CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS & ENGINEERING

PRE-ENGINEERING OF
STREET AND PAVING IMPROVEMENTS

FOR

BROADWAY STREET (NT04)

FROM

IH-45 TO GALVESTON ROAD

WBS No. N-000100-0003-3

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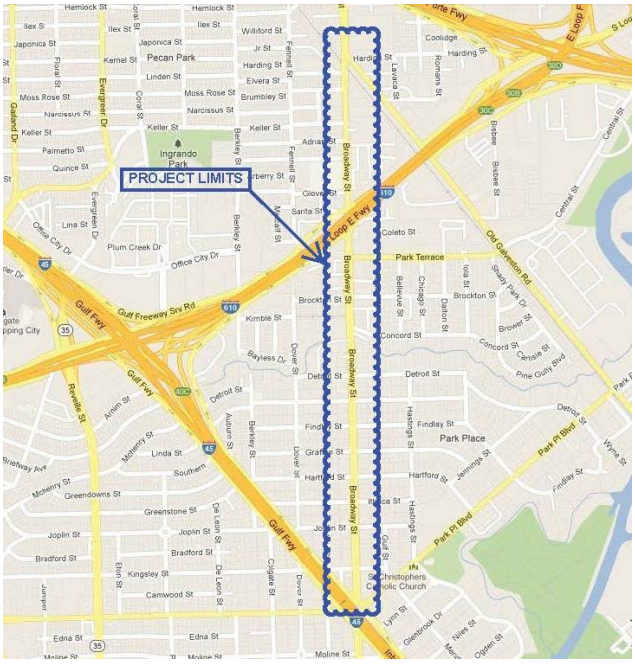
EXECUTIVE SUMMARY

INTRODUCTION
This pre-engineering study is prepared by PGAL for the City of Houston (City) under the terms of the Contract for Professional Engineering Services for pre-engineering services for Broadway Street from IH-45 to Galveston Road, Project No. N-000100-0003-3.

The purpose of the study is to provide assessment of existing conditions, identify the needs, provide alternative solutions and recommendations for street and paving improvements, drainage concepts, water line and sanitary sewer utility improvements, and cost estimates.

PROJECT LOCATION
The project is located in southeast Houston (Key Map 535 P, K & F), (Council District I), between IH-45 on the south and Galveston Road on the north (See Location Map below).



EXISTING CONDITIONS
Broadway is a south-north 4-lane principal major thoroughfare in the southeast part of Houston. The project length is approximately 1.7 miles and is generally comprised of mixed residential, commercial, and retail properties. In addition to the commercial and residential development, the study area also includes three schools, two churches and multiple medical clinics, which are some of the major traffic generators. The horizontal alignment of Broadway is relatively straight from IH-45 to Galveston Road. The vertical geometry along Broadway is generally flat with low points at intersecting streets that catch the rain water with curb inlets.

NEEDS IDENTIFICATION is evaluated in three major categories; Street and Traffic, Drainage and Utility Needs (Water and Wastewater).

Street and Traffic needs identification was evaluated based on the physical condition and capacity of the roadway. For the segment between IH-45 and IH-610, the pavement condition rating (PCR) provided by City of Houston indicates that the existing concrete pavement is in fair condition with an average rating of 65. However the pavement is over 50 years old and showing wide cracks, signs of failure at joints and has numerous asphalt patches. Pavement cracks have been sealed with asphalt to prevent water intrusion into the subgrade. The physical deficiencies noted also include missing curbs, sidewalks in poor condition and lack of wheelchair ramps at cross streets. The existing concrete pavement of the segment between IH-45 and Old Galveston Road has a PCR value of 45 and is over 50 years old. This segment was recently overlaid and some of the curb and gutters were replaced. Sidewalks are generally in fair condition however the wheelchair ramps are not compliant with current Texas Accessibility Standards (TAS). The results of Level of Service (LOS) analysis indicate that 2011 LOS is D for the entire length of the study area. The 2035 LOS is F and E applying the existing roadway geometry.

Drainage needs were identified based on the City of Houston Comprehensive Drainage Plan (CDP), record drawings and LIDAR information. The project limits lie in the Sims Bayou watershed and drainage is provided by five separate systems that serve a total drainage area of 288 acres. According to the record drawings and GIMS the storm sewer system was built in 1941. The system generally consist of Type B and BB inlets at the end of curb returns in side streets and storm sewer pipes ranging in size from 12-inch to 48-inch in diameter. Of the five systems, four are unable to convey the 2-year storm event according to the City of Houston Comprehensive Drainage

EXECUTIVE SUMMARY

Study and there have been 6 structural flooding complaints.

Utility needs were identified by City of Houston Public Works. The project area is served by 12" waterlines and 6" to 10" wastewater lines.

PROPOSED ALTERNATIVES
Two alternatives were developed for Broadway. Alternative 1 which is a 4-lane thoroughfare solution, was developed to allow for a solution consistent with the Broadway segment between IH-45 and Airport which is currently under development as a 4-lane section. Alternative 2 involves reconstruction of the roadway to 6-lanes. Based on traffic analysis, the ultimate 6-lane section will not be needed for approximately 15 years so this alternative is a viable option until additional capacity is required. As designed, the additional lanes will be added by widening on the inside, allowing for the easy implementation of future capacity.

CANDIDATE PROJECT DEVELOPMENT
Each project solution was evaluated in order to determine their merits and ranking among the project alternatives and eventually the ranking of the recommended alternative to other projects citywide based on the project priority score.

The estimated cost of the 4-lane option is approximately $11,108,000 and the estimated cost of the 6-lane option is approximately 12,558,000.

RECOMMENDATIONS
The 4-lane alternative is recommended for implementation. It was determined that the best alternative is to construct a facility that will be able to accommodate the traffic for a considerable time frame and be easily expandable to 6 lanes when the traffic demands it. The main traffic issues are at the two TxDOT controlled intersections and until such time TxDOT is able to reconstruct these areas to accommodate the 6 lanes on Broadway, reconstructing the remainder of Broadway to 6 lanes will not significantly impact the level of service in the corridor.

The total project cost of the recommended alternative is $11,108,000. The calculated score of this alternative is 82.60.

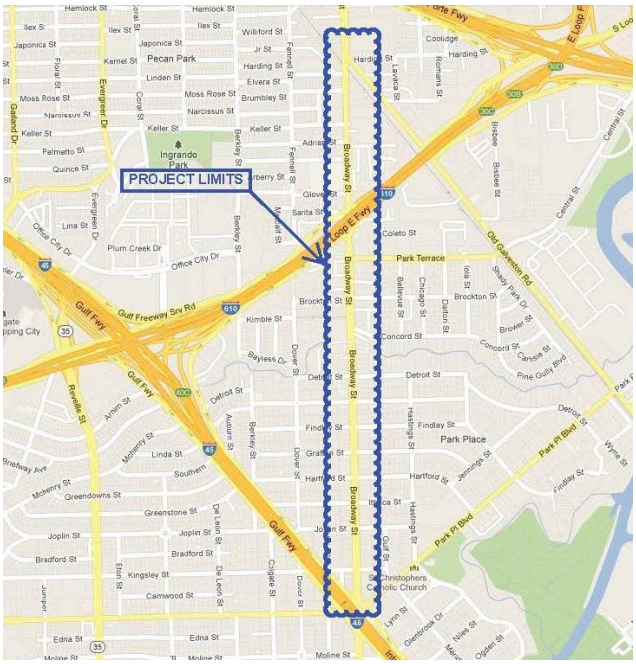
2.0 INTRODUCTION

This pre-engineering study is prepared by PGAL for the City of Houston (City) under the terms of the Contract for Professional Engineering Services for pre-engineering services for Broadway Street from IH-45 to Galveston Road, Project No. N-000100-0003-3.

The purpose of the study is to provide assessment of existing conditions, identify the needs, provide alternative solutions and recommendations for street and paving improvements, drainage concepts, water line and sanitary sewer utility improvements, and cost estimates.

2.1 Project Location

The project is located in the Pecan park super neighborhood, in southeast Houston (Key Map 535 P, K&F, Council District I) between IH-45 on the south and Galveston Road on the north. (see Location Map below).



2.2 Existing Roadway Characteristics

Broadway is a south-north principal major thoroughfare in the southeast part of Houston. The project length is approximately 1.7 miles and is generally comprised of mixed residential, commercial, and retail properties. In addition to the commercial and residential development, the study area also includes three schools, two churches and multiple medical clinics, which are some of the major traffic generators. The horizontal alignment of Broadway is relatively straight from IH-45 to Galveston Road. The vertical geometry along Broadway is generally flat with low points at intersecting streets that catch the rain water with curb inlets. There is a steep vertical slope down to the IH-610 intersection from either side of Broadway which creates a bathtub effect and traps water at the interchange which is in the 100-yr flood plain and causes flooding under the bridge and at the adjacent frontage roads.

Existing Right-of-Way (ROW) along Broadway is approximately 120-feet wide from IH-45 to Old Galveston Road. There are 19 cross streets within the study limits that has ROWs varying from 50-feet to 80-feet. Broadway from IH-45 to IH-610 is a 4 lane divided concrete curb/gutter roadway with a 14-feet wide raised median. The pavement width is approximately 23-feet both for northbound and southbound lanes. The segment from IH-610 to Galveston Road consists of an undivided 5-lane concrete curb/gutter roadway with 2 northbound, 2 southbound and 1 center lane.

3.0 NEEDS IDENTIFICATION is evaluated in three major categories; Street and Traffic, Drainage and Utility Needs (Water and Wastewater). A summary of needs is included in Table 1 of this report.

3.1 Data Collection was carried out by obtaining available record drawings from the City of Houston, shape files with record information for pavement condition and flooding from the City, contacting and obtaining record drawings for electrical and telecommunications, obtaining information regarding pipelines and information regarding waterlines and sanitary lines from utility planning. A listing of existing information for this project is in Appendix 1.

3.2 Street and Traffic Needs identification was evaluated based on the condition and the capacity of the roadway. Pedestrian facilities, signalized intersections and safety issues were also noted and are summarized below.

A. Physical Condition of the Roadway:

From IH-45 to IH-610: The pavement condition rating (PCR) provided by City of Houston indicates that the existing concrete pavement in this segment is in fair condition with an average rating of 65. However the pavement is over 50 years old and showing wide cracks, signs of failure at joints, and has numerous asphalt patches. Pavement cracks have been sealed with asphalt to prevent water intrusion into the subgrade. The physical deficiencies noted also include missing curbs, sidewalks in poor condition and lack of wheelchair ramps at cross streets.

From IH-610 to Galveston Road: The existing concrete pavement in this segment has a PCR value of 45 and is over 50 years old. This segment was recently asphalt overlayed and some of the curb and gutters were replaced. During site visits, it was noticed that a subgrade failure occurred near a curb-inlet. Sidewalks are generally in fair condition however the wheelchair ramps are not compliant with current Texas Accessibility Standards (TAS).

B. Capacity: The preliminary Level of Service (LOS) was determined using HCS software, based on the data collected on-site and Average Daily Traffic (ADT) and the V/C ratio data provided by the City of Houston. The results indicate that 2011 LOS is D for the entire length of the study area. The 2035 LOS is F and E applying the existing roadway geometry. Below is a summary of LOS for different segments of the corridor for 2011 and 2035.

STREET	SEGMENT	2011 ADT	2011 V/C Ratio	2011 LOS
Broadway	IH-45 to IH-610	21,579	NB=0.79, SB=0.58	D
	IH-610 to Keller St.	19,048	NB=072, SB=0.46	D
	Keller St to Galveston Rd	21,516	NB=0.79, SB=0.54	D

STREET	SEGMENT	2035 ADT	2035 V/C Ratio	2035 LOS
Broadway	IH-45 to IH-610	30,609	NB=1.14, SB=0.80	F
	IH-610 to Keller St.	32,081	NB=1.11, SB=0.87	E
	Keller St to Galveston Rd	31,515	NB=1.13, SB=0.81	E

C. Intersections: There are four signalized intersections within the study limit:

- IH-45 Interchange: The traffic signals at this intersection are in TxDOT's ROW and are situated on dual mast-arms. Any potential improvements to the signals equipment would have to be coordinated with TxDOT. Capacity issues were observed during field visits; turning movements would have to be looked at closer to identify deficiencies and provide recommendations for solutions.

- Hartford Street: The existing traffic signals are situated on span wires and the signal equipment is outdated. VIVIDs cameras are implemented for vehicle detection at this intersection. There are no pedestrian push buttons and wheelchair ramps are either non-existent or noncompliant with current TAS standards.

- IH-610 Interchange: The traffic signals at this intersection are in TxDOT's ROW and are situated on dual mast-arms with VIVIDS for vehicle dedication. Any potential improvements to the signals equipment would have to be coordinated with TxDOT. The observed deficiencies at the intersection include long queues during the AM and PM peak hours at the northbound left turn, which is not an exclusive left turn lane.

- Galveston Road: The existing traffic signals and equipment are outdated. The westbound right turn movement's safe sight distance should be studied in more detail. This is a T-skewed intersection and some geometric improvements may need to be implemented to provide for a safer traffic operation.

D. Geometric Deficiencies: Other noted intersection and geometry deficiencies include:

- Broadway between IH-45 and IH-610: The raised median is too narrow (14-feet) to allow for safe turning movements. Vehicles partially block the inside lanes of north and southbound traffic while turning at cross streets and mid-block median openings.

- Broadway and Park Terrace Lane: The southbound left turn movement to Park Terrace has a heavy volume and is experiencing long queues due to lack of an exclusive left turn lane.

- Broadway between IH-45 and Kingsley: The driveway on the west side is too wide and is a safety concern for southbound traffic. Assessment of access management is required.

- Broadway between IH-45 and Kingsley: Head-in parking serving the Servants Christ United Methodist Parish Church on the east side of Broadway Street is too close to the intersection and is a safety concern for vehicles exiting the parking area.

- Broadway – north of IH-45: The existing bus stop on the east side is too close to the interchange and busses stopping at this location block and create an obstruction to the vehicles turning into the outside lane from Park Place Blvd and the interchange.

- Broadway and Galveston Road: The existing bus stop on the east side of Broadway Street is located between Galveston Road and the UP railroad tracks. The location of

the bus stop is unsafe due to insufficient storage space between the traffic signals at Galveston Road and the railroad tracks.

- Broadway and Galveston Road: The existing bus stop on the westside of Broadway is situated at the stop bar and cause delays with vehicles crossing the intersection when the green light comes on during pick up and drops off operations.

3.3 Drainage Needs: The project limits lie in the Sims Bayou watershed and drainage is provided by five separate systems that serve a total drainage area of 288 acres. According to the record drawings and GIMS the storm sewer system was built in 1941. The system generally consist of Type B and BB inlets at the end of curb returns in side streets and storm sewer pipes ranging in size from 12-inch to 48-inch in diameter. Of the five systems, four are unable to convey the 2-year storm event according to the City of Houston Comprehensive Drainage Study and there have been 6 structural flooding complaints. The existing drainage conditions are summarized in table below. See Appendix A for further information on existing drainage conditions.

OUTFALL	OUTFALL LOCATION	AREA (ACRES)	FLOODPLAIN ZONE	WATER SHED	STORM SEWER PIPE SIZES	INLET TYPES	TOTAL STRUCTURAL FLOODING	2-YEAR STORM CAPACITY
C0008	Outfall at Sims Bayou (C200-00-00)	73.7	No	Sims Bayou	12",15",18", 24",36",42", 48"	B	0	Inadequate
C0155	Outfall at Plum Creek (C102-00-00)	139.15	100-Year Floodplain (Zone AE)	Sims Bayou	12",15",18", 21",24",36"	B,BB	4	Inadequate
C0156	Outfall at Plum Creek (C102-00-00)	16.31	No	Sims Bayou	18",20"	BB,C	2	Inadequate
C0160	Outfall at Pine Gully (C103-00-00)	8.65	No	Sims Bayou	15",18",24"	BB	0	Adequate
C0161	Outfall at Pine Gully (C103-00-00)	50.994	100-Year Floodplain (Zone AE)	Sims Bayou	15",18",21", 24",36"	B	0	Inadequate

3.4 Utility Needs: Existing water and sanitary sewers within the project area were researched utilizing City of Houston's GIMS website and record drawings and are listed below.

A. Water Lines: Broadway is served by a 12" PVC/CI water line from IH-610 to Galveston Road.

Size	Plan No / Completion Date	Location
12" PVC	WD7498 / 1985	Along Broadway from IH45 to Joplin
12" PVC	WD7800 / 1986	Along Broadway from Joplin to Concord
12" CI	-	Along Broadway from Concord to Park Terrace
12" CI	WD348 / 1938	Along Broadway from Park Terrace to IH610
12" PVC	P32267 / 1995	Along Broadway from IH610 to Galveston
60" STL	P4406 / 1969	Adjacent to RR tracks near Galveston

City of Houston Infrastructure Planning Branch has been contacted and no improvements are planned within the study area.

B. Sanitary Sewers: Majority of the sanitary sewers are located in the back-lot easements on west and east side of Broadway Street. City of Houston Wastewater Operation and Infrastructure Planning Branch are currently researching the need for wastewater improvements in the study area.

Size	Plan No / Completion Date		Location
	Built	Rehab	
10" CONC	P9722	SLIP - R29224 / 1992	Along Joplin crossing Broadway
6" CONC	P4771 / 1930	PB - R30794 / 1995	Along Broadway north of Detroit (400-LF)
6" CONC	P11156 / 1958	PB - R30794 / 1995	Along Broadway north of Detroit (400-LF)
8" CONC	-	CIPP – R30974 / 1996	Along Concord crossing Broadway
8" CONC	-	PB – R31008 / 1997	Along Broadway north of Concord (500-LF)
78" MRCP	P14679 / 1967	R34215 / 1999	Along Brockton crossing Broadway
8" CONC	-	SLIP - R29181 / 1992	Along Brockton crossing Broadway
54" CONC	P7091	SLIP – R31113 / -	Along Park Terrace crossing Broadway
8" CONC	P6080 / 1945	-	Along Backlot north of Scanlock
8" CONC	P9254 / -	SLIP - R29180 / 1992	Along and crossing Broadway near Brumbley

3.5 Existing Private Utilities and Pipelines:

A. Gas Facilities: CenterPoint Energy (CPE) provided gas and electric utility maps as logged under CenterPoint Energy ID 1402612826. Gas lines are generally located in backlot easements west and east of Broadway Street. Below gas lines were identified within the Broadway Street Right-of-Way.

- 8" IP STL Gas Line – Along Kingsley Street
- 3" and 6" IP STL Gas Line – Along Broadway between Ithaca and Hartford
- 4" IP STL Gas Line – Along Hartford Street
- 2" IP STL Gas Line – Along Detroit
- 2" and 6" IP STL Gas Line – Along Broadway from Detroit and IH-610
- 6" IP STL Gas Line – from IH-610 to Galveston Road

B. Electric / Street Lighting: Street lighting in the project area is provided by cobra-head light fixtures on metal poles between IH-45 and Easton Street. The segment from Easton to Galveston Road has overhead power lines with light fixtures on the west side of the Broadway Right-of-Way.

C. Telephone, Communications Facilities: An 8-4" Duct-bank is located 7-feet behind the curb on the west side of Broadway Boulevard from Kingsley to the north study limits.

D. Pipelines: There are no existing pipelines in the project area.

4.0 ALTERNATIVE SOLUTIONS

4.1 Proposed Alternatives

Two alternative solutions were developed for Broadway. Based on the analysis of the traffic evaluation a 6-lane thoroughfare solution was developed for the corridor. The proposed section and detailed layouts are shown in Exhibits 3 and 4. A major constraint to the development of all options for this corridor is the existing grade separation and intersection configuration at IH-610. Broadway crosses IH-610 with 4 11-foot lanes. Northbound and southbound left turn lanes are very short (approximately 100 feet in each direction). Due to the location of the bent columns on either side, there is no possibility of expanding the cross section thru the intersection until the grade separation is reconstructed by TxDOT. The IH-610 pavement was recently reconstructed, and no future reconstruction is currently planned. Pavement layout under both alternatives was transitioned to tie to the existing pavement on both sides of IH-610. Traffic analysis was carried out based on the constrained conditions at this intersection.

Alternative layouts were developed to the north side of the Galveston Road intersection in order to develop a proper layout for the Broadway/Galveston Road intersection. Reconstruction of this intersection will necessitate relocation of railroad signals and extension of the railroad crossing.

The 4-lane thoroughfare solution was developed to allow for a solution consistent with the Broadway segment between IH-45 and Airport which is currently under development as a 4-lane section. Based on traffic analysis, the ultimate 6-lane section will not be needed for approximately 15 years so this alternative is a viable option until additional capacity is required. As designed, the additional lanes will be added by widening on the inside, allowing for the easy implementation of future capacity. Typical sections and detailed layouts for this alternative are shown in Exhibits 5 and 6.

4.2 Traffic Analysis

The purpose of the traffic analysis is to assess traffic operations along Broadway Street from north of IH 45 to Galveston Road under existing (year 2012) and future (year 2035) traffic conditions and make recommendations to improve the quality of traffic flow, as well as to enhance safety. The following tasks were covered in this study:

- Establish two peak traffic periods; weekday A.M. and weekday P.M.
- Conduct turning movement counts during the two peak periods at the following locations:
    - Broadway Street at Hartford Street
    - Broadway Street at IH 610 Interchange
    - Broadway Street at Galveston Road
- Assess collected traffic counts and develop balanced assignments on the study network for weekday A.M. and P.M. peak hours.
- Collect available traffic signal data from City of Houston.
- Collect available traffic projections data from the City of Houston.
- Conduct traffic operational analyses under existing roadway geometry and traffic control conditions.

- Conduct traffic operational analyses under future roadway geometry and traffic control conditions.
- Test alternative improvements.
- Assess the quality of traffic flow based on analysis results such as delays, queues, Level of Service (LOS) etc.
- Make recommendations to improve traffic operations and safety, where necessary.

The study area covers Broadway Street from Galveston Road to north of IH 45 that contains the following signalized intersections:

- Broadway Street at Hartford
- Broadway Street at IH 610 Interchange
- Broadway Street at Galveston Road

Since improvements at interchange of Broadway Street and IH 45 are TXDOT's responsibility, turning movement counts were not collected at this interchange.

The future traffic assignments on Broadway Street under Alternative 1 for the year 2035 show ADT of 30,609 from IH 45 to IH 610, 32,081 from IH 610 to Keller Street and 31,515 from Keller Street to Galveston Road. Design year (2035) traffic assignments as Average Daily Traffic (ADT) in the study corridor were provided by the City of Houston. Detailed information on design year traffic patterns are shown in Appendix 1.

Capacity and LOS analyses were performed for the following Conditions during the weekday A.M. and P.M. peak hours:

- Existing Condition, Year 2012.
- Alternative 1, Year 2035.

A Summary of all analysis results is presented in **Tables 4.1 and 4.2** Appendix 1**.**

Capacity analysis results under existing condition indicate that the quality of traffic flow at interchange of Broadway Street and IH 610 is within acceptable limits during P.M peak hour. However the LOS for the same intersection is not within acceptable limits under existing traffic condition during A.M peak hour. The quality of Traffic flow at the intersection of Galveston Road and Broadway Street is within acceptable limits for A.M and P.M. peak hours. The quality of traffic flow on Broadway Street at Hartford Street is within acceptable limits for both A.M and P.M peak hours under existing (year 2012) traffic condition.

The 6-lane alternative has been tested under following geometric and traffic control conditions:

- 6-lanes on Broadway Street from IH 45 to Galveston Road
- Adding Left turn bays on Broadway Street at its intersection with Hartford Street.

Capacity analysis results indicate that the quality of traffic flow at the intersection of Broadway Street at IH 610 interchange is not within acceptable limits during peak hours under Alternative 1. This intersection has been tested by changing lane assignments and optimizing signal timing. Some geometric improvements under the bridge (adding lanes) are required to handle the

projected traffic demand at this interchange in the future. It is recommended to conduct further study by TXDOT in the future in order to improve traffic operations and safety at this interchange.

Capacity analysis results indicate that the quality of traffic flow at the following intersections is within acceptable limits during peak hours under Alternative 1.

- Broadway Street at Galveston Road
- Broadway Street at Hartford Street

Based on field investigations and traffic analysis results, we conclude the following:

- Under existing traffic and geometric conditions, the overall LOS for Broadway at Hartford Street during A.M and P.M peak hours is within acceptable limits.
- Under existing traffic and geometric conditions, the overall LOS for Broadway at Galveston Road during A.M and P.M. peak hours is within acceptable limits.
- Under existing traffic and geometric conditions, the overall LOS for Broadway at IH 610 interchange during P.M peak hours is within acceptable limits. However during A.M peak hours the LOS is not within acceptable limits.
- Under proposed traffic and geometric conditions, the overall LOS for Broadway at Hartford Street and Broadway at Galveston Road during A.M and P.M peak hours are within acceptable limits.
- Under proposed traffic and geometric conditions, the overall LOS for Broadway at IH 610 interchange during A.M and P.M peak hours are not within acceptable limits.
- Future (year 2035) traffic projections provided by the City of Houston for the year 2035 show significant traffic growth along the Broadway street corridor compared to existing (year 2012) traffic patterns.

4.3 Proposed Drainage

The study area is generally located in southeast Houston (Key Map 535P, K & F) between IH-45 on the south and Galveston Road on the north.

The proposed storm sewer system captures the existing runoff and the increased runoff due to impervious area in the proposed conditions. The flow calculations for proposed conditions are shown in Appendix B. The overall drainage area map is shown in Exhibit 4.

The total drainage area 139.15 acres for System C0155, that is mentioned in the Phase I report has been revised and subdivided to make it flow to Fennel and Broadway systems. The existing Broadway System C0155 is sufficient to convey 2-year flows. Thus, the system has not been upgraded in the proposed conditions along main trunkline but the laterals have been upgraded to minimum 24" RCP and inlets have been replaced by C inlets.

System C0156 is been upsized to 24" RCP along Broadway St.; System C0160 to 24", 30" and 36" RCP and System C0008 to 48" RCP to maintain the proposed HGL below gutter line.

The SWMM longitudinal profiles are shown in Appendix D. HGL comparison table and outflow comparison tables are shown in Table 1 and 2 respectively in Appendix E and the proposed SWMM output can be found in Appendix F.

No mitigation due to increase impervious is proposed as the proposed storm sewer system will provide an additional storage to the Broadway Street Reconstruction Project due to the upgrade of existing storm sewers. It has been concluded that the proposed Broadway Street Reconstruction Project, side street modifications, and storm sewer modifications will have no adverse impact to the existing flood hazard conditions for the 2-year and 100-year event.

This report discusses the 2-year and 100-year storm sewer and overland flow performed for drainage system along the Broadway St. The analysis was performed to determine whether the storm sewer satisfies the criteria found in Chapter 9 of the City of Houston Infrastructure Design Manual and Technical Paper 101. A summary of the results of the analyses for the drainage system that was analyzed is given in the following paragraphs.

The drainage systems found with Broadway St. Outfall Systems C0155, C0156, C0160 and C0008 were modeled using a tailwater set to soffit elevation for 2-year design analysis and a 100-year water surface elevation for 100-year extreme event analysis in the channel for existing and proposed conditions that were based on the receiving channel, Sims Bayou effective FEMA maps and HEC-RAS provided by HCFCD.

After analyzing the existing storm sewer system SWMM models, the analysis shows that the existing storm system C0156, C0160 and C0008 at Broadway St. was undersized. Also the Broadway St. inlets were undersized.

In proposed conditions, 2-year HGL’s at all times show below the gutter line and 100-year WSEL's below MPE throughout the project for all systems with upgraded sizes and inlets. Velocities in 100-year at all proposed inlets for all systems are below maximum allowable value of 12 fps except for outfall links.

No additional mitigation is required as the proposed storm sewer system will provide the inline detention for the increased impervious Broadway Street Reconstruction Project. It has been concluded that the proposed Broadway Street Reconstruction Project, side street modifications, and storm sewer modifications will have no adverse impact to the existing flood hazard conditions for the 2-year and 100-year event.

4.4 Utilities

Water and sanitary betterments and replacements were coordinated with City staff. Proposed water lines are limited to the replacement of the existing line 12-inch line between Concord and IH-610. Two segments of sanitary lines were requested to be replaced. Proposed water and sanitary lines are shown on the Drainage and Utility exhibits.

4.5 Permitting

Development of this project will require agreements with TxDOT for work at both IH-45 and IH-610 and UPRR. The agreement with UPRR will have to cover both the extension of the crossing, new or relocated railroad signals and possibly temporary gates during construction.

4.6 Candidate Project Development

Each project solution was evaluated in order to determine their merits and ranking among the project alternatives and eventually the ranking of the recommended alternative to other projects

citywide based on the project priority score. The Candidate Project Summary Information, location and vicinity maps, Project Layout, Scoring Information Sheet, Total Project cost Breakdown and COH rebuild funds to Calculate Project Priority Score breakdowns are included in this section.

The evaluation methodology and scoring followed the guidelines established in the City of Houston "Capital Improvement Plan Process Manual for Infrastructure Programs' dated July 18, 2012.
The estimated cost of the 4-lane option is approximately $11,108,000. A detailed breakdown of the cost components is included in the attached Table 1.

The estimated cost of the 6-lane option is approximately 12,558,000. A detailed breakdown of the cost components is included in Appendix 5 of this report.

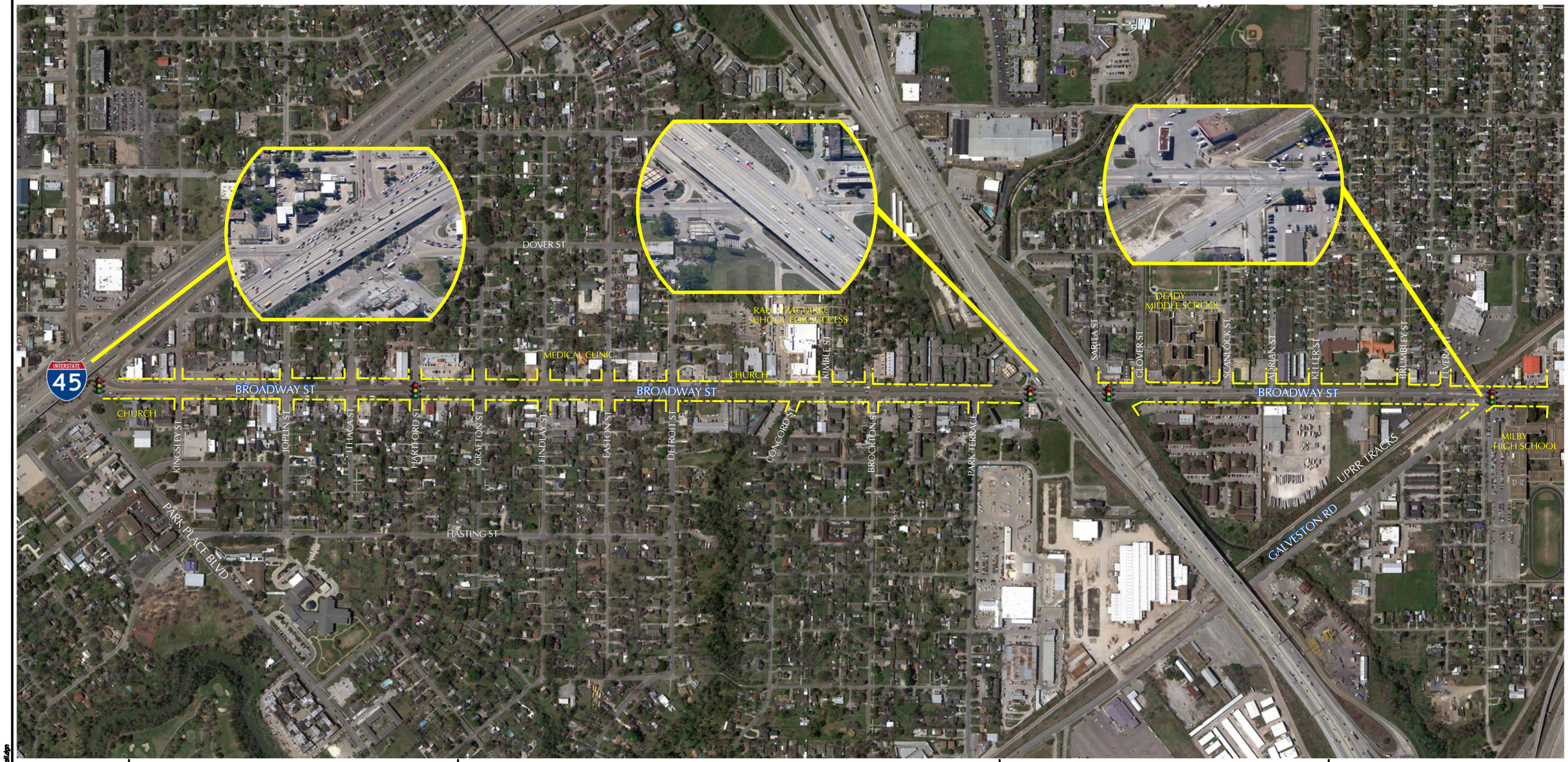
5.0 RECOMMENDATIONS

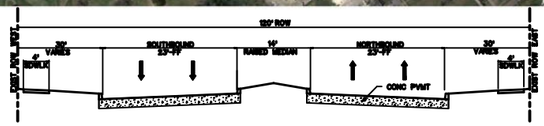
The 4-lane alternative is recommended for implementation. Based on the projected traffic and the difficulty in programming improvements at the IH-610 and IH-45 intersections due to TxDOT long range plans, it was determined that the best alternative is to construct a facility that will be able to accommodate the traffic for a considerable time frame and be easily expandable to 6 lanes when the traffic demands it. The main traffic issues are at the two TxDOT controlled intersections and until such time TxDOT is able to reconstruct these areas to accommodate the 6 lanes on Broadway, reconstructing the remainder of Broadway to 6 lanes will not significantly impact the level of service in the corridor. The complete information for the recommended alternative is included in previous sections of the report.

Reconstruction of Broadway is recommended as a single project. The Candidate Project Summary Cost, Project cost estimate Breakdown and COH Rebuild Funds to Calculate Project Priority Score for the recommended alternative are included.

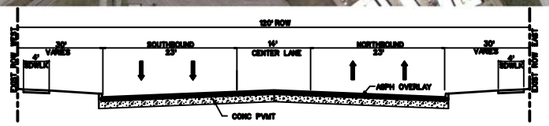
Implementation of the recommended alternative will require acquisition of one parcel of right-of-way. It is anticipated that design for the project will take approximately 9 months and construction will take 12 months.

The reconstruction of the existing 4-lane facility, Alternative 2, is recommended for development. The total cost of this alternative is estimated at $11,108,000. The candidate project priority score of this alternative is approximately 82.6. The benefited population of this project is estimated at 24,536.





BROADWAY FROM IH-45 TO IH-610
TYPICAL SECTION



BROADWAY FROM IH-610 TO GALVESTON RD
TYPICAL SECTION

LEGEND

EXISTING ROW

PONDING

METRO BUS SHELTER

SIGNALIZED INTERSTATION

PGAL
TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 988-8333

0 150 300 600
SCALE: 1" = 600'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

OVERALL LAYOUT

EXHIBIT A

DATE: 1/24/2013 6:09:34 PM
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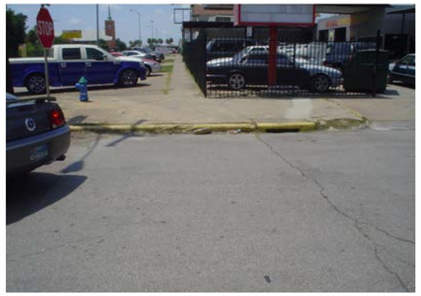
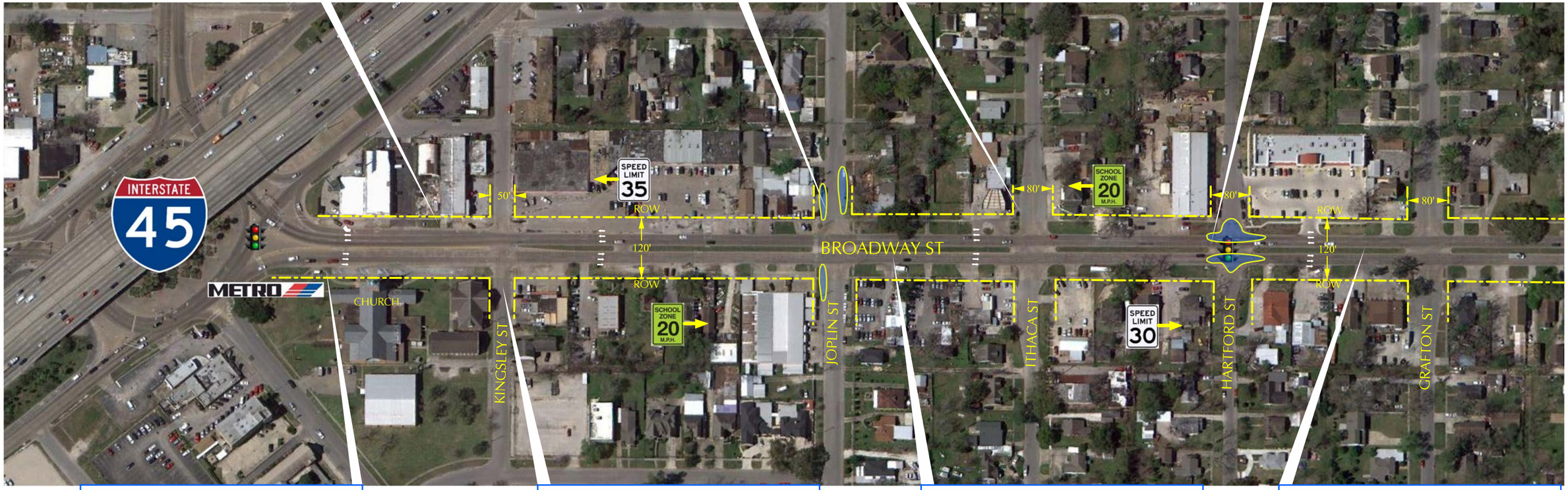
LOOKING SOUTH @ KINGSLEY
HEAD IN PARKING



ACCESSIBILITY

SUB-STANDARD INLET

SUB-STANDARD
TRAFFIC SIGNAL EQUIPMENT



HEAD-IN PARKING

LOOKING NORTH @ KINGSLEY

LOOKING NORTH
CONC PVMT OVER 50 YRS OLD

LOOKING SOUTH
MISSING CURB AT MEDIAN

LEGEND

- EXISTING ROW
- PONDING
- METRO BUS SHELTER
- SIGNALIZED INTERSECTION

PGAL
TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 988-0333

0 50 100 200
SCALE: 1" = 200'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

EXISTING CONDITIONS
SHEET 1 OF 3

EXHIBIT B

DATE: 1/24/2013 6:20:41 PM
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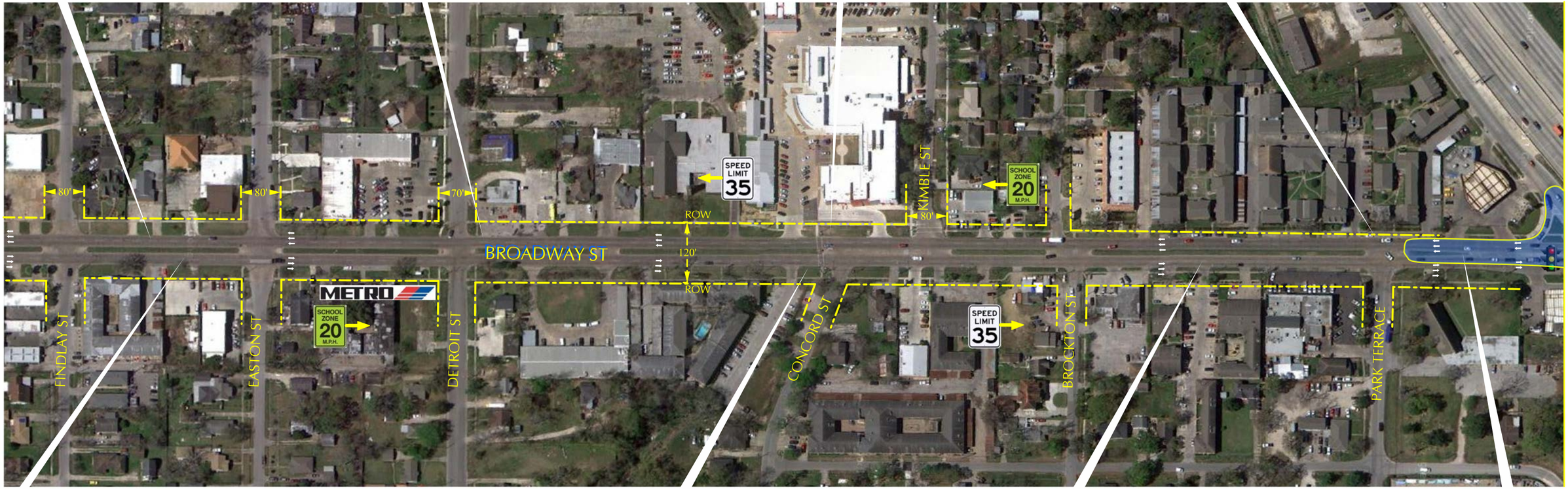
LOOKING EAST
PVMT IN POOR CONDITION

LOOKING SOUTHEAST @ DETROIT

LOOKING SOUTHEAST
MID-BLOCK SCHOOL CROSSING

LOOKING SOUTH
PARALLEL PARKING AT APT COMPLEX



LOOKING NORTHWEST
ASPHALT SEALED PVMT CRACKS

LOOKING NORTHWEST
MID-BLOCK SCHOOL CROSSING

LOOKING NORTHWEST

LOOKING NORTH @ IH-610

LEGEND

EXISTING ROW

PONDING

METRO BUS SHELTER

SIGNALIZED INTERSECTION

PGAL
TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 985-8333

0 50 100 200
SCALE: 1" = 200'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	N-000100-0003-3
CITY OF HOUSTON PM	UMESH KC, P.E.
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

EXISTING CONDITIONS
SHEET 2 OF 3

EXHIBIT B

DATE: 1/24/2013 6:05:47 PM
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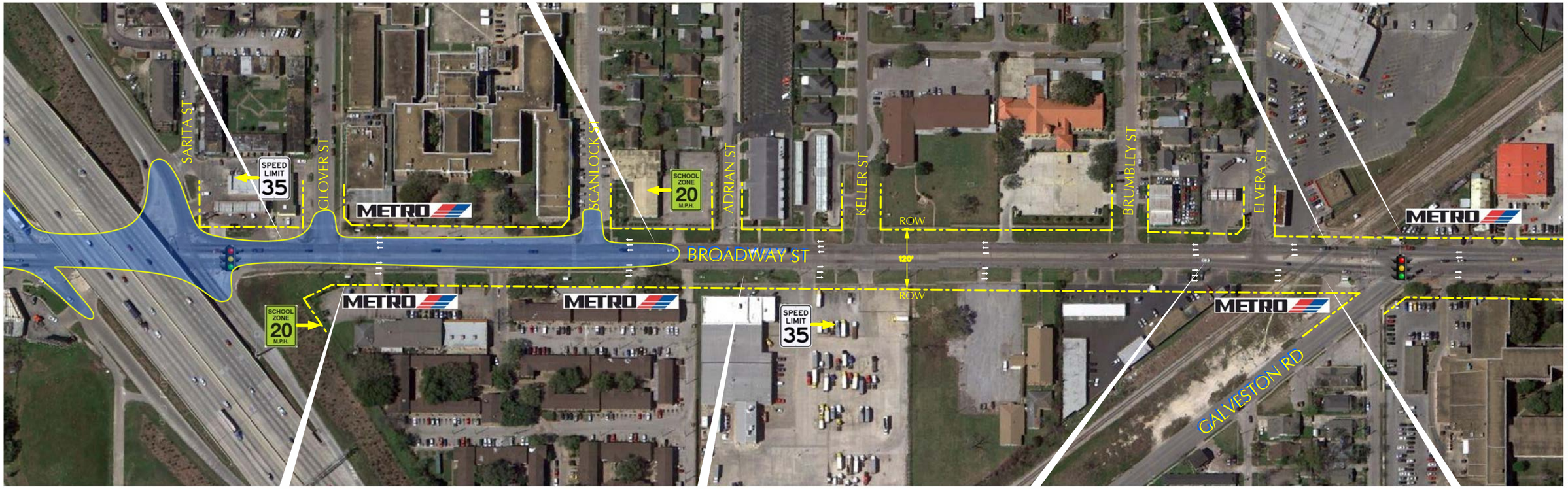
LOOKING SOUTH @ IH-610

LOOKING SOUTH

LOOKING S-EAST ALONG RR TRACKS

LOOKING SOUTH @ GALVESTON RD



LOOKING NORTHWEST
SCHOOL CROSSING/FAILED PVMT

LOOKING NORTH

LOOKING NORTH @ RR CROSSING

LOOKING NORTH @ GALVESTON RD

LEGEND

EXISTING ROW

PONDING

METRO BUS SHELTER

SIGNALIZED INTERSECTION

PGAL

TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 985-8333

SCALE: 1" = 200'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	N-000100-0003-3
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

EXISTING CONDITIONS
SHEET 3 OF 3

EXHIBIT B

DATE: 1/24/2013 6:09:53 PM
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2			NUMBERS OF LANES (EACH DIRECTION)
30 MPH	35 MPH		SPEED LIMIT
21,579	19,048	21,516	2011 DAILY TRAFFIC
30,609	32,081	31,515	2035 DAILY TRAFFIC
0.79	0.72	0.79	2011 NORTHBOUND V/C RATIO
0.58	0.46	0.54	2011 SOUTHBOUND V/C RATIO
1.14	1.11	1.13	2035 NORTHBOUND V/C RATIO
0.80	0.87	0.81	2035 SOUTHBOUND V/C RATIO
D	D	D	2011 LEVEL OF SERVICE
F	E	E	2035 LEVEL OF SERVICE
			GEOMETRIC DEFFICIENCIES
			CAPACITY ISSUES
			SAFETY ISSUES
			PEDESTRIAN SAFETY ISSUES
			OUTDATED SIGNAL EQUIPMENT

② CAPACITY ISSUE:
SBLT MOVEMENT, LONG QUEUE,
MODIFICATIONS NEEDED

SAFETY ISSUES:
PARALLEL PARKINGS CLOSE TO THE INTERCHANGE,
SAFE SIGHT DISTANCE PROBLEM
BUS STOP CLOSE TO THE INTERCHANGE

① ACCESS MANAGEMENT ISSUE:
LONG DRIVEWAY

③ OUTDATED SIGNAL EQUIPMENT

HEAVY LEFT TURN VOLUME,
SBLT MOVEMENT, ENTERING PARK TERRACE,
NO LEFT TURN BAY.

④ LEFT TURN CAPACITY ISSUE,
NBLT MOVEMENTS, ENTERING IH 610 W
NO LEFT TURN BAY

POOR PAVEMENT IN THE RAILROAD CROSSING

GEOMETRIC IMPROVEMENTS NEEDED,
OUTDATED SIGNAL EQUIPMENT,
BUS STOP CLOSE TO THE INTERSECTION, SAFETY ISSUE

①

LOOKING SOUTH AT IH-45
LONG DRIVEWAY

②

LOOKING NORTHWEST FROM IH-45
SOUTHBOUND LEFT TURNER'S QUEUE

③

LOOKING NORTH AT HARTFORD STREET
OUTDATED EQUIPMENT

④

LOOKING NORTH AT IH-610
NORTHBOUND LEFT TURNER'S QUEUE

PGAL
TBPE REG. NO. F-2242
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 960-9333

ETSI
11500 Northwest Freeway, Suite 491
Houston, Texas 77092
Tel. (713) 956-9601 Fax (713) 956-9667
Ergonomic Transportation Solutions, Inc.
Texas Registered Engineering Firm No. F-000825

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

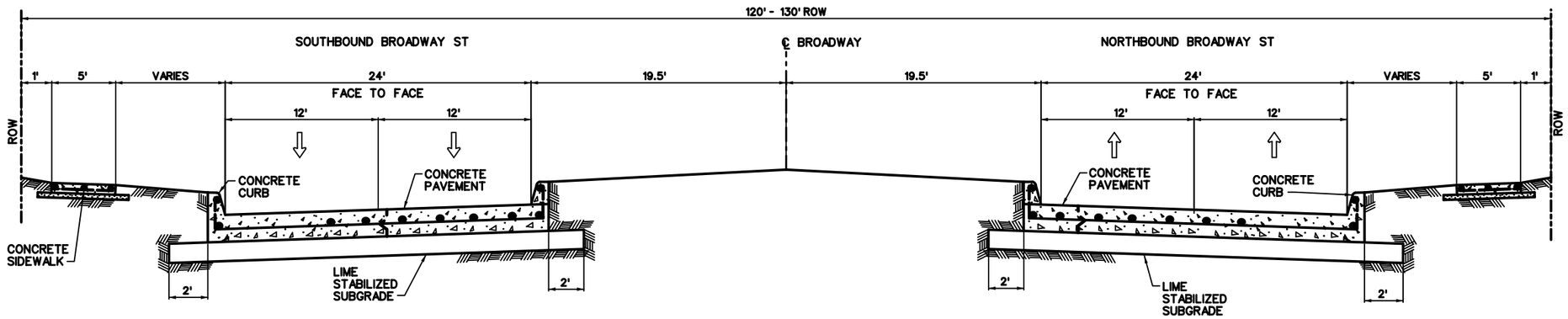
WBS NUMBER	N-000100-0003-3
CITY OF HOUSTON PM	JUAN A. RENDON, P.E.
DATE	06/29/12

STREET AND PAVING IMPROVEMENTS
FOR BROADWAY STREET

EXISTING TRAFFIC CONDITIONS

EXHIBIT C

DATE, NAMES, SPACES, STAMPS



(A) BROADWAY ROAD 4-LANE OPTION

N.T.S.

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PGAL
TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 988-9333

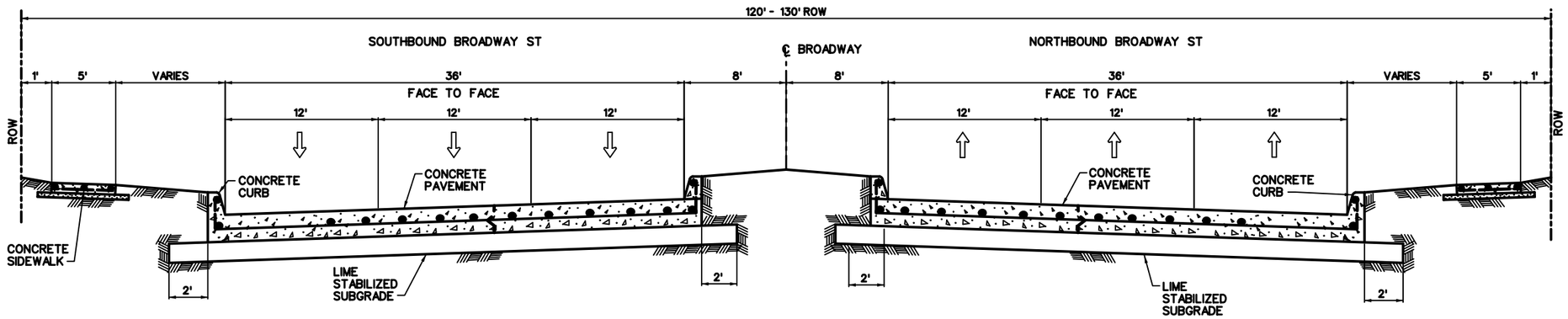
CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

BROADWAY ROAD PROPOSED TYPICAL SECTIONS

EXHIBIT D
SHEET 1 OF 2



(B) BROADWAY ROAD 6-LANE OPTION

N.T.S.

DATE: 1/24/2013 6:06:50 PM
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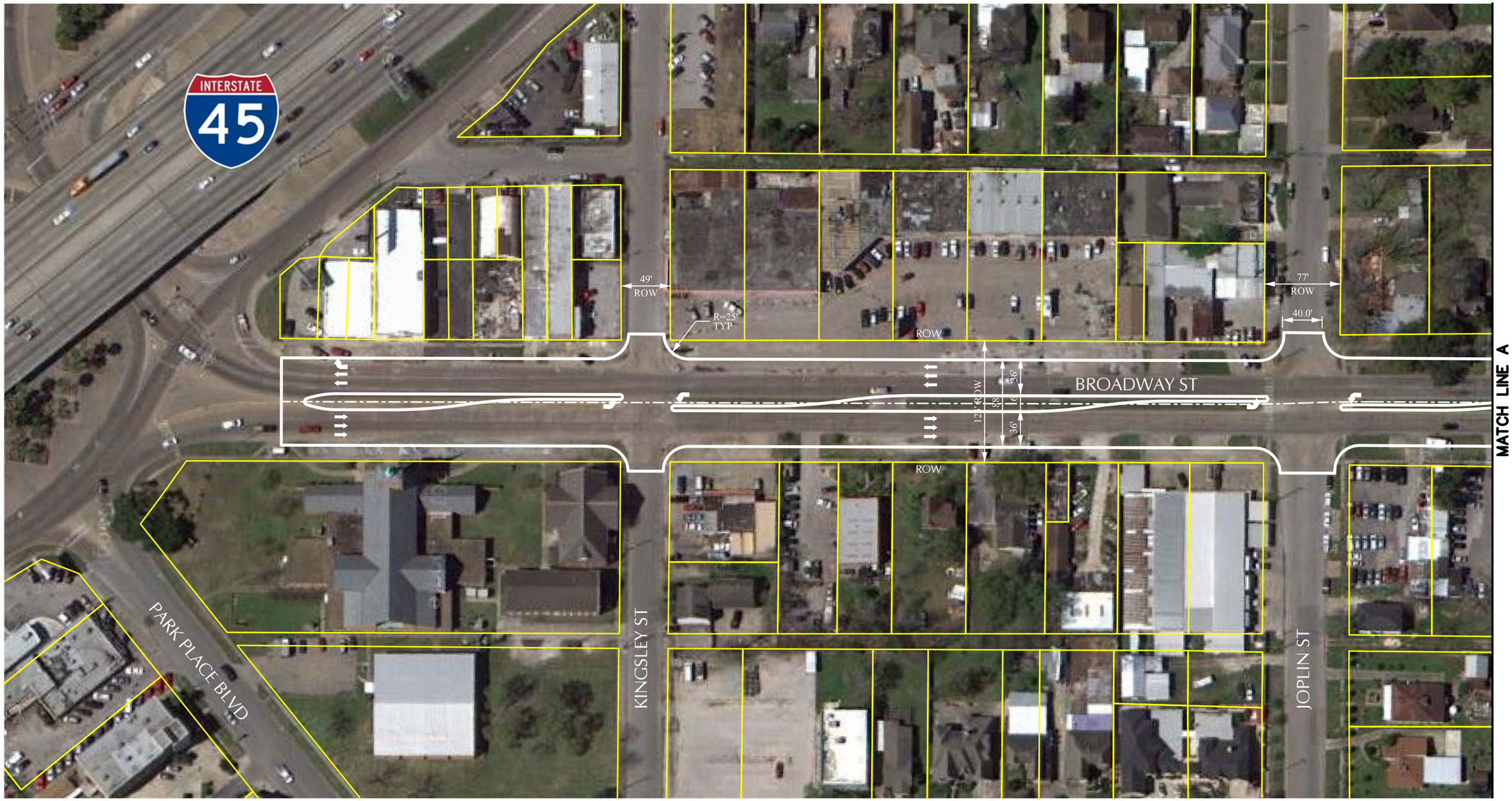
		PGAL TBPE REG. NO. F-2742 3131 BRIARPARK Suite 200 Houston, Texas 77042 Phone (713) 622-1444 Fax (713) 985-8333		CITY OF HOUSTON DEPARTMENT OF PUBLIC WORKS AND ENGINEERING	WBS NUMBER	STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET	
					N-000100-0003-3	BROADWAY ROAD PROPOSED TYPICAL SECTIONS	EXHIBIT D
					CITY OF HOUSTON PM		SHEET 2 OF 2
					UMESH KC, P.E.		
					DATE 09/21/12		



LEGEND

- PROP PAVEMENT
- ASPH PAVEMENT
- CENTERLINE ROAD
- PARCEL/ROW
- TRAFFIC FLOW

PGAL

TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 988-9333

0 25 50 100
SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
6 LANE OPTION

EXHIBIT E
SHEET 1 OF 7

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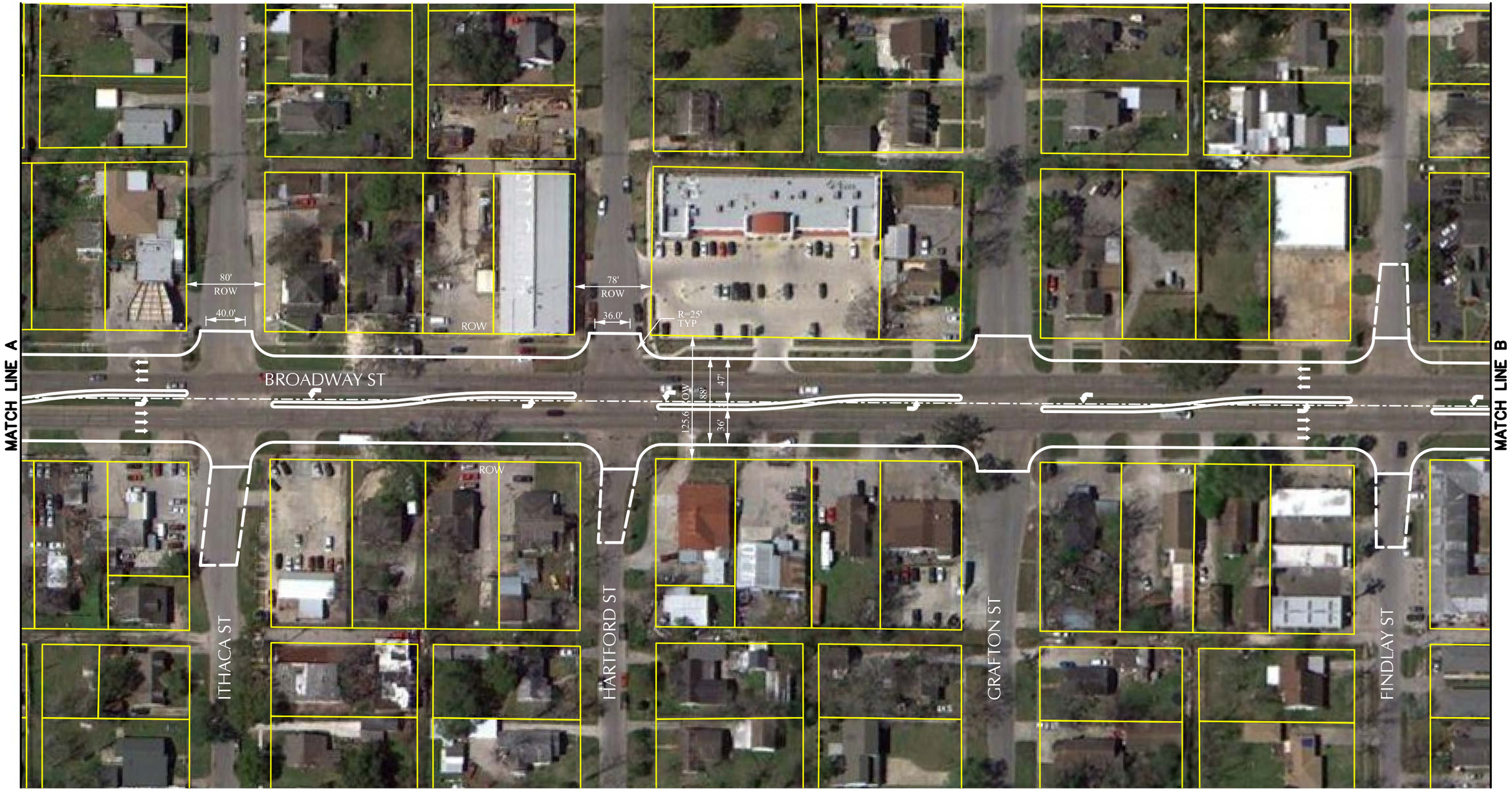

LEGEND

- PROP PAVEMENT
- ASPH PAVEMENT
- CENTERLINE ROAD
- PARCEL/ROW
- TRAFFIC FLOW

PGAL

TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 968-6333

0 25 50 100
SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
6 LANE OPTION

EXHIBIT E
SHEET 2 OF 7

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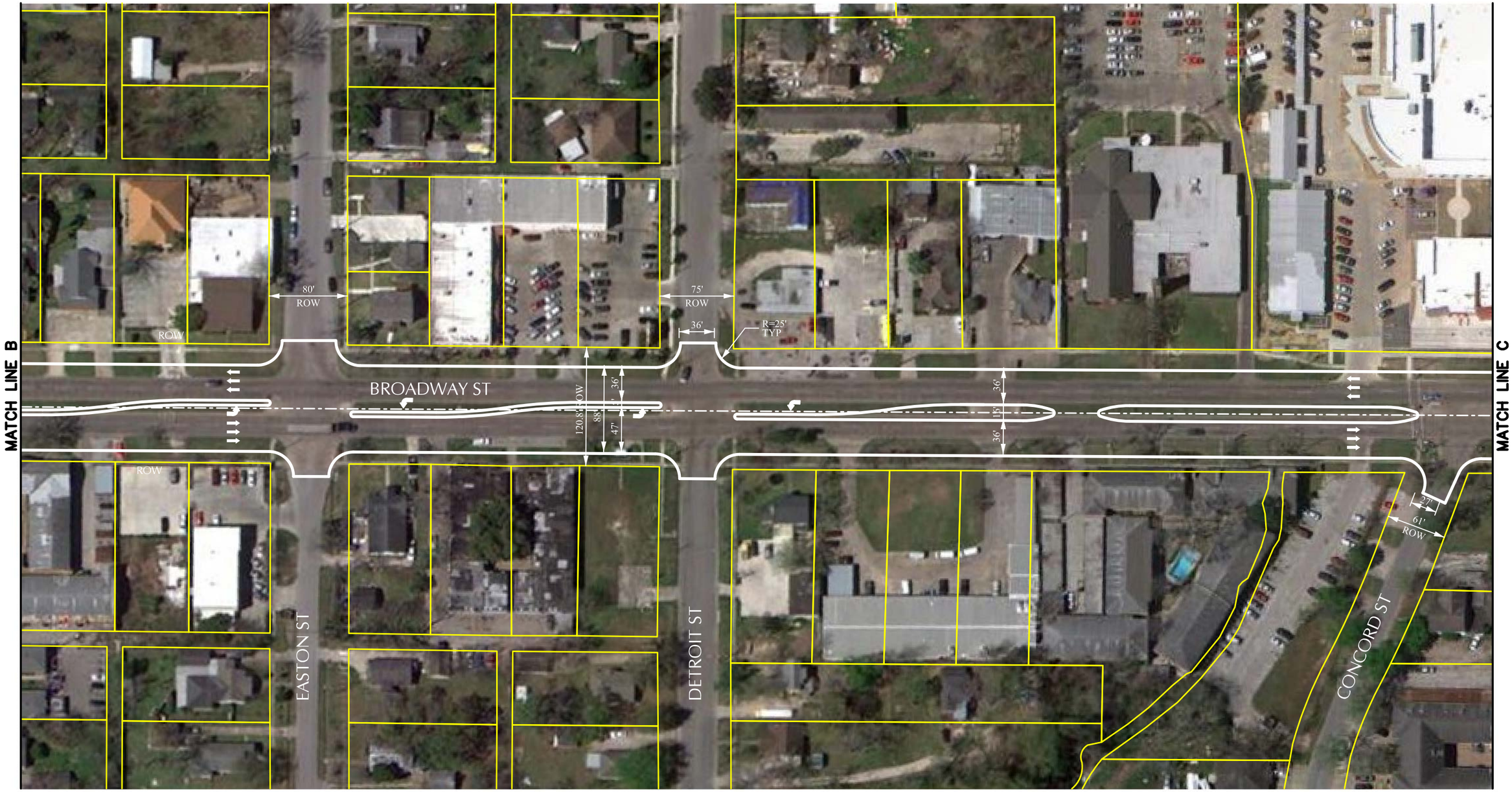

LEGEND

- PROP PAVEMENT
- ASPH PAVEMENT
- CENTERLINE ROAD
- PARCEL/ROW
- TRAFFIC FLOW

PGAL

TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 952-6333

SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	N-000100-0003-3
CITY OF HOUSTON PM	UMESH KC, P.E.
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
6 LANE OPTION

EXHIBIT E
SHEET 3 OF 7

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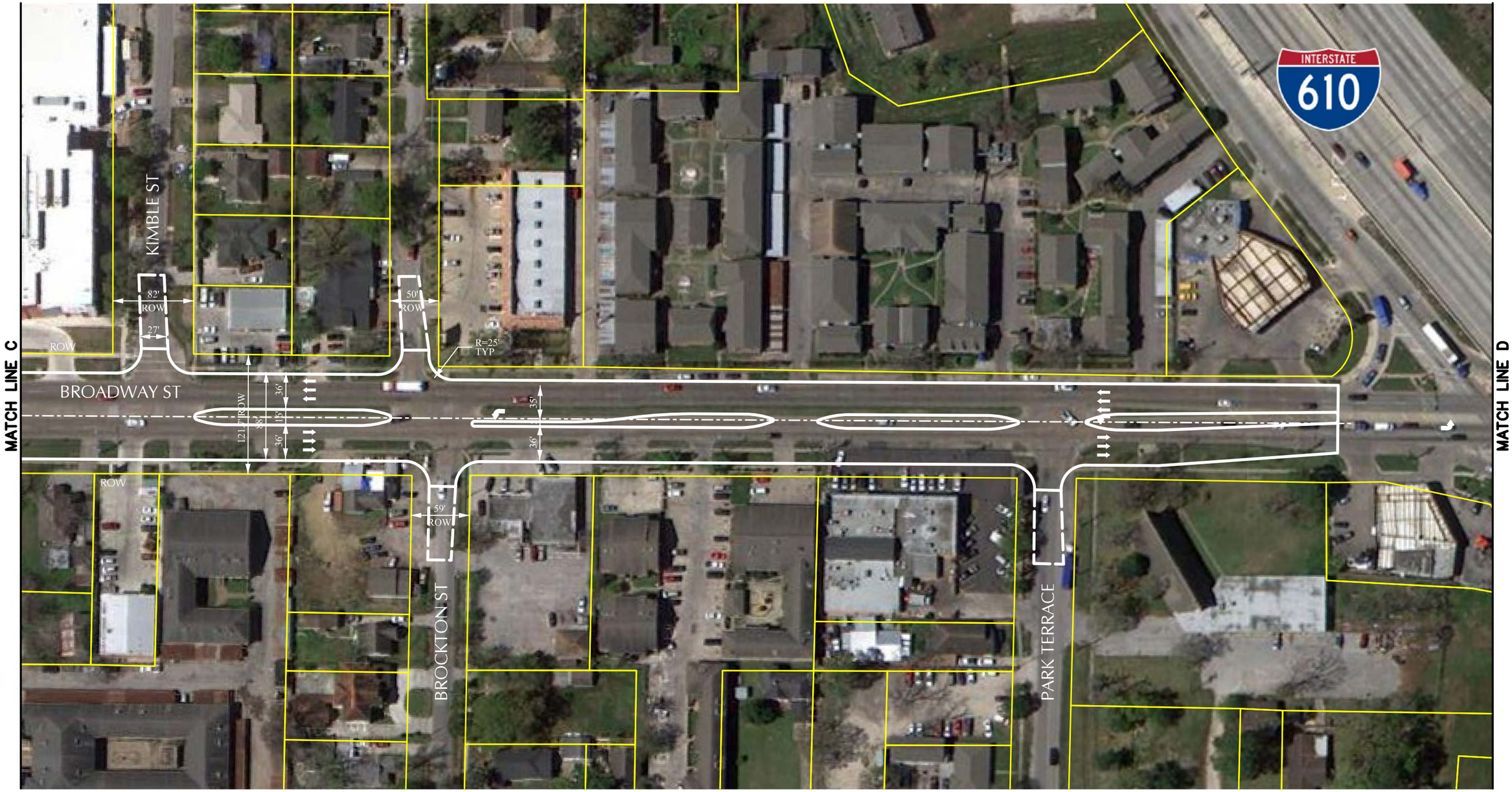

LEGEND

- PROP PAVEMENT
- ASPH PAVEMENT
- CENTERLINE ROAD
- PARCEL/ROW
- TRAFFIC FLOW

PGAL

TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 952-6333

SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	N-000100-0003-3
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
6 LANE OPTION

EXHIBIT E
SHEET 4 OF 7

DATE: 1/24/2013 8:43:41 PM
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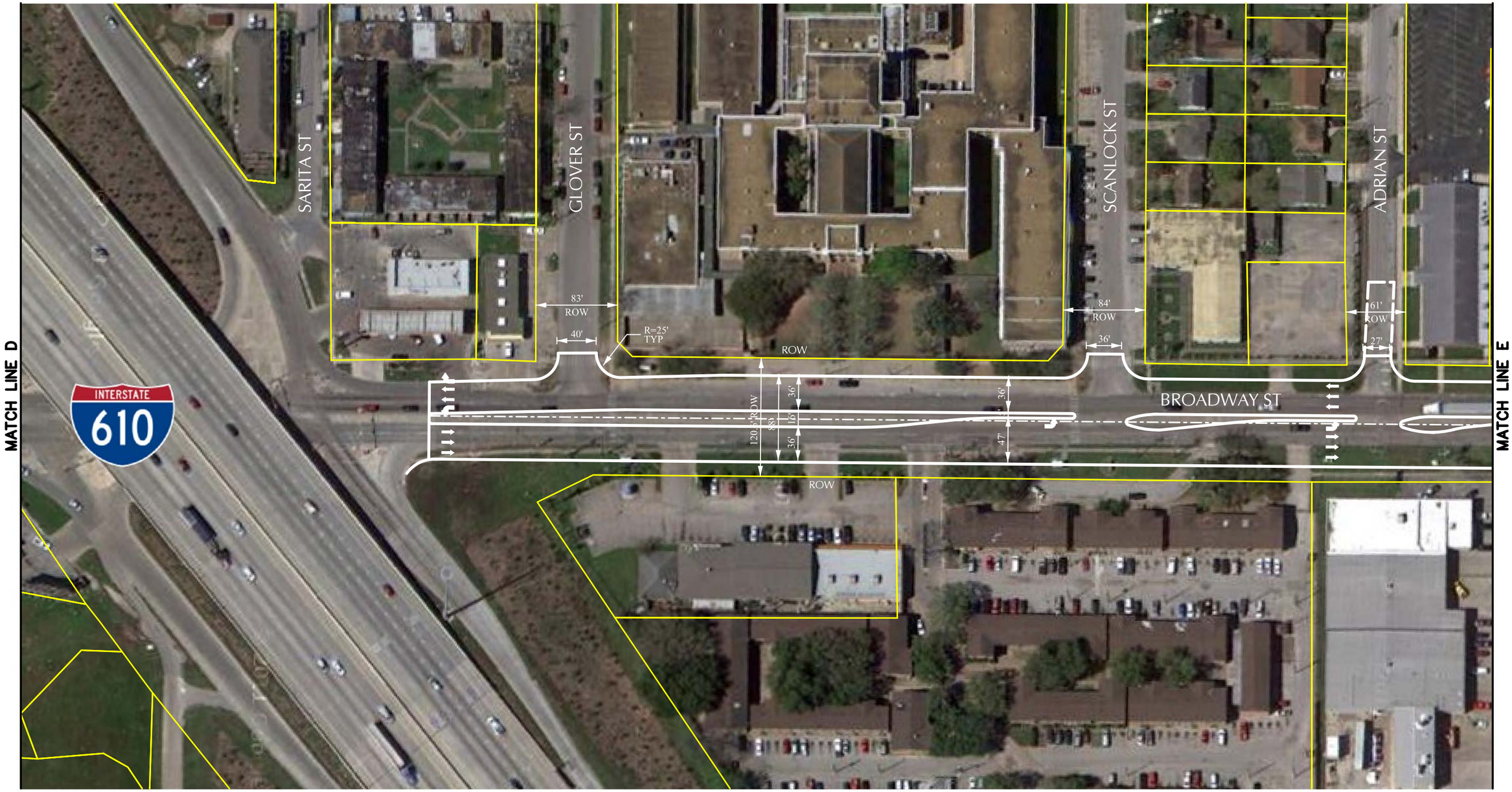

LEGEND

PROP PAVEMENT

ASPH PAVEMENT

CENTERLINE ROAD

PARCEL/ROW

TRAFFIC FLOW

N

PGAL

TBPE REG. NO. F-2742

3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 822-1444
Fax (713) 988-9333

0 25 50 100

SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
6 LANE OPTION

EXHIBIT E
SHEET 5 OF 7

DATE: 1/24/2013 8:48:45 PM
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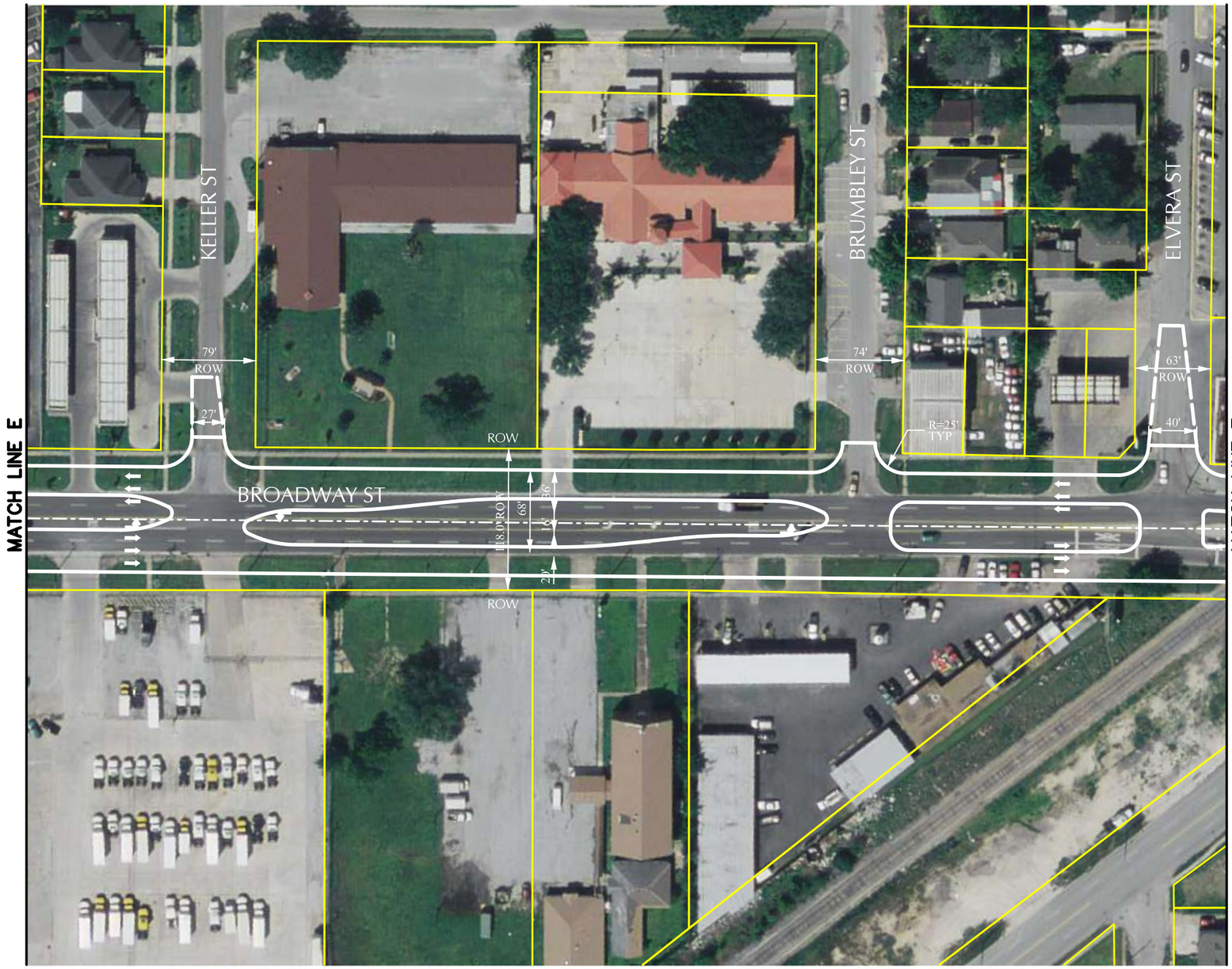

LEGEND

PROP PAVEMENT

ASPH PAVEMENT

CENTERLINE ROAD

PARCEL/ROW

TRAFFIC FLOW

PGAL

TBPE REG. NO: F-2742

3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 968-6333

0 25 50 100

SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
6 LANE OPTION

EXHIBIT E
SHEET 6 OF 7

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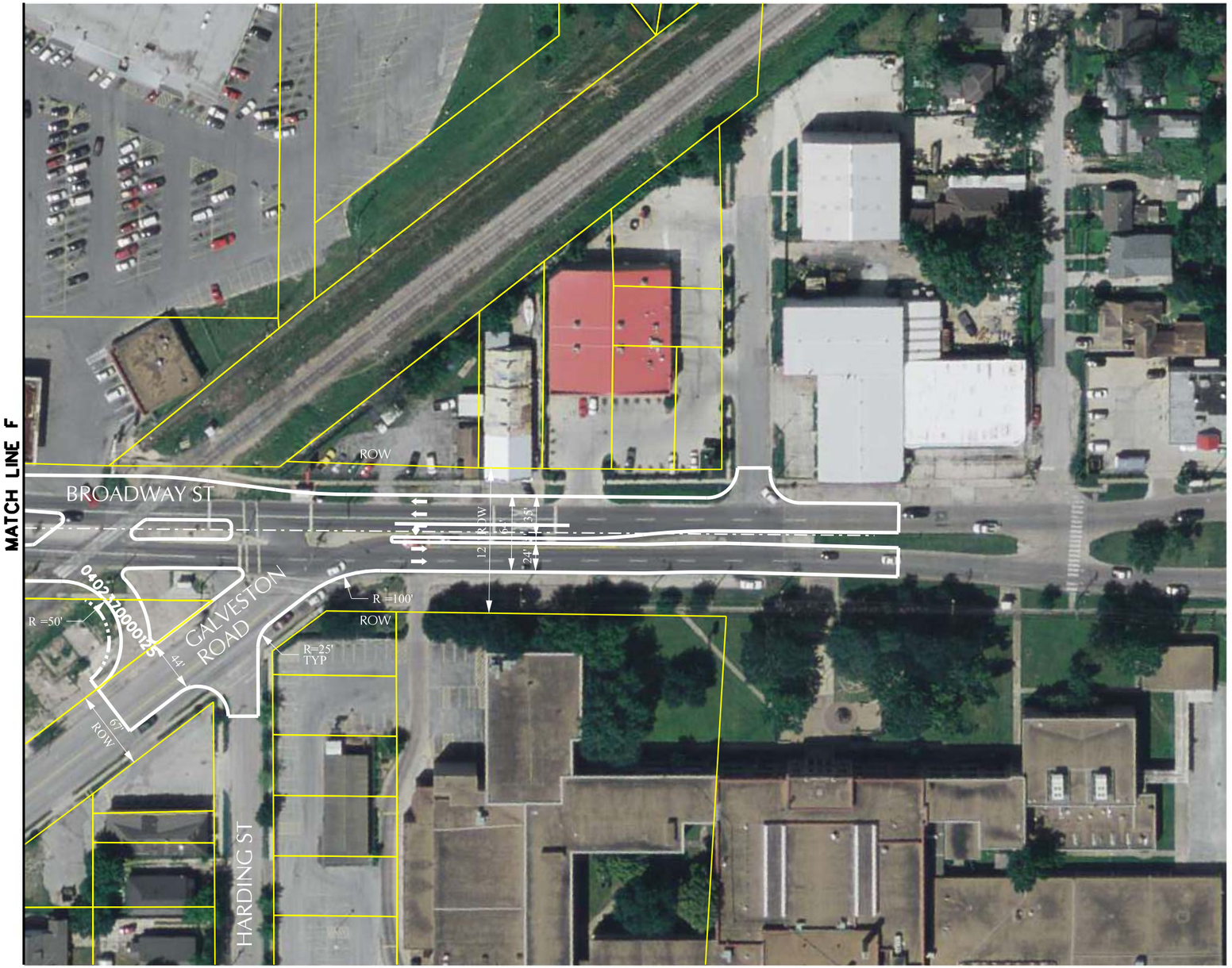

PGAL
TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 968-9333

0 25 50 100
SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS
FOR BROADWAY STREET
PROPOSED ROADWAY LAYOUT
6 LANE OPTION

EXHIBIT E
SHEET 7 OF 7

DATE: $DATE$ $TIME$
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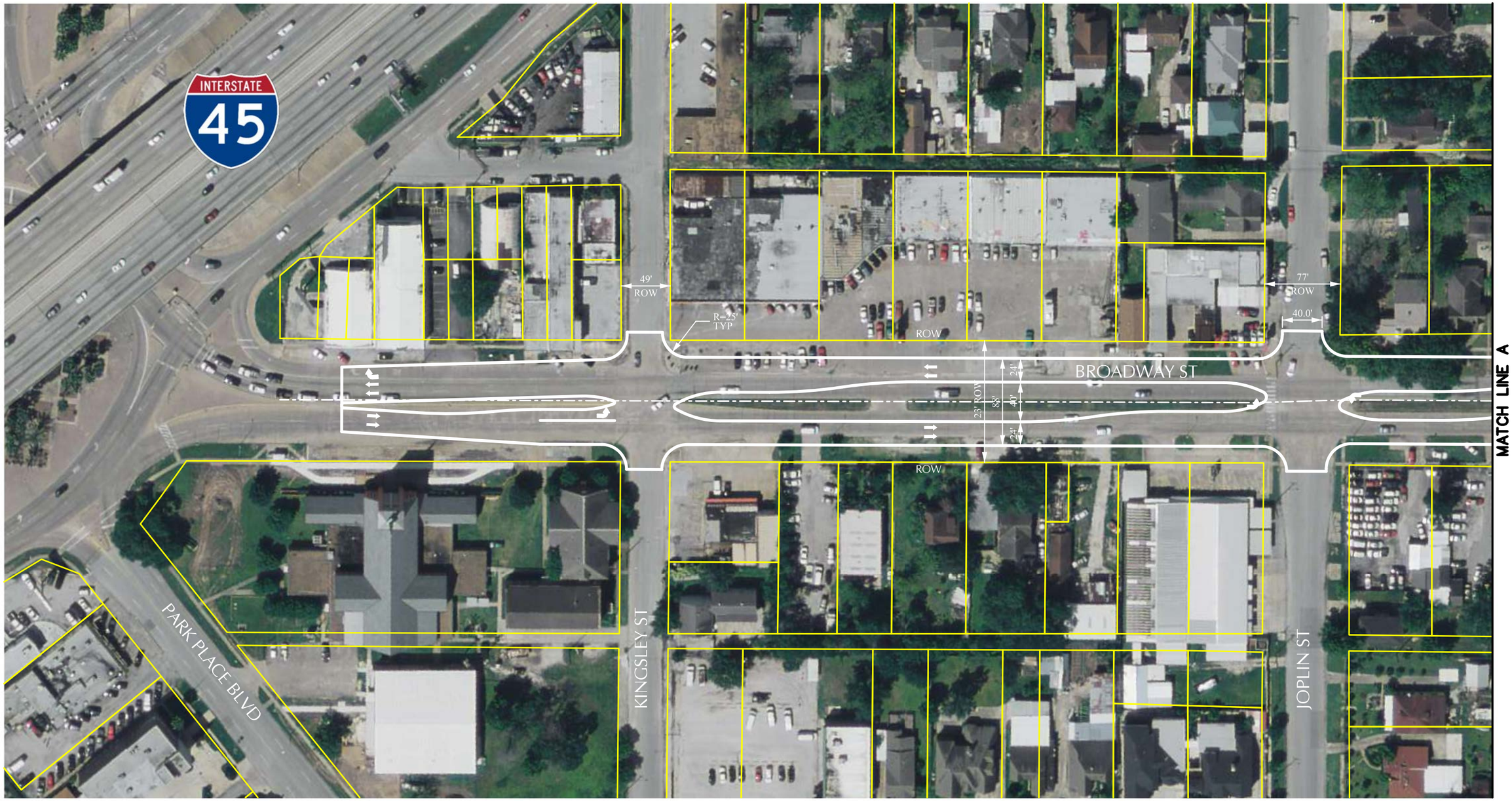

LEGEND

- PROP PAVEMENT
- ASPH PAVEMENT
- CENTERLINE ROAD
- PARCEL/ROW
- TRAFFIC FLOW

PGAL

TBPE REG. NO. F-2742
3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 952-6333

0 25 50 100
SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	N-000100-0003-3
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
4 LANE OPTION

EXHIBIT F
SHEET 1 OF 7

DATE: 1/24/2013 8:40:52 PM
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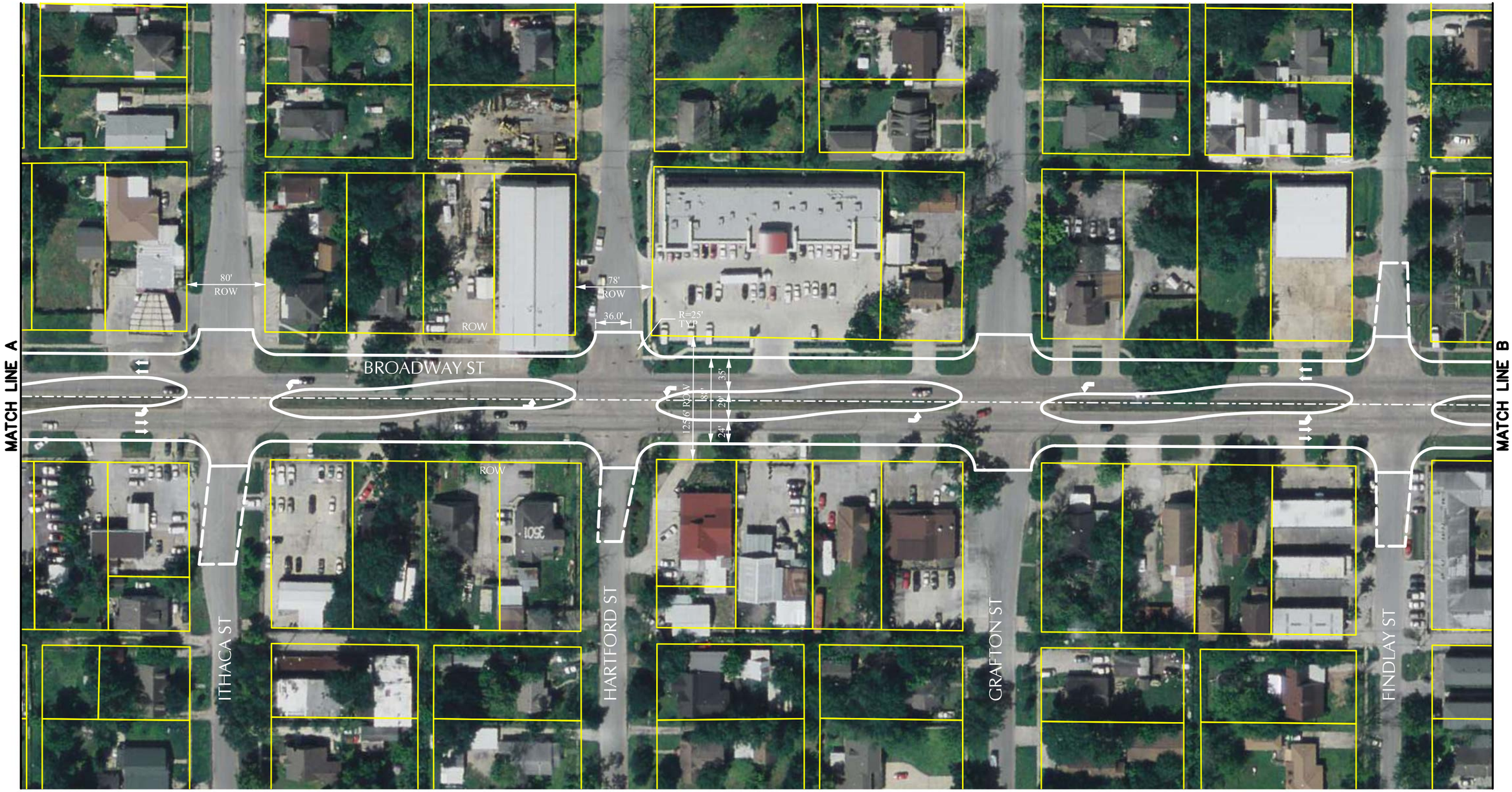

LEGEND

- PROP PAVEMENT
- ASPH PAVEMENT
- CENTERLINE ROAD
- PARCEL/ROW
- TRAFFIC FLOW

PGAL

TBPE REG. NO. F-2742

3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 988-9333

0 25 50 100
SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
4 LANE OPTION

EXHIBIT F
SHEET 2 OF 7

DATE: 1/24/2013 8:40:05 PM
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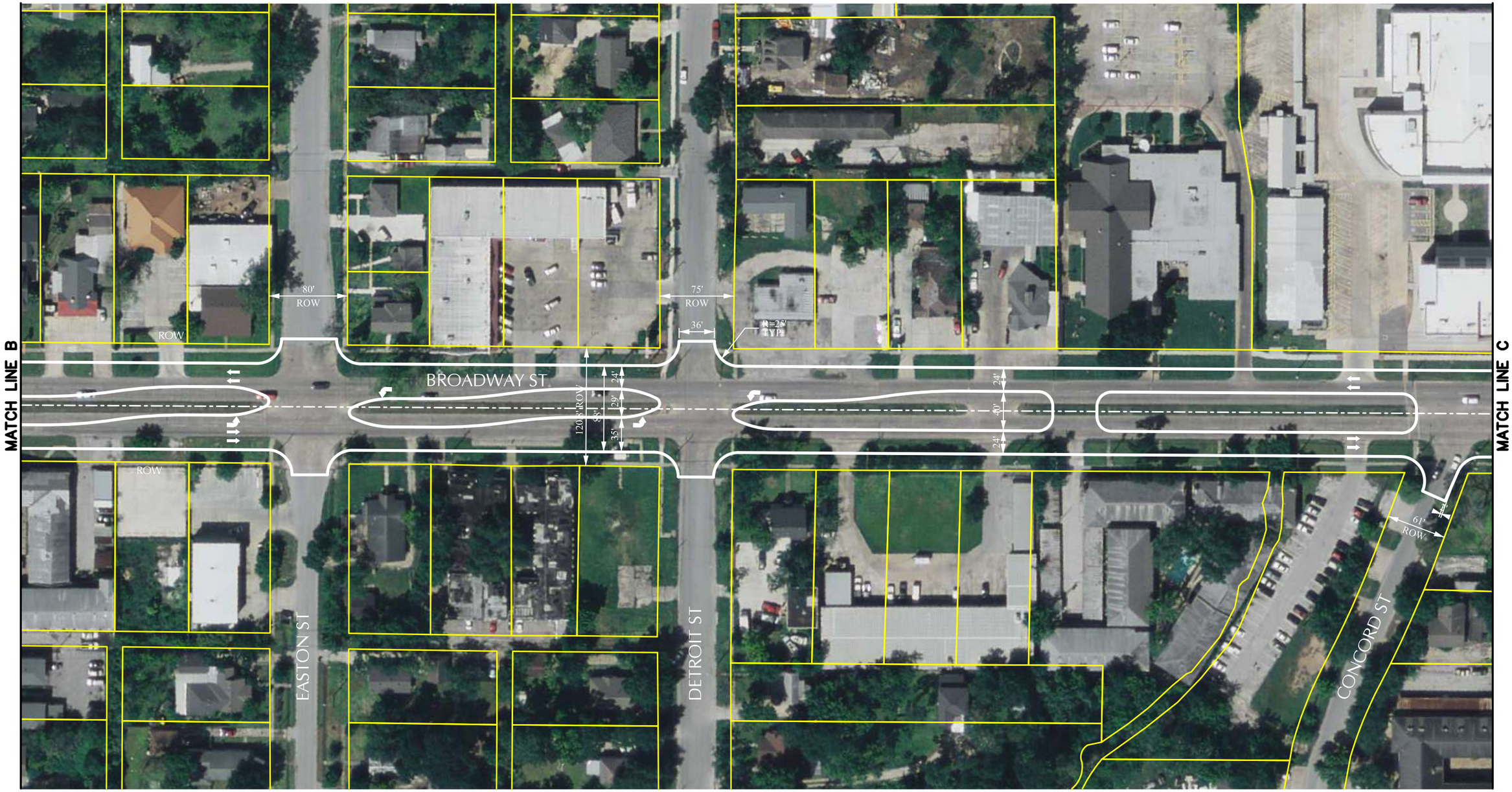

LEGEND

PROP PAVEMENT

ASPH PAVEMENT

CENTERLINE ROAD

PARCEL/ROW

TRAFFIC FLOW

PGAL

TBPE REG. NO. F-2742

3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 822-1444
Fax (713) 988-9333

0 25 50 100

SCALE: 1" = 100'

CITY OF HOUSTON

DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
4 LANE OPTION

EXHIBIT F
SHEET 3 OF 7

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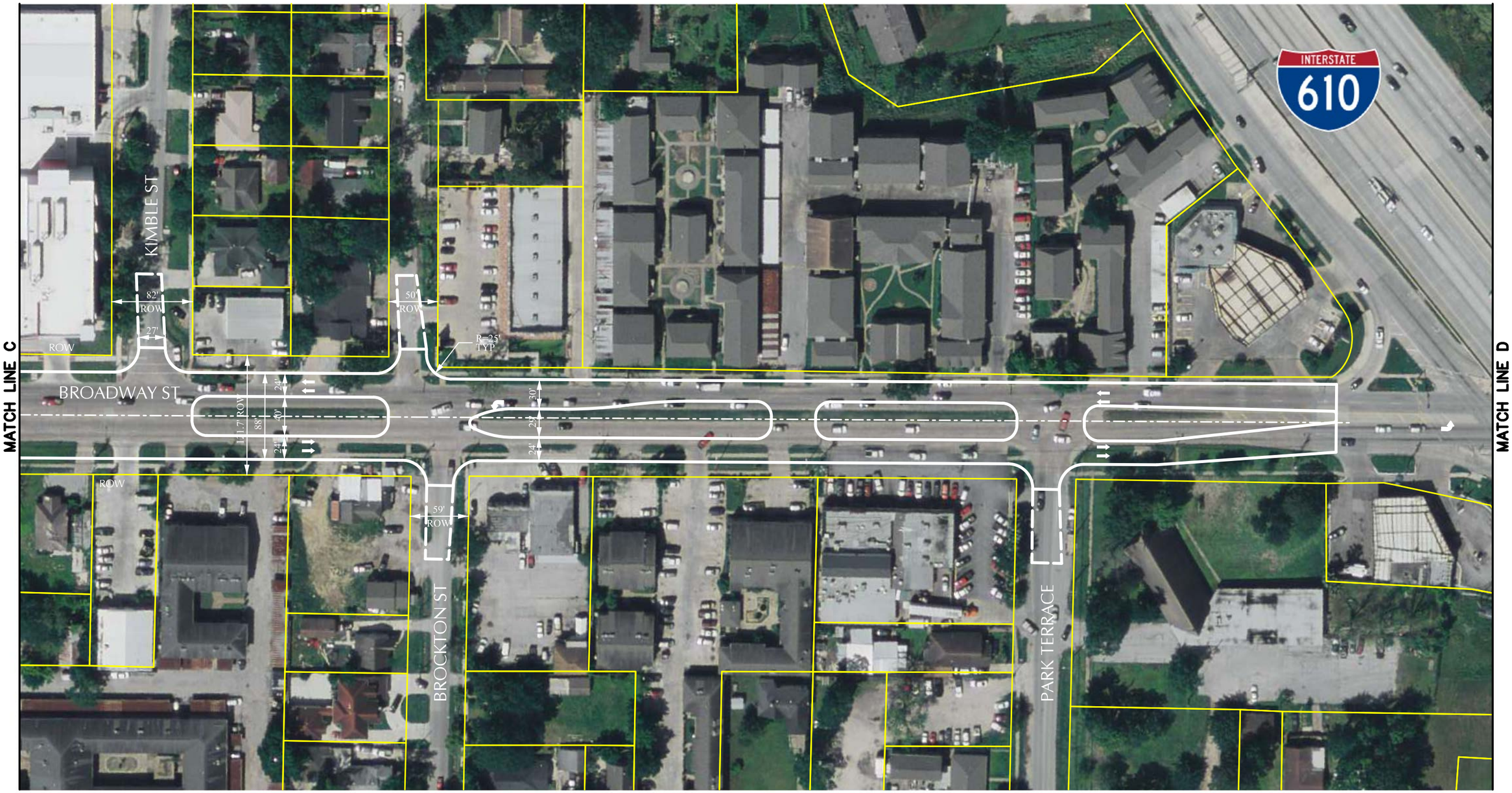

LEGEND

PROP PAVEMENT

ASPH PAVEMENT

CENTERLINE ROAD

PARCEL/ROW

TRAFFIC FLOW

PGAL

TBPE REG. NO. F-2742

3131 BRIARPARK
Suite 200
Houston, Texas 77042
Phone (713) 622-1444
Fax (713) 985-8333

0 25 50 100

SCALE: 1" = 100'

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WBS NUMBER	
N-000100-0003-3	
CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
4 LANE OPTION

EXHIBIT F
SHEET 4 OF 7

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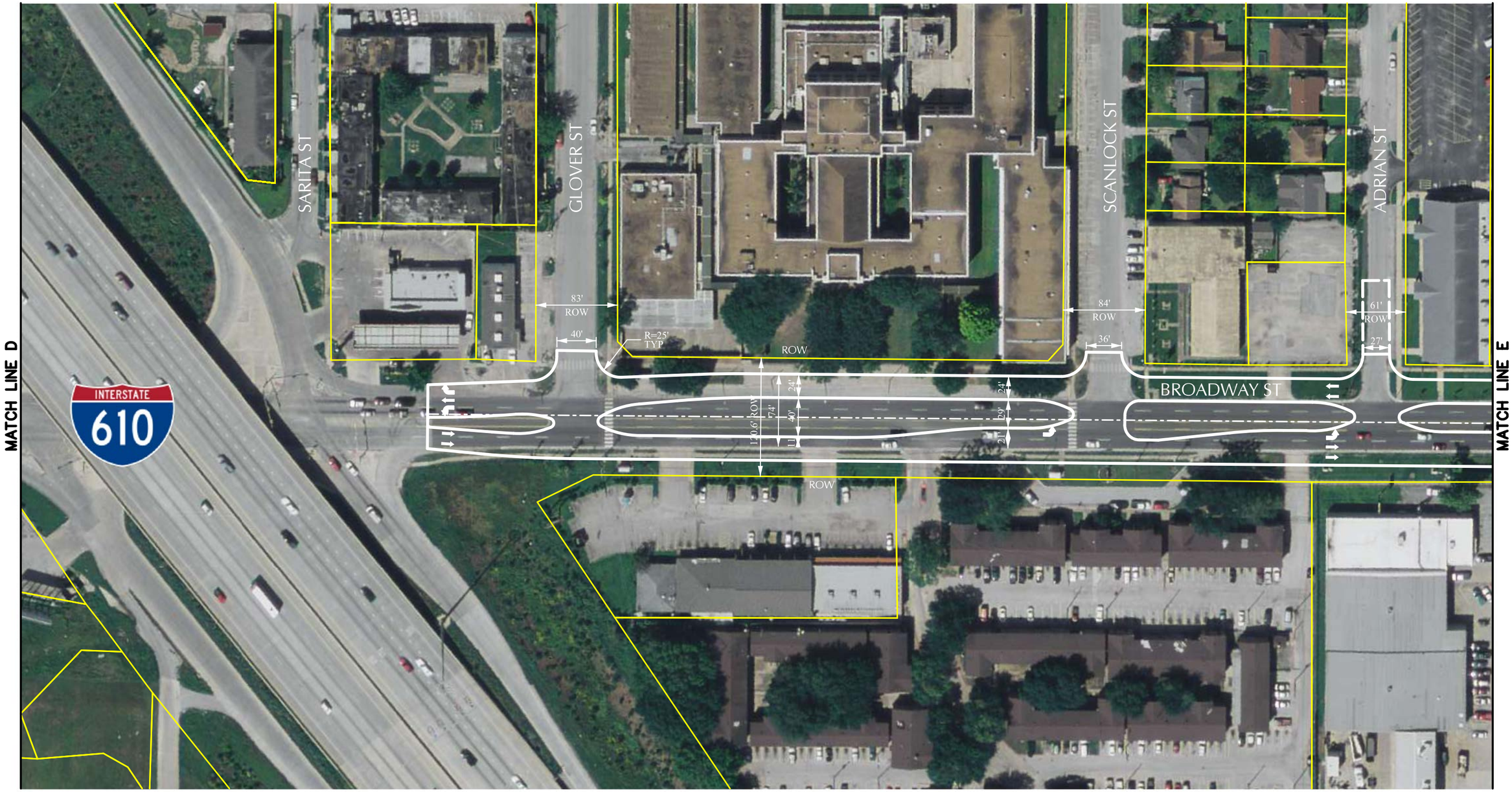

LEGEND

PROP PAVEMENT
ASPH PAVEMENT
CENTERLINE ROAD
PARCEL/ROW
TRAFFIC FLOW

PGAL
TBPE REG. NO. F-2742
3131 BRIARPARK Suite 200
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SCALE: 1" = 100'

CITY OF HOUSTON
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WBS NUMBER	
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CITY OF HOUSTON PM	
UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
4 LANE OPTION

EXHIBIT F
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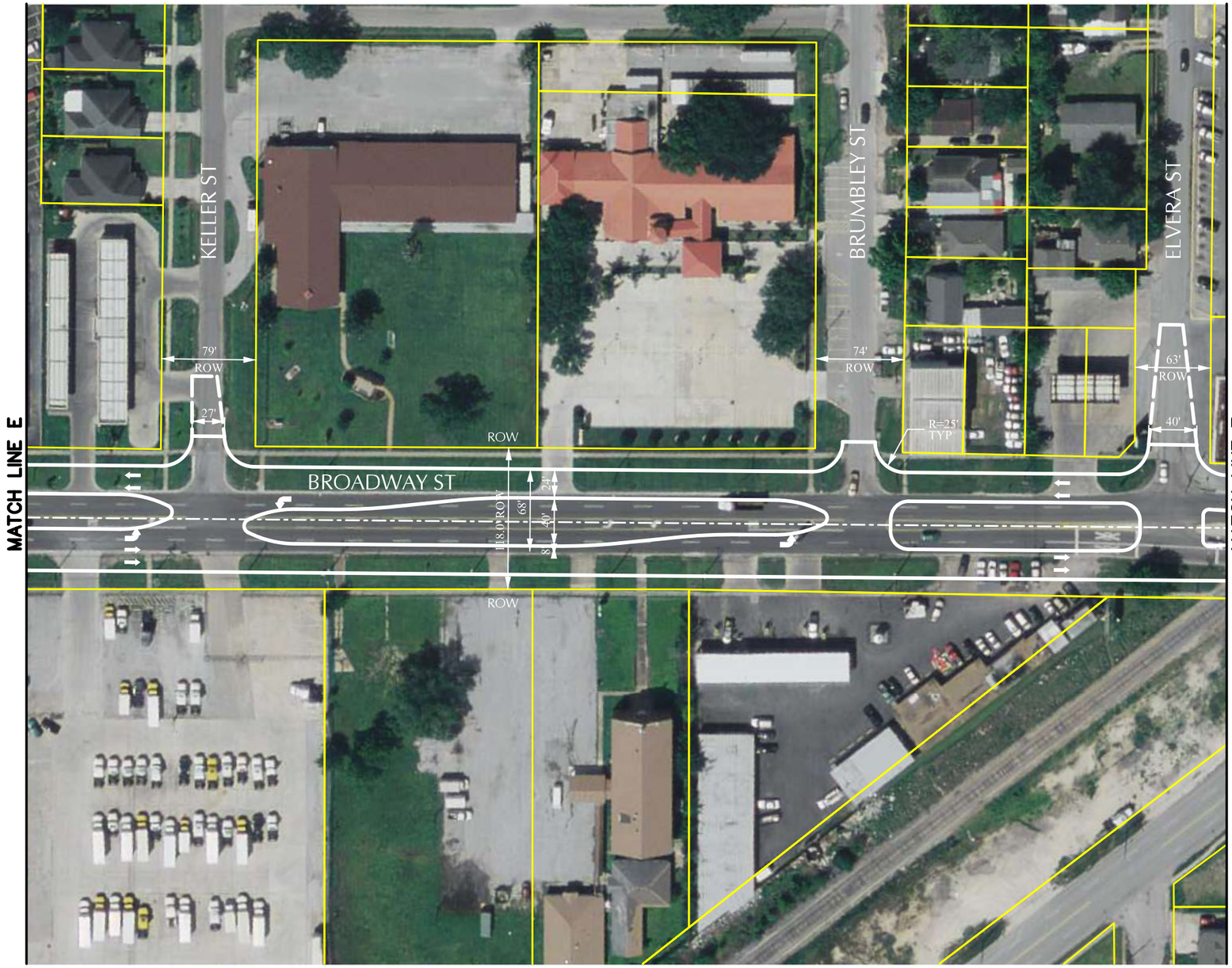

LEGEND

PROP PAVEMENT

ASPH PAVEMENT

CENTERLINE ROAD

PARCEL/ROW

TRAFFIC FLOW

PGAL

TBPE REG. NO: F-2742

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SCALE: 1" = 100'

CITY OF HOUSTON
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WBS NUMBER	
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UMESH KC, P.E.	
DATE	09/21/12

STREET AND PAVING IMPROVEMENTS FOR BROADWAY STREET

PROPOSED ROADWAY LAYOUT
4 LANE OPTION

EXHIBIT F
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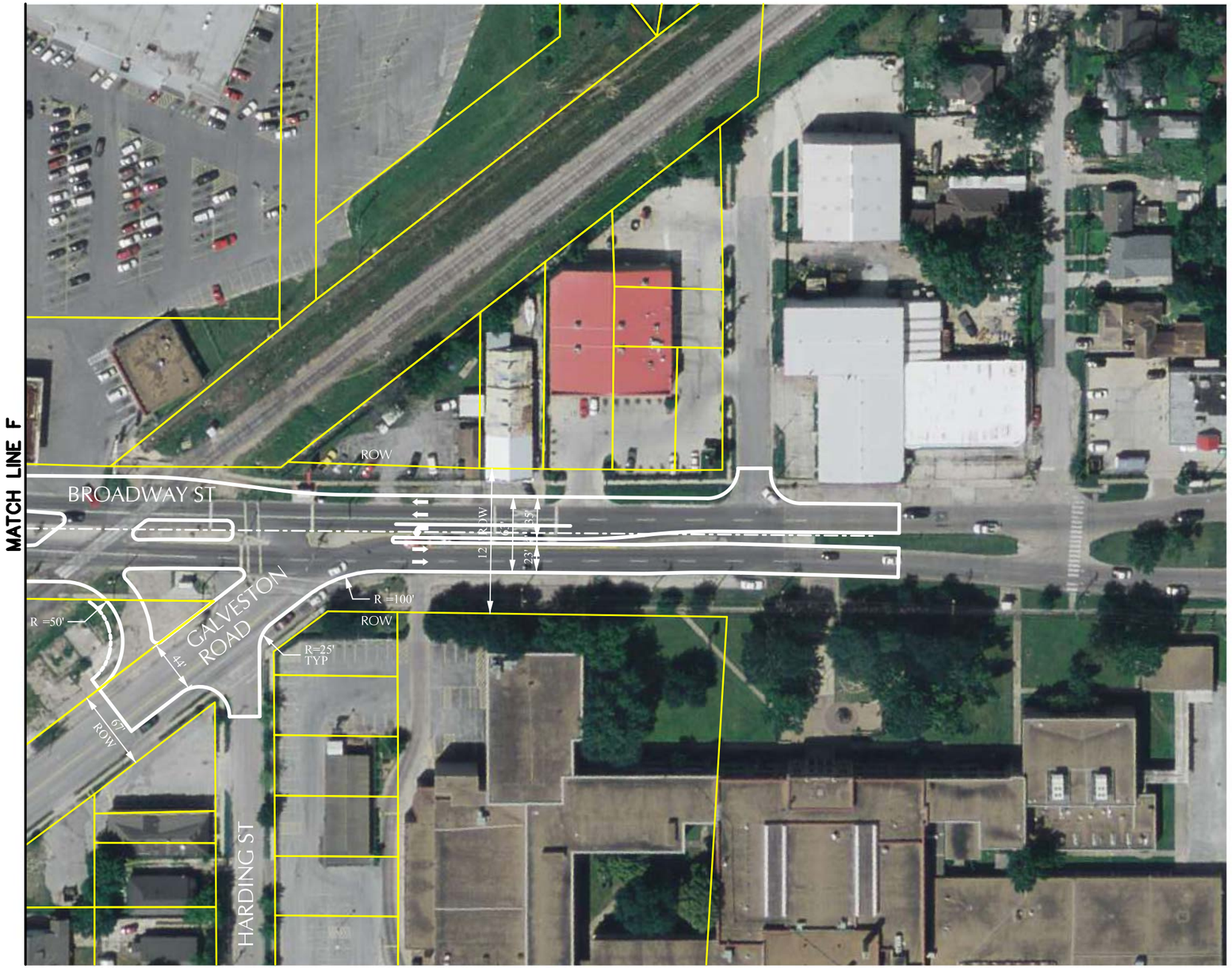

LEGEND

- PROP PAVEMENT
- ASPH PAVEMENT
- CENTERLINE ROAD
- PARCEL/ROW
- TRAFFIC FLOW

PGAL
TBPE REG. NO. F-2742
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CITY OF HOUSTON
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PROPOSED ROADWAY LAYOUT
4 LANE OPTION

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ENVIRONMENTAL ASSESSMENT

As mentioned in the drainage needs evaluation, the proposed Broadway project involves approximately 1.95 miles of street and traffic improvements. The project area is generally bounded by Park Place Blvd. at the East, Galveston Rd. at the North, I-45 at the West and Fennell St. at the West of the project. This area is located in southeast of Houston (Key Map No. 535F, 535K and 535P), Council District "I" limits. The Federal Emergency Management Agency (FEMA) floodplain data shows a small portion in the north corner of the project area is located within the 100-year floodplain of Plum Creek and Pine Gully. Plum Creek flows east into Brays Bayou along the north of IH610 of the project area. Pine Gully flows east along IH610 of the project area.

Site Reconnaissance Inspection

The following observations were made based on aerial photographs, USGS topographic maps and GIMS.

1. Several aboveground electric transmission lines, underground telephone and cable lines, sanitary sewer lines, storm lines, waterlines were observed at the project site limits.
2. The project road consists of four-lane asphalt curb and gutter roadway with a median and sidewalks on both sides along with its maintained ROWs. Project area has heavy vehicular traffic with majority of the area consisting of commercial with a few residential. The land use in the surrounding areas is also mostly commercial and residential. Most of the project pavement was found to be damaged.
3. A COH monument was found at the south corner of the project. Southwest and Sims Bayou wastewater treatment plants were identified in the project area. Several school areas were identified within the project limits, Milby High school located at the north, Deady Middle school at the west, Raul Yzaguirre school at the south, and Park Place elementary school at the south. Libraries at east and southeast portion of the project were identified.
4. The National Wetland Inventory (NWI) data identifies a freshwater emergent East of Broadway at IH 610 and southeast of project near Sims Bayou. The project area also consists of freshwater forested/shrub at IH 610 east of Galveston Rd.
5. Plum Creek (C102-00-00) and Pine Gully (C103-00-00), tributaries of Brays Bayou crosses the project area at the north side of the project. Parks at northwest and southeast, golf course at southeast portion near Sims Bayou were identified.

3.1 HEAD-IN-PARKING

3.2 SUB-STANDARD TRAFFIC SIGNAL EQUIPMENT

3.3 LOOKING NORTH @ IH-610

3.4 LOOKING NORTHWEST ASPHALT SEALED PAVEMENT CRACKS

3.5 LOOKING SOUTH

3.6 LOOKING NORTH @ GALVESTON RD

Drainage Study for Street and Paving Improvements of Broadway St.

WBS NO. N-000100-0003-3

January 2013

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EXECUTIVE SUMMARY

This report documents the storm sewer design and extreme event analysis for the Broadway Street Reconstruction Project. The storm sewer design was guided by the criteria found in Chapter 9 of the City of Houston Infrastructure Design Manual and, more specifically, Technical Paper 101-Guidelines for Consideration of Overland Flow for the Extreme Event for Improvement Projects in the City of Houston, Harris County, Texas Region (TP 101). For this report, both 2-year and extreme event analyses were performed for the drainage system associated with Broadway Street Reconstruction Project.

The study area is generally located in southeast Houston (Key Map 535P, K & F) between IH-45 on the south and Galveston Rd. on the north. The existing Broadway St. has five independent storm sewer systems; System C0155 from Galveston Rd. to IH-610, System C0156 from Park Terrans to IH-610, System C0160 from Brockton St. to Itacha St. and System C0008 from Joplin St. to IH-45.

Soffit elevations were used as the tailwater elevations for both 2-year design and extreme event analysis as the receiving channels at the outfall are non-studied FEMA channels.

After analyzing the existing storm sewer system SWMM models, the analysis shows that the Broadway St. storm sewer system for systems C0156, C0160 and C0008 was undersized for the 2-year and that the extreme event will flood properties beyond the COH ROW. Existing drainage system C0155 shows adequate both for 2-year and 100-year conditions as the drainage areas have been subdivided to convey the flow through the storm sewer system along Fennel St. and Broadway St. Therefore, less flow is been conveyed through the system along Broadway St. and thus the pipe sizes in the existing conditions suffice and no proposed improvements have been done to this system from Galveston Rd. to IH 610.

The proposed analysis is based on the recommended 4-lane alternative. The proposed storm sewer system C0156 includes up sizing the storm sewer system along Broadway St. to a 24” RCP; System C0160 to 24" RCP, 30" RCP and 36" RCP; System C0008 to 48" RCP. After analyzing the proposed storm sewer systems SWMM models, the analysis show that the 2-year and 100-year HGL proposed conditions for all systems do not exceed the existing 2-year and 100-year HGL’s respectively as well as the gutter and maximum ponding elevation at the ROW.

No mitigation due to increase impervious is proposed as the proposed storm sewer system will provide an additional storage to the Broadway Street Reconstruction Project due to the upgrade of existing storm sewers. It has been concluded that the proposed Broadway Street Reconstruction Project, side street modifications, and storm sewer modifications will have no adverse impact to the existing flood hazard conditions for the 2-year and 100-year event.

1.0 INTRODUCTION

1.1 Project Name and Purpose

The study limits of Broadway St. are approximately 1.7 miles long, extending from Park Place Blvd. at the south side to Galveston Rd. at the north side of the project. IH 610 crosses the Broadway St. at approximately 2550 feet south from Galveston Rd.

The study area consists of storm sewer drainage system and is within Sims Bayou watershed. There are two channel crossings, Plum Creek (HCFCD Unit No. C102-00-00) and Pine Gully (HCFCD Unit No. C103-00-00) tributaries of Sims Bayou, within project limits. Plum Creek crosses Broadway St. at IH 610 and Broadway St. intersection (approximately 2550 feet south from Galveston Rd.). Pine Creek crosses the Broadway St. at approximately 4300 feet south from Galveston Rd.

The purpose of this report is to document the proposed project drainage study analysis guided by the City of Houston Criteria. The drainage study is intended to provide both utility conflict relocations where the storm infrastructure is in conflict with the proposed Broadway Street Reconstruction Project and to provide mitigation if required. The storm sewer is been analyzed and designed in accordance to the City of Houston guidelines performing a 2-year and extreme event storm (100-year) sewer analysis to have no adverse hydraulic impacts to the existing conditions due to the proposed reconstruction of Broadway St. This report documents the 2-year and extreme event storm (100-year) sewer analysis to comply with City of Houston criteria.

Table 1. Corridor Segments Storm Sewer Systems & Outfalls

Corridor Segments	Outfall Name	Storm Sewer Systems	Limits Description	Outfall Location
Broadway St.	OUT C0155	BA	From Galveston Rd. to IH-610	Outfall @ Plum Creek (C102-00-00)
Broadway St.	OUT C0156	BB	From Park Terrans to IH-610	Outfall @ Plum Creek (C102-00-00)
Broadway St.	OUT C0160	BC	From Brockton St. to Ithaca St.	Outfall at Pine Gully (C103-00-00)
Broadway St.	OUT C0008	BD	From Joplin St. to IH-45	Outfall at Sims Bayou (C100-00-00)

1.2 Data Collection

The data collected and used for the Drainage Study included City of Houston Record Drawings, City of Houston Geographic Information and Management System (GIMS), Comprehensive Drainage Plan (CDP) on the Storm Water Management Program (SWMP), Effective FIRM panels for Harris County, Tropical Storm Allison Recovery Project (TSARP) LIDAR information, and FEMA Federal Insurance Rate (FIRM) maps.

1.3 FEMA

FIRM Maps No's. 48201C0885L & 48201C0895L, effective date June 18, 2007 show that a small portion in the north corner of the project area is located within the 1% and .2% flood frequency storm event of Brays Bayou watershed tributaries (C102-00-00 and C103-00-00). The effective FEMA maps (48201C0885L & 48201C0895L) are provided in Appendix I.

1.4 Environmental Assessment

The following observations were made based on aerial photographs, USGS topographic maps and GIMS.

1. Several aboveground electric transmission lines, underground telephone and cable lines, sanitary sewer lines, storm lines, waterlines were observed at the project site limits.
2. The project road consists of four-lane asphalt curb and gutter roadway with a median and sidewalks on both sides along with its maintained ROWs. Project area has heavy vehicular traffic with majority of the area consisting of commercial with few residential buildings. The land use in the surrounding areas is also mostly commercial and residential. Most of the project pavement was found to be damaged.
3. A COH monument was found at the south corner of the project. Southwest and Sims Bayou wastewater treatment plants were identified in the project area. Several school areas were identified within the project limits, Milby High school located at the north, Deady Middle school at the west, Raul Yzaguirre school at the south, and Park Place elementary school at the south. Libraries at east and southeast portion of the project were identified.
4. The National Wetland Inventory (NWI) data identifies a freshwater emergent East of Broadway at IH 610 and southeast of project near Sims Bayou. The project area also consists of freshwater forested/shrub at IH 610 east of Galveston Rd.
5. Plum Creek (C102-00-00) and Pine Gully (C103-00-00), tributaries of Brays Bayou crosses the project area at the north side of the project. Parks at northwest and southeast, golf course at southeast portion near Sims Bayou were identified.

1.5 Methodology

1.5.1 Basis of Storm Sewer Evaluation and Design

The storm sewer was evaluated and designed using the City of Houston (COH), Department of Public Works and Engineering, Infrastructure Design Manual dated July 2012 and guidelines provided in Technical Paper No. 100 (TP-100), Storm Sewer Design Applications for the City of Houston, Texas, Capital Improvement Plan Projects.

1. Intensity-Duration Curves. City of Houston IDF Curves (Chapter 9) shall be used for storm sewer and roadside ditch design in the City of Houston and the ETJ.

2. Application of Run-off Calculation Models.

a. *Rational Method*: The rational method shall be used for design on areas served by storm sewers up to 600 acres in size and for areas served by roadside ditches up to 500 acres in size.

b. *HEC-HMS Modeling*: Rainfall run-off modeling will be applied to areas greater than 500 acres in size that are drained by an open channel and/or interconnect to the project area. Rainfall run-off modeling shall be used for modeling of storm sewer areas greater than 600 acres provided the model considers the storage and ponding in streets.

3. Coefficients for the Rational Method.

The rational method was utilized for the 2-year storm event design. Typically, the purpose of the 2-year design is to keep maximum inlet ponding to one lane width and to keep the 2-year hydraulic grade line (HGL) below the gutter elevation. This report will note anywhere where the 2-year runoff causes the hydraulic grade line to exceed the gutter line and to keep ponding to one lane maximum. The Rational Method is:

$$Q = C\ I\ A \qquad (1.1)$$

Where: C = Watershed Coefficient
I = Rainfall Intensity (inches per hour)
A = Area (acres)

The C coefficients were determined from COH criteria, where the minimum C is 0.18 and the maximum is 0.80. The C coefficients for the COH are as follows:

Table 2. List of C values for Land Use Type

Land Use Type	Runoff Coefficient (C)
Residential Districts	
Lots more than ½ acre	0.35
Lots ¼ - ½ acre	0.45
Lots less than ¼ acre	0.55
Multi-Family Area	
Less than 20 Service Units/Acre	0.65
20 Service Units/Acre or Greater	0.80
Business Districts	0.80
Industrial Districts	
Light Areas	0.65
Heavy Areas	0.75
Railroad Yard Areas	0.30
Parks/Open Areas	0.18

Alternatively, the C coefficient can be found from the equation:

$$C = 0.6I_a + 0.2 \qquad (1.2)$$

Where: C = Watershed Coefficient
I_a = Impervious Area/Total Area

For this project, combinations of the C values were determined from Table 2.

The 2-year intensity is found from the formula:
I = b/ (d+ TC) e

Where: b=75.01
d=16.2
e=0.8315
TC=time of concentration (minutes) (1.3)

To determine the time of concentration (TC) for a single drainage area in equation 1.3, the following formula is used:

$$TC = 10\ A^{0.1761} + 15 \qquad (1.4)$$

Where: TC = time of concentration (minutes)
A = sub area (acres)

1.5.2 Tailwater Conditions

The receiving channels for the outfall systems are Sims Bayou watershed channels (C102-00-00, C103-00-00, C100-00-00). Soffit Elevations were used as the tailwater elevations for both 2-year design and extreme event analysis as the receiving channels are non-studied FEMA channels. See Appendix G for tailwater cross section information. The storm sewer will be designed in accordance with City of Houston guidelines using a calculated water surface elevation that do not exceed gutter line elevation for the 2-year storm frequency and the natural ground at ROW for 100-year storm. Below table shows the tailwater elevations for four systems.

Table 3. SIMS Bayou Watershed HEC-RAS Models (C102-00-00, C103-00- 00, C100-00-00) - FEMA Effective JUNE 2007

OUTFALL	LOCATION	RIVER STATION	SOFFIT EL (FT)	*100-YR WSEL USED (FT)
OUT C0155	Plum Creek (C102-00-00)	8617	24.20	24.20
OUT C0156	Plum Creek (C102-00-00)	8617	19.30	19.30
OUT C0160	Pine Gully (C103-00-00)	5722.6	27.40	27.40
OUT C0008	Sims Bayou (C100-00-00)	17913.5	23.40	23.40

*Soffit elevations were used as the tailwater elevations for extreme event analysis as the receiving channels at the outfall are non-studied FEMA channels.

1.5.3 Headwater Flow Conditions

The existing storm sewer network upstream of the project limits shall be modeled where the storm sewer enters the project limits. The 2-year and 100-year flows upstream of the project limits shall be calculated using the Run-off Calculation methodology referenced in section 1.4.1 above.

1.5.4 Extreme Event Analysis

A dynamic analysis was performed for the storm sewer system using XPSWMM software. The models were developed using the existing and proposed models for the Broadway St. storm sewer systems. Inflow hydrographs were then added to the drainage areas within the model as a 24-hour hydrograph using a 5-minute time step as a minimum. The hydrographs were generated using the Small Watershed Hydrology Method found in Section 3.6 of the Harris County Flood Control District Policy Criteria and Procedures Manual (HCFCD Manual, October 2004). Direct Runoff Depths were computed by estimating the percent impervious based on the runoff coefficient and interpolating the direct runoff depths found in the HCFCD Manual. For this storm sewer system, a 24-hour rainfall depth after losses of 13.5 inches was used. The systems were modeled by using offsite storm sewer systems beyond the project limits.

Offsite overland flow is considered to be overland runoff that is outside the drainage area boundary of the storm sewer system that sheet flows into the roadway drainage system during the extreme event. The inflow hydrographs for overland areas were generated using Small Watershed Hydrology Method and were added to the overland drainage areas that interconnect to the system. “Method 4: Dynamic Flow Routing Analysis” found from Section 4.3 from TP-101, *Guidelines for Consideration of Overland Flow for the Extreme Event for Improvement Projects in the City of Houston, Harris County, Texas Region* was used for the overland flow analysis. XPSWMM model routes the inflow hydrographs that were added through the use of the fully dynamic equations for gradually varied flow through time series computations though overland and conduit drainage segments.

Overland flows were modeled by utilizing the interconnect pipes or channels that use the approximate roadway cross-sections in the SWMM model. For modeling purposes, small channels linked the manholes to the roadway cross-sections with the starting invert of the link being the rim elevation of the manhole. This allowed the water to enter the roadway geometry (channels) when the HGL exceeds the rim elevation of the manhole. Offsite overland flow was also considered in the extreme event analysis of the drainage system.

In this analysis the maximum water surface elevations for the existing and proposed roadway were compared to ensure that there is no adverse impact. In addition, the hydraulic grade line was compared to design criteria found in TP 101, as summarized below:

- For the design storm (2-year), the hydraulic gradient shall at all times be below the gutter line for all newly developed areas.
- 100-year water surface elevations are to be maintained below the maximum ponding elevation.
- The maximum ponding elevation for the 100-year event at any point along the street shall not be higher than the natural ground elevation at the right-of-way.

The lowest elevation derived from the above criteria governs as the maximum water surface elevation in any given stretch of roadway (as long as the lowest elevation is above the top of curb).

1.5.5 SWMM Development Model

For this analysis, the XP Storm Water Management Model (SWMM) version 13.0 was used to evaluate the impacts of the existing system and the various alternatives that shall reduce the flooding. The SWMM model was selected based on its ability to incorporate all the components and aspects of the drainage system, such as culverts, weirs, orifices, storm sewers and detention facilities. The SWMM model uses a series of nodes and links to represent the physical characteristics of the drainage system. The drainage system parameters are then introduced into the model through the EXTRAN (Extended Transport) block. The EXTRAN block is a hydraulic flow routing model that is able to simulate a complex array of branched or looped drainage networks.

SWMM is a dynamic rainfall-runoff simulation model used for a single event, the 100-year storm, to simulate water surface elevations for the Extreme Events. The runoff computations are to be performed based on the computation procedures as established by City of Houston Storm Sewer requirements. The routing portion of SWMM transports this runoff through a system of pipes within each drainage area. The model tracks the quantity of runoff generated within each drainage sub-area, and the flow rate and flow depth of water in each pipe during the simulation period.

The SWMM model was designed to include almost all of the elements of the proposed drainage system, to demonstrate the feasibility and effectiveness of the mitigation measures presented. In developing the SWMM model for the proposed conditions, several components were needed to complete the SWMM models, and are defined as follows:

- The Rational Method was used in the runoff computations and is the basis for the flows within the SWMM. The flows were imported into SWMM based on the small watershed methodology. See Flow calculation table in Appendix B for flow computations.

- Each node with flows was considered a storage node to account for attenuation of the flows.

- The EXTRAN block of the SWMM model requires a boundary condition be defined to represent the tailwater at the outfall points in the drainage network. A tailwater at the soffit elevation was set to 00-year WSEL for the outfall boundary condition for the SWMM model. The existing and proposed SWMM models were modeled by using offsite storm sewer systems beyond the project limits.

- The existing storm sewer system was modeled as a system of links with nodes depicting any changes in pipe size or at the location where the flow changes due to the lateral drainage area draining into the system. The existing roadway system through which the overland sheet flow conveys the flows was then incorporated into this link so as to effectively model the underground pipe system and the existing overland sheet flow, which in SWMM is labeled as a multi-link.

2.0 EXISTING CONDITIONS

2.1.1 Needs Assessment

Based on GIMS and CDP, five independent storm drainage area network systems (C0008, C0155, C0156, C0160 and C0161) were identified within the project limits. The existing storm drainage system is shown in Exhibit 1.

Drainage System C0008 (Outfall at Sims Bayou (HCFCD Unit No. C200-00-00))
Based on SWMP, Drainage system C0008 drains approximately 48.5 acres of south side area of the project, with conduit system flowing towards east and outfalling into Sims Bayou. CDP shows a record of about 107 homes located within this system. Existing storm drainage system is shown in Exhibit 1.

The storm sewer pipe sizes consist of 12", 15" and 18" for the lateral system and 24", 36", 42" and 48" along the main trunkline. CDP shows the 2-year existing capacity cannot be analyzed. As-built drawings show Type B inlets throughout the network system. Appendix A shows storm pipe configuration from GIMS and verification from as-built drawings. The existing conditions at Broadway and IH 45 intersection show ponding in CDP website.

Drainage System C0155 (Outfall at Plum Creek (HCFCD Unit No. C102-00-00))
Drainage system C0155 drains the area runoff produced by 51.7 acres, with the conduit system flowing south along Broadway St. from Galveston to IH 610 and outfalling into Plum Creek. The total drainage area 139.15 acres that is mentioned in the Phase I report has been revised and subdivided to make it flow to Fennel and Broadway systems. The outfall location of this system is within 100-year Plum Creek floodplain zone. Existing storm drainage system is shown in Exhibit 1.

This network system consists of 12", 15", 18" and 21" lateral pipes; 24" and 36" along main trunkline. The 2-year capacity from CDP shows inadequate. As-built drawings show Type "B" and Type "BB" inlets. Appendix A shows storm pipe configuration from GIMS and verification from as-built drawings.

CDP shows ponding at the north and south side of the system and minor ponding along lateral streets. There are major flooding issues at IH-610 intersection because of low topography. There is one structural flooding, two 311 ROW flooding and 1 FEMA repetitive loss recorded within this system. Appendix A shows the structural flooding information. As from CDP and as-built drawing information, it is evident that the 2-year existing storm sewer capacity is insufficient and therefore identified as a problem area and needs to be studied further. CDP recommended pipes are shown in Exhibit 2.

Drainage System C0156 (Outfall at Plum Creek (HCFCD Unit No. C102-00-00))
Drainage system C0156 drains approximately 14.6 acres of area with the storm sewer system flowing north along Broadway St. from Park Terrans and outfalling into Plum Creek. CDP shows a record of 12 homes located within this system. There is an 18" and 20" storm sewer pipes within this system. CDP shows that the 2-year existing capacity cannot be analyzed for this system. As-built drawings show Type "BB" and Type "C" inlets. Exhibit 1 shows existing storm drainage system.

CDP shows major ponding problems within this system. Also, there are 2 FEMA loss complains, one with 3 repetitive losses and the other with 2 repetitive losses recorded within this system. Because of these ponding and structural flooding problems, the 2-year existing storm sewer system capacity is assumed to be insufficient and identified as a problem area and needs to be studied further.

Drainage System C0160/C10161 (Outfall at Pine Gully (HCFCD Unit No. C103-00-00))
Drainage system C0160 drains approximately 14.6 acres of area with the storm sewer flowing south along Broadway St. from Brockton St. outfalling into Pine Gully. CDP shows a record of about 21 homes located within this system. The lateral system consists of 15" and 18" storm sewer pipes with

the main trunkline of 21", 24" and 36" pipe. The 2-year capacity shows inadequate for this system. As built drawings show Type "BB" inlets for this network system as shown in Appendix A. Exhibit 1 shows existing storm drainage system.

There is minor ponding shown in CDP along lateral street, Kimble St and along Hartford and Broadway intersection. There are no structural complaints or FEMA repetitive losses recorded for this system as shown in Table 2. Therefore, this system is considered to be adequate for 2-year system and not identified as a problem area. Further detail analysis is discussed in below sections.

Five overland drainage areas, C100-00-011, C102-00-008, C102-00-009, C102-00-010 and C103-00-001 have been identified within the project area using CDP and GIS shape files obtained from COH. The contributing overland drainage areas in the extreme event for systems C0155, C0156, C0160 and C0008 are 205 acres, 77 acres, 291 acres and 68 acres respectively. Exhibit 3 shows contours, overland drainage areas with flow paths. The vertical geometry is identified to be flat with low depression points at intersecting streets. Because of steep sloping down to IH-610 intersection, water gets trapped at the interchange thus causing flooding under the bridge and adjacent frontage roads. Hydrodynamic storm drainage modeling were developed and discussed in below sections for design and extreme event analysis.

2.1.2 2-Year and 100-Year Storm Sewer Analysis

The existing storm sewer system C0155 captures total area runoff produced by 51.7 acres draining through 24" and 36" RCP along Broadway St outfalling to Plum Creek (C102-00-00). The total drainage area 139.15 acres that is mentioned in the Phase I report has been revised and subdivided to make it flow to Fennel and Broadway systems.

System C0156 captures total area runoff produced by 14.6 acres draining through 18" and 20" RCP outfalling into Plum Creek (C102-00-00). System C0160 captures total area runoff produced by 60.12 acres draining through 21", 24" and 36" RCP along Broadway St. outfalling through 120" RCP into Pine Gully (C103-00-00). System C0008 captures total area runoff produced by 48.52 acres draining through 24" RCP outfalling through 42", 48" RCP along Kingsley St. outfalling into Sims Bayou (C100-00-00). The overall drainage area map is shown in Exhibit 4.

Due to the lack of underground storm sewer system and undersized pipes, the existing HGL is shown to be above the gutter line for few nodes for systems C0160/C0161 and C0008 and also shows insufficient capacities to convey the 100-year storm event for Ssytems C0156, C0160/C0161 and C0008..

3.0 PROPOSED CONDITIONS

3.1.1 2-Year and 100-Year Storm Sewer Analysis

The proposed storm sewer system captures the existing runoff and the increased runoff due to impervious area in the proposed conditions. The flow calculations for proposed conditions are shown in Appendix B. The overall drainage area map is shown in Exhibit 4.

The total drainage area 139.15 acres for System C0155, that is mentioned in the Phase I report has been revised and subdivided to make it flow to Fennel and Broadway systems. The existing Broadway System C0155 is sufficient to convey 2-year flows. Thus, the system has not been upgraded in the proposed conditions along main trunkline but the laterals have been upgraded to minimum 24" RCP and inlets have been replaced by C inlets.

System C0156 is been upsized to 24" RCP along Broadway St.; System C0160 to 24", 30" and 36" RCP and System C0008 to 48" RCP to maintain the proposed HGL below gutter line.

The SWMM longitudinal profiles are shown in Appendix D. HGL comparison table and outflow comparison tables are shown in Table 1 and 2 respectively in Appendix E, and the proposed SWMM output can be found in Appendix F.

4.0 EXTREME EVENT MITIGATION

No mitigation due to increase impervious is proposed as the proposed storm sewer system will provide an additional storage to the Broadway Street Reconstruction Project due to the upgrade of existing storm sewers. It has been concluded that the proposed Broadway Street Reconstruction Project, side street modifications, and storm sewer modifications will have no adverse impact to the existing flood hazard conditions for the 2-year and 100-year event.

5.0 CONCLUSION

This report discusses the 2-year and 100-year storm sewer and overland flow performed for drainage system along the Broadway St. The analysis was performed to determine whether the storm sewer satisfies the criteria found in Chapter 9 of the City of Houston Infrastructure Design Manual and Technical Paper 101. A summary of the results of the analyses for the drainage system that was analyzed is given in the following paragraphs.

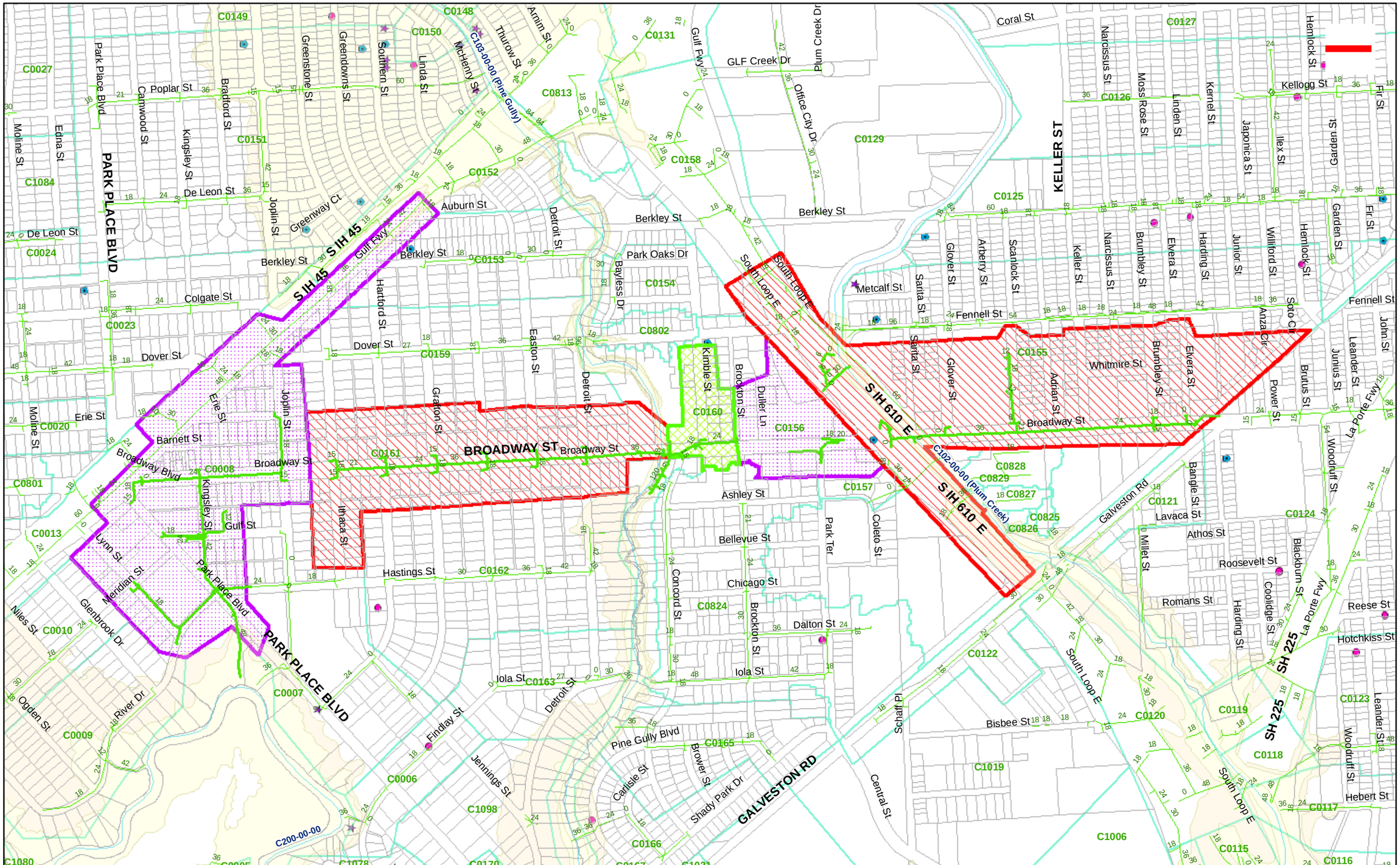
The drainage systems found with Broadway St. Outfall Systems C0155, C0156, C0160 and C0008 were modeled using a tailwater set to soffit elevation for both 2-year design and extreme event analysis as the receiving channels are not the FEMA studied channels.

After analyzing the existing storm sewer system SWMM models, the analysis shows that the existing storm system C0156, C0160 and C0008 at Broadway St. was undersized. Also the Broadway St. inlets were undersized.

In proposed conditions, 2-year HGL’s at all times show below the gutter line and 100-year WSEL's below MPE throughout the project for all systems with upgraded sizes and inlets. Velocities in 100-year at all proposed inlets for all systems are below maximum allowable value of 12 fps except for outfall links. See Table 2 in Appendix E for 2-year and100-year velocities.

No additional mitigation is required as the proposed storm sewer system will provide the inline detention for the increased impervious Broadway Street Reconstruction Project. It has been concluded that the proposed Broadway Street Reconstruction Project, side street modifications, and storm sewer modifications will have no adverse impact to the existing flood hazard conditions for the 2-year and 100-year event.

EXHIBITS



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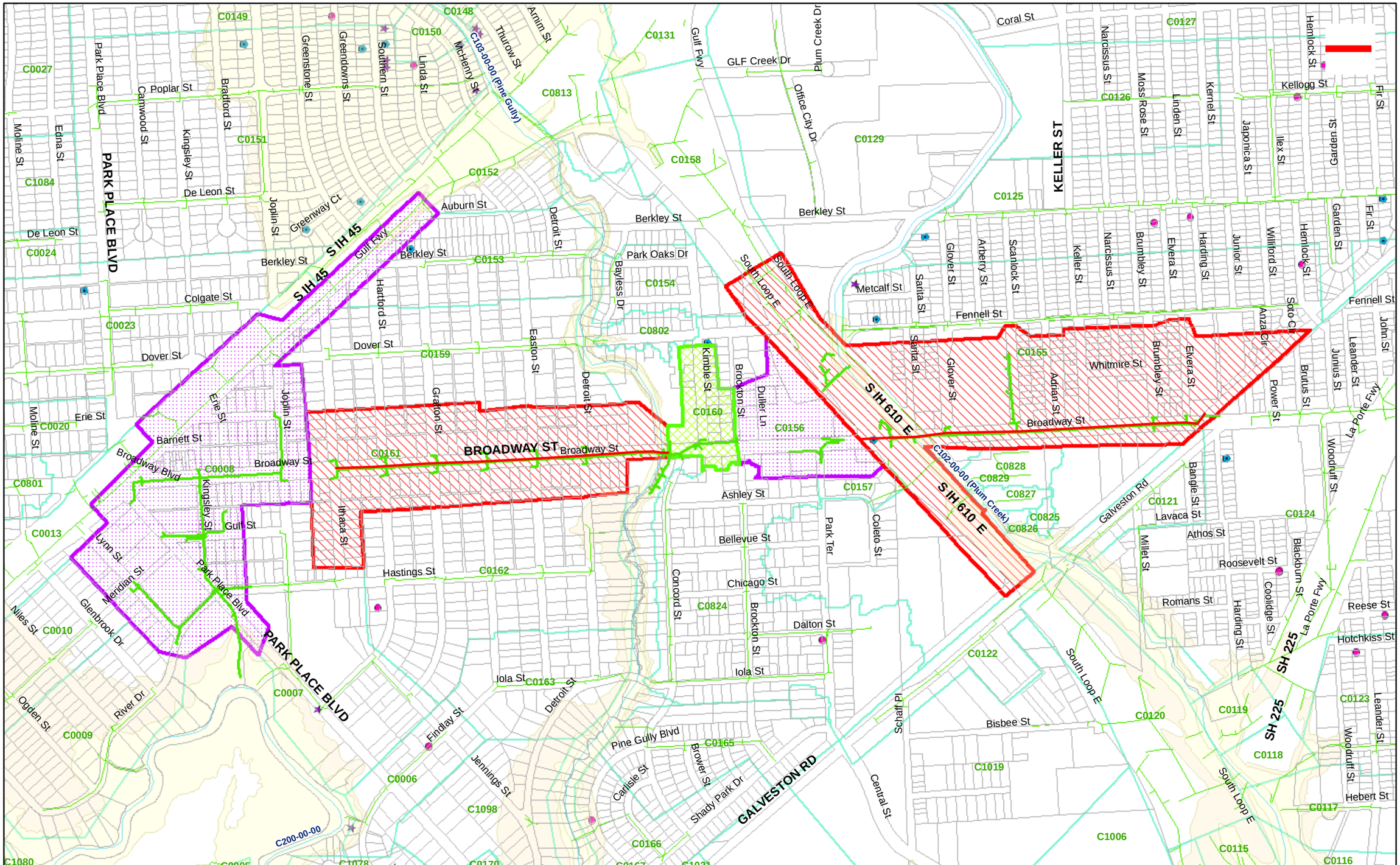
LEGEND

- Structural Flooding
- Fema Repetitive Losses
- 311 ROW Flooding
- Existing Storm Sewer
- Drainage Areas System
- **2-yr CDP Capacity**
- Adequate
- Cannot Analyze
- Inadequate
- 500-year Floodplain
- 100-year Floodplain

PGAL

Scale:	Date:	EXHIBIT 1
0 400 800 Feet	December, 2012	EXISTING STORM DRAINAGE SYSTEM BROADWAY



LEGEND

- Structural Flooding
- Fema Repetitive Losses
- 311 ROW Flooding
- CDP Recommended Upgrades
- Existing Storm Sewer
- **2-yr CDP Capacity**
  - Adequate
  - Cannot Analyze
  - Inadequate
- Drainage Areas System
- 500-year Floodplain
- 100-year Floodplain

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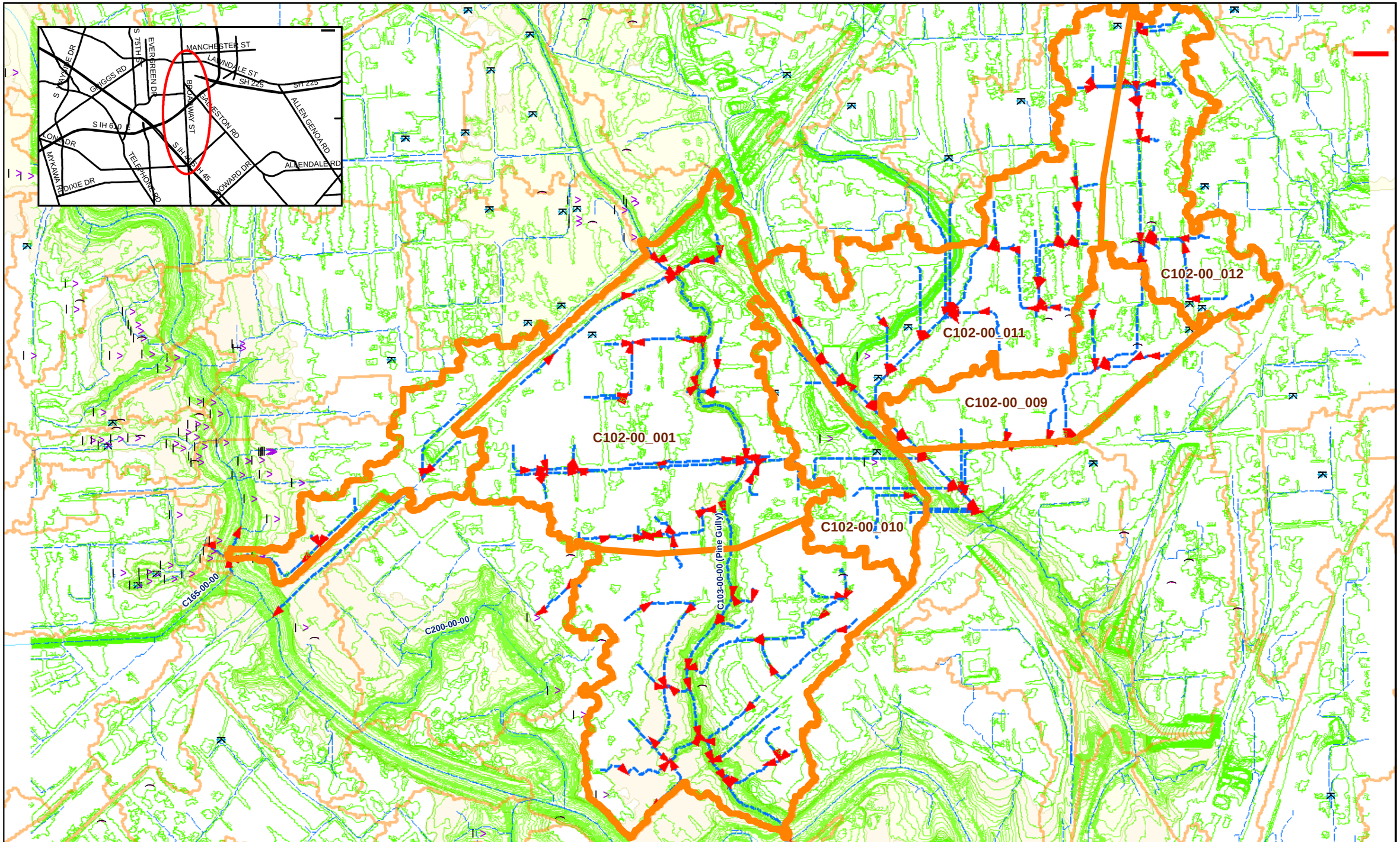
PGAL

Scale:	Date:	EXHIBIT 2
0 400 800 Feet	December, 2012	CDP RECOMMENDED UPGRADES DRAINAGE SYSTEM BROADWAY



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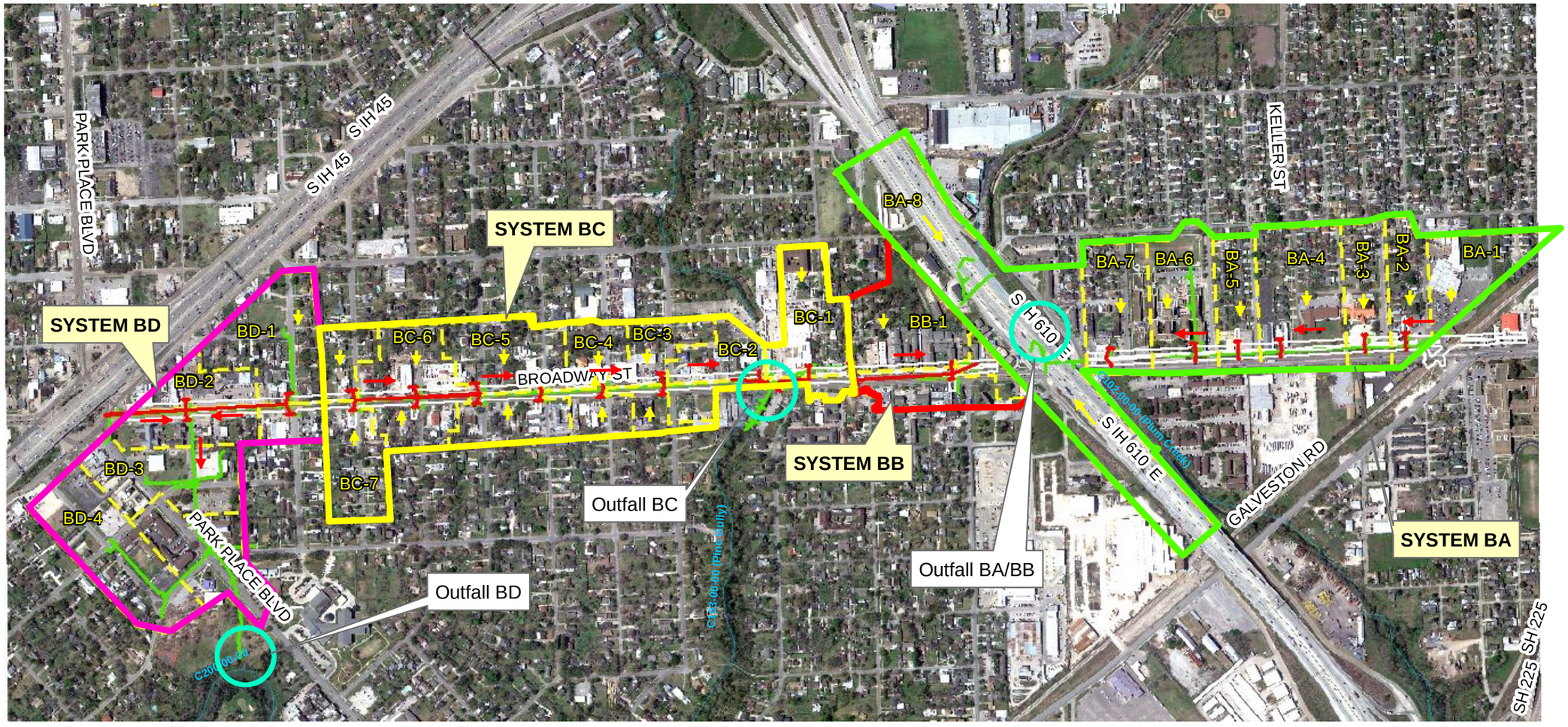
LEGEND

- Structural Flooding
- Fema Repetitive Losses
- 311 ROW Flooding
- Contributing Overland Drainage
- Overland Flowpaths
- 500-year Floodplain
- 100-year Floodplain

PGAL

Scale:	Date:	EXHIBIT 3
0 600 1,200 Feet	December, 2012	OVERLAND DRAINAGE SYSTEM BROADWAY



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LEGEND

- Proposed Pavement
- Proposed Storm Sewer
- Existing Storm Sewer
- Flow direction
- Sub Drainage Areas

PGAL

Scale:	Date:	EXHIBIT 4
0 400 800 Feet	December, 2012	PROPOSED STORM DRAINAGE SYSTEM BROADWAY

APPENDIX A

EXISTING STORM CONFIGURATION

GIMS INFORMATION

Outfall ID	Outfall Location	From	To	Main Trunkline	Lateral Storm Sewer Size
C0008	Outfall at Sims Bayou (C200-00-00)	45 Gulf Frw and Joplin	Kingsley	24"	15", 18"
		Kingsley at Broadway	Kingsley at Park Pl. Blvd	36",42"	12",15",18"
		Park Pl. Blvd	Outfall	48"	15"
C0155	Outfall at Plum Creek (C102-00-00)	Galveston	IH 610 (Outfall)	24",36"	12",15",18",21"
C0156	Outfall at Plum Creek (C102-00-00)	Park Terrans	Outfall	18", 20"	
C0160	Outfall at Pine Gully (C103-00-00)	Brockton St.	Kimble St. (Outfall)	24"	15",18"
C0161	Outfall at Pine Gully (C103-00-00)	Joplin	Concord (Outfall)	21",24",36"	15",18"

AS-BUILT DRAWING INFORMATION (VERIFICATION)

Outfall ID	Plan #	From	To	Main Trunkline	Lateral Storm Sewer Size	Inlet Type
C0008 (Outfall at Sims Bayou)	wd7498 (Year 1985)	45 Gulf Frw	Kingsley	24"	15", 18"	B
		Joplin	Kingsley	24"	15"	B
	7049 (Year 1941)	Kingsley at Broadway	Kingsley at Park Pl. Blvd	42"	15"	B
		Park Pl. Blvd	Outfall	*36"	15"	B
C0155 (Outfall at Plum Creek)	32267 (Year 1995)	Galveston	Elvera	24"	18"	B
		Elvera	Brumblay	24"	18"	B
		Brumblay	Keller	24"	18"	B
		Keller	Adrian	24", 36"	18"	BB
		Adrian	Scanlock	36"	18"	BB
		Scanlock	Glover	36"	18"	BB
		Glover	IH 610 (Outfall)	36"	18"	B
C0156 (Outfall at	18791 (Year 1976)	Park Terrans	Outfall	18", 20"		BB, C
C0160 (Outfall at	42675 (Year 1995)	Brockton St.	Kimble St. (Outfall)	24"	18"	BB
C0161 (Outfall at Pine Gully)	wd7800 (Year 1987)	Joplin	Ithaca	21"	18"	B
		Ithaca	Hartford	21", 24"	18"	B
		Hartford	Grafton	24", 36"	18"	B
		Grafton	Findlay	36"	18"	B
		Findlay	Easton	36"	18"	B
		Easton	Detroit	36"	18"	B
		Detroit	Concord	36"	18"	B

* GIMS show 48" MRC and 48" RCP from Park Pl. Blvd to Outfall

		STRUCT. FLOODING INFORMATION (FROM COH)				STORM SEWER SYSTEM (FROM CDP)				SWMM ANALYSIS	
OUTFALL	AREA (ACRES)	STRUCT. FLOODING	FEMA REPETITIVE LOSSES	311 ROW FLOODING	TOTAL FLOODING	FLOODPLAIN ZONE	WATERSHED	# OF HOUSES WITHIN THE SYSTEM	2-YEAR CDP EXISTING CAPACITY	2-YEAR EXISTING ANALYSIS	100-YEAR EXISTING ANALYSIS
C0008	48.5				0	No	Sims Bayou	107	Cannot Analyze	Inadequate	Inadequate
C0155	51.7	1	1	2	4	100-Year Floodplain (Zone AE)	Sims Bayou	384	Inadequate	Adequate	Adequate
C0156	14.6		2		2	No	Sims Bayou	12	Cannot Analyze	Inadequate	Inadequate
C0160/C0161	60.1				0	100-Year Floodplain (Zone AE)	Sims Bayou	129	Inadequate	Inadequate	Adequate

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
PRE-ENGINEERING OF STREET AND PAVING IMPROVEMENTS
WBS NO: N-000100-0003-3
AREA NT 04: BROADWAY (4-LANE ALTERNATIVE)
PRELIMINARY CONSTRUCTION COST ESTIMATE

SUMMARY

SUB-TOTAL GENERAL ITEMS	$849,846
SUB-TOTAL PAVING ITEMS	$4,974,687
SUB-TOTAL STORM SEWER ITEMS	$920,343
SUB-TOTAL SANITARY SEWER ITEMS	$55,200
SUB-TOTAL WATER LINE ITEMS	$141,480
SUMMARY OF 410 COSTS	$6,941,556
CONSTRUCTION MANAGEMENT (15% OF 410 TOTAL)	$1,041,233
CONTINGENCIES (30% OF 410 TOTAL)	$2,082,467
ENGINEERING FEE ESTIMATE (10% OF 410 TOTAL & CONTINGENCIES)	$902,402
DESIGN MANAGEMENT (15% OF ENGINEERING FEE ESTIMATE)	$135,360
LAND ACQUISITION	$4,935
TOTAL PROJECT COST	**$11,107,954**

NEEDS AREA NT 04
BROADWAY: IH 45 TO GALVESTON RD.

COST ESTIMATE

A. STIPULATED PRICE: $0.00 (N/A)

B. BASE UNIT PRICE TABLE:

B1. UNIT PRICE TABLE FOR GENERAL ITEMS

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	01502	Mobilization	LS	1	$ 297,570.74	$ 297,570.74
2	01555	Traffic Control & Regulation	LS	1	$ 292,570.74	$ 292,570.74
3	01555	Flagmen	LS	1	$ 25,000.00	$ 25,000.00
4	01555	Install Low Profile Concrete Barriers	LF	1950	$ 35.00	$ 68,250.00
5	01555	Remove Low Profile Concrete Barriers	LF	1950	$ 5.50	$ 10,725.00
6	01562	Tree and Plant Protection	LS	1	$ 20,000.00	$ 20,000.00
7	02233	Clearing and Grubbing	AC	10.4	$ 8,000.00	$ 83,200.00
8	02921	Hydromulch seeding	AC	5.1	$ 1,500.00	$ 7,650.00
9	02922	Sodding	SY	11,220	$ 4.00	$ 44,880.00
SUBTOTAL FOR GENERAL ITEMS						**$ 849,846**

NEEDS AREA NT04 **COST ESTIMATE**

BROADWAY: IH 45 TO GALVESTON RD.

B2. UNIT PRICE TABLE FOR PAVING

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	02221	Remove and Dispose of Existing Concrete Pavements (including all thickness, w/ or w/o asphalt, including base & subgrade, w/ or w/o curb, all depths)	SY	60,520	$ 5.00	$ 302,600.00
2	02315	Roadway Excavation (Offsite Disposal of Excess)	CY	10,000	$ 3.00	$ 30,000.00
3	02336	Lime Stabilized Subgrade, 8-inch	SY	69,570	$ 2.00	$ 139,140.00
4	02336	Lime (6% by dry weight)	TON	1,380	$ 150.00	$ 207,000.00
5	02581	2" Sch. 40 Street Lighting Conduit	LF	18,000	$ 8.00	$ 144,000.00
6	02711	Type A-Hot Mix Asphaltic Concrete Base Course (6 inch)	TON	964	$ 85.00	$ 81,940.00
7	02741	Type D-Hot Mix Asphaltic Concrete Surface Course (1-1/2 inch)	TON	320	$ 90.00	$ 28,800.00
8	02751	8-inch Reinforced Concrete Pavement	SY	0	$ 34.00	$ -
9	02751	10-inch Reinforced Concrete Pavement	SY	59,880	$ 40.00	$ 2,395,200.0
10	02754	7-inch Concrete Driveway	SF	63,990	$ 6.00	$ 383,940.00
11	02771	6-inch Concrete Curb	LF	30,460	$ 2.50	$ 76,150.00
12	02775	4 1/2-inch Concrete Sidewalk	SF	58,695	$ 4.50	$ 264,127.50
13		Small signs	MI	1.66	$ 5,000.00	$ 8,300.00
14		Pavement Markings	MI	1.66	$ 10,000.00	$ 16,600.00
15		Traffic Signals	EA	2	$ 200,000.00	$ 400,000.00
16		Railroad Mast Arms	EA	4	$ 50,000.00	$ 200,000.00
17		Railroad Crossing	LF	60	$ 1,000.00	$ 60,000.00
		Ancillary Items (5%)	LS	1	$ 236,889.88	$ 236,889.88
SUBTOTAL FOR PAVING/TRAFFIC SIGNAL ITEMS						**$ 4,974,687**

NEEDS AREA NT 04 **COST ESTIMATE**

BROADWAY: IH 45 TO GALVESTON RD.

B3. UNIT PRICE TABLE FOR STORM SEWER ITEMS

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	2221	Remove / Dispose Manholes all Sizes and Depths	EA	1	$ 300.00	$ 300.00
2	2221	Remove / Dispose Inlets all Sizes and Depths	EA	47	$ 300.00	$ 14,100.00
3	2221	Remove and Dispose of Pipe Culverts, Sewers, and Sewer Leads	LF	4900	$ 2.00	$ 9,800.00
4	02082/02087	Type C Manhole for 42-inch Diameter and Smaller Storm Sewers	EA	47	$ 2,500.00	$ 117,500.00
5	02082/02087	Type C Manhole for 48-inch to 72-inch Diameter Storm Sewers	EA	3	$ 6,000.00	$ 18,000.00
6	02631	24-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	3,919	$ 75.00	$ 293,925.00
7	02631	30-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	390	$ 95.00	$ 37,050.00
8	02631	36-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	400	$ 120.00	$ 48,000.00
9	02631	42-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	0	$ 130.00	$ -
10	02631	48-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	1,160	$ 150.00	$ 174,000.00
11	02632/02633	Type C Inlet, Cast-in-Place or Precast	EA	63	$ 2,000.00	$ 126,000.00
12	02632/02633	Type C-1 Inlet, Cast-in-Place or Precast	EA	0	$ 2,700.00	$ -
13	02632/02633	Type C-2 Inlet, Cast-in-Place or Precast	EA	0	$ 3,000.00	$ -
14	02632/02633	Type BB Inlet, Cast-in-Place or Precast	EA	0	$ 2,000.00	$ -
		Detention	AC-FT	1	$ 20,000.00	$ 20,000.00
		Ancillary Items (10%)	LS	1	$ 85,867.50	$ 85,867.50
SUBTOTAL FOR STORM SEWER ITEMS						**$ 920,343**

NEEDS AREA NT 04 **COST ESTIMATE**

BROADWAY: IH 45 TO GALVESTON RD.

B4. UNIT PRICE TABLE FOR WASTEWATER ITEMS

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	02221	Remove Sanitary Sewer (12" dia & smaller)	LF	450	$ 5.00	$ 2,250.00
2	02221	Remove Sanitary Sewer (15" to 27" dia)	LF	0	$ 12.00	$ -
3	02221	Remove Sanitary Manhole (all depths)	EA	0	$ 250.00	$ -
4	02082	4' Dia Precast Manhole (8' depth & less)	EA	4	$ 2,500.00	$ 10,000.00
5	02082	5' Dia Precast Manhole (8' depth & less)	EA	0	$ 5,000.00	$ -
6	02531	6" Sanitary Sewer	LF	0	$ 60.00	$ -
7	02531	8" Sanitary Sewer	LF	450	$ 75.00	$ 33,750.00
8	02531	10" Sanitary Sewer	LF	0	$ 90.00	$ -
9	02531	12" Sanitary Sewer	LF	0	$ 115.00	$ -
10	02543	Sanitary Sewer Service Line (open cut)	LF	0	$ 50.00	
		Ancillary Items (20%)	LS	1	$ 9,200.00	$ 9,200.00
SUBTOTAL FOR WASTEWATER ITEMS						**$ 55,200**

NEEDS AREA NT 04 **COST ESTIMATE**

BROADWAY: IH 45 TO GALVESTON RD.

B5. UNIT PRICE TABLE FOR WATER ITEMS

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	02511	8" PVC Water Line With Restrained Joints (Open Cut)	LF	0	$ 63.00	$ -
2	02511	8" PVC Water Line With Restrained Joints (Auger)	LF	0	$ 63.00	$ -
3	02511	8" Steel Water Line (Auger)	LF	0	$ 120.00	$ -
4	02511	12" PVC Water Line With Restrained Joints (Open Cut)	LF	1,340	$ 70.00	$ 93,800.00
5	02511	12" PVC Water Line With Restrained Joints (Auger)	LF	0	$ 70.00	$ -
6	02513	8" Wet Connection	EA	0	$ 1,100.00	$ -
7	02513	12" Wet Connection	EA	2	$ 1,250.00	$ 2,500.00
8	02513	16" Wet Connection	EA	0	$ 2,200.00	$ -
9	02513	20" Wet Connection	EA	0	$ 3,000.00	$ -
10	02520	Fire Hydrant Assembly (incl. 6" GV&B)	EA	4	$ 5,400.00	$ 21,600.00
		Ancillary Items (20%)	LS	1	$ 23,580.00	$ 23,580.00
SUBTOTAL FOR WATER ITEMS						**$ 141,480**

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
PRE-ENGINEERING OF STREET AND PAVING IMPROVEMENTS
WBS NO: N-000100-0003-3
AREA NT 04: BROADWAY (6-LANE ALTERNATIVE)
PRELIMINARY CONSTRUCTION COST ESTIMATE

SUMMARY

SUB-TOTAL GENERAL ITEMS	$926,875
SUB-TOTAL PAVING ITEMS	$5,804,376
SUB-TOTAL STORM SEWER ITEMS	$920,343
SUB-TOTAL SANITARY SEWER ITEMS	$55,200
SUB-TOTAL WATER LINE ITEMS	$141,480
SUMMARY OF 410 COSTS	$7,848,274
CONSTRUCTION MANAGEMENT (15% OF 410 TOTAL)	$1,177,241
CONTINGENCIES (30% OF 410 TOTAL)	$2,354,482
ENGINEERING FEE ESTIMATE (10% OF 410 TOTAL & CONTINGENCIES)	$1,020,276
DESIGN MANAGEMENT (15% OF ENGINEERING FEE ESTIMATE)	$153,041
LAND ACQUISITION	$4,935
TOTAL PROJECT COST	**$12,558,250**

NEEDS AREA NT 04
BROADWAY: IH 45 TO GALVESTON RD.

COST ESTIMATE

A. STIPULATED PRICE:	**$0.00 (N/A)**

B. BASE UNIT PRICE TABLE:

B1. UNIT PRICE TABLE FOR GENERAL ITEMS

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	01502	Mobilization	LS	1	$ 338,785.19	$ 338,785.19
2	01555	Traffic Control & Regulation	LS	1	$ 333,785.19	$ 333,785.19
3	01555	Flagmen	LS	1	$ 25,000.00	$ 25,000.00
4	01555	Install Low Profile Concrete Barriers	LF	1950	$ 35.00	$ 68,250.00
5	01555	Remove Low Profile Concrete Barriers	LF	1950	$ 5.50	$ 10,725.00
6	01562	Tree and Plant Protection	LS	1	$ 20,000.00	$ 20,000.00
7	02233	Clearing and Grubbing	AC	10.4	$ 8,000.00	$ 83,200.00
8	02921	Hydromulch seeding	AC	1.5	$ 1,500.00	$ 2,250.00
9	02922	Sodding	SY	11,220	$ 4.00	$ 44,880.00
SUBTOTAL FOR GENERAL ITEMS						**$ 926,875**

NEEDS AREA NT04 **COST ESTIMATE**

BROADWAY: IH 45 TO GALVESTON RD.

B2. UNIT PRICE TABLE FOR PAVING

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	02221	Remove and Dispose of Existing Concrete Pavements (including all thickness, w/ or w/o asphalt, including base & subgrade, w/ or w/o curb, all depths)	SY	60,520	$ 5.00	$ 302,600.00
2	02315	Roadway Excavation (Offsite Disposal of Excess)	CY	13,000	$ 3.00	$ 39,000.00
3	02336	Lime Stabilized Subgrade, 8-inch	SY	87,110	$ 2.00	$ 174,220.00
4	02336	Lime (6% by dry weight)	TON	1,570	$ 150.00	$ 235,500.00
5	02581	2" Sch. 40 Street Lighting Conduit	LF	20,000	$ 8.00	$ 160,000.00
6	02711	Type A-Hot Mix Asphaltic Concrete Base Course (6 inch)	TON	964	$ 85.00	$ 81,940.00
7	02741	Type D-Hot Mix Asphaltic Concrete Surface Course (1-1/2 inch)	TON	320	$ 90.00	$ 28,800.00
8	02751	8-inch Reinforced Concrete Pavement	SY	0	$ 34.00	$ -
9	02751	10-inch Reinforced Concrete Pavement	SY	77,420	$ 40.00	$ 3,096,800.0
10	02754	7-inch Concrete Driveway	SF	63,990	$ 6.00	$ 383,940.00
11	02771	6-inch Concrete Curb	LF	30,460	$ 2.50	$ 76,150.00
12	02775	4 1/2-inch Concrete Sidewalk	SF	58,695	$ 4.50	$ 264,127.50
13		Small signs	MI	1.66	$ 5,000.00	$ 8,300.00
14		Pavement Markings	MI	1.66	$ 10,000.00	$ 16,600.00
15		Traffic Signals	EA	2	$ 200,000.00	$ 400,000.00
16		Railroad Mast Arms	EA	4	$ 50,000.00	$ 200,000.00
17		Railroad Crossing	LF	60	$ 1,000.00	$ 60,000.00
		Ancillary Items (5%)	LS	1	$ 276,398.88	$ 276,398.88
SUBTOTAL FOR PAVING/TRAFFIC SIGNAL ITEMS						**$ 5,804,376**

NEEDS AREA NT 04 **COST ESTIMATE**

BROADWAY: IH 45 TO GALVESTON RD.

B3. UNIT PRICE TABLE FOR STORM SEWER ITEMS

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	2221	Remove / Dispose Manholes all Sizes and Depths	EA	1	$ 300.00	$ 300.00
2	2221	Remove / Dispose Inlets all Sizes and Depths	EA	47	$ 300.00	$ 14,100.00
3	2221	Remove and Dispose of Pipe Culverts, Sewers, and Sewer Leads	LF	4900	$ 2.00	$ 9,800.00
4	02082/02087	Type C Manhole for 42-inch Diameter and Smaller Storm Sewers	EA	47	$ 2,500.00	$ 117,500.00
5	02082/02087	Type C Manhole for 48-inch to 72-inch Diameter Storm Sewers	EA	3	$ 6,000.00	$ 18,000.00
6	02631	24-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	3,919	$ 75.00	$ 293,925.00
7	02631	30-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	390	$ 95.00	$ 37,050.00
8	02631	36-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	400	$ 120.00	$ 48,000.00
9	02631	42-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	0	$ 130.00	$ -
10	02631	48-inch-Diameter (RCP) Storm Sewer (Open Cut, All Depths)	LF	1,160	$ 150.00	$ 174,000.00
11	02632/02633	Type C Inlet, Cast-in-Place or Precast	EA	63	$ 2,000.00	$ 126,000.00
12	02632/02633	Type C-1 Inlet, Cast-in-Place or Precast	EA	0	$ 2,700.00	$ -
13	02632/02633	Type C-2 Inlet, Cast-in-Place or Precast	EA	0	$ 3,000.00	$ -
14	02632/02633	Type BB Inlet, Cast-in-Place or Precast	EA	0	$ 2,000.00	$ -
		Detention	AC-FT	1	$ 20,000.00	$ 20,000.00
		Ancillary Items (10%)	LS	1	$ 85,867.50	$ 85,867.50
SUBTOTAL FOR STORM SEWER ITEMS						**$ 920,343**

NEEDS AREA NT 04 **COST ESTIMATE**

BROADWAY: IH 45 TO GALVESTON RD.

B4. UNIT PRICE TABLE FOR WASTEWATER ITEMS

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	02221	Remove Sanitary Sewer (12" dia & smaller)	LF	450	$ 5.00	$ 2,250.00
2	02221	Remove Sanitary Sewer (15" to 27" dia)	LF	0	$ 12.00	$ -
3	02221	Remove Sanitary Manhole (all depths)	EA	0	$ 250.00	$ -
4	02082	4' Dia Precast Manhole (8' depth & less)	EA	4	$ 2,500.00	$ 10,000.00
5	02082	5' Dia Precast Manhole (8' depth & less)	EA	0	$ 5,000.00	$ -
6	02531	6" Sanitary Sewer	LF	0	$ 60.00	$ -
7	02531	8" Sanitary Sewer	LF	450	$ 75.00	$ 33,750.00
8	02531	10" Sanitary Sewer	LF	0	$ 90.00	$ -
9	02531	12" Sanitary Sewer	LF	0	$ 115.00	$ -
10	02543	Sanitary Sewer Service Line (open cut)	LF	0	$ 50.00	
		Ancillary Items (20%)	LS	1	$ 9,200.00	$ 9,200.00
SUBTOTAL FOR WASTEWATER ITEMS						**$ 55,200**

NEEDS AREA NT 04 **COST ESTIMATE**

BROADWAY: IH 45 TO GALVESTON RD.

B5. UNIT PRICE TABLE FOR WATER ITEMS

Item No.	Control No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
1	02511	8" PVC Water Line With Restrained Joints (Open Cut)	LF	0	$ 63.00	$ -
2	02511	8" PVC Water Line With Restrained Joints (Auger)	LF	0	$ 63.00	$ -
3	02511	8" Steel Water Line (Auger)	LF	0	$ 120.00	$ -
4	02511	12" PVC Water Line With Restrained Joints (Open Cut)	LF	1,340	$ 70.00	$ 93,800.00
5	02511	12" PVC Water Line With Restrained Joints (Auger)	LF	0	$ 70.00	$ -
6	02513	8" Wet Connection	EA	0	$ 1,100.00	$ -
7	02513	12" Wet Connection	EA	2	$ 1,250.00	$ 2,500.00
8	02513	16" Wet Connection	EA	0	$ 2,200.00	$ -
9	02513	20" Wet Connection	EA	0	$ 3,000.00	$ -
10	02520	Fire Hydrant Assembly (incl. 6" GV&B)	EA	4	$ 5,400.00	$ 21,600.00
		Ancillary Items (20%)	LS	1	$ 23,580.00	$ 23,580.00
SUBTOTAL FOR WATER ITEMS						**$ 141,480**

STATE OF TEXAS
C. SIMEONIDIS
60919
REGISTERED
PROFESSIONAL ENGINEER

3-19-2013

TRAFFIC OPERATIONS ANALYSIS

ON

BROADWAY STREET

FROM IH 45 TO GALVESTON ROAD

IN

HOUSTON, TEXAS

Presented to

PGAL

3131 Briarpark, Suite 200
Houston, Texas 77042

Conducted by

ETSI

11500 Northwest Freeway, Suite 491
Houston, Texas 77092
Tel: (713) 956-9601 Fax: (713) 956-9667

Ergonomic Transportation Solutions, Inc.

TBPE Firm Registration No. F-000625

MARCH 2013

1. INTRODUCTION

Broadway Street is a four lane boulevard type of roadway in the vicinity of the study area. It is generally comprised of mixed residential, commercial and retail developments. Under Planning 1, ETSI has conducted field investigation along this corridor, identified some key capacity and safety issues that need to be assessed in details under Planning 2 and documented accordingly.

This report serves as Traffic Operations Analysis on Broadway Street from north of IH 45 to Galveston Road under Planning 2.

1.1 PURPOSE AND SCOPE

The purpose of this study is to assess traffic operations along Broadway Street from north of IH 45 to Galveston Road under existing (year 2012) and future (year 2035) traffic conditions and make recommendations to improve the quality of traffic flow, as well as to enhance safety.

The following tasks are covered in this study:

- Establish two peak traffic periods; weekday A.M. and weekday P.M.
- Conduct turning movement counts during the two peak periods at the following locations:
    - Broadway Street at Hartford Street.
    - Broadway Street at IH 610 Interchange.
    - Broadway Street at Galveston Road.
- Assess collected traffic counts and develop balanced assignments on the study network for weekday A.M. and P.M. peak hours.
- Collect available traffic signal data from the City of Houston.
- Collect available traffic projections data from the City of Houston.
- Conduct traffic operational analyses under existing roadway geometry and traffic control conditions.

- Conduct traffic operational analyses under future roadway geometry and traffic control conditions.
- Test alternative improvements.
- Assess the quality of traffic flow based on analysis results such as delays, queues, Level of Service (LOS) etc.
- Make recommendations to improve traffic operations and safety, where necessary.

1.2 STUDY AREA

The study area covers Broadway Street from Galveston Road to north of IH 45 that contains the following signalized intersections:

- Broadway Street at Hartford Street.
- Broadway Street at IH 610 Interchange.
- Broadway Street at Galveston Road.

Exhibit 1.1 shows the general location of the study area.

2. DEVELOPMENT OF ALTERNATIVES

Two Alternatives were proposed to analyze under future traffic conditions (year 2035).

Alternative 1:

- Broadway Street is remained as 4-lane major thoroughfare from IH 45 to Galveston Road.

Alternative 2:

- Broadway Street is constructed as 6-lane major thoroughfare from IH 45 to Galveston Road.

3. TRAFFIC DATA

3.1 EXISTING TRAFFIC (YEAR 2012)

Based on the type of facilities being analyzed in this study, the two peak traffic periods – a typical weekday morning (6:30 A.M. to 9:00 A.M.) and a typical weekday evening (4:30 P.M. to 6:00 P.M.) were established. In this study, turning movement counts were collected on Wednesday, September 5, 2012 (during a typical weekday A.M. and P.M. peak periods) at the following key intersections:

- Broadway Street at Hartford Street.
- Broadway Street at IH 610 Interchange.
- Broadway Street at Galveston Road.

Since improvements at interchange of Broadway Street and IH 45 are TXDOT's responsibility, turning movement counts were not collected at this interchange.

The purpose of recording these counts was to determine the peak analyses hours and also to gain an understanding how traffic fluctuates during such hours.

Table 3.1 shows the peak analyses hours based on existing traffic counts at the above-mentioned intersections.

Peak Hour	Time Period
Weekday A.M.	7:15 – 8:15
Weekday P.M.	5:00 – 6:00

Table 2.1: *Peak Hours along the study corridor*

Exhibits 3.1 and 3.2 show the existing (year 2012) traffic patterns in the study corridor during typical weekday A.M. and P.M. peak hours, respectively.

Detailed traffic count spread sheets are included in the **Appendix**.

3.2 FUTURE TRAFFIC (YEAR 2035)

Average Daily Traffic (ADT) assignments along the study corridor for years 2011 and 2035 were collected from the City of Houston.

The future traffic assignments on Broadway Street under Alternative 1 and Alternative 2 for the year 2035 show ADT of 30,609 from IH 45 to IH 610, 32,081 from IH 610 to Keller Street and 31,515 from Keller Street to Galveston Road.

ETSI has developed peak hours traffic assignments for the year 2035 at the key intersections along this corridor based on the following assumptions:

- Future Average Daily Traffic Assignments information obtained from the City of Houston.
- Existing (year 2012) turning movement counts.
- Directional distribution (D-factor) from existing (year 2012) traffic patterns.

- K = 0.10, indicates the proportion of daily traffic during the peak hour.
- Compounded annual growth rate (CAGR) based on existing (year 2011) estimated ADT and future (year 2035) projected ADT.

Exhibit 3.3 shows the future (year 2035) traffic assignments as Average Daily Traffic (ADT) in the study corridor, provided by the City of Houston.

Exhibits 3.4 and 3.5 show the future (year 2035) traffic patterns in the study corridor during typical weekday A.M. and P.M. peak hours under Alternatives 1 and 2.

4.0 TRAFFIC ANALYSES

4.1 METHODOLOGY

The concept of Level Of Service (LOS) is commonly used in order to determine the operating conditions of an intersection or roadway. The LOS concept is similar to a grading system, ranging from LOS A to LOS F, where LOS A represents free flow conditions and LOS F represents congested or jammed conditions. LOS is commonly evaluated on the basis of control delay per vehicle (in seconds per vehicle). Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. For this study, the Transportation Research Board's Highway Capacity Manual (2010) signalized and unsignalized methodologies were utilized. For unsignalized intersections, the delay is reported for minor approaches only. The average control delay per vehicle will be referred to as average delay throughout this report.

4.2 LEVEL OF SERVICE STANDARDS

Most public agencies consider LOS-C to be the desirable LOS, which should be the target for traffic flow improvements. However, there are circumstances, where LOS-C cannot be achieved with reasonable improvements. In such circumstances, LOS-D is considered to be acceptable. The LOS threshold below which the quality of traffic flow would be

considered unacceptable is assumed to be LOS-C. When traffic operations at a particular intersection within the study area drop below LOS-D, improvements would be recommended. When LOS-C cannot be achieved with reasonable improvements, LOS-D improvements will be recommended.

4.3 ANALYSIS TOOL

In order to evaluate the existing quality of traffic flow and to determine if improvements are necessary, capacity analyses were performed based on the procedures contained in Highway Capacity Manual (HCM), 2010 edition. The input data for these analyses included existing/proposed geometric features, existing/ proposed traffic control at the intersections and peak hour traffic volumes. The analysis software tool SYNCHRO was utilized in this study. It is a macroscopic traffic signal timing tool that is widely used to optimize signal-timing parameters for signalized intersection and generate coordinated traffic signal timing plans for arterials and networks.

4.4 ANALYSES RESULTS

Capacity and LOS analyses were performed for the following Conditions during the weekday A.M. and P.M. peak hours:

- Existing Condition, Year 2012.
- Alternative 1, Year 2035.
- Alternative 2, Year 2035.

A Summary of all analysis results is presented in **Tables 4.1 and 4.2.**

4.4.1 Existing Condition, Year 2012

Capacity analysis results under existing condition indicate that the quality of traffic flow at interchange of Broadway Street and IH 610 is within acceptable limits during P.M peak hour. However, the LOS for the same intersection is not within acceptable limits under existing traffic condition during A.M peak hour. The quality of Traffic flow at the intersection

of Galveston Road and Broadway Street is within acceptable limits for A.M and P.M. peak hours. The quality of traffic flow on Broadway Street at Hartford Street is within acceptable limits for both A.M and P.M peak hours under existing (year 2012) traffic conditions.

Exhibits 4.1-4.8 show individual intersection geometries and capacity analysis results.

4.4.2 Alternative 1, Year 2035

This Alternative has been tested under following geometric and traffic control conditions:

- 4-lanes on Broadway Street from IH 45 to Galveston Road.
- Adding Left turn bays on Broadway Street (both approaches), at its intersection with Hartford Street.

Capacity analysis results indicate that the quality of traffic flow at the intersection of Broadway Street at Hartford Street is within acceptable limits during peak hours under Alternative 1.

Capacity analysis results indicate that the quality of traffic flow at the following intersections is not within acceptable limits during peak hours under Alternative 1.

- Broadway Street at IH 610 Interchange.
- Broadway Street at Galveston Road.

Exhibits 4.9-4.16 show the study corridor geometry and capacity analysis results for Alternative 1 under future (year 2035) traffic conditions during peak hours.

4.4.3 Alternative 2, Year 2035

This Alternative has been tested under following geometric and traffic control conditions:

- 6-lanes on Broadway Street from IH 45 to Galveston Road.

- Adding Left turn bays on Broadway Street (both approaches), at its intersection with Hartford Street.

Capacity analysis results indicate that the quality of traffic flow at the intersection of Broadway Street at IH 610 interchange is not within acceptable limits during peak hours under Alternative 2. This intersection has been tested by changing lane assignments and optimizing signal timing. Some geometric improvements under the bridge (adding lanes) are required to handle the projected traffic demand at this interchange in the future. It is recommended to conduct further study by TXDOT in the future in order to improve traffic operations and safety at this interchange.

Capacity analysis results indicate that the quality of traffic flow at the following intersections are within acceptable limits during peak hours under Alternative 2.

- Broadway Street at Galveston Road
- Broadway Street at Hartford Street

However, for the intersection of Broadway Street at Galveston Road, there are some movements that show LOS D. Even though the LOS "D" is considered as being within acceptable limits in this study, the delays on such movements (as tables 4.1 and 4.2 show) are close to LOS "E", which is not desirable.

Exhibits 4.17-4.24 show individual intersection geometries and capacity analysis results for Alternative 2 under future (year 2035) traffic conditions during peak hours.

In order to improve the undesirable delays at the intersection of Broadway Street and Galveston Road, additional improvements were tested to achieve better results.

- Extension of three through lanes in each direction on Broadway Street up to north of Galveston Road, then taper down to two lanes.

- An additional southbound left turn bay on Broadway Street at its intersection with Galveston Road. Southbound approach would have three through lanes and two exclusive left turn bays under this option.
- An additional westbound left turn lane on Galveston Road at its intersection with Broadway Street. The westbound approach would have one exclusive right lane and two exclusive left turn lanes under this option.

Exhibits 4.25-4.30 show the LOS of Broadway Street at Galveston Road for each of the above improvements, under future traffic conditions (year 2035) during A.M and P.M peak hours.

Table 4.3 shows the comparison between delays, LOS and queue lengths of Alternative 2, and each of the improvements discussed above for the intersection of Broadway Street and Galveston Road.

5.0 CONCLUSIONS

Based on field investigations and traffic analysis results, we conclude the following:

- Future (year 2035) traffic projections provided by the City of Houston for the year 2035 show significant traffic growth along the Broadway street corridor compared to existing (year 2012) traffic patterns.

- Under existing traffic and geometric conditions, the overall LOS for Broadway Street at Hartford Street during A.M and P.M peak hours is within acceptable limits.

- Under existing traffic and geometric conditions, the overall LOS for Broadway Street at Galveston Road during A.M and P.M. peak hours is within acceptable limits.

- Under existing traffic and geometric conditions, the overall LOS for Broadway at IH 610 interchange during P.M peak hours is within acceptable limits. However during A.M peak hour the LOS is not within acceptable limits.

- Capacity Analysis Results under Alternative 1 (4-lanes) for future (year 2035) traffic conditions indicate that maintaining the current lane configurations along Broadway Street with additional turn bays at intersection of Broadway Street and Hartford Street would not improve the quality of traffic flow along this corridor at the following intersections during AM and PM peak hours:

    - Broadway Street at IH 610 Interchange.
    - Broadway Street at Galveston Road.

- Under Alternative 1 traffic and geometric conditions, the overall LOS for Broadway at Hartford Street during A.M and P.M peak hours are within acceptable limits.

- Capacity Analysis Results under Alternative 2 (6-lanes) for future (year 2035) traffic conditions indicate that installing 6-lanes along Broadway Street with additional turn bays at intersection of Broadway Street and Hartford Street, would improve the quality of traffic flow at the following intersections during AM and PM peak hours:

    - Broadway Street at Hartford Street.
    - Broadway Street at Galveston Road.

  However, for the intersection of Broadway Street at Galveston Road, there are some movements that show LOS D. Even though the LOS "D" is considered acceptable in this study, the delays on such movements are close to LOS "E", which is not desirable.

- Under Alternative 2 traffic and geometric conditions, the overall LOS for Broadway at IH 610 interchange during A.M and P.M peak hours is not within acceptable limits.

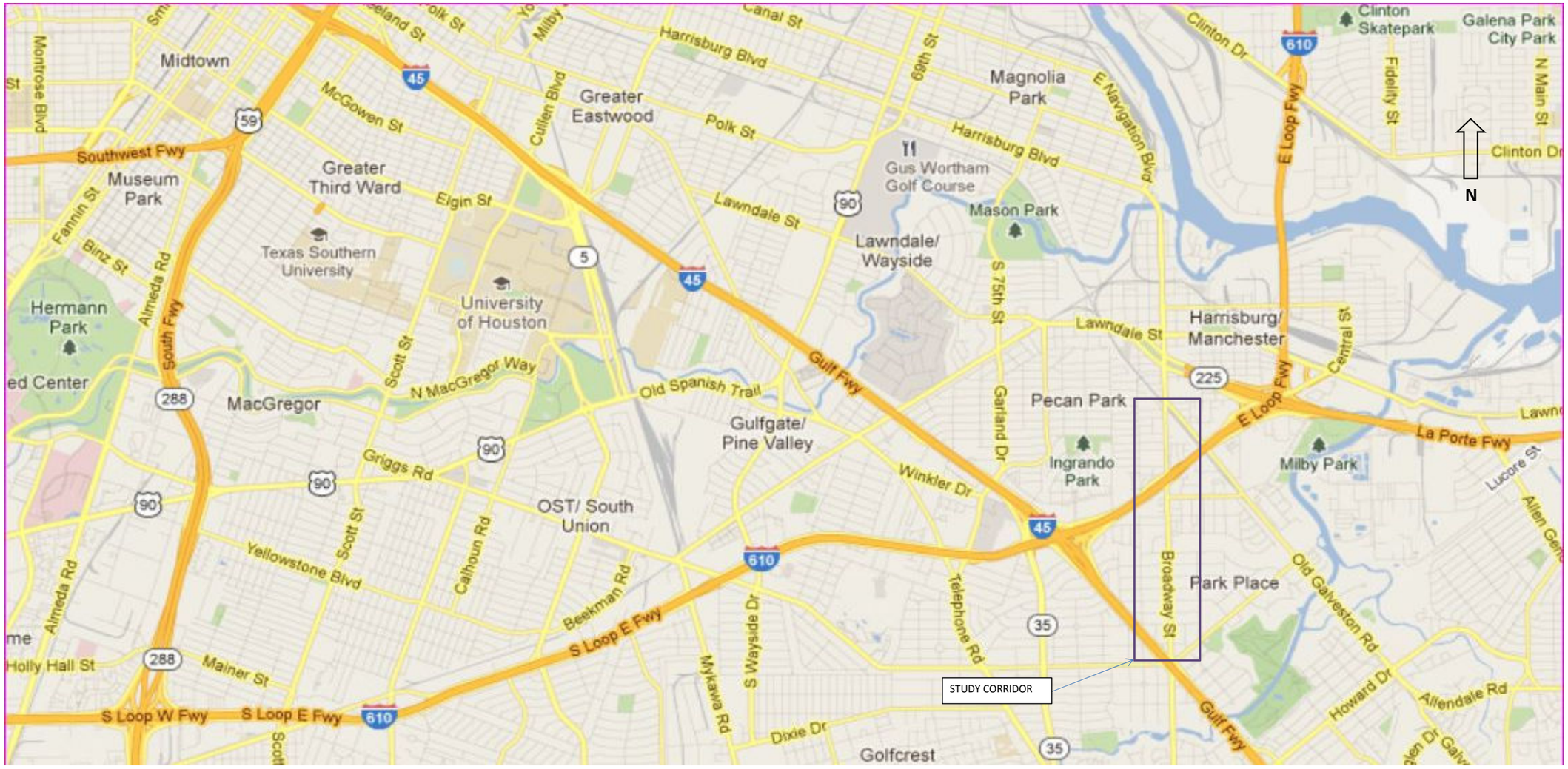
- Since capacity analysis results for Alternative 1 (4-lanes) improvements indicate significant delays (close to LOS "E") for some movements at the intersection of Broadway Street and Galveston Road, the following additional improvements were tested at this intersection:

    - Extend three through lanes in each direction on Broadway Street up to north of Galveston Road.
    - Add an additional southbound left turn bay on Broadway Street to have dual left turn option
    - Add an additional westbound left turn bay on Galveston Road to have dual left turn option.

- The interchange of Broadway Street and IH 610 would require major reconstruction in order to improve traffic operations and safety. This however is the responsibility of TXDOT. Further coordination with TXDOT, may be conducted to determine their plans at this interchange.

- The interchange of Broadway Street and IH 45 would also require major reconstruction in order to improve traffic operations and safety. This however is the responsibility of TXDOT. Further coordination with TXDOT, may be conducted to determine their plans at this interchange.

- Based on the traffic growth result from the COH model by the year 2027 traffic demand levels would reach the point, where additional capacity improvements would be required.



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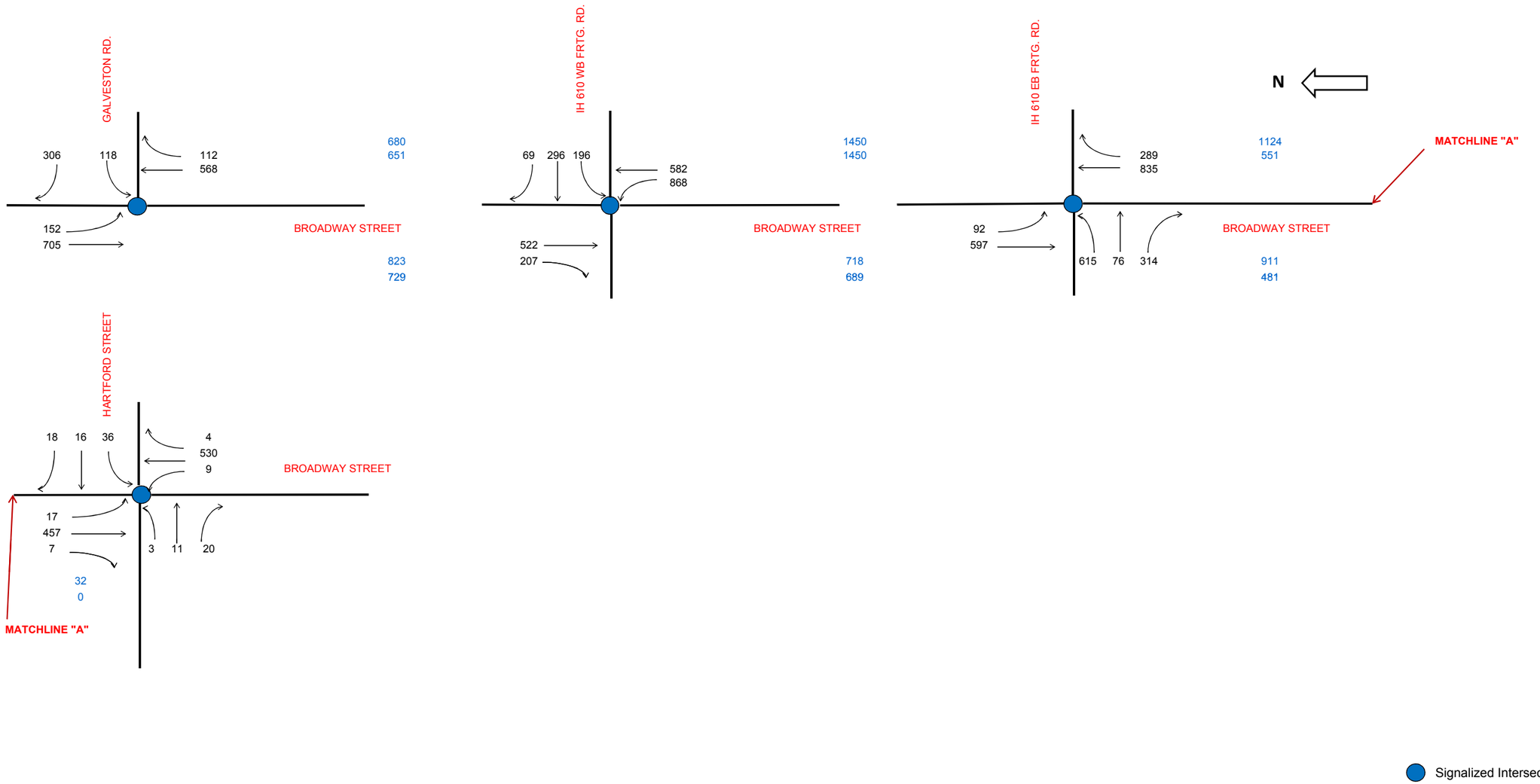
NOT TO SCALE

EXHIBIT 1.1

STUDY AREA AND EXISTING ROADWAY NETWORK



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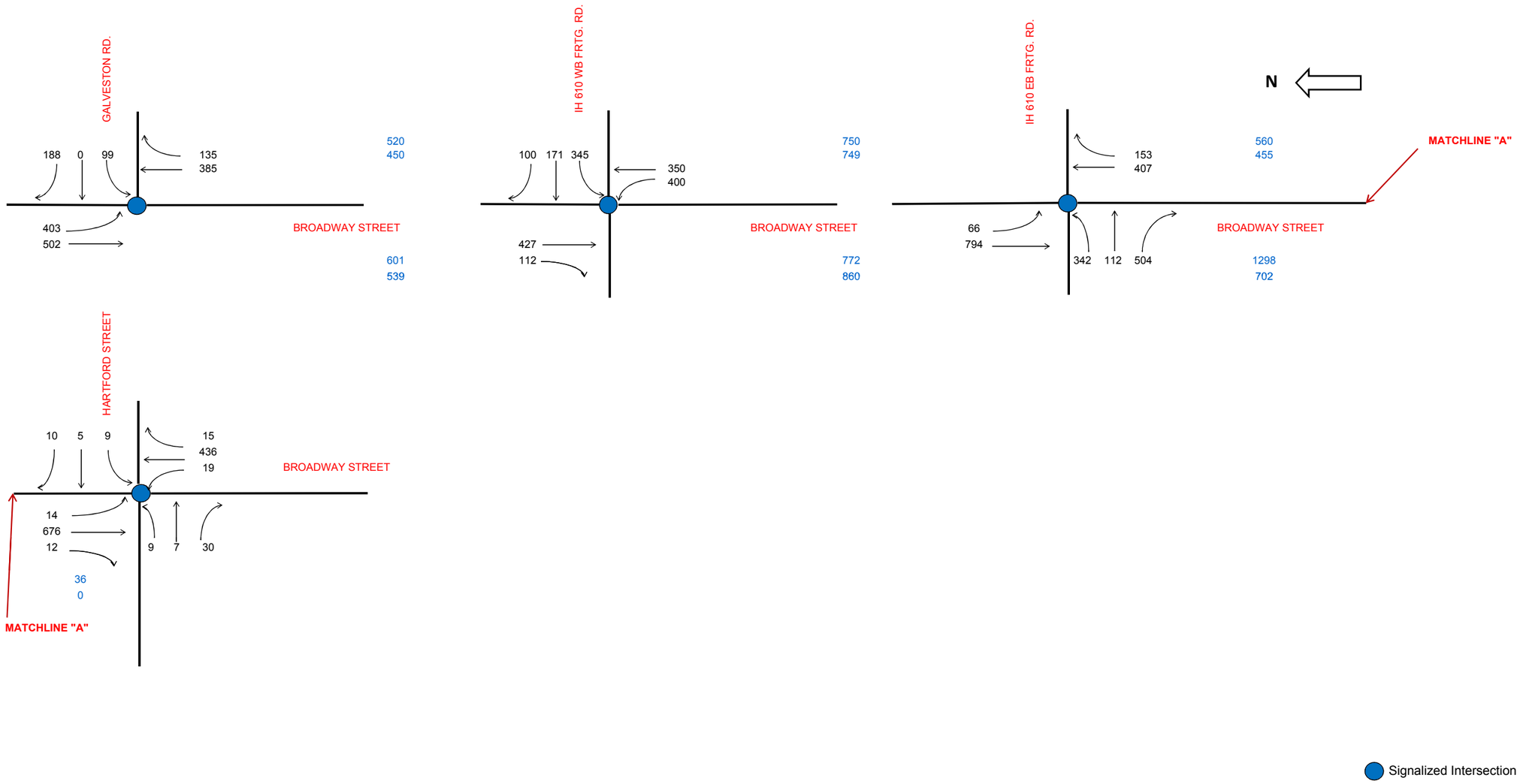
BROADWAY TRAFFIC ANALYSIS

EXHIBIT 3.1

EXISTING TRAFFIC PATTERNS (YEAR 2012)

WEEKDAY A.M. PEAK HOUR (BETWEEN 7:15 A.M. AND 8:15 A.M.)



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BROADWAY TRAFFIC ANALYSIS

EXHIBIT 3.2

EXISTING TRAFFIC PATTERNS (YEAR 2012)

WEEKDAY P.M. PEAK HOUR (BETWEEN 5:00 P.M. AND 6:00 P.M.)

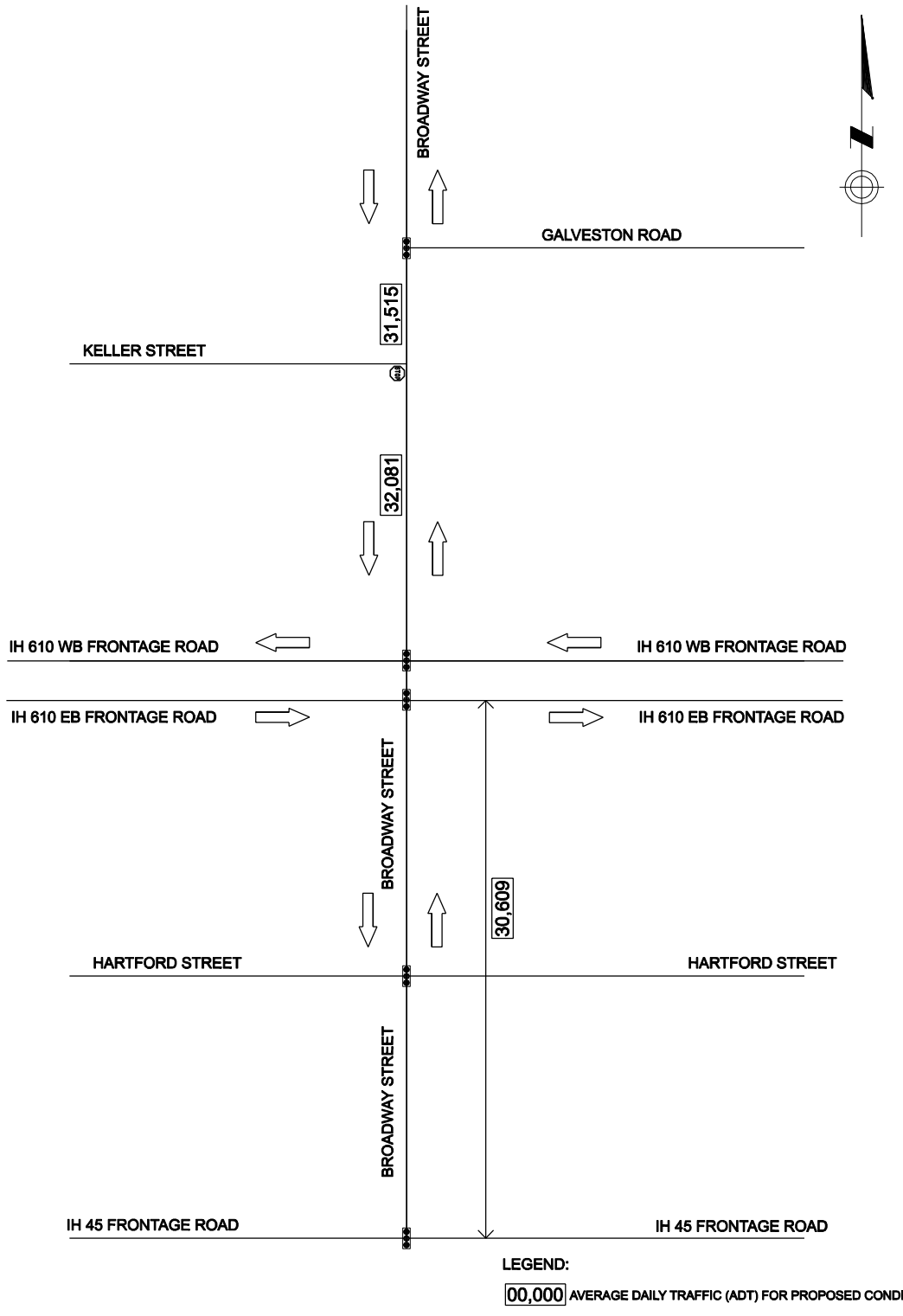

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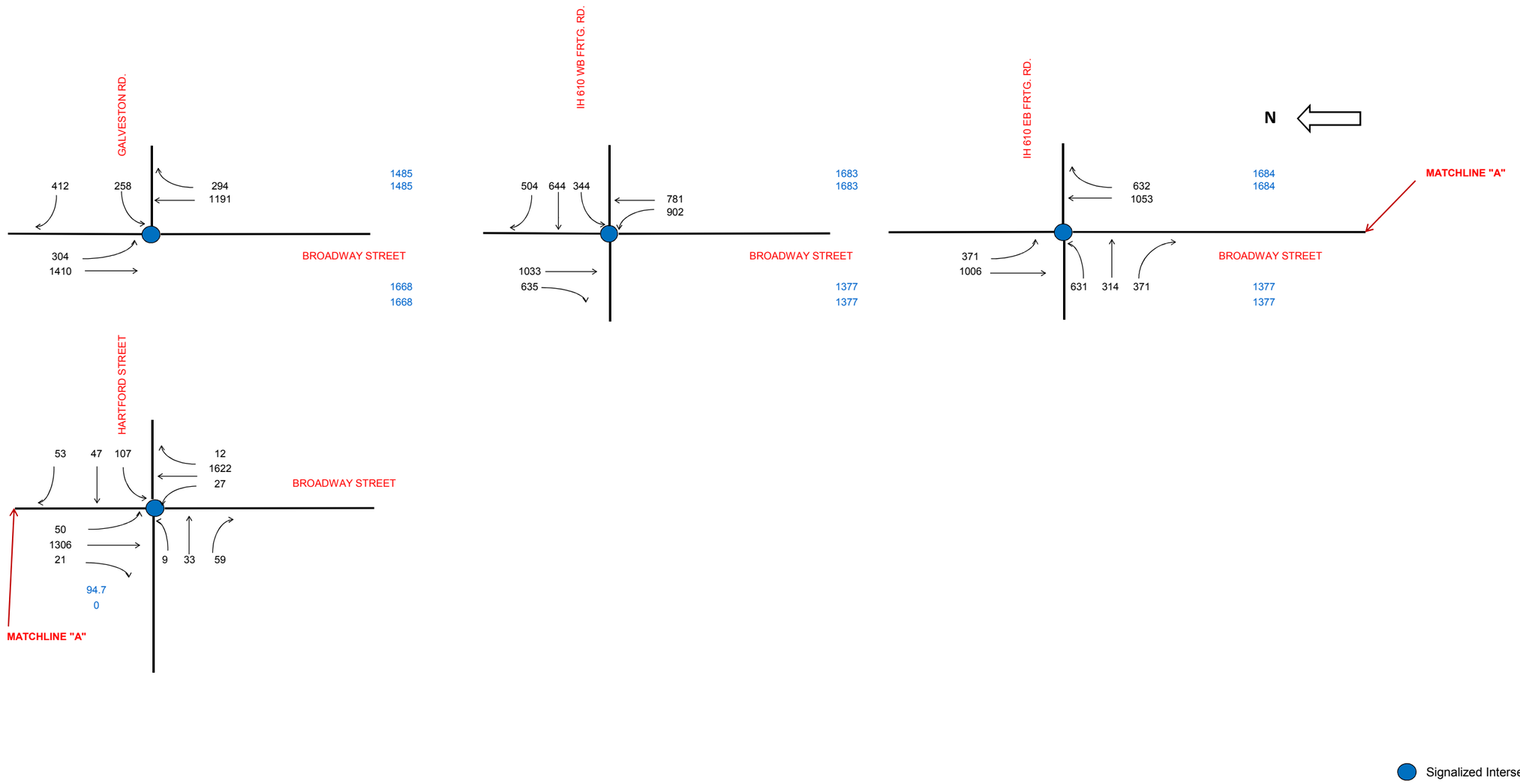
EXHIBIT 3.3

FUTURE TRAFFIC ASSIGNMENTS (YEAR 2035)

PROVIDED BY CITY OF HOUSTON



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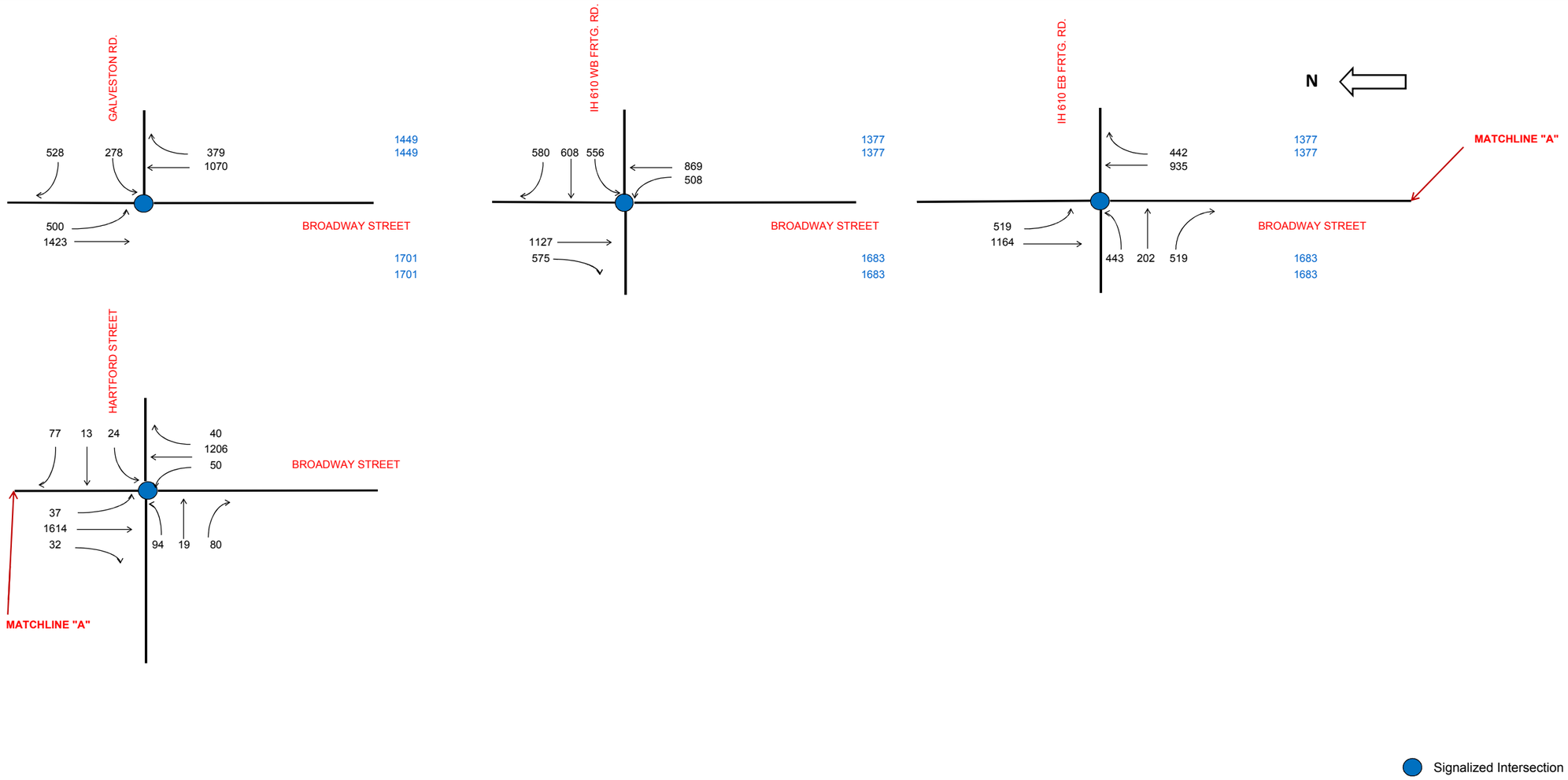
BROADWAY TRAFFIC ANALYSIS

EXHIBIT 3.4

PROPOSED TRAFFIC PATTERNS (YEAR 2035)

WEEKDAY A.M. PEAK HOUR (BETWEEN 7:15 A.M. AND 8:15 A.M.)



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NOT TO SCALE

BROADWAY TRAFFIC ANALYSIS

EXHIBIT 3.5

PROPOSED TRAFFIC PATTERNS (YEAR 2035)

WEEKDAY P.M. PEAK HOUR (BETWEEN 5:00 P.M. AND 6:00 P.M.)

TABLE 4.1: SUMMARY OF CAPACITY ANALYSES RESULTS FOR WEEKDAY A.M. PEAK HOUR

Intersection	EBL			EBT			EBR			WBL			WBT			WBR			NBL			NBT			NBR			SBL			SBT			SBR			MAX V/C Ratio	Int. Delay (Sec/Veh)	Int. LOS
	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS			
EXISTING CONDITION, YEAR 2012 (WEEKDAY A.M. PEAK HOUR)																																							
BROADWAY ST. @ OLD GALVASTON RD.	N/A			N/A			N/A			20.1	84.0	C	N/A			5.4	56.0	A	N/A			23.2	196.0	C	23.2	196.0	C	26.9	106.0	C	8.4	103.0	A	N/A			0.73	15.2	B
BROADWAY ST. @ IH 610 WB FRTG. RD.	N/A			N/A			N/A			N/A			215.3	#406	F	1.6	0.0	A	219.0	m#989	F	1.7	m0	A	N/A			N/A			29.3	226.0	C	7.8	80.0	A	1.43	116.3	F
BROADWAY ST. @ IH 610 EB FRTG. RD	64.7	#428	E	64.7	#428	E	139.1	#290	F	N/A			N/A			N/A			N/A			108.9	#545	F	17.9	173.0	B	20.2	m39	C	2.5	m0	A	N/A			1.43	66.7	E
BROADWAY ST. @ HARTFORD ST.	16.9	28.0	B	16.9	28.0	B	16.9	28.0	B	26.7	55.0	C	26.7	55.0	C	26.7	55.0	C	2.4	44.0	A	2.4	44.0	A	2.4	44.0	A	1.2	m22	A	1.2	m22	A	1.2	m22	A	0.41	3.8	A
ALTERNATIVE 1 (4-LANE OPTION), YEAR 2035 (WEEKDAY A.M. PEAK HOUR)																																							
BROADWAY ST. @ OLD GALVASTON RD.	N/A			N/A			N/A			100.4	#357	F	N/A			29.5	#258	C	N/A			51.2	#717	D	51.2	#717	D	92.5	#399	F	8.3	282.0	A	N/A			1.01	39.8	D
BROADWAY ST. @ IH 610 WB FRTG. RD.	N/A			36.9			36.9			232.0	#791	F	232.0	#791	F	96.1	#615	F	287.0	m#1167	F	8.3	m63	A	N/A			N/A			132.1	#743	F	156.7	#872	F	1.57	160.8	F
BROADWAY ST. @ IH 610 EB FRTG. RD	216.3	#751	F	216.3	#751	F	43.8	#375	D	N/A			N/A			N/A			N/A			92.7	568.0	F	58.8	#745	E	84.0	m232	F	60.3	m224	E	N/A			1.57	102.1	F
BROADWAY ST. @ HARTFORD ST.	17.1	59.0	B	17.1	59.0	B	17.1	59.0	B	41.0	#157	D	41.0	#157	D	41.0	#157	D	11.7	21.0	B	15.9	#460	B	15.9	#460	B	23.9	#61	C	10.7	258.0	B	10.7	258.0	B	0.85	15.5	B
ALTERNATIVE 2 (6-LANE OPTION), YEAR 2035 (WEEKDAY A.M. PEAK HOUR)																																							
BROADWAY ST. @ OLD GALVASTON RD.	N/A			N/A			N/A			42.9	#240	D	N/A			11.5	113.0	B	N/A			50.4	#469	D	3.9	48.0	A	23.3	#200	C	10.0	273.0	A	N/A			1.00	25.4	C
BROADWAY ST. @ IH 610 WB FRTG. RD.	N/A			36.9			36.9			197.8	#893	F	197.8	#893	F	86.6	#684	F	290.3	m#1344	F	14.6	m128	b	N/A			N/A			112.2	#815	F	162.9	#1051	F	1.57	151.1	F
BROADWAY ST. @ IH 610 EB FRTG. RD	283.1	#1017	F	194.1	#786	F	194.1	#786	F	N/A			N/A			N/A			N/A			75.5	613.0	E	53.9	#856	D	88.7	m302	F	59.5	m280	E	N/A			1.57	114.6	F
BROADWAY ST. @ HARTFORD ST.	11.4	44.0	B	11.4	44.0	B	11.4	44.0	B	32.6	#145	C	32.6	#145	C	32.6	#145	C	24.5	28.0	C	14.2	#228	B	14.2	#228	C	28.1	#44	B	9.9	164.0	A	9.9	164.0	A	0.76	13.8	A

TABLE 4.2: SUMMARY OF CAPACITY ANALYSES RESULTS FOR WEEKDAY P.M. PEAK HOUR

Intersection	EBL			EBT			EBR			WBL			WBT			WBR			NBL			NBT			NBR			SBL			SBT			SBR			MAX V/C Ratio	Int. Delay (Sec/Veh)	Int. LOS
	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS			
EXISTING CONDITION, YEAR 2012 (WEEKDAY P.M. PEAK HOUR)																																							
BROADWAY ST. @ OLD GALVASTON RD.	N/A			N/A			N/A			30.3	94.0	C	N/A			7.5	53.0	A	N/A			31.3	178.0	C	31.3	178.0	C	26.7	298.0	C	5.4	175.0	A	N/A			0.73	20.0	B
BROADWAY ST. @ IH 610 WB FRTG. RD.	N/A			N/A			N/A			106.6	#371	F	106.6	#371	F	2.8	7.0	A	5.5	18.0	A	0.9	0.0	A	N/A			N/A			61.3	247.0	E	3.3	13.0	A	1.07	49.2	D
BROADWAY ST. @ IH 610 EB FRTG. RD	N/A			37.6	225.0	D	60.1	#549	E	N/A			N/A			N/A			N/A			28.1	182.0	C	6.5	43.0	A	32.4	m30	C	28.7	m14	C	N/A			1.07	35.6	D
BROADWAY ST. @ HARTFORD ST.	16.3	33.0	B	16.3	33.0	B	16.3	33.0	B	20.0	25.0	B	20.0	25.0	B	20.0	25.0	B	2.3	37.0	A	2.3	37.0	A	2.3	37.0	A	3.1	m115	A	3.1	m115	A	3.1	m115	A	0.29	3.6	A
ALTERNATIVE 1 (4-LANE OPTION), YEAR 2035 (WEEKDAY P.M. PEAK HOUR)																																							
BROADWAY ST. @ OLD GALVASTON RD.	N/A			N/A			N/A			124.4	#389	F	N/A			88.3	#438	F	N/A			47.7	#681	D	47.7	#681	D	344.3	#720	F	8.5	286.0	A	N/A			1.67	80.1	F
BROADWAY ST. @ IH 610 WB FRTG. RD.	N/A			N/A			N/A			351.1	#974	F	351.1	#974	F	192.9	#816	F	93.5	m#594	F	7.4	m133	A	N/A			N/A			180.2	#839	F	115.3	#745	F	1.70	175.0	F
BROADWAY ST. @ IH 610 EB FRTG. RD	N/A			72.3	#434	E	136.1	#688	F	N/A			N/A			N/A			N/A			59.5	482.0	E	26.9	356.0	C	172.1	m357	F	59.6	m170	E	N/A			1.70	81.3	F
BROADWAY ST. @ HARTFORD ST.	39.8	#133	D	39.8	#133	D	39.8	#133	D	18.0	64.0	B	18.0	64.0	B	18.0	64.0	B	23.8	#60	C	9.8	232.0	A	9.8	232.0	A	12.0	27.0	B	16.1	#465	B	16.1	#465	B	0.85	15.3	B
ALTERNATIVE 2 (6-LANE OPTION), YEAR 2035 (WEEKDAY P.M. PEAK HOUR)																																							
BROADWAY ST. @ OLD GALVASTON RD.	N/A			N/A			N/A			54.0	#318	D	N/A			16.1	#188	B	N/A			46.7	#517	D	5.0	64.0	A	49.4	#492	D	9.7	312.0	A	N/A			0.94	27.3	C
BROADWAY ST. @ IH 610 WB FRTG. RD.	N/A			N/A			N/A			494.8	#1244	F	494.8	#1244	F	250.7	#999	F	69.0	m483	E	21.4	m203	C	N/A			N/A			277.2	#1087	F	174.1	#941	F	1.31	246.2	F
BROADWAY ST. @ IH 610 EB FRTG. RD	50.1	536.0	D	45.1	447.0	D	45.1	447.0	D	N/A			N/A			N/A			N/A			116.2	#782	F	29.0	342.0	C	182.1	m#366	F	60.2	m257	E	N/A			2.02	80.6	F
BROADWAY ST. @ HARTFORD ST.	27.8	#123	C	27.8	#123	C	27.8	#123	C	11.9	46.0	B	11.9	46.0	B	11.9	46.0	B	28.3	#43	C	8.5	137.0	A	8.5	137.0	A	26.1	35.0	C	12.1	205.0	B	12.1	205.0	B	0.73	12.0	B

TABLE 4.3: SUMMARY OF CAPACITY ANALYSES RESULTS FOR DEFFERENT OPTIONS ON BROADWAY STREET AT GALVESTON ROAD

BROADWAY ST. @ OLD GALVASTON RD.	WBL			WBR			NBT			NBR			SBL			SBT			MAX V/C Ratio	Int. Delay (Sec/Veh)	Int. LOS
	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS	Total Delay (S/V)	Queue Length (ft)	LOS			
YEAR 2035 (WEEKDAY A.M. PEAK HOUR)																					
ALTERNATIVE 2	42.9	#240	D	11.5	113.0	B	50.4	#469	D	3.9	48.0	A	23.3	#200	C	10.0	273.0	A	1.00	25.4	C
OPTION 1: EXTEND THREE THROUGH LANES AND DUAL LEFT TURN BAYS IN SOUTHBOUND DIRECTION	33.7	224.0	C	10.6	133.0	B	32.9	#375	C	3.9	53.0	A	15.4	91.0	B	12.3	233.0	B	0.73	25.9	C
OPTION 2: EXTEND THREE THROUGH LANES IN NORTHBOUND DIRECTION	39.3	243.0	D	25.4	#275	C	34.0	#496	C	32.4	#366	C	27.4	#221	C	12.6	323.0	B	0.91	23.0	C
OPTION 3: DUAL LEFT TURN FOR WESTBOUND MOVEMENT	29.5	100.0	C	23.0	#233	C	34.8	#459	C	3.5	47.0	A	27.6	#222	C	9.4	12.6	B	0.92	21.0	C
YEAR 2035 (WEEKDAY P.M. PEAK HOUR)																					
ALTERNATIVE 2	54.0	#318	D	16.1	#188	B	46.7	#517	D	5.0	64.0	A	49.4	#492	D	9.7	312.0	A	0.94	27.3	C
OPTION 1: EXTEND THREE THROUGH LANES AND DUAL LEFT TURN BAYS IN SOUTHBOUND DIRECTION	33.8	251.0	C	26.1	#360	C	32.5	435.0	C	3.8	54.0	A	33.2	#190	C	11.8	229.0	B	0.83	22.2	C
OPTION 2: EXTEND THREE THROUGH LANES IN NORTHBOUND DIRECTION	46.8	#286	D	12.1	150.0	B	47.9	#456	D	47.9	#546	D	44.3	#480	D	11.0	338.0	B	0.97	30.3	C
OPTION 3: DUAL LEFT TURN FOR WESTBOUND MOVEMENT	35.4	121.0	D	20.4	#236	C	37.1	#454	D	4.2	55.0	A	44.4	#445	D	7.7	252.0	A	0.92	22.7	C

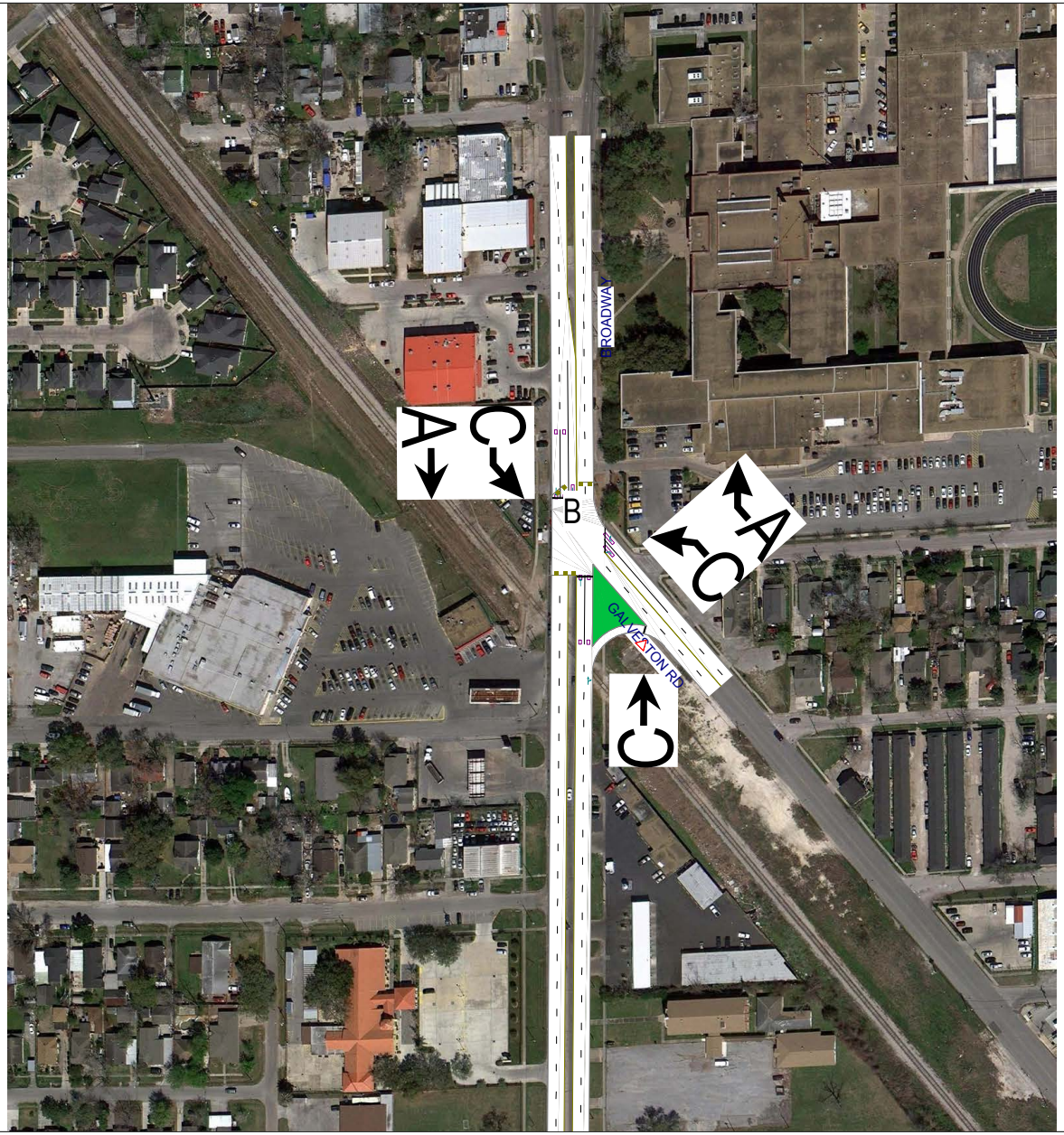
EXHIBIT 4.1

A
C
B
A
C
A
C
A
C

EXISTING CONDITION_YEAR 2012_AM

EXHIBIT 4.2

BROADWAY STREET @ GALVESTON ROAD



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EXISTING CONDITION_YEAR 2012_AM

EXHIBIT 4.3

BROADWAY ST. @ IH 610

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EXISTING CONDITION_YEAR 2012_AM

EXHIBITS 4.4

BROADWAY ST. @ HARTFORD

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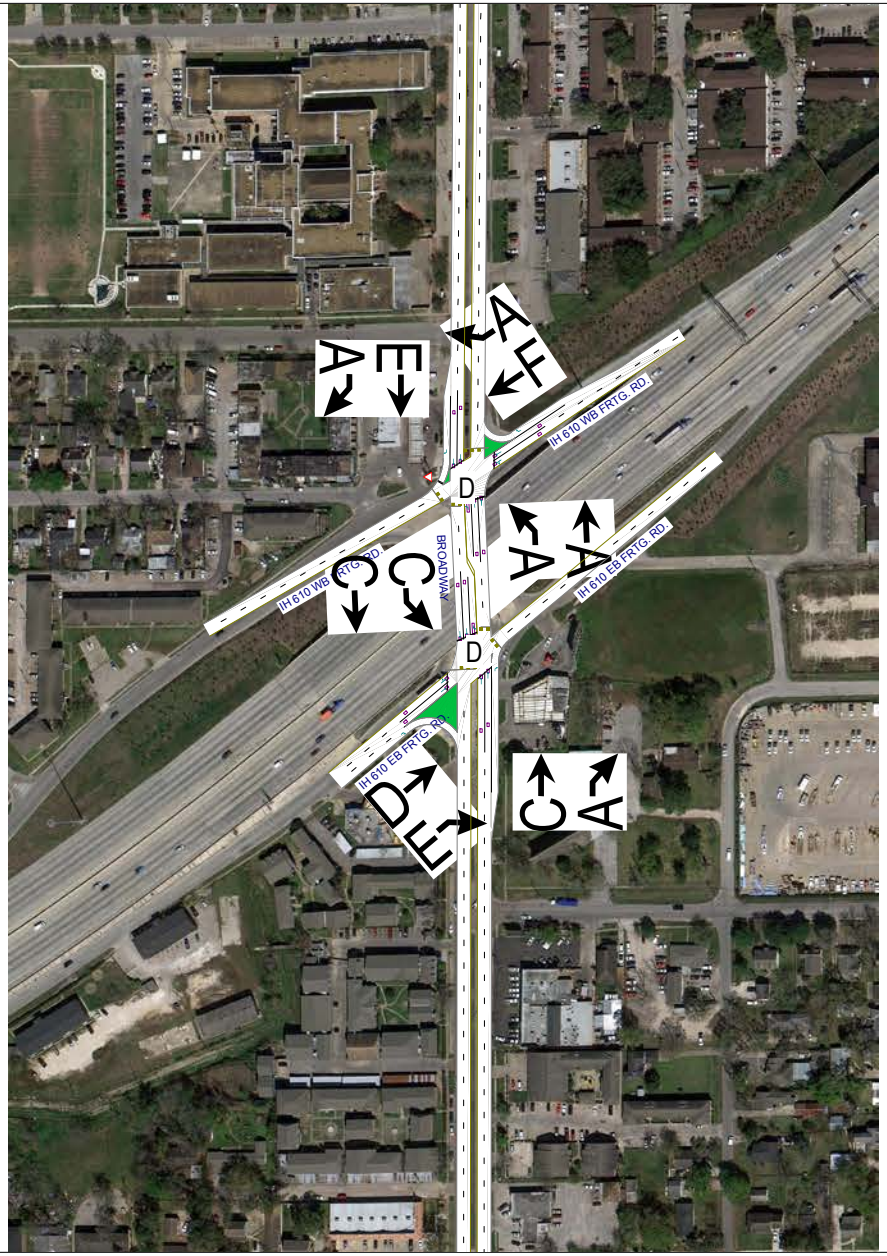
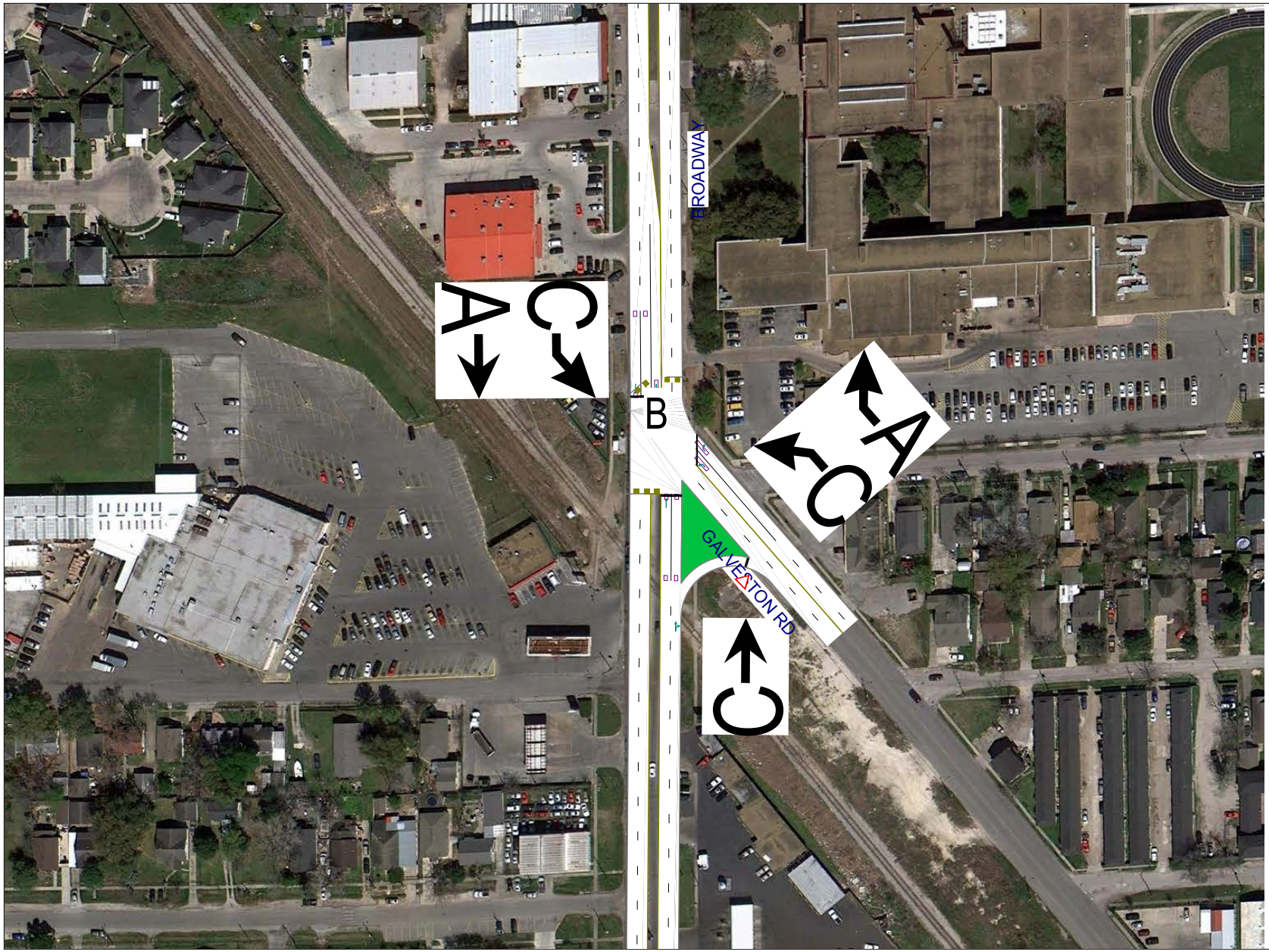
EXHIBIT 4.5

EXHIBIT 4.6


A
F
E
A
IH 610 WB FRTG. RD.
D
A
A
IH 610 EB FRTG. RD.
BROADWAY
C
C
IH 610 WB FRTG. RD.
D
IH 610 EB FRTG. RD.
D
E
C
A

EXISTING CONDITION_YEAR 2012_PM

BROADWAY ST. AT GALVESTON RD.



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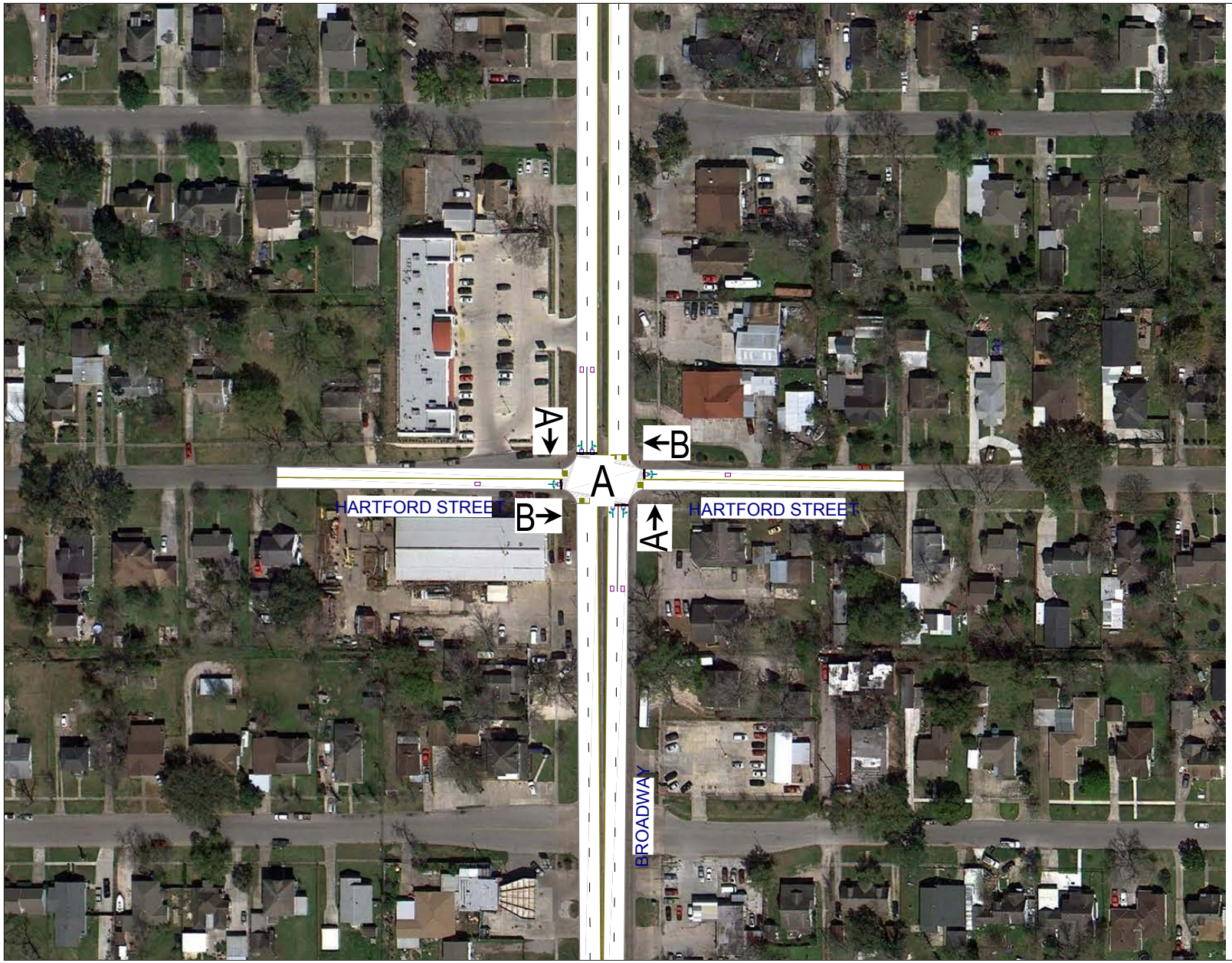
EXISTING CONDITION_YEAR 2012_PM

EXHIBIT 4.8

BROADWAY ST. @ HARTFORD



Ergonomic Transportation Solutions, Inc.

EXHIBIT 4.9

BROADWAY
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BROADWAY
BROADWAY
BROADWAY
BROADWAY
HARVEST PKWY
HARVEST PKWY
HARVEST PKWY
HARVEST PKWY
HARTFORD STREET
HARTFORD STREET

ALT 1_4 LANE OPTION_YEAR 2035_AM

EXHIBIT 4.10

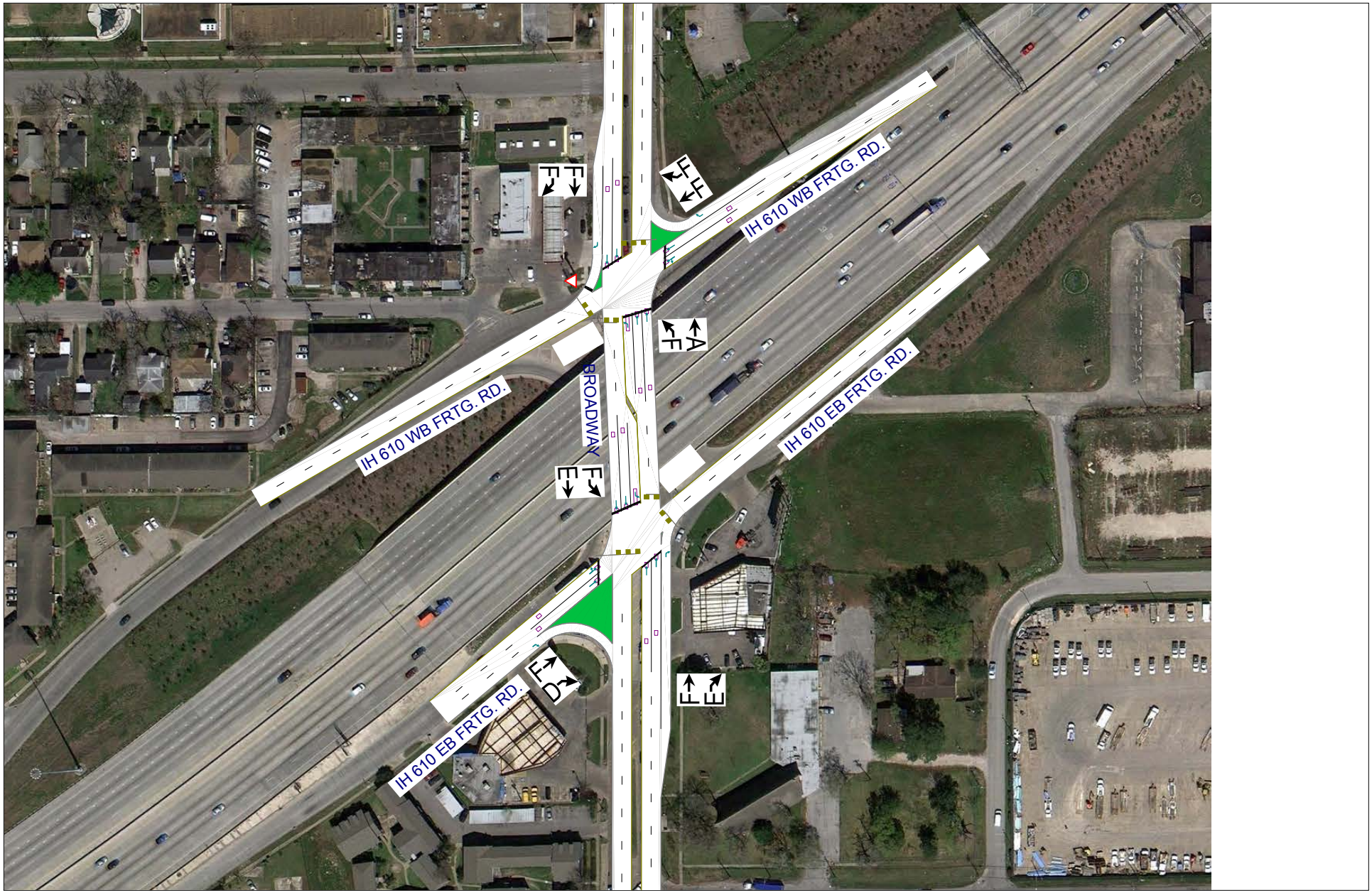
BROADWAY @ GALVESTON

Ergonomic Transportation Solutions, Inc.

ALT 1_4 LANE OPTION_YEAR 2035_AM

EXHIBIT 4.11

BROADWAY @ IH 610

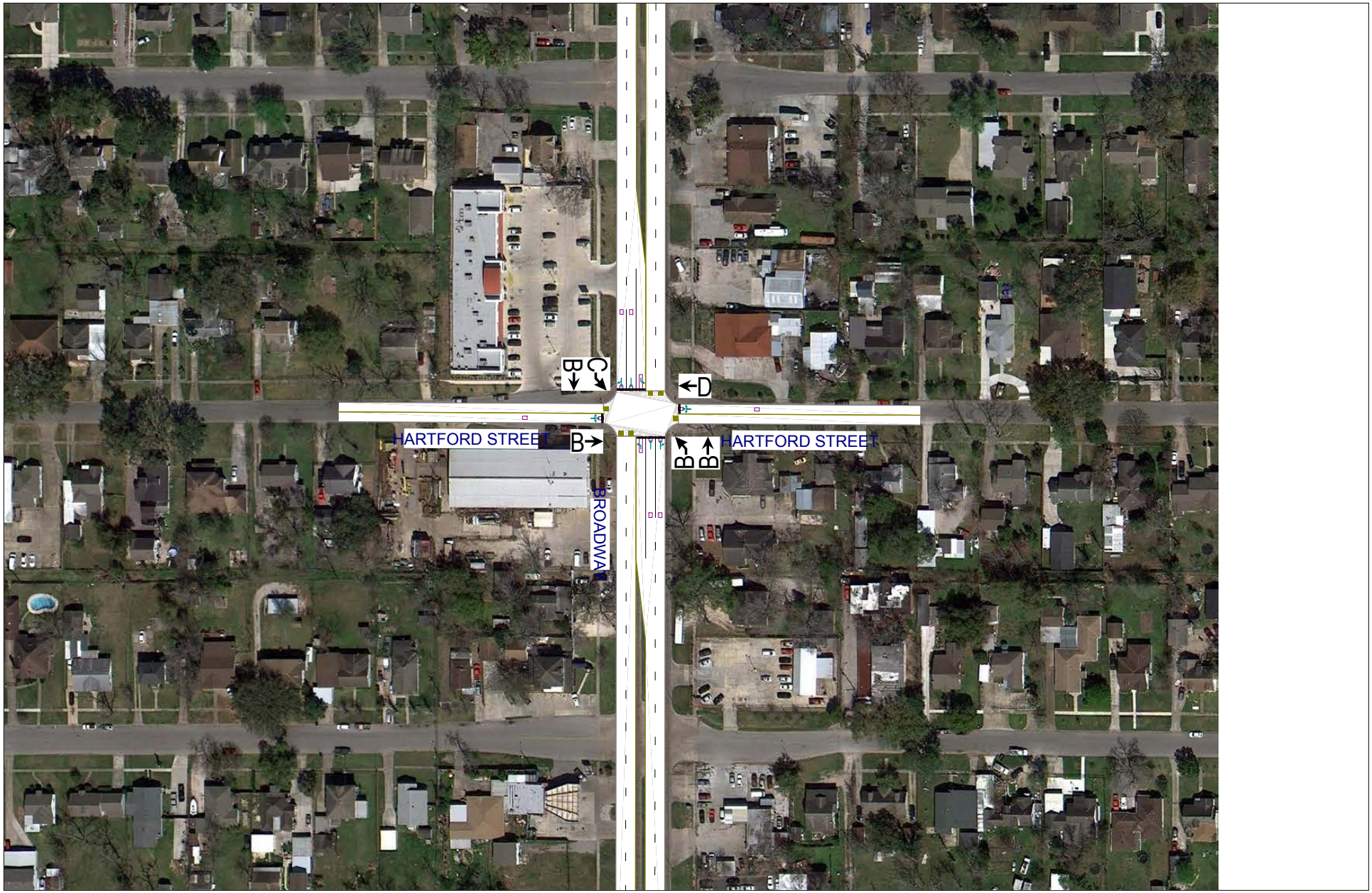


Ergonomic Transportation Solutions, Inc.

ALT 1_4 LANE OPTION_YEAR 2035_AM

EXHIBIT 4.12

BROADWAY @ HARTFORD



Ergonomic Transportation Solutions, Inc.

EXHIBIT 4.13

BROADWAY
BROADWAY
BROADWAY
BROADWAY
BROADWAY
AVENUE
AVENUE
AVENUE
AVENUE
ARTFORD STREE
ARTFORD STREE

ALT 1_4 LANE OPTION_YEAR 2035_PM

EXHIBIT 4.14

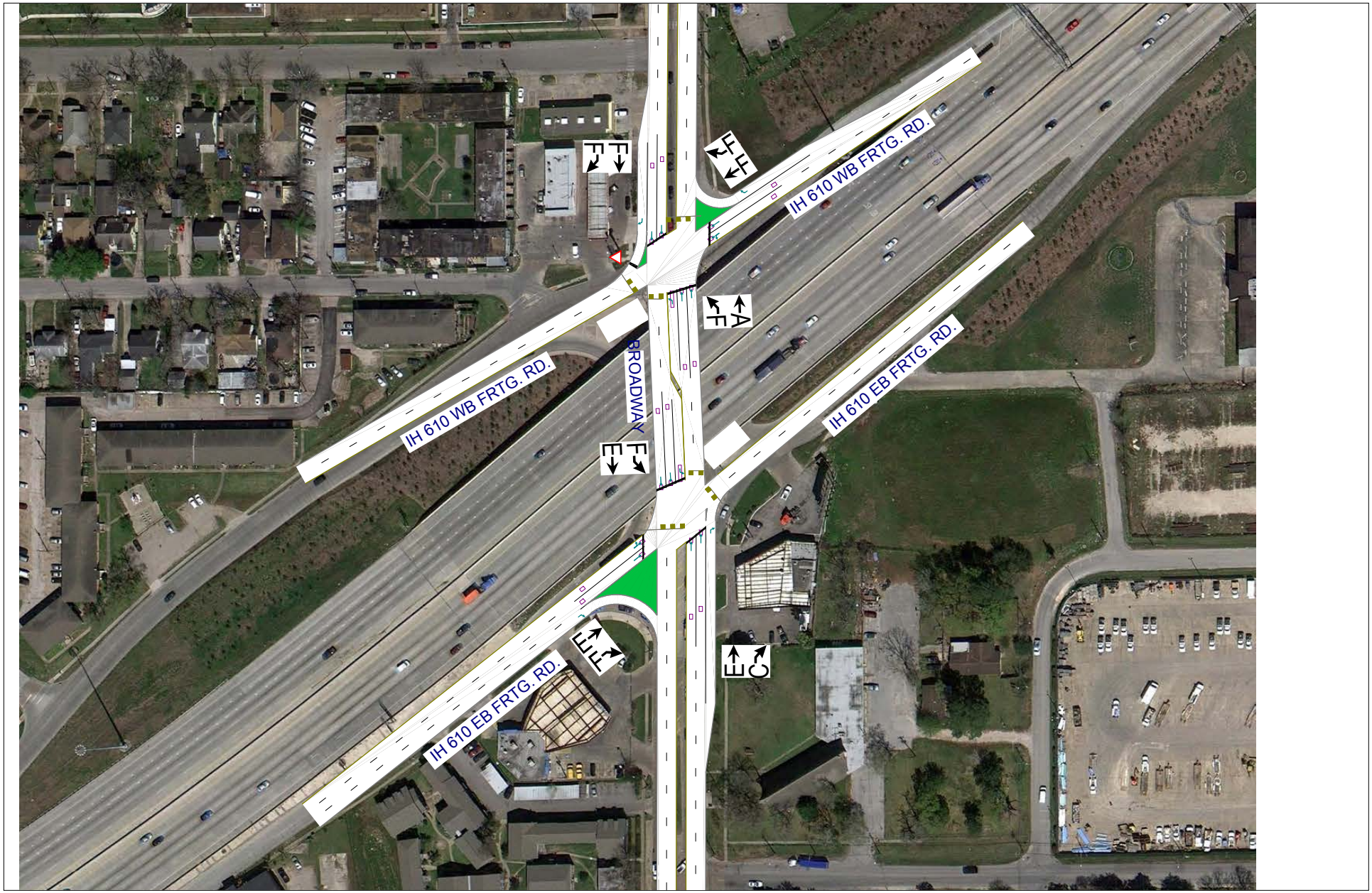
BROADWAY@GALVESTON

Ergonomic Transportation Solutions, Inc.

ALT 1_4 LANE OPTION_YEAR 2035_PM

EXHIBIT 4.15

BROADWAY @ IH 610

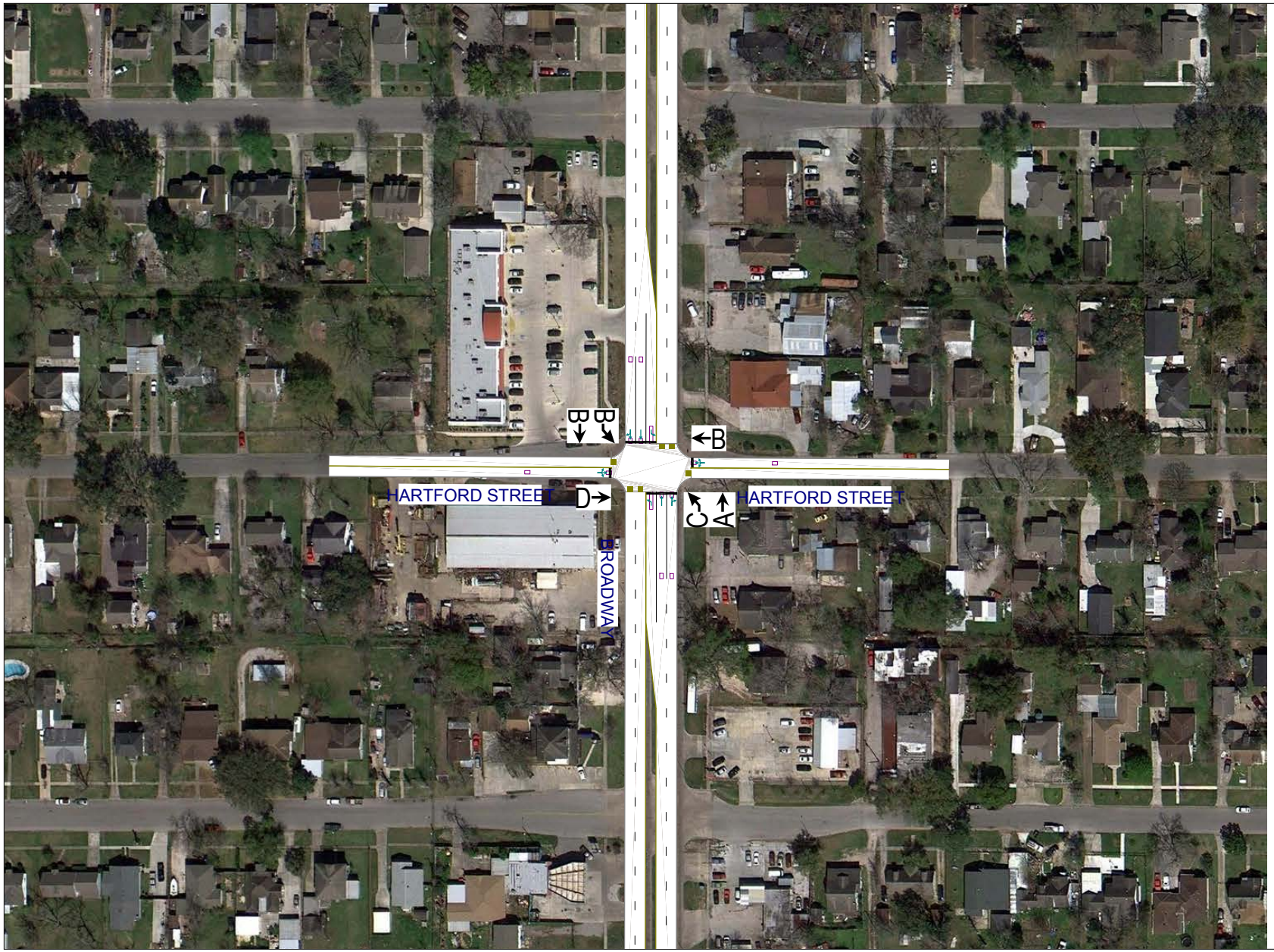


Ergonomic Transportation Solutions, Inc.

ALT 1_4 LANE OPTION_YEAR 2035_PM

EXHIBIT 4.16

BROADWAY @ HARTFORD



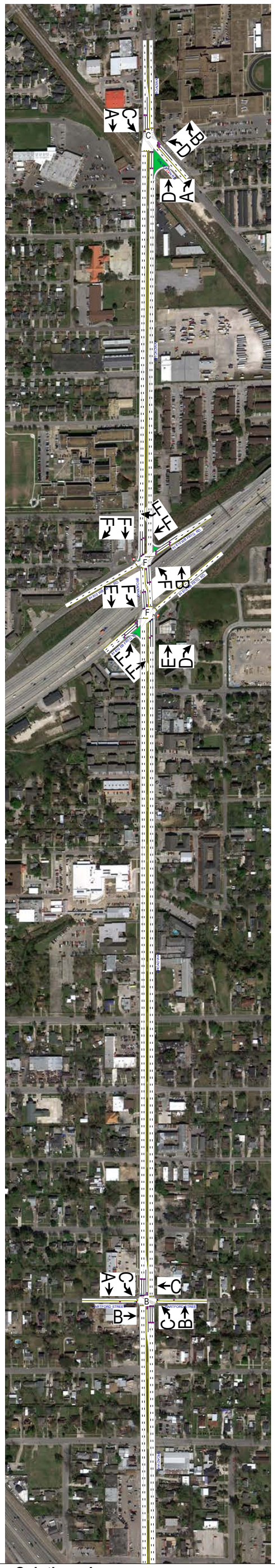
Ergonomic Transportation Solutions, Inc.

ALTERNATIVE 2

PROPOSED CONDITION_YEAR 2035_AM

EXHIBIT 4.17

BROADWAY STREET



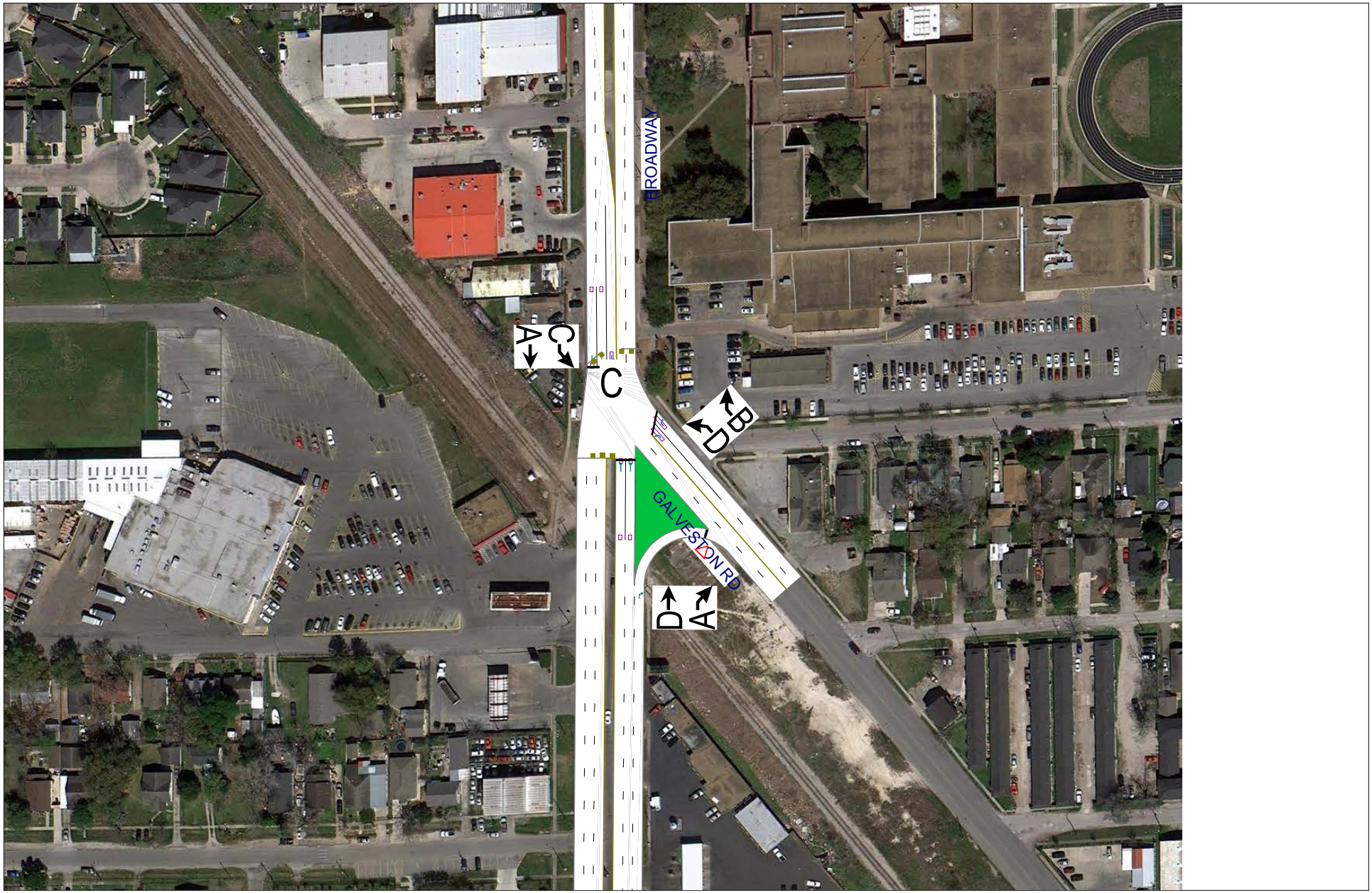
Ergonomic Transportation Solutions, Inc.

ALTERNATIVE 2

PROPOSED CONDITION_YEAR 2035_AM

EXHIBIT 4.18

BROADWAY STREET@GALVESTON ROAD



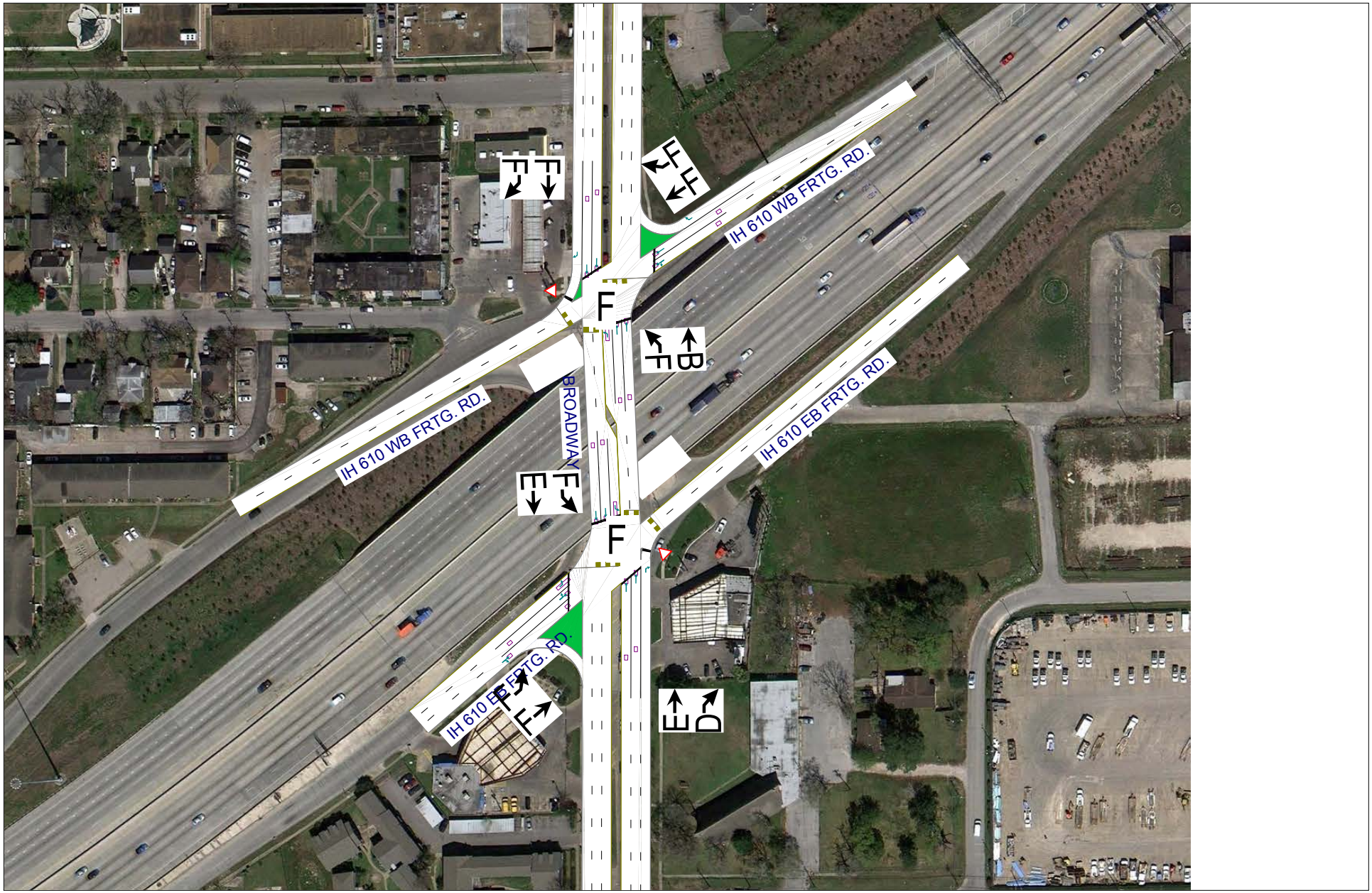
Ergonomic Transportation Solutions, Inc.

ALTERNATIVE 2

PROPOSED CONDITION_YEAR 2035_AM

EXHIBIT 4.19

BROADWAY STREET@IH 610



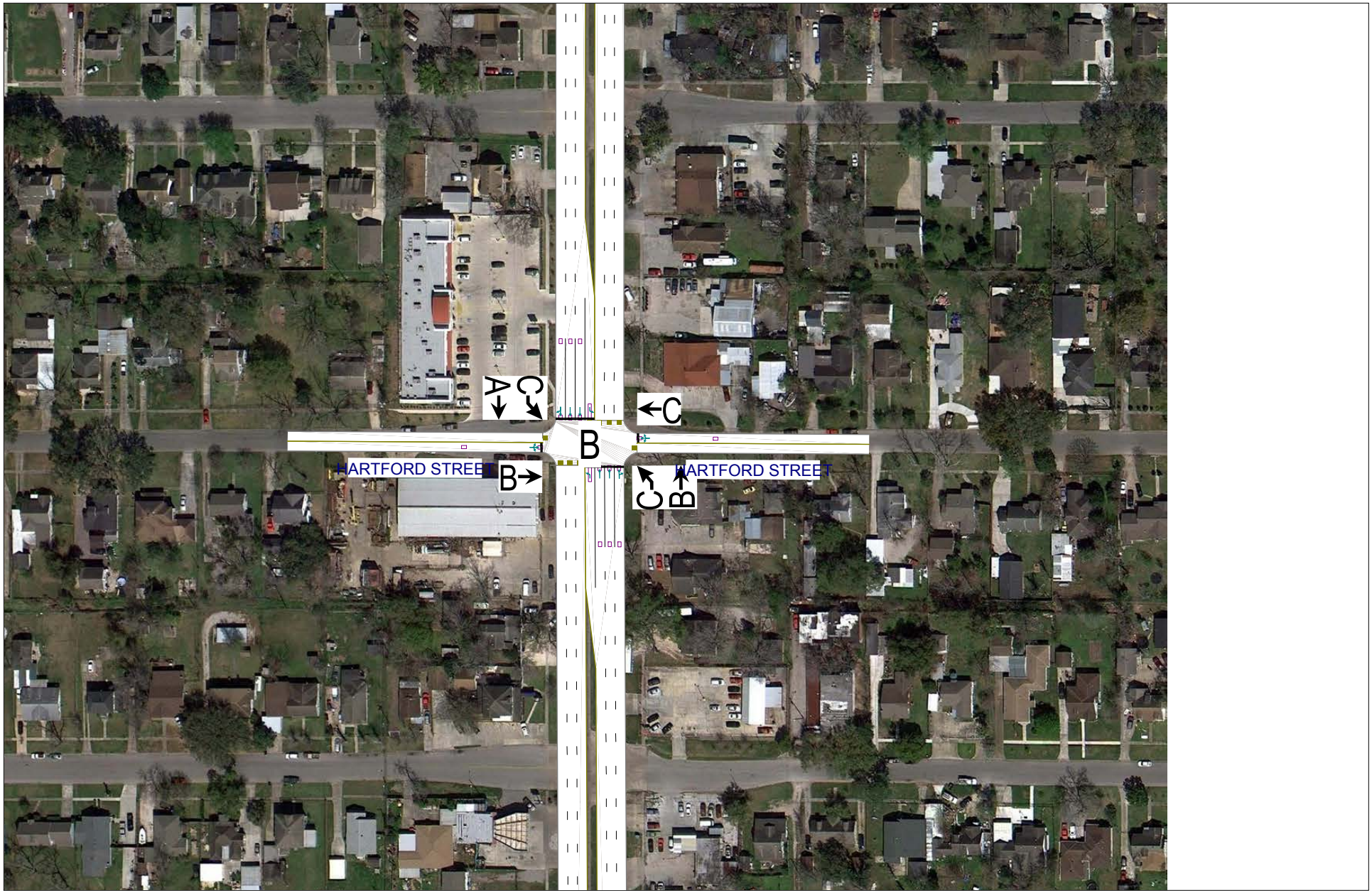
Ergonomic Transportation Solutions, Inc.

ALTERNATIVE 2

PROPOSED CONDITION_YEAR 2035_AM

EXHIBIT 4.20

BROADWAY STREET@HARTFORD STREET



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ALTERNATIVE 2

PROPOSED CONDITION_YEAR 2035_PM

EXHIBIT 4.21

BROADWAY

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ALTERNATIVE 2

PROPOSED CONDITION_YEAR 2035_PM

EXHIBIT 4.22

BROADWAY@GALVESTON

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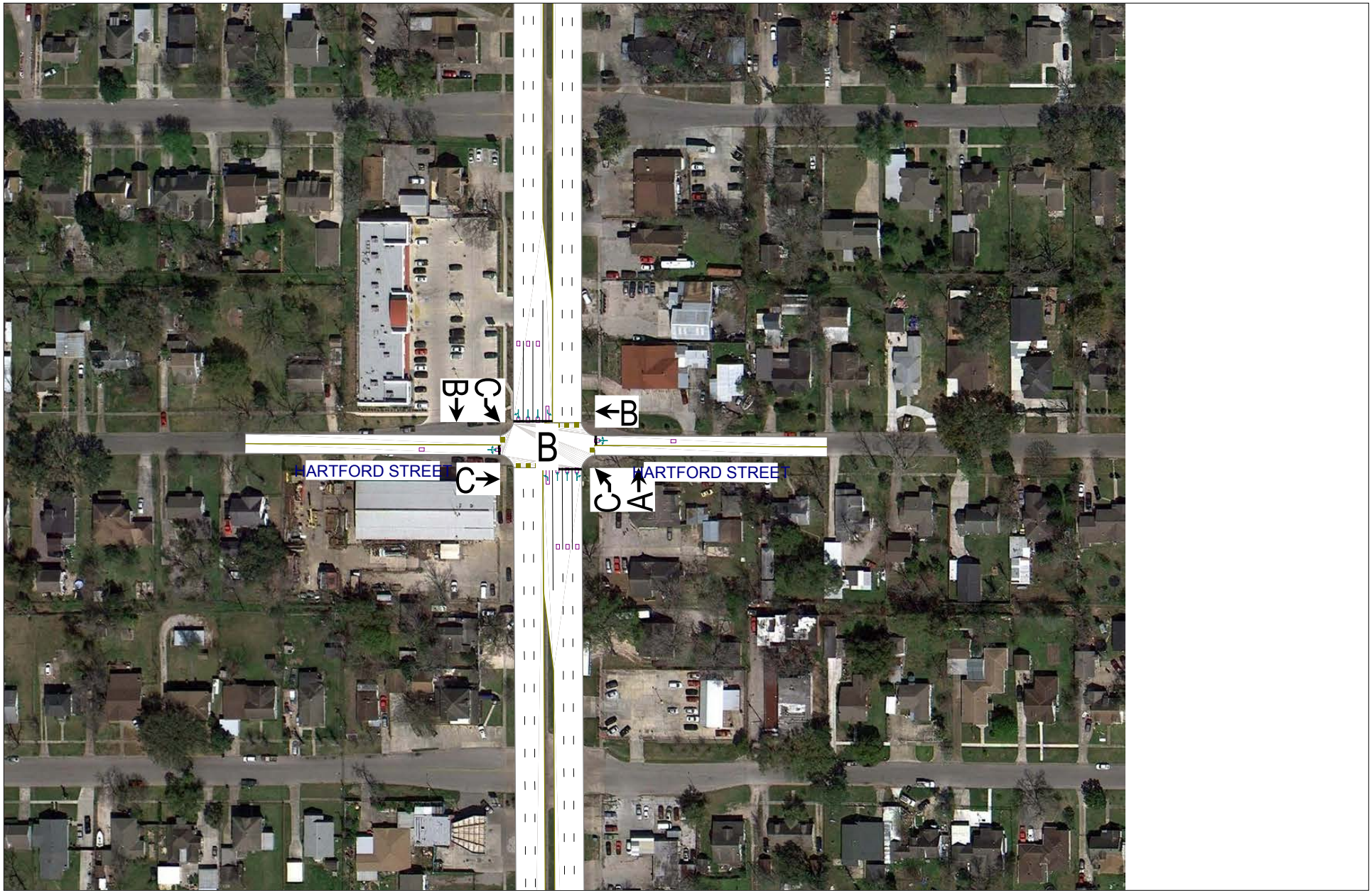
ALTERNATIVE 2

PROPOSED CONDITION_YEAR 2035_PM

EXHIBIT 4.23

BROADWAY@HARTFORD



Ergonomic Transportation Solutions, Inc.

ALTERNATIVE 2

PROPOSED CONDITION_YEAR 2035_PM

EXHIBIT 4.24

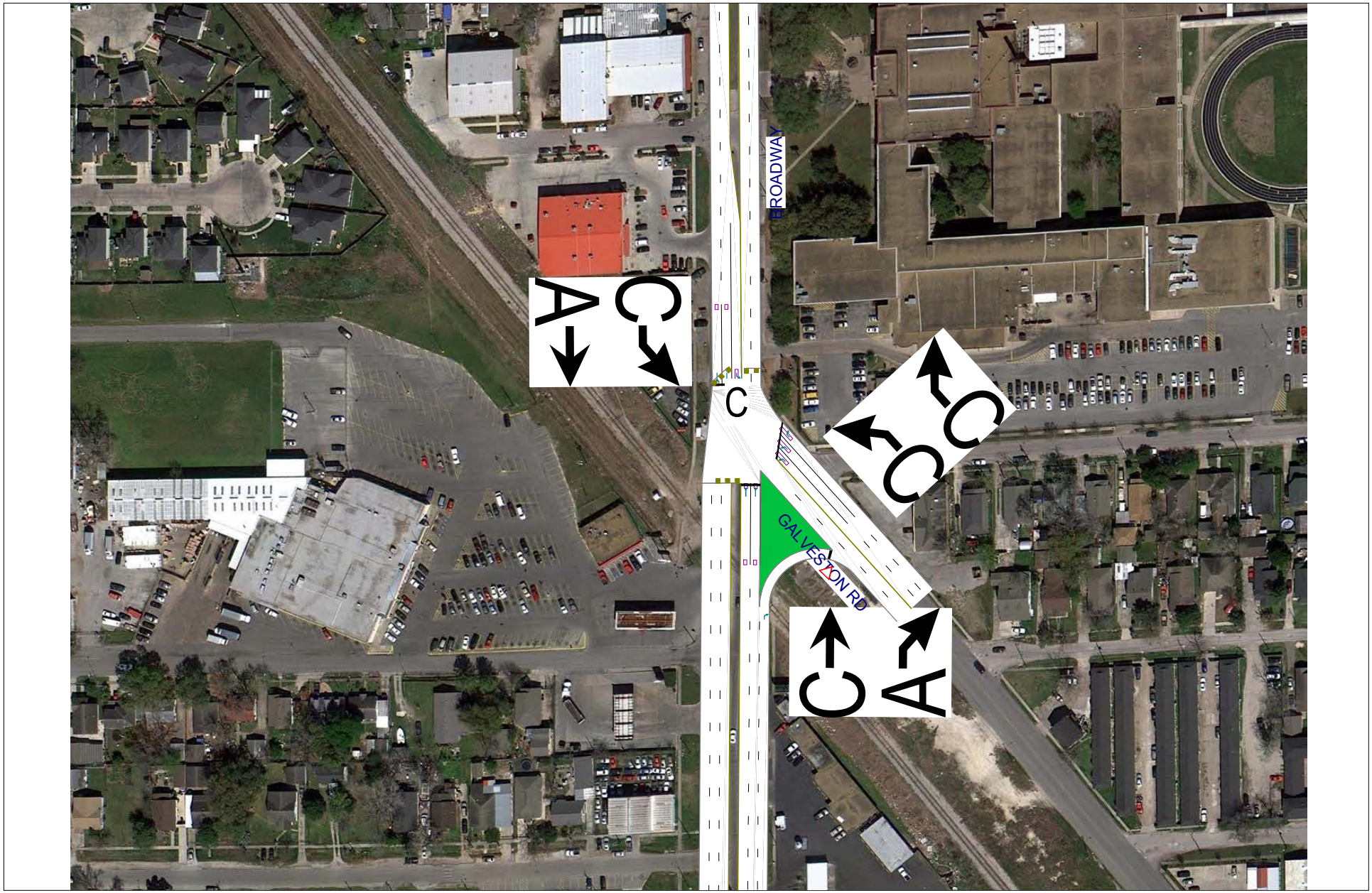
BROADWAY@IH 610

Ergonomic Transportation Solutions, Inc.

DUAL LEFT TURN FOR WESTBOUND MOVEMENT_YEAR 2035_AM

EXHIBIT 4.25

BROADWAY@GALVESTON

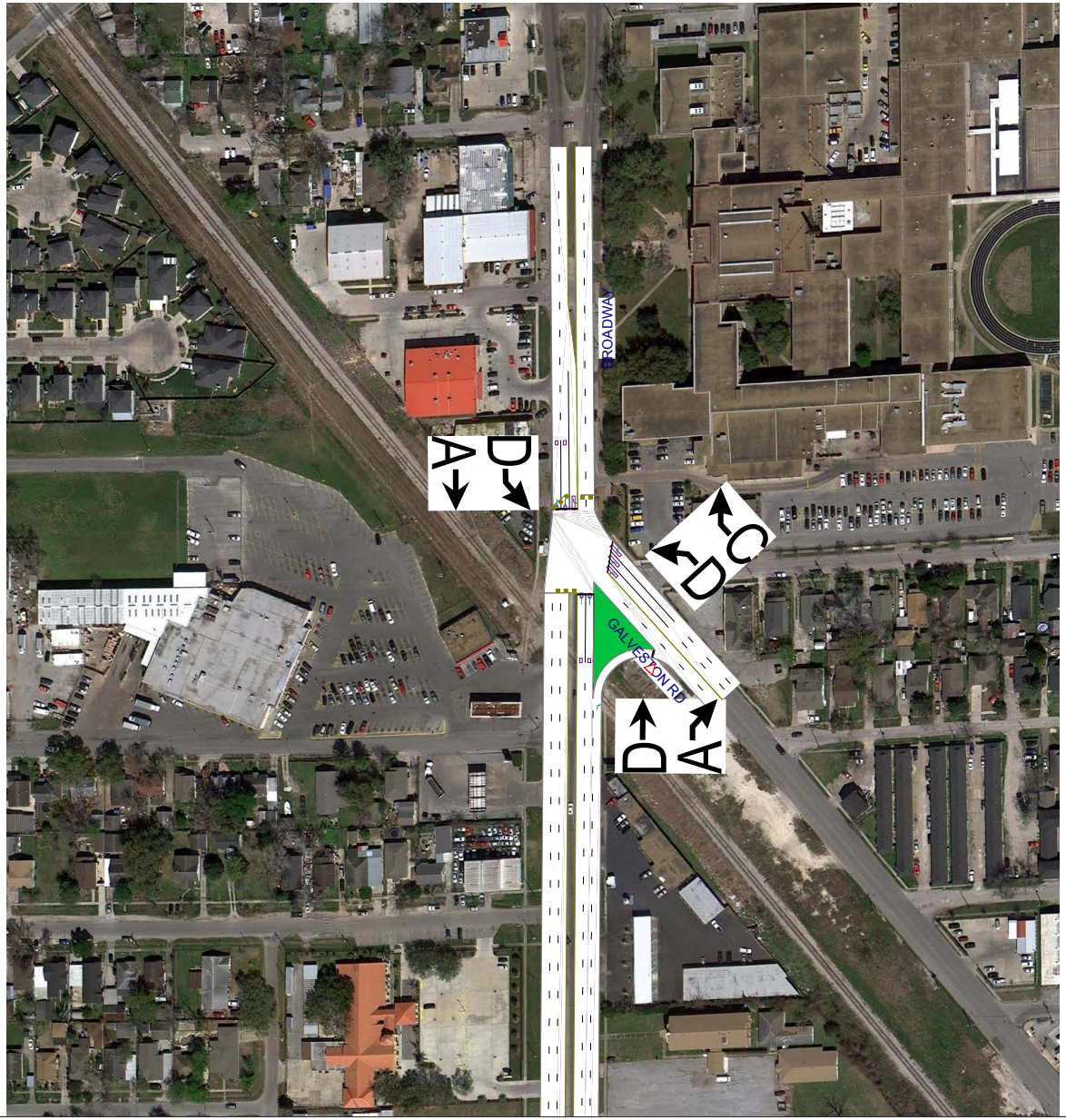


Ergonomic Transportation Solutions, Inc.

DUAL LEFT TURN FOR WESTBOUND MOVEMENT_YEAR 2035_PM

EXHIBIT 4.26

BROADWAY@GALVESTON



Ergonomic Transportation Solutions, Inc.

EXTEND THREE THROUGH LANES IN NORTHBOUND APPROACH_YEAR 2035_AM

EXHIBIT 4.27

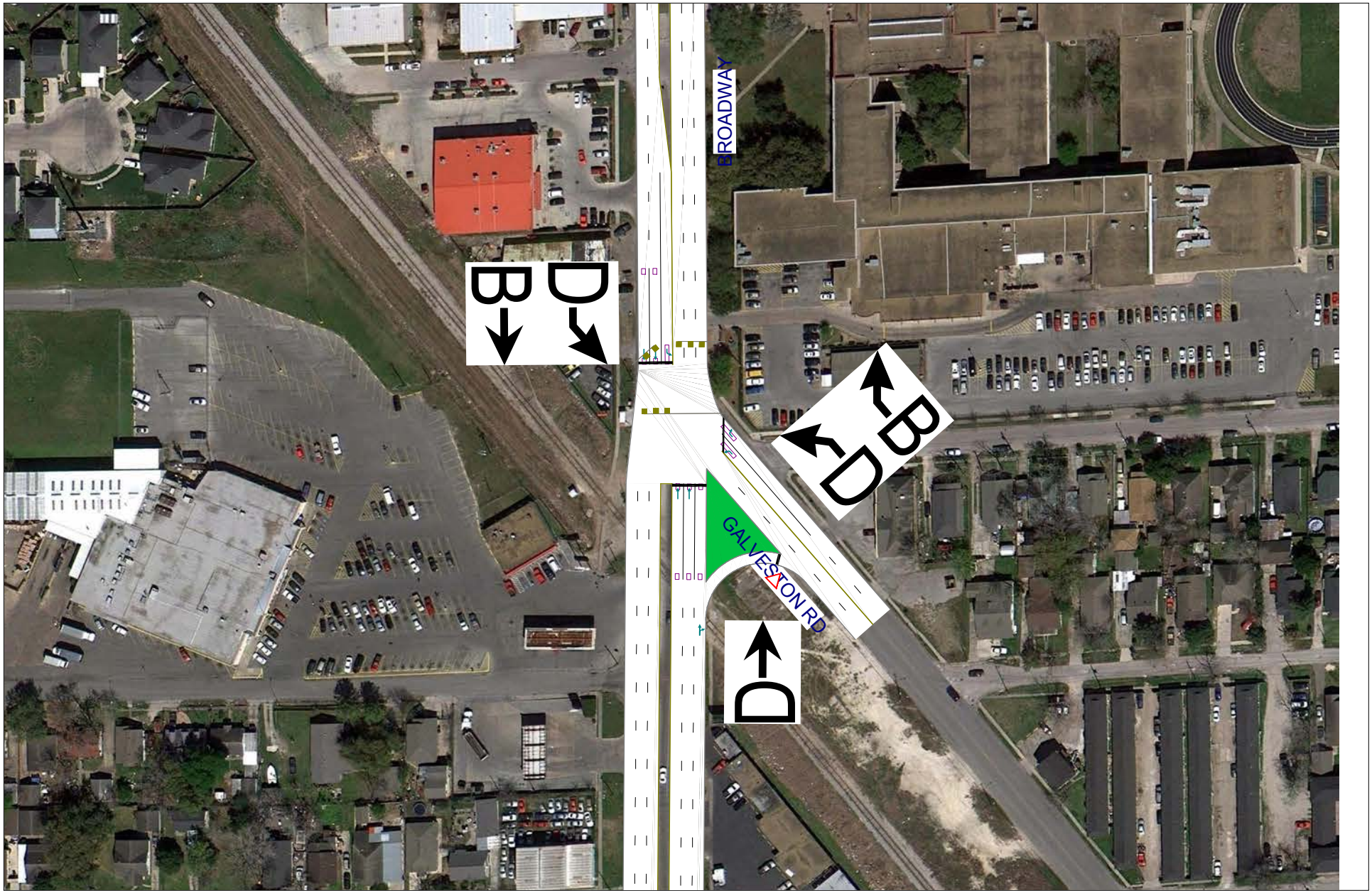
BROADWAY STREET@GALVESTON

Ergonomic Transportation Solutions, Inc.

EXTEND THREE THROUGH LANES IN NORTHBOUND APPROACH_YEAR 2035_PM

EXHIBIT 4.28

BROADWAY@GALVESTON



Ergonomic Transportation Solutions, Inc.

EXHIBIT 4.29

EXTEND THREE THROUGH LANES AND ADD ONE MORE LEFT TURN BAY IN SOUTHBOUND DIRECTION_YEAR 2035_AM **BROADWAY@GALVESTON**

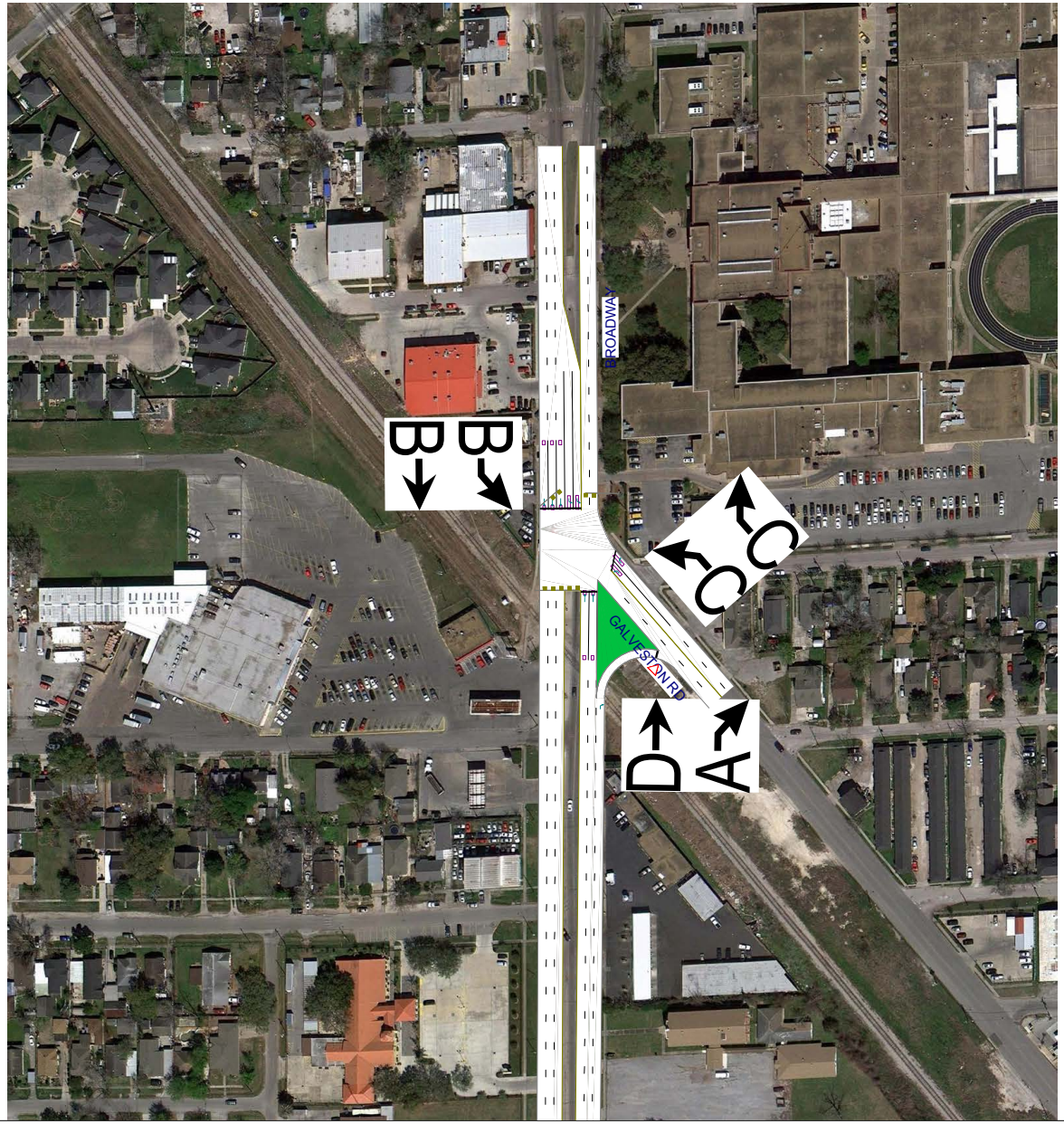


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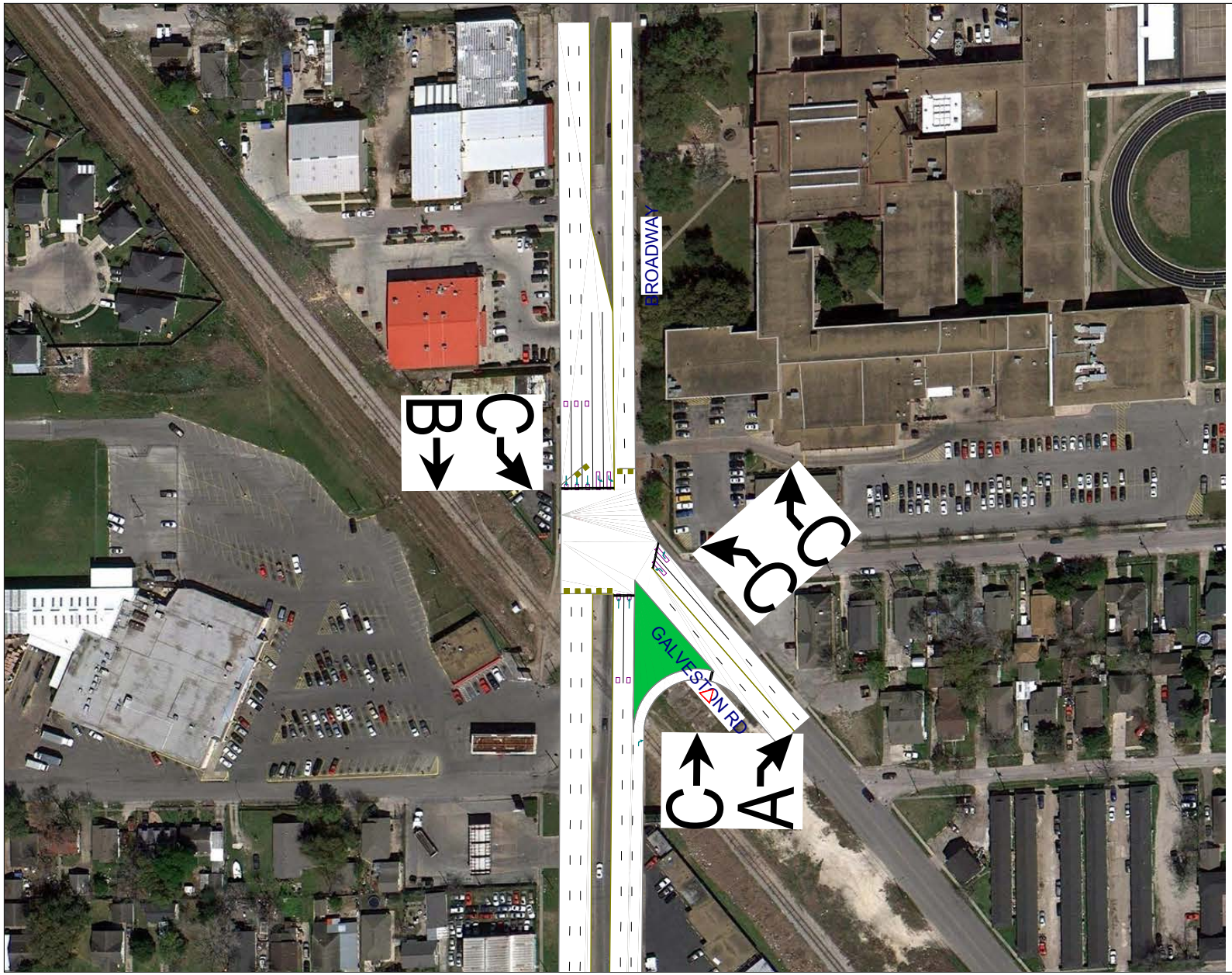
EXHIBIT 4.30

EXTEND THREE THROUGH LANES AND ADD ONE MORE LEFT TURN BAY IN SOUTHBOUND DIRECTION_YEAR 2035_PM **BROADWAY@GALVESTON**



Ergonomic Transportation Solutions, Inc.

FY 2013 Candidate Projects ($ Thousands)
Street & Traffic Control Program - Thoroughfares

Candidate Project Summary Information			
Need Area:	*NT04*	**Alternative No.:**	**2 4 Lanes (Reconstruction)**
Name:	*Broadway Street*	**Council District:**	**I**
Limits:	*IH45 to Galveston Road*	**Key Map No.:**	**535P, 535K, 535F**
Type:	Major Throughfare	**Super Neighborhood:**	**Pecan Park**
WBS No.:		**Total No. of Sub-projects:**	**0**
Description:	*Project provides for design and construction of a 4-Lane Divided concrete with curbs, sidewalks, driveways, street lighting, traffic control and necessary underground utilities. Project includes at grade crossing over UPRR tracks south of Old Galveston Road .*		
Justification:	*Project will replace a street that has been deteriorated beyond economical repair and normal maintenance. It will improve traffic circulation, mobility and drainage in service area.*		

Implementation - Estimated Cost and Duration

	City Funds	Other Entities Funds	Total	Duration
Total Project Cost	$ 11,108	$ -	$ -	
Acquisition	$ 5	$ -	$ -	18 Months
Design	$ 1,038	$ -	$ -	9 Months
Construction	$ 7,983	$ -	$ -	12 Months
Contingency	$ 2,082	$ -	$ -	NA
Private Utility Reloc.	$ -	$ -	$ -	Months
Warranty	$ -	$ -	$ -	12 Months

Candidate Project Priority Scores

Infrastructure Categories	Benefit Scores (Total Maximum 100)	
	Maximum	**Actual**
Streets	**75**	21
Drainage System	**15**	10
Water	**5**	4
Wastewater	**5**	1
Total	**100**	**36**
	Service Area Benefit score:	36
	Benefitted Population:	24536
	Rebuild Houston Funds:	$ 10,793
	Candidate Project Priority Score:	**82.60**
	Candidate Project Priority Rank No.:	(To be assigned by the City)

Other Entities & Jurisdictions Coordination

Entities		Coordination For
TxDOT	X	IH45 & IH610 pav. tie-in
Metro	☐	
HCFCD	☐	
Gulf Cost Railroad District	☐	
Union Pacific Rail Road	X	At-grade X-ing Near Galv.
Harris County	☐	
Fort Bend County	☐	
Private Utilities	☐	
(Name of Private Utility)		
(Name of Private Utility)		
Municipalities	☐	
(Name of municipality)		
(Name of municipality)		
Other	☐	
Other	☐	

Sequencing Requirements (SR) and Other Considerations

SR:	
Permits:	
Other:	

Maintenance - Estimated Cost and Frequency (By the City)

Asset Categories	Estimated Asset Life	Maintenance Items	Cost	Schedule/Frequency
Streets	40-years	Street Sweeping	$ -	4 Times Annually
		Overlay	$ -	N/A
		Pot Hole Patch	$ -	As needed - typically starts year 25
		Panel Repair	$ -	As needed
Storm Drainage	50-years	Point Repair	$ -	
			$ -	
Water	50-years	Point Repair	$ -	
			$ -	
Wastewater	50-years	Point Repair	$ -	
			$ -	

Need Area	NT04 - Broadway Street
Alternative	2
Firm	PGAL
Date	12/21/2012

Infrastructure Category	Weight	SubCategory	Point Range	Formula	Points Sub-Category	Total
Streets	75%	Pavement Condition (60%)	0-60	0.60 x (100-65)	21	**21.0**
		Traffic Level of Service (15%)	0-15	Intersections Score	0.00	
Drainage	15%		0-15			**10**

Drainage ID	Drainage Area (acres)	Pre-Project Extreme Event	Pre-Project Design Event	Candidate-Project Extreme Event	Candidate-Project Design Event
C0008	48.5	I	I	A (5)	A (10)
C0155	51.7	A	A	A (0)	A (0)
C0156	14.6	I	I	A (5)	A (10)
C0160/C0161	60.1	A	I	A (0)	A (10)
			AVERAGE	***2.5***	***7.5***

Water	5%	WIRP Rank	0-5			**4.23**
				Keymap 535P	4.77	
				Keymap 535K	4.31	
				Keymap 535F	3.61	
				AVERAGE	4.23	
Wastewater	5%	Sanitary Sewer Overflows or Agreed Order	0-5		1	**1.11**
		Mainline Rating			0	
		Age of Pipe			0.11	
					TOTAL	**36.3**

Drainage Key

I	*Inadequate*
A	*Adequate*
PA	*Partially Adequate*

Benefitted Population = ADT + Metro Ridership

Candidate Project Priority Score = Service Benefit Factor x (Benefitted Population / City ReBuild Houston Funds)

Service Area Benefit Factor =		36
Benefitted Population =		24536
City ReBuild Houston Funds=	$	10,793
Candidate Project Priority Score=		**83**

Pre-Engineering Services Contracts

Project Cost Estimate Breakdown (FY13 Dollars)

NT04 - Alternate 2

1	**410 (Summarized based on FY 13 List of Unit Prices)**		$6,941,556.00
	1.1	Total Unit Price, General Items (10% of 410)	$849,846.00
	1.2	Total Unit Price, Paving Items	$4,974,687.00
	1.3	Total Unit Price, Storm Sewer Items	$920,343.00
	1.4	Total Unit Price, Water Items	$55,200.00
	1.5	Total Unit Price, Wastewater Items	$141,480.00
	1.6	Wastewater Substitute Services [1]	$0.00
2	**Contingency (30% of 410)**		$2,082,466.80
3	**Construction Management (15% of 410)**		$1,041,233.40
4	**Engineering Fee Estimate (10% of Sum of 410 and Contingency)**		$902,402.28
5	**Design Management (15% of Engineering Fee Estimate)**		$135,360.34
6	**Land Acquisition (Engineer's Best Estimate)**		$4,935.00
	Total Project Cost		**$11,107,953.82**

Note 1: Wastewater Items separated for CIP Programming purpose.

Pre-Engineering Services Contracts

COH Rebuild Funds to Calculate Candidate Project Priority Score

NT04 - Alternate 2

1	**410 (Summarized based on FY 13 List of Unit Prices)**		$6,744,876.00
	1.1	Total Unit Price, General Items (10% of 410)	$849,846.00
	1.2	Total Unit Price, Paving Items	$4,974,687.00
	1.3	Total Unit Price, Storm Sewer Items	$920,343.00
2	**Contingency (30% of 410)**		$2,023,462.80
3	**Construction Management (15% of 410)**		$1,011,731.40
4	**Engineering Fee Estimate (10% of Sum of 410 and Contingency)**		$876,833.88
5	**Design Management (15% of Engineering Fee Estimate)**		$131,525.08
6	**Land Acquisition (Engineer's Best Estimate)**		$4,935.00
	Total Project Cost		**$10,793,364.16**