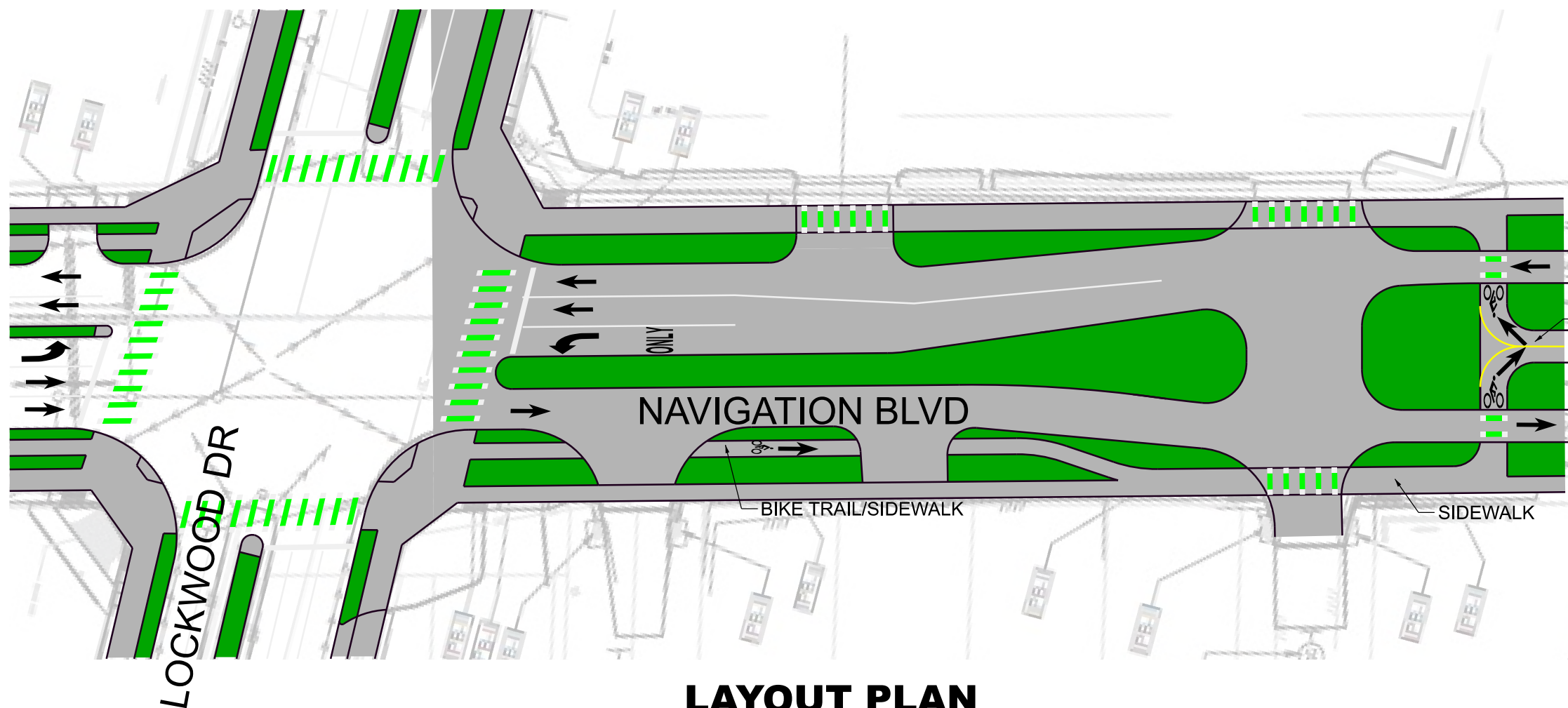
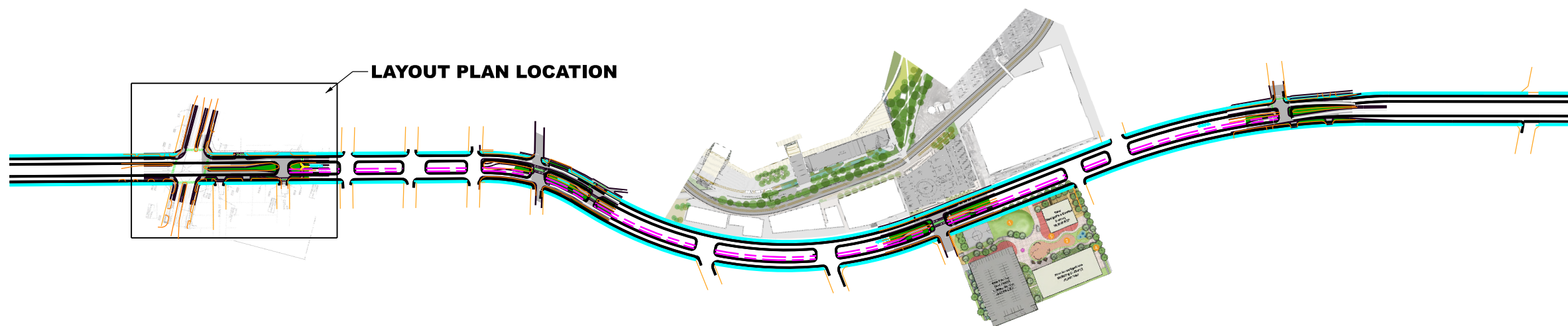




LAYOUT PLAN
SCALE: 1" = 50'



NO. OF SHEETS: 10
 SHEET NO. 10 OF 10

NO.	REVISIONS	DATE	NAME
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HARRIS COUNTY
 ENGINEERING DEPARTMENT



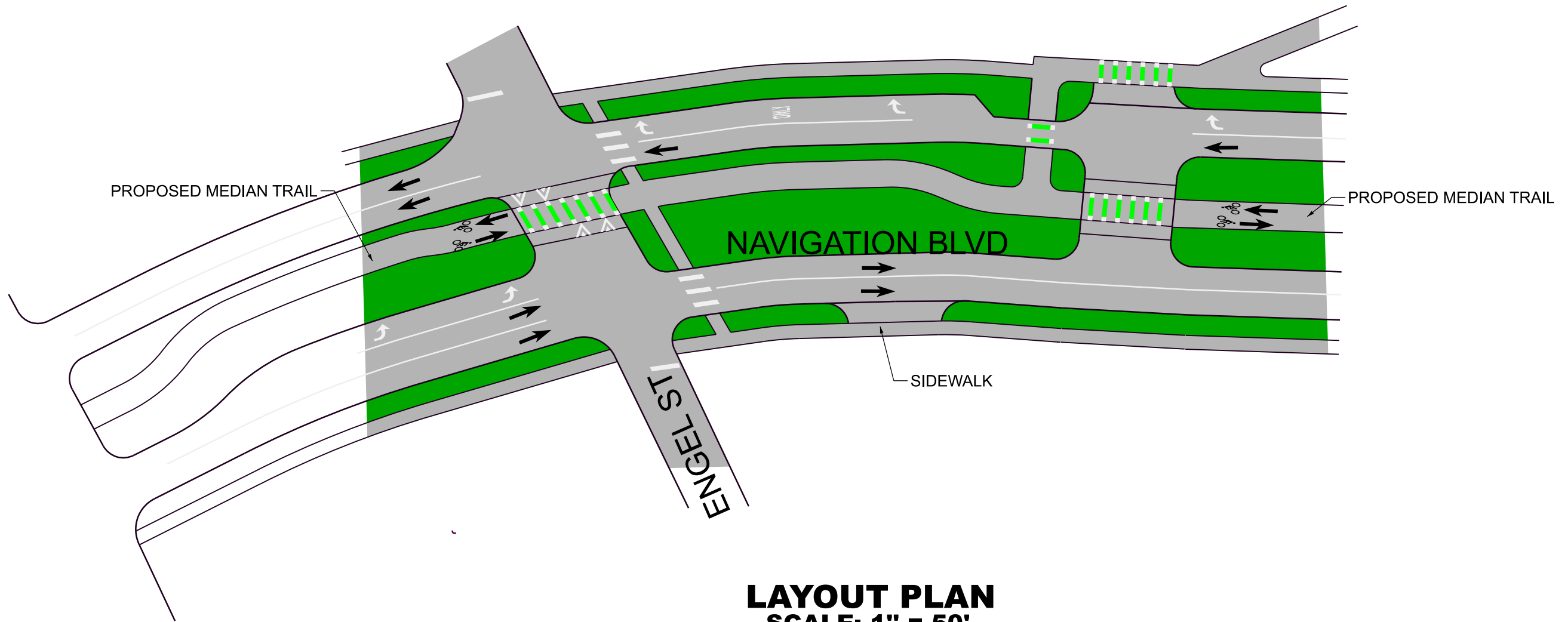
SCIENTECH
 ENGINEERS, INC.
 701 SHEPHERD DRIVE, SUITE 200
 HOUSTON, TX 77007
 TEXAS FIRM REGISTRATION NO. 4014

FOR INTERIM REVIEW ONLY
 DOCUMENT INCOMPLETE:
 NOT INTENDED FOR CONSTRUCTION,
 BIDDING, OR PERMIT PURPOSES
 ENGINEER: DAVID H. SADEGHPOUR, P.E.
 P.E. SERIAL No. 53705
 DATE: 04/07/2023

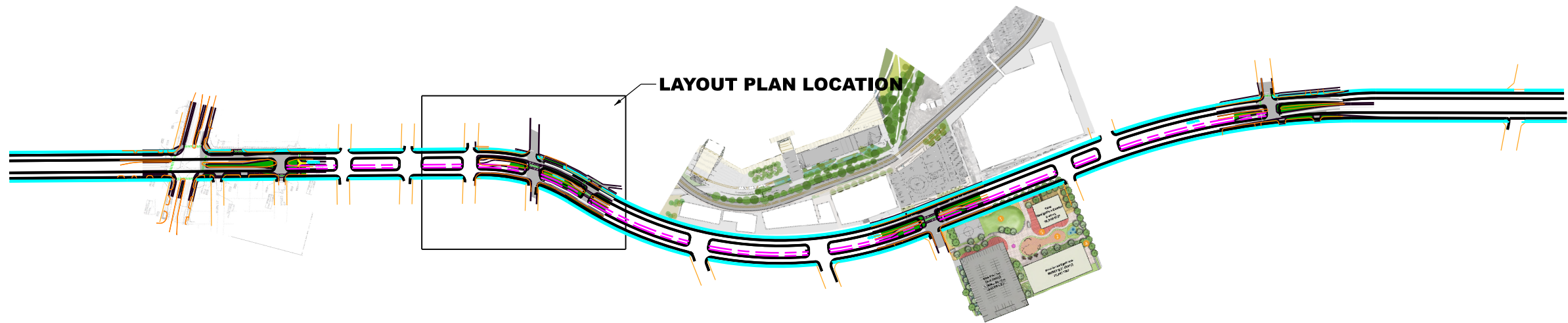
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SHEET DESCRIPTION:			
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LAYOUT PLAN
SCALE: 1" = 50'



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HARRIS COUNTY
ENGINEERING DEPARTMENT



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SHEET DESCRIPTION:			
DRAWN BY:		DATE:	04-07-2023
CK'D BY:	SCALE:	SHEET NO:	XX

AD

DHS

PROPOSED MEDIAN TRAIL

NAVIGATION BLVD

SIDEWALK

NORWOOD ST

PROPOSED MEDIAN TRAIL

LAYOUT PLAN
SCALE: 1" = 50'

LAYOUT PLAN LOCATION

NO. REVISIONS DATE NAME

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HARRIS COUNTY
ENGINEERING DEPARTMENT



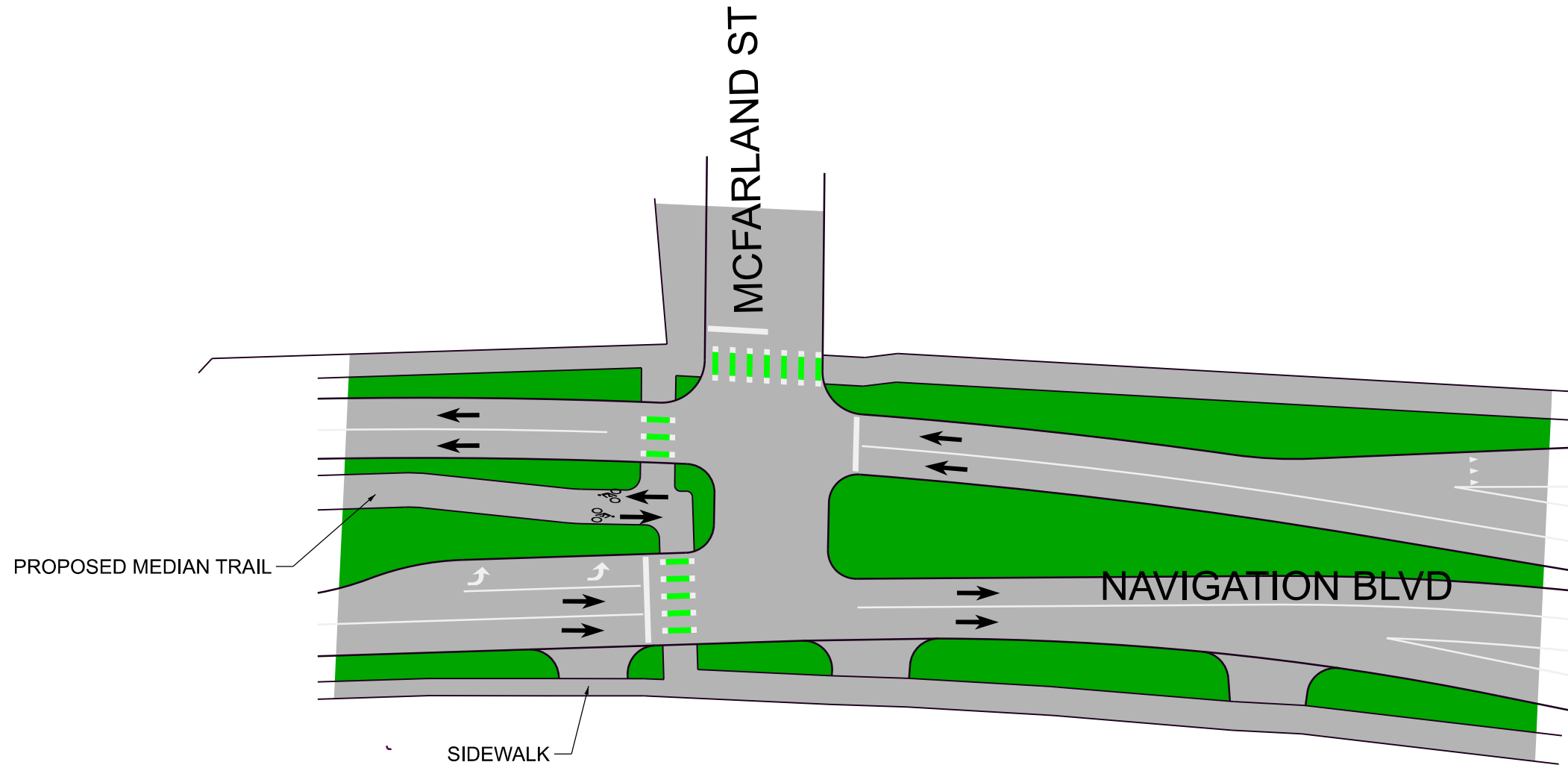
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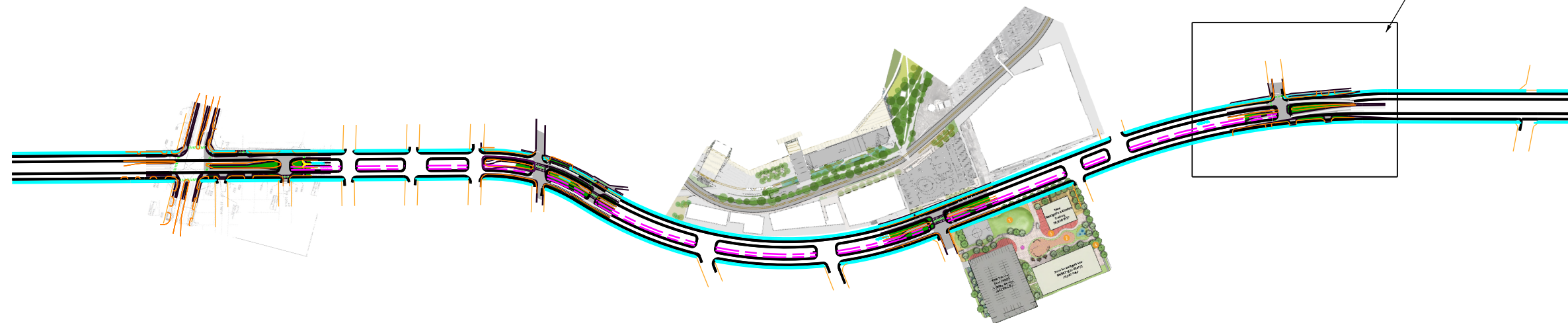
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LAYOUT PLAN
SCALE: 1" = 50'

LAYOUT PLAN LOCATION



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DRAWN BY:			DATE: 04-07-2023
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AD

DHS

Navigation Boulevard from Lockwood Dr. to Mack St., UPIN:22102MF2D601 , PRECINCT 2

PRELIMINARY CONSTRUCTION COST ESTIMATE

Item No.	Spec. No.	Description	Unit of Measure	Estimated Quantity	Unit Price	Total Price
A		Site Preparation				
100		Install , maintain and Remove Project Sign	EA	2	\$ 1,200.00	\$ 2,400.00
102		Clearing and Grubbing	LS	1	\$ 25,000.00	\$ 25,000.00
104		Removing Old Concrete, 6" Reinforced Concrete Curb (Removal and Disposal)	LF	22,000	\$ 3.00	\$ 66,000.00
104		Remove existing concrete sidewalk	SY	4,889	\$ 8.00	\$ 39,111.11
110		Roadway Excavation (Including 3" Topsoil Stripping)	CY	15,000	\$ 10.00	\$ 150,000.00
465		Remove and Dispose Reinforced Concrete Pipe	LF	5,500	\$ 22.00	\$ 121,000.00
495		Remove Old Structures, Inlets, Manholes, SET, etc	EA	37	\$ 750.00	\$ 27,500.00
495		Remove Old Structures (MBGF/Turn Down Sections) w/mow strip	LF	260	\$ 15.00	\$ 3,900.00
500		Remove and Dispose of Existing Traffic Signs, MailBoxes and Roadway signs	LS	1	\$ 7,500.00	\$ 7,500.00
540		Removing and Disposing of Existing Asphaltic Surface and Base Material	SY	45,222	\$ 10.00	\$ 452,222.22
674		Removal of all Striping and Pavement markings	LS	1	\$ 7,500.00	\$ 7,500.00
		Video Recording Construction	LS	1	\$ 15,000.00	\$ 15,000.00
		Subtotal of A				\$ 917,133.33
B		Drainage				
429		Trench Safety Systems, All Depth	LF	6,500	\$ 2.00	\$ 13,000.00
460		Reinforced Concrete Pipe, C76, Class III, Rubber Gasket (24")	LF	571	\$ 150.00	\$ 85,650.00
460		Reinforced Concrete Pipe, C76, Class III, Rubber Gasket (30")	LF	649	\$ 165.00	\$ 107,085.00
460		Reinforced Concrete Pipe, C76, Class III, Rubber Gasket (36")	LF	1,471	\$ 180.00	\$ 264,780.00
460		Reinforced Concrete Pipe, C76, Class III, Rubber Gasket (42")	LF	887	\$ 201.00	\$ 178,287.00
460		Reinforced Concrete Pipe, C76, Class III, Rubber Gasket (48")	LF	224	\$ 255.00	\$ 57,120.00
460		Reinforced Concrete Pipe, C76, Class III, Rubber Gasket (54")	LF	584	\$ 310.00	\$ 181,040.00
471		Precast Concrete Shallow Manhole, With a Depth Less Than 5 Feet	EA	7	\$ 4,500.00	\$ 31,500.00
471		Precast Concrete Extra Depth Manhole, With a Depth Greater Than 5 Feet And Less Than	EA	7	\$ 4,500.00	\$ 31,500.00
472		Standard Type "B-B" Inlet	EA	30	\$ 4,500.00	\$ 135,000.00
		Subtotal of B				\$ 1,084,962.00
C		Subgrade & Paving				
223		Lime Stabilized Subgrade Manipulations, 8" Depth	SY	47,667	\$ 3.00	\$ 143,000.00
221		Hydrated Lime (Slurry Applied) for Stabilization(6% By Dry Weight)	TON	862	\$ 200.00	\$ 172,458.00
360		Reinforced Concrete Pavement - 10" Depth	SY	45,222	\$ 94.00	\$ 4,250,888.89
516		Furnish & Install Flex Beam Guard Rail, 10 Gauge with Mow Strip	LF	200	\$ 70.00	\$ 14,000.00
516		Furnish & Install Turn Down Terminal Section (25' long), 10 Gauge, with Anchor	EA	2	\$ 2,000.00	\$ 4,000.00
530		6" Thick Reinforced Concrete Driveway	SY	1,000	\$ 90.00	\$ 90,000.00
530		4-1/2" sidewalk	SY	3,056	\$ 60.00	\$ 183,333.33
530		4-1/2" shared path (15' wide)	SY	9,167	\$ 60.00	\$ 550,000.00
530		6" Concrete Curb	LF	22,000	\$ 8.00	\$ 176,000.00
530		ADA RAMP - TYPE 7	EA	40	\$ 2,000.00	\$ 80,000.00
		Subtotal of C				\$ 5,663,680.22
D		Sanitary & Water Lines				
COH		Lump sum for adjustments of Utilities only till further coordination/design				\$ 50,000.00
		Subtotal of D				\$ 50,000.00
E		Traffic Control				
671		Traffic Control - Furnish-Install & Remove	MO	12	\$ 20,000.00	\$ 240,000.00
696		Low Profile Concrete Barrier - Furnish and Install	LF	4,000	\$ 20.00	\$ 80,000.00
696		Low Profile Concrete Barrier - Move and Reset	LF	2,000	\$ 5.00	\$ 10,000.00
696		Low Profile Concrete Barrier - Remove	LF	4,000	\$ 5.00	\$ 20,000.00
		Subtotal of E				\$ 350,000.00
F		Signing & Striping				
624		Aluminum Signs (Ground Mounted)- Furnish & Install	EA	60	\$ 450.00	\$ 27,000.00
624		Aluminum Signs (Ground Mounted)- Relocate	EA	20	\$ 150.00	\$ 3,000.00
658		Delineators and Object Markers	EA	8	\$ 150.00	\$ 1,200.00
658		Striping	LS	1	\$ 100,000.00	\$ 100,000.00
		Subtotal of F				\$ 131,200.00
G		Storm Water Pollution Prevention Plan				
162		16" Sodding Strip (Along Curbs)	LF	22,000	\$ 4.00	\$ 88,000.00
165		Hydromulch Seeding	AC	5	\$ 1,500.00	\$ 7,500.00
700		TPDES General Permit No. TXR 150000, Notice of Intent (NOI) Application Fees	EA	2	\$ 325.00	\$ 650.00
713		Reinforced Filter Fabric Barrier (60% unit cost for furnish and installation and 40% unit cost	LF	1,440	\$ 2.00	\$ 2,880.00
719		Inlet Protection Barrier (Stage 1, With Reinforced Filter Fabric Fence; 60% of unit cost for	EA	18	\$ 50.00	\$ 916.67
724		Stabilized Construction Access (Type 1-Rock; 60% of unit cost for furnish and installation,	SY	222	\$ 30.00	\$ 6,666.67
730		Concrete Truck Washout Structures (60% of unit cost for furnish and installation, and 40% of	LS	1	\$ 1,500.00	\$ 1,500.00
741		Inlet Protection Barrier (For Stage II Inlets, Gravel Bags;60% of unit cost for furnish and	EA	18	\$ 50.00	\$ 900.00
750		Rock Filter Dam (Type 3: Inlets, 60% of unit cost for furnish and installation, and 40% of unit	EA	6	\$ 2,000.00	\$ 12,000.00
751		SWPPP Inspection and Maintenance (Min. Bid of \$6000.0/MO.)	MO	18	\$ 6,000.00	\$ 108,000.00
		Subtotal of G				\$ 229,013.33
H		Miscellaneous				
		Detention Pond	LS	1	\$ -	\$ -
		Traffic Signals	LS	1	\$ 250,000.00	\$ 250,000.00
		Planting	LS	1	\$ 200,000.00	\$ 650,000.00
		Irrigation	LS	1	\$ 100,000.00	\$ 100,000.00
		Pedestrian Lighting	LS	1	\$ 350,000.00	\$ 350,000.00
		Subtotal of H				\$ 1,350,000.00
		Total (Items A-H)				\$ 9,775,988.89
		Contingency (20%)				\$ 1,955,197.78
		Grand Total				\$ 11,731,186.67



DRAFT Navigation Boulevard Cross-Section Alternatives & Traffic Analysis

To: David Sadeghpour, PE
Scientech Engineers, Inc.

From: James Llamas, PE
TEI Planning + Design

Date: March 28, 2023

Background

Navigation Boulevard is a City of Houston thoroughfare through the East End and Second Ward neighborhoods. The extents for this study are Lockwood Drive to Mack Street, approximately 1.1 miles in length. This segment of roadway is classified in the City of Houston Major Thoroughfare and Freeway Plan (MTFP) as a Principal Thoroughfare with six lanes within a 120-foot right-of-way. See **Figure 1**. The posted speed limit is 35 miles per hour. Adjacent to Navigation Boulevard, the land use is mostly a mix of industrial and light industrial, along with some commercial, residential, and adaptive reuse. A three-block section of Navigation west of the study area has been previously updated to include an esplanade in the median with amenities and programmable spaces. This study is to consider alternative roadway designs for Navigation in the study area that will best improve mobility and safety for all road users, support existing businesses, anticipate changes in land use in the surrounding area, and increase access to parks and recreational opportunities.



Figure 1: Navigation Boulevard Project Extents

Both the City of Houston and Harris County have adopted the objective of Vision Zero: achieving no traffic deaths or severe injuries. Both entities have identified part of the study segment on their High-Injury Networks, which are composed of the roadways on which a disproportionately high number of violent traffic crashes occur. Safety is an important factor in weighing different design considerations.

Anticipated developments and capital projects near Navigation will bring other mobility and public space improvements to the area. Buffalo Bayou Partnership is planning considerable investment into Buffalo Bayou East, which parallels Navigation Boulevard. The improvements will include a linear greenway along the bayou with improved connections for people walking and bicycling to existing neighborhoods and parks. Buffalo Bayou Partnership is planning a public space at Turkey Bend, a former oxbow of Buffalo Bayou, along Navigation Boulevard at the intersection with N. Norwood Street. Across the street, Harris County has plans to redevelop a site that will include a community center, public plaza, parking garage, Sheriff's Office building, and detention pond. The City of Houston has a capital project on Lockwood Drive in the works that will impact the Navigation intersection. METRO is planning Bus Rapid Transit (BRT) along Lockwood Drive. The conceptual plans for Navigation were developed to provide safe connectivity to existing and planned destinations and projects.

Existing Roadway Characteristics

Today, Navigation is four to six lanes wide with a center median. Travel lanes for vehicles tend to be far wider than contemporary City of Houston standards. Sidewalks are typically four feet wide, narrower than the six feet now required by the City of Houston on Major Thoroughfares. On both the north and south sides of the street, there are approximately 30 driveways each that provide access to businesses. Within the study area, the median has approximately twelve openings that provide vehicle access to cross streets and allow U-turns.

From Lockwood Drive to Engel Street, Navigation Boulevard has two wide travel lanes in each direction with a 30-foot-wide center median. See **Figure 2**.

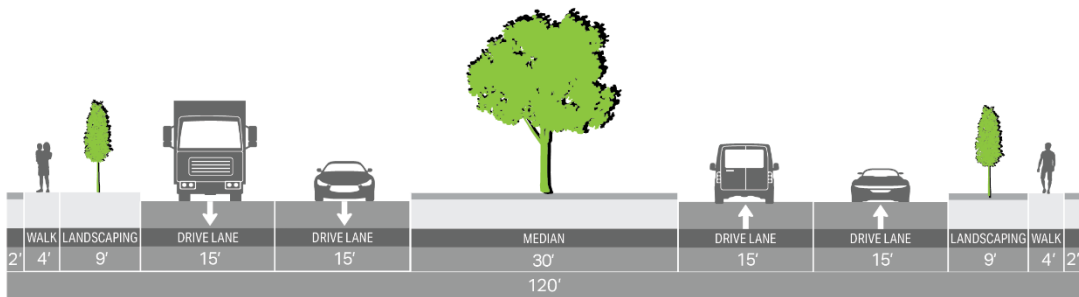


Figure 2: Existing Typical Section Lockwood to Engel

East of Engel Street, the boulevard widens to three travel lanes in each direction, while the median is narrowed to ten feet. See **Figure 3**. This typical section continues to McFarland street and comprises the majority of the study segment.

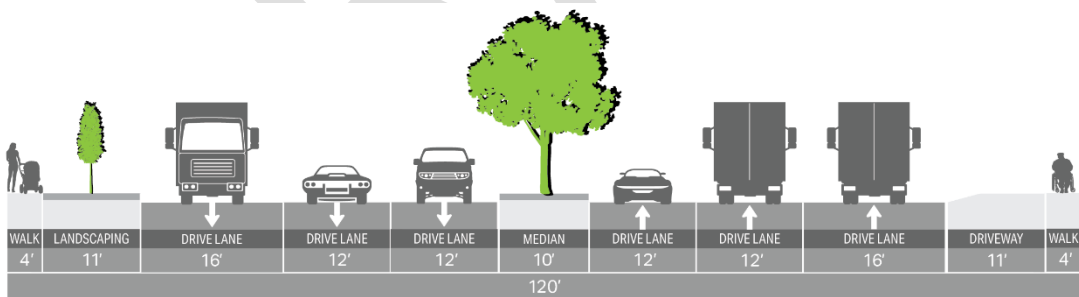


Figure 3: Existing Typical Section Engel to McFarland

Just east of the study segment, Navigation Boulevard crosses the UPRR East Belt line. Beginning around McFarland Street, Navigation Boulevard transitions two main lanes in each direction that are elevated along an overpass over the railroad tracks, while two frontage lanes in each direction cross the railroad at-grade, providing access to local destinations. See **Figure 4**.

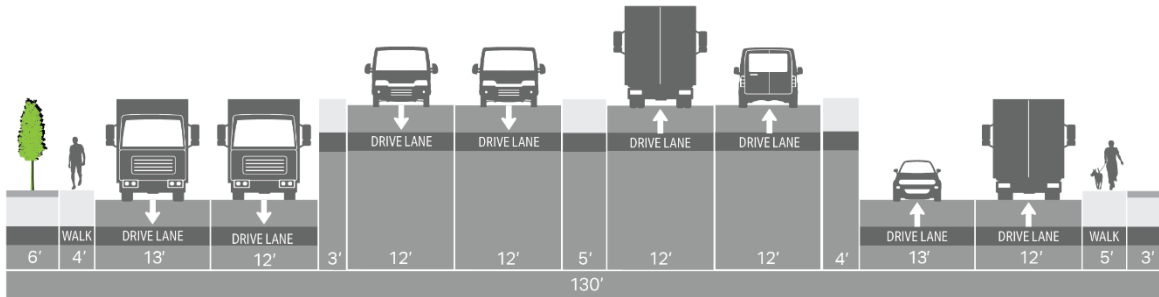


Figure 4: Existing Typical Section McFarland to Mack

Travel along the study segment of Navigation Boulevard is mostly unimpeded. The only traffic signal is at Lockwood Drive, another Principal Thoroughfare with two travel lanes in each direction. For all other streets, there is no stop control on Navigation Boulevard, while there are stop signs at cross-streets and major driveways. There are few marked crossings for people walking and bicycling. Only two marked crosswalks were observed on visual inspection, neither of which has ADA standard pedestrian ramps or median refuges. The existing stop control and pedestrian markings are summarized below in **Figure 5**.



Figure 5: Existing Stop Control and Pedestrian Crossings

Vehicle Operations

To help inform the design, existing vehicle counts were collected in October 2022. Vehicle volumes were the highest on the west end of the study segment, approaching almost 13,000 vehicles per day. The daily traffic counts were collected in three locations and summarized in **Figure 6** below.

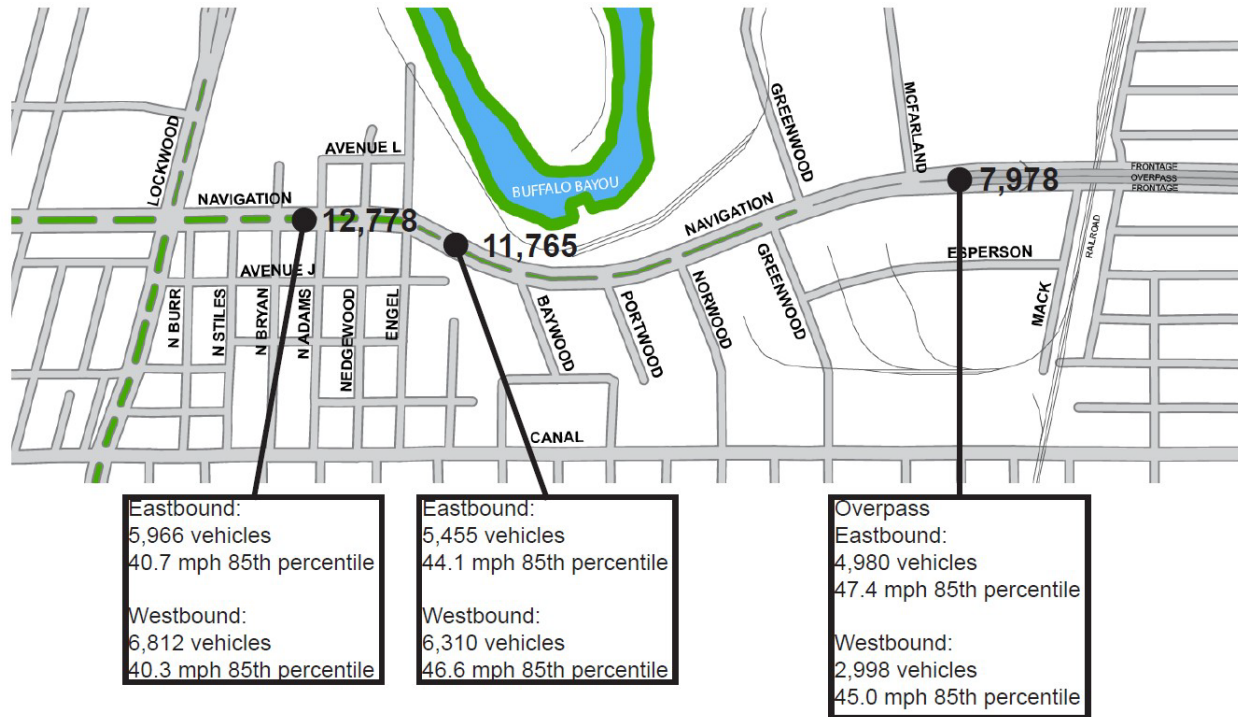


Figure 6: Average Daily Traffic & 85th Percentile Speeds

Data collection also included vehicle speeds at the same three locations. The 85th percentile speeds ranged from 40 mph on the west side of the study segment to 45 mph or more in the middle and east end of the study segment. Throughout the corridor, two in three vehicles were measured to be exceeding the 35 mph speed limit. The rates by location are summarized below.

	Eastbound	Westbound
N. Adams	50%	46%
Baywood	74%	74%
Mack	88%	74%

Table 1: % Speeding Vehicles

Capacity analyses were conducted for existing conditions in the study area using the Highway Capacity Manual, 6th Edition. Capacity analysis provides information regarding traffic operations at an intersection and is expressed in terms of the level-of-service (LOS) to provide an index to the operational qualities of a intersection. As a frame of reference, intersection levels-of-service range from A to F, with LOS A representing free flow conditions and LOS F representing highly congested conditions. LOS designation is reported differently for signalized and unsignalized intersections.

For signalized intersections, the analysis considers the operations of each lane or lane group entering the intersection and the LOS designation is for the overall conditions at the intersection.

For unsignalized intersections, however, this analysis assumes the traffic on the major approaches is not affected by traffic on the side streets. The LOS is only determined for left turns from the main street and all movements from the minor street; the LOS designation is for the most critical movement. In general, signalized intersections or stop-controlled approaches operating at LOS D or better are considered acceptable in urban areas.

Using the October 2022 traffic counts, a traffic model was developed to assess to vehicle operations and LOS for both the AM Peak Hour and PM Peak Hour. At all unsignalized intersections, vehicles along Navigation have free-flowing conditions, so the LOS indicates the delay for vehicles on the cross-streets. See **Figures 7 and 8**. All intersections are currently operating at LOS C or better, except for two locations. The signalized intersection at Lockwood Drive operates at LOS D, which is not uncommon for peak hour conditions at the intersection of two Thoroughfares. McFarland Street, which is a three-legged intersection that has the highest traffic volumes for any of the unsignalized locations, operates at LOS E in the AM Peak and LOS F in the PM Peak.



Figure 7: 2022 AM Peak LOS



Figure 8: 2022 PM Peak LOS

For a more comprehensive summary of vehicle usage along the corridor, including turning movement counts for each intersection, see **Appendix A 2022 Traffic Volumes**.

Safety

A crash analysis was conducted along the study corridor to better understand the safety performance of the current roadway and help inform the design. The types of crashes identified include vehicular, pedestrian, and bicycle in a five-year period between 2017 and 2021. The data was sourced from the Texas Department of Transportation's Crash Reporting Information System (CRIS).

A total of 188 crashes of all types were identified along the segment. A crash density analysis shows that the intersections with Lockwood Drive (28 crashes), N Edgewood Street (9 crashes), Engel Street (14 crashes), N Greenwood Street (13 crashes), and McFarland Street (15 crashes) were the most dangerous during the 5 years of study. See **Figure 9**.

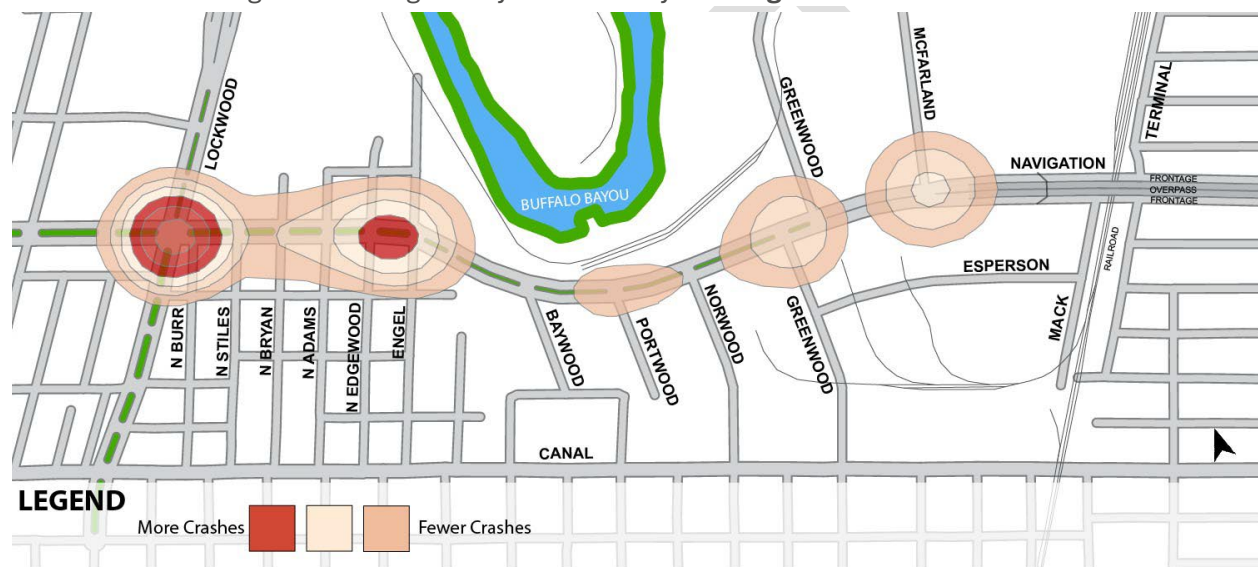


Figure 9: Crash Density Map

In five cases people were seriously injured including one crash each at Engel Street, Baywood Street, Norwood Street, Greenwood Street, and Mack Street. Additionally, one crash at Portwood Street involved a person walking, and one crash at Mack Street involved a person riding a bicycle. These findings indicate that this segment of Navigation poses a safety risk for all road users with the existing configuration.

Based on this crash history, a portion of this segment of Navigation Boulevard is on the City of Houston's High-Injury Network – the 6% of City streets where 60% of traffic deaths or serious injury crashes occur. See **Figure 10**. The City is prioritizing safety improvements along these corridors to achieve the goal of no serious injuries or deaths on City streets by 2030.



Figure 10: Segment within City of Houston High-Injury Network

METRO Transit

There is no transit service on the study segment of Navigation Boulevard, however there is existing and planned service on Lockwood. Today, the METRO 80 MLK / Lockwood provides bus services that connects Tidwell Transit Center to the north, and Eastwood Transit Center and beyond to the south. There are currently 20-minutes headways; however, before pandemic-related service cuts the headway was 15 minutes or better.

METRO is in the planning stages of the University Line, a bus rapid transit (BRT) project that would provide faster bus service within a dedicated busway. The proposed BRT alignment is over 25 miles in length and would span from Westchase District east to Texas Southern University and the University of Houston Main Campus, and then north to Tidwell Transit Center via Lockwood. Navigation intersects Segment 4 of the University Line, which is along Lockwood from Eastwood Transit Center to Fifth Ward / Denver Harbor Transit Center.

The 20 Canal/Memorial, a local bus route with 30-minute headways, operates parallel to the corridor to the south along Canal Street. Canal Street has an at-grade crossing over the freight rail line that is frequently blocked by trains. When this occurs, the 20 Canal/Memorial often detours to Navigation to make use of the overpass.



Figure 11: University Line Rendering on Lockwood

City of Houston Improvements on Lockwood

The City of Houston has a capital project underway that will reconstruct Lockwood Drive adjacent to Navigation Boulevard from the bridge over Buffalo Bayou to Suburban Street, south of Navigation. The plans include a wide multi-use path on both sides of Lockwood. At the Navigation intersection there will be elements of a protected bicycle intersection. On Navigation, the plans include the beginnings of protected bike lanes to the east and west of Lockwood. The portion of the plans that overlap with the study segment on Navigation have a narrow center median, and back-of-curb protected bikeways on both sides of the street. The lane on the north side of the street is for people bicycling westbound, while the lane on the south side of the street is for people bicycling eastbound. The plans also include the closure of median opening at N Stiles Street. It is currently expected that the City of Houston improvements will be constructed in the near term, and the METRO University Corridor will be retrofitted onto the reconstructed street in the future. In the **Preferred Alternative** section, there is a detailed summary about how improvements on Navigation will be designed with the Lockwood improvements in mind.

Future Developments

Buffalo Bayou Partnership developed a 10-Year Plan for their Buffalo Bayou East Master Plan. Near-term actions include investments in greenways, trails, parks, and redevelopment. For the Turkey Bend site near N Norwood Street, there are plans to include a Hispanic Heritage Research Center, indoor public gathering space, an outdoor event space, a boating center with a canoe/kayak launch, and a plaza in front of the building along Navigation. The roadway improvements along Navigation are intended to incorporate safe connections and crossings into the Turkey Bend site plan.



Figure 12: Turkey Bend Redevelopment Rendering
Source: Buffalo Bayou East 10-Year Plan

Harris County has plans for the redevelopment of a site across the street from the Turkey Bend redevelopment. The plans include a community center with an outdoor public plaza that will both front Navigation Boulevard. There will also be Harris County Sheriff's Office facilities, including office space and evidence processing. A parking garage with 450 to 600 spaces will be located on the site, with access from N Norwood Street.



Figure 13: Harris County Site Plan

Cross-section Alternatives

To achieve the wide-ranging project objectives, several alternative cross-section features have been considered. Four typical sections were identified, and each approach received more detailed study. The four Alternatives included:

- Alternative 1: North Greenway
- Alternative 2: South Greenway
- Alternative 3: Median Trail
- Alternative 4: North Trail

Each alternative includes a wide trail for people walking and bicycling, as well as sidewalk upgrades. The impacts to vehicle capacity and vehicles operations were considered, and lane widths were typically reduced to City standards to create safer conditions and free up room for other improvements.

Alternative 1: North Greenway

The North Greenway approach would convert the travel lanes on the north side of the median into a greenspace and relocate all westbound traffic to a reconfigured south side of the street. The repurposed north side of the street plus existing medians would provide a wide space that could include existing and new landscaping, a wide multi-use trail, and trail amenities.

From Lockwood Drive to Engel Street, there are two lanes on the south side of the median for eastbound traffic. These lanes would be reconfigured with one eastbound lane and one westbound lane. See **Figure 14**. At the Lockwood intersection, and other intersections that warrant, the median could be narrowed to provide space for an additional turn lane.

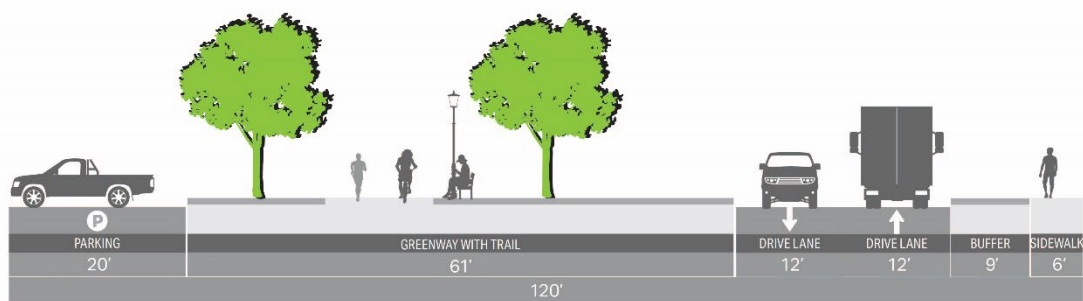


Figure 14: Alt. 1 Typical Section Lockwood to Engel

From Engel Street to McFarland Street, where the existing roadway has three travel lanes in each direction, there would be room on the south side of the street one travel lane in each direction, plus a center turn lane. See **Figure 15**.

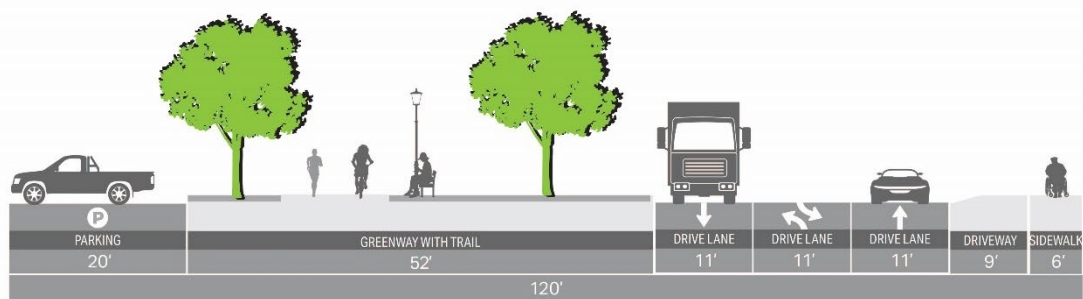


Figure 15: Alt. 1 Typical Section Engel to McFarland

East of McFarland Street, where the main Navigation lanes are elevated to pass over the railroad, the trail would likely transition out of the median and continue east back-of-curb. See **Figure 16**.

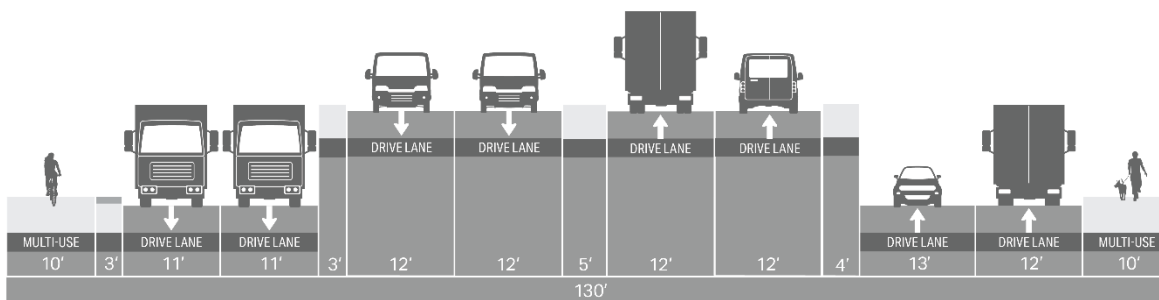


Figure 16: Alt. 1 Typical Section McFarland to Mack

With the North Greenway, it would be difficult to maintain the existing head-in parking on the north side of the street. To provide access to destinations on the north side of Navigation, there would need to be lengthy driveways that cross the greenway and trail. Opportunities for on-street parallel parking would be limited. The sidewalk on the south side of the street could also be widened to six feet.

Alternative 2: South Greenway

The South Greenway is a similar approach to Alternative 1, but with the greenway and trail on the south side of the Street.

From Lockwood Drive to Engel Street, the two lanes on the north side of the median for westbound traffic would be reconfigured with one eastbound lane and one westbound lane. See **Figure 17**. At the Lockwood intersection, and other intersections that warrant, the median could be narrowed to provide space for an additional turn lane.

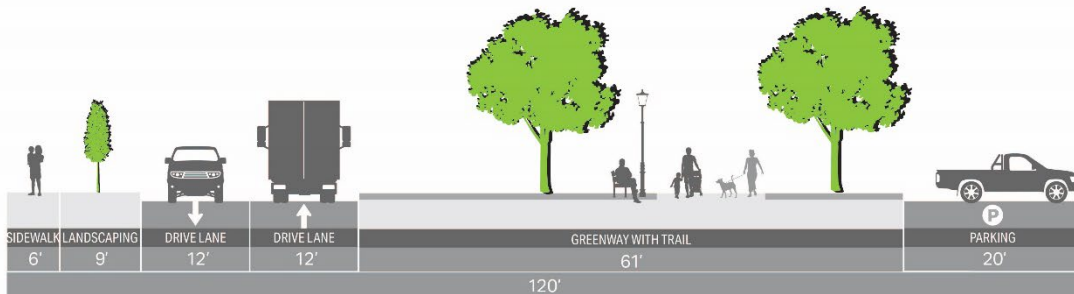


Figure 17: Alt. 2 Typical Section Lockwood to Engel

From Engel Street to McFarland Street, where the existing roadway has three travel lanes in each direction, the north side of the street would have one travel lane in each direction, plus a center turn lane. See **Figure 18**.

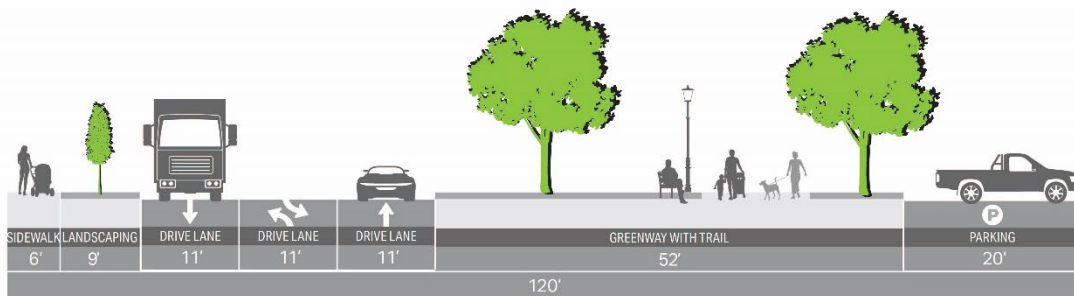


Figure 18: Alt. 2 Typical Section Engel to McFarland

East of McFarland, where the main lanes on Navigation pass over the railroad, the trail would likely transition out of the median and continue east back-of-curb. See **Figure 19**.

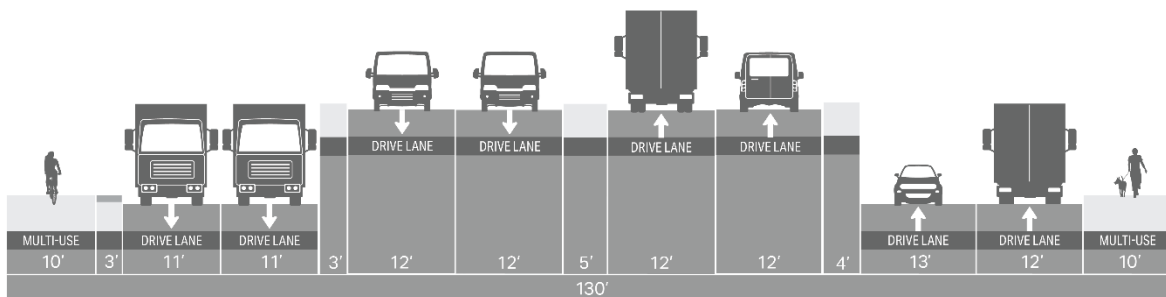


Figure 19: Alt. 2 Typical Section McFarland to Mack

Like Alternative 1, with Alternative 2 it would be difficult to maintain any head-in parking near the greenway on the south side of the street. To provide access to destinations on the south side of Navigation, there would also need to be lengthy driveways that cross the greenway and trail. Opportunities for on-street parallel parking would be limited. The sidewalk on the north side of the street could also be widened to six feet from Lockwood Street to McFarland Street.

Alternative 3: Median Trail

The Median Trail alternative takes advantage of the existing median and widens it by reallocating an eastbound and westbound lane.

From Lockwood Street to Engle Street, there would typically be two lanes with a slightly wider median than is present today. See **Figure 20**. At the Lockwood intersection there may be three westbound lanes including a left-turn lane, and only one westbound receiving lane.

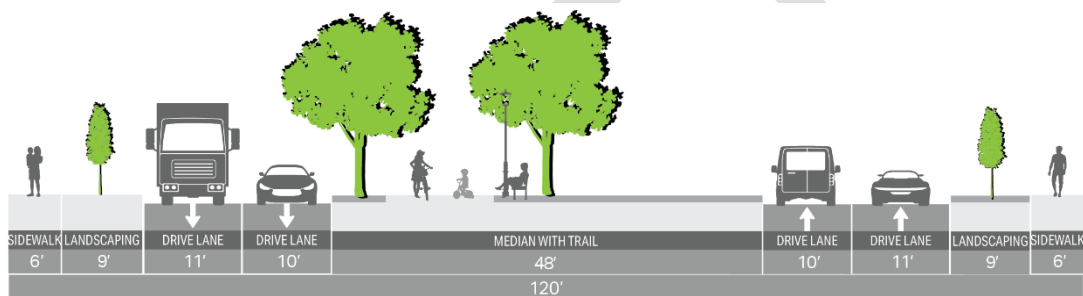


Figure 20: Alt. 3 Typical Section Lockwood to Engel

The cross-section would remain nearly identical from Engel Street to McFarland, with a wide median with a trail with landscaping and the opportunity for trail amenities. With two lanes in each direction, there is the option to provide on-street parking. See **Figure 21**.

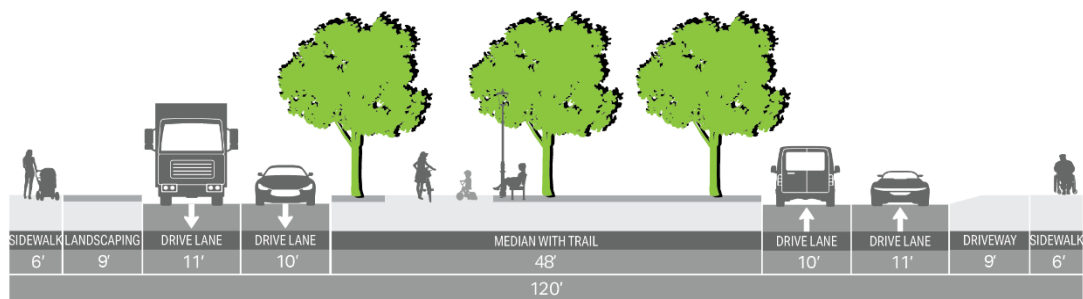


Figure 21: Alt. 3 Typical Section Engel to McFarland

Like the previous alternatives, east of McFarland the trail would likely transition out of the median and continue east back-of-curb. See **Figure 22**.

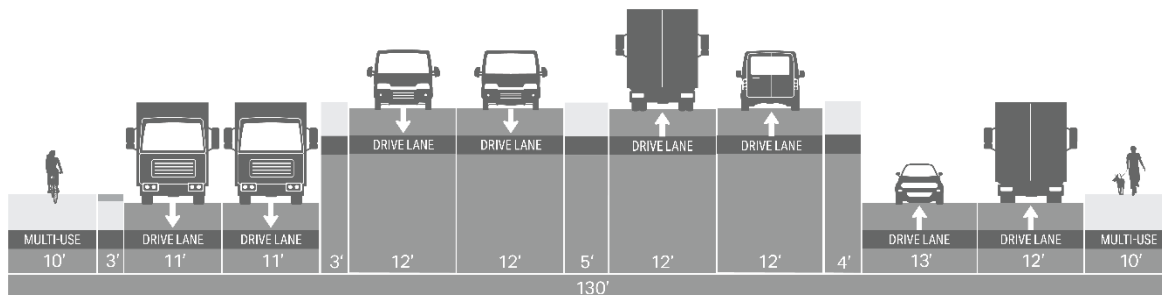


Figure 22: Alt. 3 Typical Section McFarland to Mack

With the Median Trail alternative, all existing head-in parking could be maintained. There would also be the possibility to add parallel on-street parking on either side of the street. By preserving the existing outer curbs of the roadway where they are today, it is anticipated that the utility costs associated with this approach can be minimized. The type of conflicts for the median trail would differ from Alternative 1 and Alternative 2. While each of those have approximately 30 driveway conflicts, the median trail would have no driveway conflicts, and instead approximately 10 median opening conflicts. Sidewalks on both sides of the street could also be widened to six feet.

Alternative 4: North Trail

The final alternative evaluated was to create a back-of-curb multi-use trail. The north side of the street is the preferred location for a single trail because it is closer in proximity to the planned pedestrian and bicycle facilities along Buffalo Bayou.

To create a more comfortable experience for people walking and bicycling, a wide, landscaped buffer would separate the trail from vehicles. Both westbound lanes would be narrowed to create a 12-foot-wide buffer along the Segment from Lockwood Street to Engel Street. See **Figure 23**. The median and the south side of the street could remain unchanged, preserving the existing wide median, and both travel lanes.

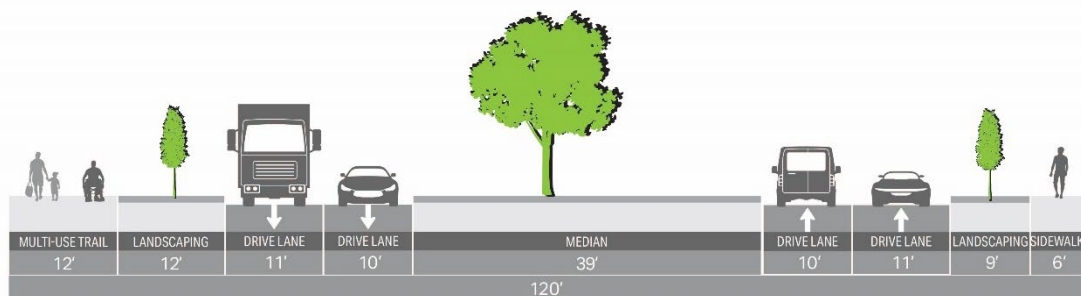


Figure 23: Alt. 4 Typical Section Lockwood to Engel

From Engel to Lockwood, one westbound lane could be reallocated for landscaping, and the two remaining travel lanes could be narrowed to create an 11-foot landscaped buffer on either side of the trail. On the south side of the street, one travel lane could be reallocated, and the two remaining could be narrowed to create a wider median. See **Figure 24**.

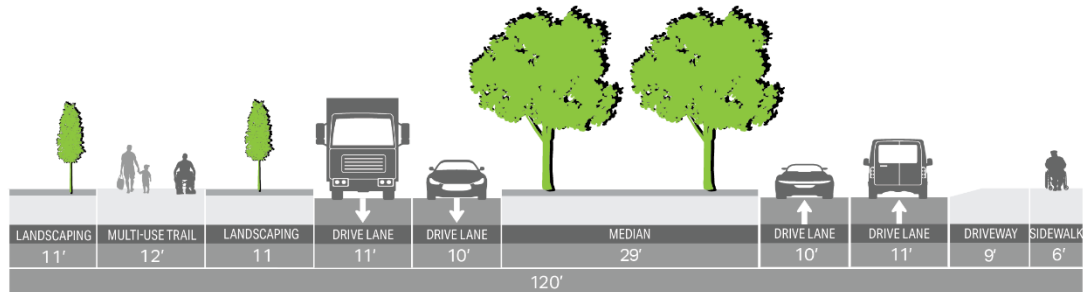


Figure 24: Alt. 4 Typical Section Engel to McFarland

Like all other alternatives, east of McFarland, the trail would remain a back-of-curb facility. See **Figure 25**.

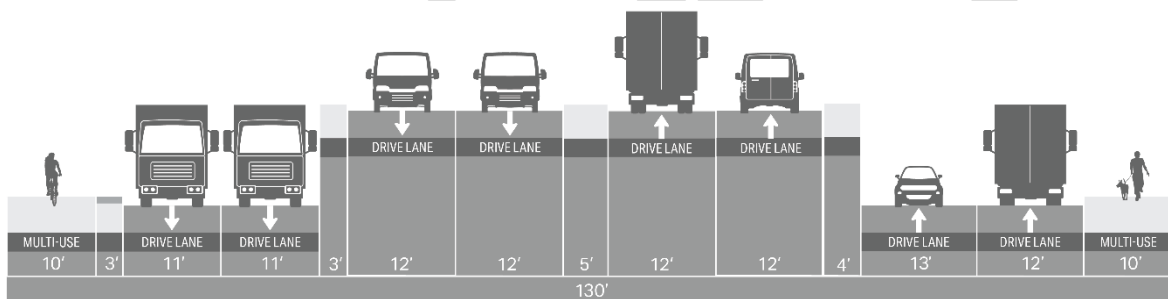


Figure 25: Alt. 4 Typical Section McFarland to Mack

On the north side of the street, it would be difficult to maintain head-in parking, and the trail would cross approximately 30 driveways. However, it would be possible to have on-street parking in select places. On the south side of the street, there would be minimal impacts to existing parking, the ability to widen the sidewalk to six feet, and the opportunity to add on-street parking.

Preferred Alternative: Median Trail

The Preferred Alternative is the Median Trail, because of the:

- Quality and safety of the experience for people walking and bicycling;
- Fewer conflict points for the trail facility;
- Lower impacts to vehicle capacity;
- Lower impacts to and new opportunities for parking;
- Anticipated minimized utility impacts; and
- Lower anticipated implementation costs.

Below is a more detailed comparison of the different alternatives, highlighting the advantages of the Median Trail.

- With the median trail, like the other scenarios, there would be a consistent wide trail for people walking and bicycling, and the opportunity to widen all sidewalks to six feet in width.
- For the North Greenway, South Greenway, and North Trail Alternatives, the trail would cross approximately 30 driveways, presenting conflicts between trail users and cars. The Median Trail would cross no driveways, and instead have ten or fewer median crossings. These crossings could be designed to be elevated, where possible, and create maximum visibility for people driving to see trail users.
- The travel lane impacts would be greatest for the North Greenway and South Greenway Alternatives, as they would reduce the number of lanes from six to three along the majority of the study segment. However, with the Median Trail and North Trail, there would be room for two lanes in each direction, with an opportunity to narrow the median and add a left-turn lane wherever deemed necessary.
- With only one travel lane in each direction in the North Greenway and South Greenway Alternatives, there would not be an option to add parallel, on-street parking. With an additional travel lane in both the Median Trail and North Trail Alternatives, there would be the possibility to add parallel parking in locations where two lanes of vehicle capacity are not needed.
- It would be difficult to maintain access to existing off-street head-in parking on the side of the street with the trail in the North Greenway, South Greenway, and North Trail Alternatives. However, with the Median Trail, all existing head-in parking could be maintained.
- Any major modifications to the existing curbs and gutters will have impacts to the roadway drainage and the drainage costs associated with the project improvements. The North Greenway and South Greenway would both have extensive impacts on the side of the street that is being converted into a greenway. The North Trail would result in the curb and gutter on the north side of the street being relocated. The Median Trail would impact the median curbs; however, the storm water inlets are typically on the north and south edges of the street, so the costs associated with the approach are anticipated to be the lowest.
- All four Alternatives would create a new roadway cross-section that varies with the roadway to the east and west of the study limits. In both the North Greenway and South Greenway Alternatives, the roadway would differ dramatically from the adjacent segments, and the transition for a three-lane street to a boulevard street would be more impactful and possibly come at a higher cost. In both scenarios with a median, the Median Trail and North Trail, the transition can be relatively straightforward since the continuous presence of a median can be used to help align the study segment with the adjacent ones. A more straightforward transition should make integration with the Lockwood project more seamless.

Preferred Alternative

Planning level schematics were developed at four locations along the study area to illustrate the Preferred Alternative improvements and demonstrate how they would be integrated with the adjacent streets and land use. The four locations include: Lockwood Drive, Engel Street, N. Norwood Street, and McFarland Street.

For larger, more comprehensive drawings, see **Appendix B Conceptual Schematic Sheets**.

Lockwood Drive

The intersection of Navigation and Lockwood is an important location to understand, because it is the only existing signalized intersection, the intersection with the highest vehicle usage, the location of the planned COH improvement project, the planned location of METRO BRT, and the western terminus of the study area.

The City of Houston plans for the Lockwood at Navigation intersection, depicted below in **Figure 26**, show the four intersection approaches and some of the improvements along Navigation. The approach lanes at the intersection are the same as they are today, with the exception of the eastbound approach which has one fewer left-turn lane. On Navigation, the median will be narrowed, creating more space on the outside of the street for landscaping and protected bike lanes. This project will only impact one block of the study area, from Lockwood to N. Stiles. The plans include the closure of the existing median opening at N. Stiles. The alternative designs for Navigation incorporate these improvements wherever possible.

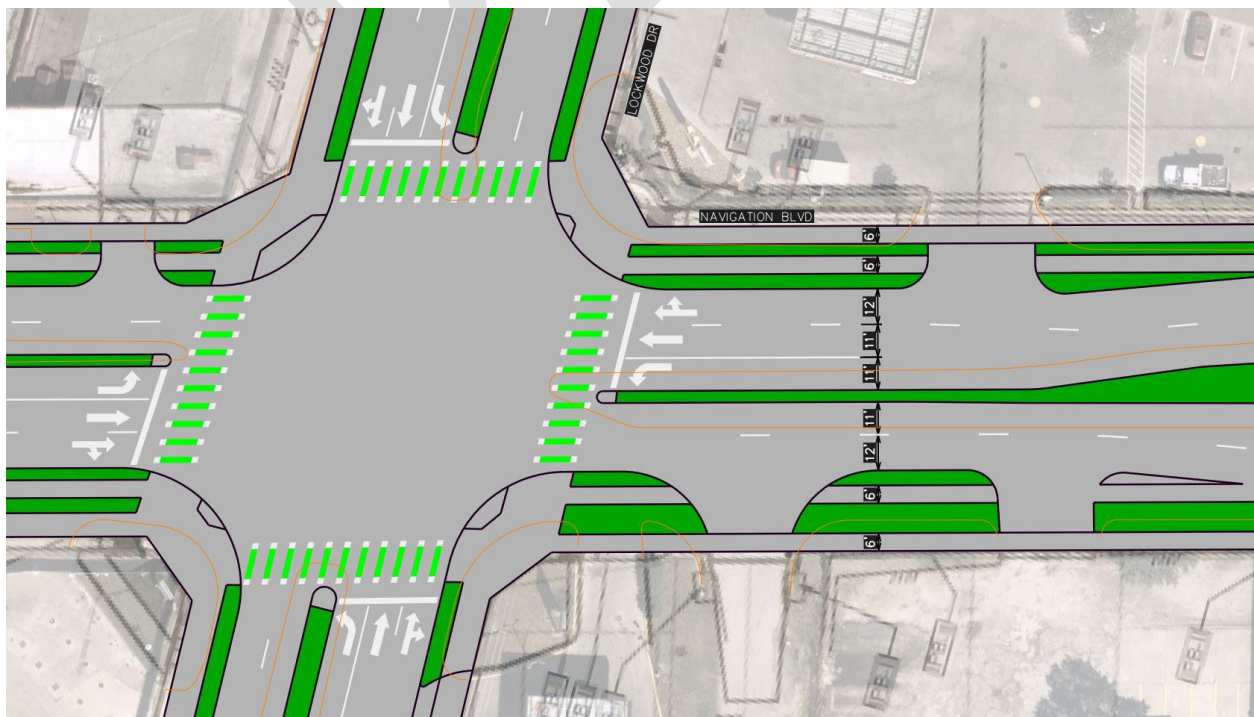


Figure 26 Navigation Design at Lockwood – COH Plans

LOCKWOOD DR

NAVIGATION BLVD

6'

10'

10'

11'

6'

e 27 Navigation Design at Lockwood

The Alternative 2 (**Figure 28**) design would cross median trail users to the north or south side of Navigation immediately east of N. Stiles Street. Between Lockwood and Stiles, the planned protected bike lane would be maintained and used to get people bicycling to the crossing to the median trail. On the north side of the street, the planned curb would remain, but back-of-curb there would be a two-way bikeway and space for people to walk. The two-way bikeway would allow people traveling from Buffalo Bayou by way of Lockwood to reach the median trail in the most direct way possible and limit the number of travel lanes that would need to be crossed.

Westbound vehicular lanes would remain as planned in the City of Houston design, with one left-turn lane, one through lane, and one through/right-turn lane. There would be one wide eastbound lane, as opposed to the two in the City design, which would be expected to provide sufficient vehicle capacity (see more detailed analysis below in the **Vehicle Operations** section). To account for the single lane on the east side of the intersection, the west approach would have one left-turn lane, one through lane, and one right-turn lane. The City plans show the N. Stiles median opening being closed off, however, due to its high usage, it is recommended that with either Alternative it be opened (see more detailed analysis of this below in the **Median Openings** section).

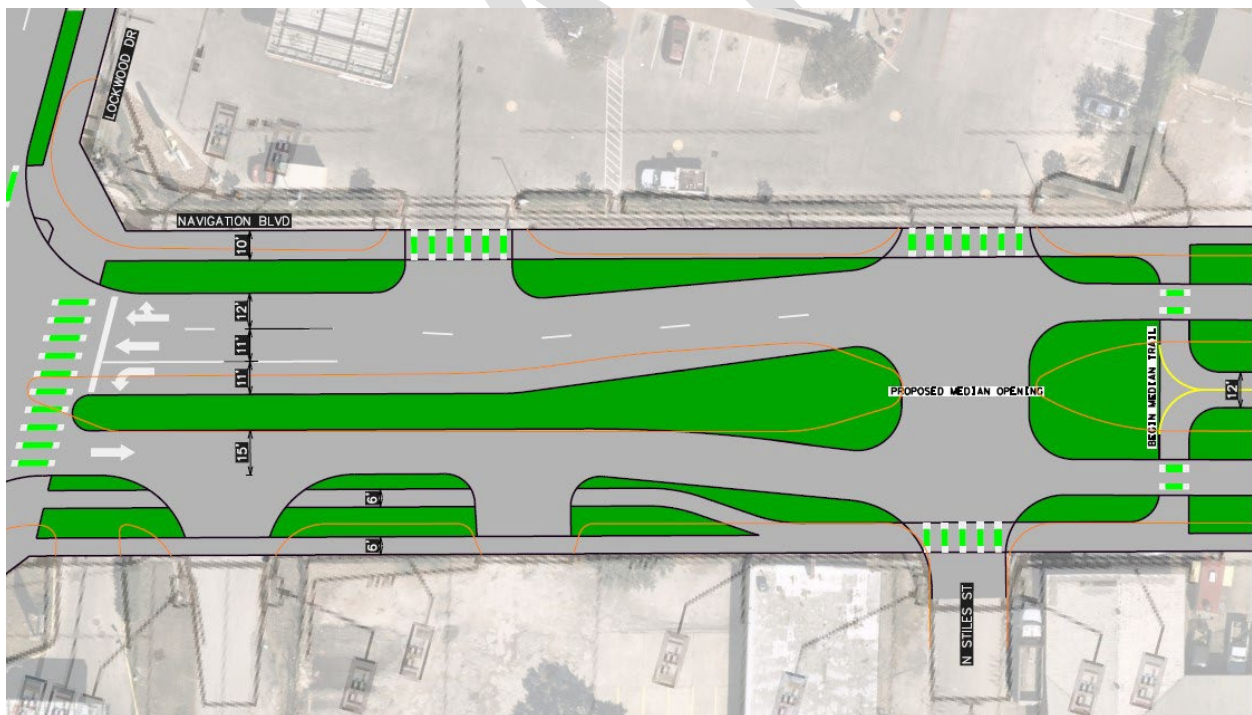


Figure 28 Navigation Design at Lockwood – Alternative 2

The Preferred Alternative for the Lockwood intersection is the Alternative 2 Design. This approach best aligns with the City of Houston plans, would have better vehicle operations, and minimizes conflicts between people driving and people walking or bicycling.

Engel Street

The median trail and roadway configuration at Engel Street provides an example of the cross-section present throughout the corridor. The wide median provides ample space for the median trail, which should be designed to minimize impacts to existing trees, while providing additional space for landscaping and trail amenities. At median openings, the trail crossings should be elevated to slow drivers down and draw attention to the trail and its users.

Eastbound there are two travel lanes, along with a left-turn pocket for vehicles turning onto Engel Street or making a U-turn. In the westbound direction, there are also two lanes, including one continuous through lane. The right lane is proposed to be a right-turn lane. This lane will be used to access a future parking lot that is part of the Turkey Bend Development. The space can be used to provide a bulbout for a trail crossing to access Turkey bend. At Engel Street, it can then function as a turn lane or queuing space for the CEMEX site.

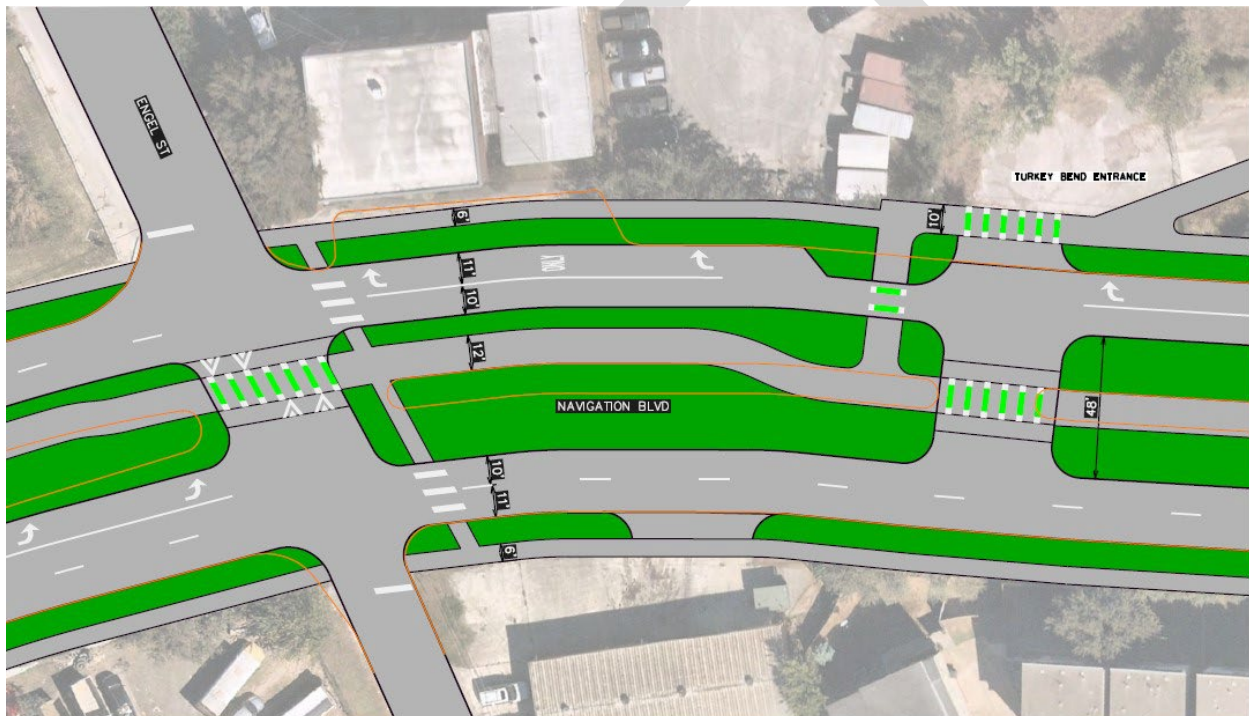


Figure 29 Navigation Design at Engel Street

N. Norwood Street

There are many changes coming to the area adjacent to the Navigation at Norwood intersection, including Buffalo Bayou Partnership's Turkey Bend redevelopment on the north side of the street, and the Harris County redevelopment on the south side of the street. Three design alternatives were developed with the changing surroundings in mind. Alternative 1 has one travel lane in each direction with many on-street parking spaces while Alternative 2 has two travel lanes in each direction and fewer on-street parking spaces. Alternative 3 has two eastbound travel lanes, and one westbound travel lane plus on-street parking.

The Alternative 1 design (**Figure 30**) creates many opportunities for on-street parking and the ability to use portions of the outer lane for curb extensions that shorten the crossing distance across Navigation. However, with only one travel lane in each direction, it creates fewer gaps in Navigation traffic for northbound drivers on Norwood Street to make turns.

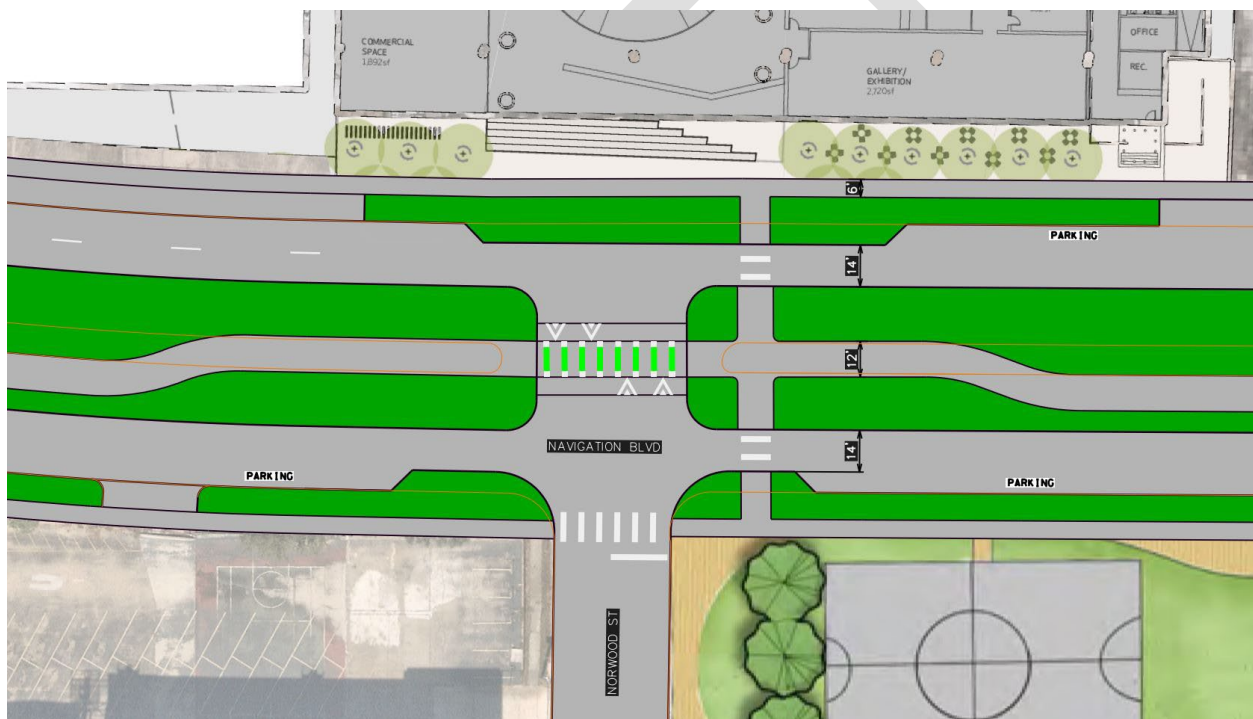


Figure 30 Navigation Design at Norwood – Alternative 1

With two travel lanes in each direction in the Alternative 2 design (**Figure 31**), the Norwood intersection operates better for vehicular traffic. However, the crossing distances on Navigation are longer, and there is less potential on-street parking. A parking or pickup/dropoff zone is planned for in front of the Turkey Bend site.

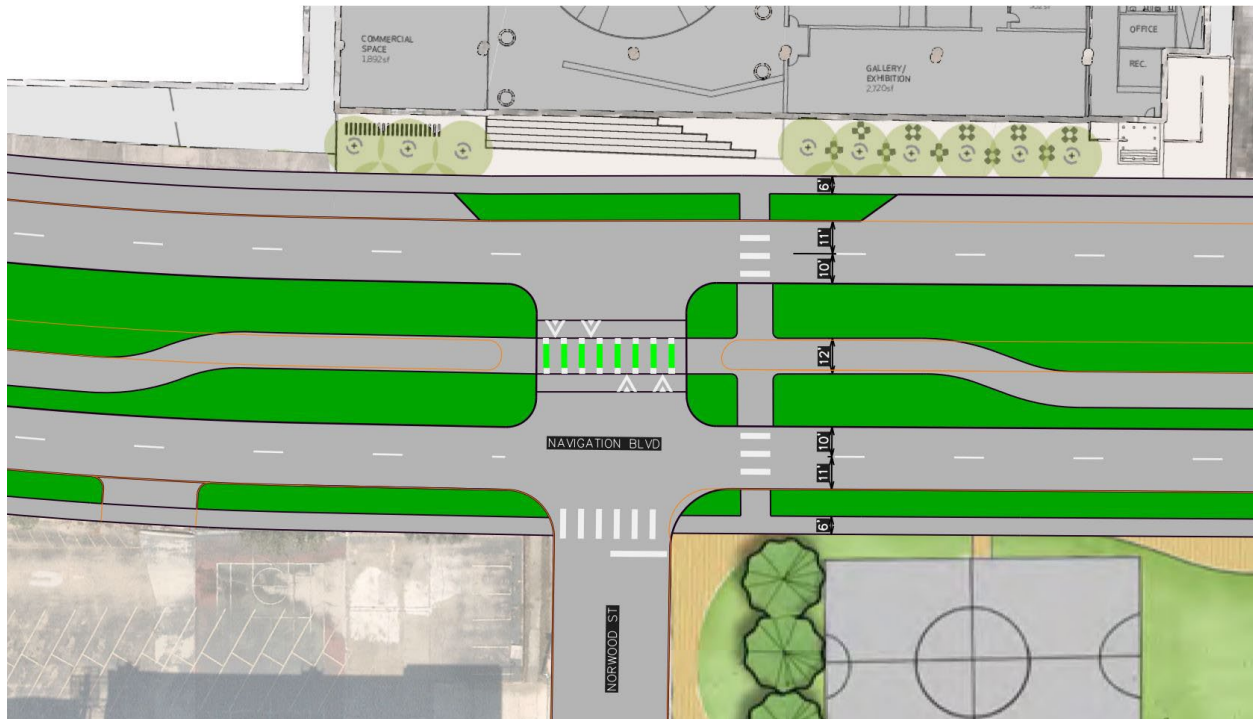


Figure 31 Navigation Design at Norwood – Alternative 2

Alternative 3 (**Figure 32**) is a hybrid of Alternatives 1 and 2, with two eastbound travel lanes, and one travel and one parking lane westbound. With only one travel in the westbound direction, there is more opportunity for on-street parking adjacent to the Turkey Bend development. There is also the opportunity for curb extensions at the crosswalk to reduce the crossing distance to only one lane. The two eastbound lanes greatly benefit vehicle operations on N. Norwood Street as compared to the single lane approach.

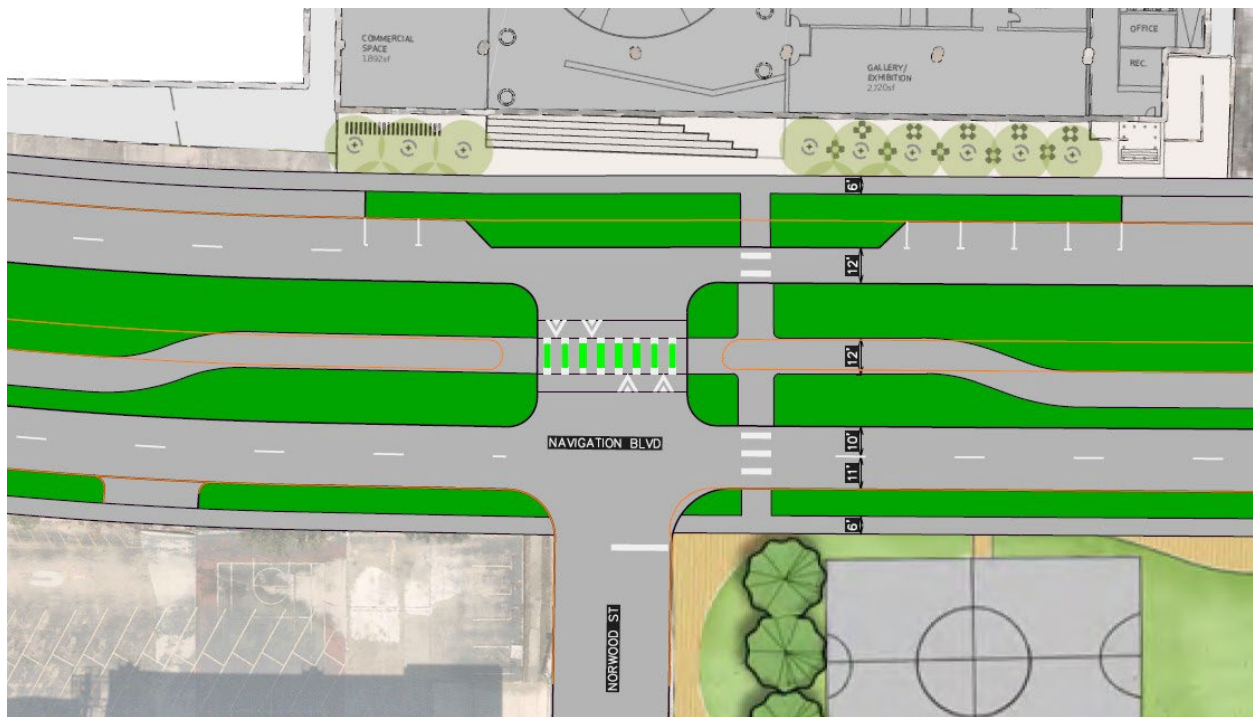


Figure 32 Navigation Design at Norwood – Alternative 3

The Preferred Alternative for the Norwood intersection is the Alternative 3 Design. The second eastbound travel lanes helps the intersection operate better for vehicles, while a single westbound travel lane improves safety and provides additional parking. The crosswalks on the east side of the intersection should be designed with enhanced safety features, such as Rectangular Rapid-Flashing Beacons (RRFB), or other design elements that create a safe environment for people crossing the street.

All median openings and intersections should be designed to accommodate turning vehicles, including U-turns. The design vehicles should be determined by the surrounding land use and number and types of larger vehicles observed to be making various turning movements.

McFarland Street

The unsignalized intersection of Navigation at McFarland operates poorly today, and with modest vehicle growth, the southbound approach would operate at LOS F in the near future (see the **Vehicle Operations** section below). A new traffic signal is recommended and warranted at this location (see the **Traffic Signal Warrant Analysis** section below). Additionally, an eastbound left-turn lane is recommended based on the vehicle volumes. Not only would a signal help vehicle operations, but it would also enable people walking and bicycling get to and from the trail at the east terminus of the study area. The presence of the signal could help slow vehicles in an area where the majority of drivers are exceeding the speed limit. East of McFarland, there is enough room back-of-curb for a wide multi-use path on either side of Navigation. In the future, the freight rail overpass could be reconfigured with one travel lane in each direction, which would provide enough space to continue the median trail along the bridge.

Advanced signage for the westbound travel lanes should be installed to draw drivers attention as the approach the new traffic signal. Additional design features should be considered to reduce westbound vehicle speeds, such as narrowing the lanes on the bridge and in advance of the signal.

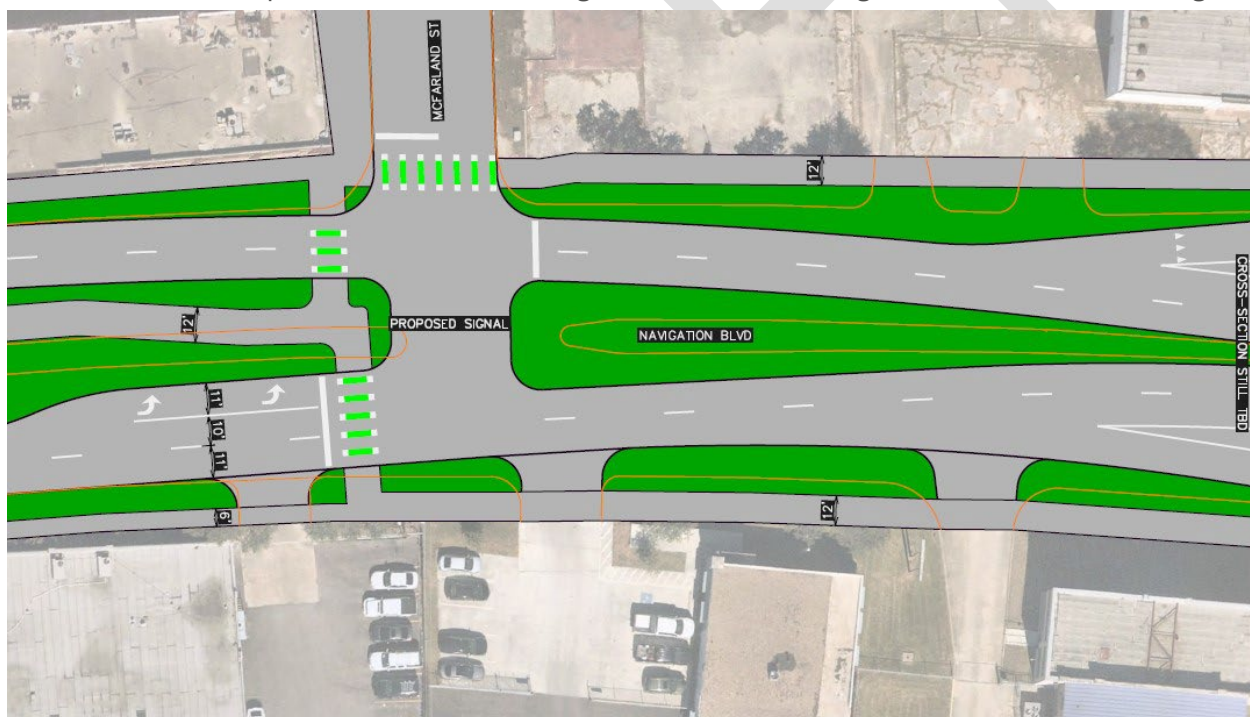


Figure 33 Navigation Design at McFarland

For larger versions of the schematic figures see **Appendix B Conceptual Schematic Sheets**

Trail Design Considerations

The median trail and adjacent pedestrian and bicycle facilities should be designed using industry best practices and be able to handle high usage on weekends and during events. All sidewalks along Navigation should be upgraded to be at least six feet wide, and all pedestrian crossing should have ADA-compliant curb ramps. The recommended width for the trail is 12 feet, wherever possible, and a minimum width of 10 feet. To improve safety at median openings, it is recommended that the trail be raised to help slow down vehicles and increase visibility of trail users. High contrast pavement marking and colored concrete should also be considered to enhance visibility.



Example of a median trail with a raised crossing

At crossing locations where a high volume of people walking and bicycling are expected, additional elements like Rectangular Rapid-Flashing Beacons (RRFBs) or other improvements should be considered based on IDM criteria.



Example of an RRFB

Traffic Signal Warrant Analysis

The intersections of Norwood at Navigation and McFarland at Navigation were selected for evaluation for a traffic signal warrant analysis based on projected future vehicle volumes, crossing conditions for people walking and bicycling, and spacing of existing traffic signals. The traffic signal warrant analyses were performed in accordance with the *Texas Manual on Uniform Traffic Control Devices (TMUTCD)* methodology.

Analysis at the intersections was conducted using projected 2042 traffic volumes, grown by the high-end rate of 1% compounded annually (22.0% total). A traffic signal is warranted if one or more of the following nine warrants are satisfied:

Warrant 1: Eight-Hour Vehicular Volume

Warrant 2: Four-Hour Vehicular Volume

Warrant 3: Peak Hour Volume

Warrant 4: Pedestrian Volume

Warrant 5: School Crossing

Warrant 6: Coordinated Signal System

Warrant 7: Crash Experience

Warrant 8: Roadway Network

Warrant 9: Intersection Near a Grade Crossing (not considered for any intersection)

The Norwood at Navigation intersection did not meet any of the above warrants.

The results of the analysis for the McFarland at Navigation intersection are summarized in **Table 2**. Based on the results of the traffic signal warrant analyses performed along the corridor, a traffic signal is proposed to be constructed at McFarland Street along the Navigation Boulevard corridor as part of this project.

Intersection	W1	W2	W3	W4	W5	W6	W7	W8
McFarland Street	X	✓	✓	X	X	X	X	X

Table 2 Traffic Signal Warrant Results

Median Openings

There are approximately twelve median openings along Navigation today which provide opportunities for left-turns, U-turns, and north-south through traffic. With the presence of the median trail, they will also create conflict points between trail users and people driving. To reduce conflicts, each median opening was considered for closure based on frequency of use (summarized in **Appendix A 2022 Traffic Volumes**). It is anticipated that any closures would lead to higher usage for U-turns at adjacent locations. On the west end of the study area there are five median openings in the span of less than 1000 feet: N. Stiles, N. Bryan, N. Adams, N. Edgewood, and Engel. There is considerably less usage of the N. Bryan and N Edgewood openings (see **Table 3**). Therefore, it is recommended that those be closed, and the nearby openings provide locations to accommodate the desired turning movements.

	Median Opening Usage		
	AM Peak	Midday Peak	PM Peak
N Stiles	86	81	103
N Bryan*	34	14	18
N Adams	52	13	34
N Edgewood*	25	11	16
Engel	58	106	42

*Proposed Median Closure

Table 3 Median Usage

Proposed Stop Control and Pedestrian Crossings

Based on the schematic designs, median usage analysis, traffic signal warrant analysis, and safety considerations, the following improvements are proposed along Navigation:

- N. Stiles – enhanced crossing with ADA ramps
- N. Bryan – median closure, unmarked crossing
- N. Adams – marked crosswalk with ADA ramps
- N. Edgewood – median closure, unmarked crossing
- Engel – Marked crosswalk with ADA ramps
- Turkey Bend East Entrance (east of Engel) – enhanced trail crossing with ADA ramps
- Baywood – marked crosswalk with ADA ramps
- Portwood – marked crosswalk with ADA ramps
- Norwood – enhanced crossing with ADA ramps
- Greenwood – marked crosswalks with ADA ramps
- McFarland – signalized intersection, trail crossing with ADA ramps

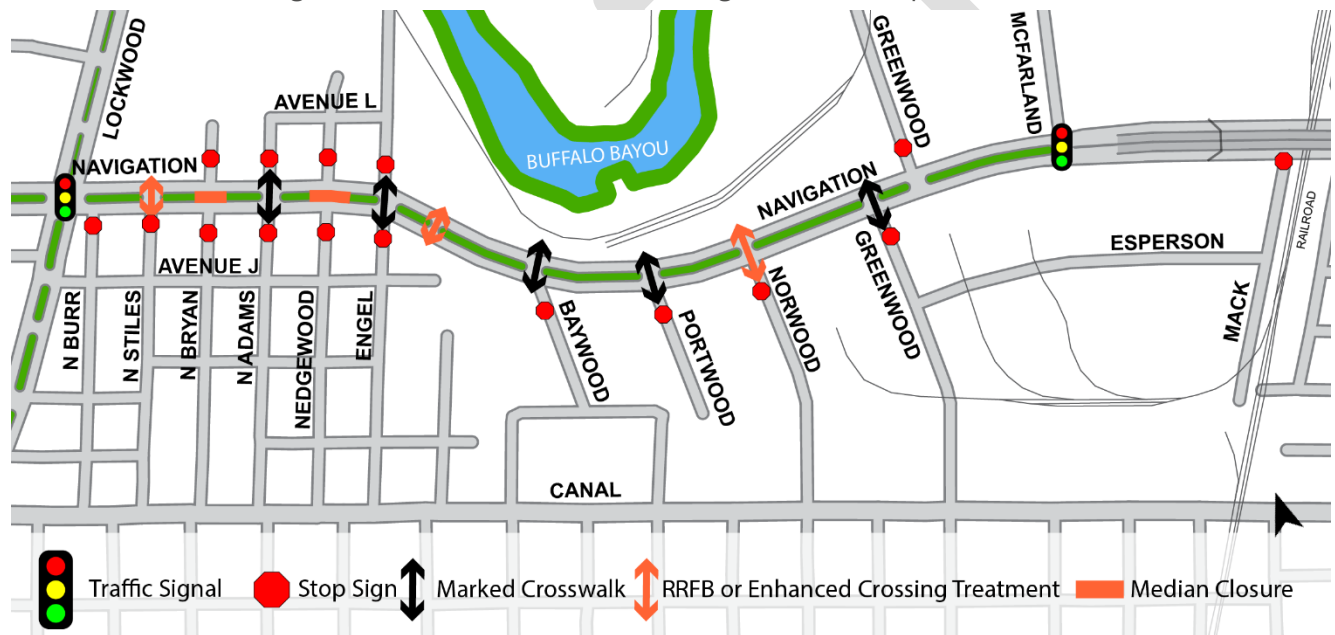


Figure 34: Proposed Stop Control and Pedestrian Crossings

With these proposed crossing treatments, all cross-streets would have a Pedestrian Level-of-Service of D or better, with the exception of Bryan and Edgewood. See **Table 4**. However, those two locations are a short walk to nearby marked crosswalks that will provide a sufficient safe crossing opportunity. The locations with proposed “RRFB or Enhanced Crossing Treatment” were evaluated assuming a marked crosswalk with a pedestrian refuge. If an RRFB or other traffic control device is installed, the LOS would be improved.

Crossing location	Proposed Treatment	Pedestrian Level-of-Service	Walk Time to Nearest Marked Crossing*
N Stiles	RRFB or Enhanced Crossing Treatment	B or Better	
N Bryan	No Treatment	E	67 seconds to N Stiles (each way)
N Adams	Marked Crosswalk	C	
N Edgewood	No Treatment	E	66 seconds to N Adams (each way)
Engel	Marked Crosswalk	C	
Turkey Bend Entrance	RRFB or Enhanced Crossing Treatment (north side)	B or Better	
Baywood	Marked Crosswalk	C	
Portwood	Marked Crosswalk	C	
Norwood	RRFB or Enhanced Crossing Treatment	C or Better	
Greenwood	Marked Crosswalk	C	

*Assumes 3.5 feet per second walking speed

Table 4 Unsignalized Crossing Location Analysis

Vehicle Operations

To understand how the various improvements would impact vehicle operations on Navigation Boulevard, future roadway conditions were modeled. First, future vehicle usage was estimated using a 1% annual growth rate compounded over 20 years, totaling a 22% increase in vehicle volumes.

These 2042 Growth Volumes were modeled using the existing roadway to develop an understanding of how the anticipated vehicle growth will impact vehicle operations. The Level-of-Service dropped for most intersections in both the AM and PM Peak Hours.

In the AM Peak, the Engel intersection dropped from LOS C to LOS F. Other intersections dropped to as low as LOS D. McFarland remained at LOS F and had increased delay. See **Figure 35**.



Figure 35: 2042 Growth Volumes - AM Peak Hour LOS

Similarly, in the PM Hour, most intersections dropped at least one level-of-service. Norwood and Greenwood joined McFarland with an F LOS. See **Figure 36**.

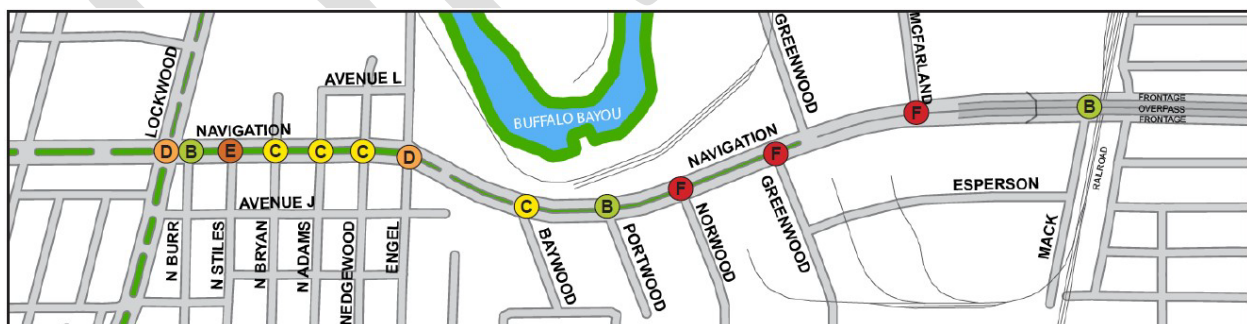


Figure 36: 2042 Growth Volumes - PM Peak Hour LOS

The proposed improvements on Navigation would also have impacts on vehicle operations. The 2042 Growth Volumes were modeled with the Preferred Alternative roadway geometry to understand the ultimate buildout conditions. The roadway changes included a reduction in travel lanes, new turn lanes, a new traffic signal, and a wider median. Some of these changes contributed to a lower LOS at some locations, but overall, they improved vehicle operations.

In the AM Peak Hour, all intersections operated at LOS E or better. Signalizing the McFarland intersection improved from the Existing LOS F and Growth Volumes LOS F to LOS C. The additional turn lanes and wider median at Engel improved from a LOS F in the Growth Volume scenario to a LOS C in the Preferred Alternative Scenario. LOS improved for all intersection between Baywood and Greenwood because of the wider median, which allows for two-stage left turns. See **Figure 37**.



Figure 37: 2042 Preferred Alternative- AM Peak Hour LOS

In the Preferred Alternative PM Peak scenario, LOS also improved compared to the Growth Volume scenario. All intersections operated at LOS E or better. The proposed traffic signal at McFarland would improve operations from LOS F to LOS C. Similarly, the intersections from Baywood to Greenwood improved by a level-of-service or more with the widened median. See **Figure 38**.



Figure 38: 2042 Preferred Alternative- PM Peak Hour LOS

A summary of all three model scenarios (Existing, Growth Volumes, and Preferred Alternative) in both the AM and PM Peak Hours are summarized in **Table 4**.

		Lockwood	N. Burr	N. Stiles	N. Bryan	N. Adams	N. Edgewood	Engel	Baywood	Portwood	Norwood	Greenwood	McFarland	Mack
AM Peak	Existing	D	B	C	B	C	C	C	C	B	B	B	F	A
	Growth	D	B	D	C	D	C	F	D	C	D	D	F	B
	Preferred	E	B	E	B	D	B	C	C	B	C	D	C	B
PM Peak	Existing	D	B	C	B	C	C	C	B	B	B	C	F	A
	Growth	D	B	E	C	C	C	D	C	B	F	F	F	B
	Preferred	D	B	E	B	C	B	C	C	B	E	C	B	B

Table 5: Vehicle LOS Summary

The above modeling presents the conditions in the Preferred Alternative.

In the Alternative 1 design near Lockwood Street, with the median trail continuing all the way to the Lockwood crosswalk, the Lockwood intersection would operate at LOS F in both the AM and PM Peaks.

The modeling for the Norwood intersection shows that with only one travel lane in each direction (Alternative 1). There would be considerable delay for vehicles using the northbound Norwood Approach, with LOS E in the AM Peak and LOS F in the PM Peak. Operations improve considerably with two lanes in each direction (Alternative 2). In the AM Peak, there would be LOS C with 21 seconds of delay. In the PM Peak, there would be LOS D with 34 seconds of delay. With the Preferred Alternative (Alternative 3), the delay in the AM and PM Peak hours would only be increased by two seconds compared to the Alternative 2 scenario. A summary of delay for northbound vehicles on Norwood is summarized in **Table 5** below.

Alternative	EB Travel Lanes	WB Travel Lanes	AM Delay	AM LOS	PM Delay	PM LOS
Alternative 1	1	1	42 seconds	E	82 seconds	F
Alternative 2	2	2	21 seconds	C	34 seconds	D
Alternative 3*	2	1	23 seconds	C	36 seconds	E

*Preferred Alternative

Table 6: Norwood Vehicle LOS Summary

For additional information about the traffic modeling, including LOS, delay, and queue lengths by approach, **See Appendix C Traffic Modeling**.

Appendix A 2022 Traffic Volumes

- AM Peak Hour Volumes
- Midday Peak Hour Volumes
- PM Peak Hour Volumes

Appendix B Conceptual Schematic Sheets

- Lockwood – COH Project
- Lockwood – Alternative 1
- Lockwood – Alternative 2
- Engel
- Norwood – Alternative 1
- Norwood – Alternative 2
- Norwood – Alternative 3
- McFarland

Appendix C Traffic Modeling

- Existing Operations
- 2042 No-Build Operations
- 2042 Preferred Alternative Operations