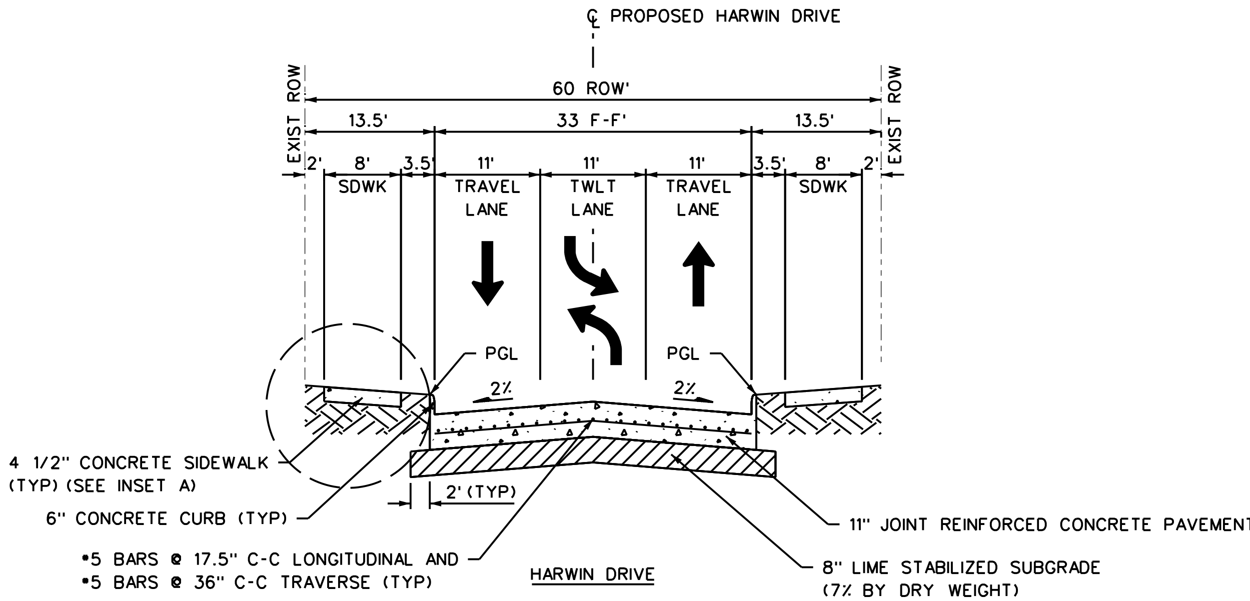
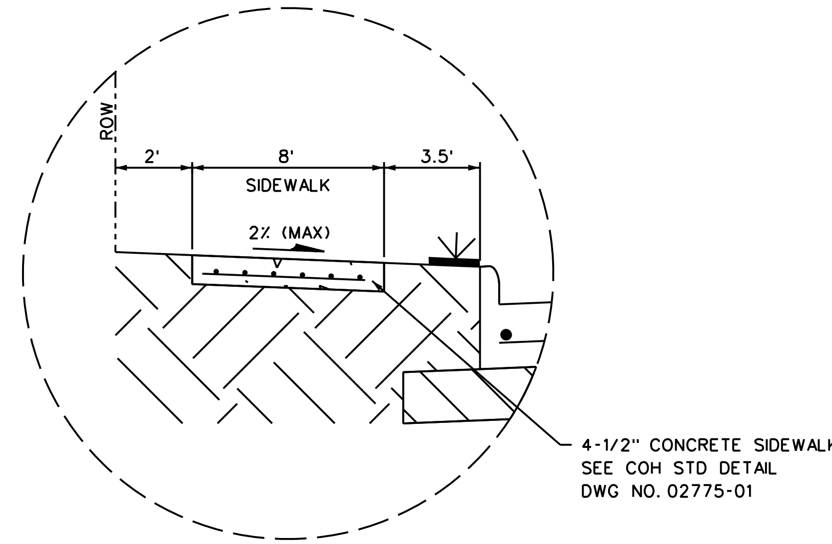
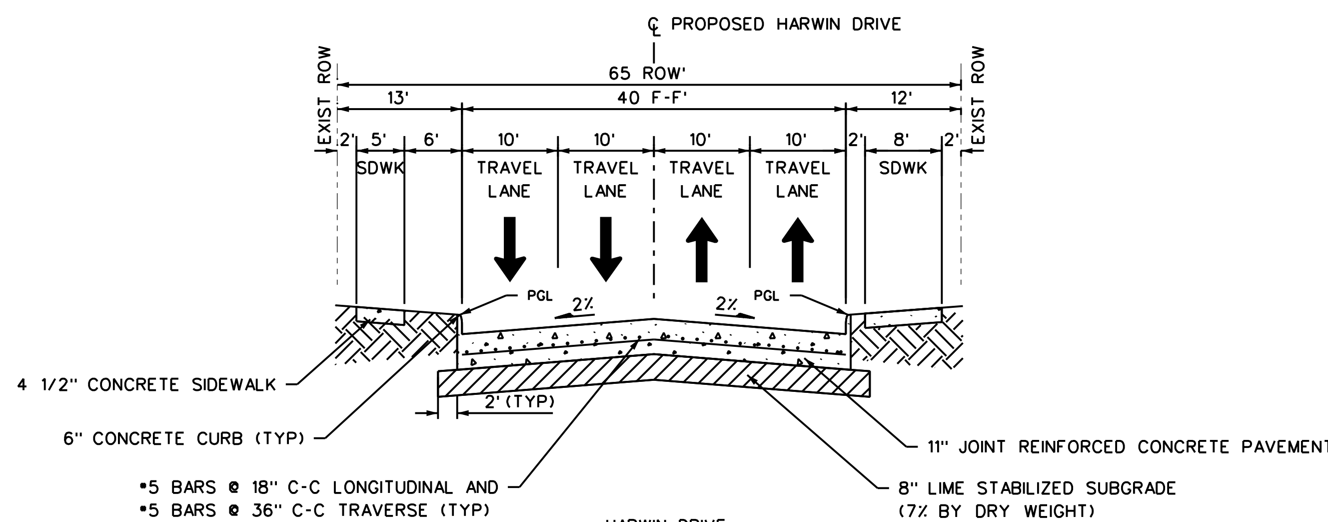


HARWIN DRIVE

PROPOSED TYPICAL SECTION
STA 17+10.83 TO STA 62+55.69

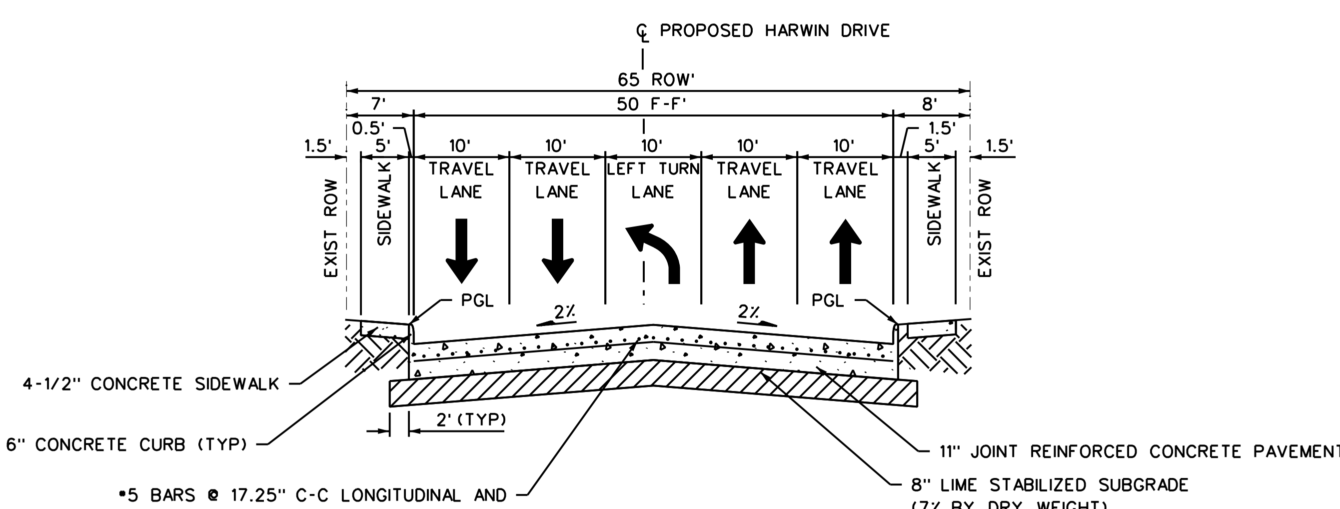


INSET A



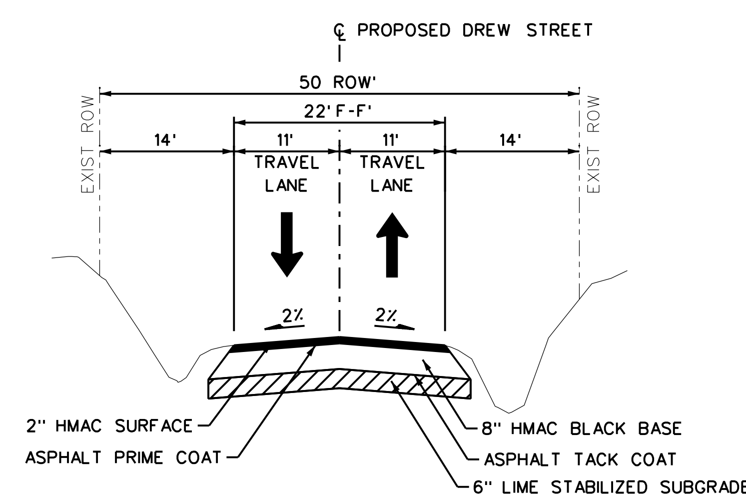
HARWIN DRIVE

PROPOSED TYPICAL SECTION
STA 62+55.69 TO STA 65+25.82



HARWIN DRIVE

PROPOSED TYPICAL SECTION
STA 67+20.75 TO STA 68+51.32



DREW STREET

PROPOSED TYPICAL SECTION

NO.	DATE	REVISION	APP

CobbFendley
Texas Registration No. 274
13430 Northwest Freeway, Suite 1100
Houston, Texas 77040
713.462.3242 | fax 713.462.3262 |
www.cobbfendley.com

INTERIM REVIEW
Not intended for construction, bidding or permit purposes.
Engineer: [illegible]
P.E. Serial No.: [illegible]
Date: 4/6/2023

HARWIN DRIVE RECONSTRUCTION
FROM GESSNER TO FONDREN

NOTE: CITY SIGNATURES VALID FOR ONE YEAR ONLY AFTER DATE OF SIGNATURES

CITY OF HOUSTON
HOUSTON PUBLIC WORKS

WATER	STORM WATER QUALITY
WASTE WATER	FACILITIES
STORM WATER	TRAFFIC & TRANSPORTATION/ STREET & BRIDGE
FILE NO.	HORIZ:
	VERT:
SHEET NO. OF	DRAWING SCALE

FOR CITY OF HOUSTON USE ONLY

8:54:15 AM
4/6/2023
B:\Projects\2022\11007_Southwest_Houston_Redevelopment_Auth_TIRZ_20\01_Reconstruction_of_Harwin_Drive\400_CAD\411_Trans\02-General\221107_PROP_TYPSEC01.dgn


PROPOSED HARWIN DRIVE
PAVING PLAN
WESTPARK TOLLWAY
GESSNER
GESSNER AND HARWIN INTERSECTION
APPROACHES CURRENTLY UNDER CONSTRUCTION
ANTICIPATED COMPLETION FALL 2024
HARWIN DRIVE
ALLDAY
REPLACE EXISTING TRAFFIC
SIGNAL WITH MODERNIZED
TRAFFIC SIGNAL HARDWARE
OSAGE
PROP DETENTION POND
GLENMONT
DREW
EXIST. CONCRETE LINED DITCH
FONDREN
FONDREN INTERSECTION
AND APPROACHES
COMPLETED IN 2016
0 50 100 200
℄ EXISTING HARWIN DRIVE
60' ROW
40' F-F
10' 10' 10' 10' 10' 10'
EXIST ROW
TRAVEL LANE
TRAVEL LANE
TRAVEL LANE
TRAVEL LANE
EXISTING HARWIN DRIVE
EXISTING TYPICAL SECTION
℄ EXISTING HARWIN DRIVE
33' F-F
13.5' 11' 11' 13.5'
2' 8' 3.5' 3.5' 8' 2'
PROP SIDEWALK
TRAVEL LANE
TWLT LANE
TRAVEL LANE
PROP SIDEWALK
HARWIN DRIVE
PROPOSED TYPICAL SECTION
℄ PROPOSED DREW STREET
50' ROW
22' F-F
14' 11' 11' 14'
TRAVEL LANE
TRAVEL LANE
DREW STREET
PROPOSED TYPICAL SECTION
CobbFendley
TBPE Firm Registration No. 274
TBPLS Firm Registration No. 100467
13430 Northwest Freeway, Suite 1100
Houston, Texas 77040
713.462.3242 | fax 713.462.3262
www.cobbfendley.com
HARWIN DRIVE RECONSTRUCTION
FROM S GESSNER ROAD TO FONDREN DRIVE

SOUTHWEST HOUSTON REDEVELOPMENT AUTHORITY/TIRZ No. 20

HARWIN ROAD RECONSTRUCTION
FROM GESSNER RD TO FONDREN RD. (5,300 LF, 1.00 Mile)
CONSTRUCTION COST ESTIMATE AT DCR LEVEL
MARCH 2023

ITEM NO.	SPEC NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL COST
SITE PREPARATION						
1	01502	Mobilization	LS	1	$ 1,500,000.00	$ 1,500,000.00
2	01580	Project Identification Sign	EA	2	$ 1,500.00	$ 3,000.00
3	02221	Remove Existing Concrete Pavement (With or Without Curbs)	SY	27,300	$ 15.00	$ 409,500.00
4	02221	Removing and Disposing of Existing Asphaltic Surface & Base Material (All Depths)	SY	1,814	$ 10.00	$ 18,140.00
5	02221	Remove Existing Sidewalk	SY	4,178	$ 15.00	$ 62,670.00
6	02221	Remove Existing Driveway	SY	1,901	$ 15.00	$ 28,515.00
7	02221	Remove Existing Concrete Pipe (All Sizes)	LF	4,401	$ 25.00	$ 110,025.00
8	02221	Remove Existing Concrete Boxes (All Sizes)	LF	120	$ 60.00	$ 7,200.00
9	02221	Remove Existing Inlets (All Depths)	EA	35	$ 800.00	$ 28,000.00
10	02221	Remove Existing Manholes	EA	27	$ 1,000.00	$ 27,000.00
11	02233	Clearing and Grubbing	STA	72	$ 1,500.00	$ 108,000.00
12	02315	Roadway Excavation	CY	5,787	$ 25.00	$ 144,675.00
Subtotal SITE PREPARATION						**$ 2,446,725.00**
PAVEMENT						
13	02336	Lime Stabilized Subgrade (6" Thick)	SY	2,183	$ 4.00	$ 8,732.00
14	02336	Lime Stabilized Subgrade (8" Thick)	SY	22,779	$ 6.00	$ 136,674.00
15	02336	Type A, Hydrated Lime (Estimated at 7% by Dry Weight)	TON	513	$ 350.00	$ 179,550.00
16	02711	HMA Black Base (8")	TON	896	$ 150.00	$ 134,400.00
17	02741	HMA Surface Course (2")	TON	204	$ 170.00	$ 34,680.00
18	02751	Reinforced Concrete Pavement (10" Thick)	SY	20,478	$ 95.00	$ 1,945,410.00
19	02751	Reinforced Concrete Pavement (10" Thick) (HES) for Intersections	SY	1,078	$ 125.00	$ 134,750.00
20	02754	Reinforced Concrete Driveways (7" Thick)	SY	2,959	$ 80.00	$ 236,720.00
21	02771	Concrete Curb (6")	LF	7,517	$ 5.00	$ 37,585.00
22	02775	Concrete Sidewalk (8-ft Wide)	SY	7,231	$ 85.00	$ 614,635.00
23	02775	Wheelchair Ramps	EA	7	$ 2,000.00	$ 14,000.00
Subtotal PAVEMENT						**$ 3,477,136.00**
STORM SEWER						
24	02082	Precast Concrete Manhole (All Depths)	EA	7	$ 6,500.00	$ 45,500.00
25	02082	Precast Concrete Manhole on RCB (All Depths)	EA	5	$ 3,000.00	$ 15,000.00
26	02082	Precast Concrete Box Manhole W/ Eccentric Cone (All Depths)	EA	13	$ 7,000.00	$ 91,000.00
27	02082	Precast Concrete Conflict Box Manhole W/ Eccentric Cone (All Depths)	EA	1	$ 8,000.00	$ 8,000.00
27	02082	Precast Concrete Box Manhole (All Depths)	EA	2	$ 7,000.00	$ 14,000.00
28	02260	Trench Safety System (5 to 10 feet)	LF	6,459	$ 1.50	$ 9,688.50
29	02631	24" diameter RCP storm sewer by open cut	LF	851	$ 160.00	$ 136,160.00
30	02631	30" diameter RCP storm sewer by open cut	LF	38	$ 210.00	$ 7,980.00
31	02631	36" diameter RCP storm sewer by open cut	LF	109	$ 280.00	$ 30,520.00
32	02631	54" diameter RCP storm sewer by open cut	LF	2,717	$ 425.00	$ 1,154,725.00
33	02631	60" diameter RCP storm sewer by open cut	LF	100	$ 600.00	$ 60,000.00
34	02631	5-foot by 4-foot box storm sewer by open cut	LF	1,290	$ 825.00	$ 1,064,250.00
35	02631	6-foot by 4-foot box storm sewer by open cut	LF	557	$ 870.00	$ 484,590.00
36	02631	8-foot by 5-foot box storm sewer by open cut	LF	797	$ 1,150.00	$ 916,550.00
37	02631	Reinforced Concrete Box Bend (5' X 4' X 8°)	EA	4	$ 7,500.00	$ 30,000.00
38	02631	Reinforced Concrete Box Bend (6' X 4' X 30°)	EA	1	$ 8,000.00	$ 8,000.00
39	02631	Reinforced Concrete Box Bend (8' X 5' X 45°)	EA	1	$ 10,000.00	$ 10,000.00
40	02632	Cast-in-Place Junction Box (10'-0" X 8'-0")	EA	1	$ 32,000.00	$ 32,000.00
41	02632	Cast-in-Place Junction Box (11'-0" X 8'-0")	EA	1	$ 35,000.00	$ 35,000.00
42	02632	Cast-in-Place Junction Box (11'-0" X 11'-0")	EA	1	$ 37,000.00	$ 37,000.00
42	02633	Precast Concrete Type 'B-B' Inlet (All Depths)	EA	4	$ 5,000.00	$ 20,000.00
40	02633	Precast Concrete Type 'C' Inlet on RCB (All Depths)	EA	1	$ 6,000.00	$ 6,000.00
41	02633	Precast Concrete Type 'C' Inlet (All Depths)	EA	20	$ 5,000.00	$ 100,000.00
42	02633	Precase Junction Box (4'-0 X 4'-0")	EA	13	$ 5,000.00	$ 65,000.00
43	02633	Precase Junction Box (8'-0 X 8'-0")	EA	2	$ 25,000.00	$ 50,000.00
39		Detention Pond including excavation, maintenance berm, trash rack, pilot channels, & backswale structures	LS	1	$ 1,500,000.00	$ 1,500,000.00
Subtotal STORM SEWER						**$ 5,930,963.50**

SOUTHWEST HOUSTON REDEVELOPMENT AUTHORITY/TIRZ No. 20

HARWIN ROAD RECONSTRUCTION
FROM GESSNER RD TO FONDREN RD. (5,300 LF, 1.00 Mile)
CONSTRUCTION COST ESTIMATE AT DCR LEVEL
MARCH 2023

ITEM NO.	SPEC NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL COST
Signing and Pavement Markings						
40	02767	Signing and Striping	LS	1	$ 75,000.00	$ 75,000.00
Subtotal SIGNING AND PAVEMENT MARKINGS						**$ 75,000.00**
WATER						
41	02520	Fire hydrant assembly, all depths, including 6-inch diameter gate valve and box	EA	18	$ 8,000.00	$ 144,000.00
42	02511	6" Diameter PVC Water Line by open-cut (Fire Hydrant)	LF	114	$ 75.00	$ 8,550.00
43	02511	8" Diameter PVC Water Line by open-cut	LF	65	$ 90.00	$ 5,850.00
44	02511	10" Diameter PVC Water Line by open-cut	LF	5	$ 110.00	$ 550.00
45	02511	12" Diameter PVC Water Line by open-cut	LF	5,341	$ 150.00	$ 801,150.00
46	02513	8-inch diameter wet connection	EA	2	$ 3,750.00	$ 7,500.00
47	02513	12-inch diameter wet connection	EA	3	$ 5,000.00	$ 15,000.00
48	02516	Cut and plug existing 8-inch diameter water line	EA	2	$ 1,500.00	$ 3,000.00
49	02516	Cut and plug existing 12-inch diameter water line	EA	3	$ 2,200.00	$ 6,600.00
Subtotal WATER						**$ 992,200.00**
WASTE WATER						
50	02082	4-foot Diameter Precast Concrete Manholes	EA	22	$ 7,000.00	$ 154,000.00
51	02260	Trench Safety System (5 to 10 feet)	LF	3,240	$ 1.50	$ 4,860.00
52	02531	12" SDR 26 PVC Sanitary Sewer Pipe	LF	3,240	$ 150.00	$ 486,000.00
Subtotal WASTE WATER						**$ 644,860.00**
TRAFFIC CONTROL						
53	01555	Traffic Control Plan	MO	24	$ 35,000.00	$ 840,000.00
Subtotal TRAFFIC CONTROL						**$ 840,000.00**
TRAFFIC SIGNAL						
54	02893	Traffic Signal	EA	1	$ 400,000.00	$ 400,000.00
Subtotal TRAFFIC SIGNAL						**$ 400,000.00**
SWPPP						
55	05170	SWPPP	LS	1	$ 100,000.00	$ 100,000.00
Subtotal SWPPP						**$ 100,000.00**
SUBTOTAL CONSTRUCTION COST (CONSTRUCTION ITEMS ONLY)						**$ 14,906,884.50**
CONTINGENCIES						
Contingencies @ 20%						$ 2,981,376.90
Subtotal Contingencies						**$ 2,981,376.90**
SUBTOTAL CONSTRUCTION COST + CONTINGENCIES						**$ 17,888,261.40**
ROW/PROPERTY ACQUISITION & PROCUREMENT COST						
ROW Acquisition & Real Estate Purchase*						$ 3,000,000.00
Engineering and Surveying						$ 1,284,014.00
Construction Management & Material Testing*						$ 650,000.00
Subtotal ROW/Property Acquisition & Procurement Cost						**$ 4,934,014.00**
GRAND TOTAL ESTIMATED COST						**$ 22,822,275.40**

*Items included for budgetary consideration for utility relocation required to construct the project.

DRAINAGE STUDY REPORT
FOR
HARWIN DRIVE RECONSTRUCTION

CITY OF HOUSTON, TEXAS

CobbFendley Project No. 2211-007-01

STATE OF TEXAS
YOSSELYN AMAYA
143838
LICENSED
PROFESSIONAL ENGINEER

March 2023

03-17-2023

Submitted By:

CobbFendley

TBPE Firm Registration No. 274 | TBPLS Firm Registration No. 100467

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

EXECUTIVE SUMMARY

This report presents the results of the drainage study performed on a segment of Harwin Drive, from just east of the Gessner intersection to the west side of the Fondren intersection. The study area is located within the Southwest Houston Redevelopment Authority, TIRZ #20 boundary in Houston, approximately 10.5 miles southwest of the City's Downtown. The overland sheetflow patterns and outfall locations were determined and associated relevant stormwater runoff rates were calculated to comply with the City of Houston ("COH") Infrastructure Design Manual (July 2020).

The study area is currently drained east through a system of storm sewers flowing into Bintliff Ditch (HCFCD Unit# D133-00-00), a tributary to Brays Bayou (HCFCD Unit# D130-00-00). The storm sewer begins approximately 900 feet east of Gessner Road and is about 2,900 feet long. At the Harwin Drive intersection with Osage Street, the storm sewer turns south and outfalls into Bintliff Ditch which continues flowing east, outside of the study area.

The hydrologic calculations were performed by using XP-Storm. The Clark Unit Hydrograph Method was used to compute the runoff hydrographs for the Atlas-14, 2 and 100-year storm events. The Rational Method was also used to calculate the peak flow for each drainage area. The peak flows from the model were then calibrated to match the flows calculated. Once the hydrologic calculations were performed, a hydraulic model was created using XP-SWMM. For the existing condition, the model was built on available data and the 2018 LiDAR was used to determine the natural ground. For proposed condition, the drainage areas were modified to represent the updated roadway topography, and the land use was updated to include the additional impervious cover from the widened road. The hydraulic model was also updated with proposed inlet and storm sewer sizes.

The existing and proposed hydraulic model results were compared to ensure no impacts were caused during the roadway improvements. Since flow and water surface elevation impacts were created, from increase in impervious cover and larger conveyance, detention was necessary. Approximately 17 ac-ft of detention storage volume will be required as part of this drainage design.

Based upon the findings described in this report it has been determined that this proposed project will result in no adverse impact to flood hazard conditions on the receiving waterways, including downstream properties within the City of Houston, for storm events up to and including the Atlas-14 100-year storm event.

Table of Contents

SECTION 1 - INTRODUCTION

1.1 Project Name and Description

"*Harwin Drive Proposed Reconstruction & Access Management – November 2022*"

The purpose of this project is to analyze the existing condition of the Harwin Drive roadway, associated utilities, and access management within the study area and provide recommendations to improve its overall safety and operations.

Cobb, Fendley & Associates, Inc. was retained by Southwest Houston Redevelopment Authority, TIRZ #20, to conduct a viability study to improve a segment of Harwin Drive from just east of the Gessner Road intersection to just west of the Fondren Road intersection. The roadway study length is approximately 6,000 feet and is located southwest of downtown Houston, south of Westpark Tollway and east of Sam Houston Tollway, as shown in **Exhibit 1** – Project Location Map. The area is also part of the Brays Bayou Watershed (HCFCD Unit# D100-00-00).

The City of Houston ("COH") has recently updated their drainage criteria, *City of Houston Public Works Infrastructure Design Manual – July 2020 edition*, which resulted in updated rainfall and detention requirements. Due to the changes, the Atlas 14 rainfall was utilized to analyze the stormwater drainage associated with this property.

1.2 Scope of Work

The purpose of this study is to perform a drainage impact analysis to determine overland sheetflow patterns, outfall locations and associated relevant stormwater runoff rates which comply with the COH Infrastructure Design Manual ("IDM") in order to ensure the proposed improvements will result in no increases in flow or water surface elevations ("WSEL") to the existing outfall locations.

Specific tasks include:

- Determine overland sheetflow parameters.
- Identify outfall locations.
- Determine Proposed Condition drainage area boundaries.
- Perform hydrologic calculations for the Existing and Proposed Conditions.
- Perform an Existing Condition storm sewer analysis for Harwin Drive which extends from the intersecting streets, Gessner and Fondren to establish a baseline for comparison of flow and WSEL.
- Analyze potential alternative solutions to provide additional conveyance and detention of stormwater runoff.
- Mitigate any impacts which may result from increased conveyance capacity or increased impervious cover as part of the recommended improvement.

1.3 FEMA Floodplain Designation

The project area is located within FEMA FIRM panel 48201C0835L, as shown in **Figure 1**. The property is not located within a mapped 100-, or 500-year FEMA floodplain.

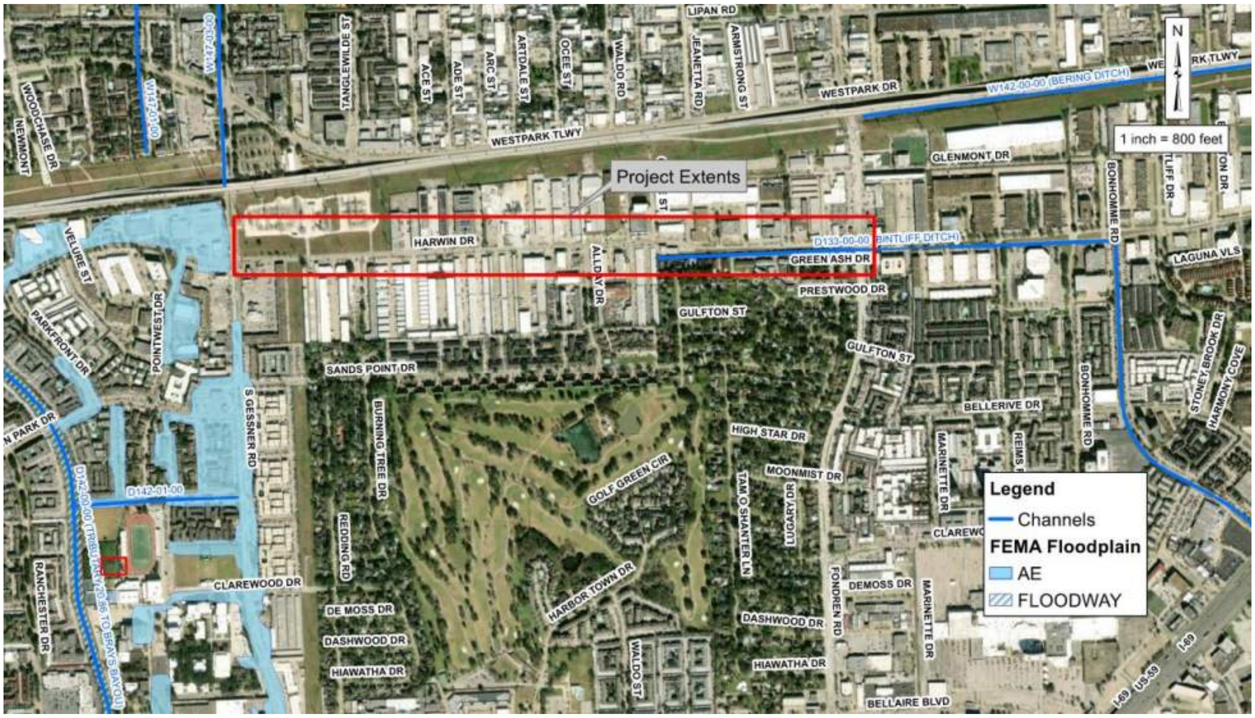


Figure 1 - FEMA Floodplain Map

SECTION 2 - EXISTING CONDITION DRAINAGE ANALYSIS

This study is intended to analyze the Existing Condition drainage for Harwin Drive from the intersections with Gessner to Fondren Road. The Existing Condition refers to the property in its natural state prior to any construction of road or drainage improvements.

Along Harwin Drive, an existing storm sewer drains from slightly east of Gessner Road to Osage Street. At Osage Street, the storm sewer drains slightly south into the Brays Bayou tributary, Bintliff Ditch (HCFCD Unit# D133-00-00), as shown in **Exhibit 2** – Topographic Map. Past Fondren Road, the tributary continues flowing east along Harwin Drive until about 400 feet east of Bonhomme Road. Then, the tributary takes a 90 degree turn south and flows for approximately 16,200 feet to the confluence with Brays Bayou. The entire project area is located within the Brays Bayou watershed. The Existing Condition terrain generally slopes southwest from the initial Harwin and Gessner intersection to Bintliff Ditch and finally towards Brays Bayou.

In the Existing Condition, the study area land use, offsite to the roadway, is predominantly retail shopping centers and store fronts to commercial corridors. Harwin Drive is a 4-lane undivided concrete with curb and gutter road, as shown in **Exhibit 3** – Existing Condition Land Use. The existing Right of Way (“ROW”) is 60 feet wide and does not contain building setbacks. The general pavement condition is also rough, PCI less than 70, and the markings are generally faded and inconsistent. The utilities observed in the area are communication, sanitary sewer, street lighting, water, gas and overhead power.

The Existing Condition terrain was analyzed using 2018 LiDAR, ArcHydro, aerial imagery and existing plan sets in order to identify overland sheetflow patterns and determine locations in which the overland sheetflow exits the property and is conveyed by offsite drainage systems. The drainage areas can be seen in **Exhibits 4A&4B** – Existing Condition Drainage Areas.

2.1 Hydrology

The Rational Method was used to calculate hydrologic runoff rates for both the existing and proposed conditions. The COH IDM was followed for guidance for the determination of “C” values, percent impervious and time of concentration for each of the drainage areas. The runoff coefficient “C” values were determined based on land use types within the study area. The COH IDM provides a table that relates different land uses with unique “C” values. The distinct land uses were delineated using 2018 HGAC aerial imagery.

Once the “C” values were determined, the percent impervious was calculated. The equation for relating the impervious cover to “C” values is shown below.

$$C = 0.6 \times Ia + 0.2$$

Where:
C = watershed coefficient
Ia = impervious area/total area

The equation for determining the time of concentration is also stated below. This equation utilizes the area from the delineated drainage areas. **Appendix A** shows the existing condition hydrologic runoff rate calculations.

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

Where:
TC = Time of concentration (minutes)
A = Area (acres)

2.2 Runoff Hydrographs

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, and storage value to compute a runoff hydrograph. The storage parameter was calibrated by adjusting the value, in XP-Storm, 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. These values were obtained from the Brays Bayou FEMA Effective HEC-HMS model, shown in **Table 1**.

Table 1 – Green & Ampt Loss Parameters

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

2.3 Hydraulic Analysis

Bintliff Ditch Outfall –
Along Harwin Drive, there is an existing storm sewer that conveys runoff east of Gessner Road to Osage Street. The storm sewer is about 2,900 feet long and the initial RCP size is 36” for 300 feet. The culvert then increases to a 42” RCP for the next approximate 800 feet. The culvert size increases an additional 3 times to a 48”, 54” and 60” storm sewer for the next approximate 980, 280 and 540 feet, respectively. At the intersection of Harwin Drive and Osage Street, there is a junction that converges the upstream flows and directs them into a rectangular 5’X4’ box culvert that flows south into Bintliff Ditch. Bintliff Ditch is a tributary of Brays Bayou which has a trapezoidal shape, 1.5H:1V side slopes, 9-foot depth and 10-foot bottom width, at the project extents. Past the intersection with Fondren Road, the drainage system was modeled for an additional 1,500 feet to an outfall analysis point within Bintliff Ditch. An XP-SWMM model *“Exist.xp”* was created to determine flow within the pipes and resultant WSEL associated with the 2-, and 100-year Atlas 14 rainfall events, shown in **Exhibits 5A-5E –** Existing Condition XP-SWMM Node/Link Diagram. The existing storm sewer trunk was evaluated based upon its ability to convey the design 2-year rainfall. Through the existing condition XP-SWMM analysis, it was determined that the hydraulic gradeline (“HGL”) was able to remain below the gutterline of the existing roadway and therefore the existing storm sewer trunk was adequately sized for 2-year conveyance capacity.

***Additional Model Outfalls* –**

Although the project area drains east of Gessner Road into Bintliff Ditch, there were 2 additional outfalls in the model. A roadway length of approximately 430 feet east of the Harwin Drive and Gessner Road intersection flows west towards Gessner Road, and an additional 230 feet of roadway, west of the intersection, also drain east towards Gessner Road. The respective roadway offsite area also flows towards the Harwin Drive and Gessner Road intersection. The flows converge into a junction and flows into a 5' X 4' box culvert that drains south and acts as an outfall for that system. The final outfall of the model is south of the study area, near the Bellaire Boulevard and Osage Street intersection. The outfall is a 54" culvert that drains into HCFCD Unit# D133-01-00.

SECTION 3 - PROPOSED CONDITION DRAINAGE ANALYSIS

The primary goal of this drainage analysis is to determine proposed drainage infrastructure necessary within the property to adequately convey flow from the improved Harwin Drive project site to the appropriate outfall location.

3.1 Hydrology

In order to incorporate the proposed improvements, the existing condition drainage areas were revised within the extents of the study area to include flows which are contributed to inlets and/or other relevant inflow locations, shown in **Exhibits 6A-6D** – Proposed Condition Drainage Area Map. The existing condition landuse categories were also updated to include the additional impervious cover associated with the modified roadway, shown in **Exhibit 7** – Proposed Landuse. After the proposed drainage area acreage was recalculated and the land use was modified, the updated percent impervious and time of concentration was determined. **Appendix B** shows the proposed condition hydrologic drainage area calculations.

3.2 Hydraulics

The proposed storm sewer system is designed to convey stormwater runoff from the proposed roadway drainage areas and the adjacent offsite areas. The proposed roadway modifications on Harwin Drive include the widening of the road and updating inlet locations and roadway high points. Similar to the existing conditions, a storm sewer system flows east along Harwin Drive into Bintliff Ditch. The culvert diameter, of the storm sewer system that outfalls into the ditch, was modified from an existing 5' X 4' box culvert to a proposed 66" culvert. Bintliff Ditch was not modified in proposed conditions, but a 5' X 4' box culvert was added the northern ROW of the channel. The new culvert conveys flow from the junction of the storm sewers from Harwin Drive and Osage Street and flows east towards Drew Street. The culvert was designed to mitigate WSEL impacts on the upstream project areas adjacent to Harwin Drive. Along Drew Street, a proposed 8' X 5' box culvert travels south, towards Harwin Drive, and intersects with the proposed Bintliff Ditch ROW 5' X 4' box culvert. The storm sewers converge into a 5' X 4' box culvert that outflows directly onto Bintliff Ditch. The existing and proposed conditions have the same model outfalls. Refer to **Exhibits 8A-8E** – Proposed Storm Sewer Node/Link Diagram for the storm sewer layout and dimensions.

The ponding along the roadway was calculated to not exceed the 11-foot width stated in the COH IDM. To reduce the ponding width for inlets that exceeded the allowable 11-foot, additional inlets were added to reduce the flow to a single inlet. Once the inlet locations were verified, the HouStorm computational program was utilized to determine internal 2-year storm sewer sizes within the drainage network. A 100-year frequency Atlas 14 storm event was imposed on the 2-year proposed design and modified where necessary to ensure the critical elevations within the project extents were not exceeded. This was accomplished by increasing the size of the initial 2-year proposed storm sewer for selective reaches. To eliminate potential increased flows and/or increases to water surface elevations along the corridor to the receiving system in the 100-year rainfall event, a detention pond was added to collect and hold part of the runoff during the peak flows. The portion of the storm sewer system, area shown in green on **Exhibit 9** – Proposed Detention Layout, collects and conveys flow to the detention pond. The pond is located approximately 700 feet northwest of the Drew Street and Harwin Drive intersection.

3.3 Mitigation

As a result of the proposed improvements and increase in overall impervious cover, the flow conveyed to the Bintliff Ditch outfall increased an approximate 1 cfs. Along with an increase in outfall flow, there were several locations in the project area which had an increase in WSEL from existing to proposed conditions. As mentioned in Section 3.2, detention was essential for mitigating flow and WSEL impacts for the 100-year storm. The detention was placed on a tract approximately 5.5 acres in size, northwest of the Harwin Drive and Drew Street intersection, but south of the Westpark Tollway, shown in **Exhibit 9**. In proposed conditions, an 8' X 5' box culvert storm sewer was added along Drew Street to allow runoff to backflow north, into the detention pond. Once the flow in the storm sewer trunk begins to recede, the water in the culvert would begin to drain south again, towards the proposed Bintliff Ditch ROW 5' X 4' box culvert. The system would then discharge into Bintliff Ditch. **Table 2** summarizes the outfall flows between the proposed conditions without mitigation, proposed conditions with mitigation and existing conditions.

Table 2 - Outfall Flow Comparison

	Existing Condition		Proposed Conditions Without Mitigation		Proposed Conditions With Mitigation	
Outfall	2-year (cfs)	100-year (cfs)	2-year (cfs)	100-year (cfs)	2-year (cfs)	100-year (cfs)
Bintliff Ditch	304	495	304	496	251	475
Gessner Road	85	129	57	122	57	122
D133-01-00	142	216	142	216	142	216

The detention pond was designed to have a 30-foot maintenance berm and have 3H:1V side slopes. The elevation of the top of the pond was set to an average terrain elevation of 66.8 feet and a depth of 10.5 feet. Based on the 2022 Harwin Drive Reconstruction Geotechnical Engineering Study, the Slope Stability analyses concluded that a proposed pond with the mentioned geometry meets the minimum requirements for factors of safety against slope failures for short term, rapid drawdown and long-term conditions. It was also determined that a 30-foot maintenance berm was feasible if the proposed pond parcel included an additional 43 feet south of the boundary. The additional area includes an existing road that connect Osage Street and Fondren Road. **Appendix C** shows the proposed detention pond stage-storage values. The slope for the inflow/outflow culvert was designed at 0.033 ft/ft, and the slope for the Bintliff Ditch ROW 5' X 4' box culvert was designed at 0.1 ft/ft which were higher than the minimum allowed slope for the respective box culvert size. The designed starting box culvert elevation and slope inclination allowed for a pond depth capacity of 10.5 feet.

The maximum WSEL in the detention pond, for the 100-year storm, is 64.4 feet, which would allow for approximately 2.4 feet of freeboard. The maximum volume of the detention pond is

25.9 ac-ft and approximately 17 ac-ft were utilized for the proposed 100-year storm. It should be noted that although there is additional freeboard remaining in the pond, the remaining available volume cannot be utilized for further mitigation. Further increases in volume to the pond will result in adverse water surface elevation impacts along Harwin Drive. As per City of Houston drainage criteria, the runoff is maintained at or below the gutterline elevation during the 2-year storm and ponding remains within ROW during the 100-year rainfall event. It was also verified that the WSEL was not increased for the sites next to the roadway, that contribute flow towards Harwin Drive. **Table 3** provides a summary of offsite drainage area WSEL comparisons between the existing and proposed conditions. A copy of the output files for all XP-SWMM models is also included in **Appendix C** of this report.

Table 3 – Offsite Drainage Areas Water Surface Elevation Comparison

Offsite Drainage Areas	Existing WSEL (ft)	Proposed WSEL Without Mitigation (ft)	Proposed WSEL With Mitigation (ft)	WSEL Difference (Proposed-Existing, ft)
G9	68.9	68.5	68.46	-0.4
G5	69.3	68.5	68.51	-0.8
A47	69.6	69.2	69.57	0.0
A43	69.3	69.0	69.17	-0.1
A40	69.3	69.3	69.32	0.0
A42	69.4	69.1	69.38	0.0
A36	69.3	69.3	69.27	0.0
A39	68.8	68.6	68.75	0.0
A35	68.5	68.5	68.47	0.0
A33	70.1	70.1	70.07	0.0
A34	68.1	68.2	68.07	0.0
A29	68.9	69.0	68.86	-0.1
A30	68.4	68.2	68.34	0.0
A26	68.0	68.0	68.00	0.0
A25	68.3	68.3	68.26	0.0
A24	67.2	67.5	67.13	0.0
A19	67.7	68.0	67.50	-0.2
A14	67.4	67.5	67.27	-0.1
A15	67.9	67.0	67.82	-0.1
A5	66.0	66.4	65.64	-0.4
M40B	66.2	66.2	66.14	0.0
M40	66.5	66.5	66.47	-0.1
M34	66.4	66.4	66.17	-0.3
MHB1	64.6	64.6	64.56	0.0
M43	64.5	64.5	64.40	-0.1
A49	69.2	68.9	68.92	-0.3
A48	69.2	68.9	68.90	-0.3
M40A	65.1	65.3	64.69	-0.4

SECTION 4 - CONCLUSIONS AND RECOMMENDATIONS

The primary goal of this drainage analysis was to examine and understand the existing drainage patterns associated with Harwin Drive, between the intersection with Gessner and Fondren Road, in preparation for future road improvements.

After analyzing drainage associated with the proposed development, we have determined:

- In proposed conditions, the storm sewer along Harwin Road will be replaced with a trunk adequately sized to increase conveyance along the roadway.
- Without detention and the Bintliff Ditch ROW 5' X 4' box culvert, there would be WSEL and flow impacts along Harwin Road and the outfalls.
- In order to mitigate impacts, 17 ac-ft of detention is required.

Based upon the recommended drainage improvements, it has been determined that this proposed project will cause no adverse impact to flood hazard conditions on the receiving waterways, including downstream properties within the City of Houston, for storm events up to and including the Atlas-14 100-year storm event.

Harwin Drive from Gessner to Fondren

Proposed Reconstruction & Access Management

Evaluation of Existing Condition & Recommended Improvements

CobbFendley

Key Staff

CobbFendley

- Mahmoud Salehi, P.E. – Principal in Charge
- Evan Shields, P.E. – Paving & Drainage Design/Project Manager
- Brian Castille, P.E., PTOE – Traffic Engineering Lead
- Carl Ahrendt, P.E. ENV. SP – H&H Specialist

Purpose & Need

The (purpose) of this Pre-Engineering study is to analyze the existing condition of the Harwin Drive roadway, associated utilities, and access management within the study area and provide recommendations to improve its overall safety and operations. This effort is coordinated with the COH staff and documented in the DCR to obtain an approval to move forward with preparation of detailed engineering design.

It is the desire (need) of the Southwest Houston Redevelopment Authority / TIRZ #20 to fund the reconstruction of this project that will improve traffic operations, safety, pedestrian accommodations, pavement drivability, drainage and aesthetics along this segment of Harwin Drive.

Project Background

- Cobb, Fendley & Associates, Inc. was retained by Southwest Houston Redevelopment Authority / TIRZ #20 to conduct a viability study to improve a segment of Harwin Drive from east of the Gessner intersection to west of the Fondren intersection. Harwin Drive Annexed by TIRZ 20 in 2015.

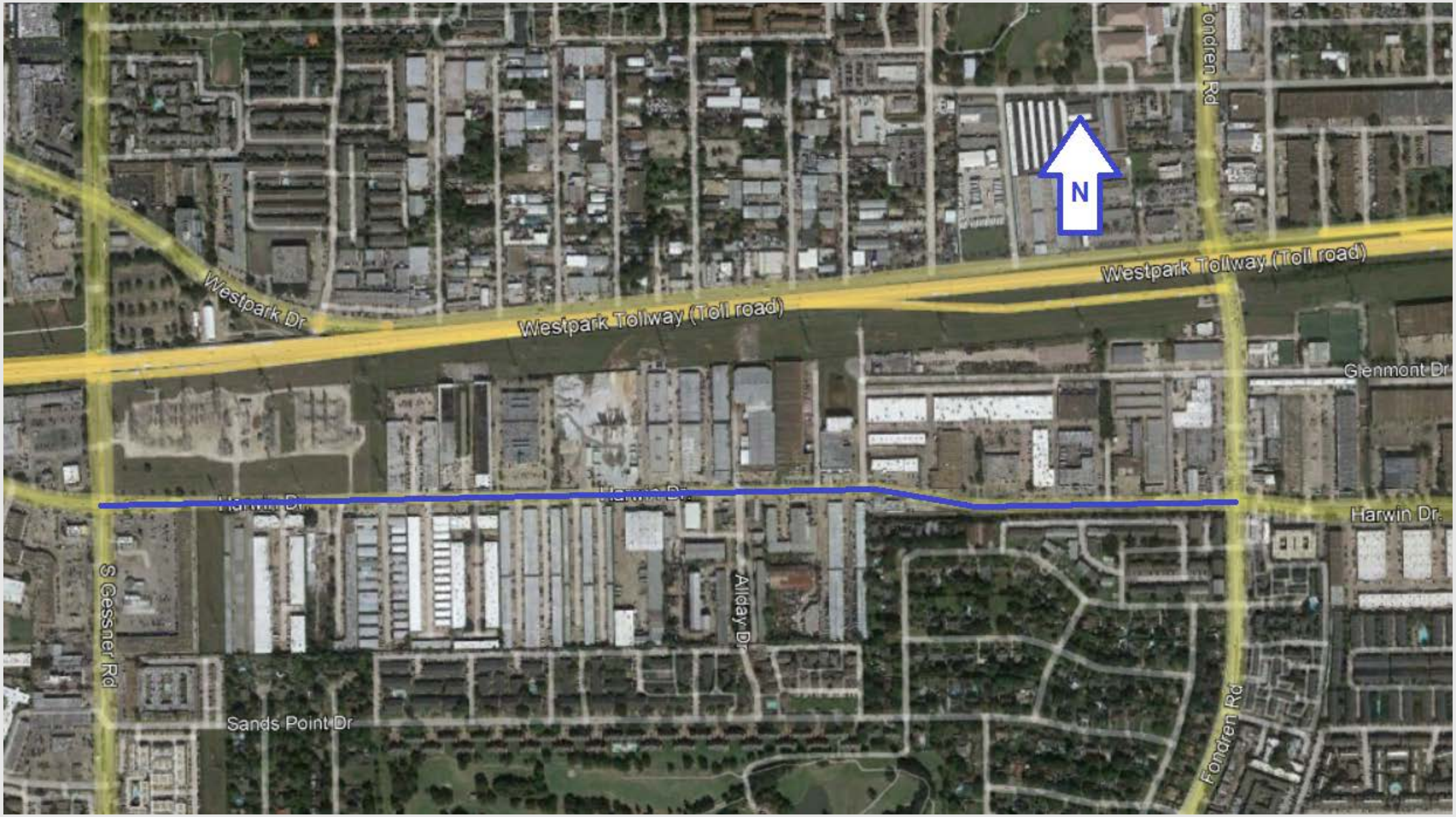
- The Harwin & Fondren intersection and approaches constructed in late 2016 as part of the Fondren reconstruction from US 59 to Westpark tollway. The Harwin & Gessner intersection and approaches is currently under construction and anticipated to be open to traffic in Spring 2023. CobbFendley was the design engineer for Both projects.

- The purpose of this viability study is to evaluate the existing condition of pavement, drainage & utility infrastructure in addition to pedestrian and vehicular safety, mobility, and access management along the roadway within the study area and provide recommendations to improve overall safety and operations.

- CobbFendley staff have conducted several meetings and coordinated its efforts with the City of Houston Traffic Engineering section in which comments are being addressed.

- The DCR Intake Form for the project was submitted on November 17, 2021.

Site Map of Study Area

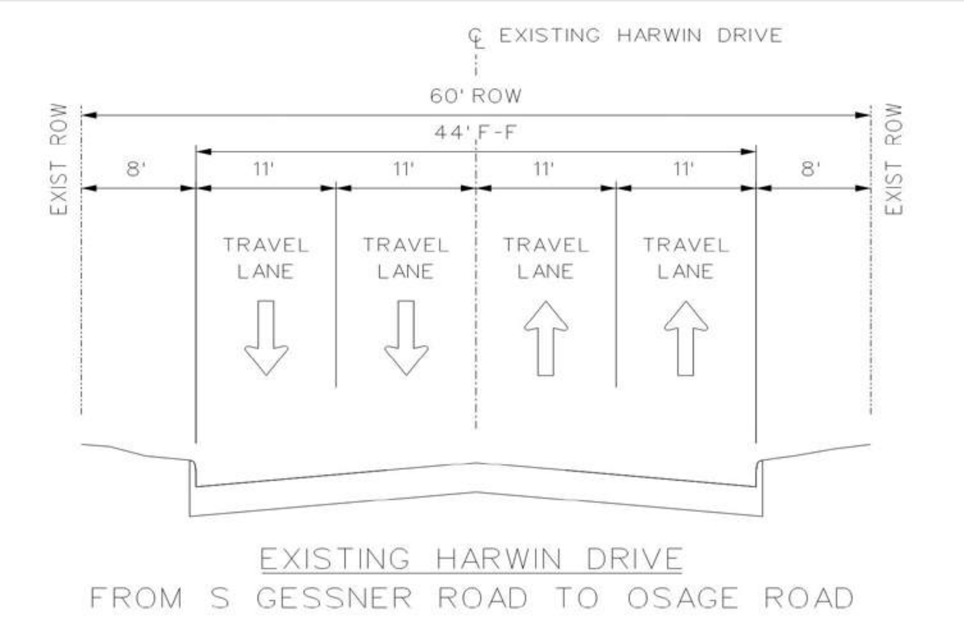


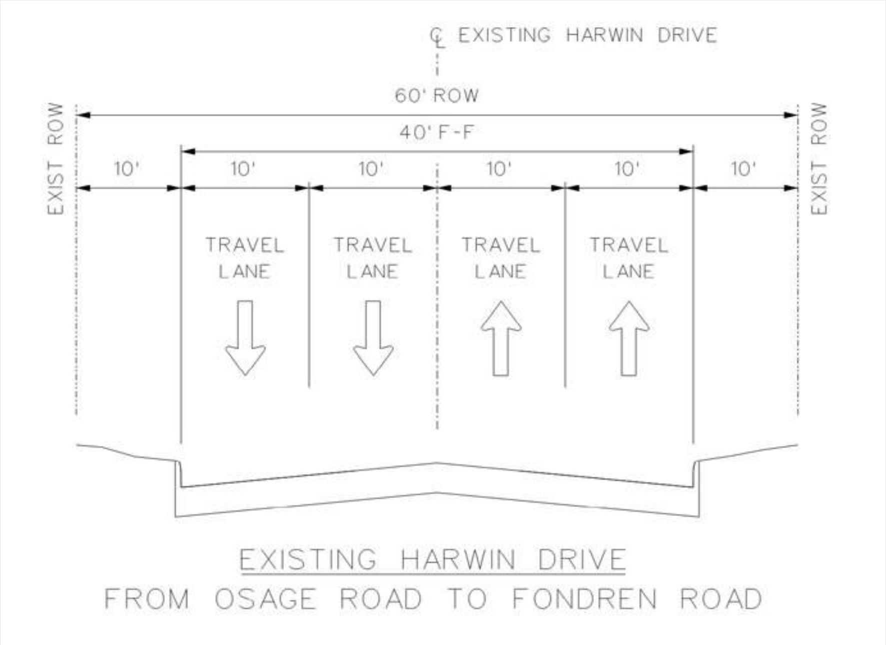
Existing Conditions

Harwin Drive

- Study area land use is predominantly retail shopping centers and store fronts commercial corridor.
- 4-lane undivided concrete with curb & gutter roadway and storm sewer system
- Pavement width are 40-ft F-F and 44-ft F-F constructed in the early 1970's
- Existing ROW is 60-ft wide with no building setbacks.
- The posted speed limit is 35 mph and there are no turn bays to provide safe access to the businesses along the corridor.
- METRO bus stops are present along this segment of Harwin Drive.
- 1 (one) traffic signal at Allday intersection (aging span wire)
- General pavement condition is rough, PCI <70
- Pavement markings are generally faded and inconsistent
- Pedestrian curb ramps generally not very accommodating and are not ADA compliant
- 4' sidewalks (generally) all around
- Utilities observed in the area:
    - Communication
    - Sanitary sewer
    - Street lighting
    - Water
    - Gas
    - Overhead power

Existing Typical Sections - Harwin Drive





Houston Vision Zero

HIGH INJURY NETWORK

The High Injury Network represents 60% of traffic deaths and serious injuries occurring on 6% of Houston streets. This subset of streets helps the City and its partners identify solutions to prevent future severe crashes.

The segment of Harwin Drive between Gessner Road and Fondren Road is identified as part of the **HIGH INJURY NETWORK**.

2021 Traffic Volumes

Recent 24-hour traffic counts were conducted along each end of the project limits for a weekday and a weekend. Based on this data, the ADT calculates out as 19,660 ADT (weekday) and 19,630 ADT (weekend).

Driveway Density

In looking at the project limits, west of channel the channel there are 38 driveways on south side and 20 on north side. From east of CNP to the channel, there are 25 driveways on the south side and 18 on the north side or 43 driveways in only 2,900 feet. That is a driveway every 70 feet.

Many driveways do not line up and are offset. This is very high driveway density and most likely a raised median project would not work on this stretch without upsetting many business owners.

3-Lane Section Assessment

Per FHWA, an ADT in the 15,000 to 20,000 range is a good candidate for a “road diet”. In this case, the roadway would be converted from a 4-lane undivided section to a 3-lane section with two-way left turn lane (TWLTL).

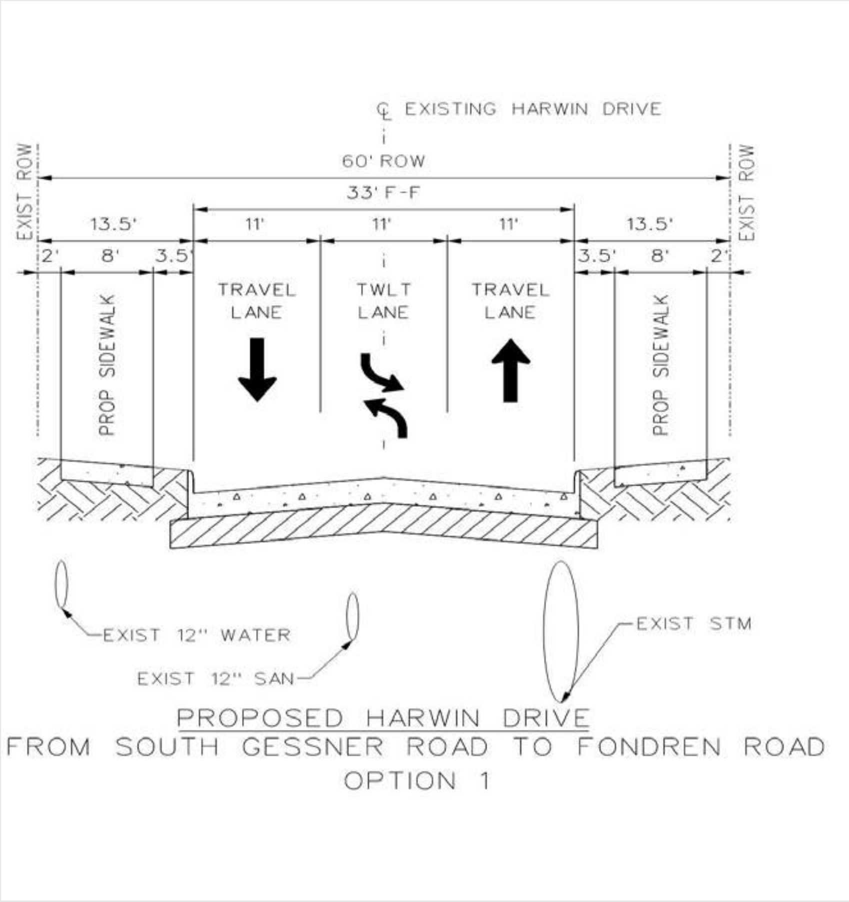
Due to the driveway density, the two inside lanes currently operate mainly as left turn lanes and the outside lanes are the only lanes that move consistently. The intersections at Gessner and Fondren will not change lane configuration so it would only be in between those intersections that would be adjusted.

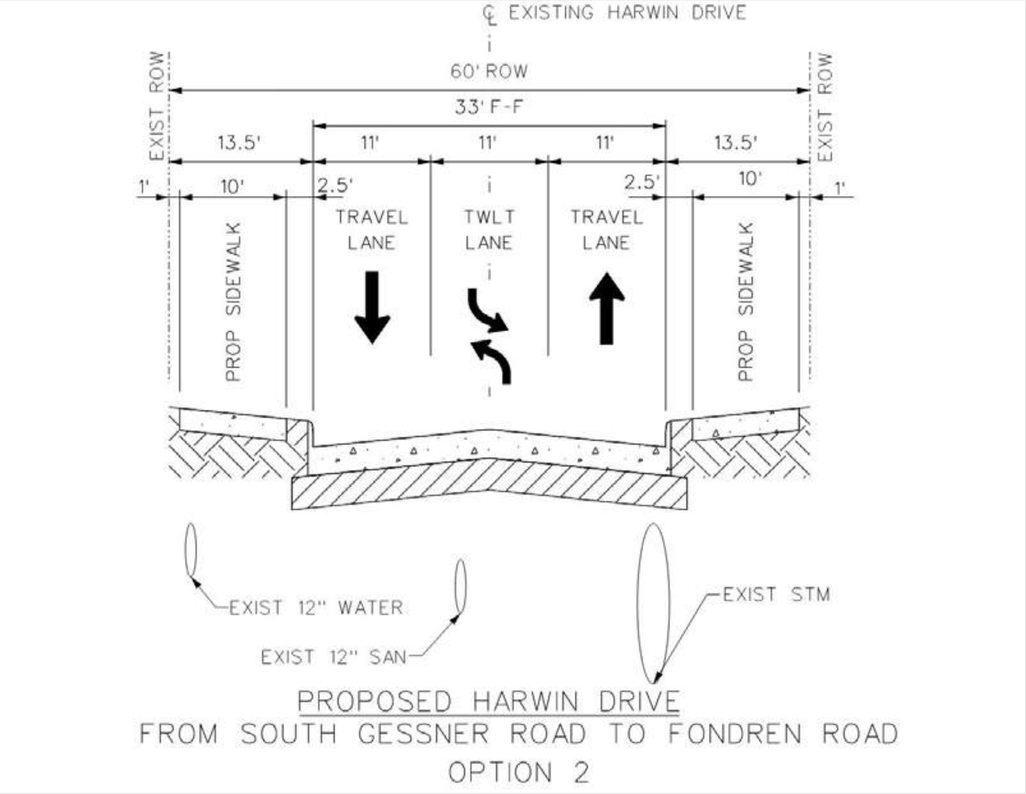
Proposed Harwin Drive Improvements

The proposed Harwin Drive Reconstruction features will include but not limited to:

- Reconstruction of Pavement to 3 Lanes configuration to include 1 (one) 11-ft Travel Lane in each direction and a Two-way center turn lane (2WCTL), and
- Installation of walkability Realm Option (1) - 8’ wide sidewalk results in 3.5’ buffer between the outside lane & edge of sidewalk with 2’ from ROW to edge of sidewalk
- Installation of walkability Realm Option (2) - 10’ wide sidewalk results in 2.5’ buffer between the travel lane & edge of sidewalk with 1’ from ROW to edge of sidewalk
- Providing access management
- Reconstruction of an 8” AC WM & evaluate existing 12” WM for potential rehabilitation
- Reconstruction of existing 12” gravity sanitary sewer within the project limits
- Reconstruction of existing storm sewer conveyance to the current IDM criteria
- Analyze the existing drainage and provide adequate storm conveyance and necessary drainage mitigation to avoid structural flooding
- Reconstruction of existing traffic signal at Allday intersection
- Providing street lighting
- Providing aesthetics
- Coordination with METRO for improved bus stops

Proposed Typical Sections - Harwin Drive





SOUTHWEST HOUSTON REDEVELOPMENT AUTHORITY

Tax Increment Reinvestment Zone No. 20

Harwin Drive Reconstruction Viability Drainage Study

CobbFendley Project No. 1711-015-00

January 2018

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

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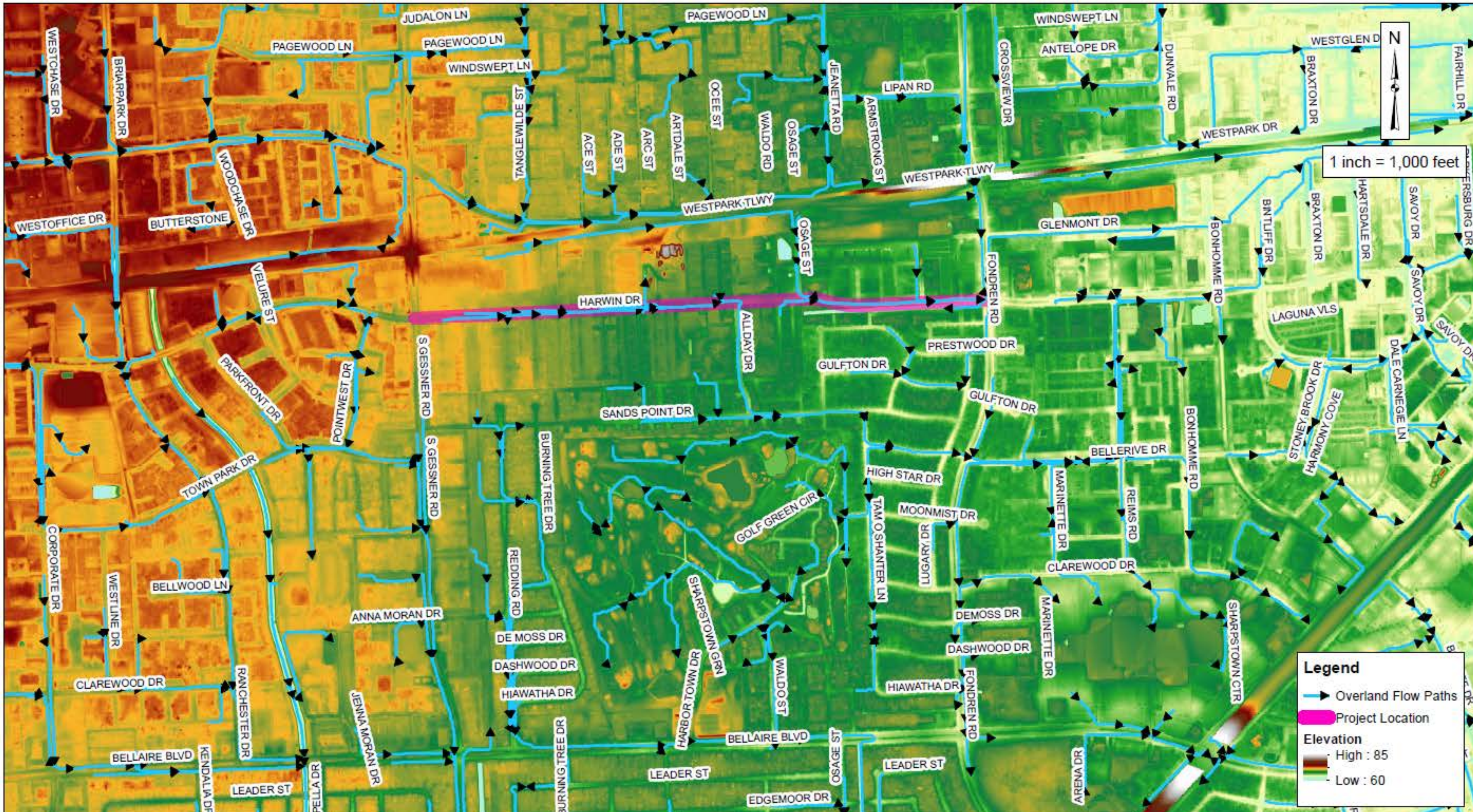

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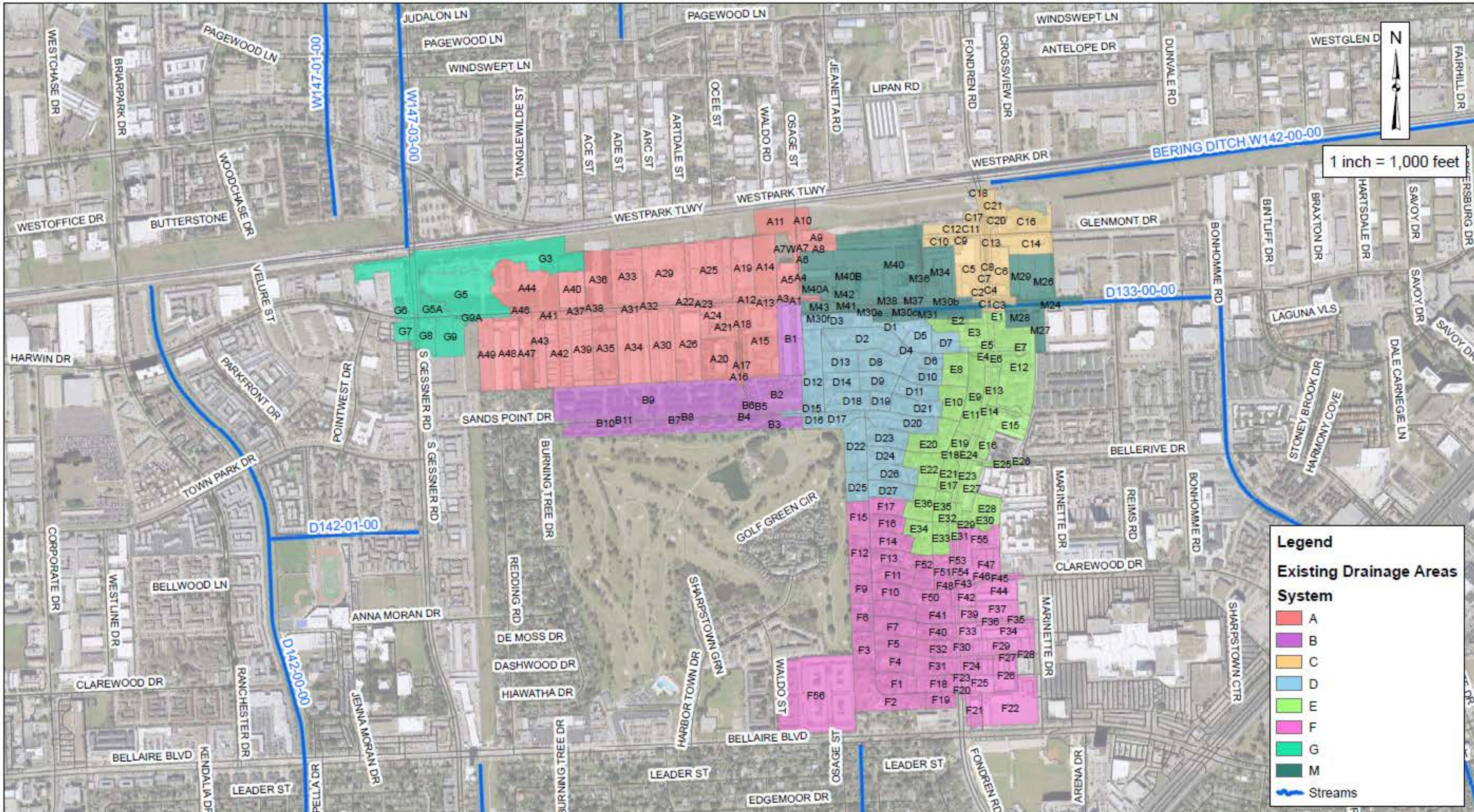
Harwin Drive Reconstruction
Overland Flow Map

Date: January 2018 | Exhibit 4



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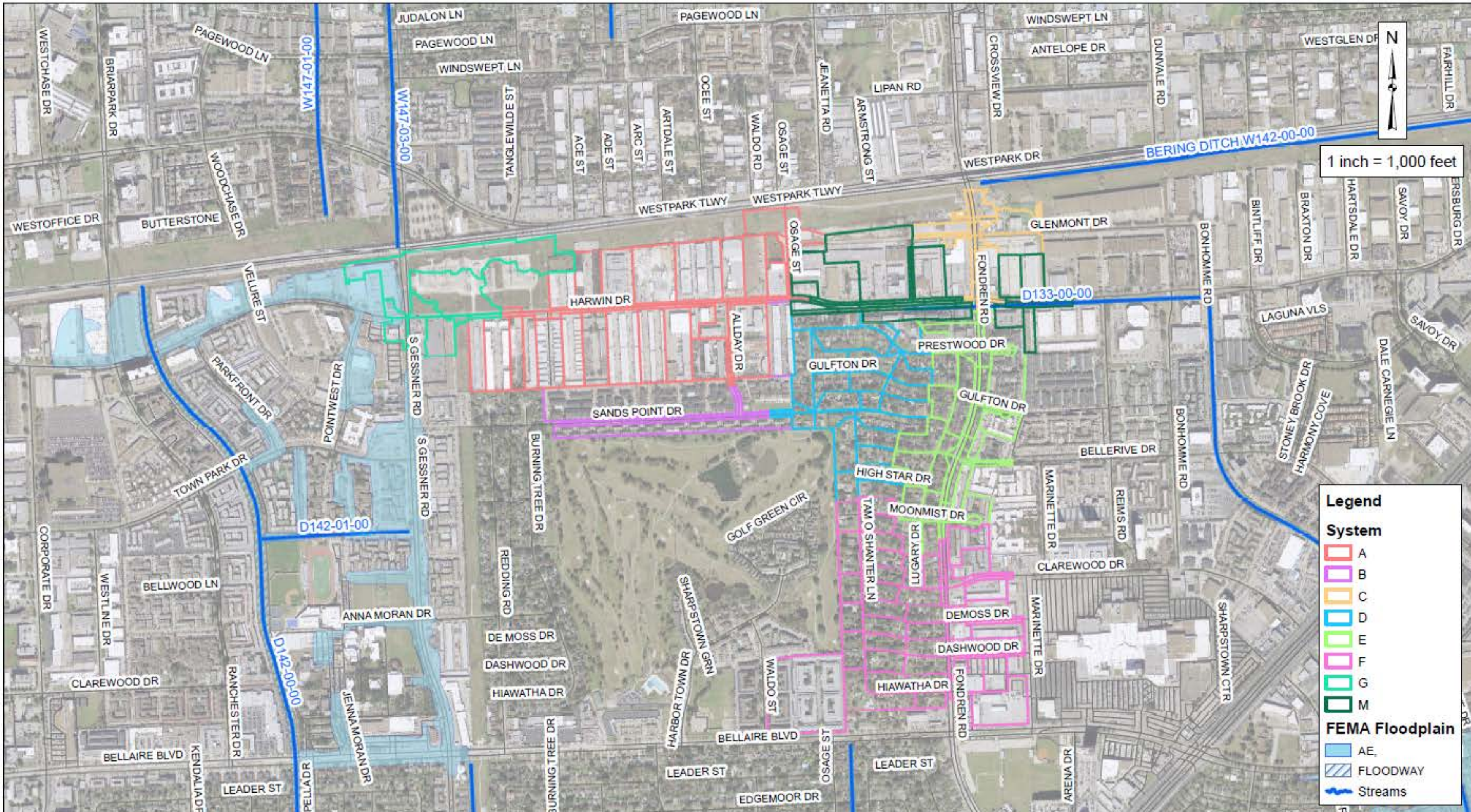
Harwin Drive Reconstruction
Existing Drainage Area Map

Date: January 2018	Exhibit 3



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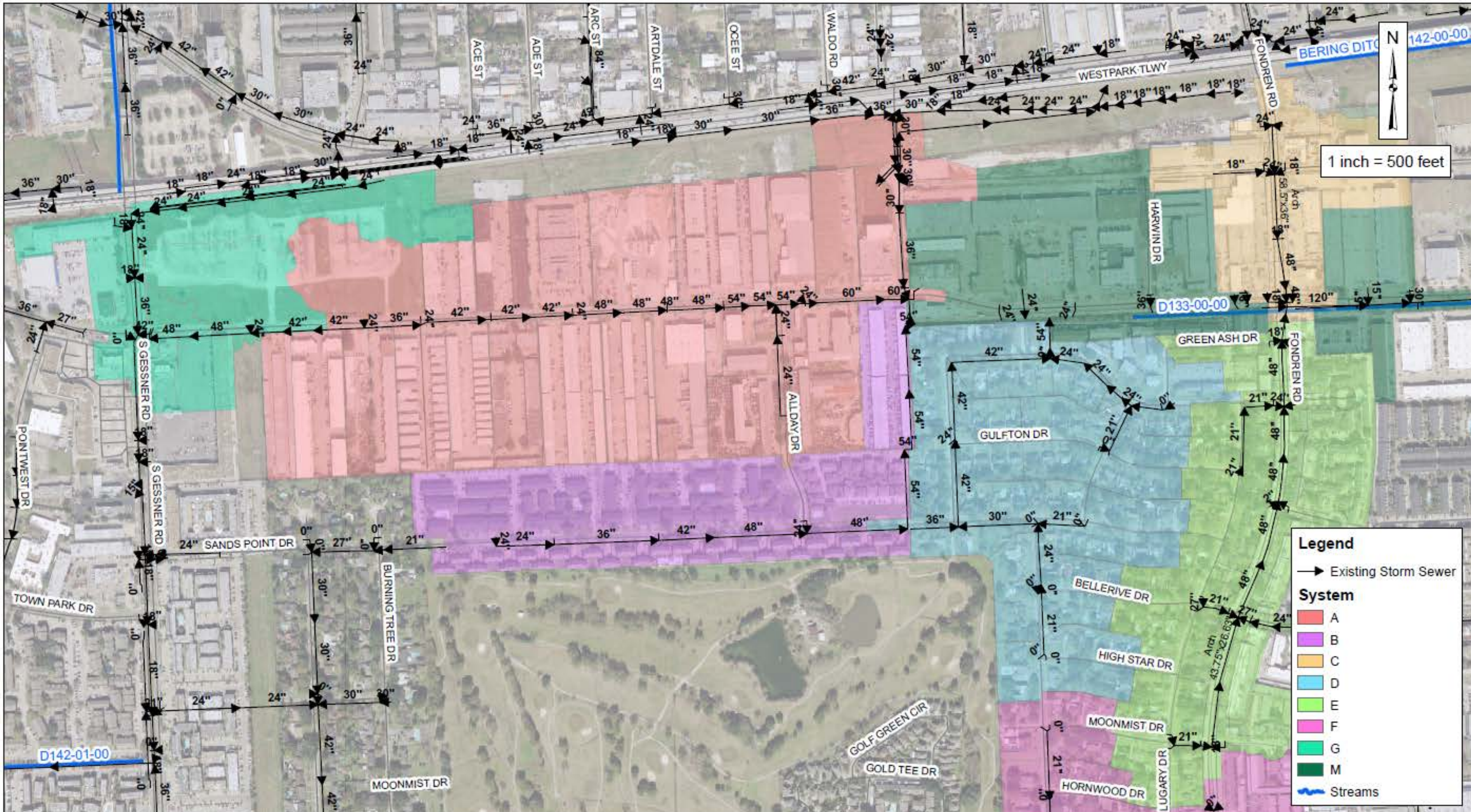
Harwin Drive Reconstruction
FEMA Floodplain Map

Date: January 2018	Exhibit 5



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Harwin Drive Reconstruction
Existing Storm Sewer Layout

Date: January 2018	Exhibit 6

Recommendations

Based on the existing field conditions and recently collected traffic volumes, it is recommended to reconstruct the Harwin Drive from Gessner to Fondren with proposed 3-Lane configuration in addition to modernization of the existing traffic signal at the Allday intersection. This would allow for improved vehicular operations and enhance pedestrian accommodations to ADA standards within the project limits. It is also recommended to consider access management changes within the study area.

However, it should be noted due to the limited & available existing 60-ft ROW, it may not be feasible to meet the desirable values for pedestrian realm, drainage and bicycle criteria set forth in the IDM.

Conclusion and Recommendations

The intent of this project is to improve upon and upgrade what is existing today. While it may not meet all minimum requirements as specified in the IDM, it will substantially enhance & improve:

- Vehicular operations & safety
- Pedestrian safety & ADA accessibility
- Pavement structure
- Drainage conveyance & flood mitigation
- Egress & ingress access management
- an aging span wire traffic signal at Allday intersection

The goal of the study is to determine requirements for pedestrian realm & drainage criteria prior to moving to the preliminary engineering phase of the project and ultimately design and construction.

Planning Level Cost Estimate

Based on Year 2020 construction prices and trends in the industry, a planning level cost estimate was developed in order to give an idea on the order of magnitude approximate construction costs.

For the reconstruction including the off-site drainage mitigation, the planning level cost estimate developed is a total of approximately $20 M.

Note: 30% contingency applied and actual construction costs could be higher or lower than the planning level cost estimate due to changes in the industry

Goals for Today's Meeting:

- **Discuss the concepts presented.**
- **Gain feedback / comments on any adjustments that are desired for any component of the project.**

What is next?

- **Gain City of Houston concurrence with our findings & Recommendations.**
- **Upon approval of the project DCR, a preliminary engineering report (PER) would be developed.**
- **Ultimately, the goal is to have an approved PER, move forward to an approved set of design plans and construct the proposed improvements.**

Questions / Comments?

Appendix A

Harwin Dr Reconstruction Project

Benefit/Cost Analysis

Completed for:

Southwest Houston TIRZ

February 2022

Completed by:

THE **GOODMAN** CORPORATION

Contents

Tables

Equations

Executive Summary

The 2021 USDOT BCA Guidance for Discretionary Grant Programs provides the foundation for the methodologies used to estimate the quantified and subsequent monetized benefits in this BCA.[1] The evaluation process examines the fundamental question of whether the expected societal benefits of the project justify the cost with the understanding that some benefits and costs are difficult to quantify. This analysis examines how the "No-Build" and "Build" Scenarios improve the societal benefits throughout the planning horizon.

The BCA quantifies the net difference between the "No-Build" and "Build" Scenarios for the project corridor. The Harwin Drive Reconstruction Project (Project)'s limits are from about 100 feet from Fondren Dr to 100 feet from Gessner Rd.

The **No-Build Scenario** assumes that the roadway will continue to deteriorate and be minimally maintained throughout the planning horizon, 20 years from opening year 2025.

The **Build Scenario** assumes a replacement of infrastructure within public ROW along the project limits, which will include the following major components:

- Reconstruction of Pavement to 3 Lanes configuration to include 1 (one) 11-ft travel lane in each direction and a two-way center turn lane (2WCTL), and
- Installation of walkability Realm Option (1) - 8' wide sidewalk results in 3.5' buffer between the outside lane & edge of sidewalk with 2' from ROW to edge of sidewalk
- Installation of walkability Realm Option (2) - 10' wide sidewalk results in 2.5' buffer between the travel lane & edge of sidewalk with 1' from ROW to edge of sidewalk
- Providing access management
- Reconstruction of an 8" AC WM & evaluate existing 12" WM for potential rehabilitation
- Reconstruction of existing 12" gravity sanitary sewer within the project limits
- Reconstruction of existing storm sewer conveyance to the current IDM criteria
- Analyze the existing drainage and provide adequate storm conveyance and necessary
- Drainage mitigation to avoid structural flooding
- Reconstruction of existing traffic signal at Allday intersection
- Providing street lighting
- Coordination with METRO for improved bus stops

[1] U.S. Department of Transportation. Benefit-Cost Analysis Resource Guide, 2021. Retrieved April 2021 from https://www.transportation.gov/sites/dot.gov/files/2021-02/Benefit%20Cost%20Analysis%20Guidance%202021.pdf

Summarized Planning, Design, Environmental, ROW and Capital Costs

The costs (excluding ongoing maintenance; found in the SOGR section of this technical memorandum) for the Project in year of expenditure, or nominal dollars, is $21,663,000. The annual inflation factor of 2.27% that was applied to the projected costs (nominal $) was discounted from the year of expenditure to reflect the real $ in year 2019. The 2.27% inflation factor is derived from inflation adjustment values found in Table A-7 in the 2021 USDOT BCA Resource Guide. The total project cost in 2019 real dollars is $19,471,000. These costs are discounted 7% from the expenditure year to year 2019. The total year 2019 real discounted costs are $14,187,000. Project planning, environmental, ROW and capital costs are described in the following table.

Project Planning, Design, Environmental, and Capital Costs			
Scenario	Nominal $ Year of Expenditure No Discount	Real $ $2019 No Discount	7% Discount $2019
Planning	$25,000	$24,000	$21,000
Design/Environmental/ROW	$4,219,000	$3,901,000	$3,081,000
Construction	$17,389,000	$15,546,000	$11,084,000
Project Capital Costs	**$21,633,000**	**$19,471,000**	**$14,187,000**

Table ES1. Project Design, Environmental, and Capital Costs

Summarized Benefits

The proposed Project will provide a variety of societal benefits to the national, state, and local transportation system.

The **No-Build Scenario** will result in the following:

- The Corridor will likely remain **unsafe**. The failing infrastructure and pedestrian crossing barriers make the project corridor unsafe for all users. Failing pavement, dark streets, and the lack of center turn lane create unsafe conditions and increase potential conflict points in the roadway segment for motorists. Some pedestrian facilities are not meeting current City of Houston (COH) design standards, which create unsafe pedestrian environments.

- The Corridor will continue to be in **disrepair**. The roadway is composed of a concrete surface that is in not a good state of repair. The pavement condition scores less than 70. Pavement markings are generally faded and inconsistent. The defects progress in severity throughout the corridor.

- **Alternative modes are fully not supported** nor will be in the future no build scenario. Pedestrian curb ramps generally not very accommodating and are not ADA compliant. The sidewalks are only 4' foot throughout the corridor.

- Existing infrastructure **does not support economic growth**. The Project area is predominantly retail, shopping centers, and store fronts along the commercial corridor. Current transportation infrastructure does not support the integration of all modes at the level of activity demonstrated today, let alone in the future.

Moving forward with the **Build Scenario** will result in 11 monetized societal benefits and one local economic benefit:

Benefits Monetized – Transportation

- Benefit 1: Remaining Useful Life of Asset
  - The asset will be built with a useful life of 50 years, therefore there will be 60% remaining useful life at the end of the 20-year planning horizon.
- Benefit 2: State of Good Repair (SOGR)
  - The Project will significantly reduce vehicle wear and tear and on-going maintenance costs and reduce life cycle maintenance cost.
- Benefit 3: Roadway Safety Improvements
  - The Project will experience significant safety improvements and as a result, reduce roadway related crashes by 24% to 50% depending on the crash type.
- Benefit 4: Pedestrian Safety Improvements
  - The Project will experience significant pedestrian safety improvements and as a result, reduce pedestrian related injuries by 65%.
- Benefit 5: Health Benefit - Sidewalk
  - The Project will include a safe sidewalk for users and therefore encourage active transportation, resulting in measurable health benefits to society.
- Benefit 6: Auto Benefit – Sidewalk
  - The Project will include a safe sidewalk for users and therefore encourage active transportation, which reduces automobile usage.

- Benefit 7: Auto Benefit – Transit
  - The Project will improve the connectivity to existing transit amenities for users and therefore encourage transit usage, which reduces automobile usage.
- Benefit 8: Environmental Benefit – Sidewalk
  - The Project will include a safe sidewalk for users and therefore encourage active transportation, which reduces automobile usage and results in fewer environmental emissions.
- Benefit 9: Environmental Benefit – Transit
  - The Project will improve the connectivity to existing transit amenities for users and therefore encourage transit usage, which reduces automobile usage and results in fewer environmental emissions.

Benefits Monetized but Not Widely Accepted in Transportation Grant Applications – Local Economic

- Sidewalk Economic Benefit.
  - The Project will include safe sidewalks, which can increase the property values of residential and commercial properties

Each benefit's baseline (No-Build) and Build methodology and calculations are contained within this technical memorandum, supported by the BCA Excel Workbook. The benefit-cost ratio is 4.1 in 2019 real dollars and when discounted at a 7% discount rate, the benefit-cost ratio is 2.4. The 2019 real dollar NPV is $60,278,000 and when discounted at 7%, $19,690,000.

BCA Summary		
Scenario	$2019 Real Dollars No Discount	$2019 Real Dollars 7% Discount
Benefits	$79,749,000	$33,877,000
Costs	$19,471,000	$14,187,000
BCA	**4.1**	**2.4**
NPV	$60,278,000	$19,690,000

Table ES2. BCA Summary

The following table presents a high-level summary of the BCA.

Harwin Dr Reconstruction Project Benefits Summary					
Benefit	Current Status/Baseline and Problem to be Addressed	Change to Baseline or Alternatives	Types of Impacts	$2019 Monetized Benefit	7% Discount Rate
Benefit 1: Useful Life	The current asset has 0% remaining useful life	Replace infrastructures within public ROW	Extend useful life	$9,328,000	$1,606,000
Benefit 2: SOGR	Ongoing expensive maintenance	No to little maintenance required of new facility through the planning horizon	Maintenance cost savings	$8,944,000	$5,191,000
Benefits 3 and 4: Safety Benefits	Outdated design, disproportionally higher crash rates	Significant safety improvement resulting in 24% to 50% reduction in certain types of vehicle crashes, and 65% reduction in pedestrian crashes.	Reduced crashes resulting in reduced fatalities and injuries	$58,754,000	$26,142,000
Benefit 5: Health Benefit	Existing condition is not conducive for walking, therefore limiting the demand for additional active transportation users.	New updated, safe sidewalks will induce pedestrian demand	Health benefits derived from exercise	$2,200,000	$723,000
Benefits 6 and 7: Automobile Maintenance Benefits	Roadway is not conducive for walking. Connection to transit amenities is lacking. Therefore, limits the demand for additional pedestrian and transit users	Sidewalks will induce pedestrian demand, and transit demand	Reduced auto cost benefits derived from modal shift from auto to walk and transit	$390,000	$136,000
Benefits 8 and 9: Environmental Benefits	Roadway is not conducive for walking. Connection to transit amenities is lacking. Therefore, limits the demand for additional pedestrian and transit users	Sidewalks will induce pedestrian demand, and transit demand	Reduced auto cost benefits derived from modal shift from auto to walk and transit	$133,000	$79,000
			Totals	**$79,749,000**	**$33,877,000**

Table ES3. Harwin Dr Reconstruction Benefits Summary

Foundations to Benefit/Cost Analysis

The following methodologies and/or general assumptions are used throughout quantification of the benefits and the cost benefit analysis for the Project.

Real Dollars & Discount Rate

All monetized values in both benefit and cost equations within the analysis have been converted to a base year (real dollars) of 2019. Cost elements that were expended or derived from cost estimates in prior years where inflated using the inflation adjustment values found in Table A-7 in the 2021 USDOT BCA Guidance for Discretionary Grant Programs.[2]

The OMB Circular A-94 provides guidance on discount rates. As a default position, OMB Circular A-94 states that a discount rate of 7% should be used as a base-case for regulatory analysis. The 7% rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy. It is a broad measure that reflects the returns to real estate and small business capital as well as corporate capital. A 7% discount rate was applied to all $2019 real dollar monetized costs and benefits.

PLANNING, DESIGN, ENVIRONMENTAL AND CAPITAL COSTS

The costs (excluding ongoing maintenance; found in the SOGR section of this technical memorandum) for the Project in year of expenditure, or nominal dollars, is $21,663,000. The annual inflation factor of 2.27% that was applied to the projected costs (nominal $) was discounted from the year of expenditure to reflect the real $ in year 2019. The 2.27% inflation factor is derived from inflation adjustment values found in Table A-7 in the 2021 USDOT BCA Resource Guide. The total project cost in 2019 real dollars is $19,471,000. These costs are discounted 7% from the expenditure year to year 2019. The total year 2019 real discounted costs are $14,187,000. (See Table ES1. Project Design, Environmental, and Capital Costs).

Planning Horizon

The analysis period for the Project is 20 years from opening year 2025 and the discounted at 7% to 2019 dollars. The 20-year planning horizon is from 2025 to 2045.

No-Build

The No-Build Scenario assumes that roadway improvements will only consist of replacement of any concrete panels that significantly deteriorate over time. There are minimal planned improvements to sidewalks or the creation of bike lanes within the No-Build Scenario.

Build

The Build Scenario assumes that roadway will be fully reconstructed to a to 3 Lanes configuration to include 1 (one) 11-ft travel lane in each direction and a two-way center turn lane (2WCTL) with a 8’ to 10’ sidewalk.

[2] U.S. Department of Transportation. Benefit-Cost Analysis Guidance for Discretionary Grant Programs, 2021. Retrieved April 2021 from https://www.transportation.gov/sites/dot.gov/files/2021-02/Benefit%20Cost%20Analysis%20Guidance%202021.pdf

Benefit 1: Remaining Useful Life of Asset

No-Build Scenario

The COH would continue to repair the Project throughout the planning horizon.

Build Scenario

The Project will be designed and built for a useful life of 50 years.[3]

Methodology/Summary

The residual life benefit assumes there will be 60% of the Project life remaining at the end of the planning horizon. The residual life benefit only captures 60% of the construction cost of the Project. Using the formula below, the remaining useful life for the Project is calculated.

Equation 1. Useful Life Methodology

Useful Life = Construction Costs * 60%

Accumulated benefits for the 20-year horizon are quantified and discounted at a 7% rate, shown in the table below.

Useful Life Benefit	
Scenario	**Monetized Value**
No-Build	$0
Build	$9,328,000
Net Benefit	$0
Net Benefit Discounted @ 7% to $2019	**$1,606,000**

Table 1. Useful Life Benefit

[3] City of Houston Public Works Infrastructure Design Manual. 2018

Benefit 2: State of Good Repair

Maintenance and user costs associated with the condition of a roadway's surface are significant factors in the decision to continue with the current pavement or replace it with a new one. The capital expenditure required for a reconstruction project may make economic sense if it saves money over the planning horizon. Demonstrating a roadway's current surface condition, or State of Good Repair, and projecting the costs and benefits for alternative maintenance strategies will provide the information needed to make this decision.

No-Build Scenario

Continue maintenance strategy through remaining life of facility.

Build Scenario

The current facility will be replaced with jointed concrete pavement with a 50-year useful life.

Methodology/Summary

This section summarizes the methodology and results of this analysis.

Life Cycle Cost Analysis (LCCA) Methodology

The evaluation for SOGR uses a LCCA model adapted to the scope of this project to determine the more cost-effective of the No-Build and Build Scenarios. [4] The primary purpose of this method is to compare the costs of reconstruction to those of continued maintenance of the existing roadway surface. The focus of the analysis is pavement condition and does not include costs associated with drainage, traffic management, or other non-vehicular support facilities. The analyzed costs include agency costs due to reconstruction or repair, user costs due to construction zone time delays, and operation and upkeep of vehicles used on the roadway throughout its life cycle. The life cycle for concrete pavement is assumed to be 50 years.[5]

The key assumption is that if the proposed Project is not implemented (the No-Build Scenario), COH will follow a maintenance strategy that includes annual routine maintenance and periodic rehabilitation for the roadway. Conversely, the Build Scenario, in which the roadways are rebuilt and thus are brand new, would result in no maintenance or rehabilitation requirements within the planning horizon. The scope of this study consists of the Project limits. The key roadway characteristics related to the analysis are summarized below:

The key assumption is that if the proposed project is not implemented, the No-Build Scenario, COH and Harris County will follow a maintenance strategy that includes annual routine maintenance and periodical rehabilitation for each roadway.

[4] Federal Highway Administration (FHWA), Life-Cycle Cost Analysis, Retrieved in June 2017 at https://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm.

[5] TxDOT Transportation Asset Management Plan, p. 53, Retrieved in April 2017 from https://www.nctcog.org/nctcg/media/Transportation/DocsMaps/Data/Performance/TxDOT-Initial-Transportation-Asset-Management-Plan.pdf; City of Houston Public Works Infrastructure Design Manual, 2018, p. 10-6, Retrieved in June 2019 from https://edocs.publicworks.houstontx.gov/documents/design_manuals/idm.pdf

Roadway Characteristics							
Roadway	**Class**	**Pavement**	**Length (ft)**	**Lanes**	**Lane-miles**	**Average Daily Traffic**	**Truck %**
Harwin Dr (Fondren Rd to S Gessner Rd)	Arterial	JCP	6000	4	4.55	16,000	3.20%

Table 2. Roadway Characteristics

Maintenance

An assessment of the pavement's current SOGR determines where the roadway is on its life cycle curve. As an example, the life cycle curve is composed of phases established by the TxDOT TAMP and assumes a 25-year life for asphalt pavement shown in the figure below. By modeling the deterioration of pavement over time due to environmental and traffic factors, the phases establish timings for maintenance requirements and effects on user vehicle operating costs for the No-Build Scenario.

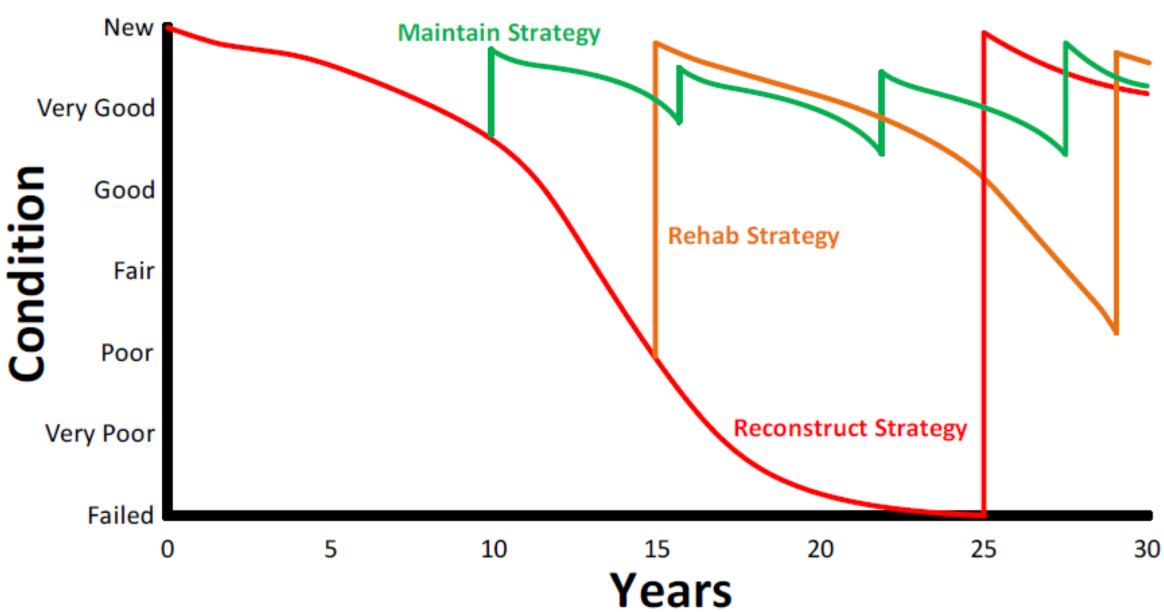


Figure 1 Pavement Life Cycle Curve

The figure shows that without maintenance, the pavement condition declines gradually in its first 8 years, but then quickly deteriorates to an unacceptable state. Any rehabilitation or maintenance strategy can reset the pavement's life cycle to a certain extent. Based on information from the COH Public Works, and verified by site survey, the corridor is mostly in the end phase of its service life. Most of the corridor is in poor condition. Therefore, the overall condition assessment of this corridor is poor (see table below).

Overall Condition Assessment	
Street Name	**Overall Condition (Weighted Average)**
Harwin Dr (Fondren Rd to S Gessner Rd)	Poor

Table 3. Condition Assessment

A critical planning factor for maintenance operations is that the cost of repairs increases as the reliability of pavement decreases over the service life.[6] Essentially, newer pavement requires less maintenance than older, more deteriorated pavement to maintain acceptable levels of service. To approximate the increasing probabilities of portions of each roadway requiring repairs and the effects on maintenance costs, this analysis used approximate failure rate factors as a multiplier of the annual maintenance costs incurred by the COH. The COH five-year (FY 2015-2019) average of actual expenditures on street and bridge maintenance is nearly $59.4 million, which covers 16,000 lane-miles of roadways, according to the Department of Public Works.[7] This analysis used the average expenditure from these totals ($3,710 per lane-mile) the lane-miles of each roadway, and the failure rate factor to develop estimates of annual maintenance costs by life cycle phase based on condition, shown in the table below.

Annual Pavement Maintenance Costs by Life Cycle Phase			
Phase	**Percent of Life**	**Failure Rate Factor**	**Harwin Dr**
New	24%	0.00	$0
Very Good	40%	0.00	$0
Good	52%	0.25	$4,216
Fair	64%	1.00	$16,862
Poor	80%	1.50	$25,294
Very Poor	100%	3.00	$50,587

Table 4. Annual Pavement Maintenance Costs by Life Cycle Phase

Rehabilitation, which for this analysis consists of full-depth concrete panel replacement, would be conducted at select intervals in addition to routine annual repairs to maintain the structural integrity of the roadways. The expected result of this strategy is the extension of the service lives of the roadways by approximately 25 years for concrete.[8] Based on each pavement's life cycle, two to three iterations of systematic repairs would be required over the next 20 years. The following table shows the schedule for Hawrin Dr under the No-Build Scenario.

Roadway Rehabilitation Schedule					
Roadway	**Pavement**	**2025-2030**	**2031-2035**	**2036-2040**	**2041-2045**
Harwin	Panel Replacement	Maintain	Maintain	Maintain	Panel Replacement

Table 5. Roadway Rehabilitation Schedule

For simplicity, this analysis assumes the rehabilitation of the entire length of Harwin Dr within the stated limits would be accomplished within time periods noted in the previous table. Similarly, it is assumed all failures of concrete panels within a certain life cycle phase occur simultaneously and the replacement costs may be captured as discrete projects. This analysis also assumes that unforeseen pavement failures that affect daily traffic are addressed as needed through annual maintenance and there would be residual life of the last major rehabilitation within the planning horizon.

[6] FHWA, Reformulated Pavement Remaining Service Life Framework, 2013, p. 43-49, Retrieved in June 2019 from https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/13038/13038.pdf
[7] City of Houston Fiscal Year Operating Budgets, Retrieved in June 2019 from https://www.houstontx.gov/budget/.
[8] City of Houston Report to TTI Committee, Retrieved in June 2019 from https://www.houstontx.gov/council/committees/tti/20140513/Maintaining_Houston_Streets.pdf

This analysis assumes the rehabilitation of the corridor takes the form of concrete panel replacement, as opposed to asphalt overlay on top of concrete. According to TxDOT's Average Low Bid Unit Prices, the cost for full-depth repair of joint concrete pavement is about $214 per square yard (SY). If the TxDOT standard panel dimensions of 12 feet (lane size) by 50 linear feet are used, the per panel replacement cost can be calculated using the following formula:

Equation 2 Cost of Concrete Panel Replacement

$$\text{Panel Replacement Cost} = \$214 \cdot A \cdot P$$

A = 67 SY (panel surface area)
P = number of panels required

The number of panels required to be replaced is based on the condition assessment presented above. The concrete panel replacement costs are state below.

Concrete Panel Replacement Costs							
Phase	*Percent of Total*	*Number of Panels*	*Service Life*	*Year(s) of Replacement*	*Replacement Cost*	*Remaining Life*	*Total Cost*
Very Poor	100%	438	1	2023	$6,268,000	$5,014,000	$1,254,000

Table 6 Concrete Panel Replacement Costs

The preferred alternative minimizes total maintenance costs over the planning horizon. In the previous table, annual maintenance and scheduled concrete panel requirements for the existing pavements create a cost, or disbenefit, to the COH for the No-Build Scenario. The Build Scenario presents an opportunity to avoid most of that financial burden. The proposed construction calls for concrete roadways and the new pavement would not require maintenance or rehabilitation for the remainder of the planning horizon; thus, the only maintenance costs are those incurred prior to project implementation. The following table summarizes the maintenance and rehabilitation costs for each scenario.

Summary of Maintenance & Rehabilitation Costs						
Roadway	**No-Build Scenario**			**Build Scenario**		
	Life Cycle Maintenance	**Scheduled Rehab**	**Roadway Subtotal**	**Life Cycle Maintenance**	**Scheduled Rehab**	**Roadway Subtotal**
Harwin Dr	$139,000	$6,268,000	$6,400,000	$4,000	$0	$4,000

Table 7. Summary of Maintenance & Rehabilitation Costs

User Costs

As pavement condition worsens over the life of the roadway, the cost to the community to maintain vehicles operated on the roads also increases.[9] For planning purposes, this analysis assumes that qualitative assessments of pavement condition are correlated with established roughness indices and thus may be used to estimate its impact on vehicle operating costs. The study referenced by this analysis established baseline costs in terms of cents per mile for passenger and commercial vehicles on new pavement, as well as cost factors for each of five roughness index values (see below).

[9] National Academy of Sciences, Engineering, and Medicine, Estimating the Effects of Pavement Condition on Vehicle Operating Costs, 2012, p. 40-50, Retrieved 4/17/19 from https://www.nap.edu/catalog/22808/estimating-the-effects-of-pavement-condition-on-vehicle-operating-costs

Vehicle Operating Costs in ¢/mile (inflated to $2019)							
Vehicle Class	Road Class	Pavement Roughness Index / TxDOT Phase					
		Baseline	Adjustment Factors (multiplied by baseline for cost per mile)				
		Cents Per Mile ($2019)	2 Very Good	3 Good	4 Fair	5 Poor	6 Very Poor
Car	Collector	18.8	1.02	1.03	1.07	1.15	1.25
	Arterial	23.4	1.02	1.03	1.07	1.15	1.24
	Highway	30.7	1.01	1.02	1.06	1.14	1.22
Truck	Collector	49.4	1.02	1.03	1.07	1.13	1.21
	Arterial	76.1	1.01	1.02	1.05	1.11	1.18
	Highway	108.2	1.01	1.02	1.04	1.09	1.15

Table 8. Vehicle Operating Costs in ¢/mile (inflated to $2019)

When correlated with the five TxDOT pavement condition phases, these factors can be applied to forecast vehicle operating costs that the public bears to the planning horizon. Several variables are required to complete this calculation. This analysis used current condition assessments of the roadways, the H-GAC traffic model data for volume on each road type over time, and TxDOT traffic count data for commercial vehicle (truck) percentage, all of which were provided earlier in this section.

The difference between the costs due to the condition of the pavement during any year within the planning horizon and the baseline costs for new pavement is the disbenefit to the community from the state of good (or bad) repair. This analysis accumulated the year-over-year car and truck cost differentials to compare the total disbenefit due to vehicle operating costs for No-Build and Build Scenarios. The following table shows the total operating costs for each alternative.

Summary of vehicle Operating Cost Differential Disbenefit						
Roadway	No-Build Scenario			Build Scenario		
	Car	Truck	Total Vehicle	Car	Truck	Total Vehicle
Harwin Dr	$1,838,000	$139,000	$1,977,000	$444,000	$25,000	$469,000

Table 9. Summary of Vehicle Operating Cost Differential Disbenefit

During reconstruction (Build Scenario) or maintenance treatment cycles (No-Build Scenario), users incur costs due to delays. They may need to merge lanes, reduce speed, or wait in a queue. For the purposes of this analysis, overall speed through work zones is assumed to drop by 25%. Repairs are assumed to take approximately 240 days per mile for reconstruction and 60 days per mile for the maintenance treatment cycles. Per USDOT guidance, the VoTT is $17.90 per hour per person, and vehicle occupancy is 1.67 persons per vehicle. Since repair projects occur in multiple years, this analysis adjusted traffic volume used to calculate cost based on growth rate to the year of repair. The total user cost due to delays during the construction period is equivalent to time lost to slower overall speeds through the work zones.

Equation 3. User (Delay) Cost

$$\text{User (Delay) Cost} = AADT \cdot 1.67 * \$17.90 * D * 0.75(T)$$

AADT = Average Annual Daily Traffic (number vehicles per day)
D = construction work zone duration (workdays)
T = Normal travel time (hours) through zone = Lane-miles / Speed Limit (mph)

The analysis tabulated AADT for each year in the planning horizon by factoring the growth rate inferred from results of forecast year traffic volumes from the H-GAC travel demand model.

Assuming linear growth, annual traffic volume can be calculated using Equation 4.

Equation 4. Traffic Volume

$$\text{Traffic Volume} = AADT * (1+x)^n$$

$AADT_c$ = Current year's volume
X = Annual growth rate
N = Number of years to which volume is being forecasted

The results of the user delay costs are shown in the following table.

Summary of Value of Travel Time Costs	
Scenario	*Hawrin Dr*
No-Build	$1,368,000
Build	$1,318,000

Table 10. Summary Value of Travel Time Costs

Summary

The preferred alternative from the perspective of SOGR minimizes costs due to maintenance and user costs. Overall, the Build Scenario is preferable to No-Build on the merits of savings in each of the three categories covered in this section: life cycle costs, maintenance, and user costs. Accumulated benefits for the analysis period are quantified and discounted at a 7% rate, shown in the following table.

SOGR Benefit	
Scenario	**Monetized Value**
No-Build	$10,735,000
Build	$1,791,000
Net Benefit	**$8,944,000**
Net Benefit Discounted @ 7% to $2019	**$5,191,000**

Table 11. State of Good Repair Benefit

Benefits 3 and 4: Safety Benefits

The Project will improve safety along the Project corridor by reducing the number of crashes. Benefits can be derived from the projected reduction in the number of crashes and property damages incurred.

No-Build Scenario

The corridor would incur no safety improvements and would continue to be unsafe.

Build Scenario

The Project will experience significant safety improvements and as a result a reduction of roadway and pedestrian related accidents would likely occur.

Methodology/Summary

For all project types, when the number of crashes decrease with the improvements, benefits also accrue from reduced property damages. This methodology is documented in the 2021 USDOT BCA Resource Guide.[2] The guide values each crash with only property damage at $4,500 in damages ($2019).

The analysis uses the average number of crashes by type over the last 5 years (2017-2021) from TxDOT CRIS database. The appropriate reduction factor was given by TxDOT based on the 2021 TxDOT HSIP work codes, and the damages avoided are quantified. [10] Accumulated benefits are quantified and discounted at a 7% rate.

Roadway and Sidewalk Improvements

To evaluate the existing conditions on the Project corridor, crash records are obtained from TxDOT CRIS database for years 2017-2021. TxDOT uses the KABCO Scale in the CRIS database, which uses law enforcement data and rates traffic crash injuries on a five-point scale: fatal (K), serious (A), moderate (B), minor (C), and none (O).

The Abbreviated Injury Scale (AIS) scale was developed by the FHWA and classifies injuries on a scale of one to six, with one being minor and six not a survivable injury. This represents the “threat to life” associated with an injury and is not meant to represent a comprehensive measure of severity. The AIS is not an injury scale, in that the difference between AIS 1 and AIS 2 is not the same as that between AIS 4 and AIS 5. The CRIS Data Conversion Table shows the conversion between the TxDOT crash classification system and the maximum AIS.

Reductions in traffic incident rates that result from the Project have economic value. The 2014 USDOT TIGER BCA Resource Guide, recommends monetizing the value of injuries per the maximum AIS; however, accident data is not always reported as AIS numbers, hence the conversion.[11]

[10] TxDOT. Highway Safety Improvement Manual, 2018. Retrieved April 2020 from https://www.txdot.gov/inside-txdot/forms-publications/publications/highway-safety.html

[11] U.S. Department of Transportation. TIGER Benefit-Cost Analysis Resource Guide, 2014. Retrieved June 2016 from https://www.transportation.gov/policy-initiatives/tiger/tiger-benefit-cost-analysis-bca-resource-guide

Estimated Monetary Value of Injuries from Traffic Accidents		
AIS Level	**Severity**	**Unit value ($2019)**
NA	Property Damage Only	$4,500
AIS 1	Minor	$32,700
AIS 2	Moderate	$512,300
AIS 3	Serious	$1,144,500
AIS 4	Severe	$2,899,400
AIS 5	Critical	$6,463,700
AIS 6	Unsurvivable	$10,900,000

Table 12. Estimated Monetary Value of Injuries from Traffic Accidents

NHTSA provides a conversion matrix that allows KABCO-reported and generic accident data to be re-interpreted as AIS data. It is understood that the severity of an injury observed and reported at a crash site may be slightly different than the KABCO scale indicates. Similarly, any accident can, statistically, generate many different injuries for the parties involved. Each column of the conversion matrix in the table below represents a probability distribution of the different AIS-level injuries that are statistically associated with a corresponding KABCO-scale injury or a generic accident.

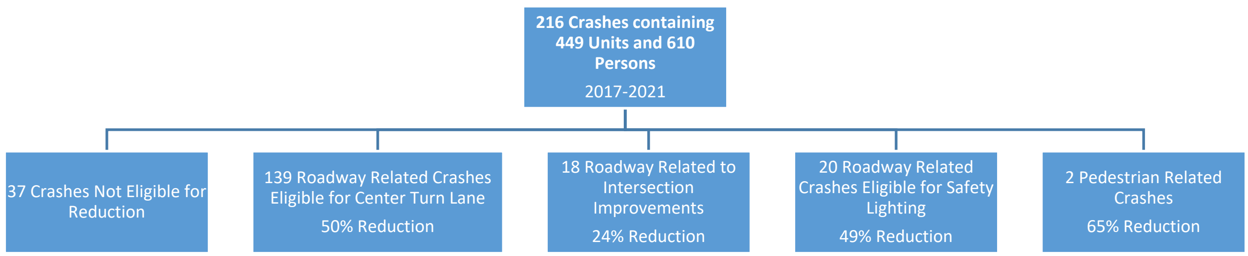
CRIS Data Conversion							
AIS Level	**Severity**	**KABCO Scale**					
		Death	**Incapacitating Injury**	**Non-Incapacitating Injury**	**Possible Injury**	**No Injury**	**AIS Level**
AIS 0	No Injuries	0.0%	3.4%	8.3%	23.4%	92.5%	43.7%
AIS 1	Minor	0.0%	55.4%	76.8%	68.9%	7.3%	41.7%
AIS 2	Moderate	0.0%	20.9%	10.9%	6.4%	0.2%	8.9%
AIS 3	Serious	0.0%	14.4%	3.2%	1.1%	0.0%	4.8%
AIS 4	Severe	0.0%	4.0%	0.6%	0.1%	0.0%	0.6%
AIS 5	Critical	0.0%	1.8%	0.1%	0.0%	0.0%	0.3%
AIS 6	Unsurvivable	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Sum (Probability)		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 13. CRIS Data Conversion

The monetary value of potential safety improvements used in the BCA are derived from Table A-1: Value of Reduced Fatalities and Injuries in the 2021 USDOT BCA Resource Guide. The methodology uses the reduction in crashes associated with each roadway improvement, as identified in the HSIP.

HSIP Work Codes correspond to different enhancements (e.g., new sidewalks, added through lanes, raised medians, additional stop signs). TxDOT has a work code table that provides associated definitions, reduction factors, and preventable crash codes. Preventable crashes are those with defined characteristics that may be affected by the proposed improvement as described by the work code. The codes correspond to numeric codes assigned in CRIS to the indicated variable. Information is collected from law enforcement crash reports and converted into a coded format that corresponds to the work code table.

A crash can only be assigned to one work code. For the Project the previous 5-year crashes were assigned to the following codes:



The tables below show the work codes used for the intersection/roadway, safety treatment (clear zone), and pedestrian improvements based on what crashes can be avoided.

Roadway Improvement 1: Work Code 518: Install Continuous Turn Lane	
Definition	Provide a continuous two-way left turn lane where none existed previously.
Reduction Factor	50%
Service Life (Years)	10
Preventable Crashes	Vehicle Movements/Manner of Collision = 20-22, 24, 26, 28-30, 34 or 38

Table 14. Intersection/Roadway Improvements Crash Reduction Factors

Roadway Improvement 2: Work Code 108: Improve Traffic Signals	
Definition	TxDOT HSIP Work Code 108: Improve Traffic Signals
Reduction Factor	24%
Service Life (Years)	10
Preventable Crashes	(Intersection Related = 1 or 2) AND [(Vehicle Movements/Manner of Collision = 10-39) OR (First Harmful Event = 1 or 5)]

Roadway Improvement 3: Work Code 304: Install Safety Lighting	
Definition	TxDOT HSIP Work Code 304: Safety Lighting
Reduction Factor	49%
Service Life (Years)	15
Preventable Crashes	Light Condition =3,4,6

Table 15. Intersection/Roadway Improvements Crash Reduction Factors

Using the average crash data from 2017-2021 available in the CRIS dataset, eligible roadway related crashes are reduced by the reduction factor above and monetized based on the AIS values. Accumulated benefits for the specified service life are quantified up and discounted at a 7% rate, shown in the following table.

Roadway Safety Benefit	
Scenario	*Monetized Value*
No-Build	$119,655,000
Build	$61,785,000
Net Benefit	**$57,870,000**
Net Benefit Discounted @ 7% to $2019	**$25,712,000**

Table 16. Roadway Safety Benefit

Sidewalk Improvement: Work Code 407: Install Sidewalk	
Definition	Install sidewalks where none existed previously.
Reduction Factor	65%
Service Life (Years)	10
Preventable Crashes	First Harmful Event = 1 (Pedestrian Related) or 5 (Bike Related)

Table 17. Sidewalk Improvements Crash Reduction Factors

Using the average crash data from 2017-2021 available in the CRIS dataset, eligible pedestrian related crashes are reduced by reduction factor above and monetized based on the AIS values. Accumulated benefits for the specified service life are quantified and discounted at a 7% rate, presented in the following table. The service life for this improvement, per the HSIP guidance, is 10 years.

Pedestrian Safety Monetized Value	
Scenario	*Monetized Value*
No-Build	$1,405,000
Build	$522,000
Net Benefit	**$884,000**
Net Benefit Discounted @ 7% to $2019	**$430,000**

Table 18. Pedestrian Safety Benefit

New Pedestrian and Transit Users & VMT Reduced

The benefits for back-of-curb (sidewalk) portions of the Project are mostly derived from the new projected users/trips of the pedestrian facilities. The additional transit users are derived from the addition of better amenities for access. The additional users using these alternative modes results in less automobile usage. This in turn, leads to reduced VMT which has a variety of benefits.

Sidewalk Improvements

For sidewalks, and other improvements that improve the walkability of an area, there is a presumed increased pedestrian mode share. According to Ewing, et al. (2009) and Handy, et al (2014), sidewalk and other back-of curb improvements can result in an increase of pedestrian mode share by increasing the share of new sidewalk coverage in an existing network of sidewalks within the TAZ area.[12,13] According to these studies, the reported elasticity as the change in walking for a 1 percent increase in the measure of the built environment is 0.27%. In other words, by adding 1% of new sidewalk, 0.27% of the internal automobile trips will be converted to pedestrian trips. For this Project, the new sidewalk share is 100% of the existing sidewalk network, thus the pedestrian mode share would be 27% (Equation 7).

The H-GAC Origin and Destination Trip Flow Database (2018 model run) predicts approximately 146 daily internal automobile trips within the Project area in 2025. The Project will result in 27% of these trips converting from automobile to new pedestrian daily trips, yielding in ~40 new pedestrian trips per day in the Build Scenario.

Pedestrian Modal Share = (Proposed Sidewalk Length/ Existing Sidewalk Length within adjacent TAZs)*27%

Pedestrian Users Demand (Opening Year)
Build Scenario Daily Pedestrian Trips: 40

Decreased Automobile Usage from New Pedestrian Users

The 2017 NHTS reports an average walking trip length of 0.87 mile.[14] The following formulas are used to estimate new converted auto to pedestrian trips to reduced VMT. The annual reduction of VMT is used to calculate the benefit from reduced emissions and reduced automobile maintenance required.

Equation 5. New Pedestrian Daily Trips

New Pedestrian Daily Trips = (Proposed Sidewalk Length/ Existing Sidewalk Length within adjacent TAZs) * 27% * Pedestrian Area Auto Trips

Equation 6. Back of Curb – New Trips to VMT Reduction

Annual VMT reduced = New Pedestrian Daily Trips * 260 * 0.87

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[12] Ewing, R., Greenwald, M. J., Zhang, M., et. al. (2009). Measuring the Impact of Urban Form and Transit Access on Mixed Use Site Trip Generation Rates -- Portland Pilot Study. Washington, D.C.: U.S. Environmental Protection Agency.

[13] Handy, S. et al. (2014). Impacts of Pedestrian Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions - Policy Brief and Technical Background Document. California Air Resources Board.

[14] 2017 National Household Travel Survey. Retrieved in August 2021 from https://nhts.ornl.gov/

VMT = Vehicle Miles Traveled
0.87 = Average walking trip distance in miles
260 = Weekdays in the year (Annual trips)

Auto VMT Reduced from Pedestrian Diversion (Open Year)
Build Scenario Annual VMT Reduced: 8,900

Transit Improvements

Better access to transit amenities (e.g., shelters, sidewalks, ramps, signage) will improve the transit level of service of an area, thus there is a presumed increase in transit usage. TCRP Report 163 *Strategy Guide to Enable and Promote the Use of Fixed Route Transit by People with Disabilities* reports that of the transit systems studied, updated or newly installed transit amenities increase the stop ridership by 12.9%.[15] According to METRO, in 2018 annual boarding and alighting counts (henceforth transit trips) at stops along the Project corridor totaled 29,000 annual transit trips (24,700 on the weekdays, 2,800 on Saturdays and 2,800 on Sundays) in the No-Build Scenario. The Build Scenario would result in an increase of transit trips by 12.9%, which is an annual increase of 3,800 annual transit trips in 2021 for a total of 33,300. According to National Transit Database, the CAGR for local transit bus stops is 0.88%. By applying the CAGR, in 2025 the Build Scenario will yield 34,500 annual transit trips.

Transit Trips Demand (Opening Year)
No-Build Scenario Annual Transit Trips: 30,500
Build Scenario Annual Transit Trips: 34,500

Decreased Automobile Usage from New Transit Users

An average one-way transit trip length in the METRO service area is 6.43 miles.[16] The following formula is used to estimate new converted auto to transit trips to reduced VMT:

Equation 7. Back of Curb – New Users to VMT Reduction

Annual VMT reduced = TrT * 6.43

VMT = Vehicle Miles Traveled
TrT = Annual Transit Trips
6.43 = Average transit trip distance in miles

[15] Transit Cooperative Research Program. Report 163 Strategy Guide to Enable and Promote the Use of Fixed-Route Transit by People with Disabilities. Retrieved in June 2019 from https://nacto.org/wp-content/uploads/2016/05/2-9_Thatcher-et-al-Strategy-Guide-to-Enable-and-Promote-the-Use-of-Fixed-Route-Transit-by-People-with-Disabilities-TCRP-Report-163_2013.pdf
[16] National Transit Database. 2018 Annual Report Houston Metro

The VMT saved is used to calculate the benefit from reduced emissions and reduced automobile maintenance required.

<u>Transit Trips Diversion to Auto VMT Reduced (Opening Year)</u>
No-Build Scenario Daily VMT Reduced: 196,000
Build Scenario Daily VMT Reduced: 222,000

Benefit 5: Health Benefits

No-Build Scenario

The current condition of the trail is not conducive for walking and therefore limits the demand for additional users.

Build Scenario

The Project will include a safe sidewalk and crossing for users and therefore encourage active transportation, which lead to measurable health benefits to society.

Methodology/Summary

According to the World Health Organization (WHO) increasing physical activity for health leads *to improved cardiorespiratory, musculoskeletal, depression, functional health and reduces likelihoods of breast and colon cancer*.[17] Through observed data, peer reviewed research and other findings, the WHO states that at least 30 minutes a moderate exercise provides a strong linkage to improved overall health. According to the Centers for Disease Control and Prevention (CDC), in 2021, the leading causes of death in the United States is heart disease.[18] Both the CDC and WHO state that increase in physical exercise is proven to help prevent and manage heart disease.

When the community enhances or provides new active transportation infrastructure, then users health will benefit from the improvements. Using several worldwide studies, The WHO's HEAT tool, and observed data, The Waka Notahi New Zealand Transport Agency completed a detailed examination of the societal monetized benefits of increased physical activity (walking and cycling). The quantification measures are the quality of life, health loss, years of life loss dues to premature disability, and years lost due to the disability.[19] The Waka Notahi New Zealand Transport Agency Health and Active Modes Impacts Report estimates the cost savings value for walking to be $4.76 per mile with a maximum annual per new user at $4,169 (Equation 8). The Project will induce uses 365 days per year.

Equation 8. Pedestrian Users - Annual Health Benefit

Annual Health Benefit = Total New Pedestrian Users * Recreation Days (365) * $4.67 per mile not greater than $4,169 annually per user

The number of total new active transportation users is assumed to grow annually at the same rate as the trip growth rate, as derived from the Travel Demand Model data. Accumulated benefits for the analysis period are quantified and discounted at a 7% rate, shown in the following table.

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[17] The World Health Organization. (2010). Global Recommendations on Physical Activity for Health (ISBN 978 92 4 159 997 9). WHO Press.

[18] FastStats. (2021). Leading Causes of Death. Retrieved January 2021, from https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm

[19] Waka Kotahi NZ Transport Agency. (2020, March). Health and Active Modes Impacts. A technical paper prepared for the Investment Decision Making Framework Review. https://www.nzta.govt.nz/assets/resources/Monetised-benefits-and-costs-manual-technical-notes/health-and-active-modes-impacts-march-2020.pdf

Pedestrian Health Benefit	
Scenario	**Monetized Value**
No-Build	$0
Build	$2,200,000
Net Benefit	**$2,200,000**
Net Benefit Discounted @ 7% to $2019	**$723,000**

Table 19. Pedestrian Health Benefit

Benefits 6 and 7: Automobile Maintenance Benefits

Operating a vehicle is one of the most expensive budgets items in American households. The reduction in VMT from automobile trips converted to pedestrian and transit results in a benefit for automobile owners. Improved roadway conditions also result in benefit for vehicle owners.

No-Build Scenario

The current condition of the roadway surface is in poor condition and damages vehicles.

Build Scenario

The Project will reconstruct the roadway providing a smooth surface for vehicles.

Methodology

The 2021 USDOT BCA Resource Guide estimates the cost of automobile operation as 43 cents ($2019) per mile. The value per mile includes operating costs, such as gasoline, maintenance, and depreciation. The benefit omits fixed costs of owning a vehicle, such as insurance and registration. The total automobile maintenance avoided by reducing VMT can be estimated using the following formula:

Equation 9. Automobile Maintenance Savings

Automobile Maintenance Savings = VMT * MC

VMT = Vehicle Miles Traveled Reduced from Modal Diversion to Pedestrian and Transit (see methodology above)
MC = Automobile Maintenance Costs per mile (assumes 43 cents in $2019)

VMT is assumed to grow annually at the same rate as the internal trips, as derived from 2018 H-GAC TDFM. The accumulated benefits of increased pedestrian and transit trips on automobile maintenance savings for the analysis period are quantified and discounted at a 7% rate, presented in the following tables.

Pedestrian Reduced Auto Use Benefit	
Scenario	**Monetized Value**
No-Build	$0
Build	$140,000
Net Benefit	**$140,000**
Net Benefit Discounted @ 7% to $2019	**$46,000**

Table 20. Pedestrian Reduced Auto Use Benefit

Transit Reduced Auto Use Benefit	
Scenario	**Monetized Value**
No-Build	$1,939,000
Build	$2,189,000
Net Benefit	**$250,000**
Net Benefit Discounted @ 7% to $2019	**$90,000**

Table 21. Transit Reduced Auto Use Benefit

Benefits 8 and 9: Environmental Benefits

The EPA has classified the Houston-Galveston-Brazoria area in marginal nonattainment of the eight-hour ozone standard; air quality does not meet federal standards.[20] The investment in mobility infrastructure could produce environmental benefits due to decreased automobile use or vehicle delay which will reduce air pollutants, which is important to the region's future growth.

No-Build Scenario

The current condition of the roadway is not conducive for walking.

Build Scenario

The Project will install new sidewalks to provide better access to transit stops, to nearby retail and commercial outlets. This improvement will induce new pedestrian and transit users.

Methodology/Summary

H-GAC models NOx using the following emissions factor:

- NOx: 0.19 grams (g) per VMT

NOx has a measurable societal economic impact on the economy. The 2021 USDOT BCA Resource Guide provides recommended monetized values for NOx ($15,700 per metric ton in $2020).[2] These values are used to calculate the Project's benefit derived from the reduction of harmful air pollutants.

For sidewalk and other improvements that improve the walkability of an area, as well as transit utilization, there is a presumed environmental benefit from automobile trips being converted into pedestrian and/or transit trips. The methodology for trip conversion and VMT reduced is explained in a prior section of this document (New Pedestrian and Transit Users & VMT Reduced). The VMT benefit is derived and converted into the amount of NOx grams reduced, which is then monetized based on the H-GAC emissions factor. VMT is assumed to grow annually at the same rate as internal trips. Accumulated benefits are quantified over the 20-year analysis period and discounted at a 7% rate, shown in the following tables.

Pedestrian Reduced Auto Use Environmental Benefit	
Scenario	**Monetized Value**
No-Build	$0
Build	$7,000
Net Benefit	**$7,000**

[20] 8-Hour Ozone (2015) Nonattainment Area State/Area/County Report | Green Book | US EPA. (2021). Https://Www3.Epa.Gov/Airquality/Greenbook/Jncs.Html#TX. Retrieved September 2021, from https://www3.epa.gov/airquality/greenbook/jncs.html#TX

Net Benefit Discounted @7% to $2019	**$4,000**

Table 22. Pedestrian Reduced Auto Use Environmental Benefit

Transit Reduced Auto Use Environmental Benefit	
Scenario	**Benefit**
No-Build	$979,000
Build	$1,105,000
Net Benefit	**$126,000**
Net Benefit Discounted @7% to $2019	**$72,000**

Table 23. Transit Reduced Auto Use Environmental Benefit

Benefits Monetized but Not Widely Accepted in Transportation Grant Applications – Local Economic

Sidewalk facilities can spur increased property values, resulting in increased appraisal values that provide additional property tax benefits to the study area.

No-Build Scenario

The current condition of the roadway is not conducive to walking.

Build Scenario

The Project will include safer sidewalks. Research has shown that improving walkability can increase the property values of residential and commercial properties. [21,22] Improving sidewalks along the corridor can increase the residential property values by $4,672 per property and 9% for commercial property values is applied similarly. The following equations estimate the property tax value increase when adding sidewalks. Benefits are only attributed to the increment for each property.

Equation 10. Sidewalk Projects – Residential Property Tax Value

Residential Tax Increase = # of residential properties abutting corridor * $4,672 * Tax Rate

Equation 11. Sidewalk Projects – Commercial Property Tax Value

Commercial Tax Increase = No-Build Commercial Value * (1+9%) * Tax Rate

The net economic benefit of sidewalks on property values in the study area is $1,289,000 over the 20-year planning horizon, shown in the table below.

Economic Benefits of Sidewalks on Property Values	
Scenario	**Monetized Value**
No-Build	$38,208,000
Build	$41,609,000
Net Benefit	**$3,400,000**
Net Benefit Discounted @ 7% to $2019	**$1,289,000**

Table 24. Sidewalk Economic Benefits

[21] Liu, J. H., & Shi, W. (2017). Impact of bike facilities on residential property prices. Transportation research record, 2662(1), 50-58.

[22] The University of Delaware. Healthy and complete communities in Delaware: The walkability assessment tool. Retrieved in June 2017, from http://www.ipa.udel.edu/healthyDEtoolkit/walkability/benefits.html.

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MEMO

Date:	**April 29, 2022**
To:	**Don Huml, Senior Project Manager, Southwest Houston Redevelopment Authority**
From:	**Kirk Myers, EIT, PMP**
Subject:	**Mobility Project Profiles**

Summary

The purpose of the Southwest Houston Redevelopment Authority (TIRZ 20) is to address mobility deficiencies and provide resources for redevelopment of commercial corridors in the vicinity of Bellaire Blvd and Fondren Rd located in the Southwest District of the City of Houston, within Harris County. The TIRZ has identified several candidate projects for inclusion in its Capital Improvements Program (CIP) and has programmed those most suitable for implementation for full or partial funding through Fiscal Year (FY) 2025.

The Goodman Corporation (TGC), through close coordination with the TIRZ and its consulting Engineer, Cobb, Fendley & Associates, Inc. (CobbFendley), identified two projects through a needs-based analysis for further development for grant application readiness for the Houston-Galveston Area Council (HGAC) Transportation Improvement Program (TIP) Call for Projects. The two projects selected for development are Harwin Drive Reconstruction and Sharpstown Hike and Bike Trail Segment 1.

The project profiles contained in this report provide the information necessary for grant applications for each of the selected projects. The details include project purpose and need narratives, benefit/cost analyses, and documentation from site visits. The Design Concept Report (DCR) CobbFendley is coordinating with the City of Houston (COH) is providing scope, cost, and other preliminary engineering details for the Harwin Drive Reconstruction. Conceptual and preliminary planning and engineering coordination between CobbFendley and the Houston Parks Board (HPB) provides similar details for the Sharpstown Hike and Bike Trail.

This report consists of two parts, one for each of the selected projects, with the following sections:

- Project Scope
- Project Purpose and Need
- Existing Conditions and Benefits of the Project
- Project Coordination and Readiness
- Funding Recommendations

Part I – Harwin Drive Reconstruction

Harwin Drive is commercial corridor in the northern part of the TIRZ, running nearly parallel to the Westpark Tollway and between I-69 and the Sam Houston Parkway. Land uses on this corridor are mainly wholesale and outlet commercial establishments with various retail, personal and automotive services interspersed. Other nearby uses include a concrete batch plant and a CenterPoint Energy substation on the north side of the street and multifamily and single family residential around the Sharpstown Park Golf Course to the south. Adjacent roads include S Gessner Rd to the west, Westpark Tollway to the north, Fondren Rd to the east, and Sands Point Dr to the south.

The TIRZ annexed this portion of Harwin Dr in 2015 and immediately recognized the need for its eventual reconstruction. Through the TIRZ public meeting process, the Project was developed and prioritized for the Capital Improvements Program (CIP) with input from members of the public and other stakeholders. Cobb, Fendley & Associates, Inc. (CobbFendley) was retained as the design engineer for the project. CobbFendley had designed the reconstruction of both intersections at either end of the Project. The findings of the viability study and recommendations in the design concept review developed by CobbFendley for this Project are integrated into this project profile.

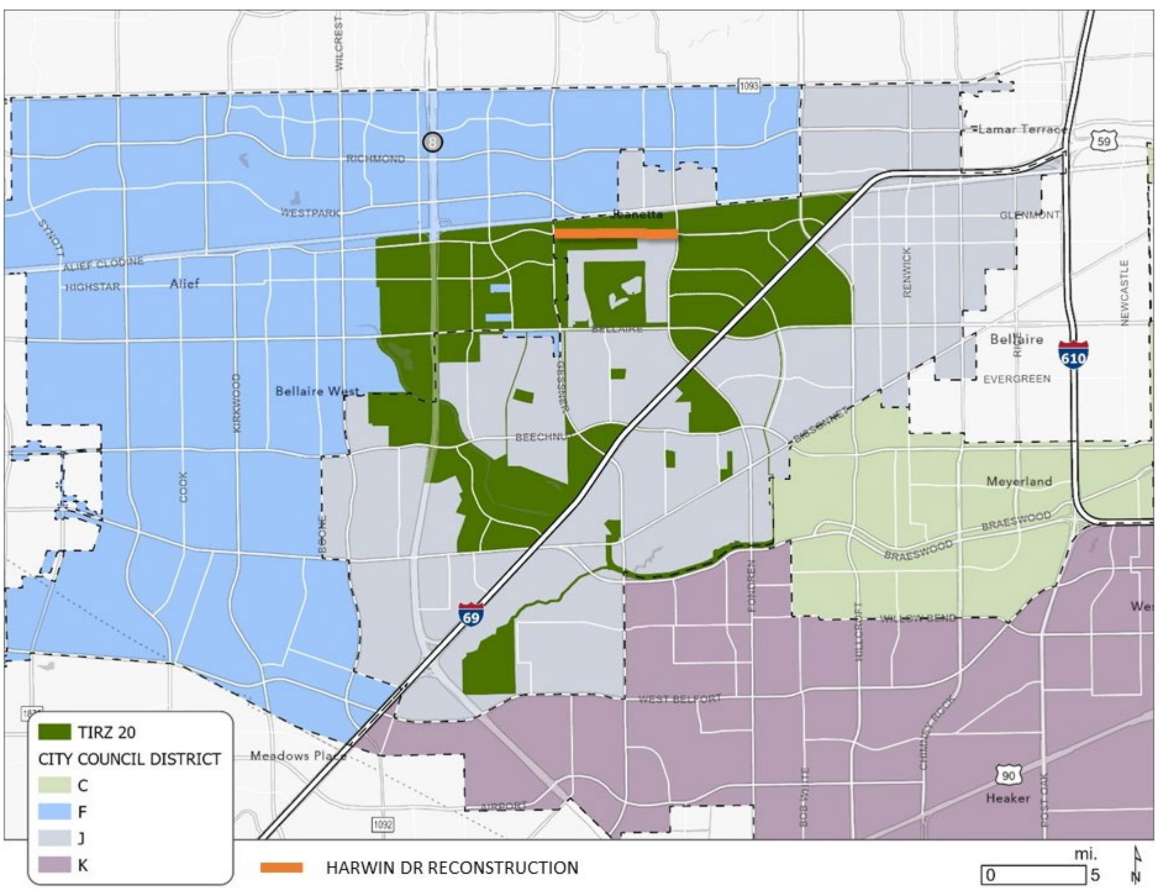

Figure 1: Harwin Dr Reconstruction Project Location

Project Scope

The Harwin Dr Reconstruction Project (Project) will replace the existing, aging, and deteriorated facilities with modern infrastructure that is compliant with current design standards on the segment of Harwin Dr from S Gessner Rd to Fondren Rd (approximately 5,325 linear ft). By employing a full reconstruction, the TIRZ intends to improve traffic operations, safety, pedestrian accommodations, pavement drivability, drainage, and aesthetics along this segment of Harwin Dr. The reconstruction is also intended to match the proposed configuration of the roadway to the approaches that will be already constructed at the S Gessner Rd and Fondren Rd intersections.

Roadway	Multimodal	Utilities
Reduction to three lanes (two 11-ft travel lanes and one two-way center turn lane)	Accessible sidewalks (8-10 ft) with 2.5-3.5-ft buffer and curb ramps	Fully compliant stormwater detention infrastructure
New pavement, curb, and gutter	New streetlighting, bus stops, and landscaping	Improved water and sanitary mains and service lines
All new traffic control devices	Updated traffic signals, markings, and signage	

Table 1: Harwin Dr Reconstruction Scope Elements

CobbFendley has developed the proposed layout and existing and proposed sections, through consultations with the TIRZ and City of Houston (COH) via the Design Concept Review (DCR) process. As depicted on CobbFendley's Harwin Drive Reconstruction From S Gessner Road to Fondren Drive schematic, the Project is proposed to begin approximately 500 ft east of the S Gessner Rd intersection and end at about 170 ft west of the Fondren Rd intersection. The proposed improvements include construction of concrete curb and gutter, pavement, storm sewer, traffic signals, ADA compliant sidewalks and ramps, landscaping, and streetlighting. The existing water and wastewater lines will be evaluated and reconstructed if necessary.[1]

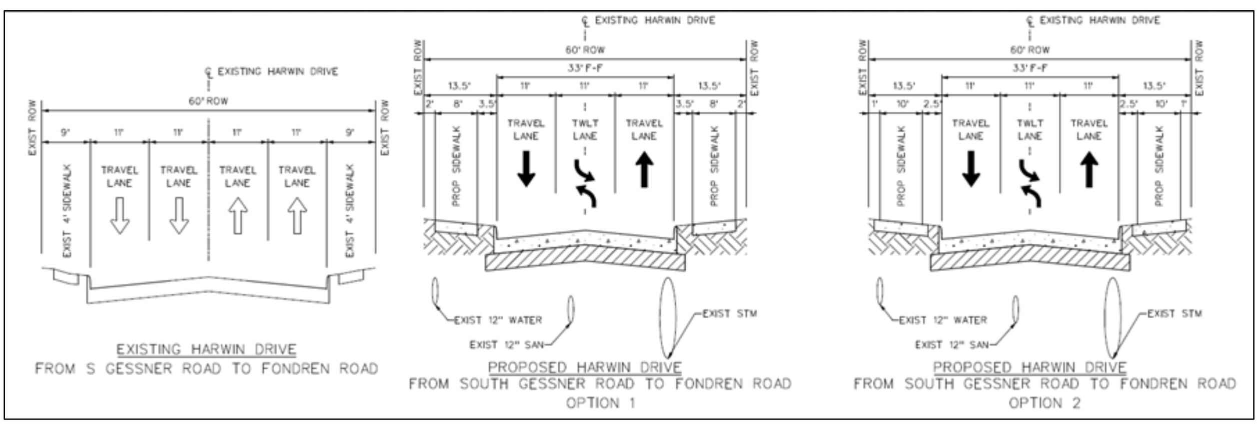

Figure 2: Harwin Dr Reconstruction Existing and Proposed Sections

The existing right-of-way of 60 feet is constrained by development and physical barriers that prevent expansion of the pedestrian realm to the extent outlined by the COH Infrastructure Design Manual (IDM) without significant costs from the required property acquisitions. The proposed section balances the need

[1] CobbFendley (2022). Task Order No. 3 Re: Reconstruction of Harwin Drive from Gessner to Fondren intersection Phases I, II, & III services.

to maintain reasonable level of service for traffic capacity while optimizing remaining available right-of-way for sidewalks. Option 2 proposes sidewalks that are two feet wider than Option 1. Additional sidewalk width is provided by narrowing the dimensions of pervious surfaces by one foot each.

Project Purpose and Need

The purpose of the Project is to improve roadway safety and accessibility for all users, reduce costs associated with maintenance, and provide modern streetscape and utilities for the Sharpstown super neighborhood.[2] There are many equity, safety, accessibility, and mobility needs that can be addressed by the reconstruction of this segment of Harwin Dr. The aging pavement and other infrastructure are causing general state of disrepair issues for motorists and business owners. Architectural barriers and lack of multimodal facilities act to prevent suitable accessibility for pedestrians. The substandard roadway configuration discourages economic development on the corridor.

This Project is estimated to provide a benefit-cost ratio (BCR) of 2.4 with an expected opening year of 2025.[3] With total estimated costs of $14,187,000 and benefits of $33,874,000, this project stands to provide a public good at an acceptable rate of return. The following sections provide details on the existing conditions of the roadway and the related benefits that can be realized by the Project.

Benefit	Existing Conditions	Proposed Changes	Types of Impacts	Benefit (7% Discount)
Safety	Outdated design; disproportionally high crash rates	Redesign to slow traffic and improve and expand pedestrian realm	24% to 50% fewer vehicle crashes and 65% fewer pedestrian crashes	$26,142,000
Useful Life	Infrastructure at end of useful life; ongoing costly maintenance	Replace infrastructure within public ROW via capital investment	New useful life cycle; lower maintenance costs through planning horizon	$6,933,000
Health & Environmental	Limited multimodal access; auto-dominated corridor	Active transportation infrastructure that promotes multimodal use	Health, auto maintenance, and emissions benefits from modal shift	$802,000
			Total Benefits	**$33,877,000**

Table 2: Harwin Dr Reconstruction Benefits

Existing Conditions and Benefits of the Project

Safety

Harwin Dr is an extension of Alief Clodine Rd, which parallels the Westpark Tollway from west of State Highway (SH) 6, becomes Harwin Dr near the Sam Houston Tollway, and terminates at Gulfton St near the Westpark Tollway and Southwest Freeway interchange. Being in such proximity to these major highways, Harwin Dr serves as an essential relief route for drivers navigating through Southwest Houston. Combined with typical travel demand associated with the dense residential, commercial, and light industrial developments immediately surrounding the corridor, these drivers compete with multimodal users for

[2] City of Houston (2022). Super Neighborhoods. Retrieved from https://www.houstontx.gov/superneighborhoods/, 4/5/2022.

[3] This profile summarizes costs and benefits discounted to 2019 dollars based on an engineering estimate from CobbFendley and benefit-cost analysis performed by TGC (see Appendix A for details).

limited roadway space. The average daily traffic is approximately 20,000 vehicles,[4] with a posted speed limit of 35 mph. However, during site visits vehicles were observed to be generally moving at speeds above the posted limit. There is one traffic light at Allday Dr, which is 3,350 ft from Gessner and 2,270 ft from Fondren Rd.

Figure 3: Allday Dr Intersection Facing West

Many of this corridor's safety issues can be tied to its lack of access management. This segment of Harwin Dr is composed of two travel lanes in each direction, separated by a double yellow center line, and minimal pedestrian realm. There are three intersections between Gessner and Fondren. The connecting streets, Allday Dr, Osage Rd, and Drew St, are short, local streets that link to adjacent commercial establishments or residential neighborhoods. They each form a three-way, or T, junction at Harwin Dr and Allday is the only signalized intersection.

This area has a dense cluster of warehouse outlets and other businesses, and nearly each building has its own driveway onto Harwin Dr. The result is on average there is a driveway every 70 ft on both sides of the street. The closely spaced driveways create the conditions where the inside lane in each direction operates as a left turn lane, leaving the outside lane as the de facto through lane. Since FHWA rates roads handling less than 25,000 vehicles per day good candidates for lane reductions,[5] CobbFendley is proposing conversion to a three-lane section with a two-way left turn lane. It is assumed this change would not negatively impact the facility's capacity.

This corridor is generally an unsafe environment for motorists and pedestrians. According to the Texas Department of Transportation (TxDOT) Crash Records Information System (CRIS), there were 216 crashes between 2017 and 2021. There were 177 roadway and two pedestrian crashes that could have been mitigated by this Project's improvements, which is considered a relatively high rate. Through its Vision Zero program, the COH has designated portions of Harwin Dr, including the segment that is the scope of

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[4] Cobb, Fendley & Associates, Inc. (2021) Harwin Drive from Gessner to Fondren: Proposed Reconstruction & Access Management Evaluation of Existing Condition & Recommended Improvements.
[5] Federal Highway Administration (2021). Road Diets. Retrieved from https://safety.fhwa.dot.gov/provencountermeasures/road_diets.cfm, 4/5/2022.

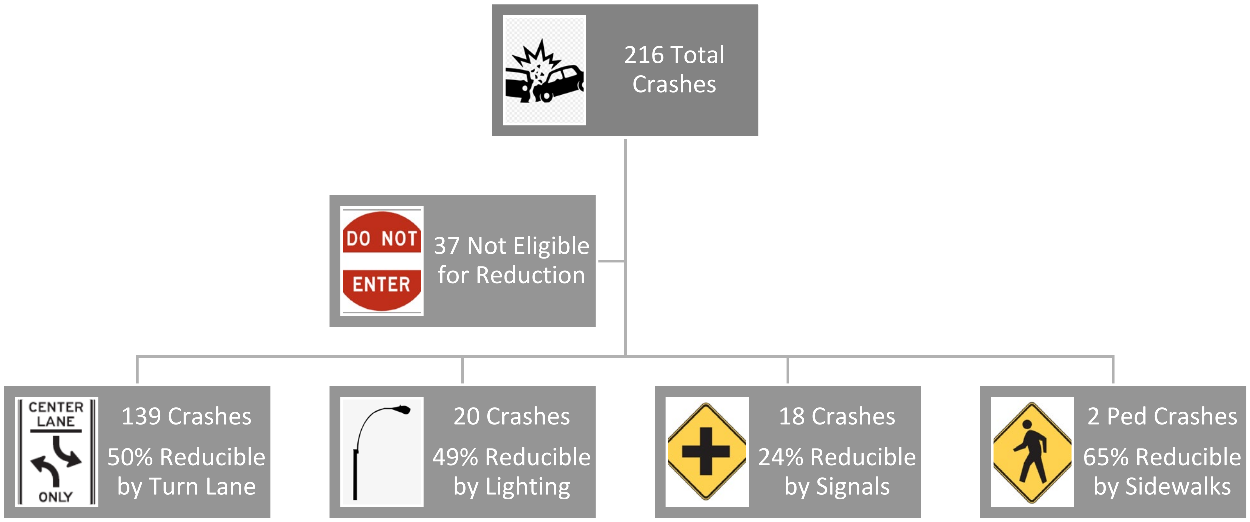

Figure 4: Crashes and Potential Mitigation on Harwin Dr

this Project, as part of the High Injury Network (HIN).[6] The HIN consists of the top 6% of the streets in the City that have the highest incidence rate of traffic deaths and serious injuries.

For the roadway crashes, this Project's improvements include a proposed center turn lane, improved traffic signals, and safety lighting, which stand to reduce crash incidence by 50%, 24%, and 49%, respectively, over the lifetimes of the improvements. The estimated net benefit of these safety enhancements is $25,712,000. For pedestrians, sidewalk improvements have been shown to reduce crash rate by 65%. This safety enhancement will provide a $430,000 net benefit. The total safety benefits resulting from the Project are estimated to be $26,142,000.

Figure 5: Example of Driveway-Sidewalk Conflicts on Harwin Dr

Though there are existing sidewalks on Harwin Dr, they are deteriorated and unusable in several locations, due to lack of maintenance, dismantling resulting from other works, and many driveways that do not provide suitable crossings. These conditions prevent Harwin Dr from being a walkable street, so there is likely to be an increase in pedestrian mode share when the sidewalk and other back-of-curb improvements are made.

[6] City of Houston (2022). Vision Zero High Injury Network. Retrieved from https://houstontx.gov/visionzero/, 4/7/2022.

Useful Life

Harwin Dr is a designated major thoroughfare on the City of Houston Major Thoroughfare & Freeway Plan (MTFP).[7] As it has reached the end of its useful life, the impacts of traffic and environmental degradation are reaching a critical point. This segment of Harwin Dr is comprised of jointed concrete panels that are showing signs of subsidence and water infiltration. Poor pavement conditions occur along the gutter line, near drainage structures, or where adjacent panels have settled at different angles. At these locations, storm water has infiltrated the pavement and caused various cracking, spalling, and shattering of the concrete slabs. These defects have been observed across the 40-44 ft width of the pavement. The existing 60 ft right-of-way has seen heavy use and deterioration, as well. There are no building setbacks and the continuous breaks in the curb structure for driveways have led to many extreme changes of level and other barriers to accessibility. Other right-of-way features in various states of disrepair include the pavement markings, traffic control devices, and utility structures.

Figure 6: Example of Deteriorating Pavement on Harwin Dr

The City of Houston rates the pavement as Satisfactory to Poor,[8] though CobbFendley determined current pavement condition index is less than 70, which is considered failing.[9] The full-depth replacement of the pavement will improve safety, mobility, and economic development for this major thoroughfare. The monetized benefits of the new roadway include $1,606,000 for residual 50-year life benefit at the end of the 20-year planning horizon and $5,327,000 for reduced maintenance and user costs due to the improved pavement surface. Total monetized life cycle benefits from this Project come to $6,933,000.

Land uses in the Project area are greatly varied and there are many destinations on or adjacent to the roadway that are difficult to reach other than by car due to the lack of multimodal infrastructure. This is due to both the necessity for a redesign of an obsolete roadway as well as the need for improvements in connectivity to nearby infrastructure. In addition to the pavement, the underground infrastructure on this corridor is reaching the end of its life cycle. The water, wastewater, and storm lines were installed or rehabilitated in the 1970s and their conditions and composition qualify them for rehabilitation at a minimum.

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[7] City of Houston Planning & Development (2022). Major Thoroughfare & Freeway Plan. Retrieved from https://www.houstontx.gov/planning/transportation/MTFP.html, 1/25/2022.
[8] Houston Public Works (2022). Open Data. Retrieved from https://geohub.houstontx.gov/, 4/4/2022.
[9] City of Houston Transportation and Drainage Operations (2019). Pavement Data Collection, Rating History & Pavement Management Program. Municipal League Conference. Retrieved from https://tmlconference.org/wp-content/uploads/2019/10/TML-2019-Presentation-2019-1008-Houston.pdf, 4/5/2022.

Overall, the corridor's pedestrian infrastructure is not compliant with Texas Accessibility Standards (TAS). Harwin Dr does not meet IDM standards for pedestrian realm facilities either. The existing sidewalks are four feet wide, which is less than that currently required by the IDM. There are many large gaps in sidewalk coverage, non-compliant ramps and crossings, and utility and other barriers. Additionally, none of the bus stops in the Project area have standard bus pads or landings.[10] According to CobbFendley, existing right-of-way may prevent full compliance with IDM standards for pedestrian realm, but the Project would improve accessibility and comfort to the greatest degree possible.

Figure 7: Example of Missing Pedestrian Infrastructure on Harwin Dr

Health and Environmental

There are substantial health and environmental needs in the Project's area. This segment of Harwin Dr is in Census Tract 4329.01, Harris County, Texas, which is an area of persistent poverty. As shown on the table, every statistic of population vulnerability is higher in this area than the average for the City, County, or Metro area (Houston-The Woodlands-Sugar Land Metropolitan Statistical Area). These statistics are combined into an indicator known as the Social Vulnerability Index,[11] which for this area was 0.7215 in 2018, the most recent year the indices are available. This is considered a moderate to high level of vulnerability. It should also be noted that adjacent tracts are in the highest vulnerability category (SVIs greater than 0.85).

Demographics (2019 data[12])	Project Area	City of Houston	Harris County	Metro Area
Population Density (pop per sq. mi.)	4,263	3,778	2,805	875
Population Density (pop per sq. mi.)	30%	18%	14%	13%
People of Color Population (%)	37%	43%	37%	35%
Less Than HS Education (%)	19%	8%	8%	7%
Households with No Vehicles (%)	11%	8%	6%	5%
Households with 1+ Persons w/ Disability (%)	21%	19%	20%	21%

Table 3: Environmental Justice and Equity Statistics for Harwin Dr

In addition to promoting investment in an area of socioeconomic need, this Project's sidewalks will contribute to the community's active transportation infrastructure. These kinds of improvements promote increased physical activity, which provides annual health benefits in the form of quality of life, physical and mental well-being, and increased years of life. The aggregate benefit based on projected travel demand data for the Project area across the 20-year planning horizon is estimated to be $723,000.

[10] City of Houston Public Works (2021). Infrastructure Design Manual. Figure 10.14 Standard Bus Pad and Landings.
[11] US Department of Health & Human Services: Agency for Toxic Substances and Disease Registry (2022). Social Vulnerability Index. Retrieved from https://www.atsdr.cdc.gov/placeandhealth/svi/index.html, 4/5/2022.
[12] ESRI (2021). 2021 Total Population by Block Groups. Retrieved from ESRI Business Analyst, 1/18/2022.

The Project area is well served by transit, and better accessibility will encourage people to use the bus. Houston METRO provides express bus service on Harwin Dr.[13] Route 152 runs from the Westwood Park and Ride and Route 153 runs from the Briar Forest Park and Ride. Both lines terminate at the Wheeler Transit Center in Midtown. Both routes operate on 30-minute headways, seven days a week, offset by 15 minutes. There are four pairs of stops in the Project area, in addition to stops at the S Gessner Rd and Fondren Rd intersections. There are two other METRO routes adjacent to the Project area. Route 46 runs on Gessner Rd from the West Little York Park and Ride to W Airport Blvd south of Sharpstown. Route 63 runs on Fondren Rd from Westheimer to the Missouri City Park and Ride. The Gessner Park and Ride, which is served by Route 151, is located just to the north of Harwin Dr.

Figure 8: METRO Bus Route 153 on Harwin Dr

Thus, a more walkable street that provides suitable facilities for pedestrians and access to transit stops is expected to increase the share of pedestrian and transit modes among all trips taken along Harwin Dr once the improvements are made. The subsequent increase in vehicle miles traveled by cars should be reduced compared to what the growth would be if the Project is not built, resulting in lower emissions, which is an environmental benefit for the community. The amount of this benefit is estimated at $79,000 over the 20-year planning horizon. Combined benefits to the health and environment in the Project area are estimated at $802,000.

Project Coordination and Readiness

CobbFendley submitted the DCR intake form to COH on November 17, 2021. Following several coordination meetings, CobbFendley presented the findings of its viability study with recommended improvements, as detailed in the Project Scope, on December 2, 2021. Off-site stormwater detention is being provided near the Project area to fulfill COH drainage requirements. COH approved the study and authorized the Project to move into preliminary design. Subsequent interagency coordination will include lane width, drainage mitigation, and utilities relocations. All work is expected to occur within existing right-of-way to avoid the need for property acquisition. CobbFendley received approval by the TIRZ to begin Phase I (preliminary engineering) on the Project April 14, 2022. The Phase I work will include geotechnical investigation and Environmental Site Assessment (ESA).

An environmental risk assessment of the Project area identified multiple hazardous waste sites adjacent to the project alignment.[14] There are also some structures in the area that may be eligible for historic designation. However, the Project is not anticipated to have permanent adverse impacts on these

[13] Metropolitan Transit Authority of Harris County (2022). System Map. Retrieved from https://www.ridemetro.org/Pages/SystemMap.aspx, 4/5/2022.

[14] The Goodman Corporation (2022). Southwest Houston TIRZ (TIRZ 20) Environmental Risk Assessment Harwin Drive.

structures or other cultural resources. There are no adverse impacts identified for other environmental categories. These preliminary findings will be verified by the Phase I ESA.

Funding Recommendation

This project is competitive for Transportation Improvement Program (TIP) funding. The Houston-Galveston Area Council (HGAC) is expected to issue its Call for Projects this year. This profile and the accompanying documents provide the information expected to be required for the initial application submittal for this funding opportunity.

The TIRZ has allocated a total of $13 million through 2026 in its CIP for this Project. The preliminary estimated costs developed by CobbFendley for the Project are $21.5 million. The construction estimate is $16.7 million and soft costs, including engineering and survey services, construction management, materials testing, and potential right-of-way acquisition, total $4.8 million.

Provided the TIRZ maintains its CIP allocation for this Project and non-construction costs are eligible for funding, an application would request $8.5 million, or a 40% share of the total Project costs. If only construction costs are eligible, the TIRZ may allocate its CIP funds to the $4.8 million for soft costs, leaving $8.2 million for construction. The request amount would remain the same, but the non-local share would increase to 51%.