



## Slope Paving Report

Bay Area Boulevard at Alderwood

## Slope Paving Failure at Sound Wall



June 26, 2014

Prepared by  
HR Green, Inc.  
TBPE Firm No. 11278

## INTRODUCTION AND EXISTING CONDITIONS

The Bay Area Boulevard sound wall at Alderwood Street was designed in 1995 and constructed in 1996 by TxDOT. The intent of the sound wall was to minimize the noise level to residential areas along Bay Area Boulevard. The 10' high wall is mounted on columns that are 20' apart and are supported on 30" drilled shafts that are 20' deep. The natural ground at the Right of Way (ROW) along the west side of Bay Area Blvd is approximately 2'-3' higher than the top of the existing roadway curb. Under this condition it was required to install concrete slope paving for the entire length (approximately 711') of the sound wall between the sidewalk and the sound wall. There are 351' of sound wall to the south of Alderwood and 360' to the north.

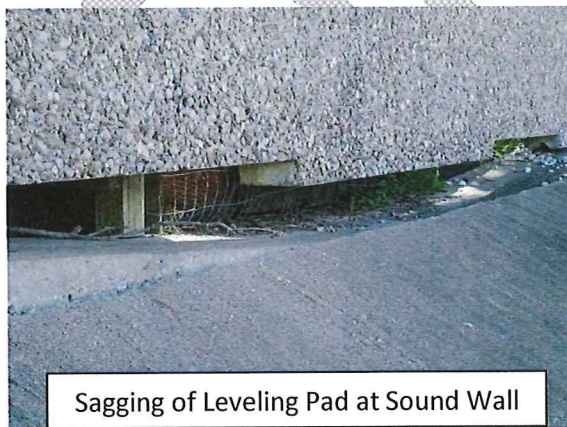


Slope Paving Between the Sidewalk and the Sound Wall

The sound wall was designed with 5' long X 4" deep drainage openings to facilitate sheet flow from the backyards of houses east of the sound wall onto Bay Area Blvd where the water is collected by roadway inlets. In recent years the slope paving has developed severe cracking and failure along the entire length of sound wall. Visual observation indicates that the sheet flow



Sagging of Leveling Pad at Sound Wall



Sagging of Leveling Pad at Sound Wall

from the backyards is not draining as originally intended. It appears that ponding behind the wall has created settlement of the natural ground and sheet flow is no longer able to drain through the drainage slots as intended. This created a situation where the leveling pad and slope paving settled and cracked and residents have resorted to make-shift measures to close up the enlarged openings. These measures include wire fabric, plywood panels, and concrete blocks which exacerbates the problem by trapping trash and debris behind the wall and a creates a dam effect at the openings.





Slope paving pulling away from drilled shaft and sagging of sound wall leveling pad.

The primary factor for the existing natural ground settlement and the standing water at the base of the sound wall appears to be caused by improper drainage. In addition, the slope paving does not have an underdrain system to facilitate the drainage of water trapped behind the slope paving. Review of the TxDOT plans for the sound wall indicates that the elevation of the leveling pad was originally intended to be at the elevation of the roadway top of curb. Field conditions in this segment of Bay Area Boulevard made it necessary to install the leveling pad at a higher

elevation thus requiring the slope paving between the sound wall and the sidewalk. The slope paving was installed but it appears that the necessary backfill embankment (reinforced volume or cement stabilized sand), and weep holes and underdrain was not installed behind the slope paving.

The City of League City desires to repair the slope paving failure and restore the area to original condition. Two phases to address for the restoration are 1) provide a method for draining the runoff behind the wall and 2) repair of the slope paving.

### **Phase 1: Provide a Method for Draining Runoff Behind the Sound Wall:**

The primary factor to address is the problem with improper drainage. We consider this to be of primary importance because repairs made to the slope paving would likely reoccur if the drainage problem is not addressed. Options that would allow the drainage sheet flow from the backyards to be captured and collected from the back yards are explored below.

#### **OPTION 1 – Install Trench Drain Behind Sound Wall with Curb Openings**

Install trench drain behind the entire length of the sound wall and connect the trench drain with 4" PVC out to the roadway curb at the midpoint of each Sound Wall panel. The area behind the sound wall will be graded to the original elevations and will drain towards the trench drain. See Exhibit A-1 for a detail of this option. The curb and sidewalk on Bay Area Boulevard will be saw cut and removed for the placement of the pipe and then a new curb and sidewalk will be placed around the pipe. The engineer's estimate for this work is in the amount of \$135,000 which does not include removal and replacement of the slope paving, since this work will be done under Phase 2 work. Please see Appendix A for a detailed description of the costs associated with this option.

***Advantages:***

1. Provides capturing of backyard drainage sheet flow at the base of the sound wall.
2. No standing water to undermine the fill behind the slope paving.
3. Reduce settlement of sound wall leveling pad and slope paving.

***Disadvantages:***

1. Multiple curb cuts and areas of sidewalk/slope paving replacement. Directly above the pipe, the sidewalk and curb will not be full depth and they will likely crack with age.
2. Small diameter pipes have an increased potential to clog.

**OPTION 2 - Install Trench Drain behind Sound Wall with 4" pipes through slope paving.**

In addition to installing the trench drain behind the sound wall to collect the backyard drainage, install 4" PVC outlet pipe through the existing slope paving. See Exhibit A-2 for a detail of this option. In Option 2, the water will pass through the outlet pipe and drain onto the existing sidewalk and then to the street gutter. The engineer's estimate for this work is in the amount of \$106,000 which does not include removal and replacement of the slope paving, since this work will be done under Phase 2 work. This option is less than Option 1 because it does not involve removing and replacing the curb and sidewalk for the placement of the outlet pipe. Please see Appendix A for a detailed description of the costs associated with this option.

***Advantages:***

1. Provides capturing of backyard drainage sheet flow at the base of the sound wall.
2. Eliminates the need to remove and replace the existing curb and sidewalk that is required in option 1.
3. This method can be easily installed when the slope paving is repaired.

***Disadvantages:***

1. Potential for runoff to create hazard areas where water passes over the sidewalk.
2. Small diameter pipes have an increased potential to clog.

**OPTION 3- Install Trench Drain behind Sound Wall and install with 12" pipe connecting to back of existing inlets on Bay Area Blvd.**

In addition to installing the trench drain behind the sound wall to collect the backyard drainage, install a 12 inch pipe connecting the trench drain to the back of the nearest existing inlet on Bay Area Boulevard. Two inlets exist on each side of the Alderwood intersection and can be used as connection points. See Exhibit A-3 for a detail of this option. The engineer's opinion of construction cost this work is in the amount of \$104,000 which does not include removal and



replacement of the slope paving, since this work will be done under Phase 2 work. This option is less than Option 1 because it does not involve removing and replacing the curb and sidewalk for the placement of the outlet pipe. Please see Appendix A for a detailed description of the costs associated with this option.

***Advantages:***

1. Provides capturing of backyard drainage sheet flow at the base of the sound wall.
2. Larger pipe diameters reduce the potential for clogging.
3. No damage to the existing curb and sidewalk (except behind the existing inlets) on Bay Area Boulevard.

***Disadvantages:***

1. None when compared to options 1 and 2.

Of the three options described above, option 3 will provide the best overall solution for providing drainage to the area behind the wall.

## **Phase 2: Repair of Slope Paving and Leveling Pad**

The second factor to address is the slope paving failure and leveling pad settlement. The slope paving has pulled away from the drilled shaft at every column due to settlement. Options that would allow the repair of the areas of concrete failure are explored below.

### **OPTION 1 – Repair Area around the Drilled Shafts and other Select Areas**

Saw cut and remove the slope paving a minimum of two feet around each of the drilled shafts with a full depth saw cut, install flowable fill or properly compacted select fill, where voids are found, and install a board expansion joint to separate the new and old slope paving. Where the damaged area extends beyond two feet, the saw cut should extend to the limit of the damaged area. Remove the concrete immediately around the column and install new concrete, or similar surface material. The expansion joint will allow the concrete around the column to move separately from the other slope paving and should minimize future cracking. In addition to the areas around the columns, saw-cut and replace the slope paving where failure has occurred in other select areas. The sound wall leveling pad may be able to be raised by



Slope paving around column cracked due to settlement. No expansion joint to separate drilled shaft foundation from

jacking methods to the correct elevation, however a geotechnical investigation should be done to confirm this method before it is implemented. See Exhibit B-1 for a detail of this option. The engineer's opinion of construction cost for this work is in the amount of \$96,000. See Appendix A for a more detailed cost estimate for this option.

***Advantages:***

1. Restores leveling pad and slope paving to their planned location.
2. Reduce cracked/failed concrete at columns and other failure locations.
3. This is the most cost effective method of repairing the slope paving.

***Disadvantages:***

1. This method would require multiple repair joints on the slope paving surface.
2. Areas not replaced may still have voids under the slope paving and failures in these areas may continue.

## **OPTION 2 – Remove Slope Paving and Install Low Retaining Wall**

Remove the entire slope paving, levelling pad and sidewalk in this area and install a 2' to 3' high retaining wall between the sidewalk and sound wall. The retaining wall will serve to structurally uphold the embankment and will be installed at the required elevation while providing a more aesthetically pleasing visual than currently exists. The retaining wall option will also consist of replacing the existing sidewalk (see Exhibit B-2). Although the more costly alternative, the retaining wall and sidewalk will replace the deficient slope paving and will replace the sidewalk that is settling in select areas, especially at the location of the existing roadway inlets. The engineer's opinion of construction cost for this work is in the amount of \$205,000. See Appendix A for a more detailed cost estimate for this option.

***Advantages:***

1. Eliminates entire slope paving and provides a new vertical wall and sidewalk.
2. Reduce concrete failure at other select locations.

***Disadvantages:***

1. Higher construction cost.

## **OPTION 3 – Remove and Replace all Slope Paving**

Remove the entire slope paving in this area and replace it with new slope paving within the limits of the entire sound wall. In addition to replacing the entire slope paving, select areas of sidewalk that has settled will also have to be replaced. Replacing the slope paving will also allow the removal of inadequate soil behind the slope paving and the additions of select fill that is properly compacted. The new slope paving will be installed with expansion joints at



appropriate locations in order to reduce future concrete failure. The engineer's opinion of construction cost for this work is in the amount of \$122,500. See Appendix A for a more detailed cost estimate for this option.

***Advantages:***

1. Eliminates entire slope paving and provides a new slope paving.
2. Replacement of the entire slope paving will provide an aesthetically pleasing appearance and will allow for removal of voids behind the existing slope paving.

***Disadvantages:***

1. Higher construction cost.

## **Implementation of Preferred Option**

Residents have blocked the drainage slots using methods previously described. These blockages should be removed and in addition, we suggest the City consider sending post-construction letters to the residents explaining what has been done and explaining why the slots should not be blocked. However, even if slots are blocked, the installation of the trench drain system should provide a secondary flow path for the drainage.

Regardless of the slope paving option selected, correcting the drainage problem will be the highest priority. Without proper drainage, the settlement and paving failures will likely continue to occur.

## **RECOMMENDATIONS**

Based on examination of the options for slope paving repair and the relative costs, the following recommendations are made for repair:

1. Option 3 (Exhibit A-3)- Install a Trench Drain System behind entire Sound Wall and connect to back of Inlets- This option maintains the critical function of removing the backyard drainage flow and keeping the standing water from collecting at the base of the sound wall. We further recommend that the larger diameter pipe outfalls to the back of the existing inlets option since the Bay Area Boulevard curb will not be disturbed and the potential for clogging will be reduced.
2. To correct the failed slope paving, any of the three options can be done. In our opinion, Option 2 (Exhibit B-2) - Removal of the existing slope paving and installation of a short retaining wall instead of slope paving and replacement of the existing sidewalk is the preferred method, but is also the most expensive. Option 3 (Exhibit B-3) – Removal and replacement of the slope paving for the full length of the project is the second preferred

method. Both of these options will allow for the material under the slope paving to be properly compacted and any voids under the slope paving to be filled and properly compacted. Option 3 is less expensive than Option 2 because the existing sidewalk is not being replaced everywhere. It is possible that the existing sidewalk will be damaged during removal and construction of the new slope paving and may end up being replaced anyway. If this occurs, the difference in cost between Options 2 and 3 will be negligible.

The Engineer's opinion of probable construction costs for the recommended solution of installation of the trench drain and retaining wall and sidewalk replacement is in the amount of \$306,000.

The engineer's opinion of probable construction (EOPC) costs included in this report are based on a preliminary analysis of the failure areas and are intended to be used for comparison purposes only. A more complete EOPC should be generated in the final design phase once a more detailed survey and geotechnical analysis of the existing conditions are available.



## APPENDIX A – ENGINEER’S OPINION OF PROBABLE CONSTRUCTION COST

### Phase 1: Provide Drainage Behind Sound Wall

#### Drainage Option 1: Install Trench Drain Behind Sound Wall with 4-inch PVC outlet pipes through the Bay Area Boulevard Curb

Item	Description	Quantity	Unit	Unit Price	Total Cost
1	Clearing and Grubbing of area behind the sound wall; removal and replacement of residential fencing and other appurtenances required to access the immediate area behind the wall.	710	LF	\$10.00	\$7,100.00
2	Site restoration; Including sod and fence replacement.	710	LF	\$20.00	\$14,200.00
3	Trench Drain: Install trench drain behind the soundwall	710	LF	\$75.00	\$53,250.00
4	Regrade area behind the sound wall to drain towards trench drain	710	LF	\$5.00	\$3,550.00
5	Compact existing soil and add select fill as required	150	CY	\$20.00	\$3,000.00
6	Saw cut, remove and replace existing curb and sidewalk as required for installation of outlet pipe	200	SY	\$50.00	\$10,000.00
7	4" PVC outlet pipe to existing roadside curb, complete in place	350	LF	\$35.00	\$12,250.00

<b>Subtotal for Option 1:</b>	<b>\$103,350.00</b>
<b>30% Contingency:</b>	<b>\$31,650.00</b>
<b>Total for Option 1:</b>	<b>\$135,000.00</b>

#### Drainage Option 2: Install Trench Drain Behind Sound Wall with 4-inch PVC outlet pipes through the Slope Paving

Item	Description	Quantity	Unit	Unit Price	Total Cost
1	Clearing and Grubbing of area behind the sound wall; removal and replacement of residential fencing and other appurtenances required to access the immediate area behind the wall.	710	LF	\$10.00	\$7,100.00
2	Site restoration; Including sod and fence replacement.	710	LF	\$20.00	\$14,200.00
3	Trench Drain: Install trench drain behind the soundwall	710	LF	\$75.00	\$53,250.00
4	Regrade area behind the sound wall to drain towards	710	LF	\$5.00	\$3,550.00

	trench drain				
5	Compact existing soil and add select fill as required	150	CY	\$20.00	\$3,000.00
6	4" PVC outlet pipe to slope paving	200	LF	\$35.00	\$7,000.00

<b>Subtotal for Option 2:</b>	<b>\$81,000.00</b>
<b>30% Contingency:</b>	<b>\$25,000.00</b>
<b>Total for Option 2:</b>	<b>\$106,000.00</b>

### Drainage Option 3: Install Trench Drain Behind Sound Wall with 12-inch PVC outlet pipes to back of Inlets

Item	Description	Quantity	Unit	Unit Price	Total Cost
1	Clearing and Grubbing of area behind the sound wall; removal and replacement of residential fencing and other appurtenances required to access the immediate area behind the wall.	710	LF	\$10.00	\$7,100.00
2	Site restoration; Including sod and fence replacement.	710	LF	\$20.00	\$14,200.00
3	Trench Drain: Install trench drain behind the soundwall	710	LF	\$75.00	\$53,250.00
4	Regrade area behind the sound wall to drain towards trench drain	710	LF	\$5.00	\$3,550.00
5	Compact existing soil and add select fill as required	150	CY	\$20.00	\$3,000.00
6	Saw cut, Remove and Replace existing sidewalk at Inlets	20	SY	\$50.00	\$1,000.00
7	12" PVC outlet pipes	60	LF	\$50.00	\$3,000.00
8	Connect 12" outlet pipes to back of existing inlets	4	Ea	\$500.00	\$2,000.00

<b>Subtotal for Option 2:</b>	<b>\$80,000.00</b>
<b>30% Contingency:</b>	<b>\$24,000.00</b>
<b>Total for Option 2:</b>	<b>\$104,000.00</b>

## PHASE 2: Repair Slope Paving and Raise the Leveling Pad

### Slope Repair Option 1: Repair of slope paving at drilled shaft locations and a selected areas

Item	Description	Quantity	Unit	Unit Price	Total Cost
1	Sawcut, remove and dispose of concrete pavement at each sound wall column	700	SF	\$10.00	\$7,000.00
2	Sawcut,remove and dispose of concrete pavement at select locations on slope paving	1,700	SF	\$7.00	\$11,900.00
3	Compaction and fill of existing base material	200	CY	\$20.00	\$4,000.00
4	Install 4" Reinforced Concrete Slope Paving at Sound	154	SY	\$60.00	\$9,240.00



	Wall Columns and at other Select Locations, complete in place, including expansion joints				
5	Raise the leveling pad to the original elevation	700	LF	\$30.00	\$21,000.00
6	Proposed Slope Paving	270	SY	\$75.00	\$20,250.00

<b>Subtotal for Option 1:</b>	<b>\$73,390.00</b>
<b>30% Contingency:</b>	<b>\$22,610.00</b>
<b>Total for Option 1:</b>	<b>\$96,000.00</b>

**Slope Repair Option 2: Remove slope paving and sidewalk and install low retaining wall and new sidewalk**

Item	Description	Quantity	Unit	Unit Price	Total Cost
1	Remove and dispose of concrete slope paving, leveling pad and sidewalk	7,000	SF	\$8.00	56,000.00
2	Compaction and fill of existing base material	400	CY	\$20.00	\$8,000.00
3	Install new leveling pad	711	LF	\$15.00	\$10,665.00
4	Install retaining wall	2,200	SF	\$10.00	\$22,000.00
5	Install 4" Reinforced Concrete Sidewalk , complete in place, including expansion joints	3500	SF	\$7.00	\$24,500.00

<b>Subtotal for Option 2:</b>	<b>\$157,165.00</b>
<b>30% Contingency:</b>	<b>\$47,149.00</b>
<b>Total for Option 2:</b>	<b>\$205,000.00</b>

**Slope Repair Option 3 -Remove and Replace slope paving**

Item	Description	Quantity	Unit	Unit Price	Total Cost
1	Remove and dispose of concrete slope paving and leveling pad	3,600	SF	\$8.00	\$28,800.00
2	Compaction and fill of existing base material	400	CY	\$20.00	\$8,000.00
3	Install new leveling pad	711	LF	\$30.00	\$21,330.00
4	Install Concrete Slope Paving	400	SY	\$75.00	\$30,000.00
5	Install Sidewalk at Select Locations	875	SF	\$7.00	\$6,125.00

<b>Subtotal for Option 3:</b>	<b>\$94,255.00</b>
<b>30% Contingency:</b>	<b>\$28,277.00</b>
<b>Total for Option 3:</b>	<b>\$122,500.00</b>

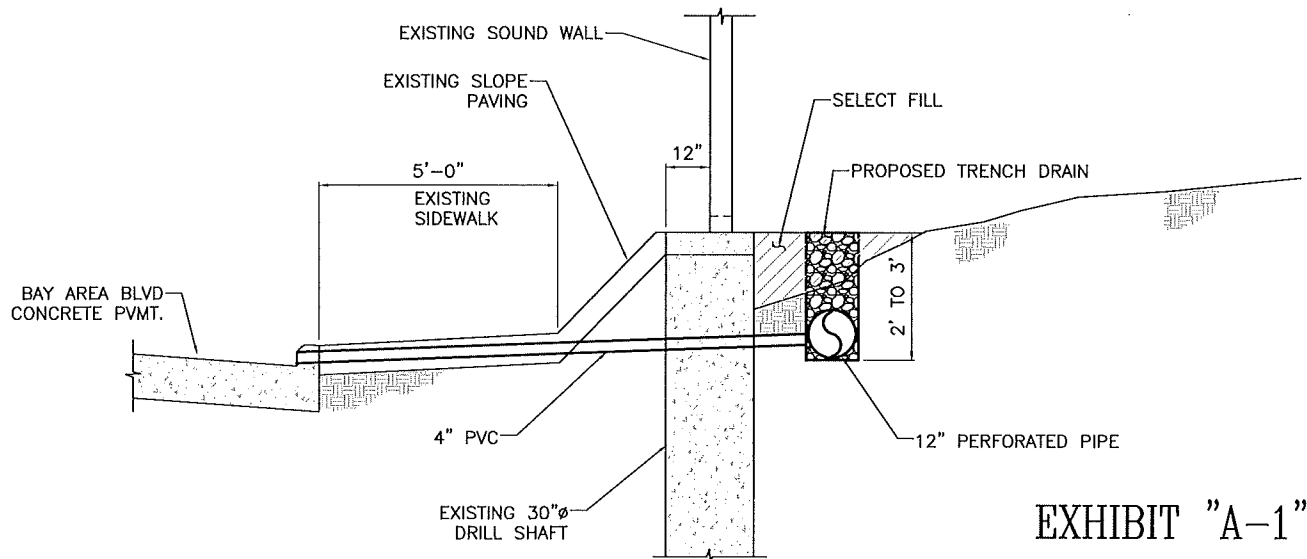


EXHIBIT "A-1"

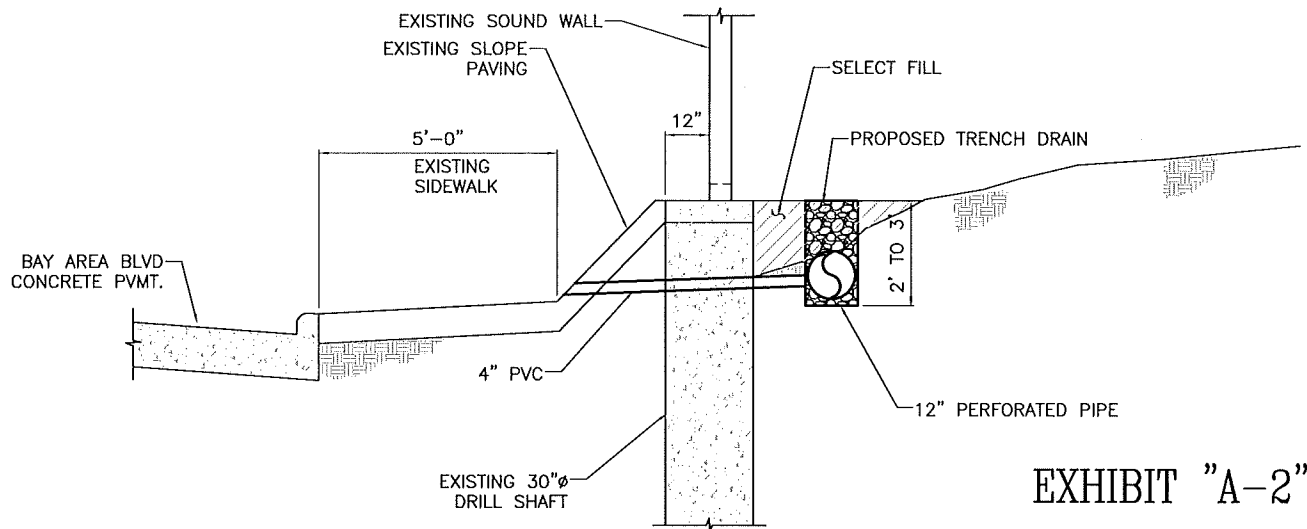


EXHIBIT "A-2"

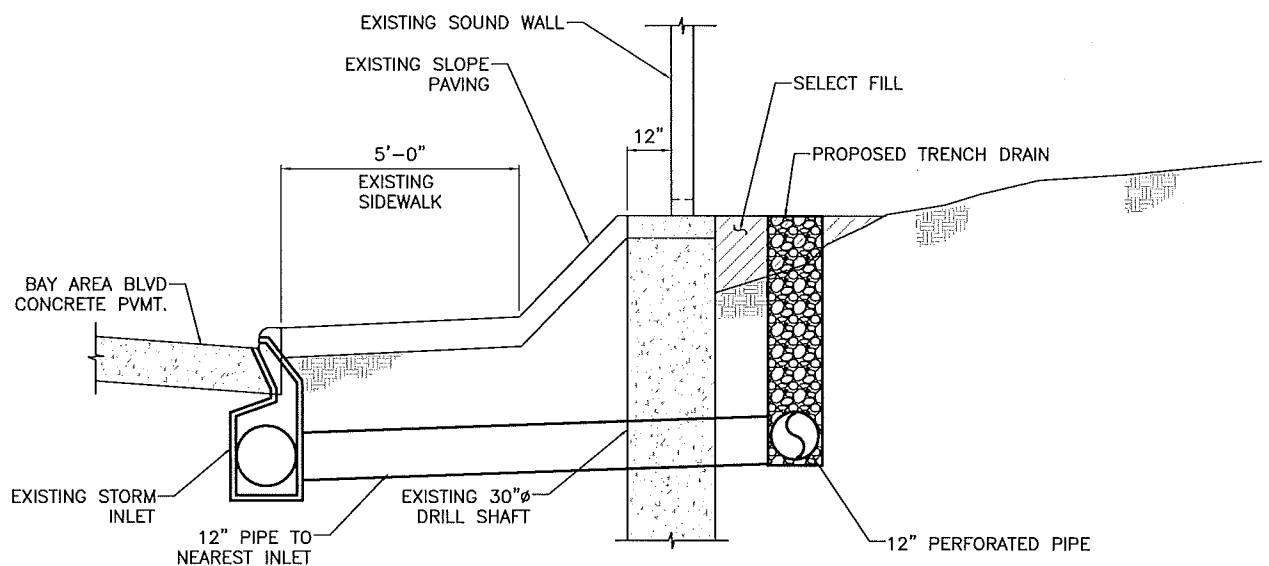


EXHIBIT "A-3"



11011 RICHMOND AVE, SUITE 375  
HOUSTON, TX 77042  
(713) 965-9996  
(713) 965-0044 FAX  
HRGreen.com  
Firm No. F-11278

FILENAME:  
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Repair\CAD\DWG\C\OPTION\_1.dwg

DATE:  
6-16-14

# EXHIBIT "A"

## PHASE 1

### TRENCH DRAIN OPTIONS 1-3



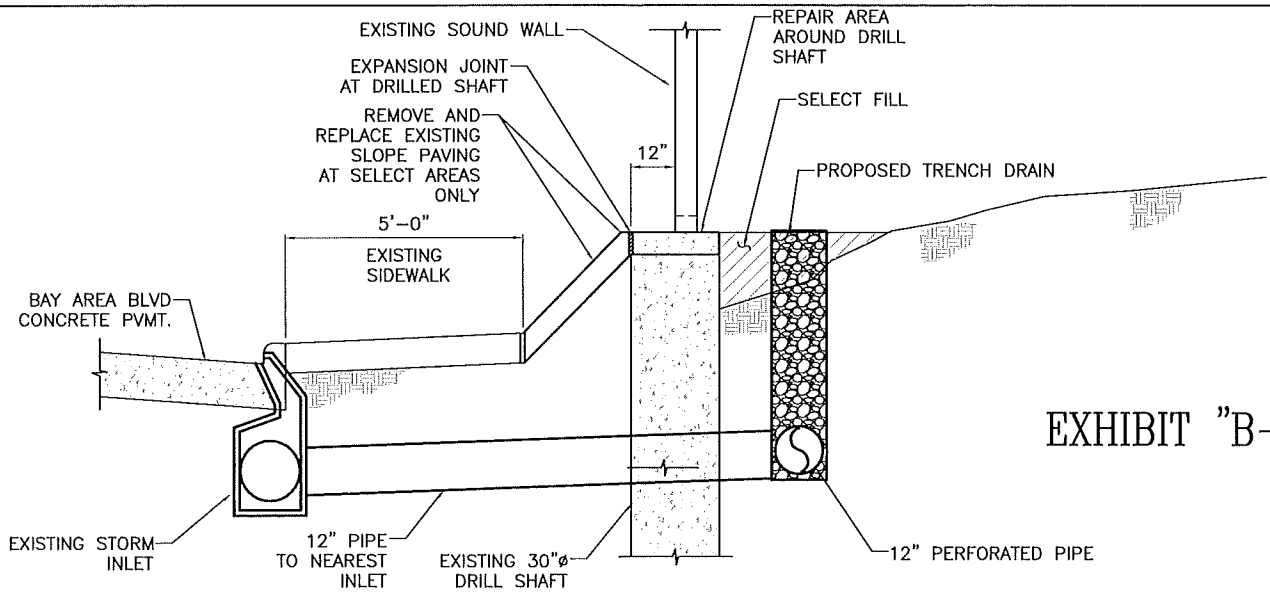


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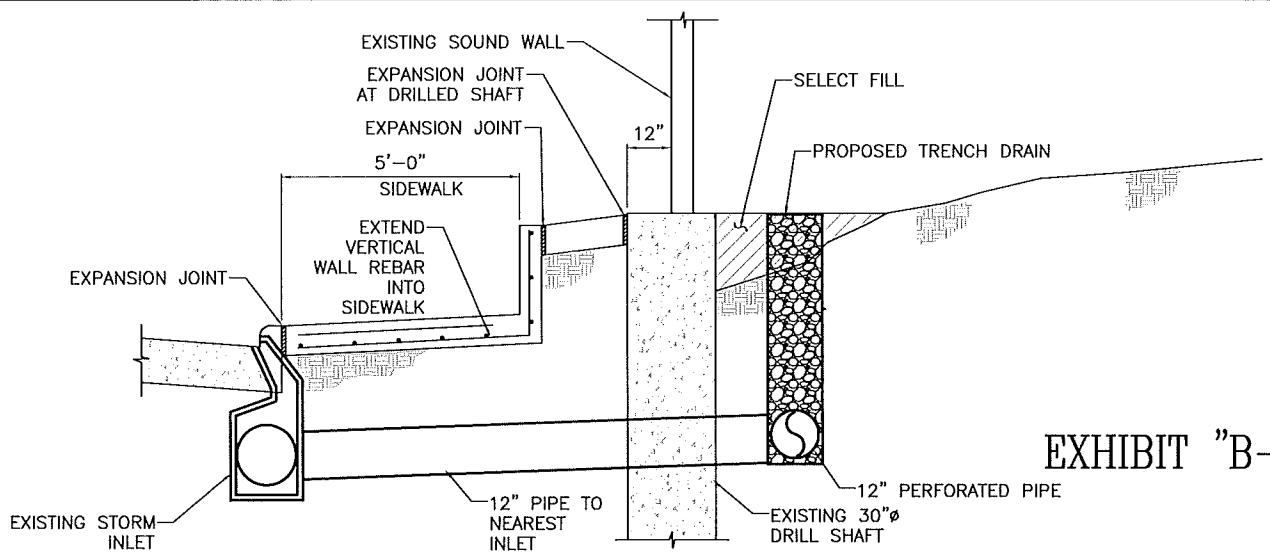


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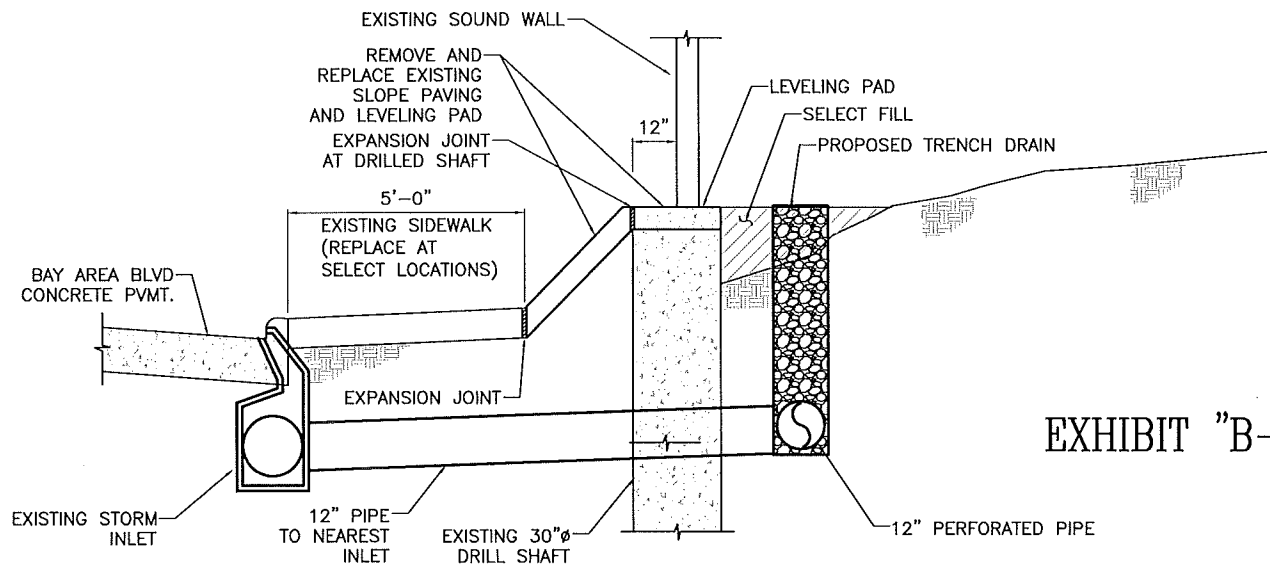


EXHIBIT "B-3"



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Firm No. F-11278

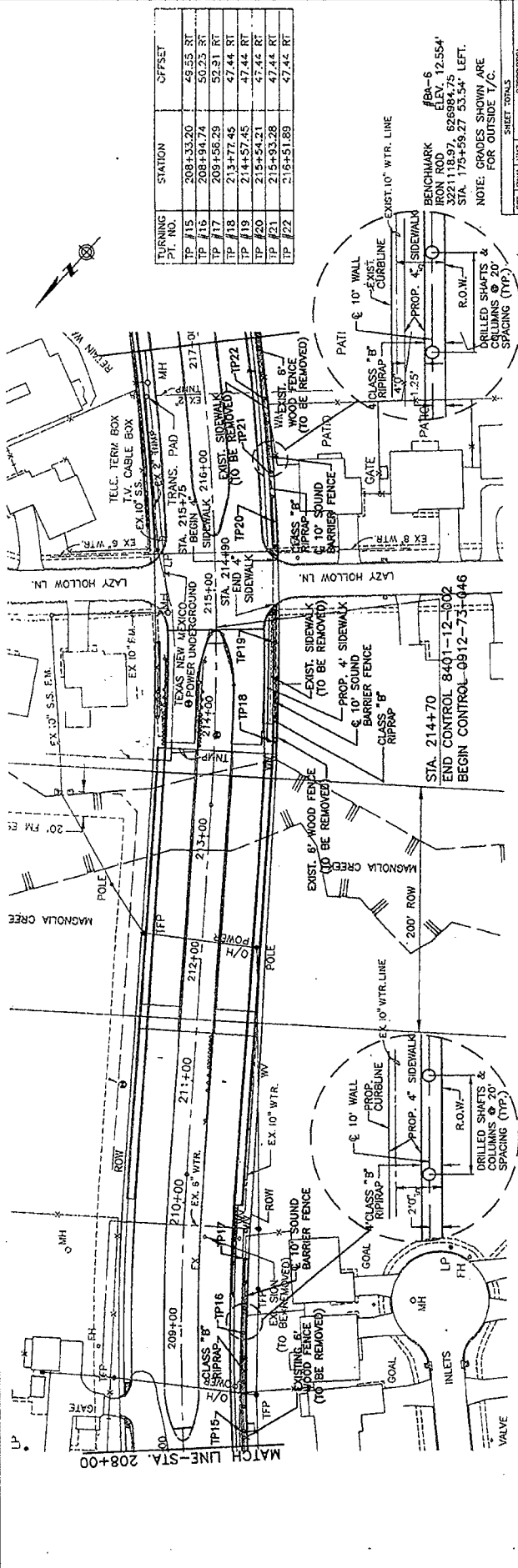
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DATE:  
6-16-14

## EXHIBIT "B" PHASE 2 SLOPE PAVING REPAIR OPTIONS 1-3







TURNING PT. NO.	STATION	OFFSET
TP 15	208+33.20	49.55 RT
TP 16	208+94.74	50.23 RT
TP 17	209+156.29	52.31 RT
TP 18	213+77.45	47.44 RT
TP 19	214+57.45	47.44 RT
TP 20	215+54.21	47.44 RT
TP 21	215+93.28	47.44 RT
TP 22	216+51.89	47.44 RT

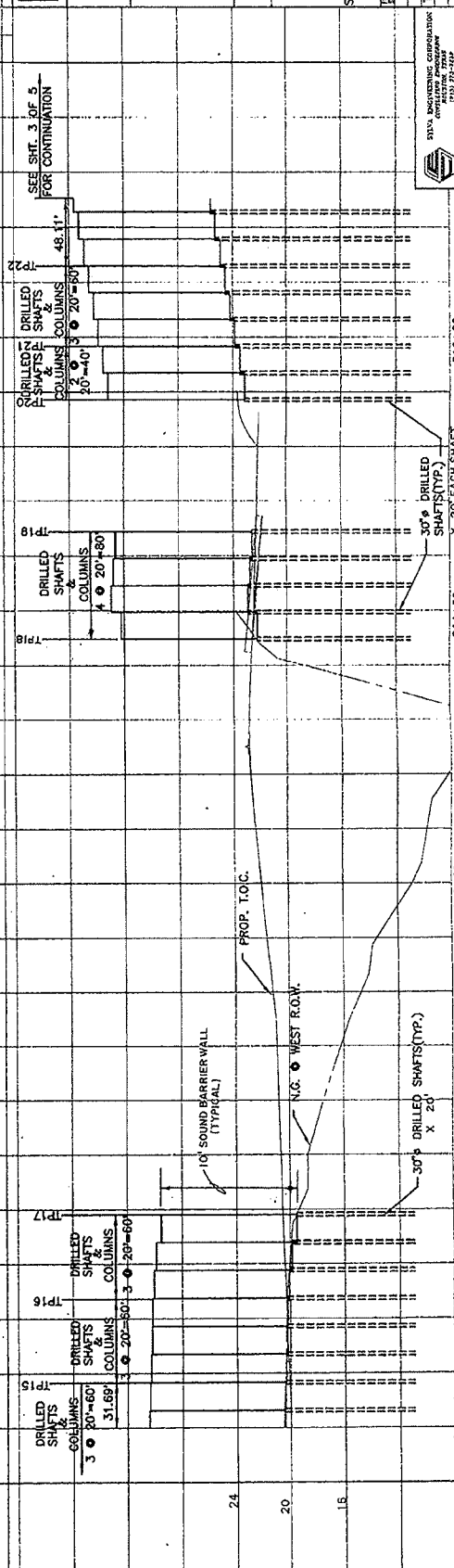
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 NOTE: GRADES SHOWN ARE  
 FOR OUTSIDE 1/2 C.

EST. PAVL. LING.	DESCRIPTION
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 V: 1"=4'

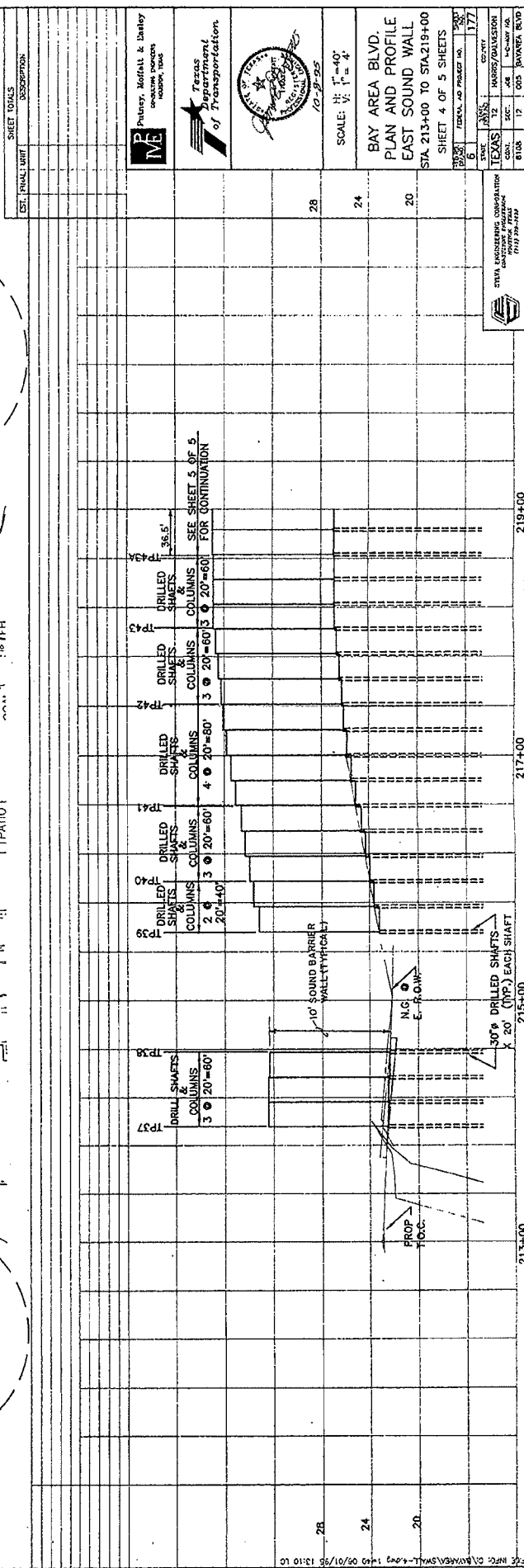
BAY AREA BLVD.  
 PLAN AND PROFILE  
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 SHEET 2 OF 5 SHEETS

STATIONING CORPORATION  
 1115 22-224





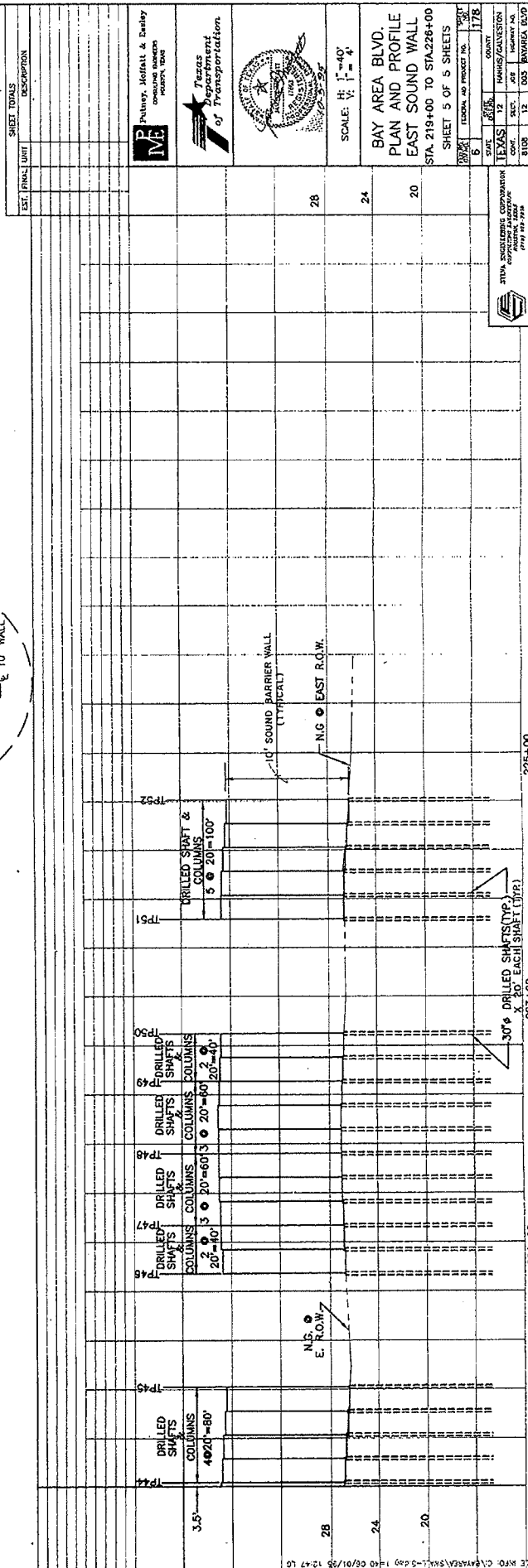
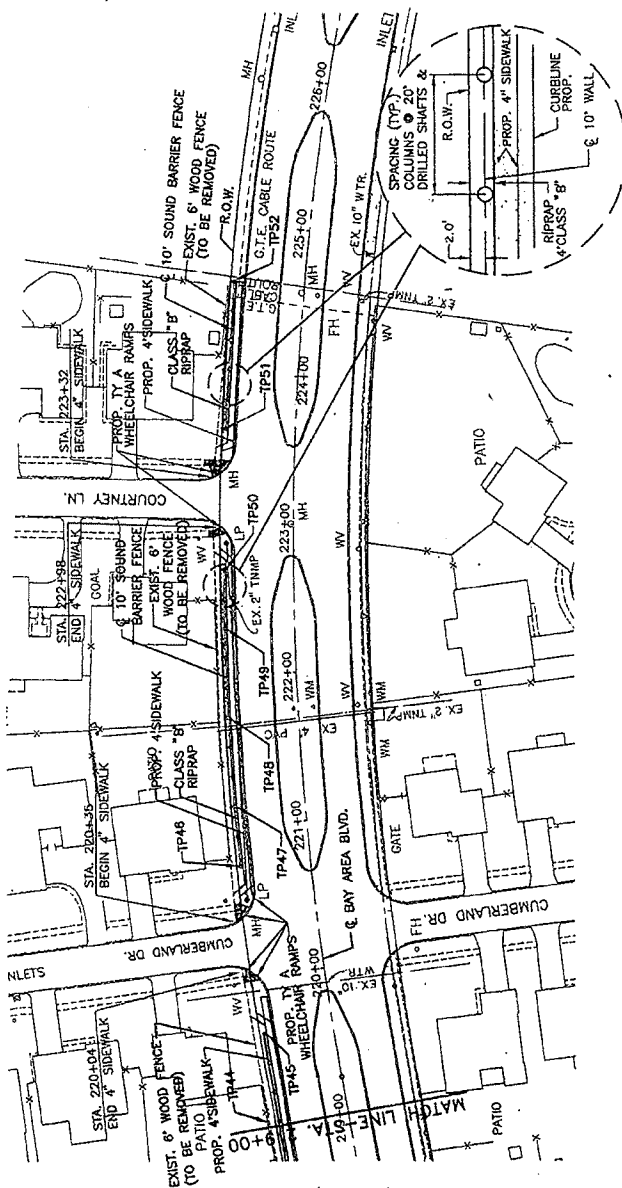


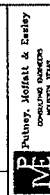


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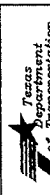
TURNING PT. NO.	STATION	OFFSET
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TP #45	219+42.56	47.50 L
TP #46	220+74.35	47.50 L
TP #47	221+13.43	47.50 L
TP #48	221+72.04	47.50 L
TP #49	222+30.65	47.50 L
TP #50	222+69.72	47.50 L
TP #51	223+43.32	47.50 L
TP #52	224+61.03	47.50 L

REVISION - 8/12/96  
 BENCHMARK  
 118.97, 626884.75  
 STA. 175+59.27 53.54' LEFT.  
 NOTE: GRADES SHOWN ARE  
 FOR OUTSIDE T/C.






P. M. Engineering, Inc.  
 118.97, 626884.75  
 STA. 175+59.27 53.54' LEFT.



Texas Department of Transportation



STATE OF TEXAS

SCALE: H: 1" = 40'  
 V: 1" = 4'

BAY AREA BLVD.  
 PLAN AND PROFILE  
 EAST SOUND WALL  
 STA. 219+00 TO STA. 226+00  
 SHEET 5 OF 5 SHEETS

STATIONING: 219+00, 221+00, 223+00, 225+00



