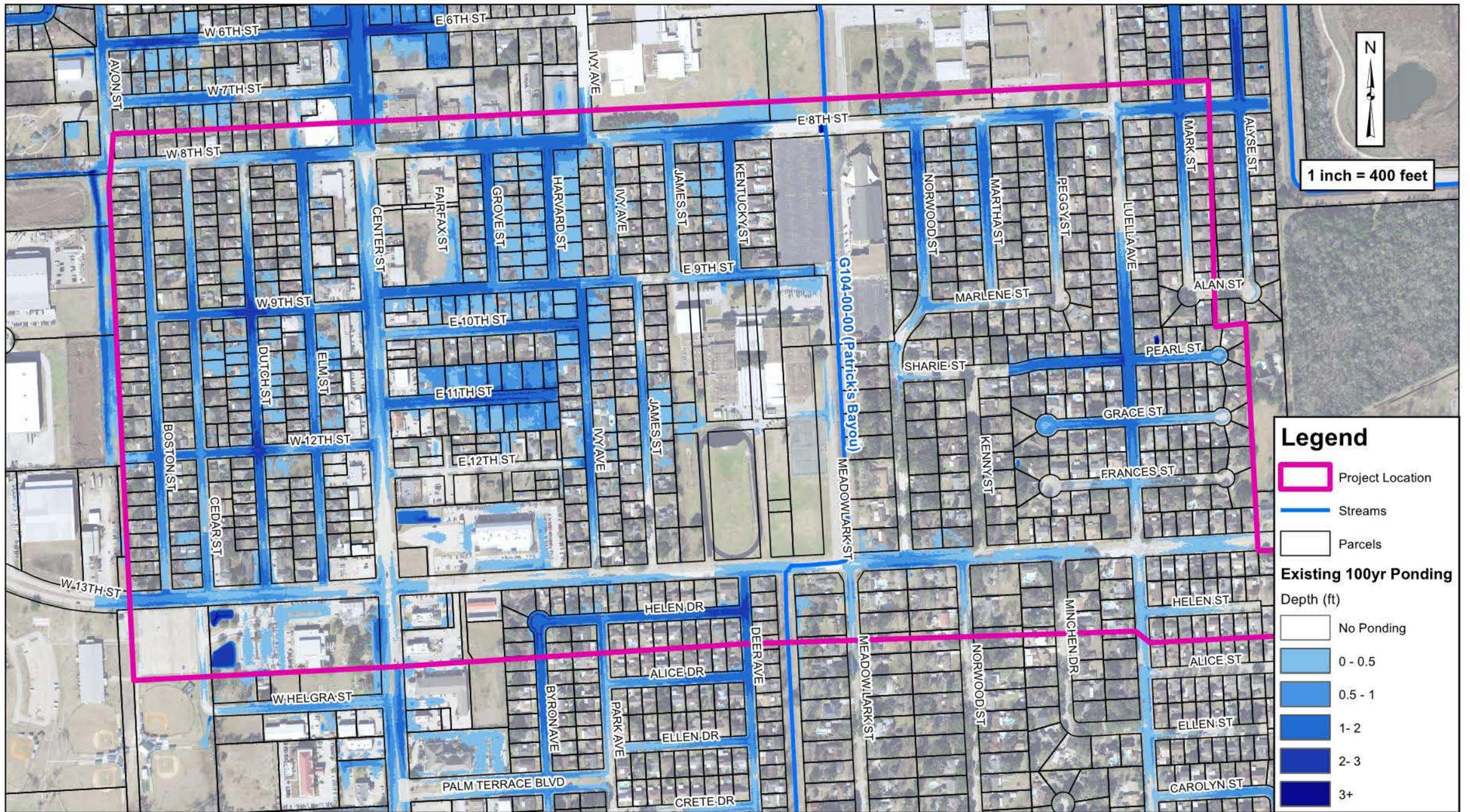
**Legend**

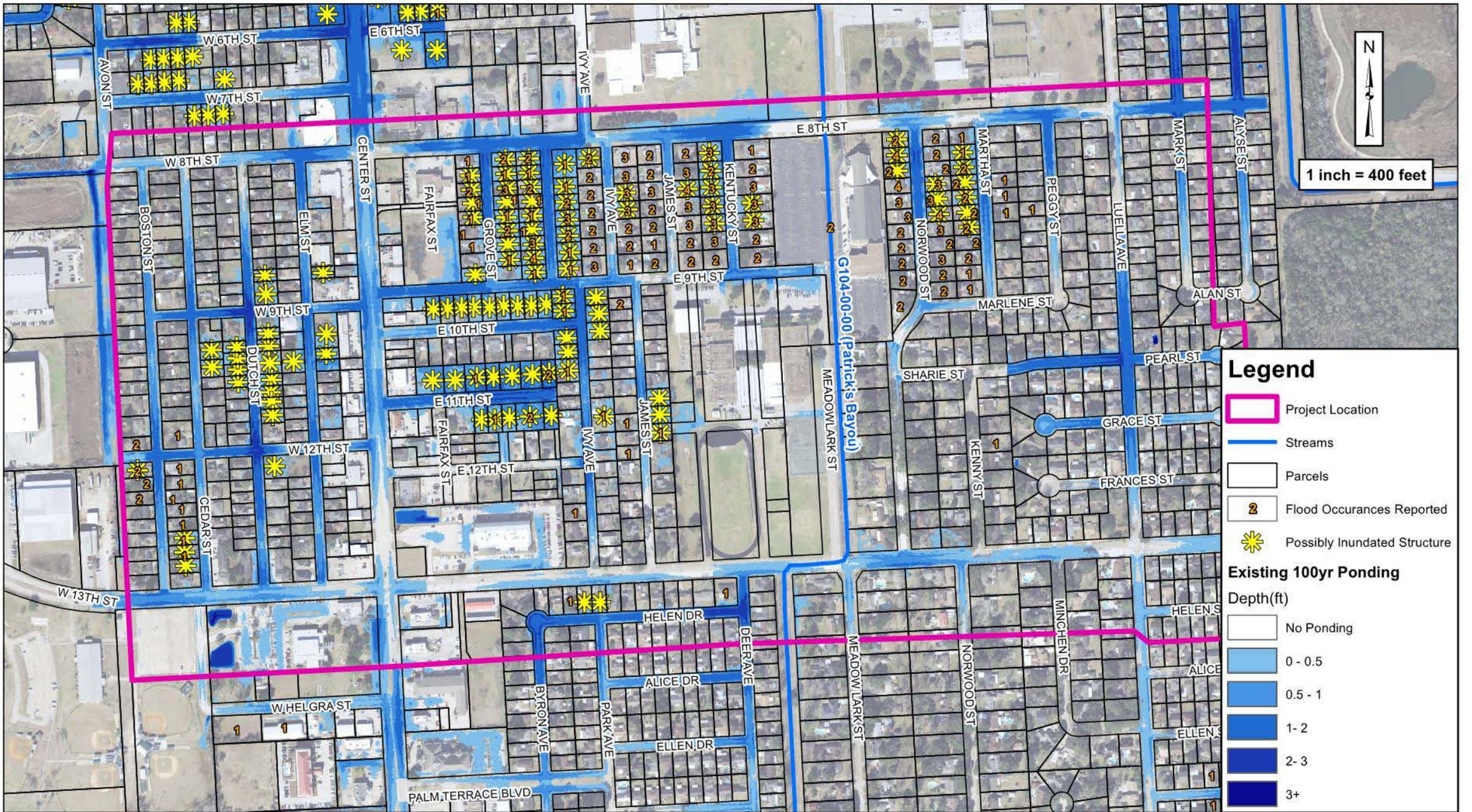
- Project Location
- Streams
- Parcels

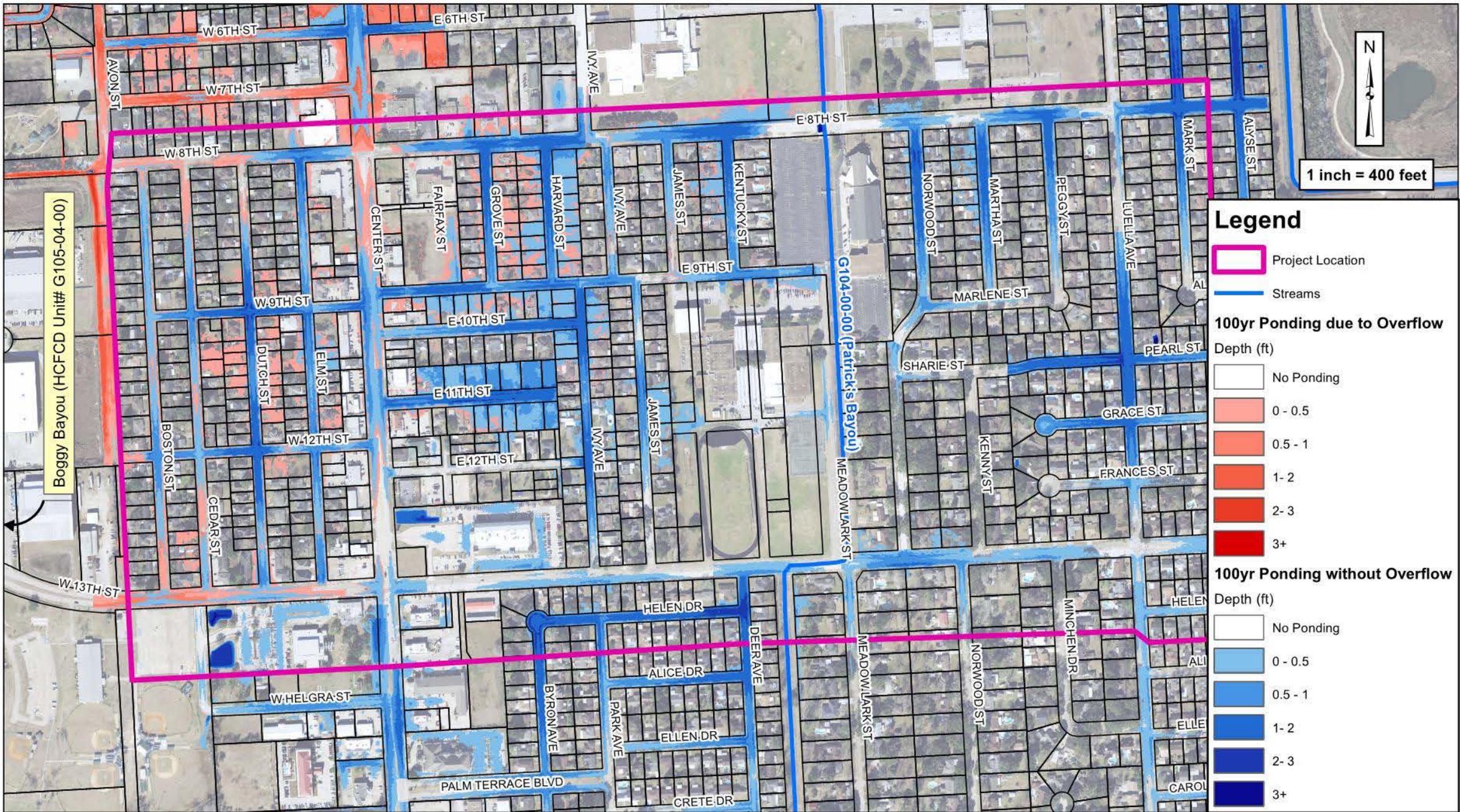
**Existing 2yr Ponding**

Depth (ft)

- No Ponding
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3+







### Legend

- Project Location
- Streams

#### 100yr Ponding due to Overflow

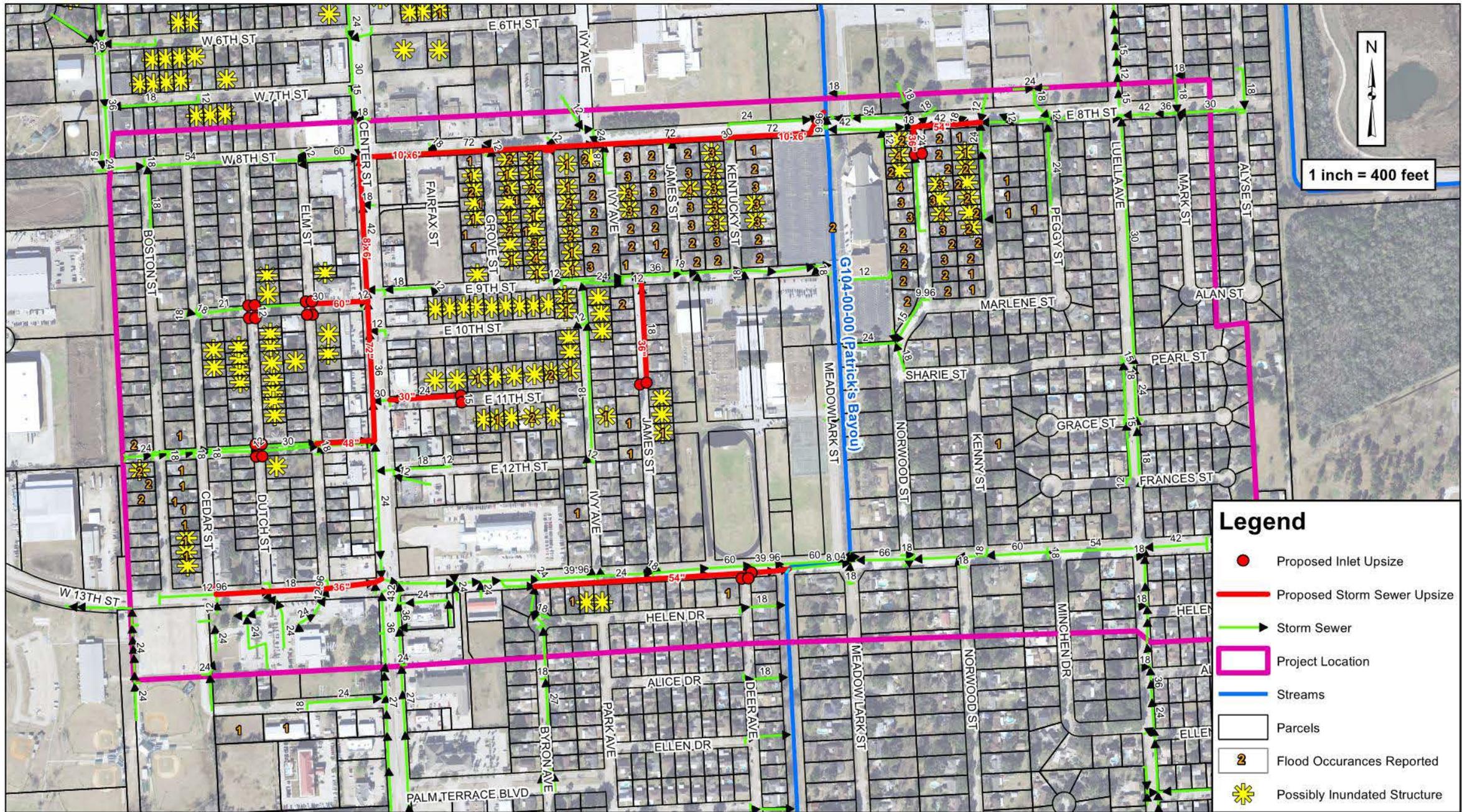
Depth (ft)

- No Ponding
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3+

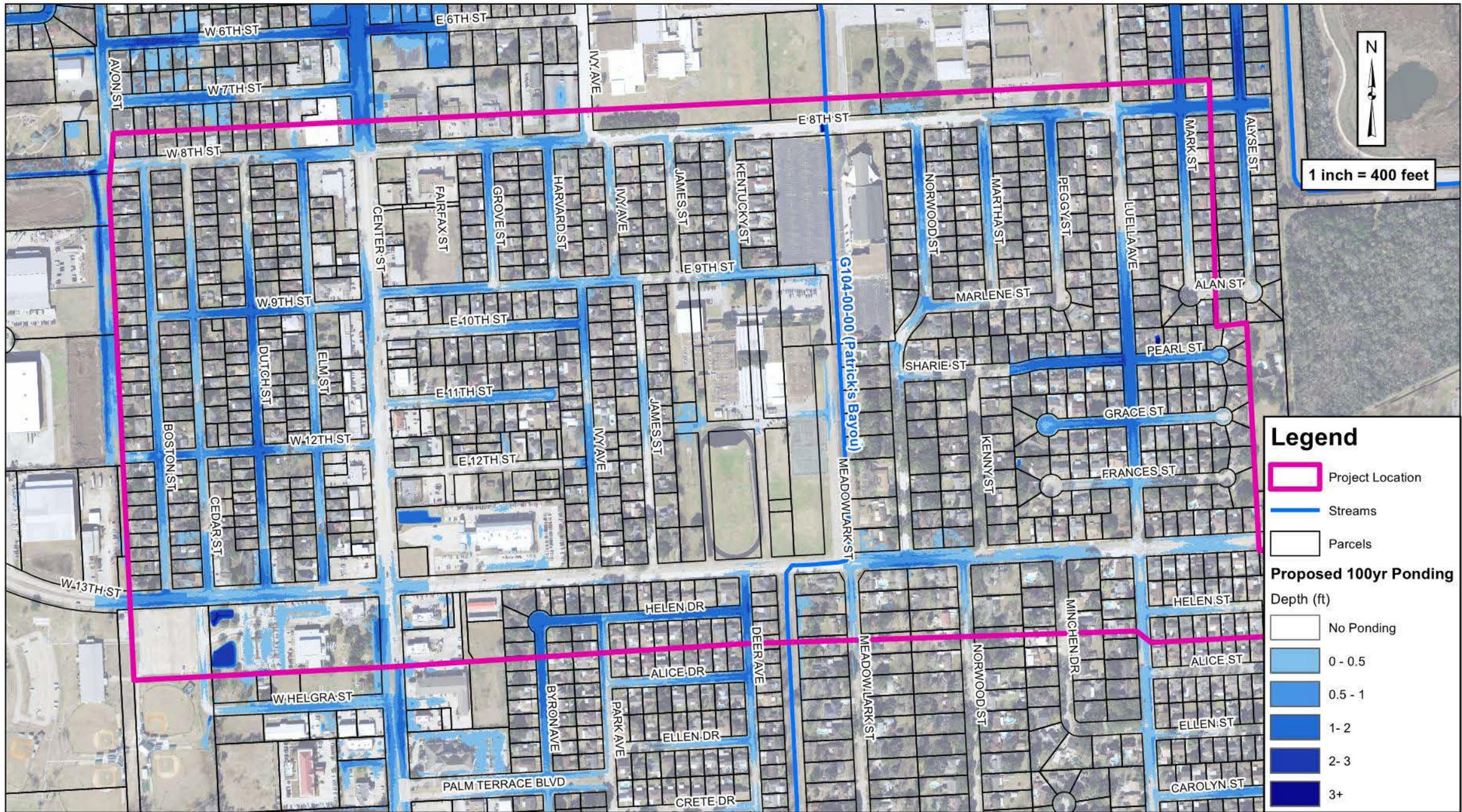
#### 100yr Ponding without Overflow

Depth (ft)

- No Ponding
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3+



- ### Legend
- Proposed Inlet Upsize
  - Proposed Storm Sewer Upsize
  - Storm Sewer
  - Project Location
  - Streams
  - Parcels
  - 2 Flood Occurances Reported
  - ★ Possibly Inundated Structure



**Legend**

- Project Location
- Streams
- Parcels

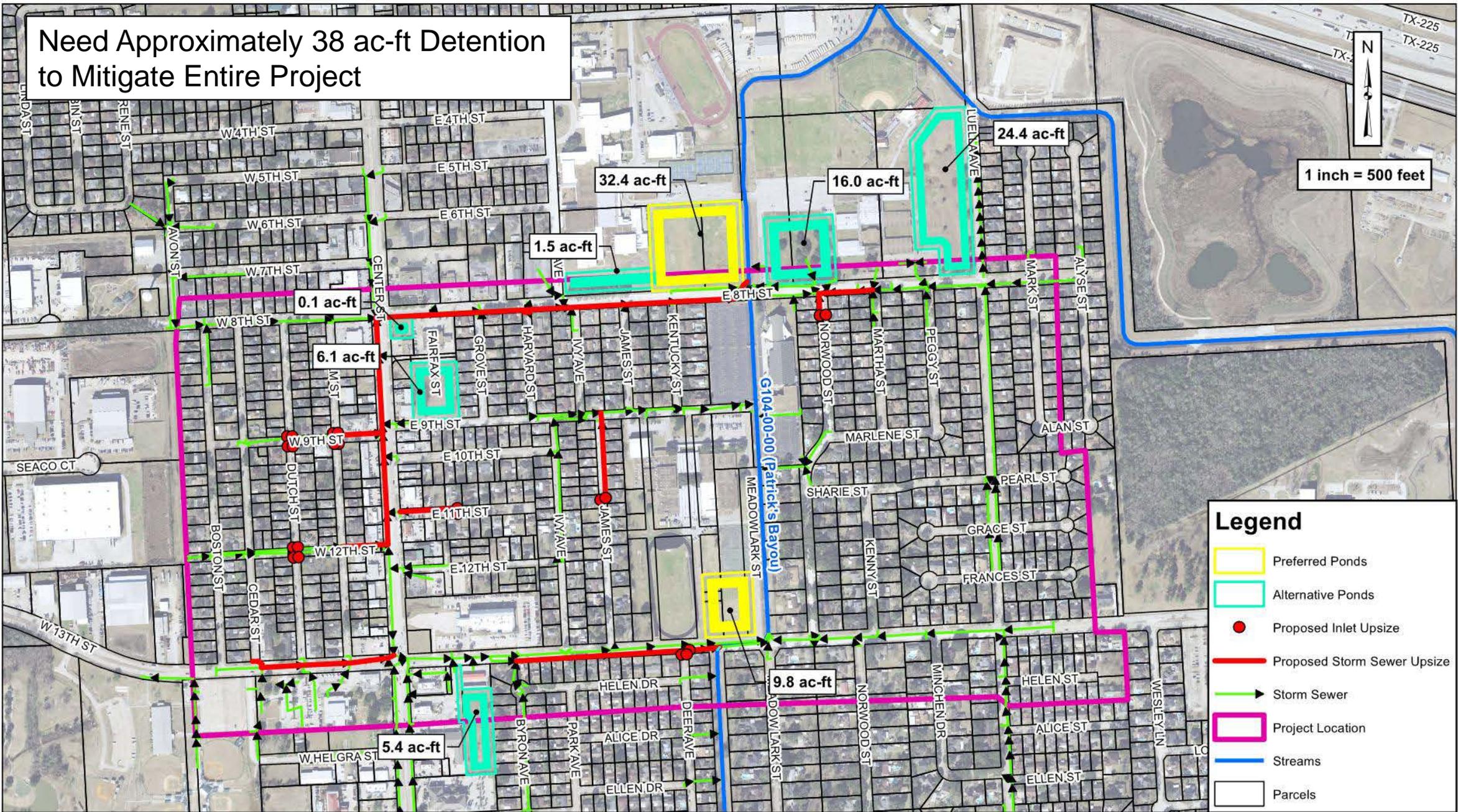
**Proposed 100yr Ponding**

Depth (ft)

- No Ponding
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3+

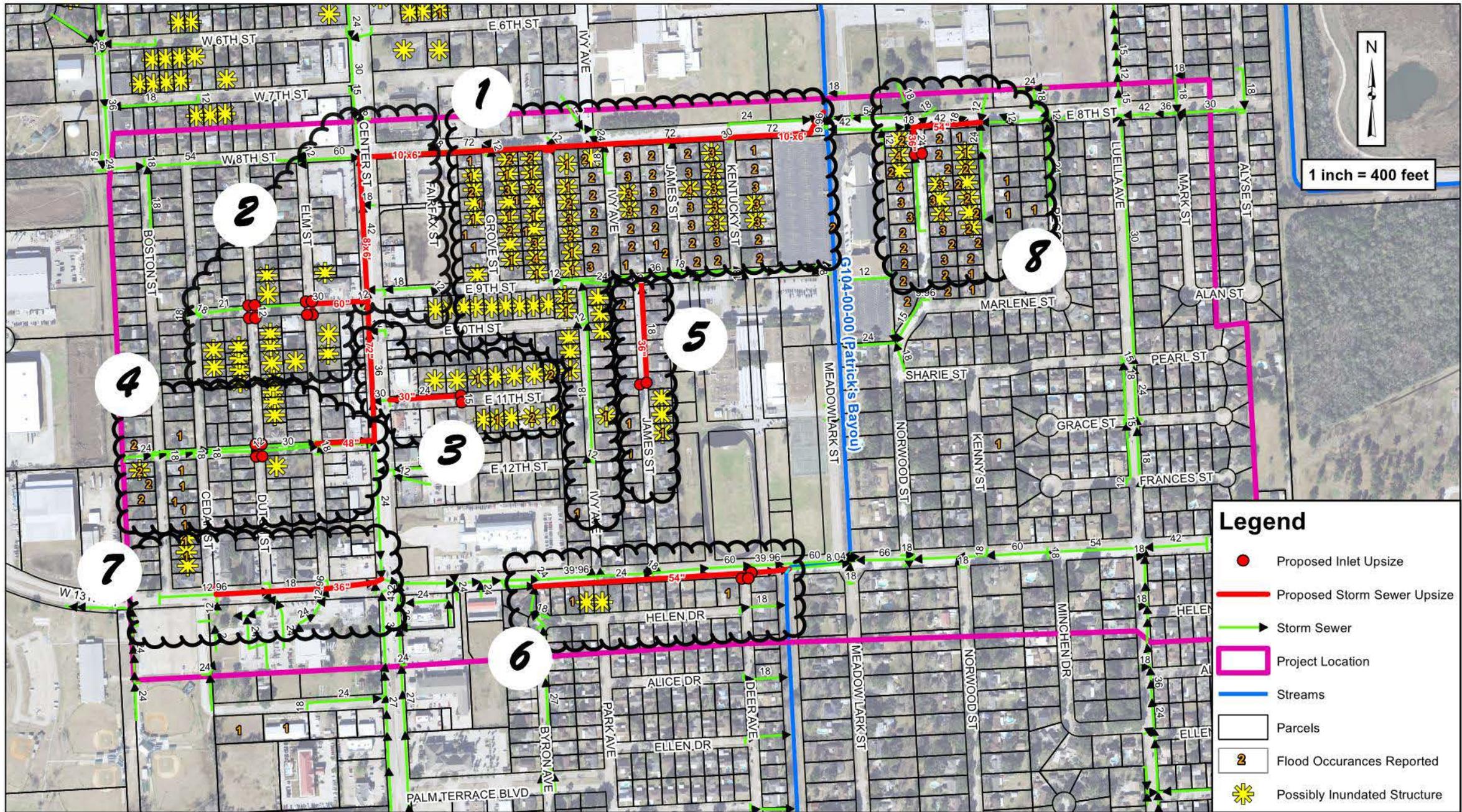
Need Approximately 38 ac-ft Detention to Mitigate Entire Project

1 inch = 500 feet

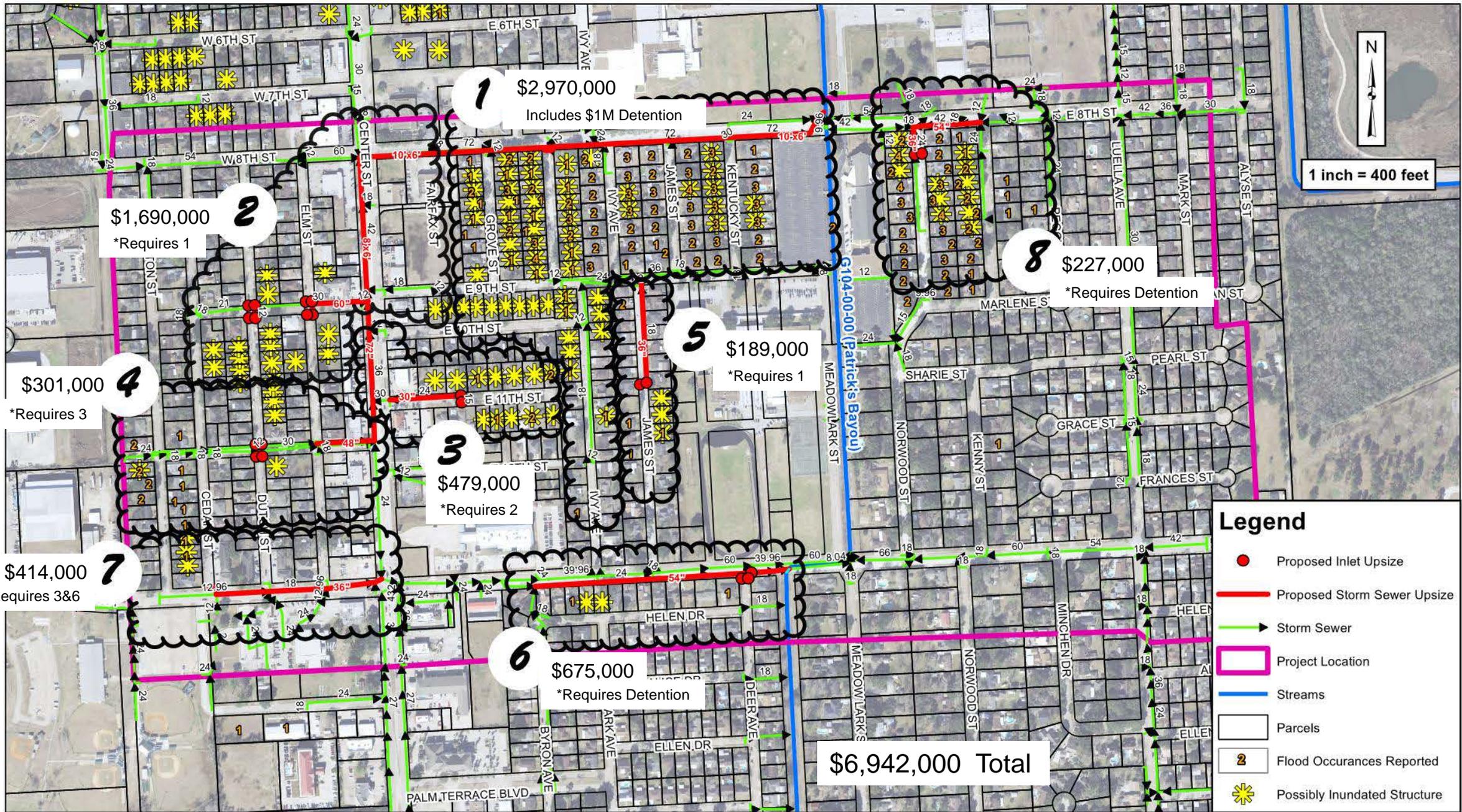


**Legend**

- Preferred Ponds
- Alternative Ponds
- Proposed Inlet Upsize
- Proposed Storm Sewer Upsize
- Storm Sewer
- Project Location
- Streams
- Parcels



- Legend**
- Proposed Inlet Upsize
  - Proposed Storm Sewer Upsize
  - Storm Sewer
  - Project Location
  - Streams
  - Parcels
  - 2 Flood Occurances Reported
  - ★ Possibly Inundated Structure



# **EXHIBIT C**

## **“MASTERPLAN”**

College Park and Deer Park Gardens Subdivision neighborhoods  
Masterplan Drainage Report – Executive Summary

Klotz and Associates

August 2009

## EXECUTIVE SUMMARY

### Background

The City of Deer Park, Texas (City) has a variety of drainage and flooding problems, ranging from nuisance flooding in streets, backup of storm sewers and culverts, overflow of both roadside ditches and major drainage ways, and ponding of low lying areas to repeated flooding of residential structures. While much of the City is well established and developed, residential and commercial growth of some areas can be expected in the future; such development could further aggravate current drainage problems.

While the City has made significant strides over the years in addressing various specific problems or problem areas, drainage and flooding problems remain or have grown in recent years. This present Master Drainage Plan (MDP) for the City is intended to provide a roadmap to guide the City in a comprehensive program for remedy of its drainage and flooding problems in a cost effective manner.

### Methodology

The development of this MDP uses a four step process:

- *Problem Assessment and Delineation:* In this step, drainage and flooding problems have been, using a variety of information sources, identified, located, and generally characterized; and with the concurrence of the City, a master list of impacted subdivisions and other key areas in the City has been prepared. Significant interaction with and assistance from the City has been an important contribution to this step.
- *Hydrologic and Hydraulic Model Development and Revision:* Existing hydrologic and hydraulic computer models were gathered and updated as appropriate for analysis of

channel flow-related problems. Where existing models were needed but unavailable, new models were developed.

- *Identification of MDP Needs:* Collected data and modeling results have been reviewed to identify and quantify needed drainage and flood control improvements. Critical improvement needs have been identified.
- *Development of MDP:* Based upon the needs identified, specific projects for addressing critical drainage and flooding problems both for current and anticipated levels of development are proposed. Costs have been estimated and priorities for implementing the proposed projects have been recommended.

### **Drainage and Flooding Problems**

Using information from the City, prior studies, analyses performed specifically for this study, hydrologic and hydraulic modeling and application of Geographic Information System (GIS) tools, FEMA repetitive loss data, and citizen's complaints, drainage and flooding problems across the City have been identified. The majority of issues are the result of significant ponding on the roads and streets, overburdened storm sewer systems, riverine flooding of open channel drainage systems due to a lack of needed flow capacity to prevent out of bank conditions and/or culverts and bridges of insufficient capacity to convey the needed drainage flow, and inundation due to houses located in low lying areas.

### **Proposed Solutions and Their Costs**

After reviewing the type and severity of the drainage and flooding problems, fifty-nine solutions are proposed. Several of the improvement projects are sheet flow swales. Select culvert improvements are also identified. Channel conveyance improvements involving channel widen are proposed. Mitigation is proposed in conjunction with channel conveyance improvements. Need for sewer system improvements are identified,

but more detailed analysis is needed to define the details of the improvements. Future detention pond site possibilities are identified to address potential runoff increases associate with land development. We have identified and have shown more detention sites than are needed to provide the City with flexibility. Not all of the identified detention sites are needed.

Problematic areas along East Boulevard are being addressed by improvements recently completed or underway along the primary drainage ditch B112-02-00 east of East Boulevard including the replacement of the Pasadena Street bridge and by the lowering of the end of San Augustine Street.

The construction costs of the recommended solutions range from as little as an estimate \$30,000 for several swale construction projects to amounts in the several millions. There are several swales, many storm sewer system improvements, several channel improvements, several culvert replacements, and several detention ponds. Storm sewer improvement costs assume a general upgrading of sewer system capabilities in various subdivision areas, but detailed assessment of individual systems is needed to define the details of needed improvements.

The problematic areas along Patrick's Bayou in the vicinity of Highway 225 are currently being address in part by a proposed regional detention pond near Luella and 13<sup>th</sup> Street and with other local proposed improvement projects in the area. The limiting capacity Patrick's Bayou are the long dual culverts under the industrial area north of the freeway. A recent reconnaissance investigation through those culverts showed that the culverts are essentially open with some small areas of gravel, sand and soil build up in a few areas within the culverts but not enough to create significant capacity limitations at this time. Because Patrick's Bayou drains a large area of the north east portion of Deer Park it will be a good practice to have these culverts investigated on a somewhat regular basis to ensure that they remain open.

A somewhat similar limiting capacity of the culverts north of Highway 225 also exists for Boggy Bayou. There is limited information on this area of Boggy Bayou. Recommendations for investigation of these culverts is also recommended.

### **Recommended Priorities for Implementing Solutions**

Potential solutions to the various problems are ranked by cost, number of losses/complaints removed or improved, and the amount of acreage beneficially impacted from the project solution as an initial basis for defining priorities for making improvements. However a more comprehensive roadmap for undertaking projects is obtained by identified areas of concentrations of drainage and flooding problems so that improvement funds can be applied in a focused manner. Zones of problems and projects to remedy are identified. Seven critical zones are identified and prioritized. Within each zone, proposed projects are ordered for construction. Projects within a priority zone are typically ordered by cost. This ordering sets out a roadmap for implementing projects in an effective manner.

Projects suitable for joint funding with other parties such as the Harris County Flood Control District are identified. Recommendations for drainage criteria to be employed for drainage development and construction are identified. Issues in project implementation are highlighted.

# **EXHIBIT D**

## **“HISTORICAL FLOOD LOSS MAP”**

College Park and Deer Park Gardens Subdivision neighborhoods

Map – Flood Complaint Grouped by Source

Klotz and Associates

August 2009

