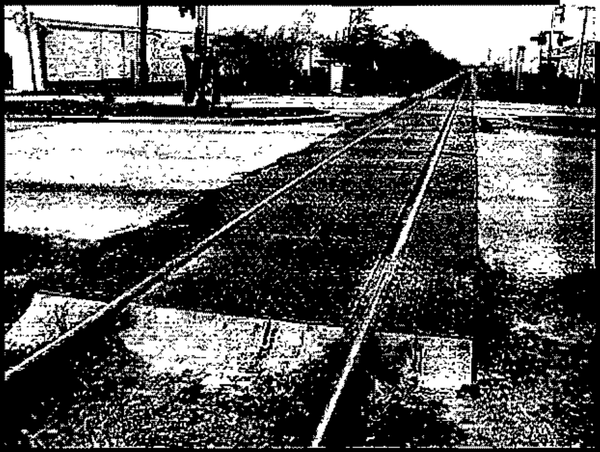
Design Report for

Midway Road Reconstruction

TOWN OF
ADDISON



May 2002

Prepared By:

Grantham, Burge & Waldbauer
Engineers, Inc.

ENGINEERING DESIGN REPORT

FOR

MIDWAY ROAD RECONSTRUCTION

for the

TOWN OF ADDISON

THIS DOCUMENT REPRESENTS
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June 2002

Engineering Design Report for Midway Road Reconstruction

GBW Engineers, Inc. (GBW) was retained by the Town of Addison on September 7, 2000, to provide the surveying, engineering, and geotechnical services required for the design of Phase One of the reconstruction of Midway Road from Belt Line Road to Keller Springs Road. GBW's subconsultants on this project were HNTB Corporation (construction sequencing and traffic control) and Alpha Testing, Inc. (geotechnical).

GBW's agreement with the Town represents Phase One of what is anticipated to be a two-phase design process. Phase One consists of the preparation of all the construction plans and specifications necessary for the reconstruction work except for construction sequencing and traffic control, landscaping and irrigation, storm water pollution prevention plan and erosion control, signalization, and temporary lighting, and sidewalks. All median opening widths, turn lane lengths, and street and driveway radii have been reviewed and design changes made where appropriate.

Phase One included the preparation of this engineering report which is intended to provide a basis for the Town to establish a construction phasing and funding approach for this project. The scope of work for this design report included the following project issues:

- phasing alternatives for the reconstruction work
- a recommended construction sequencing and traffic control approach for the project
- the limits of reconstruction work which can be accomplished with available bond funds
- preparation of an Opinion of Probable Cost.

Phase Two, which will be completed at a later date, consists of completing the remaining construction plans along with separating the plans prepared in Phase One into a separate bid package for construction phasing purposes. Public notification and coordination with other cities, DART and affected businesses will be included in Phase Two. Bidding and construction services will also be provided.

During the execution of this project, several important design related issues surfaced that required detailed evaluation. As these issues were not included in the scope of services for the design report, they are not included in the main body of this report. However, in order to make this report an all-inclusive reference for Phase One of the Midway Road Reconstruction Project, previous memos and letters that discuss related design issues have been included in the Appendices A through C. These memos include the following:

- Appendix A: April 2, 2001 memo from GBW to Steve Chutchian (Town) and Jerry Holder (HNTB) concerning Cement Treated Permeable Base;

- Appendix B: May 7, 2001 memo from GBW to Steve Chutchian concerning Ductbanks;

- Appendix C: May 16, 2001 letter from GBW to Steve Chutchian concerning the Midway Road Pavement Section.

Phase One of the design included the preparation of a geotechnical report by Alpha Testing. This report contains the results of field explorations and laboratory testing and an engineering interpretation of this data. The results and analyses were used to develop recommendations for remedial design and reconstruction of the Midway Road pavement. A copy of the geotechnical report is contained in Appendix D.

An important design issue that surfaced which was beyond GBW's initial scope of services, was the adequacy of the existing storm drainage system. The Town's staff determined that it would be worthwhile to evaluate whether or not the existing storm sewer system meets current city criteria. One reason for doing so is the significant savings that could be realized by upgrading the existing system during the pavement reconstruction process, as opposed to doing so independently from the reconstruction work. Given the comprehensive nature of GBW's evaluation of the storm drainage system, a written summary is provided in Section 5.

In order to obtain a comprehensive inventory of the distress in the Midway Road pavement, the following steps were taken:

- In conjunction with staff from the Town of Addison and Alpha Testing, GBW performed an indepth inspection of the existing condition of the Midway Road pavement.

- GBW performed an independent walk-through, from Belt Line Road to Keller Springs Road, during which all the evidence of pavement distress was marked on a set of base sheets.

- Town of Addison staff provided a history of the pavement's life, including a summary of the repair and rehabilitation work which had previously been carried out.

- Alpha Testing obtained, tested and evaluated 22 pavement core samples and furnished a geotechnical report.

Pictures taken during the walk-through, which are representative of the condition of Midway Road, are shown at the end of this section.

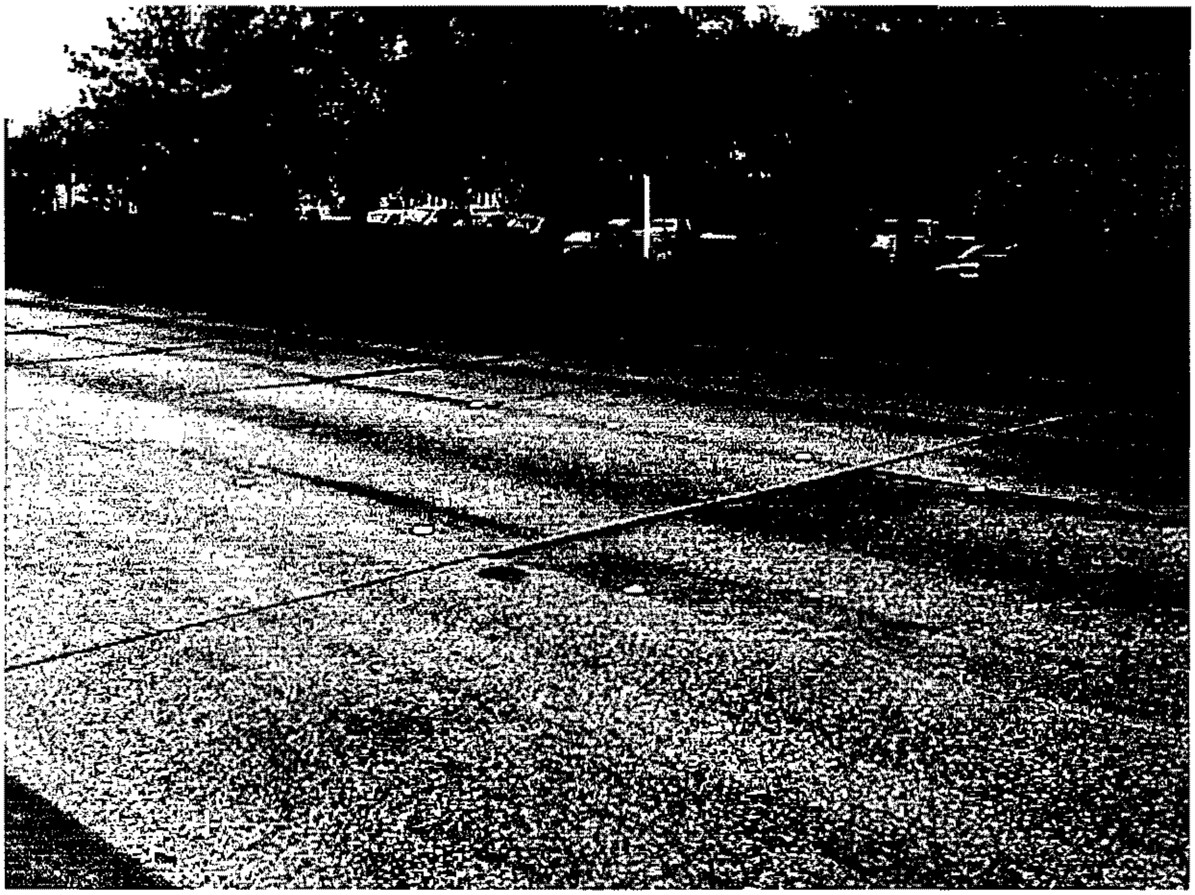
A summary of the results of GBW's inventory and analysis is contained in a letter report which was prepared for the Town of Addison on May 16, 2001 and is contained in Appendix C. The highlights of this letter report are provided below:

- The pavement distress along the northbound lanes is more pronounced than the southbound lanes.
- The worst section of the southbound lanes is in the vicinity of the railroad crossing near the Belt Line Road end of the project where there is a sag in the profile.
- The cross-slope on the northbound lanes, which is mostly in the 1/8 to 1/4-inch per foot range, is significantly less than the southbound lanes, where it is mostly in the 1/4 to ½-inch per foot range.
- The difference between the northbound and southbound lane cross-slopes appears to have resulted from an attempt to match the existing ground at the east and west right-of-way lines when the current Midway Road pavement was designed in 1982.
- The flatter cross-slope on the northbound lanes increases the likelihood that surface water will pond or runoff slowly, resulting in a higher infiltration rate into the subgrade through pavement joints and cracks.
- In addition to rainfall, sprinkler systems in the medians and adjacent parkways are other sources of water which can infiltrate the subgrade.
- Flat longitudinal slopes along some sections of Midway Road also slow the rate of storm water runoff; for example, in the vicinity of the railroad crossing.
- Poor surface drainage appears to be the primary reason why pavement distress has been more rapid along most of the northbound lanes than along the southbound lanes.
- The poor condition of many pavement joints, some of which may have been widened when the pavement was milled and resealed in 1994, provide conduits for surface water to reach the subgrade.

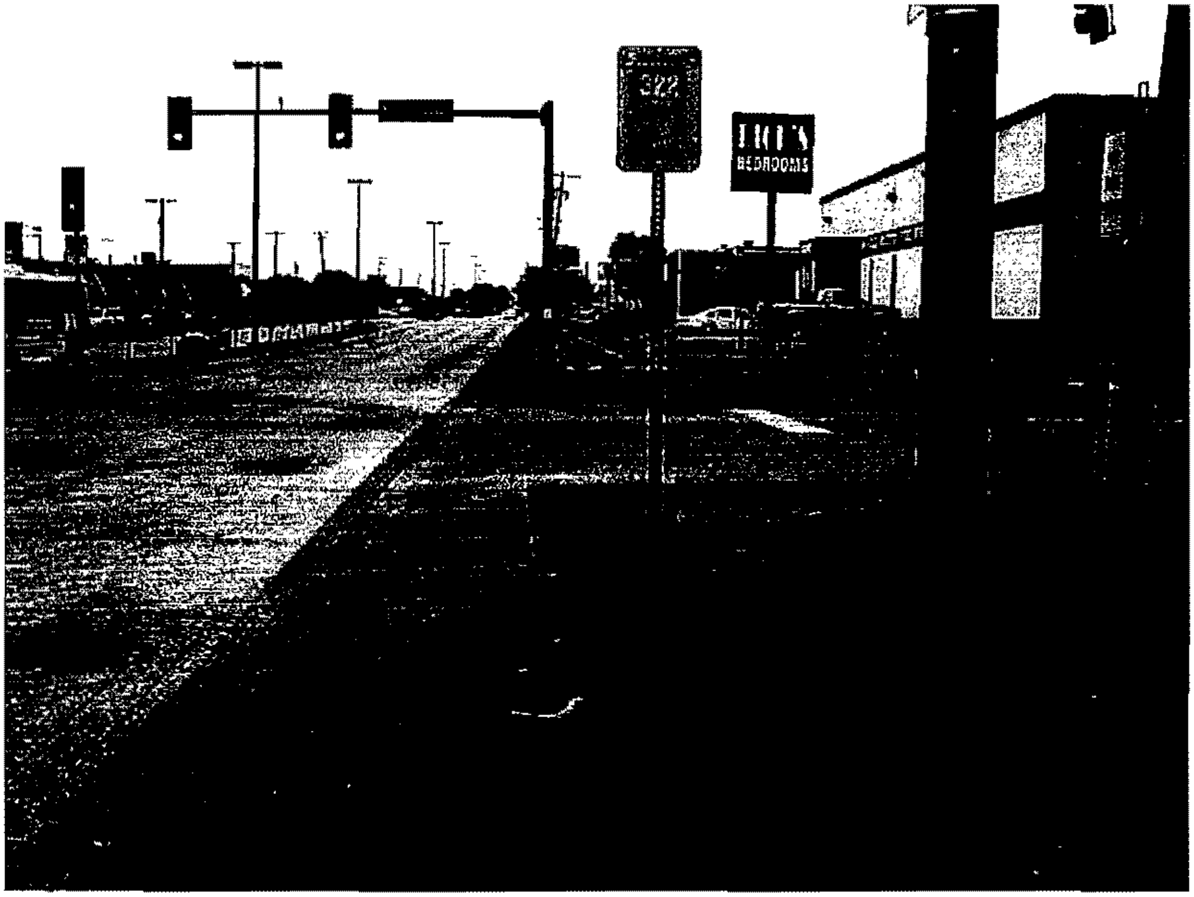
- The plasticity index of the underlying clay soil is generally in the 18 to 55 range, which indicates a high potential to shrink and swell.
- The soil borings do not provide evidence of a ground water problem.
- Only eight of the 22 soil borings showed evidence of lime in the subgrade, which suggests that the lime stabilized subgrade was not uniformly constructed.
- A combination of moisture penetration over time and nonuniform lime stabilization during construction has probably reduced the bearing capacity of the subgrade.
- The load transfer capability of the transverse contraction joints has been insufficient to support the heavy traffic volume, resulting in a difference in pavement elevation at the front and back ends of adjacent slabs.
- This difference, which results in a bump at the pavement joints on the northbound lanes in particular, has also resulted in a transverse crack at the midpoint of some slabs.

Looking North towards Wright Brothers Drive

Looking North from Wiley Post Road



East side of Midway between railroad tracks and Lindberg Drive



Looking North from Lindberg Drive

Looking South towards railroad tracks

Looking South towards Beltline Road

After the pavement inspection process was completed, GBW calculated approximate quantities for the reconstruction work. These quantities were then matched with unit prices obtained from similar projects and from contractor estimates to determine whether or not there were sufficient bond funds available to reconstruct Midway Road from Belt Line Road to Keller Springs Road as one project.

According to Town staff, $4.75 million in bond funds is available for this project. It was determined that these funds were budgeted to include payment for engineering services, landscape and irrigation replacement, temporary lighting, in addition to all other project related expenses.

An initial order-of-magnitude Opinion of Probable Cost prepared by GBW revealed that the available bond money was significantly less than that total funds required to reconstruct the entire project. Consequently, it was apparent that, unless additional funds were found, the project would need to be phased, with the limits of Phase 1 reconstruction being established so as not to exceed the available $4.75 million.

As GBW's plan preparation work neared completion, a more detailed Opinion of Probable cost of $6,682,583.60 was prepared for the reconstruction of the complete project in one phase. This Opinion of Probable Cost, which is included in Section 5.0, confirmed that insufficient funds were available to reconstruct the roadway, from Belt Line Road to Keller Springs Road, in one phase. At this time, GBW met with the Town's staff to determine the most appropriate construction phasing limits.

Through coordination with the Town's staff, it was determined to reconstruct the project in three phases, with the worst condition pavement being replaced first and the pavement in the best condition being constructed last. The Phase One Reconstruction limits were established such that this phase could be constructed with the available funds. The Opinion of Probable Cost for each phase includes an allowance for the landscaping and irrigation, which was provided by Dave Baldwin, a landscape architect under separate contract with the Town. Section 5 of this report presents an Opinion of Probable Cost for each construction phase in more detail.

<u>Reconstruction Phases</u>

Phase 1: Construct the northbound lanes from Belt Line Road to Keller Springs Road (approximately 5700 feet of roadway) and the southbound lanes from Belt Line Road to Lindbergh Drive (approximately 1500 feet of roadway).

Opinion of Probable Cost $4,300,251.56

Phase 2: Construct the southbound lanes from Boyington Drive to Keller Springs Road (approximately 1700 feet of roadway).

Opinion of Probable Cost $1,073,233.92

Phase 3: Construct the southbound lanes from Lindbergh Drive to Boyington Drive (approximately 2500 feet of roadway).

Opinion of Probable Cost	$1,668,715.62

GBW's subconsultant, HNTB, prepared construction sequencing and traffic control alternatives for the Midway Road Pavement Reconstruction project. During Phase 1 of the project, approximately 1500 linear feet of the northbound and southbound lanes will be constructed simultaneously from Belt Line Road to Lingbergh Drive. The remainder of Phase 1 and all of Phases 2 and 3, from Lindbergh Drive to Keller Springs Road, the project will consist of the northbound and southbound lanes being constructed separately. Therefore, the construction sequencing has been broken into two sections, Belt Line Road to Lindbergh Drive and Lindbergh Drive to Keller Springs Road.

Belt Line Road to Lindbergh Drive

Through this segment of the project, both the northbound and southbound lanes will be reconstructed during Phase 1. Exhibits 1, 2 and 3 illustrate the lane sequencing alternatives considered for this segment of the project. It should be noted that each construction sequencing alternative involves the installation of temporary pavement in the median. The temporary paving of the median is needed in order to provide sufficient pavement surface so that at least two lanes of traffic can be maintained during the reconstruction work. The median landscaping will need to be removed and replaced, however, the Town's Landscape staff had projected to re-landscape the Midway Road corridor in the future. In addition, the street lights in the median will need to be removed prior to, and replaced after, the reconstruction work. It is also anticipated that temporary lighting will be required while the median lights are out of service. Temporary relocation of the railroad gates will need to be coordinated with DART.

The only temporary paving alternative to the median is to use the parkways and adjacent properties. However, the impact on existing driveways, parking, landscaping inlets and other related improvements, along with the need to acquire numerous temporary construction easements from the adjacent property owners, made this alternative less desirable. The following is a description of each.

Alternative 1 – Both Directions: This alternative would provide two lanes in each direction with a continuous left turn lane, leaving two lanes to be constructed during Steps 2, 3 and 4.

Step 1

- Remove necessary street lights, traffic lights, and landscaping.
- Install necessary temporary street lights and traffic lights.
- Remove the center median and install temporary asphalt.

Step 2

- Move traffic to allow for the construction of the first two outside lanes.

Step 3

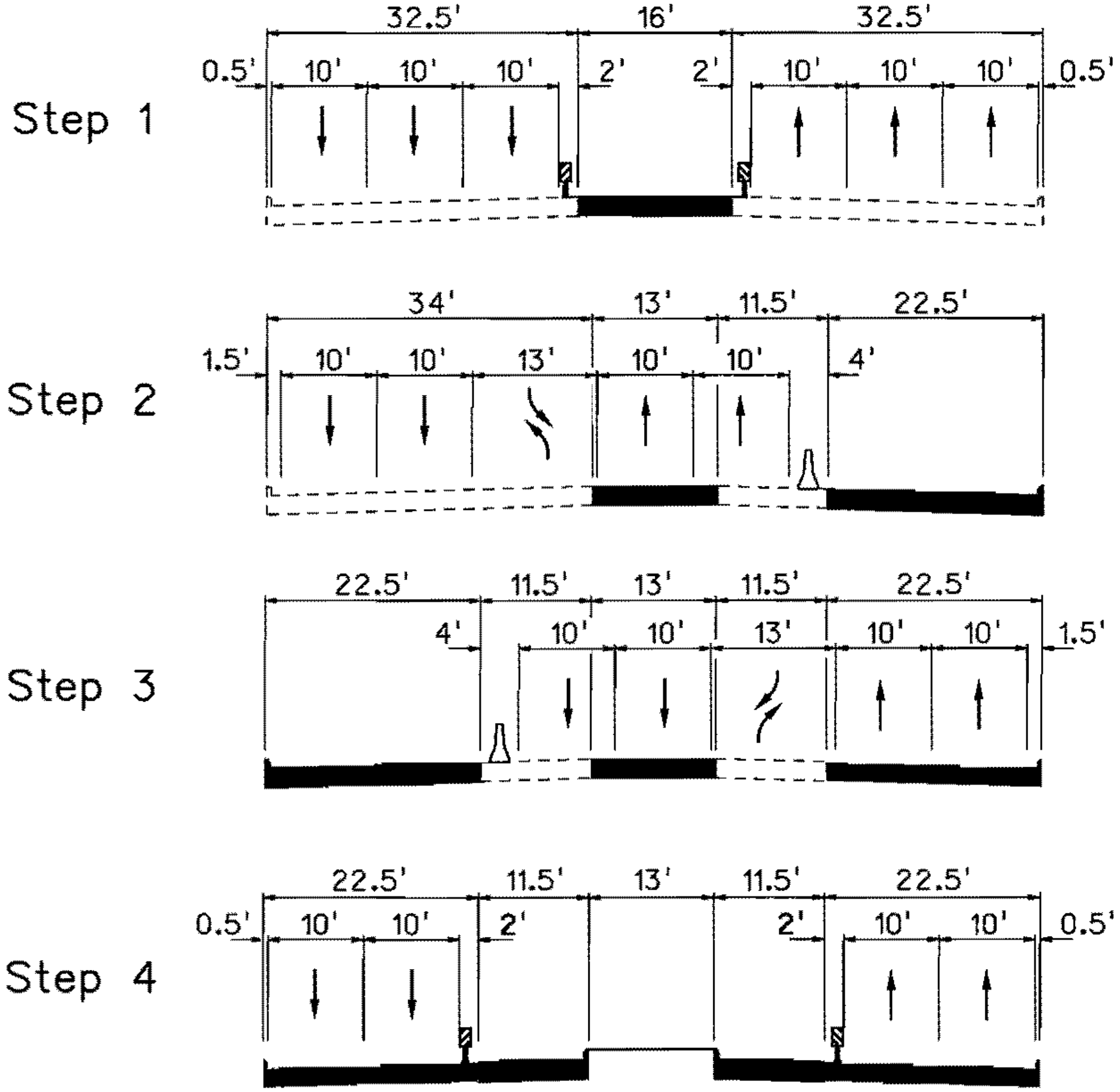
- Once the first two outside lanes are constructed, move traffic to these lanes and construct the opposite outside two lanes.

Step 4

- Move traffic to the two outside lanes on each side and construct the center lanes and median.
- Install permanent street lights, traffic lights, and median landscaping.
- During this step there would not be a continuous left turn lane.

Midway Road Reconstruction
Belt Line Road to Lindbergh Drive

ALTERNATIVE 1



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TOWN OF ADDISON

HNTB

EXHIBIT 1

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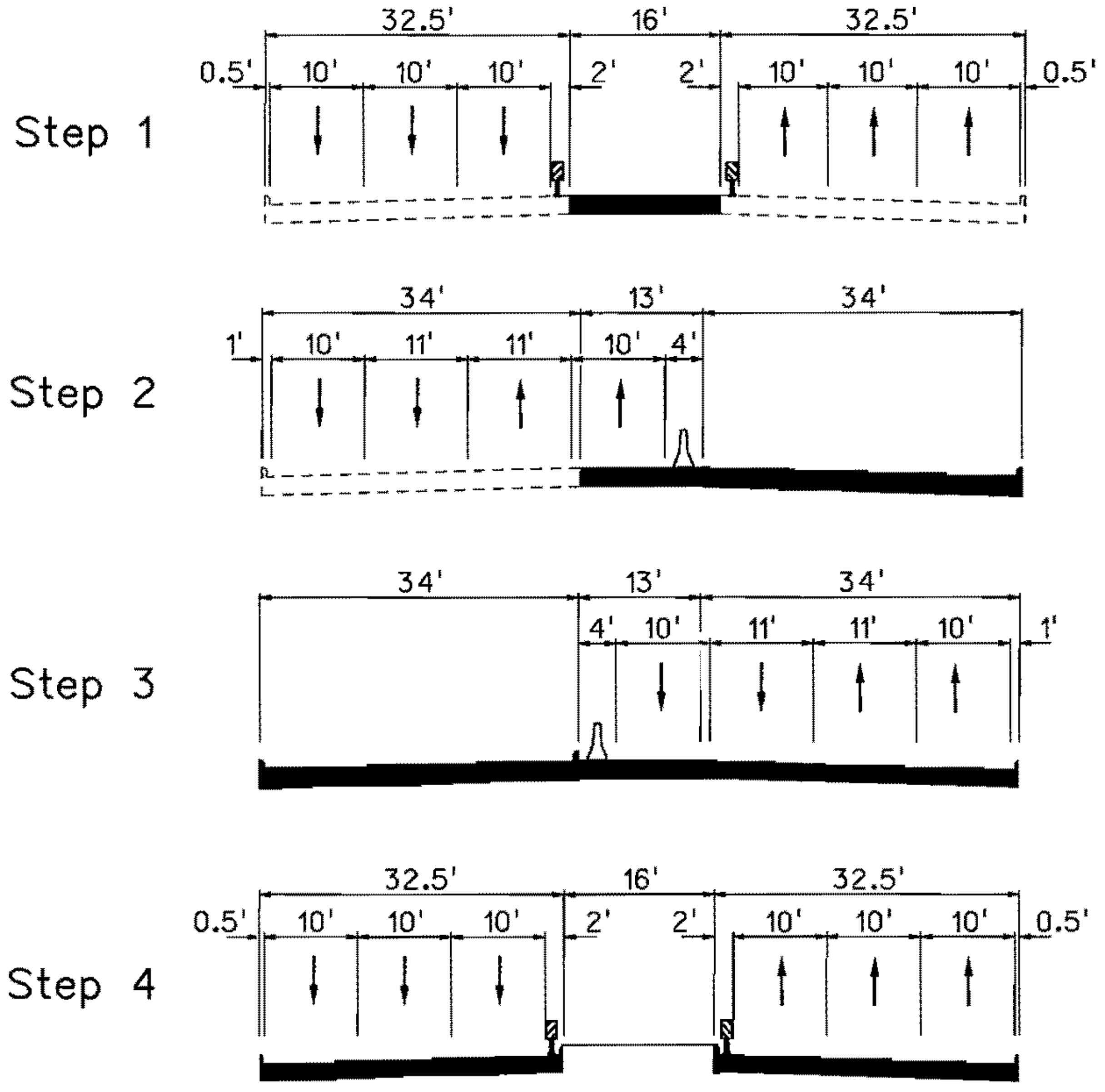
Midway Road Reconstruction
Belt Line Road to Lindbergh Drive

ALTERNATIVE 2



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Belt Line Road to Lindbergh Drive

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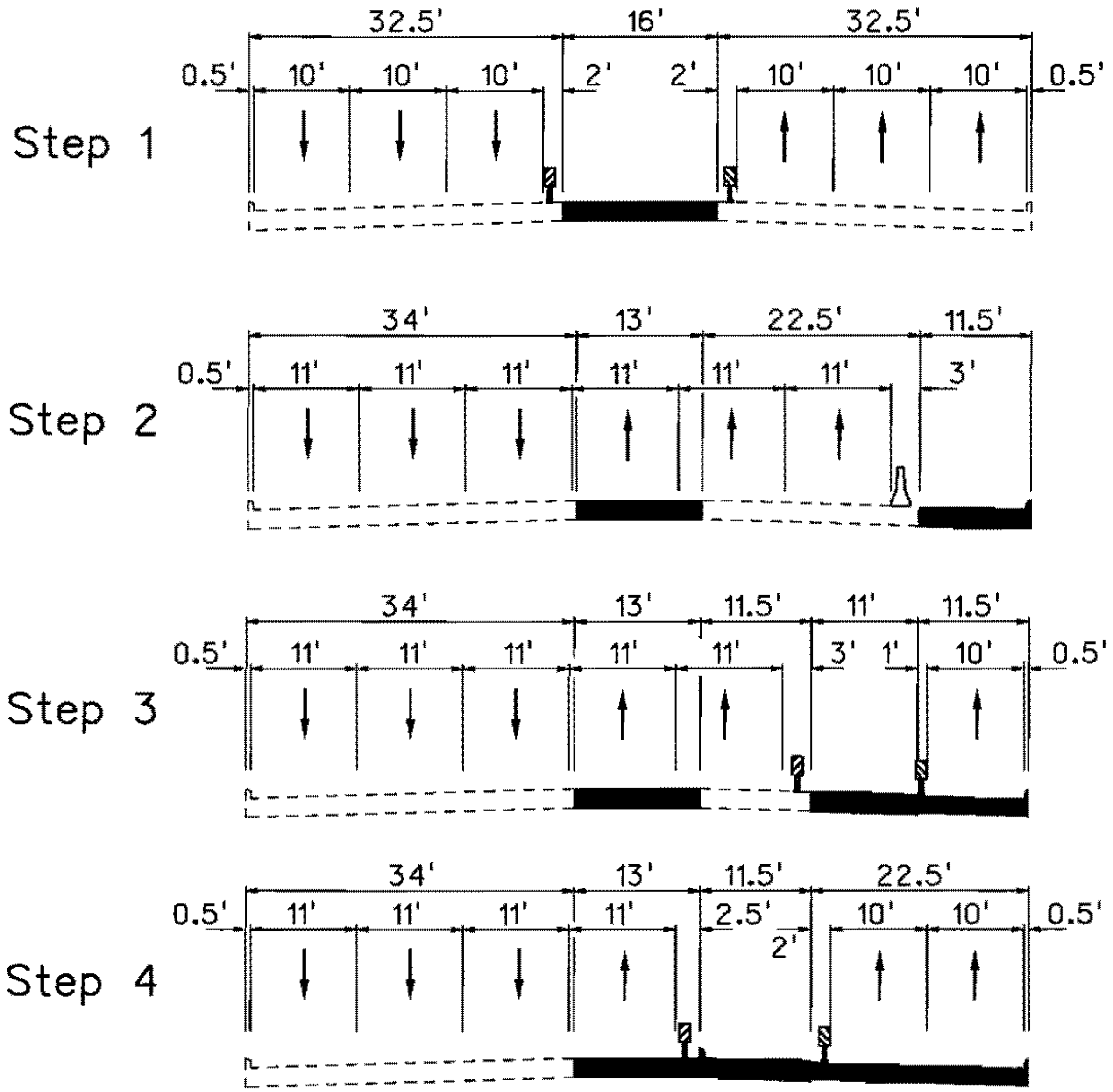

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Midway Road Reconstruction
Belt Line Road to Lindbergh Drive

ALTERNATIVE 3 (CONTINUED)

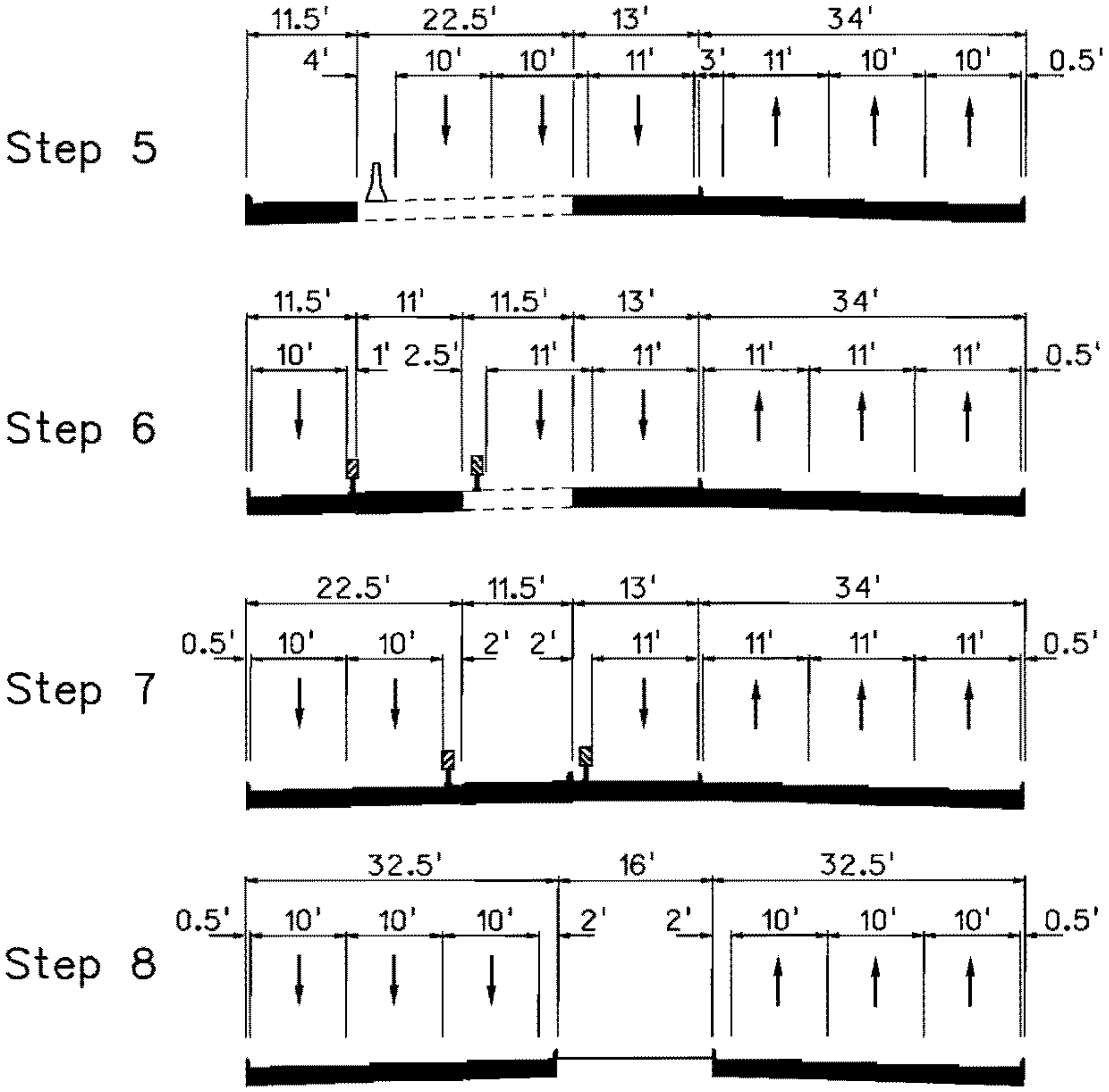

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EXHIBIT 3

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Alternative 1: Pros and Cons

Pros	Cons
• Removes left turning vehicles from through traffic lanes	• 10-foot lanes
• No splits in same direction traffic	• Left turns in Step 3 in very few locations
• Curb offsets in Steps 1 and 2	• Vertical panels in Step 3 do not provide positive protection from pavement drop off
	• No curb offsets in Step 3
	• Some driveways may be closed temporarily

Alternative 2 -- Both Directions: This alternative proposes to construct three lanes of traffic while maintaining two lanes of traffic in each direction during Steps 2 and 3. No continuous left turn lane is provided.

Step 1
- Remove necessary street lights, traffic lights, and landscaping.
- Install necessary temporary street lights, traffic lights, and landscaping.
- Remove the center median and install temporary asphalt.

Step 2
- Move traffic to the outer three southbound lanes and the temporary median asphalt while the northbound lanes are constructed.

Step 3
- Reverse traffic for the construction of the southbound lanes.

Step 4
- Construct the median and turning lanes.
- Install permanent street lights, traffic lights, and landscaping.

Alternative 2: Pros and Cons

Pros	Cons
• Lower construction costs likely	• Left and right turning movements will impede through traffic
• Shorter duration project likely	• Lower capacity than other two options (due to turns)

Pros	Cons
Positive protection for pavement drop offs	10-foot lanes
No splits in same direction traffic	No curb offsets in Step 3
Curb offsets in Steps 1 and 2	Good signing and sign maintenance is critical

Alternative 3 -- Both Directions This alternative provides three lanes in each direction at all times. During some steps of the sequencing for this alternative, traffic flow in one direction would be split by traffic control devices. No continuous turning lanes would be provided.

Step 1
- Remove necessary street lights, traffic lights, and landscaping.
- Install necessary temporary street lights and traffic lights.
- Remove the center median and install temporary asphalt and traffic control devices.

Step 2
- Move traffic to facilitate one lane of construction.

Step 3
- Open the new lane to traffic and close the next lane for construction.

Steps 4 through 7
- Repeat this step until all the lanes are constructed.

Step 8
- Construct the median and turning lanes.
- Install permanent street lights, traffic lights, and landscaping.

Alternative 3: Pros and Cons

Pros	Cons
Allows for 3 lanes of traffic each direction throughout construction	Splits same direction traffic during construction process causing safety concerns and potential to confuse motorists
Curb offsets in Steps 2, 3, 4, and 5	Vertical panels do not provide positive protection for pavement drop off
	10-foot lanes in most steps
	No curb offsets in Steps 1 and 6
	Longer duration construction likely
	More costly construction likely

Recommended Alternative: Alternatives 1 and 2 are preferred to Alternative 3 because they have less sequencing steps which reduces the construction time. Alternative 1 is preferred over Alternative 2 because the continuous turn lane will provide for better traffic flow during most of the construction. Consequently, Alternative 1 is the preferred alternative.

Lindbergh Drive to Keller Springs Road

North of Lindbergh Drive, the construction of the northbound and southbound lanes will be performed separately for all three phases of construction. Exhibits 4, 5 and 6 illustrate the lane sequencing alternatives that were considered.

Alternative 1 – One Direction: This alternative, which follows the same concept as Alternative 1 - Both Directions, would provide two lanes in each direction with a continuous left turn lane during Step 2, leaving two lanes under construction.

Step 1
- Remove necessary street lights, traffic lights, and landscaping.
- Install necessary temporary street lights and traffic lights.
- Remove the center median and install temporary asphalt.

Step 2
- Move traffic to allow for the construction of the two outside lanes.

Step 3
- Move traffic to the two new lanes and construct the remaining lane and left turn lanes.
- Install permanent street lights, traffic lights and median landscaping.

The pros and cons for this alternative, which includes the expense of removing and replacing the median, are similar to those identified for Alternative 1 – Both Directions.

Alternative 2 – One Direction: This alternative would provide two lanes of traffic in each direction, allowing for the construction of three lanes. No continuous left turn lane would be provided.

Step 1
- Remove necessary street lights, traffic lights and landscaping.
- Install necessary temporary street lights and traffic lights.
- Remove the center median and install temporary asphalt.

Step 2
- Move traffic to allow for the construction of all three lanes.

Step 3
- Move traffic to the new pavement.
- Install permanent street lights, traffic lights, and median landscaping.

The pros and cons for this alternative, which includes the expense of removing and replacing the median, are similar to those identified for Alternative 1 – Both Directions.

Alternative 3 -- One Direction: This alternative does not require the removal of the median. In the direction of construction, two 10' lanes of traffic would be provided without turning lanes, leaving one lane to be constructed at the time.

Step 1

- Move traffic from the outside lane to remaining two lanes, providing 10' traffic lanes.
- Demolish and construct outside lane.

Steps 2 and 3

- Move one lane of traffic to new surface and demolish and construct next lane.
- Repeat until all lanes and turning lanes are constructed.

The pros and cons for this alternative, which does not require the median removal, are similar to those identified for Alternative 3 -- Both Directions.

Alternative 3 is the preferred alternative because it saves the considerable expense of removal and replacement of the median, the street lighting, and the landscaping. In addition, no temporary lighting is required.

Midway Road Reconstruction
Lindbergh Drive to Keller Springs Road

ALTERNATIVE 1

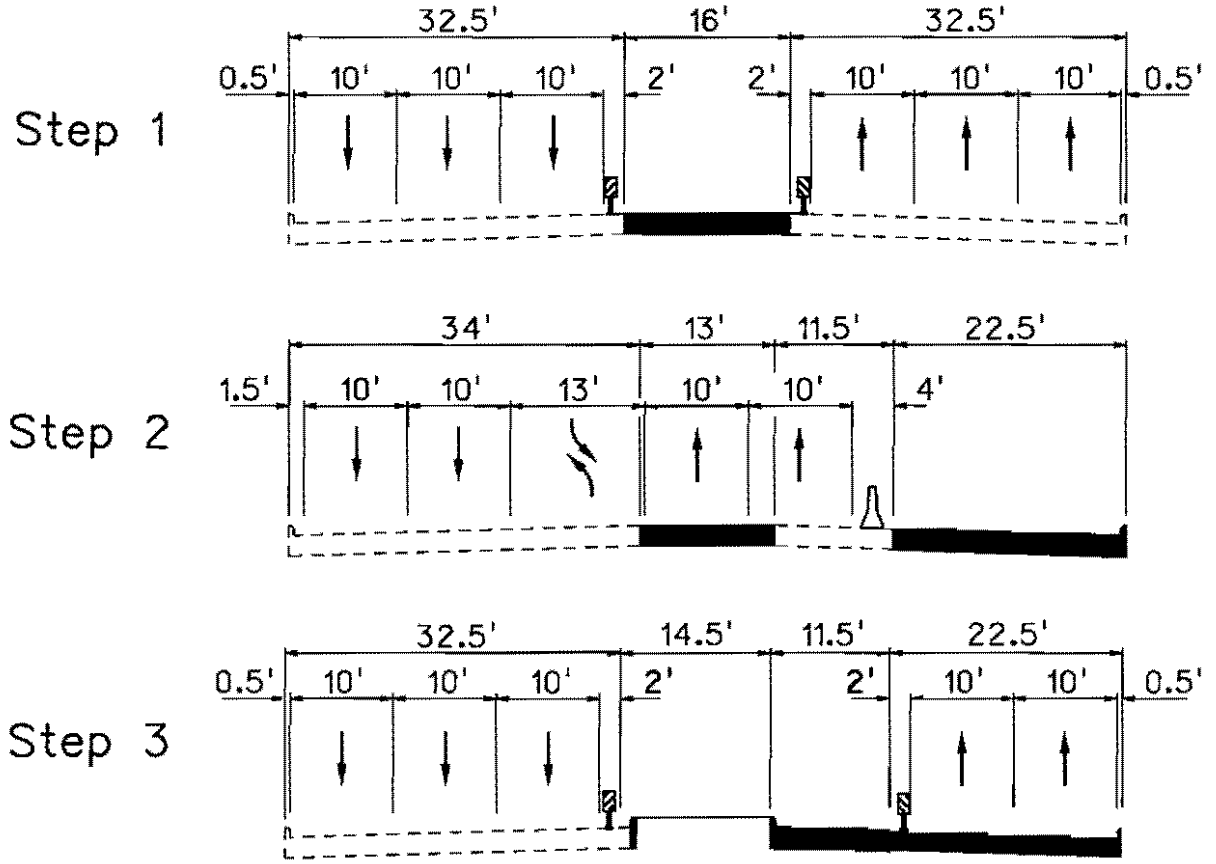

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EXHIBIT 4

Midway Road Reconstruction
Lindbergh Drive to Keller Springs Road

ALTERNATIVE 2

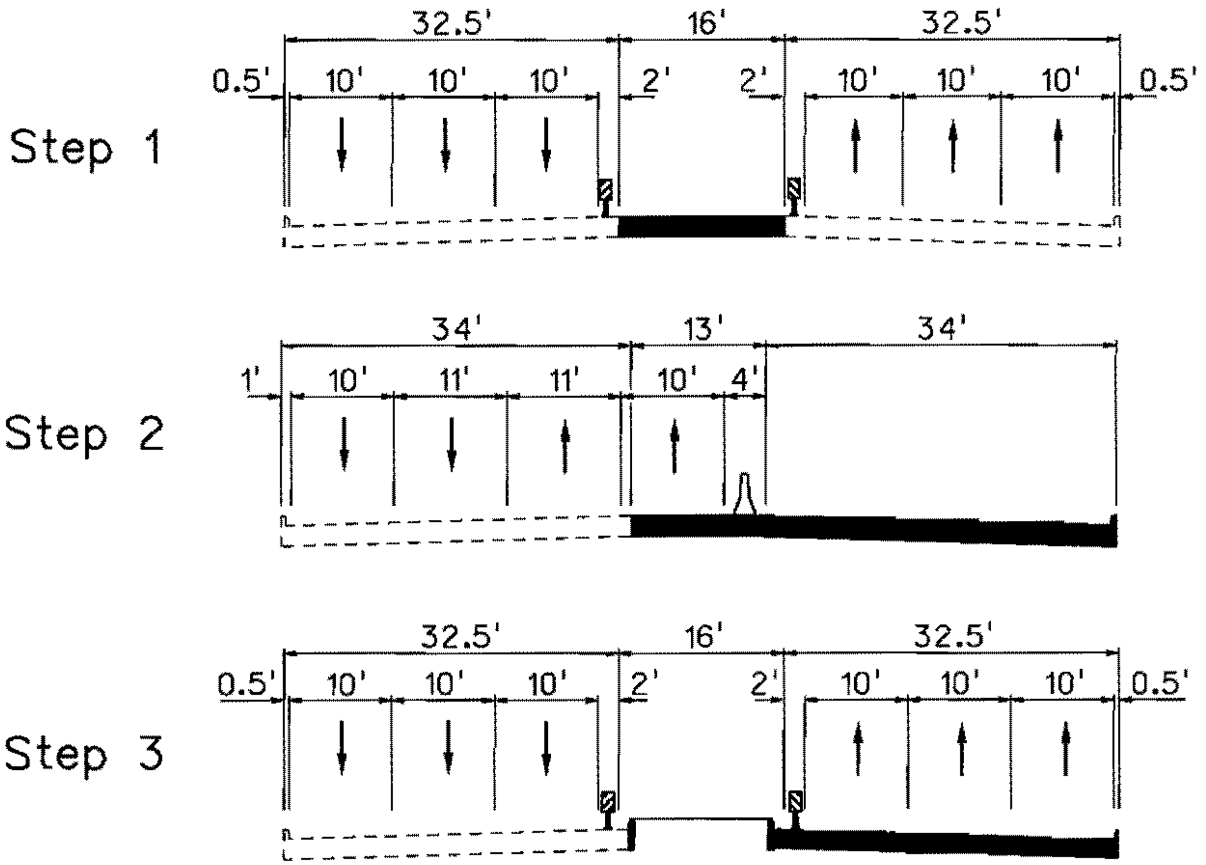

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EXHIBIT 5

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Midway Road Reconstruction
Lindbergh Drive to Keller Springs Road

ALTERNATIVE 3

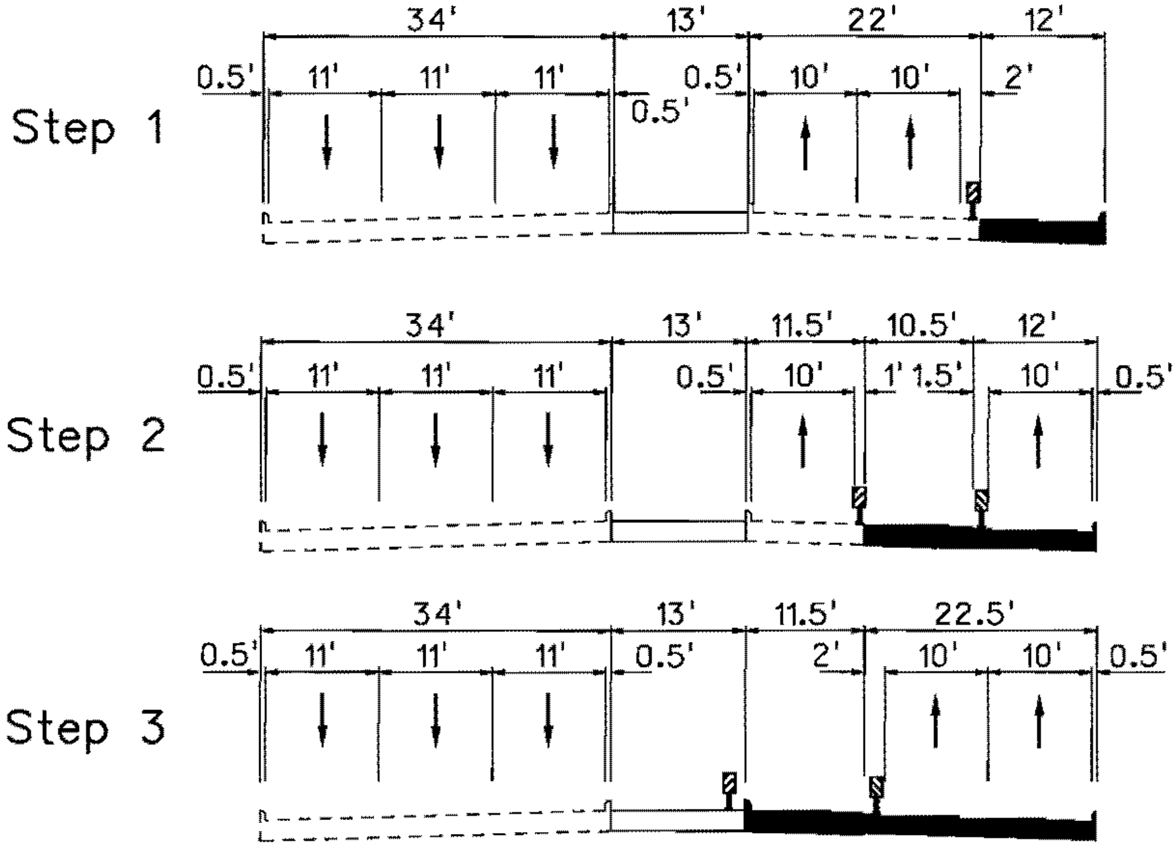

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EXHIBIT 6

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As an extension of the scope of this design report, GBW performed an analysis of the storm sewer system along Midway Road from Belt Line Road to Keller Springs Road. Exhibits 7 and 8 have been included in this section to show the drainage areas and the existing and proposed improvements to the storm sewer system.

To analyze the existing and proposed storm sewer system, a spreadsheet was developed based upon the principles outlined in the Town of Addison's Drainage Criteria Manual. The results are attached in Appendices B and C. The following is a summary of the analysis of the existing system, and the proposed modifications, which will bring the existing system up to current Town standards.

5.1 Existing Storm Sewer System

The existing Midway Road storm sewer system between Belt Line Road and Keller Springs Road consists of five separate storm sewer lines. Lines A, C and D outfall into a 9' x 5' concrete box culvert located just south of the DART owned railroad crossing, while Line B outfalls into Line A. No plans were found for Line E which drains one inlet in the northbound lanes just upstream of the Keller Springs intersection. As a result, it was not possible to analyze this system.

The following is a detailed description of the four lines.

South of 9' x 5' Box Culvert, North of Belt Line Road

- Line A: 158 linear feet of 30" RCP
  - intercepts flow from the northbound lanes via one 10' inlet located in a low-point of the roadway;
  - outfalls into box culvert.
- Line B: 19 linear feet of 21" RCP, 303 linear feet of 24" RCP
  - intercepts flow from the north and southbound lanes via 1-20' inlet and 2-10' inlets;
  - outfalls into Line A.

North of 9' x 5' Box Culvert, South of Wright Road

- Line C: 420 linear feet of 24" RCP, 337 linear feet of 30" RCP, 163 linear feet of 36" RCP, 387 linear feet of 42" RCP, 644 linear feet of 48" RCP, 691 linear feet of 2 barrel 42" RCP, 139 linear feet of 2 barrel 48" CMP; 2,781 total linear footage of storm sewer
  - intercepts flow from the north and southbound lanes via 1-20' inlet, 21-10' inlets and 1-6' inlet;
  - outfalls into box culvert.
- Line D: 136 linear feet of 24" RCP; 166 linear feet of 40" CMP;
  - intercepts flow from the northbound lanes via one 20' inlet located in a low-point of the roadway;
  - outfalls into box culvert.

9' x 5' Box Culvert

The 9' x 5' box culvert was designed on a 1.25% slope. It is approximately 165 feet long with two 30 degree bends located approximately 10 to 15 feet from each end to align the culvert with the incoming and outgoing channels. These channels are trapezoidal with 2:1 side slopes and a 10 foot flat bottom. The bottom and the side slopes, up to a depth of 4 feet, are lined with concrete riprap. The downstream channel has a slope of approximately 1.0%.

Exhibit 9 shows the as-builts for the box culvert. The plans do not provide a hydraulic grade line elevation through the box or a summary of the computations performed to develop the flow. A tailwater of 616.12 for the box is provided; however, the storm event and flow used to determine this tailwater was not indicated.

The existing 9' x 5' box culvert carries the flow from a local drainage ditch that intercepts the drainage east of Midway Road. According to the as-built plans, the box culvert was designed to carry a flow of approximately 700 cfs; however, GBW's drainage calculations show that a 100-year flow at this culvert for a fully developed watershed of approximately 1,334 cfs. This flow was developed in conjunction with the drainage calculations for Arapaho Road Phase 2.

To determine the tailwater for the storm sewer analysis, it was necessary to determine the hydraulics of the existing box culvert. The Federal Highway Administration's Culvert Analysis program, HY-8, was used, however, HY-8 does not take into account the occurrence of backwater in the channel. Midway Road is approximately 4 feet higher than the top of the box in elevation with a sloping embankment from the parkway to the top of the box. The top of the channel bank immediately upstream of Midway Road ends about one foot below the top of the box; consequently, any backwater in the channel would not exceed the height of the culvert before it overflows the channel banks. The overflow storage area is sufficiently large that no over flow over Midway Road has been reported from backwater in the channel.

Based on the HY-8 analysis, overtopping of the roadway occurs around 500 cfs. The box culvert is under inlet control during flows greater than 100 cfs. Based on this analysis, the box culvert does not have the capacity to carry the flows from a 100-year flood event. The results of the analysis are provided in Appendix D. It should be noted, however, that an additional box culvert is proposed at this location in conjunction with the Arapaho 2 project.

The existing system was analyzed based on the geometry of the existing roadway and the proposed roadway. Under both conditions, many of the inlets along the northbound lanes were undersized causing excessive carryover between inlets the allowable gutter depth along the majority of the northbound lanes to be exceeded. The analysis appears to indicate that for the majority of the system, the actual pipe system is sized adequately to carry the flow; however, due to inadequate inlets in the existing system, much of the water is currently detained in the streets and slowly released into the pipe system.

5.2 Proposed Storm Sewer System Improvements

Because the analysis shows that, for the majority of the system, the pipes are adequate to carry the 100-year flow, the proposed modifications focus primarily on new inlets and the extension of the system in select locations. The following is a summary of the storm drainage modifications that are recommended. These modifications have been illustrated in Exhibit 8.

Line A: Expand the existing 10' curb inlet to a 20' curb inlet.

Line B: Replace 108 linear feet of 24" RCP with 30" RCP beginning at Inlet / Lateral B3 and ending at the tie-in to Line A.

Line C: Extend Line C north on Midway with 330 linear feet of 24" RCP and add 3 - 10' curb inlets.
- Replace or expand 11 - 10' curb inlets with 14' and 20' curb inlets, depending on the location. Remove inlets C2, C23, and C24 from Line C and connect to Line D (see below).
- Add a special inlet opening to drain area 10A prior to the runoff reaching the street.

Line D: Extend Line D north on Midway with 470 linear feet of 30" RCP and connect inlets C2, C23 and C24 to Line D.
- Inlet C2 should be expanded to a 20' curb inlet.
- An additional 10' curb inlet on Lindbergh should be added to decrease the flow depth in the gutter. This would include an additional 200 linear feet of 21" RCP.
- One 10' curb inlet should be added to Line D south of Lindbergh on Midway.

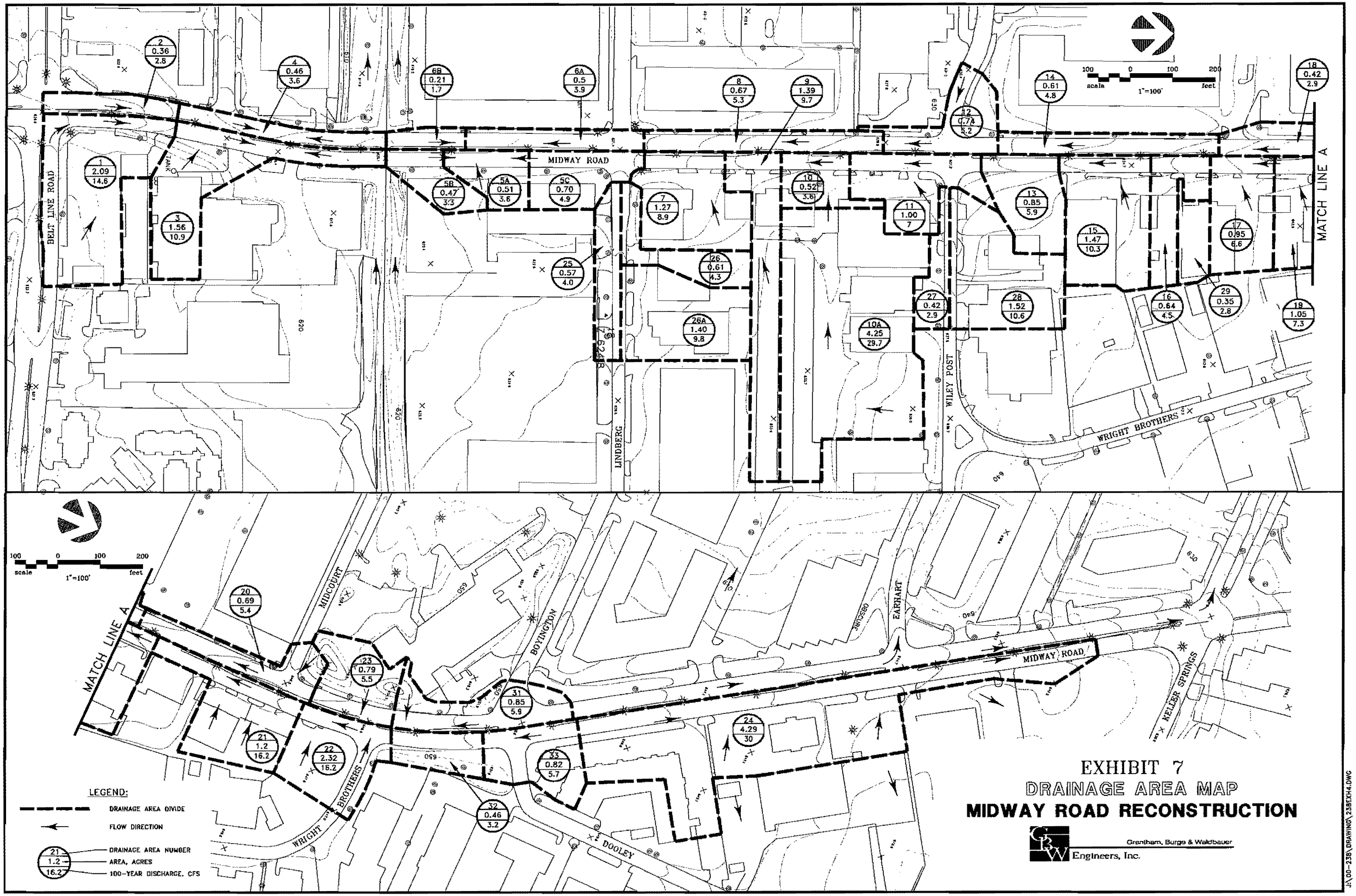


EXHIBIT 7

DRAINAGE AREA MAP

MIDWAY ROAD RECONSTRUCTION

Grantham, Burge & Waldbauer
Engineers, Inc.

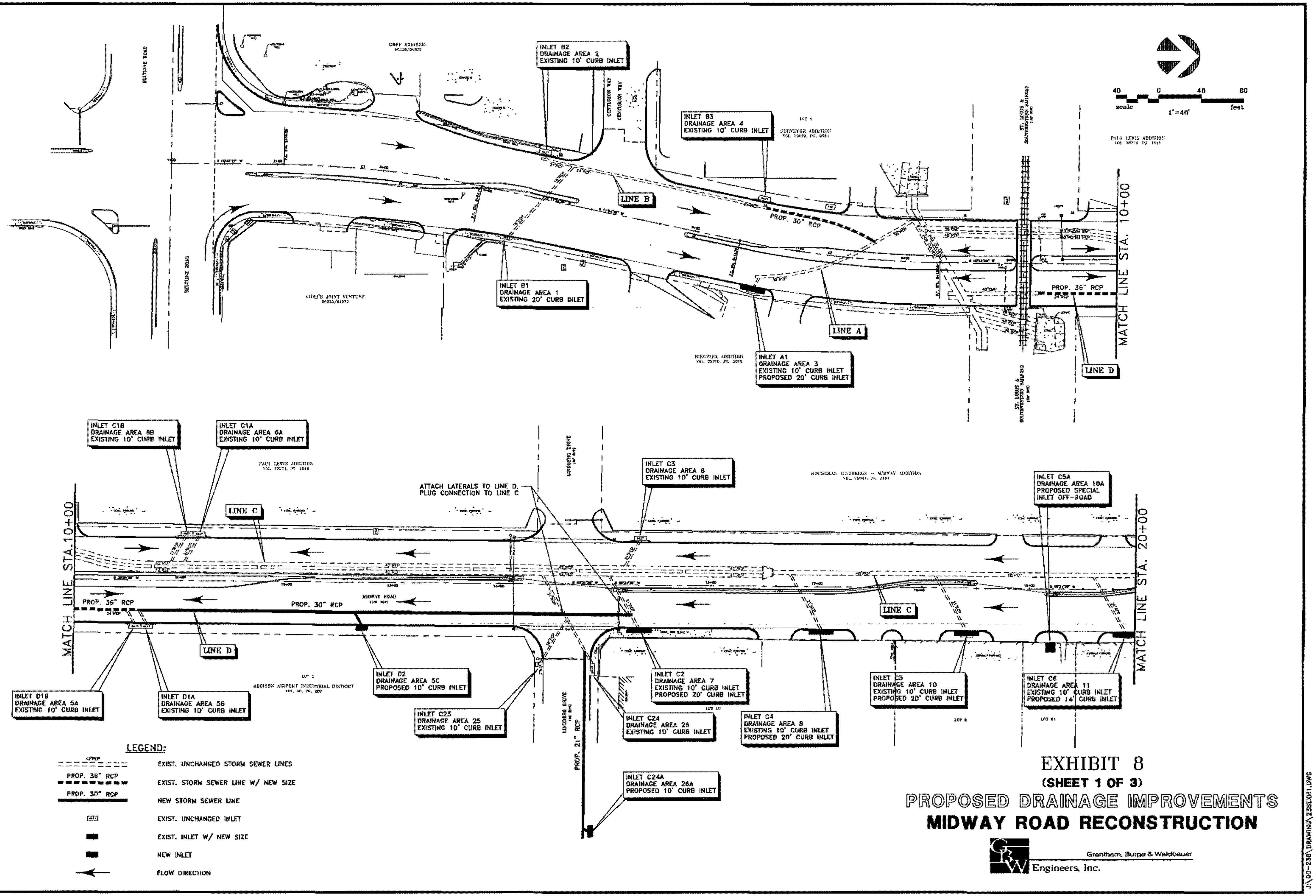


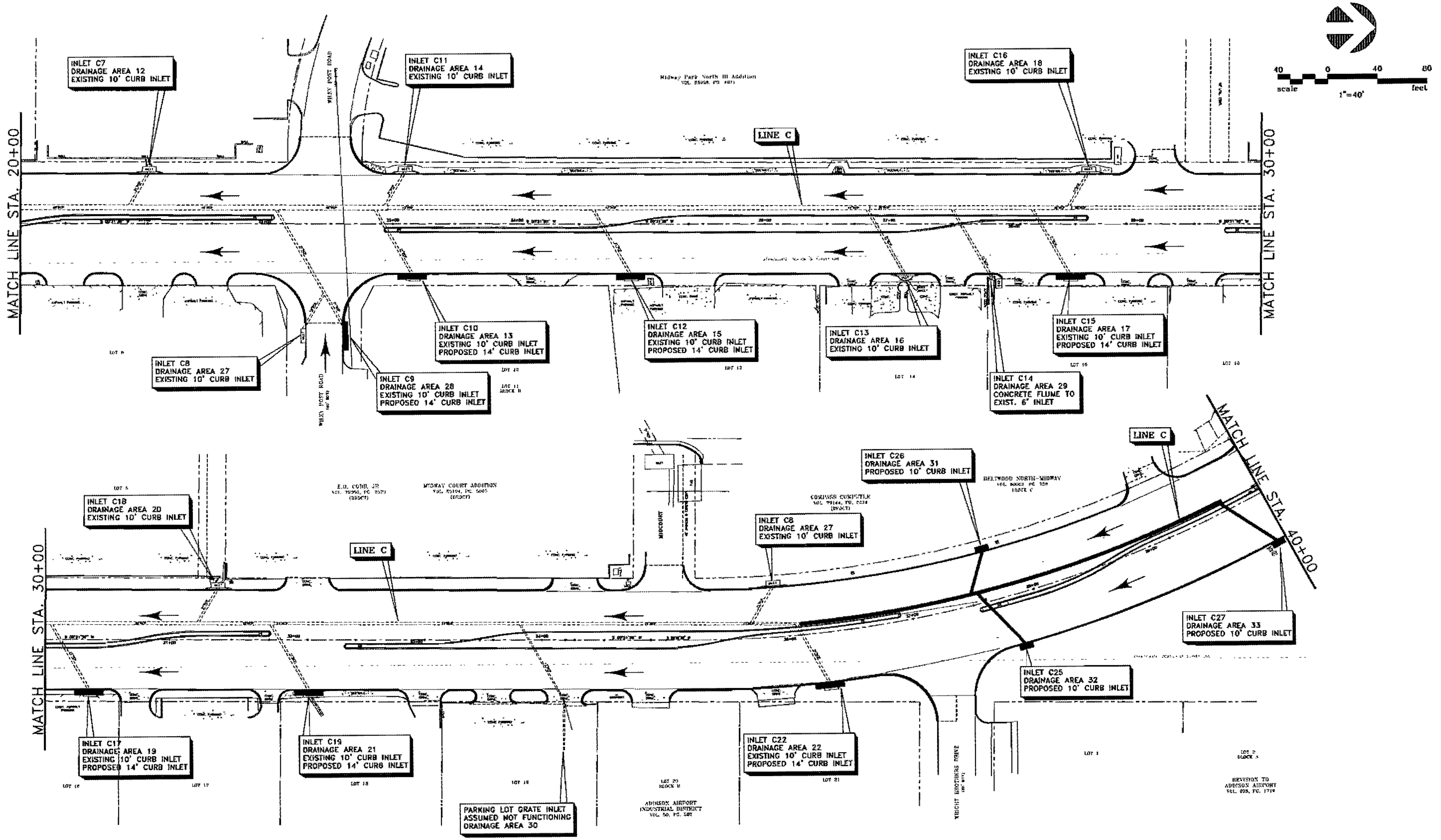
EXHIBIT 8

(SHEET 1 OF 3)

PROPOSED DRAINAGE IMPROVEMENTS

MIDWAY ROAD RECONSTRUCTION

Grantham, Burge & Waldbauer
Engineers, Inc.



LEGEND:

42"RCP	EXIST. UNCHANGED STORM SEWER LINES
PROP. 36" RCP	EXIST. STORM SEWER LINE W/ NEW SIZE
PROP. 30" RCP	NEW STORM SEWER LINE
INLET	EXIST. UNCHANGED INLET
■	EXIST. INLET W/ NEW SIZE
■	NEW INLET
←	FLOW DIRECTION

EXHIBIT 8

(SHEET 2 OF 3)

PROPOSED DRAINAGE IMPROVEMENTS

MIDWAY ROAD RECONSTRUCTION

Grantham, Burge & Waldbauer
Engineers, Inc.

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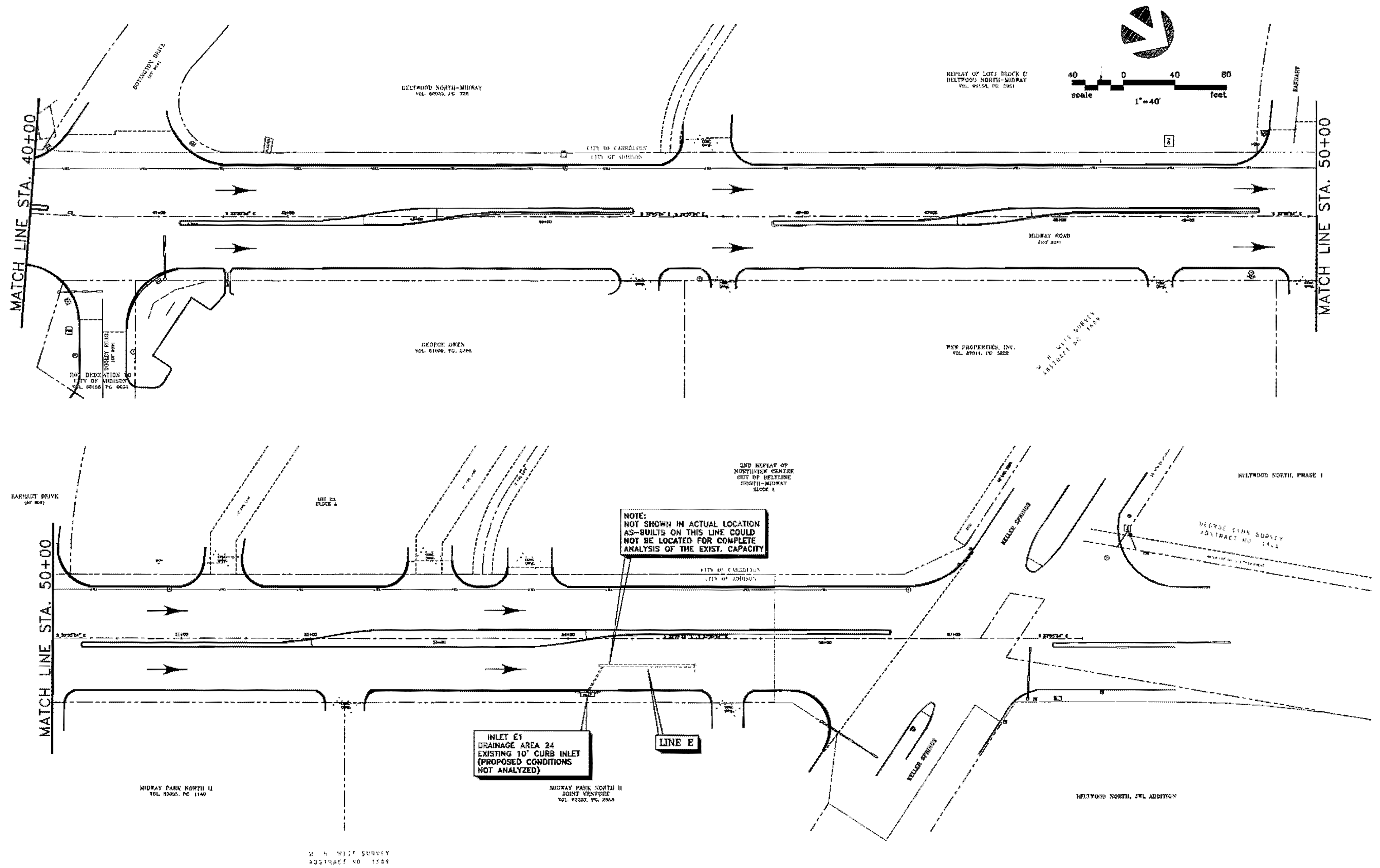

LEGEND:

42"RCP	EXIST. UNCHANGED STORM SEWER LINES
PROP. 36" RCP	EXIST. STORM SEWER LINE W/ NEW SIZE
PROP. 30" RCP	NEW STORM SEWER LINE
▭	EXIST. UNCHANGED INLET
■	EXIST. INLET W/ NEW SIZE
■	NEW INLET
←	FLOW DIRECTION

EXHIBIT 8

(SHEET 3 OF 3)

PROPOSED DRAINAGE IMPROVEMENTS

MIDWAY ROAD RECONSTRUCTION

Grantham, Burge & Waldbauer
Engineers, Inc.

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Based on the recommended project phasing and construction sequencing, an Opinion of Probable Cost has been prepared. Tables 1 through 3 contain the Opinions of Probable Cost for Phases 1, 2, and 3, respectively. Table 4 includes an Opinion of Probable Cost for the entire roadway, given that it is constructed as one project. These costs, which include a 10% contingency, are shown below:

Phase 1:	$4,300,251.56
Phase 2:	$1,073,233.92
Phase 3:	$1,668,715.62
Entire Project:	$6,682,583.60

As previously noted, the current funding available for Phase 1 of the project is $4.75 million, which includes design and landscaping.

The following assumptions were made when preparing the Opinions of Probable Costs for this project:

- The cost of entire project constructed at one time is less than the sum of the three phases, due to economies of scale.
- Proposed improvements to the existing storm sewer system as outlined in this report have been included.
- Concrete sidewalks will be replaced when located directly adjacent to the existing curb.
- Median brick pavers will be used in areas where the median width is less than 3'.
- Coordination with DART regarding the railroad crossing gates will be required during the design and construction process.
- Coordination with Oncor will be required for the removal and replacement of the street lights and installation of the new traffic signals.
- A 10-inch Portland cement pavement section with dowelled joints on a crushed limestone base and a compacted subgrade has been utilized.
- A minimum pavement strength of 650 psi has been specified.
- A thicker pavement section has been used in lieu of lime stabilization in order to reduce the construction time.

TABLE 1
ENGINEER'S OPINION OF PROBABLE COST
PHASE 1 MIDWAY ROAD RECONSTRUCTION
NORTHBOUND LANES FROM BELT LINE ROAD TO KELLER SPRINGS (5,700 LINEAR FEET)
SOUTHBOUND LANES FROM BELT LINE ROAD TO LINDBERG (1,500 LINEAR FEET)
ADDISON, TEXAS

ITEM NO.	ITEM DESCRIPTION	UNIT	UNIT COST	TOTAL QUANTITY	TOTAL COST
1	MOBILIZATION	LS	$110,000.00	1	$110,000.00
2	PREPARE RIGHT OF WAY	STA	$2,500.00	57	$142,500.00
3	UNCLASSIFIED ROADWAY EXCAVATION	CY	$10.00	5,500	$55,000.00
4	SAWCUT EXISTING PAVEMENT / DRIVEWAY	LF	$3.00	4,893	$14,679.00
5	REMOVE EXISTING CONCRETE PAVEMENT	SY	$7.50	30,501	$228,757.50
6	REMOVE EXISTING CONCRETE DRIVEWAY	SY	$10.00	1,655	$16,550.00
7	10" REINFORCED CONCRETE PAVEMENT (DOWELLED JOINTS)	SY	$50.00	32,883	$1,644,150.00
8	6" CRUSHED STONE BASE	SY	$6.00	33,869	$203,214.00
9	6" COMPACTEDED SUBGRADE	SY	$3.00	36,174	$108,522.00
10	6" INTEGRAL CONCRETE CURB	LF	$3.00	11,869	$35,607.00
11	MONOLITHIC MEDIAN NOSE	EA	$1,000.00	4	$4,000.00
12	6" CONCRETE DRIVEWAY	SY	$25.00	1,655	$41,375.00
13	MEDIAN BRICK PAVERS	SF	$7.50	1,592	$11,940.00
14	REMOVE / REPLACE 4" REINFORCED CONCRETE SIDEWALK (5')	SY	$45.00	598	$26,910.00
15	TEMPORARY 8" ASPHALT (PLACE AND REMOVE)	SY	$20.00	1,786	$35,720.00
16	TACK COAT (0.05 GAL / SY)	GAL	$2.00	89	$178.60
17	RAILROAD HEADER	LF	$200.00	162	$32,400.00
18	RELOCATE EXISTING FIRE HYDRANT ASSEMBLY	EA	$1,200.00	1	$1,200.00
19	REMOVE / REPLACE STORM SEWER INLET	EA	$2,500.00	8	$20,000.00
20	ADJUST EXISTING WATER VALVE COVERS	EA	$250.00	19	$4,750.00
21	ADJUST EXISTING SANITARY SEWER MANHOLES	EA	$600.00	8	$4,800.00
22	ADJUST EXISTING UTILITY MANHOLES	EA	$750.00	5	$3,750.00
23	20' CURB INLET	EA	$3,000.00	4	$12,000.00
24	14' CURB INLET	EA	$2,500.00	9	$22,500.00
25	10' CURB INLET	EA	$2,500.00	4	$10,000.00
26	SPECIAL INLET OPENING OFF ROAD	EA	$5,000.00	1	$5,000.00
27	36" RCP STORM SEWER PIPE	LF	$60.00	334	$20,040.00
28	30" RCP STORM SEWER PIPE	LF	$55.00	578	$31,790.00
29	24" RCP STORM SEWER PIPE	LF	$45.00	330	$14,850.00
30	21" RCP STORM SEWER PIPE	LF	$35.00	652	$22,820.00
31	REMOVE EXISTING INLET	EA	$500.00	13	$6,500.00
32	REMOVE SHRUBS	EA	$20.00	88	$1,760.00
33	REMOVE TREE 0" - 6"	EA	$75.00	12	$900.00
34	REMOVE TREE GREATER THAN 6"	EA	$150.00	10	$1,500.00
35	BLOCK SODDING FOR PARKWAYS	SY	$5.00	4,372	$21,860.00
36	24" SOLID WHITE THERMOPLASTIC STOP BAR	LF	$10.00	541	$5,410.00
37	6" SOLID WHITE THERMOPLASTIC STRIPES	LF	$2.50	1,374	$3,435.00
38	4" WHITE REFLECTIVE TYPE I-W-C CERAMIC BUTTON	EA	$6.00	1,962	$11,772.00
39	6"x 6" WHITE REFLECTIVE JIGGLE BAR TILES	EA	$15.00	143	$2,145.00
40	WHITE THERMO DIRECTIONAL PAVEMENT MARKINGS	EA	$250.00	21	$5,250.00
41	RR CROSSING SYMBOL	EA	$500.00	6	$3,000.00
42	REMOVE RR ARM ASSEMBLY	EA	$5,000.00	2	$10,000.00
43	REMOVE LIGHT POLE ASSEMBLY	EA	$2,000.00	22	$44,000.00
44	TEMPORARY RR ARM ASSEMBLY (SEQUENCING)	EA	$10,000.00	2	$20,000.00
45	TEMPORARY 4" WHITE TRAFFIC STRIPE	LF	$0.50	4,963	$2,481.50
46	TEMPORARY 4" YELLOW TRAFFIC STRIPE	LF	$0.50	24,646	$12,323.00
47	TEMPORARY TRAFFIC SIGNALIZATION AT INTERSECTIONS	EA	$20,000.00	4	$80,000.00
48	2" PVC CONDUIT FOR LIGHT POLES	LF	$2.50	1,350	$3,375.00
49	PULL BOXES FOR LIGHT POLES	EA	$350.00	7	$2,450.00
50	INLET EROSION PROTECTION	EA	$100.00	20	$2,000.00
51	SILT FENCE	LF	$4.00	990	$3,960.00
52	TEMPORARY CONSTRUCTION ENTRANCE	EA	$2,500.00	6	$15,000.00
53	MAINTAIN EROSION CONTROL DEVICES	LS	$10,000.00	1	$10,000.00
54	REMOVE TRAFFIC SIGNALS (MEDIANS)	EA	$5,000.00	5	$25,000.00
55	SIGNS, BARRICADES, TRAFFIC CONTROL	MO	$10,000.00	18	$180,000.00
56	ADJUST EXISTING UTILITIES	LS	$100,000.00	1	$100,000.00
57	ROOT BARRIER	LF	$5.00	2,039	$10,195.00
58	REPLACE LIGHT POLE ASSEMBLY	EA	$2,000.00	10	$20,000.00
59	PERMANENT TRAFFIC SIGNALS AT INTERSECTIONS (MEDIAN ONLY)	EA	$30,000.00	5	$150,000.00
60	REPLACE RR ARM ASSEMBLY	EA	$50,000.00	2	$100,000.00
61	TEMPORARY LIGHTING	LS	$20,000.00	1	$20,000.00
62	REMOVE/REPLACE LANDSCAPING AND IRRIGATION	LS	$150,000.00	1	$150,000.00
				SUB-TOTAL	$3,909,319.60
				10 % CONTINGENCY	$390,931.96
				TOTAL	$4,300,251.56

TABLE 2
ENGINEER'S OPINION OF PROBABLE COST
PHASE 2 MIDWAY ROAD RECONSTRUCTION
SOUTHBOUND LANES FROM BOYINGTON TO KELLER SPRINGS (1,700 LINEAR FEET)
ADDISON, TEXAS

ITEM NO.	ITEM DESCRIPTION	UNIT	UNIT COST	TOTAL QUANTITY	TOTAL COST
1	MOBILIZATION	LS	$70,000.00	1	$70,000.00
2	PREPARE RIGHT OF WAY	STA	$2,500.00	17	$42,500.00
3	UNCLASSIFIED ROADWAY EXCAVATION	CY	$10.00	3,000	$30,000.00
4	SAWCUT EXISTING PAVEMENT / DRIVEWAY	LF	$3.00	5,100	$15,300.00
5	REMOVE EXISTING CONCRETE PAVEMENT	SY	$7.50	7,402	$55,515.00
6	REMOVE EXISTING CONCRETE DRIVEWAY	SY	$10.00	387	$3,870.00
7	10" REINFORCED CONCRETE PAVEMENT (DOWELLED JOINTS)	SY	$50.00	7,402	$370,100.00
8	6" CRUSHED STONE BASE	SY	$6.00	7,624	$45,744.00
9	6" COMPACTED SUBGRADE	SY	$3.00	8,143	$24,429.00
10	6" INTEGRAL CONCRETE CURB	LF	$3.00	2,986	$8,958.00
11	MONOLITHIC MEDIAN NOSE	EA	$1,000.00	8	$8,000.00
12	6" CONCRETE DRIVEWAY	SY	$25.00	387	$9,675.00
13	MEDIAN BRICK PAVERS	SF	$7.50	2,628	$19,710.00
14	TEMPORARY 8" ASPHALT (PLACE AND REMOVE)	SY	$20.00	287	$5,740.00
15	TACK COAT (0.05 GAL / SY)	GAL	$2.00	14	$28.70
16	ADJUST EXISTING WATER METER COVER	EA	$300.00	2	$600.00
17	ADJUST EXISTING WATER VALVE COVERS	EA	$250.00	10	$2,500.00
18	ADJUST EXISTING UTILITY MANHOLES	EA	$750.00	3	$2,250.00
19	TRIM SHRUBS	EA	$100.00	5	$500.00
20	TRIM TREE 0" - 6"	EA	$200.00	4	$800.00
21	TRIM TREE GREATER THAN 6"	EA	$300.00	6	$1,800.00
22	BLOCK SOD FOR MEDIANS	SY	$5.00	390	$1,950.00
23	BLOCK SODDING FOR PARKWAYS	SY	$5.00	1,584	$7,920.00
24	24" SOLID WHITE THERMOPLASTIC STOP BAR	LF	$10.00	80	$800.00
25	6" SOLID WHITE THERMOPLASTIC STRIPES	LF	$2.50	460	$1,150.00
26	4" WHITE REFLECTIVE TYPE I-W-C CERAMIC BUTTON	EA	$6.00	435	$2,610.00
27	6"x 6" WHITE REFLECTIVE JIGGLE BAR TILES	EA	$15.00	34	$510.00
28	WHITE THERMO DIRECTIONAL PAVEMENT MARKINGS	EA	$250.00	4	$1,000.00
29	REMOVE LIGHT POLE ASSEMBLY	EA	$2,000.00	1	$2,000.00
30	TEMPORARY 4" WHITE TRAFFIC STRIPE	LF	$0.50	1,431	$715.50
31	TEMPORARY 4" YELLOW TRAFFIC STRIPE	LF	$0.50	7,944	$3,972.00
32	TEMPORARY TRAFFIC SIGNALIZATION AT INTERSECTIONS	EA	$20,000.00	2	$40,000.00
33	2" PVC CONDUIT FOR LIGHT POLES	LF	$2.50	1,700	$4,250.00
34	PULL BOXES FOR LIGHT POLES	EA	$350.00	7	$2,450.00
35	SILT FENCE	LF	$4.00	830	$3,320.00
36	TEMPORARY CONSTRUCTION ENTRANCE	EA	$2,500.00	2	$5,000.00
37	MAINTAIN EROSION CONTROL DEVICES	LS	$5,000.00	1	$5,000.00
38	SIGNS, BARRICADES, TRAFFIC CONTROL	MO	$30,000.00	5	$150,000.00
39	ADJUST EXISTING UTILITIES	LS	$25,000.00	1	$25,000.00
40	ROOT BARRIER	LF	$5.00	415	$2,075.00
41	PERMANENT TRAFFIC SIGNALS AT INTERSECTIONS	EA	$30,000.00	2	$60,000.00
42	REMOVE/REPLACE LANDSCAPING AND IRRIGATION	LS	$40,000.00	1	$40,000.00
				SUB-TOTAL	$975,667.20
				10 % CONTINGENCY	$97,566.72
				TOTAL	$1,073,233.92

TABLE 3
ENGINEER'S OPINION OF PROBABLE COST
PHASE 3 MIDWAY ROAD RECONSTRUCTION
SOUTHBOUND LANES FROM LINDBERG TO BOYINGTON (2,500 LINEAR FEET)
ADDISON, TEXAS

ITEM NO.	ITEM DESCRIPTION	UNIT	UNIT COST	TOTAL QUANTITY	TOTAL COST
1	MOBILIZATION	LS	$80,000.00	1	$80,000.00
2	PREPARE RIGHT OF WAY	STA	$2,500.00	25	$62,500.00
3	UNCLASSIFIED ROADWAY EXCAVATION	CY	$10.00	4,500	$45,000.00
4	SAWCUT EXISTING PAVEMENT / DRIVEWAY	LF	$3.00	7,500	$22,500.00
5	REMOVE EXISTING CONCRETE PAVEMENT	SY	$7.50	10,804	$81,030.00
6	REMOVE EXISTING CONCRETE DRIVEWAY	SY	$10.00	543	$5,430.00
7	10" REINFORCED CONCRETE PAVEMENT (DOWELLED JOINTS)	SY	$50.00	10,804	$540,200.00
8	6" CRUSHED STONE BASE	SY	$6.00	11,128	$66,768.00
9	6" COMPACTED SUBGRADE	SY	$3.00	11,885	$35,655.00
10	6" INTEGRAL CONCRETE CURB	LF	$3.00	4,041	$12,123.00
11	MONOLITHIC MEDIAN NOSE	EA	$1,000.00	11	$11,000.00
12	6" CONCRETE DRIVEWAY	SY	$25.00	543	$13,575.00
13	MEDIAN BRICK PAVERS	SF	$7.50	4,661	$34,957.50
14	REMOVE / REPLACE 4" REINFORCED CONCRETE SIDEWALK (5')	SY	$45.00	322	$14,490.00
15	TEMPORARY 8" ASPHALT (PLACE AND REMOVE)	SY	$20.00	392	$7,840.00
16	TACK COAT (0.05 GAL / SY)	GAL	$2.00	20	$39.20
17	REMOVE / REPLACE STORM SEWER INLET	EA	$5,000.00	5	$25,000.00
18	ADJUST EXISTING WATER VALVE COVERS	EA	$250.00	4	$1,000.00
19	ADJUST EXISTING UTILITY MANHOLES	EA	$750.00	4	$3,000.00
20	ADJUST STORM SEWER MANHOLES	EA	$600.00	1	$600.00
21	TRIM TREE GREATER THAN 6"	EA	$300.00	13	$3,900.00
22	BLOCK SOD FOR MEDIANS	SY	$5.00	491	$2,455.00
23	BLOCK SODDING FOR PARKWAYS	SY	$5.00	1,878	$9,390.00
24	24" SOLID WHITE THERMOPLASTIC STOP BAR	LF	$10.00	20	$200.00
25	6" SOLID WHITE THERMOPLASTIC STRIPES	LF	$2.50	100	$250.00
26	4" WHITE REFLECTIVE TYPE I-W-C CERAMIC BUTTON	EA	$6.00	567	$3,402.00
27	6"x 6" WHITE REFLECTIVE JIGGLE BAR TILES	EA	$15.00	55	$825.00
28	WHITE THERMO DIRECTIONAL PAVEMENT MARKINGS	EA	$250.00	8	$2,000.00
29	REMOVE LIGHT POLE ASSEMBLY	EA	$2,000.00	3	$6,000.00
30	TEMPORARY 4" WHITE TRAFFIC STRIPE	LF	$0.50	1,057	$528.50
31	TEMPORARY 4" YELLOW TRAFFIC STRIPE	LF	$0.50	8,452	$4,226.00
32	TEMPORARY TRAFFIC SIGNALIZATION AT INTERSECTIONS	EA	$20,000.00	1	$20,000.00
33	2" PVC CONDUIT FOR LIGHT POLES	LF	$2.50	2,500	$6,250.00
34	PULL BOXES FOR LIGHT POLES	EA	$350.00	10	$3,500.00
35	INLET EROSION PROTECTION	EA	$100.00	6	$600.00
36	SILT FENCE	LF	$4.00	840	$3,360.00
37	TEMPORARY CONSTRUCTION ENTRANCE	EA	$2,500.00	3	$7,500.00
38	MAINTAIN EROSION CONTROL DEVICES	LS	$7,500.00	1	$7,500.00
39	SIGNS, BARRICADES, TRAFFIC CONTROL	MO	$30,000.00	7	$210,000.00
40	ADJUST EXISTING UTILITIES	LS	$40,000.00	1	$40,000.00
41	ROOT BARRIER	LF	$5.00	484	$2,420.00
42	PERMANENT TRAFFIC SIGNALS AT INTERSECTIONS	EA	$30,000.00	2	$60,000.00
43	REMOVE/REPLACE LANDSCAPING AND IRRIGATION	LS	$60,000.00	1	$60,000.00
				SUB-TOTAL	$1,517,014.20
				10 % CONTINGENCY	$151,701.42
				TOTAL	$1,668,715.62

TABLE 4
ENGINEER'S OPINION OF PROBABLE COST
MIDWAY ROAD RECONSTRUCTION - ENTIRE PROJECT
BELT LINE ROAD TO KELLER SPRINGS (5,700 LINEAR FEET)
ADDISON, TEXAS

ITEM NO.	ITEM DESCRIPTION	UNIT	UNIT COST	TOTAL QUANTITY	TOTAL COST
1	MOBILIZATION	LS	$200,000.00	1	$200,000.00
2	PREPARE RIGHT OF WAY	STA	$3,000.00	57	$171,000.00
3	UNCLASSIFIED ROADWAY EXCAVATION	CY	$10.00	13,000	$130,000.00
4	SAWCUT EXISTING PAVEMENT / DRIVEWAY	LF	$3.00	17,493	$52,479.00
5	REMOVE EXISTING CONCRETE PAVEMENT	SY	$7.50	48,707	$365,302.50
6	REMOVE EXISTING CONCRETE DRIVEWAY	SY	$10.00	2,585	$25,850.00
7	10" REINFORCED CONCRETE PAVEMENT (DOWELLED JOINTS)	SY	$50.00	51,089	$2,554,450.00
8	6" CRUSHED STONE BASE	SY	$6.00	52,621	$315,726.00
9	6" COMPACTEDED SUBGRADE	SY	$3.00	56,202	$168,606.00
10	6" INTEGRAL CONCRETE CURB	LF	$3.00	18,896	$56,688.00
11	MONOLITHIC MEDIAN NOSE	EA	$1,000.00	23	$23,000.00
12	6" CONCRETE DRIVEWAY	SY	$25.00	2,585	$64,625.00
13	MEDIAN BRICK PAVERS	SF	$7.50	8,881	$66,607.50
14	REMOVE / REPLACE 4" REINFORCED CONCRETE SIDEWALK (5')	SY	$45.00	920	$41,400.00
15	TEMPORARY 8" ASPHALT (PLACE AND REMOVE)	SY	$20.00	2,465	$49,300.00
16	TACK COAT (0.05 GAL / SY)	GAL	$2.00	123	$246.50
17	RAILROAD HEADER	LF	$200.00	162	$32,400.00
18	RELOCATE EXISTING FIRE HYDRANT ASSEMBLY	EA	$1,200.00	1	$1,200.00
19	REMOVE / REPLACE STORM SEWER INLET	EA	$2,500.00	13	$32,500.00
20	ADJUST EXISTING WATER METER COVER	EA	$300.00	2	$600.00
21	ADJUST EXISTING WATER VALVE COVERS	EA	$250.00	33	$8,250.00
22	ADJUST EXISTING SANITARY SEWER MANHOLES	EA	$600.00	8	$4,800.00
23	ADJUST EXISTING UTILITY MANHOLES	EA	$750.00	12	$9,000.00
24	ADJUST STORM SEWER MANHOLES	EA	$600.00	1	$600.00
25	20' CURB INLET	EA	$3,000.00	4	$12,000.00
26	14' CURB INLET	EA	$2,500.00	9	$22,500.00
27	10' CURB INLET	EA	$2,500.00	4	$10,000.00
28	SPECIAL INLET OPENING OFF ROAD	EA	$5,000.00	1	$5,000.00
29	36" RCP STORM SEWER PIPE	LF	$60.00	334	$20,040.00
30	30" RCP STORM SEWER PIPE	LF	$55.00	578	$31,790.00
31	24" RCP STORM SEWER PIPE	LF	$45.00	330	$14,850.00
32	21" RCP STORM SEWER PIPE	LF	$35.00	652	$22,820.00
33	REMOVE EXISTING INLET	EA	$500.00	13	$6,500.00
34	REMOVE SHRUBS	EA	$20.00	88	$1,760.00
35	REMOVE TREE 0" - 6"	EA	$75.00	12	$900.00
36	REMOVE TREE GREATER THAN 6"	EA	$150.00	10	$1,500.00
37	TRIM SHRUBS	EA	$100.00	5	$500.00
38	TRIM TREE 0" - 6"	EA	$200.00	4	$800.00
39	TRIM TREE GREATER THAN 6"	EA	$300.00	19	$5,700.00
40	BLOCK SOD FOR MEDIANS	SY	$5.00	881	$4,405.00
41	BLOCK SODDING FOR PARKWAYS	SY	$5.00	7,834	$39,170.00
42	24" SOLID WHITE THERMOPLASTIC STOP BAR	LF	$10.00	641	$6,410.00
43	6" SOLID WHITE THERMOPLASTIC STRIPES	LF	$2.50	1,934	$4,835.00
44	4" WHITE REFLECTIVE TYPE I-W-C CERAMIC BUTTON	EA	$6.00	2,964	$17,784.00
45	6"x 6" WHITE REFLECTIVE JIGGLE BAR TILES	EA	$15.00	232	$3,480.00
46	WHITE THERMO DIRECTIONAL PAVEMENT MARKINGS	EA	$250.00	33	$8,250.00
47	RR CROSSING SYMBOL	EA	$500.00	6	$3,000.00
48	REMOVE RR ARM ASSEMBLY	EA	$5,000.00	2	$10,000.00
49	REMOVE LIGHT POLE ASSEMBLY	EA	$2,000.00	26	$52,000.00
50	TEMPORARY RR ARM ASSEMBLY (SEQUENCING)	EA	$10,000.00	2	$20,000.00
51	TEMPORARY 4" WHITE TRAFFIC STRIPE	LF	$0.50	7,451	$3,725.50
52	TEMPORARY 4" YELLOW TRAFFIC STRIPE	LF	$0.50	41,042	$20,521.00
53	TEMPORARY TRAFFIC SIGNALIZATION AT INTERSECTIONS	EA	$20,000.00	5	$100,000.00
54	2" PVC CONDUIT FOR LIGHT POLES	LF	$2.50	5,550	$13,875.00
55	PULL BOXES FOR LIGHT POLES	EA	$350.00	24	$8,400.00
56	INLET EROSION PROTECTION	EA	$100.00	26	$2,600.00
57	SILT FENCE	LF	$4.00	2,660	$10,640.00
58	TEMPORARY CONSTRUCTION ENTRANCE	EA	$2,500.00	11	$27,500.00
59	MAINTAIN EROSION CONTROL DEVICES	LS	$22,500.00	1	$22,500.00
60	REMOVE TRAFFIC SIGNALS (MEDIANS)	EA	$5,000.00	5	$25,000.00
61	SIGNS, BARRICADES, TRAFFIC CONTROL	MO	$10,000.00	24	$240,000.00
62	ADJUST EXISTING UTILITIES	LS	$165,000.00	1	$165,000.00
63	ROOT BARRIER	LF	$5.00	2,938	$14,690.00
64	REPLACE LIGHT POLE ASSEMBLY	EA	$2,000.00	35	$70,000.00
65	PERMANENT TRAFFIC SIGNALS AT INTERSECTIONS	EA	$30,000.00	5	$150,000.00
66	REPLACE RR ARM ASSEMBLY	EA	$50,000.00	2	$100,000.00
67	TEMPORARY LIGHTING	LS	$50,000.00	1	$50,000.00
68	REMOVE/REPLACE LANDSCAPING AND IRRIGATION	LS	$350,000.00	1	$350,000.00
				SUB-TOTAL	$6,075,076.00
				10 % CONTINGENCY	$607,507.60
				TOTAL	$6,682,583.60

Based on the information presented within this design report, GBW's conclusions and recommendations are presented below.

- Extensive research was carried out by GBW regarding the value of using Cement Treated Permeable Base in the pavement section for the reconstruction of Midway Road. It was determined, however, that a crushed limestone base would be more appropriate. (See Appendix A and Appendix C).

- Research was also carried out by GBW regarding the possible installation of a ductbank in conjunction with the pavement reconstruction. This research, which is summarized in Appendix B, lead to the conclusion that the Town should not install a ductbank.

- The pavement distress along the northbound lanes is more pronounced than along the southbound lanes. GBW determined that the cross-slope on the northbound lanes, which is generally less than on the southbound lanes, increases the likelihood that surface water will pond on the pavement surface. Subsequently, a higher infiltration rate of moisture into the subgrade under the northbound lanes, through pavement joints and cracks, has increased the rate of pavement deterioration relative to the southbound lanes. (See Appendix C)

- According to Town staff, $4.75 million in bond funds is available for this project, which includes payment for engineering services, landscape and irrigation replacement, temporary lighting, in addition to all other project related expenses. An Opinion of Probable Cost prepared by GBW revealed that the available bond money was significantly less than that total funds required to reconstruct the entire project at one time. Consequently, it was apparent that, unless additional funds were found, the project would need to be phased.

- In conjunction with the Town's staff, it was determined that the project will be constructed in three phases which are described in Section 3. The limits of Phase 1, which were set to allow this phase to be constructed with the available bond funds, replaces the pavement in the poorest condition. The phase includes reconstruction of all the northbound lanes and a portion of the southbound lanes from Belt Line Road to Lindbergh Drive.

- Phase 2 replaces the southbound lanes from Boyington Drive to Keller Springs Drive while Phase 3 replaces the southbound lanes from Lindbergh Drive to Boyington Drive.

- Once the construction phasing had been determined, consideration was given to the construction sequencing and traffic control. Section 4 describes three alternatives which were evaluated for two construction scenarios: Belt Line Road to Lindbergh Drive where the northbound and southbound lanes will be reconstructed together, and Lindbergh Drive to Keller Springs Road, where the lanes in one direction will be constructed separately from the lanes in the other direction.

- From Belt Line Road to Lindbergh Drive, the recommended alternative involves removing the median and installing temporary asphalt pavement so that two lanes of traffic can be maintained in each direction during construction, along with a continuous left-turn lane during most construction steps.

- From Lindbergh Drive to Keller Springs Road, the recommended alternative involves reconstructed each lane of the three lanes in one direction separately without the removal of the median. Two lanes of traffic are still maintained in the direction of flow with this alternative.
- As a supplement to the initial scope of this report, GBW performed an analysis of the existing storm sewer system in Midway Road to determine whether or not it meets current Town of Addison drainage criterial. This analysis concluded that there are several locations, as detailed in Section 5, where the existing system should be modified or extended.
- It is recommended that these storm sewer system improvements be made in conjunction with the Midway Road pavement reconstruction with the exception of the culvert improvements which are scheduled to be made in conjunction with the Arapaho Road Phase 3 project.
- When the funds are allocated for the construction of Phase 1 of Midway Road, the Town will need to authorize GBW to perform Phase Two of the design contract. This work will include completing the preliminary set of construction plans which have been prepared as if the entire project was being constructed at one time.

APPENDIX A

GENERAL NOTES ON CEMENT TREATED PERMEABLE BASE

GBW Engineers, Inc.

DESIGN MEMO

Date: April 2, 2001 **Job No.** 00-238

From: GBW **Job Name:** Midway Road/Arapaho Road

To: Steve Chutchian, P.E.; Jerry Holder, P.E.

Re: General Notes on Cement Treated Permeable Base

BASE COURSE NOTES

General

- If construction traffic will be allowed on the permeable base, cement stabilization is generally needed to avoid the substantial cost of constructing a temporary adjacent haul road for side delivery of concrete to the paver.

Aggregate

- Quality of crushed aggregates is the single most important factor for the stability of a permeable base. Aggregate should be stored, handled, and placed in a manner to keep segregation to a minimum.

- The most popular aggregate gradations are AASHTO No. 57 and No. 67, which are characterized by having very little material finer that No. 8 sieve.

- The aggregate material should have at least two mechanically fractured faces to ensure good mechanical interlock. This will require a crushed material.

Permeability

- Cement-treated bases have coefficients of permeability in the range of 3,000 to 15,000 ft per day. Untreated permeable bases range from 500 to 2,000 ft per day.

- Edge-drains are usually filled with the same highly permeable material that is used for the base or a material with even higher permeability.

Cement

- While 200 lb cement per cubic yard has been the amount most generally specified, agencies have used amounts varying from 150 to 300 lb.

- Mixes with 150 lb/c.y. cement content should be restricted to areas subjected to only a few truck hauls over stable subgrade.

- Mixes with 200 lb/c.y. cement content are appropriate for general use (average trucking and subgrade conditions.).
- Mixes with 250 lb/c.y. cement should be used where heavy trucking will occur or where support conditions are questionable.
- From the low to the high cement content, 7 day field compressive strengths varied from 150 to 600 psi; however, cement content rather than strength should be used to select the most appropriate mix.

Water Content

- Water contents for workable mixtures are usually in the range of 100 to 120 lb/yd3. Water content should be based on the contractor's assessment of the mix workability.
- A water/cement ratio at the higher end of the range may encourage the cement paste to flow to points of aggregate contact where its cementing action is needed. The FHWA recommends this design approach.

Pavement Section

- The thickness of permeable bases used has varied from 3 to 6 inches, with 4 inches being the most common. The thickness should be adequate to overcome any construction variances and provide an adequate hydraulic conduit to transmit the water to the edge-drain.
- A minimum resultant slope of 2 percent is recommended wherever possible.

Construction

- Most commonly, the base is compacted by vibratory plates or screeds: The objective is to solidly seat the material.
- Over-rolling can cause degradation of the material with a resulting loss of permeability
- Cement-treated permeable bases are cured by water misting several times a day or by covering with polyethylene sheets for 3 to 5 days.
- The need for curing is one of the least understood aspects of constructing cement treated permeable bases.
- Some agencies are studying the cost-effectiveness of curing; Wisconsin found little difference between material covered with polyethylene and that left exposed.
- During construction, care must be taken to prevent contamination of the permeable base from mud and dirt carried by truck tires. Construction traffic should be kept to a minimum and sharp truck turning should be avoided.

SEPARATOR NOTES

General

- Beneath the permeable base course, a separator or filter layer prevents fine particles in the subgrade soil from infiltrating the open-graded base.
- An asphalt prime coat placed on the stabilized subgrade/subbase would provide additional protection.
- A separator layer can be provided by an aggregate separator layer or by a geotextile.

Aggregate Layer

- The aggregate layer must be strong enough to provide a stable working platform for constructing the permeable base.
- The gradation of this layer must be carefully selected to prevent fines from pumping up from the subgrade into the permeable base.
- The aggregate layer must have a low permeability to deflect infiltrated water over to the edge drain.
- The FHWA recommends the percent of fines passing the No. 200 sieve should not exceed 12 percent and the coefficient of uniformity should be greater the 20 (preferably greater the 40.)
- A minimum thickness of 4 inches is recommended for the aggregate separator layer.

Geotextile

- In subgrades with a high percentage of fines, a geotextile might be a preferred choice.
- The geotextile must have enough strength to survive the construction phase.
- The principal advantage of a geotextile is its filtration capability. A geotextile will allow any rising water, due to capillary action or a rising water table, to enter the permeable base and rapidly drain to the edge-drain system.
- The main disadvantage is if the geotextile becomes clogged, rising water will be trapped under the geotextile, saturating the subgrade and reducing subgrade support.
- Pore openings should be sized to retain larger soil particles and pass smaller soil particles. Large numbers of openings should be provided in case there is some clogging.
- The geotextile should have a permeability several times greater than the subgrade so that any vertical draining water will not be unduly impeded by the geotextile.

- The geotextile should be specified based on performance rather than type (woven or non-woven).
- Geotextiles are subject to degradation when exposed to sunlight for extended periods of time. To prevent this, geotextiles should be placed and covered as quickly as possible.

LONGITUDINAL EDGE-DRAIN NOTES

General

- For crowned pavement, edge-drains are installed along both the inner and outer pavement edge. For uncrowned sections, only one edge-drain is installed at the low side.

- For the longitudinal edge-drain pipe, most agencies use 6-inch diameter flexible corrugated polyethylene tubing (perforated and meeting AASHTO M252.) Rigid PVC pipe (slotted, AASHTO M278-PC50) has also been used but is more expensive. If the pipe is to be installed in trenches that are to be backfilled with asphalt-stabilized permeable material, the pipe must be capable of withstanding the temperature.

- The trench backfill material should be of the same material as the permeable base course to ensure adequate capacity.

- The preferred location for the edge-drain is 2 or 3 feet outside the curb to avoid settlement problems or crushing the collector pipe beneath construction equipment. Sometimes, the permeable base is extended under the shoulder with the edge-drain placed at the outside shoulder edge.

- The suggested minimum pipe size is 4 inches and the minimum slope should be 0.0035 ft/ft.

- Depending on the pipe size, the trench width should be between 8 and 10 inches. The trench should be deep enough to allow the top of the pipe to be located 2 inches below the bottom of the permeable base.

- The edge-drain trench should be lined with a geotextile, but the top of the trench adjacent to the permeable base is left open to allow a direct path for the water into the edge-drain pipe.

- The ability to flush or jet rod the system is important in the maintenance scheme. The edge-drain and outlet pipes must have proper bends (2 to 3-feet radii) and vents to facilitate this operation.

- Videotaping the completed edge-drain with flexible fiber optic equipment is suggested for final acceptance of the project.

Lateral Pipes

- Lateral outlet pipes are rigid PVC or metal. Rigid pipe provides more protection against crushing due to construction operations.

- The Federal Highway Administration recommends a maximum outlet spacing of 250 feet to ensure rapid drainage. The pipes should be placed on a 3 percent grade with the outlet at least 6 inches above the 10-year design flow in the ditch or storm sewer.
- Pipe outlets into open ditches are usually protected by concrete headwalls and are equipped with rodent screens.

Construction

- Edge-drains may be installed before or after construction of the permeable base and concrete surface. This will affect the edge-drain location and geotextile placement.

- Pre-pavement installation of the edge-drain may be necessary in some urban situations, but in general, the option should be given to the contractor.

- Post-pavement installation has several advantages: less threat of pipe damage and trench cave-ins due to construction traffic, less susceptibility to bad weather delays, and better line and grade because these are taken off the previously constructed concrete pavements.

Maintenance

- Flushing and rodding of the edge-drain system should be done on a routine schedule.

- Edge-drain outlets and pipe systems should be inspected at least once a year using flexible fiber optic video equipment to determine their condition.

- If regular maintenance is not done, the pavement section will become flooded, increasing the rate of pavement damage.

DESIGN NOTES

- When rainfall events occur that are greater than the design storm, the permeable base will fill with water and excess water will simply run off on the pavement surface. After the storm event, the permeable base will drain as designed.

- A time to drain 50 percent of the drainable water of 1 hour is recommended for the highest class roads with the greatest amount of traffic. For most other highways and freeways, a time to drain 50 percent of the drainable water of 2 hours is recommended.

- Construction traffic on the completed base course is the single most important parameter in the selection of the type of permeable base to be used.

CONSTRUCTION NOTES

- Central plant mixing of permeable cement-treated base course is essentially the same as that for conventional concrete.

- The City may want to construct a test strip of the base course to determine which curing method to employ as well as which method of compaction should be used. Requirements for moist curing should be investigated to see if they might be eliminated without substantial loss of performance under actual job conditions.
- The FHWA recommends that a control strip be constructed at the beginning of construction so that the combination of aggregate materials and construction practices be tested, and if necessary, adjusted to produce a stable permeable base with adequate drainage characteristics. A minimum length of 500 feet is recommended, and this section can become part of the finished roadway if found to be acceptable.

J:\WPDOCS\PROJECTS\ADDISON\00-238\DESIGNMEMO.CTPB

APPENDIX B

DUCTBANK MEMO

GBW Engineers, Inc.

1919 S. Shiloh Rd., Suite 530, LB 27, Garland, TX 75042

MEMO

Date: May 7, 2001

To: Steve Chutchian, P.E.
cc: Jerry Holder, P.E. (HNTB)

From: Bruce Grantham

Re: Ductbank

This memo provides a summary to a meeting I recently had with Catherine Lisenbee, Utility Franchise Coordinator for the City of Irving, and Mike Lisenbee, Construction Manager for Future Telecom Inc.

- Irving has adopted Ordinance No. 7533 (attached) which governs right-of-way construction.
- Ms. Lisenbee communicates the ordinance requirements with all franchise utility companies that plan to install utilities within the City's right-of-way.
- Irving investigated the viability of the City installing ductbanks with street construction projects but rejected this notion for the following reasons:
  - After reviewing House Bill 1777, the City attorney ruled that Irving would assume liability for future maintenance of the ductbank and for potential damages if fiber service were disrupted due to problems with the ductbank.
  - HB 1777 does not allow the ductbank owner to profit from the sale or lease of ducts.
- HB 1777 no longer allows cities to collect permit fees for reviewing and processing requests from franchise utility companies to install ducts within their right-of-ways.
- Irving is currently having discussions with two companies that install and sell ducts to determine their interest in installing ductbanks in conjunction with future City street projects.

Another approach Irving is considering involves contacting all known utility companies that operate in the region and informing them that no future franchise utility construction will be allowed in a right-of-way after the street is constructed; consequently, sufficient ducts must be installed by and for these utility companies prior to construction. The downside of this approach is that new utility companies may enter the region in the future and require service along the right-of-way.

According to Ms. Lisenbee, many businesses today require that comprehensive fiber facilities be available in the right-of-way near their buildings. The availability of these facilities assists in the economic development of commercial sectors of the City like Las Colinas.

Mr. and Ms. Lisenbee recommended that any ductbank installation be designed by a qualified firm that is currently working in the industry and knows the requirements of the fiber companies such as:

- Manholes are typically spaced 800' to 1,000' apart unless a Central Bell Office is located along the corridor, in which case more manholes are required. Three or four manholes are typically installed at each location so that the ducts can be separated and routed through different manholes.
- For security purposes, the fiber companies prefer to have their own 3' x 5' x 4' (deep) manholes installed and reserved for the use of one company; however, larger 8' x 6' x 4' (deep) manholes are used on ductbanks where the future users are not known and the manholes will need to be shared. These larger manholes will have security partitions installed inside the manhole and, whenever a utility needs to access the manholes, all the utilities with services in that manhole are called so that their inspectors can be onsite when the manhole is accessed.
- Service laterals are typically installed from the ductbank to the back of curb at the manhole locations.
- The type of duct used in ductbanks can vary; a form of ribbed PVC pipe is typically used for fiber.
- The size of ducts used for fiber has increase from 1.25" to 1.5" diameter recently.
- Mr. and Ms. Lisenbee suggested that 12 - 6" ducts would be a good choice for a ductbank where the future users are unknown. A 6" duct would allow for several smaller 1.5" fiber ducts inside in addition to providing a larger duct for other types of cable such as telephone or electric.
- Ms. Lisenbee supported Addison's proposal to have a ductbank installed prior to street construction.

Fort Worth also has also taken a progressive approach to franchise utility management within its right-of-ways. Mr. Mitch Montgomery at (817) 998-0937 is the utility coordinator. Ms. Lisenbee and Mr. Montgomery are members of a Right-of-Way Management committee which meets every second Thursday at 2 p.m. in Irving's City Hall. This committee is open to City representatives who have questions regarding the issues summarized in this memo.

APPENDIX C

LETTER REPORT FOR MIDWAY ROAD PAVEMENT SECTION

Grantham, Burge & Waldbauer
GBW Engineers, Inc.

May 21, 2001

Mr. Steve Chutchian, P.E.
Town of Addison
Post Office Box 9010
Addison, Texas 75001

Re: Letter Report for Midway Road
Pavement Section

GBW No. 238

Dear Steve:

This letter report summarizes data from an in-depth field inspection of the Midway Road pavement condition performed by GBW staff and the enclosed draft geotechnical report prepared by Alpha Testing, Inc. In addition, this report includes a review of the pavement section alternatives included in the Alpha Testing report and an opinion of probable cost for two of the pavement sections that utilize alternative base materials.

Description of Problem

Alpha Testing, Inc. strategically selected boring locations in order to determine how subsurface conditions were affecting the level of pavement distress. Following an analysis of the field inspection and soil boring data, we have the following observations:

- The pavement distress along the northbound lanes is more pronounced than the southbound lanes.
- The worst section of the southbound lanes is in the vicinity of the railroad crossing near the Belt Line Road end of the project where a sag is located.
- The cross-slope on the northbound lanes, which is mostly in the 1/8 to 1/4-inch per foot range, is significantly less than the southbound lanes, where it is mostly in the 1/4 to 1/2-inch per foot range.
- The difference between the northbound and southbound lane cross-slopes appears to have resulted from an attempt to match the existing ground at the east and west right-of-way lines when the current Midway Road pavement was designed in 1982.
- The flatter cross-slope on the northbound lanes increases the likelihood that surface water will pond or runoff slowly, resulting in a higher infiltration rate into the subgrade through pavement joints and cracks.
- In addition to rainfall, sprinkler systems in the medians and adjacent parkways are other sources of water which can infiltrate the subgrade.
- Flat longitudinal slopes along some sections of Midway Road also slow that rate of storm water runoff; for example, in the vicinity of the railroad crossing.
- Poor surface drainage appears to be the primary reason why pavement distress has been more rapid along most of the northbound lanes when compared with the southbound lanes.
- The poor condition of many pavement joints, some of which may have been widened when the pavement was milled and resealed in 1994, provide conduits for surface water to reach the subgrade.
- The plasticity index of the underlying clay soil is generally in the 18 to 55 range, which indicates a high potential to shrink and swell.
- The soil borings do not provide evidence of a ground water problem.
- Only eight of the 22 soil borings showed evidence of lime in the subgrade, which suggests that the lime stabilized subgrade was not uniformly constructed.
- A combination of moisture penetration over time and nonuniform lime stabilization during construction has probably reduced the bearing capacity of the subgrade.

- The load transfer capability of the transverse contraction joints has been insufficient to support the heavy traffic volume, resulting in a difference in pavement elevation at the front and back ends of adjacent slabs.
- This difference, which results in a bump at the pavement joints on the northbound lanes in particular, has also resulted in a transverse crack at the midpoint of some slabs.
- Exhibit A contains a summary of data from the field inspection and the geotechnical report.

Comparable Pavement Alternatives

We received a copy of your letter to Jerry Holder dated March 23, 2001 in which you authorize the design team to proceed with pavement section Alternative 3 which included Portland Cement Concrete (PCC) on a Cement Treated Permeable Base (CTPB) with edge drains. Pursuant to our previous discussions, it is understood that the Town intends to use the same type of pavement section for both the Midway and Arapaho Road projects, given that the depths of the concrete and base layers may differ.

In a similar manner to the Terra-Mar, Inc. report for Arapaho Road, the Alpha Testing report for Midway Road analyzes several alternative pavement sections. These alternatives, which assume a 30-year project life, are summarized in the following section.

- *If the load transfer between joints is through aggregate interlock and the subgrade is compacted; either*

11.5 inches	PCC
6 inches	Crushed Limestone Base
6 inches	Compacted subgrade

OR

10.5 inches	PCC
6 inches	CTPB
6 inches	Compacted subgrade

- *If the load transfer between joints is through aggregate interlock and the subgrade is lime stabilized; either*

11 inches	PCC
6 inches	Crushed Limestone Base
6 inches	Lime stabilized subgrade

OR

10 inches	PCC
6 inches	CTPB
6 inches	Lime stabilized subgrade

- *If the load transfer between joints is through dowels and the subgrade is compacted; either*

10 inches	PCC
6 inches	Crushed Limestone Base
6 inches	Compacted subgrade

OR

9 inches	PCC
6 inches	CTPB
6 inches	Compacted subgrade

- *If the load transfer between joints is through dowels and the subgrade is lime stabilized; either*

9.5 inches	PCC
6 inches	Crushed Limestone Base
6 inches	Lime stabilized subgrade

OR

9 inches	PCC
6 inches	CTPB
6 inches	Lime stabilized subgrade

Review of Alternatives

Upon a review of the pavement sections listed above, it is evident that each of the following alternatives reduce the required PCC thickness by ½ to 1 inch:

- *The use of CTPB in lieu of Crushed Limestone Base.*

  Given the Town's selection of CTPB for the Arapaho Road project, it is anticipated that CTPB will also be the base material of choice for the Midway Road project.

- *The use of lime stabilized subgrade in lieu of compacted subgrade.*

  In Section 5.4 of the Terra-Mar report, it states that 'If construction proceeds during wet weather, a lime stabilized subgrade in lieu of a compacted subgrade may be desirable in order to provide a more stable and less moisture sensitive working platform.' A representative with Jackson Brothers, the contractor on the Post and Paddock paving project for the City of Grand Prairie, strongly recommended that a lime stabilized subgrade be used with CTPB due to constructability problems which they experienced on Post and Paddock with a compacted subgrade. If the Town of Addison is willing to consider lime stabilization on Midway Road, it could be bid as an alternate to a compacted subgrade.

- *The use of dowels in lieu of aggregate interlock for load transfer between joints.*

  In Section 5.5 of the Terra-Mar report, it states that 'Steel dowels should be used for load transfer at all joints transverse to traffic.' This recommendation applies to transverse contraction joints which they indicate should typically be placed at 15 feet on-center. The Terra-Mar report does not provide an alternative pavement section for load transfer through aggregate interlock between joints. Locally, aggregate interlock is most commonly used on municipal roadways; nevertheless, both load transfer options could be bid as alternates on Midway Road.

Cost Comparison of Alternatives

If lime stabilization is bid as an alternate to a compacted subgrade, and dowels are bid in lieu of aggregate interlock for load transfer between joints, the contractors that bid the Midway Road project will determine the cost effectiveness of these alternatives. If one or more or these alternatives is not acceptable to the Town, we would be pleased to do the research necessary to prepare an opinion of probable cost for each alternative.

Although it is anticipated that the pavement section on Midway Road will incorporate CTPB, Exhibit B provides an opinion of probable cost for informational purposes to compare it with a pavement section that incorporates Crushed Limestone Base. This comparison, which indicates a $866,805 increase in cost to use CTPB, is contained in that attached spreadsheet.

CTPB Design Memo

Given the limited use of CTPB as a base material for urban pavements in the metroplex, we have prepared a design memo based on our research of this material. The attached design memo on CTPB has been prepared following conversations with a supplier, a contractor, other local and state agency representatives, and other engineers.

This memo is to provides an evaluation of CTPB along with technical data for consideration prior to developing consistent pavement section design standards and specifications for the Midway and Arapaho Road projects.

Fly Ash

The Town of Addison's staff has expressed an interest in using fly ash in the mix design of the PCC pavement for the Midway and Arapaho Road projects. Mr. Michael Caldarone, P.E. with TXI indicated that fly ash is used in concrete paving by number of local cities including Dallas, Fort Worth Arlington, Plano and Grand Prairie, and by TxDOT on the majority of their concrete paving projects. I also contacted the City of Garland's construction manager and confirmed that they permit fly ash in concrete paving mix designs, although the amount is limited to the lesser of 15% of the cement weight or 100 lbs.

Mr. Caldarone furnished our office with sample concrete mix designs, with and without fly ash, which achieve 3,000 psi in 3 days and 7 days respectively. These mix designs are attached for you information. If the Town wishes to utilize fly ash on the subject projects, we can include appropriate limits for its use in the technical specifications.

After reviewing the enclosed geotechnical report for Midway Road and this letter, please contact me if you any comments. I will then request that Alpha Testing finalize their report.

Very truly yours,

Bruce R. Grantham, P.E.
President

Attachments

cc: Jerry Holder, HNTB
Dave Lewis, Alpha Testing

BG/gg
J:\WPDOCS\PROJECTS\ADDISON\00-238\Design Report\Chutchian.ltr

APPENDIX D

ALPHA TESTING GEOTECHNICAL REPORT

REMEDIAL GEOTECHNICAL EXPLORATION

on

MIDWAY ROAD RECONSTRUCTION
Beltline Road to Keller Springs Road
Addison, Texas
ALPHA Report No. 00988

Prepared for:

GBW ENGINEERS, INC.
1919 Shiloh Road, Suite 530, LB 27
Garland, Texas 75042
Attention: Mr. Bruce R. Grantham, P.E.
April 2, 2001

Prepared By:

ALPHA TESTING, INC.
2209 Wisconsin Road, Suite 100
Dallas, Texas 75229

ALPHA TESTING, INC.
2209 Wisconsin St., Suite 100
Dallas, Texas 75229
972/620-8911 - 972/263-4937 (Metro)
FAX: 972/406-8023

April 2, 2001

GBW ENGINEERS, INC.
1919 Shiloh S. Road, Suite 530, LB 27
Garland, Texas 75042
Attention: Mr. Bruce R. Grantham, P.E.

Re: Remedial Geotechnical Exploration
MIDWAY ROAD RECONSTRUCTION
Beltline Road to Keller Springs Road
Addison, Texas
ALPHA Report No. 00988

Attached is the report of the remedial geotechnical exploration performed for the project referenced above. This study has been authorized by Mr. Bruce Grantham, P.E. on December 28, 2000 and performed in accordance with ALPHA Proposal No. GT 7371 dated June 27, 2000.

This report contains results of field explorations and laboratory testing and an engineering interpretation of these with respect to available project characteristics. The results and analyses have been used to develop recommendations for remedial design and reconstruction of a segment of Midway Road in Addison, Texas.

ALPHA TESTING, INC. appreciates the opportunity to be of service on this project. If we can be of further assistance, such as providing materials testing services during construction, please contact our office.

DAVID A. LEWIS
47040

Sincerely yours,

ALPHA TESTING, INC.

David A. Lewis, P.E.
Manager of Engineering Services

Jim L. Hillhouse, P.E.
President

DAL/JLH/dal
Copies: (3) Client

TABLE OF CONTENTS

on

MIDWAY ROAD RECONSTRUCTION
Beltline Road to Keller Springs Road
Addison, Texas
ALPHA Report No. 00988

1.0 PURPOSE AND SCOPE

The purpose of this remedial geotechnical exploration is to evaluate some of the physical and engineering properties of subsurface materials at the subject study area with respect to design and reconstruction of a segment of Midway Road in Addison, Texas. The field exploration has been accomplished by securing subsurface samples (including concrete pavement) from widely spaced test borings performed along the study area. Engineering analyses have been performed from results of the field exploration and results of laboratory tests performed on representative samples. The analyses have been used to develop recommended pavement section options for the subject reconstructed roadway.

Also included is an evaluation of the site with respect to potential construction problems and recommendations concerning earthwork and quality control testing during construction. This information can be used to verify subsurface conditions and to aid in ascertaining all construction phases meet project specifications.

Recommendations provided in this report have been developed from information obtained in test borings depicting subsurface conditions only at the specific boring locations and at the particular time designated on the logs. Subsurface conditions at other locations may differ from those observed at the boring locations. The scope of work is not intended to fully define the variability of subsurface materials that may be present on the study area.

The nature and extent of variations between borings may not become evident until construction. If significant variations then appear evident, our office should be contacted to re-evaluate our recommendations after performing on-site observations and tests.

Professional services provided in this geotechnical exploration have been performed, findings obtained, and recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. The scope of services provided herein does not include an environmental assessment of the site or investigation for the presence or absence of hazardous materials in the soil, surface water or groundwater.

ALPHA TESTING, INC. is not responsible for conclusions, opinions or recommendations made by others based on this data. Information contained in this report is intended for exclusive use of the Client (and their design representatives) and design of the specific pavement outlined in Section 2.0. Recommendations presented in this report should not be used for design of any other pavements except those specifically described in this report. Further, subsurface conditions can change with passage of time. Recommendations contained herein are not considered applicable for an extended period of time after the completion date of this report. It is recommended our office be contacted for a review of the contents of this report for construction commencing more than two (2) years after completion of this report.

Recommendations provided in this report are based on our understanding of information provided by the Client about characteristics of the project. If the Client notes any deviation from the facts about project characteristics, our office should be contacted immediately since this may materially alter the recommendations. Further, ALPHA TESTING, INC. is not responsible for damages resulting from workmanship of designers or contractors and it is recommended that the owner retain qualified personnel to verify work is performed in accordance with plans and specifications.

2.0 PROJECT CHARACTERISTICS

It is proposed to reconstruct a segment of Midway Road located between Beltline Road and Keller Springs Road in Addison, Texas. A site plan illustrating the general outline of the study area is provided as Figure 1, the Location Plan, in the Appendix of this report. At the time the field exploration was performed, the study area was developed with the existing concrete roadway.

Present plans provide for reconstruction of the existing pavement. The existing pavement has experienced some distress. The distress is generally in the form of depressed areas adjacent to the existing pavement joints and generally occur in the direction of traffic flow from the pavement joints. Joints in the pavement were noted to be unusually large (up to about ½" wide) and in some areas it appears surface water is entering the pavement subgrade through these wide joints. At the north end of the study area (north of Borings 21 and 22; north-bound lane) in particular, water was actually noted emerging from the joints immediately after passage of large trucks. In general, transverse cracking was noted across the pavement panel near their midpoint in areas where significant pavement distress was noted.

3.0 FIELD EXPLORATION

Subsurface conditions along the study area have been explored by drilling 22 test borings in general accordance with ASTM D 420 to a depth of 10 ft using standard rotary drilling equipment. The approximate location of each test boring is shown on the Boring Location Plans, Figures 2-7, enclosed in the Appendix of this report. Some borings were drilled in distressed areas while others were drilled in non-distressed areas for comparison. Details of drilling and sampling operations are briefly summarized in Methods of Field Exploration, Section A-1 of the Appendix.

Soil and rock (shaly limestone) types encountered during the field exploration are presented on Record of Subsurface Exploration sheets included in the Appendix of this report. The boring logs contain our Field Technician's and Engineer's interpretation of conditions believed to exist between actual samples retrieved. Therefore, these boring logs contain both factual and interpretive information. Lines delineating subsurface strata on the boring logs are approximate and the actual transition between strata may be gradual.

Fill materials have been encountered at some boring locations as will be discussed in Section 5.0. There may be fill in other borings than noted or at other locations, but could not be readily identified. Composition of the fill has been evaluated based on samples retrieved from 6-inch maximum diameter boreholes. It is anticipated this fill was placed and compacted during construction of the existing concrete roadway. However, since no records were made available of fill placement, compaction or uniformity, subsurface conditions immediately adjacent to test borings could be substantially different than conditions observed in test borings.

4.0 LABORATORY TESTS

Selected samples of the subsurface materials have been tested in the laboratory to evaluate their engineering properties as a basis in providing recommendations for pavement design and earthwork construction. A brief description of testing procedures used in the laboratory can be found in Methods of Laboratory Testing, Section B-1 of the Appendix. Individual test results are presented either on Record of Subsurface Exploration sheets or on summary data sheets also enclosed in the Appendix.

5.0 GENERAL SUBSURFACE CONDITIONS

In general, the existing concrete pavement is underlain by soils derived from the Austin Chalk formation. Within the 10-ft maximum depth explored during this study, subsurface materials consist generally of clay (CH) underlain by calcareous clay (CL) and deeper shaly limestone. In the southern and central portions of the study area (Borings 1-16), the existing pavement sectiongenerally consists of about 8 inches of Portland cement concrete overlying lime treated subgrade soils. (It should be noted that lime treated subgrade soils were *not* encountered in all of these boring locations.) In the northern portion of the study area (Borings 17-22), the existing pavement section generally consists of 6.5 to 7 inches of Portland cement concrete overlying a clayey (CH/CL) subgrade. The letters in parenthesis represent the soils' classification according to the Unified Soil Classification System (ASTM D 2488). More detailed stratigraphic information is presented on the Record of Subsurface Exploration Sheets attached to this report.

Most of the subsurface materials are relatively impermeable and are anticipated to have a slow response to water movement. Therefore, several days of observation will be required to evaluate actual groundwater levels within the depths explored. Also, the groundwater level at the study area is anticipated to fluctuate seasonally depending on the amount of rainfall, prevailing weather conditions and subsurface drainage characteristics.

During field explorations, free groundwater has been noted in Borings 1-4 on drilling tools and in open boreholes upon completion at depths of 4.5 to 8 ft. Free groundwater was not observed in the other borings during drilling or in the other open boreholes upon completion. In our opinion, the current groundwater level on the study area may be located below the bottom of the borings and water within the depths explored may be "perched" groundwater which has percolated downward through desiccation cracks in the clayey type soils. It is not uncommon to detect seasonal groundwater either from natural fractures within the clay matrix, near the soil/rock interface or from fractures in the rock, particularly after a wet season. If more detailed groundwater information is required, monitoring wells or piezometers can be installed.

Further details concerning subsurface materials and conditions encountered can be obtained from the Record of Subsurface Exploration sheets provided in the Appendix of this report.

6.0 DESIGN RECOMMENDATIONS

The following design recommendations have been developed on the basis of the previously described Project Characteristics (Section 2.0) and Subsurface Conditions (Section 5.0). If project criteria should change, our office should conduct a review to determine if modifications to the recommendations are required. Further, it is recommended our office be provided with a copy of the final plans and specifications for review prior to construction.

6.1 Pavement

Clay or calcareous clay encountered near the existing ground surface will probably constitute the subgrade for the new pavement. Therefore, it is recommended these materials be improved prior to construction of pavement. Due to the wide spacing of the borings, division of the study area into areas with similar subgrade conditions was not possible. Delineation of areas with similar subgrade conditions, if required, should be performed during construction after the subgrade material has been exposed. The specific type of improvement procedures required in given pavement areas will be dependent upon the type of subgrade material present after final subgrade elevation has been achieved.

Calculations used to determine the required pavement thickness are based only on the physical and engineering properties of the materials and conventional thickness determination procedures. Related civil design factors such as subgrade drainage, shoulder support, cross-sectional configurations, surface elevations, reinforcing steel, joint design and environmental factors will significantly affect the service life and must be included in preparation of the construction drawings and specifications, but were not included in the scope of this study. Normal periodic maintenance will be required for all pavement to achieve the design life of the pavement system.

Please note, the recommended pavement section options provided below are considered the minimum necessary to provide satisfactory performance based on the expected traffic loading. In some cases, City minimum standards for pavement section construction may exceed those provided below.

The following design information has been provided by the Client:

- New pavement will consist of Portland-cement concrete and the design life is 30 years.
- Daily traffic based on 1999 information for the study area is about 51,000 vehicles per day.

- The projected daily traffic volume by Year 2020 will be up to about 60,000 vehicles per day.
- It is anticipated the new pavement will be subject to significant truck traffic.
- Truck traffic will be about 20 percent of the daily traffic volume. Therefore, the design traffic used for the new pavement is 15.118,000 18-kip equivalent axle load applications for a 30-year design life.

6.1.1 Pavement Subgrade Preparation

Due to the relatively heavy truck traffic expected, it is recommended a non-erodable base material be provided immediately below the Portland-cement concrete pavement. The non-erodable base material could consist of either a crushed limestone base material or a cement treated permeable base. The non-erodable base should be supported on an improved subgrade consisting of either a re-compacted subgrade or a mechanically lime stabilized subgrade. It should be noted that a geotextile fabric (e.g., Marafi 180N or equivalent) should be provided between the improved subgrade soils and the cement treated permeable base to prevent fines from the improved soils from penetrating into the permeable base material. If a permeable base is used, the subgrade must be carefully graded (i.e., no birdbaths and minimum slope of 1.5 percent) to provide positive flow of percolated water through the permeable base to collection points at the extreme perimeter of the pavement. Collected water at the perimeter of the pavement should be drained to an appropriate receptacle.

If the subgrade soils are mechanically lime stabilized, it is recommended lime stabilization procedures extend at least 1 ft beyond the edge of the pavement to reduce effects of seasonal shrinking and swelling upon the extreme edges of pavement. The soil-lime mixture should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 0 to 4 percentage points above the mixture's optimum moisture content. In all areas where hydrated lime is used to stabilize subgrade soil, routine Atterberg-limit tests should be performed to verify the resulting plasticity index of the soil-lime mixture is at/or below 15.

Mechanical lime stabilization of the pavement subgrade soil will not prevent normal seasonal movement of the underlying untreated materials. Normal maintenance of pavement should be expected over the pavement design life.

6.1.2 Pavement Sections Options

California Bearing Ratio (CBR) tests performed on composite samples from the test borings indicate the CBR value for the existing clay subgrade soils will be about 3 whereas the CBR value for the same material after mechanical lime stabilization would increase to about 20. Using the above values and assuming normal traffic for a 30-year project life, the following pavement sections are recommended if load transfer between joints is through *aggregate interlock*:

Compacted Subgrade

11.5 inches	Portland-cement concrete
6 inches	crushed limestone base material
6 inches	compacted subgrade

OR

10.5 inches	Portland-cement concrete
6 inches	cement treated permeable base
6 inches	compacted subgrade

Lime Stabilized Subgrade

11 inches	Portland-cement concrete
6 inches	crushed limestone base material
6 inches	lime stabilized subgrade

OR

10 inches	Portland-cement concrete
6 inches	cement treated permeable base
6 inches	lime stabilized subgrade

If dowels are provided for load transfer at the joints in the new pavement, the following pavement section options are provided:

Compacted Subgrade

10 inches	Portland-cement concrete
6 inches	crushed limestone base material
6 inches	compacted subgrade

OR

9 inches	Portland-cement concrete
6 inches	cement treated permeable base
6 inches	compacted subgrade

Lime Stabilized Subgrade

9.5 inches	Portland-cement concrete
6 inches	crushed limestone base material
6 inches	lime stabilized -subgrade

OR

9 inches	Portland-cement concrete
6 inches	cement treated permeable base
6 inches	lime stabilized subgrade

6.1.3 Pavement Specifications

Pavement should be specified, constructed and tested to meet the following requirements:

1. Portland-Cement Concrete: Texas SDHPT Item 360. Specify a minimum flexural strength of 650 lbs per sq inch at 28 days. Concrete should be designed with 5 ± 1 percent entrained air.

2. Crushed Limestone Base Material: Texas SDHPT Item 247, Type A or B, Grade 2 or better. The material should be compacted to a minimum 95 percent of standard Proctor maximum dry density (ASTM D 698) and within three percentage points of the material's optimum moisture content.

3. Cement Treated Permeable Base Material: Cement treated permeable base should have a minimum hydraulic conductivity of 3,000 feet per day after compaction. Permeable base material shall consist of coarse aggregate with no fine aggregate (sand, etc.) and shall be treated with 6 percent Portland cement by dry weight of the aggregate. The material should be compacted to a minimum 95 percent of standard Proctor maximum dry density (ASTM D 558) and within three percentage points of the material's optimum moisture content. The material supplier shall submit an acceptable mix design for approval.

4. Lime Stabilized Subgrade: Texas SDHPT Item 260. An estimated 3 and 8 percent of hydrated lime (by dry soil weight) should be applied to existing calcareous clay and clay soils, respectively, which have been scarified to a depth of 6 inches. The actual amount of lime required should be confirmed by additional laboratory tests prior to construction.

a. The soil-lime mixture should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 0 to 4 percentage points above optimum moisture. The moisture content of the subgrade should be maintained until the pavement surface is placed.

b. In all areas where hydrated lime is utilized to stabilize the subgrade soil, routine Atterberg-limit tests should be performed prior to completion of construction to assure the resulting plasticity index of the soil-lime mixture will be at/or below 15. Gradation, Atterberg-limits and density tests should be performed at a frequency of 1 test per 5000 sq ft of pavement.

5. Re-compacted Subgrade: On-site materials should be scarified to a depth of at least 6 inches and re-compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 1 percentage point below to 3 percentage points above the material's optimum moisture content. The moisture content of the subgrade should be maintained until the pavement surface is placed. Density tests should be performed at a frequency of 1 test per 5000 sq ft of pavement.

7.0 GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS

Variations in subsurface conditions could be encountered during construction. To permit correlation between test boring data and actual subsurface conditions encountered during construction, it is recommended a registered Geotechnical Engineer be retained to observe construction procedures and materials.

Some construction problems, particularly degree or magnitude, cannot be anticipated until the course of construction. The recommendations offered in the following paragraphs are intended, not to limit or preclude other conceivable solutions, but rather to provide our observations based on our experience and understanding of the project characteristics and subsurface conditions encountered in the borings.

7.1 Site Preparation and Grading

All areas supporting pavement should be properly prepared.

After completion of the necessary stripping, clearing, and excavating and prior to placing any required fill, the exposed subgrade should be carefully inspected by probing and testing. Any undesirable material (organic material, wet, soft, or loose soil) still in place should be removed.

> The exposed subgrade should be further inspected by proof-rolling with a heavy pneumatic tired roller, loaded dump truck or similar equipment weighing approximately 10 tons to check for pockets of soft or loose material hidden beneath a thin crust of possibly better soil.
>
> Proof-rolling procedures should be observed by the project geotechnical engineer or his representative.
>
> Any unsuitable materials exposed should be removed and replaced with well-compacted material as outlined in Section 7.2.

Slope stability analysis of embankments (natural or constructed) was not within the scope of this study. Trench excavations should be braced or cut at stable slopes in accordance with Occupational Safety and Health Administration (OSHA) requirements, Title 29, Items 1926.650-1926.653 and other applicable building codes.

7.2 Fill Compaction

Calcareous or sandy materials with a plasticity index below 25 should be compacted to a dry density of at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 1 percentage point below to 3 percentage points above the material's optimum moisture content.

Clay soils with a plasticity index equal to or greater than 25 should be compacted to a dry density between 95 and 100 percent of standard Proctor maximum dry density (ASTM D 698). The compacted moisture content of the clays during placement should be within the range of 0 to 4 percentage points above optimum. Clay fill should be processed and the largest particle or clod should be less than 6 inches prior to compaction.

Limestone or other rock-like materials used as random fill should be compacted to at least 95 percent of standard Proctor maximum dry density. The compacted moisture content of limestone or other rock-like materials used as random fill is not considered crucial to proper performance. However, if the material's moisture content during placement is within 3 percentage points of optimum, the compactive effort required to achieve the minimum compaction criteria may be minimized. Individual rock pieces larger than 6 inches in dimension should not be used as fill. However, if rock fill is utilized within 1 ft below the bottom of the pavement, the maximum allowable size of individual rock pieces should be reduced to 3 inches.

APPENDIX

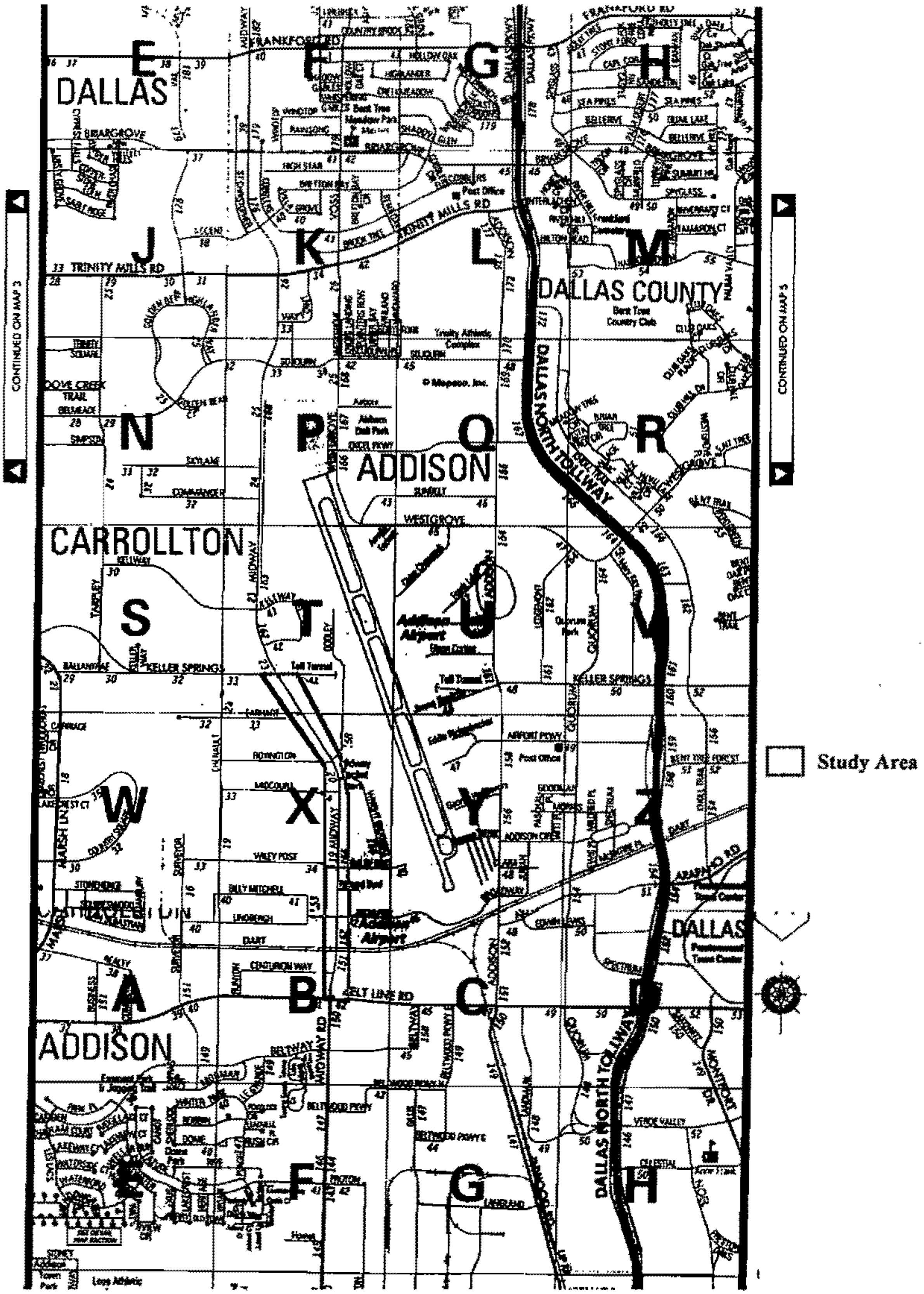
A-1 METHODS OF FIELD EXPLORATION

Using standard rotary drilling equipment, a total of 22 test borings have been performed for this geotechnical exploration at the approximate locations shown on the Boring Location Plans, Figures 2-7. The test boring locations have been staked by either pacing or taping and estimating right angles from landmarks which could be identified in the field and as shown on the site plans provided during this study. The location of test borings shown on the Boring Location Plan is considered accurate only to the degree implied by the method used to locate the borings. The surface elevations provided on the Record of Subsurface Exploration sheets have been obtained by plotting the boring locations on the site plans and interpolating the surface elevation. Surface elevations given on the boring logs are approximate.

Relatively undisturbed samples of the cohesive subsurface materials have been obtained by hydraulically pressing 3-inch O.D. thin-wall sampling tubes into the underlying soils at selected depths (ASTM D 1587). These samples have been removed from the sampling tubes in the field and examined visually. One representative portion of each sample has been sealed in a plastic bag for use in future visual examinations and possible testing in the laboratory.

Modified Texas Cone Penetration (TCP) tests have also been completed in the field to determine the apparent in-place strength characteristics of the rock type materials. A 3-inch diameter steel cone driven by a 170-pound hammer dropped 24 inches is the basis for Texas State Department of Highways and Public Transportation strength correlations. In this case, ALPHA TESTING, INC. has modified the procedure allowing the use of a 140-pound hammer dropping 30-inches for completion of the field test. Depending on the resistance (strength) of the materials, either the number of blows of the hammer required to provide 12 inches of penetration, or the inches of penetration of the cone due to 100 blows of the hammer are recorded on the field logs and are shown on the Record of Subsurface Exploration sheets as TCP (reference: Texas State Department of Highways and Public Transportation, Bridge Design Manual), using the modified procedure.

Logs of all borings have been included in the Appendix of this report. The logs show visual descriptions of all soil and rock (shaly limestone) strata encountered using the Unified Soil Classification System. Sampling information, pertinent field data, and field observations are also included. Soil and rock samples not consumed by testing will be retained in our laboratory for at least 30 days and then discarded unless the Client requests otherwise.



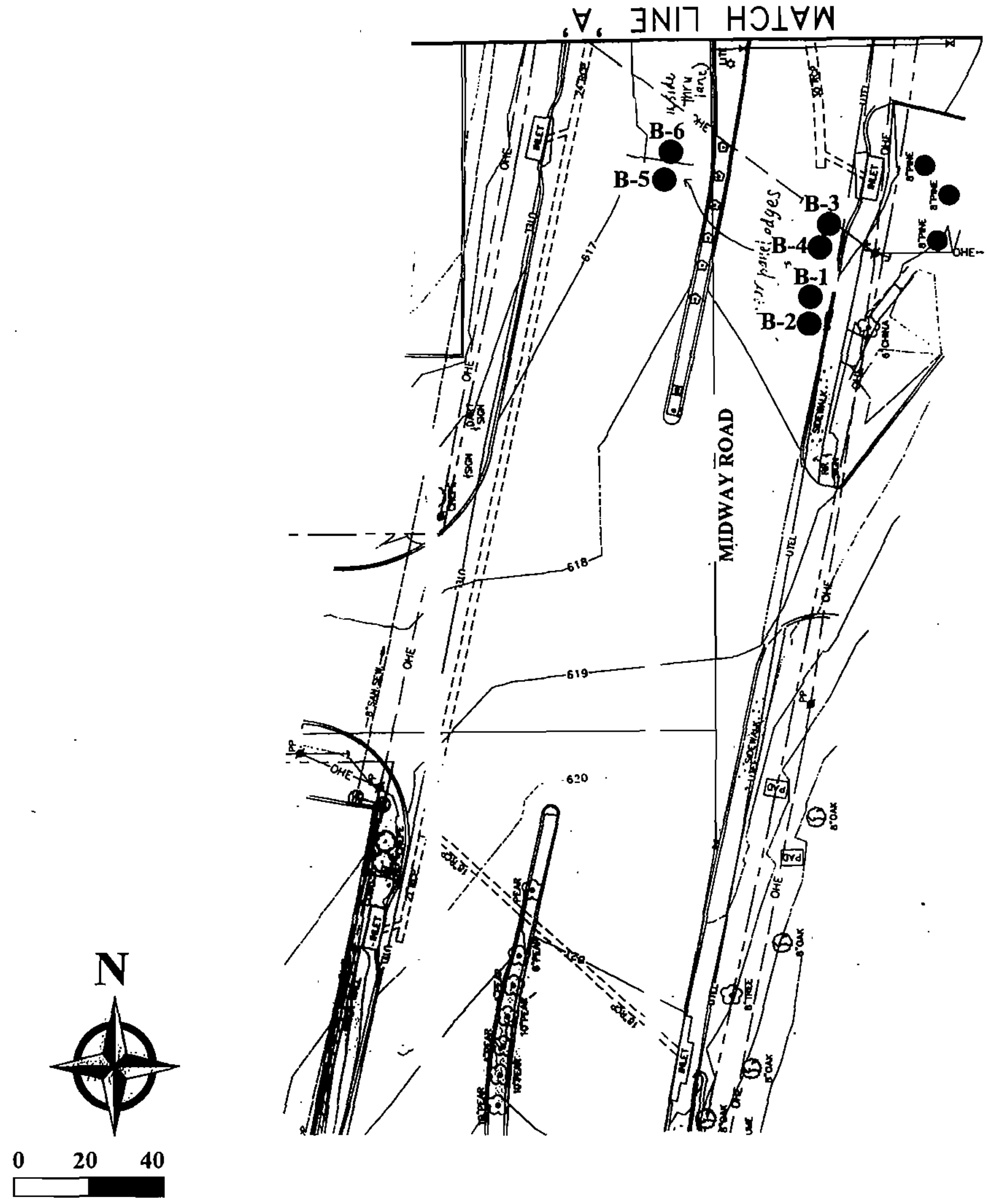
GBW Engineers, Inc.
Garland, Texas

Midway Road Reconstruction
Addison, Texas

General Location
Figure 1

00988

4/02/01



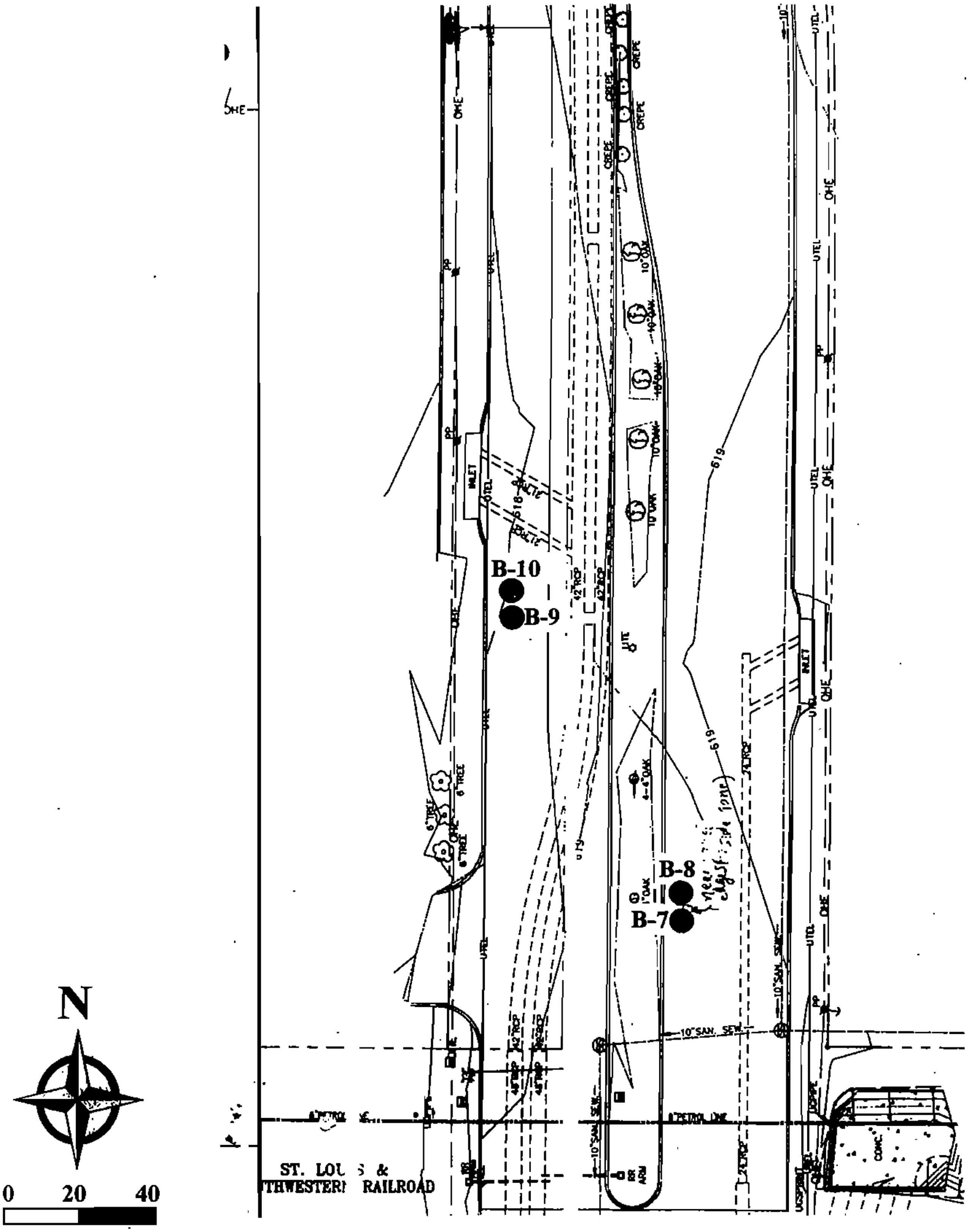
GBW Engineers, Inc.
Garland, Texas

Midway Road Reconstruction
Addison, Texas

Boring Location Plan
Figure 2

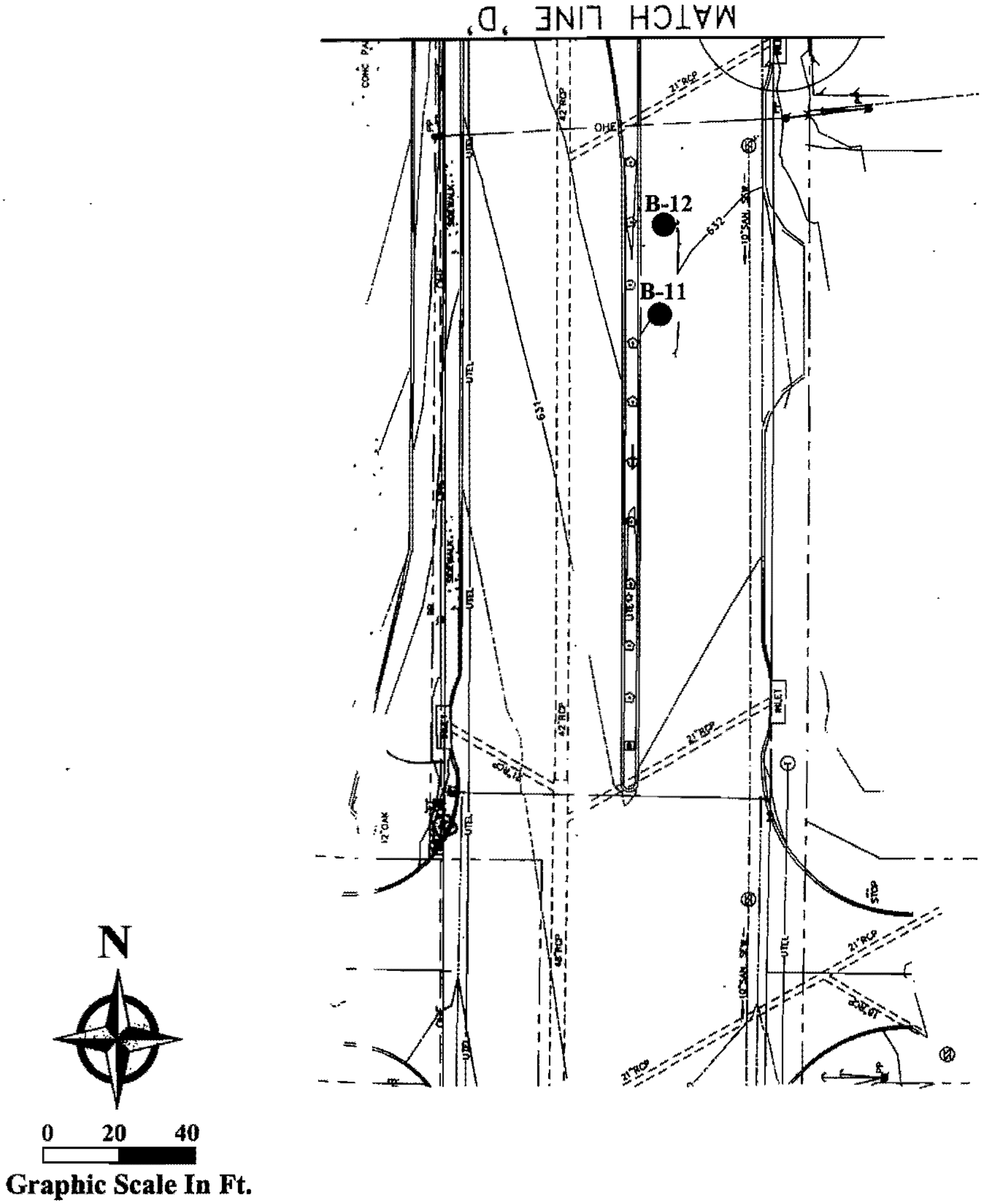
00988

4/02/01



Graphic Scale In Ft.

GBW Engineers, Inc. **Garland, Texas**	**Boring Location Plan** **Figure 3**
Midway Road Reconstruction **Addison, Texas**	**00988**
	4/02/01



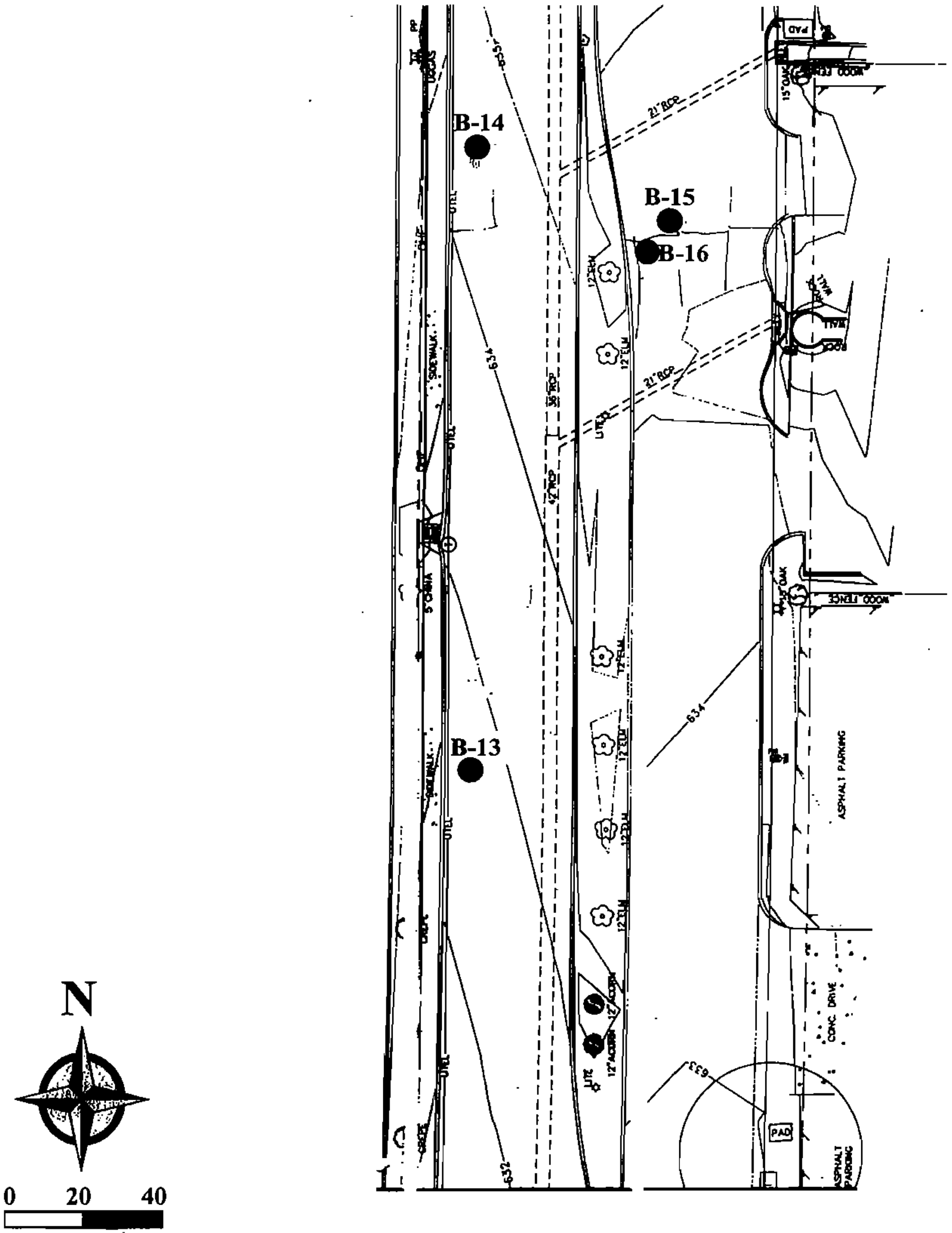
GBW Engineers, Inc.
Garland, Texas

Midway Road Reconstruction
Addison, Texas

Boring Location Plan
Figure 4

00988

4/02/01



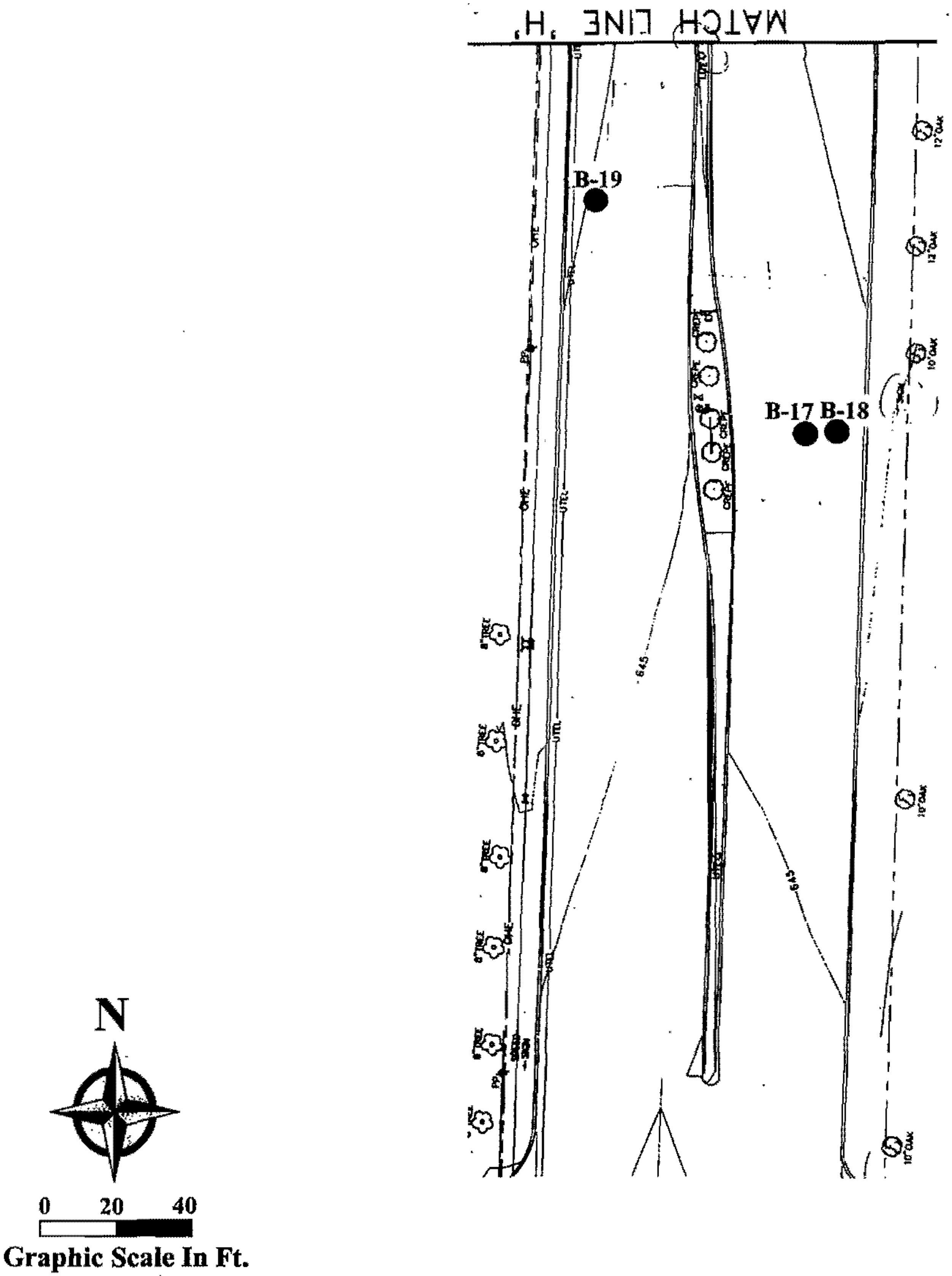
Graphic Scale In Ft.

GBW Engineers, Inc.
Garland, Texas

Midway Road Reconstruction
Addison, Texas

Boring Location Plan
Figure 5

00988	4/02/01



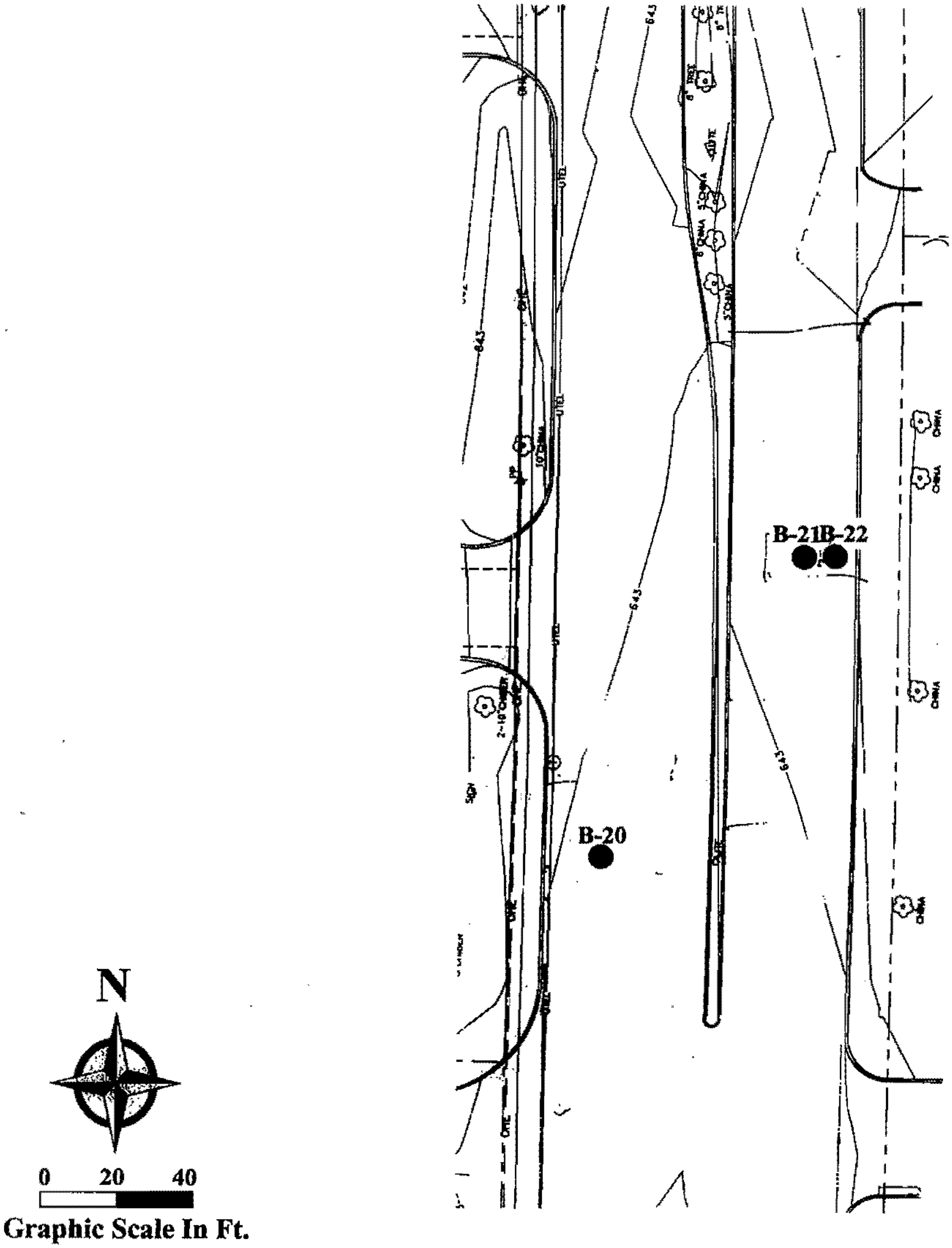
GBW Engineers, Inc.
Garland, Texas

Midway Road Reconstruction
Addison, Texas

Boring Location Plan
Figure 6

00988

4/02/01



GBW Engineers, Inc.
Garland, Texas

Midway Road Reconstruction
Addison, Texas

Boring Location Plan
Figure 7

00988	4/02/01

B-1 METHODS OF LABORATORY TESTING

Representative samples are inspected and classified by a qualified member of the Geotechnical Division and the boring logs are edited as necessary. To aid in classifying the subsurface materials and to determine the general engineering characteristics, natural moisture content tests (ASTM D 2216), Atterberg-limit tests (ASTM D 4318) and dry unit weight determinations are performed on selected samples. In addition, unconfined compression (ASTM D 2166) and pocket-penetrometer tests are conducted on selected soil samples to evaluate the soil shear strength. Results of all laboratory tests described above are provided on the accompanying Record of Subsurface Exploration sheets or on summary data sheets as noted.

ALPHA TESTING, INC.
2209 Wisconsin St., Suite 100
Dallas, Texas 75229
972/620-8911 - 972/263-4937 (Metro)
FAX: 972/406-8023

Client: BGW ENGINEERS, INC.
Garland, Texas
Project: Midway Road Reconstruction
Addison, Texas

Our Report Number.: 00988 Date: 1/29/01
Material Description: Dark Brown Clay
Classification: (CH)
Sample Location: Composite Sample B-3 to B-16

Method of Test: ASTM-D-698-A
Soil Identification Number: Composite
Maximum Dry Unit Weight: 91.0 pcf
Optimum Moisture Content: 24.5 %
Liquid Limit: 77
Plasticity Index: 48

MOISTURE DENSITY RELATIONSHIP

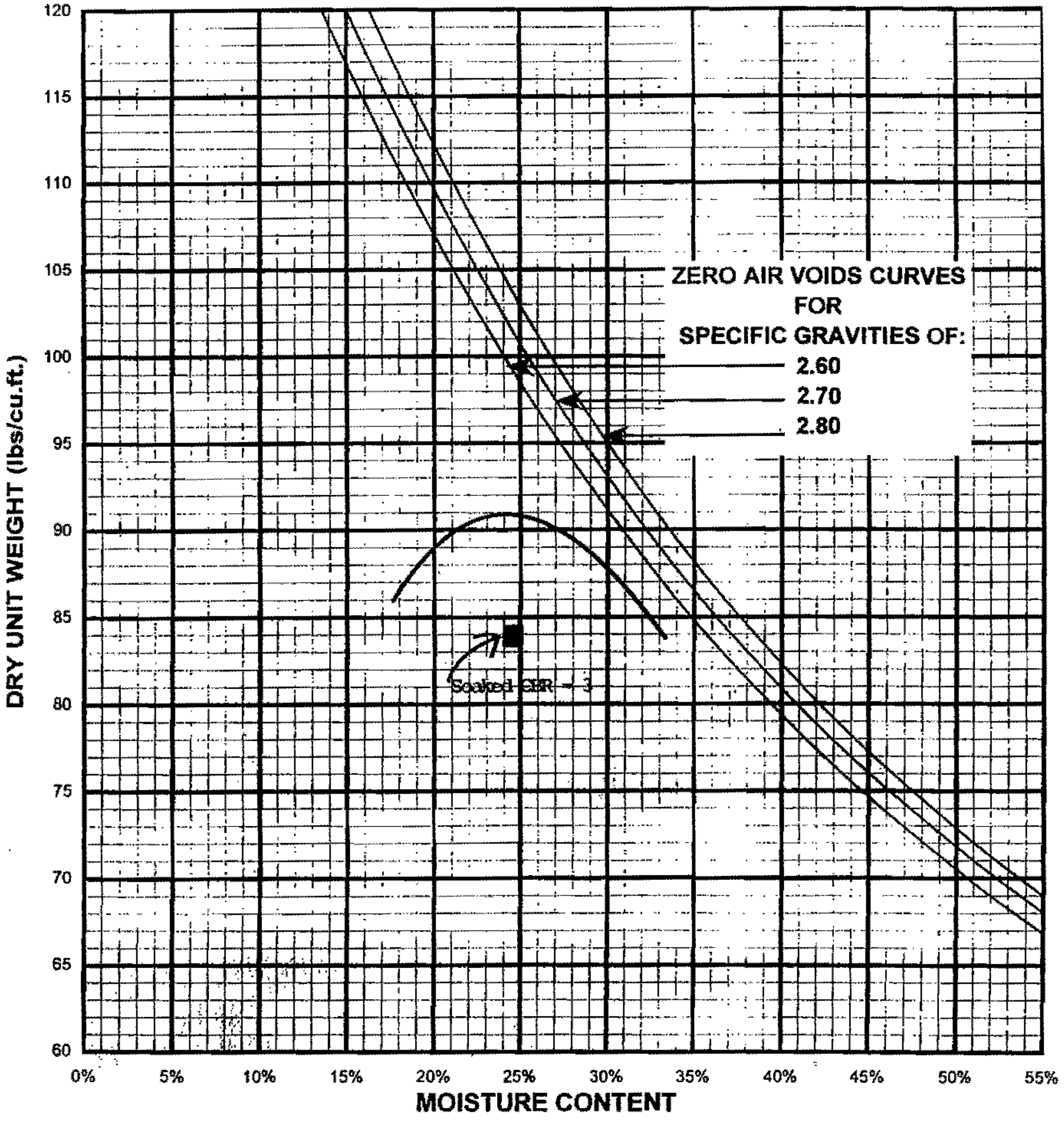


Figure - 8

ALPHA TESTING, INC.

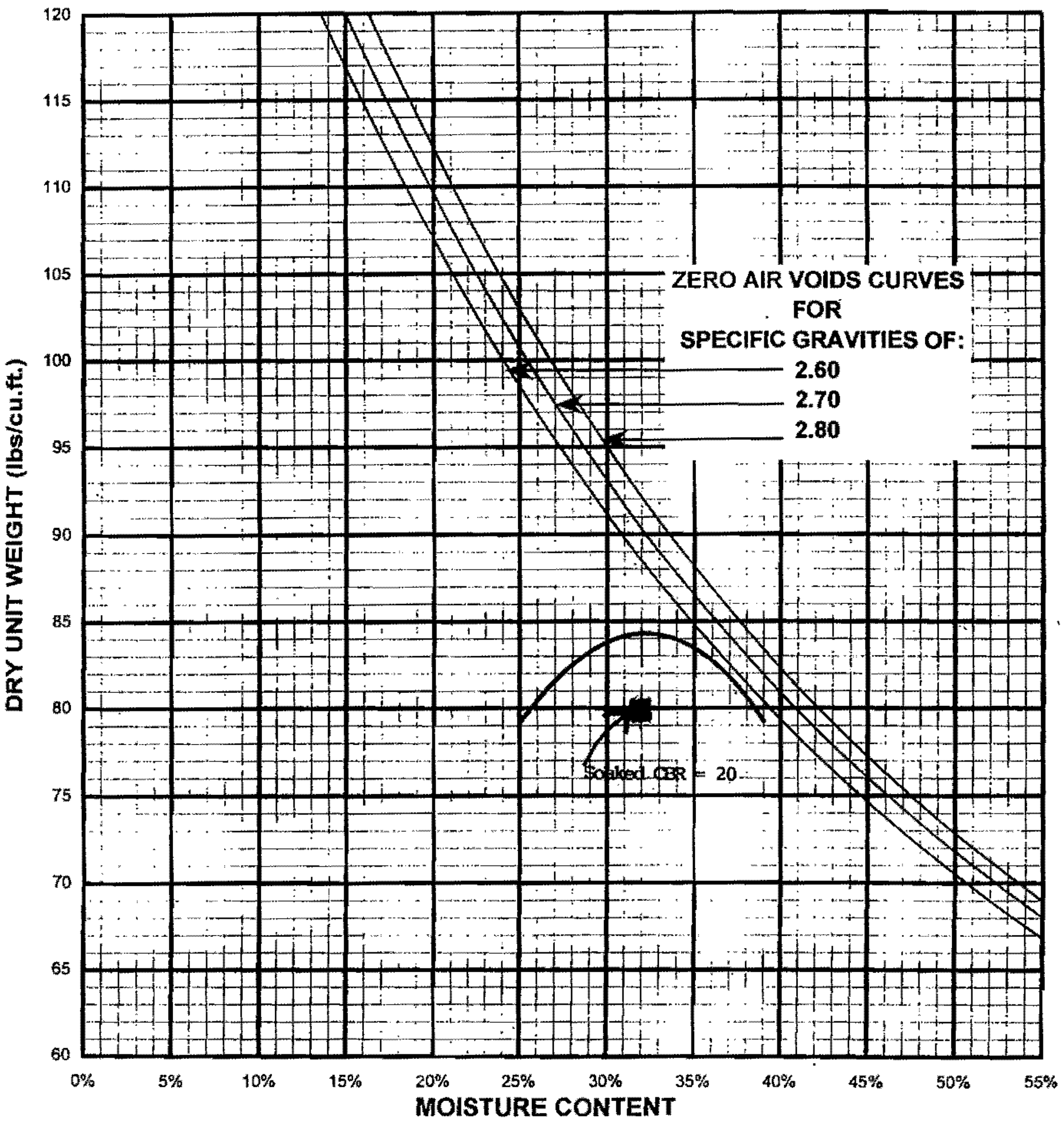
2209 Wisconsin St., Suite 100
Dallas, Texas 75229
972/620-8911 - 972/263-4937 (Metro)
FAX: 972/406-8023

Client: GBW ENGINEERS, INC.
Garland, Texas
Project: Midway Road Reconstruction
Addison, Texas

Our Report Number.: 00988 Date: 1/29/01
Material Description: Dark Brown Clay
Classification: with 8 percent lime added
Sample Location: Composite Sample B-3 to B-16

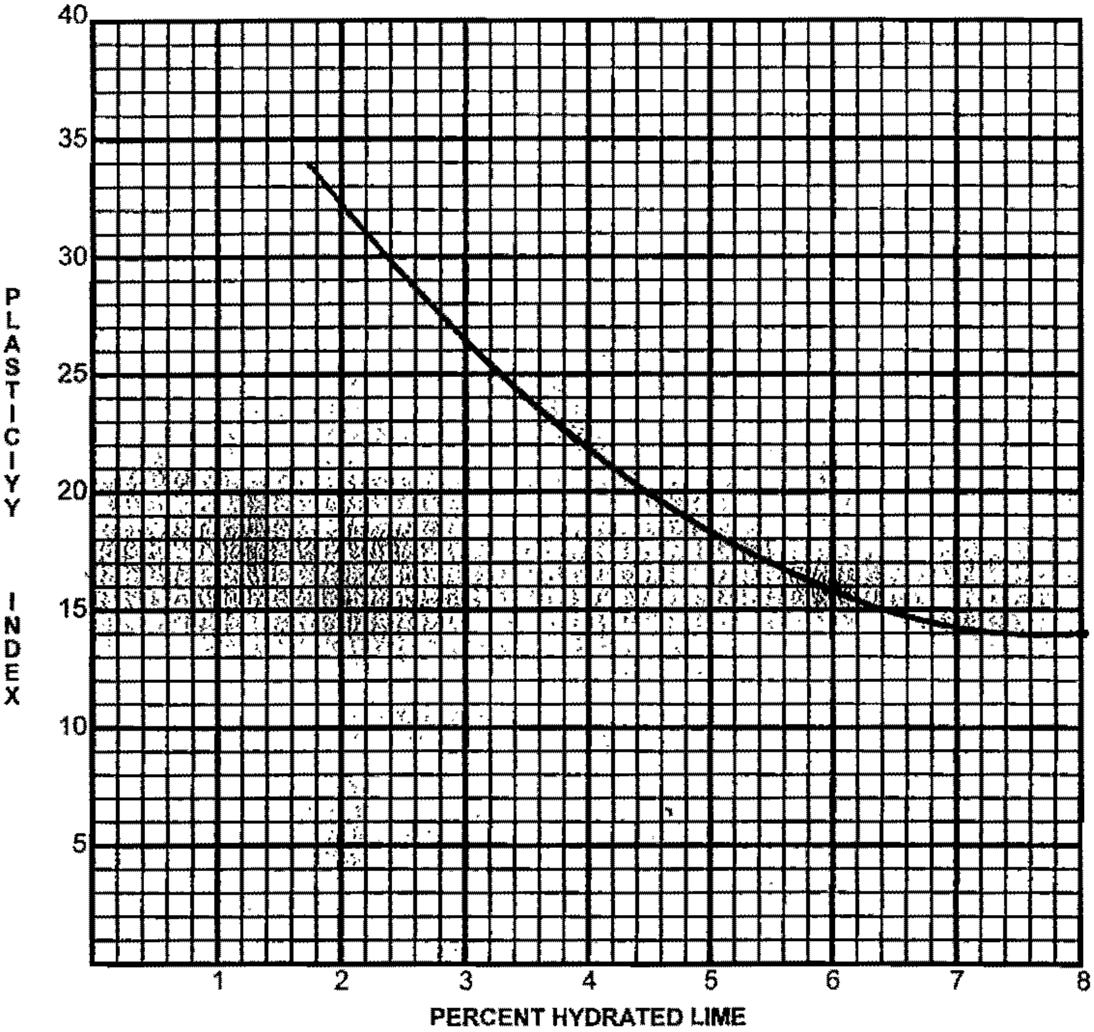
Method of Test: ASTM-D-698-A
Soil Identification Number: Composite
Maximum Dry Unit Weight: 84.5 pcf
Optimum Moisture Content: 32.0 %
Liquid Limit: 61
Plasticity Index: 14

MOISTURE DENSITY RELATIONSHIP



ALPHA TESTING, INC.
2209 Wisconsin St., Suite 100
Dallas, Texas 75229
972/620-8911 - 972/263-4937 (Metro)
FAX: 972/406-8023

MECHANICAL LIME STABILIZATION



SAMPLE NO. Composite Sample (Borings 3-16)

DESCRIPTION: Brown Clay

CLIENT:	LABORATORY TEST:
GBW ENGINERRS, INC. GARLAND, TEXAS	LIME SERIES Figure 10

PROJECT NAME:	ALPHA PROJECT NO	DATE:
MIDWAY ROAD RECONSTRUCTION ADDISON, TEXAS	00988	April 3, 2001

ALPHA TESTING, INC.
2209 Wisconsin St., Suite 100
Dallas, Texas 75229
(972) 620-8911

RECORD OF SUBSURFACE EXPLORATION

ent GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-1
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 618±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown very stiff CLAY(CH) with some sand and gravel. -8" of concrete at surface.		0										
			1	ST					2.2		39	LL=76 PL=27 PI=49
	2'	2										
Reddish Brown very stiff CLAY(CH/CL) with some sand, calcareous nodules and gravel. -hard 2'-3'. -stiff below 5'.			2	ST					4.5+		26	
			3	ST					2.7		26	LL=53 PL=20 PI=33
		4										
			4	ST					2.2		25	
			5	ST					1.7		24	
	6'	6										
Tan firm CALCAREOUS CLAY(CL) with some silty sand and limestone gravel. -stiff 6'-7'.			6	ST					1.0		28	LL=33 PL=15 PI=18
			7	ST					0.7		27	
		8										
			8	ST					0.5		28	
			9	ST					0.5		46	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
- SS - STANDARD PENETRATION TEST
- ST - SHELBY TUBE
- CA - CONTINUOUS FLIGHT AUGER
- TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION 5 FT.
AFTER HRS. FT.
WATER ON RODS 8 FT.

BORING METHOD
- HSA - HOLLOW STEM AUGERS
- CFA - CONTINUOUS FLIGHT AUGERS
- DC - DRIVEN CASINGS
- MD -MUD DRILLING

ALPHA TESTING, INC.
2209 Wisconsin St., Suite 100
Dallas, Texas 75229
(972) 620-8911

RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS
Boring No. B-2
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA
Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 618±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown hard CLAY(CH) with some sand and gravel. -7.75" of concrete at surface.		0										
			1	ST					4.5+		33	LL=68 PL=37 PI=31
	2'											
Reddish Brown and Tan very stiff CLAY(CH/CL) with some sand, calcareous nodules and gravel. -hard 2'-3'. -stiff below 5'.		2	2	ST					4.5+		26	
			3	ST					3.5		22	
		4	4	ST					2.5		20	
	5'											
Tan firm CALCAREOUS CLAY(CL) with some silty sand and limestone gravel. -very stiff 5'-6'. -stiff 6'-7'.			5	ST					2.2		21	
		6	6	ST					1.2		24	
			7	ST					0.5		29	
		8	8	ST					0.5		30	
			9	ST					0.5		32	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION 5 FT.
AFTER HRS. FT.
WATER ON RODS 8 FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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2209 Wisconsin St., Suite 100
Dallas, Texas 75229
(972) 620-8911

RECORD OF SUBSURFACE EXPLORATION

ent GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-3
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION *618±*	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown hard Lime Treated CLAY(CH) with some sand and calcareous nodules and gravel. -8" of concrete at surface.		0										
			1	ST					4.5+		38	LL=57 PL=36 PI=21
		2	2	ST					4.0		31	
Brown very stiff CLAY(CH) with some sand, calcareous nodules and gravel. -reddish brown below 4'. -stiff below 5'.	3'		3	ST					2.7		30	
		4	4	ST					3.2		22	
			5	ST					1.7		22	
Tan firm CALCAREOUS CLAY(CL) with some silty sand and limestone gravel. -stiff 6'-7'.	6'	6	6	ST					1.5		25	
			7	ST					0.5		26	
		8	8	ST					0.7		32	
			9	ST					0.5		35	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION 5.5 FT.
AFTER HRS. FT.
WATER ON RODS 8 FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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(972) 620-8911

RECORD OF SUBSURFACE EXPLORATION

ent GBW ENGINEERS, INC.

Architect/Engineer

Project Name MIDWAY ROAD RECONSTRUCTION

Project Location ADDISON, TEXAS

Boring No. B-4

Job No. 00988

Drawn By AM

Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01

Date Completed 1-21-01

Drill Foreman EDI

Inspector

Boring Method CFA

Hammer Wt. lbs.

Hammer Drop in.

Spoon Sample OD in.

Rock Core Dia. in.

Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 618±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown hard CLAY(CH) with some sand and calcareous nodules and gravel. -7.75" of concrete at surface.		0										
			1	ST					4.5+		31	
		2										
			2	ST					4.0		33	
	3'											
Reddish Brown and Tan very stiff CLAY(CH/CL) with some silty sand, calcareous nodules and gravel. -hard 3'-4'. -stiff below 5'.			3	ST					4.0		25	
		4										
			4	ST					3.2		20	
			5	ST					3.2		23	
	6'	6										
Tan firm CALCAREOUS CLAY(CL) with some silty sand and limestone gravel.			6	ST					0.7		26	
			7	ST					0.7		29	
		8										
			8	ST					0.5		30	
			9	ST					0.5		28	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
- SS - STANDARD PENETRATION TEST
- ST - SHELBY TUBE
- CA - CONTINUOUS FLIGHT AUGER
- TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS

AT COMPLETION 4.5 FT.

AFTER HRS. FT.

WATER ON RODS 7 FT.

BORING METHOD
- HSA - HOLLOW STEM AUGERS
- CFA - CONTINUOUS FLIGHT AUGERS
- DC - DRIVEN CASINGS
- MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-5
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 617±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown hard Lime Treated CLAY(CH) with some sand and calcareous nodules. -8" of concrete at surface.		0										
			1	ST					4.5+		37	LL=56 PL=35 PI=21
	2'	2										
Dark Brown very stiff CLAY(CH) with some sand. -brown with calcareous nodules below 4'. -tannish brown below 8'.			2	ST					3.0		40	
		4										
			3	ST					3.2		29	
		6										
			4	ST					3.2		28	
		8										
			5	ST					3.0		28	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.

Architect/Engineer

Project Name MIDWAY ROAD RECONSTRUCTION

Project Location ADDISON, TEXAS

Boring No. B-6

Job No. 00988

Drawn By AM

Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01

Date Completed 1-21-01

Drill Foreman EDI

Inspector

Boring Method CFA

Hammer Wt. lbs.

Hammer Drop in.

Spoon Sample OD in.

Rock Core Dia. in.

Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
SURFACE ELEVATION 617±												
Brown very Dense SAND(SP) with some gravel and clay. -8" of concrete at surface.		0										
			1	ST	13				-		30	
	2'	2										
Brown very stiff CLAY(CH) with some sand. -tannish brown with calcareous nodules and gravel below 4'. -tannish brown below 8'.			2	ST				1.2	2.7	80	34	LL=80 PL=30 PI=50
		4										
			3	ST					3.7		26	
		6										
			4	ST					3.0		24	LL=66 PL=24 PI=42
		8										
			5	ST					2.2		29	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-7
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 619±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown very stiff CLAY(CH) with some sand and gravel. -8.25" of concrete at surface.		0										
			1	ST					2.5		26	
	2'	2										
Dark Brown very stiff CLAY(CH) with some sand, calcareous nodules and a trace of gravel. -brown below 6'. -tannish brown below 8'.			2	ST					3.7		27	
		4										
			3	ST					3.2		28	
		6										
			4	ST					3.0		24	
	8'	8										
Tan weathered SHALY LIMESTONE.			5	TCP		100 3.3"					5	
		10										
BOTTOM OF TEST BORING AT 10'.												
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

Client	GBW ENGINEERS, INC.	Boring No.	B-8
Architect/Engineer		Job No.	00988
Project Name	MIDWAY ROAD RECONSTRUCTION	Drawn By	AM
Project Location	ADDISON, TEXAS	Approved By	DAL

DRILLING AND SAMPLING INFORMATION

Date Started	1-21-01	Hammer Wt.	140	lbs.
Date Completed	1-21-01	Hammer Drop	30	in.
Drill Foreman	EDI	Spoon Sample OD		in.
Inspector		Rock Core Dia.		in.
Boring Method	CFA	Shelby Tube OD	3	in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 619±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown hard Lime Treated CLAY(CH) with some sand and gravel. -8.5" of concrete at surface.		0	1	ST					-		23	LL=46 PL=29 PI=17
	2'											
Dark Brown very stiff CLAY(CH) with sand laminations. -with limestone seams below 6'.			2	ST					3.7		29	
		5	3	ST					2.7		28	
			4	ST					2.7		26	
	8'											
Tan weathered SHALY LIMESTONE.			5	TCP		100/3"					9	
BOTTOM OF TEST BORING AT 10'.		10										
		15										
		20										
		25										
		30										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

ALPHA TESTING, INC.
2209 Wisconsin St., Suite 100
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RECORD OF SUBSURFACE EXPLORATION

ent GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-9
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 618±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown stiff Lime Treated CLAY(CH) with some sand, calcareous nodules and gravel. -8" of concrete at surface		0	1	ST				0.9	1.2	79	37	LL=55 PL=32 PI=23
Dark Brown very stiff CLAY(CH) with sand laminations and a trace of calcareous nodules.	2'	2	2	ST					2.2		33	
		4	3	ST					2.2		35	
		6	4	ST					2.2		31	
		8	5	ST					2.2		31	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-10
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 618±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown hard Lime Treated CLAY(CH) with some sand, calcareous nodules and gravel. -8" of concrete at surface -with lime to 17".		0	1	ST					4.5+		38	LL=53 PL=38 PI=17
	3'		2	ST					2.5		35	
Dark Brown very stiff CLAY(CH) with sand laminations. -stiff with limestone gravel below 8'.		5	3	ST					3.0		36	LL=83 PL=31 PI=52
			4	ST					2.0		29	
			5	ST					1.5		33	
BOTTOM OF TEST BORING AT 10'.		10										
		15										
		20										
		25										
		30										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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(972) 620-8911

RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.

Architect/Engineer

Project Name MIDWAY ROAD RECONSTRUCTION

Project Location ADDISON, TEXAS

Boring No. B-11

Job No. 00988

Drawn By AM

Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01

Date Completed 1-21-01

Drill Foreman EDI

Inspector

Boring Method CFA

Hammer Wt. lbs.

Hammer Drop in.

Spoon Sample OD in.

Rock Core Dia. in.

Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 632±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown stiff CLAY(CH) with some sand. -8" of concrete at surface		0										
			1	ST					1.7		34	
	2'	2										
Dark Brown very stiff CLAY(CH) with some sand and a trace of calcareous nodules and gravel.			2	ST					2.5		31	
		4										
			3	ST					3.0		32	
		6										
			4	ST					2.5		38	
	8'	8										
Tan and Gray hard CALCAREOUS CLAY(CL) with some silty sand and gravel.			5	ST					4.5+		18	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ent GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-12
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 632±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown stiff Lime Treated CLAY(CH) with some sand. -8" of concrete at surface		0	1	ST				0.6	1.2	78	40	LL=60 PL=23 PI=37
Dark Brown very stiff CLAY(CH) with sand laminations. -stiff 2'-4'.	2'	2	2	ST					1.7		35	
		4	3	ST					2.0		34	LL=46 PL=29 PI=17
		6	4	ST					2.0		34	
Tannish Brown very stiff CALCAREOUS CLAY(CL) with some silty and and gravel.	7.5'	8	5	ST					3.0		22	LL=38 PL=18 PI=20
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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2209 Wisconsin St., Suite 100
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RECORD OF SUBSURFACE EXPLORATION

jent GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-13
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. 140 lbs.
Hammer Drop 30 in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 633±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown stiff Lime Treated CLAY(CH) with some sand. -8" of concrete at surface.		0	1	ST				1.1	1.2	70	42	LL=79 PL=38 PI=41
Dark Brown stiff CLAY(CH) with sand laminations.	2'	2	2	ST					1.5		35	
		4	3	ST					1.5		34	
Tan and Gray hard CALCAREOUS CLAY(CL) with limestone seams.	6'	6	4	ST					4.5+		24	
Tan weathered SHALY LIMESTONE.	8'	8	5	TCP		$\frac{100}{1"}$					18	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

ALPHA TESTING, INC.
2209 Wisconsin St., Suite 100
Dallas, Texas 75229
(972) 620-8911

RECORD OF SUBSURFACE EXPLORATION

ent GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-14
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. 140 lbs.
Hammer Drop 30 in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 634±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown very stiff Lime Treated CLAY(CH) with some sand. -8" of concrete at surface.		0										
			1	ST					2.0		36	
	2'	2										
Dark Brown very stiff CLAY(CH) with sand laminations. -brown below 4'.			2	ST					2.2		30	
		4										
Tan weathered SHALY LIMESTONE.	5'		3	ST					2.2		30	
		6										
		8										
			4	TCP		100 1.5"					18	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
- SS - STANDARD PENETRATION TEST
- ST - SHELBY TUBE
- CA - CONTINUOUS FLIGHT AUGER
- TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS

AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
- HSA - HOLLOW STEM AUGERS
- CFA - CONTINUOUS FLIGHT AUGERS
- DC - DRIVEN CASINGS
- MD -MUD DRILLING

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Dallas, Texas 75229
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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-15
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 635±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown very stiff CLAY(CH) with some sand and a trace of gravel. -8.25" of concrete at surface -brown with calcareous nodules below 8'.		0										
			1	ST					3.5		37	LL=85 PL=30 PI=55
		2										
			2	ST					2.0		32	
		4										
			3	ST					2.2		37	
		6										
			4	ST					2.5		32	
		8										
			5	ST					2.7		34	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ent GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-16
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. lbs.
Hammer Drop in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION *635±*	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown hard CLAY(CH) with some sand and a trace of gravel. -8.25" of concrete at surface -very stiff below 4'.		0										
			1	ST					4.5+		35	LL=65 PL=36 PI=29
		2										
			2	ST					1.7		33	
		4										
			3	ST					2.2		31	LL=83 PL=30 PI=53
Dark Brown very stiff CLAY(CH) with some sand.	6'	6										
			4	ST					2.2		32	
Tannish Brown stiff CALCAREOUS CLAY(CL/CH) with petro-chemical odor.	8'	8										
			5	ST					1.5		22	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
- SS - STANDARD PENETRATION TEST
- ST - SHELBY TUBE
- CA - CONTINUOUS FLIGHT AUGER
- TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
- HSA - HOLLOW STEM AUGERS
- CFA - CONTINUOUS FLIGHT AUGERS
- DC - DRIVEN CASINGS
- MD -MUD DRILLING

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(972) 620-8911

RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.

Architect/Engineer

Project Name MIDWAY ROAD RECONSTRUCTION

Project Location ADDISON, TEXAS

Boring No. B-17

Job No. 00988

Drawn By AM

Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01

Date Completed 1-21-01

Drill Foreman EDI

Inspector

Boring Method CFA

Hammer Wt. 140 lbs.

Hammer Drop 30 in.

Spoon Sample OD in.

Rock Core Dia. in.

Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 644±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown very stiff CLAY(CH) with calcareous deposit and some sand - poss. fill -6.5" of concrete at surface.		0										
			1	ST					2.0		27	LL=85 PL=30 PI=55
		2	2	ST					2.7		38	
	3'											
Tannish Brown and Gray very stiff CALCAREOUS CLAY(CL/CH) with clay zones. -hard with limestone seams below 4'.			3	ST					2.5		27	
		4	4	ST					4.5+		15	
	5'											
Tan weathered SHALY LIMESTONE.		6										
	8'	8										
Tan weathered SHALY LIMESTONE.			5	TCP		100/1"					15	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-18
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. 140 lbs.
Hammer Drop 30 in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 644±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Dark Brown very stiff CLAY(CH) with some sand and calcareous nodules - poss. fill -6.5" of concrete at surface.	3'	0	1	ST					3.2		32	LL=73 PL=27 PI=46
			2	ST					3.2		38	
Tan and Gray hard CALCAREOUS CLAY(CL/CH) with limestone seams.	5'		3	ST					4.5+		19	
		5	4	ST					4.5+		14	
Tan weathered SHALY LIMESTONE.	8'											
Gray SHALY LIMESTONE.		10	5	TCP		100 1"					14	
BOTTOM OF TEST BORING AT 10'.												
		15										
		20										
		25										
		30										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-19
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. 140 lbs.
Hammer Drop 30 in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 644±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Brown and Tan hard CLAY(CH) with calcareous deposit, gravel and some sand. - poss. fill -6.5" of concrete at surface.		0	1	ST					4.5+		21	LL=73 PL=28 PI=45
		2	2	ST					4.5+		32	
Tan and Gray hard CALCAREOUS CLAY(CL) with limestone seams.	4'	4	3	ST					4.5+		20	LL=48 PL=20 PI=28
Tan weathered SHALY LIMESTONE.	6'	6										
Gray SHALY LIMESTONE.	8'	8	4	TCP		100 1.3"					13	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-20
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. 140 lbs.
Hammer Drop 30 in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 643±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Tannish Brown and Gray hard CALCAREOUS CLAY(CL) with limestone seams. -7.25" of concrete at surface.		0	1	ST					4.5+			LL=59 PL=21 PI=38
Gray SHALY LIMESTONE.	2'	2										
		4	2	TCP		100 1.3"					13	
		6										
		8	3	TCP		100 1.3"					15	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

lient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-21
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. 140 lbs.
Hammer Drop 30 in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 643±	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Tannish Brown very stiff to hard CALCAREOUS CLAY(CL) with limestone seams. -6.75" of concrete at surface.		0										
			1	ST					2.7		22	
	2'	2										
Gray SHALY LIMESTONE.												
		4										
			2	TCP		100/1.5"					13	
		6										
		8										
			3	TCP		100/1.3"					16	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

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RECORD OF SUBSURFACE EXPLORATION

ient GBW ENGINEERS, INC.
Architect/Engineer
Project Name MIDWAY ROAD RECONSTRUCTION
Project Location ADDISON, TEXAS

Boring No. B-22
Job No. 00988
Drawn By AM
Approved By DAL

DRILLING AND SAMPLING INFORMATION

Date Started 1-21-01
Date Completed 1-21-01
Drill Foreman EDI
Inspector
Boring Method CFA

Hammer Wt. 140 lbs.
Hammer Drop 30 in.
Spoon Sample OD in.
Rock Core Dia. in.
Shelby Tube OD 3 in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION *643±*	STRATUM DEPTH	DEPTH SCALE	SAMPLE NO.	SAMPLE TYPE	Percent Passing No. 200 Sieve	Texas Cone Penetration Test or Standard Penetration Test (Blows/Ft)	Soil Suction Test (Total), pF	Unconfined Compressive Strength Tons/Sq Ft.	Pocket Penetrometer Tons/Sq Ft.	Dry Unit Weight lbs./cu. ft.	Water Content %	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index
Tannish Brown and Gray hard CALCAREOUS CLAY(CL) with limestone seams. -6.75" of concrete at surface.		0	1	ST					4.5+		18	LL=35 PL=17 PI=18
	2'	2										
Gray SHALY LIMESTONE.			2	CA							13	
		4	3	TCP		100/1"					12	
		6										
		8										
			4	TCP		100/1.5"					16	
BOTTOM OF TEST BORING AT 10'.		10										
		12										

SAMPLER TYPE
SS - STANDARD PENETRATION TEST
ST - SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
TCP- TEXAS CONE PENETRATION TEST

GROUNDWATER OBSERVATIONS
AT COMPLETION DRY FT.
AFTER HRS. FT.
WATER ON RODS NONE FT.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVEN CASINGS
MD -MUD DRILLING

KEY TO SOIL SYMBOLS AND CLASSIFICATIONS

THE ABBREVIATIONS COMMONLY EMPLOYED ON EACH "RECORD OF SUBSURFACE EXPLORATION", ON THE FIGURES AND IN THE TEXT OF THE REPORT, ARE AS FOLLOWS:

SOIL OR ROCK TYPES
(SHOWN IN SYMBOLS COLUMN)

▨	▥	░	▦	▤	▩
CLAY	SILT	SAND	LIMESTONE	SHALE	ASPHALT/CONCRETE

I. SOIL DESCRIPTION

(A) COHESIONLESS SOILS

RELATIVE DENSITY	N, BLOWS/FT
VERY LOOSE	0 TO 4
LOOSE	5 TO 10
COMPACT	11 TO 30
DENSE	31 TO 50
VERY DENSE	OVER 50

(B). COHESIVE SOILS

CONSISTENCY	Qu, TSF
VERY SOFT	LESS THAN .25
SOFT	.25 TO .50
FIRM	.50 TO 1.00
STIFF	1.00 TO 2.00
VERY STIFF	2.00 TO 4.00
HARD	OVER 4.00

II. PLASTICITY

DEGREE OF PLASTICITY	PLASTICITY INDEX
NONE TO SLIGHT	0 - 4
SLIGHT	5 - 10
MEDIUM	11 - 30
HIGH TO VERY HIGH	OVER 30

NOTE: ALL SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

III. RELATIVE PROPORTIONS

DESCRIPTIVE TERM	PERCENT
TRACE	1 - 10
LITTLE	11 - 20
SOME	21 - 35
AND	36 - 50

IV. PARTICLE SIZE IDENTIFICATION

BOULDERS: -8 INCH DIAMETER OR MORE
COBBLES : -3 TO 8 INCH DIAMETER
GRAVEL : -COARSE - 3/4 TO 3 INCH
-FINE - 5.0 MM TO 3/4 INCH
SAND : -COARSE - 2.0 MM TO 5.0 MM
-MEDIUM - 0.4 MM TO 2.0 MM
-FINE - 0.07 MM TO 0.4 MM
SILT : -0.002 MM TO 0.07 MM
CLAY : -0.002 MM

V. DRILLING AND SAMPLING SYMBOLS

AU: AUGER SAMPLE
RC: ROCK CORE
TCP: TEXAS CONE PENETRATION TEST
SS: SPLIT-SPOON 1 3/8" I.D. 2" O.D. EXCEPT WHERE NOTED
ST: SHELBY TUBE = 3" O.D. EXCEPT WHERE NOTED
WS: WASHED SAMPLE
HSA: HOLLOW STEM AUGERS
CFA: CONTINUOUS FLIGHT AUGERS
MD: MUD DRILLING

APPENDIX E

EXISTING STORM SEWER ANALYSIS

MIDWAY ROAD RECONSTRUCTION
COMMON VARIABLES USED IN ANALYSIS

EXISTING STORM SEWER SYSTEM

Mannings "n"		
Pipe Mat'l	**Recommended n-value**	**Source**
RCP	0.013	Per the Town of Addison Drainage Manual
CMP,PLN	0.024	(Plain or Coated) Per the Town of Addison Drainage Manual
CMP,PVD	0.020	(Paved Invert) Per the Town of Addison Drainage Manual

Outfall Information				
	Storm Sewer	**HGL (tailwater)**	**Outfall Location**	**Comments**
LINE A	610.50	616.12	9'x5'	HGL shown based on "tailwater" elevation shown on as-built plans, associated storm event not listed.
LINE B	610.93	616.54	LINE A	
LINE C	610.60	616.12	9'x5'	HGL shown based on "tailwater" elevation shown on as-built plans, associated storm event not listed.
LINE D	611.73	616.12	9'x5'	HGL shown based on "tailwater" elevation shown on as-built plans, associated storm event not listed.
LINE E			Unknown	Plans for this system could not be found, only one inlet located within the limits of pavement reconstruction

MIDWAY ROAD RECONSTRUCTION
DRAINAGE AREA CALCULATIONS

EXISTING STORM SEWER SYSTEM

DRAINAGE AREA CALCULATIONS								
DRAINAGE AREA NO.	INLET		DESIGN STORM FREQUNCY	AREA RUNOFF (Q=CIA)				
	NO.	PAVING STATION		TIME OF CONC.	RUNOFF COEFF. "C"	MULTIPLIER "Ca"	AREA	C*Ca*A
			(years)	(min)			(acres)	
1			100	10	0.8	1	2.09	1.672
Combined	B1			10				1.672
2			100	10	0.9	1	0.36	0.324
Combined	B2			10				0.324
3			100	10	0.8	1	1.56	1.248
Combined	A1			10				1.248
4			100	10	0.9	1	0.46	0.414
Combined	B3			10				0.414
5A			100	10	0.8	1	1.2	0.96
Combined	D1A			10				0.96
5B			100	10	0.8	1	0.47	0.376
Combined	D1B			10				0.376
6A			100	10	0.9	1	0.5	0.45
Combined	C1A			10				0.45
6B			100	10	0.9	1	0.21	0.189
Combined	C1B			10				0.189
7			100	10	0.8	1	1.27	1.016
Combined	C2			10				1.016
8			100	10	0.9	1	0.67	0.603
Combined	C3			10				0.603
9			100	10	0.8	1	1.39	1.112
Combined	C4			10				1.112
10			100	10	0.8	1	4.77	3.816
Combined	C5			10				3.816
11			100	10	0.8	1	1	0.8
Combined	C6			10				0.8
12			100	10	0.8	1	0.74	0.592
Combined	C7			10				0.592
13			100	10	0.8	1	0.85	0.68
Combined	C10			10				0.68
14			100	10	0.9	1	0.61	0.549
Combined	C11			10				0.549
15			100	10	0.8	1	1.47	1.176
Combined	C12			10				1.176
16			100	10	0.8	1	0.64	0.512
Combined	C13			10				0.512
29			100	10	0.9	1	0.35	0.315
Combined	C14			10				0.315
17			100	10	0.8	1	0.95	0.76
Combined	C15			10				0.76
18			100	10	0.8	1	0.42	0.336
Combined	C16			10				0.336

MIDWAY ROAD RECONSTRUCTION
DRAINAGE AREA CALCULATIONS

EXISTING STORM SEWER SYSTEM

DRAINAGE AREA CALCULATIONS								
DRAINAGE AREA NO.	INLET		DESIGN STORM FREQUNCY	AREA RUNOFF (Q=CIA)				C*Ca*A
	NO.	PAVING STATION		TIME OF CONC.	RUNOFF COEFF. "C"	MULTIPLIER "Ca"	AREA	
			(years)	(min)			(acres)	
19			100	10	0.8	1	1.05	0.84
Combined	C17			10				0.84
20			100	10	0.9	1	0.69	0.621
Combined	C18			10				0.621
21			100	10	0.8	1	1.2	0.96
Combined	C19			10				0.96
30			100	10	0.9	1	0	0
Combined	C20			10				0
22			100	10	0.8	1	2.32	1.856
Combined	C22			10				1.856
23			100	10	0.8	1	1.64	1.312
Combined	C21			10				1.312
25			100	10	0.8	1	0.57	0.456
Combined	C23			10				0.456
26			100	10	0.8	1	2.01	1.608
Combined	C24			10				1.608
24			100	10	0.8	1	4.29	3.432
Combined	E1			10				3.432
27			100	10	0.8	1	0.42	0.336
Combined	C8			10				0.336
28			100	10	0.8	1	1.52	1.216
Combined	C9			10				1.216

MIDWAY ROAD RECONSTRUCTION
INLET CALCULATIONS

EXISTING STORM SEWER SYSTEM

INLET CALCULATIONS

INLET		DRAINAGE AREA NO.	DESIGN STORM FREQUNCY	AREA RUNOFF (Q=CIA)				CARRY-OVER FROM	TOTAL FLOW	CROSS SLOPE	GUTTER DEPTH	ALLOWABLE DEPTH	GUTTER SLOPE	ON-GRADE/ LOWPT	CAPACITY PER FOOT OF INLET	LENGTH OF INLET REQ'D	INLET LENGTH	TYPE OF INLET	CARRY-OVER TO		FLOW INTO INLET	C*Ca*A INTO INLET
NO.	PAVING STATION			TIME OF CONC.	INTENSITY	C*Ca*A	"Q"												INLET NO.	FLOW "Q"		
			(years)	(min)	(in/hr)	(acres)	(c.f.s.)	(c.f.s.)	(c.f.s.)	%	ft	ft	ft / ft		(cfs/ft)	(ft)	(ft)			(cfs)	(cfs)	
B1	4+25	1	100	10	8.74	1.67	14.6	0.0	14.6	0.610	0.22	0.13	0.02	GRADE	0.45	32.5	20	CURB	A1	5.6	9.0	1.03
B2	4+45	2	100	10	8.74	0.32	2.8	0.0	2.8	4.740	0.25	0.42	0.023	GRADE	0.48	5.9	10	CURB	B3	0.0	2.8	0.32
B3	6+60	4	100	10	8.74	0.41	3.6	0.0	3.6	3.970	0.29	0.42	0.012	LOWPT	0.48	7.6	10	CURB	LOWPT	0.0	3.6	0.41
A1	6+65	3	100	10	8.74	1.25	10.9	5.6	16.5	1.350	0.35	0.30	0.011	LOWPT	0.61	26.9	10	CURB	LOWPT	10.4	6.1	0.70
D1A	10+65	5A	100	10	8.74	0.96	8.4	55.4	63.8	2.840	0.80	0.42	0.009	LOWPT	1.06	60.2	10	CURB	D1B	53.2	10.6	1.21
D1B	10+65	5B	100	10	8.74	0.38	3.3	53.2	56.5	2.840	0.78	0.42	0.009	LOWPT	1.06	53.2	10	CURB	LOWPT	45.9	10.6	1.21
C1A	11+10	6A	100	10	8.74	0.45	3.9	0.2	4.1	4.160	0.34	0.42	0.007	LOWPT	0.61	6.8	10	CURB	C1B	0.0	4.1	0.47
C1B	11+10	6B	100	10	8.74	0.19	1.7	0.0	1.7	4.160	0.24	0.42	0.007	LOWPT	0.36	4.5	10	CURB	LOWPT	0.0	1.7	0.19
C2	15+30	7	100	10	8.74	1.02	8.9	47.1	56.0	1.770	0.57	0.39	0.016	GRADE	0.79	71.2	10	CURB	D1A	48.1	7.9	0.90
C3	15+31	8	100	10	8.74	0.60	5.3	0.0	5.3	3,060	0.29	0.42	0.016	GRADE	0.51	10.3	10	CURB	C1A	0.2	5.1	0.58
C4	17+05	9	100	10	8.74	1.11	9.7	45.6	55.4	2.160	0.60	0.42	0.017	GRADE	0.82	67.1	10	CURB	C2	47.1	8.2	0.94
C5	18+40	10	100	10	8.74	3.82	33.4	19.6	53.0	1.260	0.52	0.28	0.012	GRADE	0.73	72.3	10	CURB	C4	45.6	7.3	0.84
C6	18+90	11	100	10	8.74	0.80	7.0	19.5	26.5	1.770	0.48	0.39	0.009	GRADE	0.69	38.3	10	CURB	C5	19.6	6.9	0.79
C7	21+05	12	100	10	8.74	0.59	5.2	0.0	5.2	4.420	0.37	0.42	0.009	GRADE	0.58	6.9	10	CURB	C3	0.0	5.2	0.59
C8	WP[2]	27	100	10	8.74	0.34	2.9	0.0	2.9	6.250	0.32	0.42	0.013	GRADE	0.54	5.5	10	CURB	C6	0.0	2.9	0.34
C9	WP[2]	28	100	10	8.74	1.22	10.6	0.0	10.6	4.050	0.41	0.42	0.018	GRADE	0.62	17.0	10	CURB	C6	4.4	6.2	0.71
C10	23+15	13	100	10	8.74	0.68	5.9	15.3	21.2	1.580	0.39	0.35	0.013	GRADE	0.61	34.9	10	CURB	C8	15.2	6.1	0.70
C11	23+10	14	100	10	8.74	0.55	4.8	0.7	5.5	4.030	0.34	0.42	0.012	GRADE	0.56	9.9	10	CURB	C7	0.0	5.5	0.63
C12	24+90	15	100	10	8.74	1.18	10.3	11.2	21.5	1.660	0.40	0.37	0.013	GRADE	0.62	34.7	10	CURB	C10	15.3	6.2	0.71
C13	27+16	16	100	10	8.74	0.51	4.5	12.3	16.8	1.460	0.34	0.33	0.015	GRADE	0.56	30.0	10	CURB	C12	11.2	5.6	0.64
C14	27+80	29	100	10	8.74	0.32	2.8	0.0	2.8	-	-	0.42	OFF RD	LOWPT	1.06	2.8	6	CURB	C13	0.0	2.8	0.32
C15	28+45	17	100	10	8.74	0.76	6.6	10.5	17.2	0.710	0.26	0.16	0.015	GRADE	0.49	35.4	10	CURB	C13	12.3	4.9	0.56
C16	28+60	18	100	10	8.74	0.34	2.9	3.5	6.4	3.970	0.35	0.42	0.015	GRADE	0.56	11.3	10	CURB	C11	0.7	5.6	0.65
C17	30+35	19	100	10	8.74	0.84	7.3	8.4	15.6	1.190	0.30	0.28	0.017	GRADE	0.52	30.3	10	CURB	C15	10.5	5.2	0.60
C18	31+40	20	100	10	8.74	0.62	5.4	5.1	10.5	4.740	0.49	0.42	0.009	GRADE	0.71	14.9	10	CURB	C16	3.5	7.1	0.81
C19	32+10	21	100	10	8.74	0.96	8.4	5.1	13.5	0.900	0.28	0.20	0.010	GRADE	0.50	26.7	10	CURB	C17	8.4	5.0	0.58
C20[1]	GR[2]	30	100	10	8.74	0.00	0.0	0.0	0.0	0.000	-	0.00	OFF RD	LOWPT	2.2	0.0	4	GRATE	C19	0.0	0.0	0.00
C21	35+90	23	100	10	8.74	1.31	11.5	0.0	11.5	2.900	0.42	0.42	0.009	GRADE	0.64	18.0	10	CURB	C18	5.1	6.4	0.73
C22	36+20	22	100	10	8.74	1.31	11.5	0.0	11.5	2.000	0.42	0.42	0.004	GRADE	0.64	17.9	10	CURB	C19	5.1	6.4	0.73
C23	LB[2]	25	100	10	8.74	0.46	4.0	0.0	4.0	3.400	0.27	0.42	0.018	GRADE	0.49	8.1	10	CURB	D1A	0.0	4.0	0.46
C24	LB[2]	26	100	10	8.74	1.61	14.1	0.0	14.1	3.700	0.46	0.42	0.014	GRADE	0.67	20.6	10	CURB	D1A	7.3	6.7	0.77
E1	54+15	24	100	10	8.74	3.43	30.0	0.0	30.0	6.560	0.66	0.42	0.030	GRADE	0.89	33.6	10	CURB		21.1	8.9	1.02

1 COULD NOT VERIFY EXISTENCE IN FIELD OR FROM FIELD SURVEY; THEREFORE, ASSUME FOR CONSERVATIVENESS THAT THE FLOW ENTERS THE STREET AND ENTERS THE SYSTEM AT INLET C19. ALSO, SINCE THE PLANS CALL THIS A DOUBLE GRATE INLET, IT IS POSSIBLE THAT IT WILL BE CLOGGED BY DEBRIS DURING THE STORM AND THEREFORE, BE INEFFECTIVE.

2 INLETS OFF OF MIDWAY:

WP	WILEY POST
LB	LINDBERG
GR	GRATE INLET

MIDWAY ROAD NSTRUCTION
LATERAL CALCULATIONS

EXISTING STORM SEWER SYSTEM

STORM SYSTEM CALCULATIONS - LATERAL LINES ON MAIN LINE

		MANHOLE OR INLET					TIME OF CONCENTRATION						PIPE DESCRIPTION				HYDRAULIC GRADIENT ELEV.		HEAD LOSS AT CHANGE IN SECTION											ELEV. OF INVERT AT DESIGN POINT	
LATERAL NUMBER	INLET NUMBER	DESIGN POINT UP-STREAM	DOWN-STREAM	DISTANCE BETWEEN POINTS	C*Ca*A	TOTAL C*Ca*A	INLET TIME	TIME IN SEWER	DOWN-STREAM TIME	DESIGN FREQUENCY	INTENSITY	TOTAL DESIGN DISCHARGE	SLOPE PER PLANS	MATERIAL	SIZE	FRICTION GRADIENT SLOPE Sf	UP-STREAM	DOWN-STREAM	UP-STREAM VELOCITY V_1	DOWN-STREAM VELOCITY V_2	$V_1^2/2g$	$V_2^2/2g$	K_j	h_j	H.G. ELEV. AT DESIGN POINT	ELEV. OF TOP OF CURB AT DESIGN POINT	TOTAL C*Ca*A INTO MAIN LINE	TOTAL INLET TIME TO MAIN LINE	TOP OF CURB - H.G. ELEV.	UP-STREAM PIPE	DOWN-STREAM PIPE
				(ft)			(min)	(min)	(min)	(years)	(in/hr)	(cfs)	(ft/ft)		(in)	(%)	(ft)	(ft)	(fps)	(fps)	(ft)	(ft)		(ft)	(ft)	(ft)	(cfs)	(min)	(ft)	(ft)	(ft)
LAT A1	A1	21	0	21	0.703	0.703	10	0.0	10.0	100	8.74	6.1	0.103	RCP	21	0.0015	616.59	616.56	2.6	2.6	0.1	0.1	0.5	0.1	616.59	617.60	0.703	10.137	1.01	613.78	611.62
		0	0	0		0.703	-	0.1	10.1	100	8.716	6.1	0.103	RCP	21	0.0015	616.56	616.56	2.5	1.2	0.1	0.0	0.5	0	616.56	617.60	0.703	10.137	1.04	611.62	611.62
LAT B1	B1	88	0	88	1.028	1.028	10	0.0	10.0	100	8.74	9.0	0.033	RCP	21	0.0032	617.93	617.65	3.7	3.7	0.2	0.2	0.5	0.1	617.93	621.84	1.028	10.392	3.91	617.71	614.80
		0	0	0		1.028	-	0.4	10.4	100	8.67	8.9	0.033	RCP	21	0.0032	617.65	617.65	3.7	3.7	0.2	0.2	0.5	0.1	617.65	621.84	1.028	10.392	4.19	614.80	614.80
LAT B2	B2	10	0	10	0.324	0.324	10	0.0	10.0	100	8.74	2.8	0.065	RCP	18	0.0007	617.86	617.85	1.8	1.8	0.0	0.0	0.5	0.0	617.86	619.77	0.324	10.104	1.91	616.10	615.45
		0	0	0		0.324	-	0.1	10.1	100	8.72	2.8	0.065	RCP	18	0.0007	617.85	617.85	1.8	1.2	0.0	0.0	0.5	0.0	617.85	619.77	0.324	10.104	1.92	615.45	615.45
LAT B3	B3	10	0	10	0.414	0.414	10	0.0	10.0	100	8.74	3.6	0.08	RCP	21	0.0005	617.09	617.08	1.5	1.5	0.0	0.0	0.5	0.0	617.09	616.75	0.414	10.111	-0.34	612.72	611.92
		0	0	0		0.414	-	0.1	10.1	100	8.72	3.6	0.08	RCP	21	0.0005	617.08	617.08	1.5	4.7	0.0	0.3	0.5	0.2	617.08	616.75	0.414	10.111	-0.33	611.92	611.92
LAT C1A	C1A	62	0	62	0.469	0.469	10	0.0	10.0	100	8.74	4.1	0.023	RCP	21	0.0007	617.22	617.18	1.7	1.7	0.0	0.0	0.5	0.0	617.22	618.21	0.469	10.606	0.99	614.85	613.42
		0	0	0		0.469	-	0.6	10.6	100	8.60	4.0	0.023	RCP	21	0.0006	617.18	617.18	1.7	5.4	0.0	0.5	0.5	0.2	617.18	618.21	0.469	10.606	1.03	613.42	613.42
LAT C1B	C1B	62	0	62	0.189	0.189	10	0.0	10.0	100	8.74	1.7	0.023	RCP	21	0.0001	617.03	617.02	0.7	0.7	0.0	0.0	0.5	0.0	617.03	618.28	0.189	11.505	1.25	614.80	613.36
		0	0	0		0.189	-	1.5	11.5	100	8.35	1.6	0.023	RCP	21	0.0001	617.02	617.02	0.7	5.5	0.0	0.5	0.5	0.2	617.02	618.28	0.189	11.505	1.26	613.36	613.36
LAT C2	C2	61	0	61	0.9	0.9	10	0.0	10.0	100	8.74	7.9	0.038	RCP	21	0.0025	618.65	618.50	3.3	3.3	0.2	0.2	0.5	0.1	618.65	621.95	0.900	10.311	3.30	617.72	615.43
		0	0	0		0.9	-	0.3	10.3	100	8.67	7.8	0.038	RCP	21	0.0024	618.50	618.50	3.2	5.0	0.2	0.4	0.5	0.2	618.50	621.95	0.900	10.311	3.45	615.43	615.43
LAT C3	C3	31	0	31	0.584	0.584	10	0.0	10.0	100	8.74	5.1	0.034	RCP	21	0.0010	618.70	618.67	2.1	2.1	0.1	0.1	0.5	0.0	618.70	621.03	0.584	10.244	2.33	616.57	615.51
		0	0	0		0.584	-	0.2	10.2	100	8.69	5.1	0.034	RCP	21	0.0010	618.67	618.67	2.1	4.6	0.1	0.3	0.5	0.2	618.67	621.03	0.584	10.244	2.36	615.51	615.51
LAT C4	C4	64	0	64	0.943	0.943	10	0.0	10.0	100	8.74	8.2	0.053	RCP	21	0.0027	619.10	618.92	3.4	3.4	0.2	0.2	0.5	0.1	619.10	624.05	0.943	10.311	4.96	620.20	616.81
		0	0	0		0.943	-	0.3	10.3	100	8.67	8.2	0.053	RCP	21	0.0027	618.92	618.92	3.4	6.9	0.2	0.7	0.5	0.4	618.92	624.05	0.943	10.311	5.13	616.81	616.81
LAT C5	C5	64	0	64	0.838	0.838	10	0.0	10.0	100	8.74	7.3	0.065	RCP	21	0.0021	619.74	619.61	3.0	3.0	0.1	0.1	0.5	0.1	619.74	626.62	0.838	10.350	6.88	622.66	618.51
		0	0	0		0.838	-	0.4	10.4	100	8.67	7.3	0.065	RCP	21	0.0021	619.61	619.61	3.0	6.4	0.1	0.6	0.5	0.3	619.61	626.62	0.838	10.350	7.01	618.51	618.51
LAT C6	C6	64	0	64	0.793	0.793	10	0.0	10.0	100	8.74	6.9	0.082	RCP	21	0.0019	621.38	621.26	2.9	2.9	0.1	0.1	0.5	0.1	621.38	628.32	0.793	10.370	6.94	624.33	620.39
		0	0	0		0.793	-	0.4	10.4	100	8.67	6.9	0.082	RCP	21	0.0019	621.26	621.26	2.9	5.9	0.1	0.5	0.5	0.3	621.26	628.32	0.793	10.370	7.06	620.39	620.39
LAT C7	C7	34	0	34	0.592	0.592	10	0.0	10.0	100	8.74	5.2	0.071	RCP	21	0.0011	622.65	622.62	2.2	2.2	0.1	0.1	0.5	0.0	622.65	628.57	0.592	10.263	5.92	624.39	621.98
		0	0	0		0.592	-	0.3	10.3	100	8.69	5.1	0.071	RCP	21	0.0011	622.62	622.62	2.1	5.5	0.1	0.5	0.5	0.2	622.62	628.57	0.592	10.263	5.95	621.98	621.98
LAT C8	C8	34	0	34	0.336	0.336	10	0.0	10.0	100	8.74	2.9	0.008	RCP	18	0.0008	624.37	624.35	1.7	1.7	0.0	0.0	0.5	0.0	624.37	631.12	0.336	10.341	6.75	629.27	628.99
		0	0	0		0.336	-	0.3	10.3	100	8.67	2.9	0.008	RCP	18	0.0008	624.35	624.35	1.6	3.8	0.0	0.2	0.5	0.1	624.35	631.12	0.336	10.341	6.77	628.99	628.99
LAT C9	C9	114.32	81	33.32	0.714	0.714	10	0.0	10.0	100	8.74	6.2	0.02	RCP	21	0.0015	624.40	624.35	2.6	2.6	0.1	0.1	0.5	0.1	624.40	631.28	1.050	10.698	6.88	628.15	627.49
	C8	81	0	81	0.336	1.05	10.3	0.2	10.3	100	8.67	9.1	0.0500	RCP	21	0.0033	624.35	624.08	3.8	3.8	0.2	0.2	0.5	0.1	624.35	631.12	1.050	10.698	6.77	627.49	623.44
		0	0	0		1.05	-	0.4	10.7	100	8.60	9.0	0.0500	RCP	21	0.0000	624.08	624.08	3.8	5.2	0.2	0.4	0.5	0.2	624.08	631.28	1.050	10.698	7.20	623.44	623.44
LAT C10	C10	64	0	64	0.696	0.696	10	0.0	10.0	100	8.74	6.1	0.049	RCP	21	0.0015	625.17	625.07	2.5	2.5	0.1	0.1	0.5	0.0	625.17	631.13	0.696	10.422	5.96	627.59	624.44
		0	0	0		0.696	-	0.4	10.4	100	8.64	6.0	0.049	RCP	21	0.0014	625.07	625.07	2.5	4.6	0.1	0.3	0.5	0.2	625.07	631.13	0.696	10.422	6.06	624.44	624.44
LAT C11	C11	34	0	34	0.635	0.635	10	0.0	10.0	100	8.74	5.5	0.039	RCP	21	0.0012	625.25	625.21	2.3	2.3	0.1	0.1	0.5	0.0	625.25	629.96	0.635	10.246	4.71	625.93	624.60
		0	0	0		0.635	-	0.2	10.2	100	8.69	5.5	0.039	RCP	21	0.0012	625.21	625.21	2.3	4.1	0.1	0.3	0.5	0.1	625.21	629.96	0.635	10.246	4.75	624.60	624.60
LAT C12	C12	64	0	64	0.709	0.709	10	0.0	10.0	100	8.74	6.2	0.035	RCP	21	0.0015	627.46	627.36	2.6	2.6	0.1	0.1	0.5	0.1	627.46	632.75	0.709	10.414	5.29	628.74	626.48
		0	0	0		0.709	-	0.4	10.4	100	8.64	6.1	0.035	RCP	21	0.0015	627.36	627.36	2.5	5.0	0.1	0.4	0.5	0.2	627.36	632.75	0.709	10.414	5.39	626.48	626.48
LAT C13	C13	64	0	64	0.64	0.64	10	0.0	10.0	100	8.74	5.6	0.04	RCP	21	0.0012	629.68	629.60	2.3	2.3	0.1	0.1	0.5	0.0	629.68	635.26	0.640	10.458	5.58	631.30	628.72
		0	0	0		0.64	-	0.5	10.5	100	8.64	5.5	0.04	RCP	21	0.0012	629.60	629.60	2.3	4.8	0.1	0.4	0.5	0.2	629.60	635.26	0.640	10.458	5.66	628.72	628.72
LAT C14	C14	70	0	70	0.315	0.315	10	0.0	10.0	100	8.74	2.8	0.038	RCP	21	0.0003	630.69	630.67	1.1	1.1	0.0	0.0	0.5	0.0	630.69	636.60	0.315	11.019	5.91	632.25	629.61
		0	0	0		0.315	-	1.0	11.0	100	8.50	2.7	0.038	RCP	21	0.0003	630.67	630.67	1.1	5.7	0.0	0.5	0.5	0.3	630.67	636.60	0.315	11.019	5.93	629.61	629.61
LAT C15	C15	64	0	64	0.556	0.556	10	0.0	10.0	100	8.74	4.9	0.039	RCP	21	0.0009	631.39	631.33	2.0	2.0	0.1	0.1	0.5	0.0	631.39	636.74	0.556	10.528	5.35	632.76	630.27
		0	0	0		0.556	-	0.5	10.5	100	8.62	4.8	0.039	RCP	21	0.0009	631.33	631.33	2.0	5.3	0.1	0.4	0.5	0.2	631.33	636.74	0.556	10.528	5.41	630.27	630.27

MIDWAY ROAD [illegible]ONSTRUCTION
LATERAL CALCULATIONS

EXISTING STORM SEWER SYSTEM

STORM SYSTEM CALCULATIONS - LATERAL LINES ON MAIN LINE

		MANHOLE OR INLET					TIME OF CONCENTRATION						PIPE DESCRIPTION				HYDRAULIC GRADIENT ELEV.		HEAD LOSS AT CHANGE IN SECTION											ELEV. OF INVERT AT DESIGN POINT	
		DESIGN POINT		DISTANCE BETWEEN POINTS	C'Ca'A	TOTAL C'Ca'A	INLET TIME	TIME IN SEWER	DOWN-STREAM TIME	DESIGN FREQUENCY	INTENSITY	TOTAL DESIGN DISCHARGE	SLOPE PER PLANS	MATERIAL	SIZE	FRICTION GRADIENT SLOPE Sf	UP-STREAM	DOWN-STREAM	UP-STREAM VELOCITY V_1	DOWN-STREAM VELOCITY V_2	$V_1^2/2g$	$V_2^2/2g$	Kj	hj	H.G. ELEV. AT DESIGN POINT	ELEV. OF TOP OF CURB AT DESIGN POINT	TOTAL C'Ca'A INTO MAIN LINE	TOTAL INLET TIME TO MAIN LINE	TOP OF CURB - H.G. ELEV.	UP-STREAM PIPE	DOWN-STREAM PIPE
LATERAL NUMBER	INLET NUMBER	UP-STREAM	DOWN-STREAM	(ft)			(min)	(min)	(min)	(years)	(in/hr)	(cfs)	(ft/ft)		(in)	(%)	(ft)	(ft)	(fps)	(fps)	(ft)	(ft)		(ft)	(ft)	(ft)	(cfs)	(min)	(ft)	(ft)	(ft)
LAT C16	C16	34	0	34	0.645	0.645	10	0.0	10.0	100	8.74	5.6	0.035	RCP	21	0.0013	631.64	631.60	2.3	2.3	0.1	0.1	0.5	0.0	631.64	635.90	0.645	10.242	4.26	631.60	630.60
		0	0	0		0.645	-	0.2	10.2	100	8.69	5.6	0.035	RCP	21	0.0013	631.60	631.60	2.3	4.7	0.1	0.3	0.5	0.2	631.60	635.90	0.645	10.242	4.30	630.60	630.60
LAT C17	C17	64	0	64	0.596	0.596	10	0.0	10.0	100	8.74	5.2	0.048	RCP	21	0.0011	634.25	634.18	2.2	2.2	0.1	0.1	0.5	0.0	634.25	640.17	0.596	10.493	5.92	636.24	633.30
		0	0	0		0.596	-	0.5	10.5	100	8.64	5.2	0.048	RCP	21	0.0011	634.18	634.18	2.1	5.8	0.1	0.5	0.5	0.2	634.18	640.17	0.596	10.493	5.99	633.30	633.30
LAT C18	C18	34	0	34	0.81	0.81	10	0.0	10.0	100	8.74	7.1	0.053	RCP	21	0.0020	636.08	636.01	2.9	2.9	0.1	0.1	0.5	0.1	636.08	640.87	0.810	10.192	4.79	638.93	635.14
		0	0	0		0.81	-	0.2	10.2	100	8.72	7.1	0.053	RCP	21	0.0020	636.01	636.01	2.9	4.7	0.1	0.3	0.5	0.2	636.01	640.87	0.810	10.192	4.86	635.14	635.14
LAT C19	C19	64	0	64	0.578	0.576	10	0.0	10.0	100	8.74	5.0	0.047	RCP	21	0.0010	636.73	636.67	2.1	2.1	0.1	0.1	0.5	0.0	636.73	642.85	0.576	10.509	6.12	639.13	636.12
		0	0	0		0.576	-	0.5	10.5	100	8.62	5.0	0.047	RCP	21	0.0010	636.67	636.67	2.1	3.4	0.1	0.2	0.5	0.1	636.67	642.85	0.576	10.509	6.18	636.12	636.12
LAT C21	C21	38	0	38	0.728	0.728	10	0.0	10.0	100	8.74	6.4	0.014	RCP	21	0.0016	641.80	641.74	2.6	2.6	0.1	0.1	0.5	0.1	641.80	645.29	0.728	10.240	3.49	641.29	640.74
		0	0	0		0.728	-	0.2	10.2	100	8.69	6.3	0.014	RCP	21	0.0016	641.74	641.74	2.6	4.0	0.1	0.2	0.5	0.1	641.74	645.29	0.728	10.240	3.55	640.74	640.74
LAT C22	C22	57	0	57	0.733	0.733	10	0.0	10.0	100	8.74	6.4	0.008	RCP	21	0.0016	642.06	641.96	2.7	2.7	0.1	0.1	0.5	0.1	642.06	645.37	0.733	10.357	3.31	641.41	640.97
		0	0	0		0.733	-	0.4	10.4	100	8.67	6.4	0.008	RCP	21	0.0016	641.96	641.96	2.6	2.0	0.1	0.1	0.5	0.0	641.96	645.37	0.733	10.357	3.41	640.97	640.97
LAT C23	C23	48	0	48	0.456	0.456	10	0.0	10.0	100	8.74	4.0	0.029	RCP	18	0.0014	618.50	618.43	2.3	2.3	0.1	0.1	0.5	0.0	618.50	621.99	0.456	10.355	3.49	618.04	616.64
		0	0	0		0.456	-	0.4	10.4	100	8.67	4.0	0.029	RCP	18	0.0014	618.43	618.43	2.2	4.4	0.1	0.3	0.5	0.2	618.43	621.99	0.456	10.355	3.56	616.64	616.64
LAT C24	C24	99.3	52	47.3	0.772	0.772	10	0.0	10.0	100	8.74	6.7	0.029	RCP	21	0.0018	618.52	618.43	2.8	2.8	0.1	0.1	0.5	0.1	618.52	622.13	1.228	10.551	3.61	618.03	616.64
	C23	52	0	52	0.456	1.228	10.4	0.3	10.4	100	8.67	10.6	0.029	RCP	21	0.0045	618.43	618.20	4.4	4.4	0.3	0.3	0.5	0.2	618.43	622.13	1.228	10.551	3.70	616.64	615.11
		0	0	0		1.228	-	0.2	10.6	100	8.62	10.6	0.029	RCP	21	0.0000	618.20	618.20	4.4	5.4	0.3	0.5	1.5	0.7	618.20	622.13	1.228	10.551	3.93	615.11	615.11
LAT D1A	D1A	32	0	32	1.214	1.214	10	0.0	10.0	100	8.74	10.6	0.015	RCP	21	0.0045	618.44	618.30	4.4	4.4	0.3	0.3	0.5	0.2	618.44	618.92	1.214	10.121	0.48	615.87	615.39
		0	0	0		1.214	-	0.1	10.1	100	8.72	10.6	0.015	RCP	21	0.0045	618.30	618.30	4.4	3.4	0.3	0.2	0.5	0.1	618.30	618.92	1.214	10.121	0.62	615.39	615.39
LAT D1B	D1B	32	0	32	1.214	1.214	10	0.0	10.0	100	8.74	10.6	0.013	RCP	21	0.0045	617.85	617.71	4.4	4.4	0.3	0.3	0.5	0.2	617.85	618.91	1.214	10.121	1.06	615.76	615.34
		0	0	0		1.214	-	0.1	10.1	100	8.72	10.6	0.013	RCP	21	0.0045	617.71	617.71	4.4	6.7	0.3	0.7	0.5	0.4	617.71	618.91	1.214	10.121	1.20	615.34	615.34

MIDWAY ROAD CONSTRUCTION
STORM SEWER CALCULATIONS

EXISTING STORM SEWER SYSTEM

STORM SYSTEM CALCULATIONS - MAIN LINE

MANHOLE OR INLET		DISTANCE BETWEEN POINTS	INCOMING LATERAL NUMBER	C*Ca*A (ENTERING INLET)	TOTAL C*Ca*A (ENTERING INLET)	TIME OF CONCENTRATION			DESIGN FREQUENCY	INTENSITY	TOTAL DESIGN DISCHARGE	SELECTED PIPE SLOPE	NUMBER OF BARRELS	PIPE MAT'L	SELECTED SIZE OF PIPE	FULL FLOW CAPACITY OF PIPE	FRICTION GRADIENT SLOPE Sf	HYDRAULIC GRADIENT ELEV.		HEAD LOSS AT CHANGE IN SECTION						[2]HGL BASED ON FRICTION OR PROP.	H.G. ELEV. AT DESIGN POINT (U/S)	ELEV. OF INVERT AT DESIGN POINT		TOP OF CURB ELEVATION	TOP OF CURB - H.G. ELEV.
DESIGN POINT						INLET TIME	TIME IN SEWER	DOWN-STREAM TIME										UP-STREAM	DOWN-STREAM	UP-STREAM VELOCITY V1	DOWN-STREAM VELOCITY V2	$V1^2/2g$	$V2^2/2g$	K	[1]hL			UP-STREAM PIPE	DOWN-STREAM PIPE		
UP-STREAM	DOWN-STREAM	(ft)				(min)	(min)	(min)	(years)	(in/hr)	(cfs)	(ft/ft)			(in)	(cfs)	(%)	(ft)	(ft)	(fps)	(fps)	(ft)	(ft)		(ft)	FRIC / PROP	(ft)	(ft)	(ft)	(ft)	(ft)
LINE A																															
158	39.98	118.02	LAT A1	0.703	0.703	10.1	0.0	10.1	100	8.72	6.1	0.005	1	RCP	30	27.8	0.0002	616.56	616.54	1.2	4.2	0.024	0.270	0.75	0.25	FRIC	616.56	611.24	610.70	617.60	1.04
39.98	0	39.98	LINE B	1.766	2.469	11.6	1.8	11.7	100	8.29	20.5	0.005	1	RCP	30	29.0	0.0025	616.29	616.19	4.2	4.2	0.270	0.268	0.75	0.07	FRIC	616.29	610.70	610.50	-	-
0	0	0.00		0.000	2.469	0.0	0.2	11.9	100	8.26	20.4	0.005	1	RCP	30	29.0	0.0025	616.12	616.12	4.2	0.0	0.268	0.000		0.00	FRIC	616.12	610.50	610.50	-	-
LINE B																															
322	303	19.00	LAT B2	0.324	0.324	10.1	0.0	10.1	100	8.72	2.8	0.021	1	RCP	21	23.0	0.0003	617.85	617.65	1.2	3.7	0.021	0.216	0.75	0.20	FRIC	617.85	615.33	614.93	619.77	1.92
303	200	103.00	LAT B1	1.028	1.352	10.4	0.3	10.4	100	8.67	11.7	0.021	1	RCP	24	33.0	0.0027	617.65	617.37	3.7	3.7	0.216	0.210	0.75	0.05	FRIC	617.65	614.68	612.48	621.84	4.19
200	108	92.00	GBRK	0.000	1.352	-	0.5	10.9	100	8.55	11.6	0.008	1	RCP	24	19.6	0.0026	617.32	617.08	3.7	4.7	0.210	0.350		0.00	FRIC	617.32	612.48	611.79	-	-
108	0	108.00	LAT B3	0.414	1.766	10.1	0.4	11.3	100	8.44	14.9	0.008	1	RCP	24	20.2	0.0043	617.08	616.51	4.7	4.7	0.350	0.340	0.75	0.08	FRIC	617.08	611.79	610.93	616.75	-0.33
D	0	0.00		0.000	1.766	0.0	0.4	11.6	100	8.32	14.7	0.008	1	RCP	24	20.2	0.0042	616.54	616.54	4.7	0.0	0.340	0.000		0.00	FRIC	616.54	610.93	610.93		
																									0.00						
LINE C																															
2781.6	2752.8	28.78	LAT C22	0.733	0.733	10.4	0.00	10.4	100	8.67	6.4	0.0080	1	RCP	24	20.2	0.0008	641.96	641.94	2.0	4.0	0.063	0.249	0.75	0.20	FRIC	641.96	640.85	640.62	645.37	3.41
2752.8	2600.0	152.84	LAT C21	0.728	1.460	10.2	0.24	10.6	100	8.62	12.6	0.0080	1	RCP	24	20.2	0.0031	641.74	640.45	4.0	3.9	0.249	0.239	0.75	0.05	PROP	641.74	640.62	639.40	645.29	3.55
2600.0	2381.2	238.80	GBRK	0.000	1.460	-	0.84	11.2	100	8.44	12.3	0.0132	1	RCP	24	28.0	0.0030	640.40	636.67	3.9	3.4	0.239	0.178		0.00	PROP	640.40	639.40	636.24	-	-
2381.1	2298.2	82.89	LAT C19	0.576	2.037	10.1	1.01	12.2	100	8.16	16.8	0.0156	1	RCP	30	51.2	0.0018	636.67	636.22	3.4	4.7	0.178	0.343	0.75	0.21	PROP	636.67	635.74	634.76	642.85	6.18
2298.2	2180.7	117.51	LAT C18	0.810	2.847	10.1	0.31	12.6	100	8.10	23.1	0.0156	1	RCP	30	51.2	0.0032	636.01	634.41	4.7	5.6	0.343	0.491	0.75	0.23	PROP	636.01	634.76	632.93	640.87	4.86
2180.7	2023.7	157.00	LAT C17	0.596	3.443	10.1	0.42	13.0	100	8.02	27.6	0.0156	1	RCP	30	51.2	0.0045	634.18	631.57	5.6	4.7	0.491	0.339	0.75	-0.03	PROP	634.18	632.93	630.48	640.17	5.99
2023.7	1990.7	33.00	LAT C16	0.645	4.088	10.1	0.47	13.4	100	8.08	33.0	0.0100	1	RCP	36	66.7	0.0025	631.60	631.51	4.7	5.3	0.339	0.440	0.75	0.19	FRIC	631.60	629.98	629.65	635.90	4.30
1990.7	1924.5	66.20	LAT C15	0.558	4.644	10.1	0.12	13.6	100	8.10	37.6	0.0100	1	RCP	36	66.7	0.0032	631.33	630.84	5.3	5.7	0.440	0.506	0.75	0.18	PROP	631.33	628.65	628.99	636.74	5.41
1924.5	1860.7	63.80	LAT C14	0.315	4.959	10.1	0.21	13.8	100	8.14	40.4	0.0100	1	RCP	36	66.7	0.0037	630.67	629.57	5.7	4.8	0.506	0.352	0.75	-0.03	PROP	630.67	628.99	628.35	636.60	5.93
1860.7	1636.7	224.00	LAT C13	0.640	5.600	10.1	0.19	13.9	100	8.18	45.6	0.0100	1	RCP	42	100.6	0.0021	629.60	627.48	4.8	5.0	0.352	0.386	0.75	0.12	PROP	629.60	627.85	625.81	635.26	5.66
1636.7	1473.7	163.03	LAT C12	0.709	6.308	10.1	0.78	14.7	100	7.80	48.0	0.0100	1	RCP	42	100.6	0.0023	627.36	625.19	5.0	4.1	0.386	0.267	0.75	-0.02	PROP	627.36	625.61	623.98	632.75	5.39
1473.7	1460.2	13.43	LAT C11	0.635	6.943	10.1	0.54	15.3	100	7.51	52.1	0.0125	1	RCP	48	160.6	0.0013	625.21	625.19	4.1	4.6	0.267	0.323	0.75	0.12	FRIC	625.21	623.48	623.31	629.96	4.75
1460.2	1380.8	79.41	LAT C10	0.696	7.639	10.1	0.05	15.3	100	7.50	57.3	0.0125	1	RCP	48	160.6	0.0016	625.07	624.25	4.6	5.2	0.323	0.415	0.75	0.17	PROP	625.07	623.31	622.32	631.13	6.06
1380.8	1263.7	117.08	LAT C9	1.050	8.689	10.6	0.29	15.6	100	7.48	65.0	0.0125	1	RCP	48	160.6	0.0020	624.08	622.77	5.2	5.5	0.415	0.471	0.75	0.16	PROP	624.08	622.32	620.86	631.28	7.20
1263.7	1138.2	127.51	LAT C7	0.592	9.281	10.6	0.36	16.0	100	7.46	69.2	0.0125	1	RCP	48	160.6	0.0023	622.62	621.46	5.5	5.9	0.471	0.547	0.75	0.19	PROP	622.62	620.86	619.28	628.57	5.95
1138.2	988.2	150.00	LAT C6	0.793	10.074	10.6	0.39	16.4	100	7.41	74.8	0.0125	1	RCP	48	160.6	0.0027	621.26	619.83	5.9	6.4	0.547	0.629	0.75	0.22	PROP	621.26	619.26	617.39	628.32	7.06
988.2	849.7	138.50	LAT C5	0.838	10.911	10.6	0.42	16.8	100	7.33	80.0	0.0125	1	RCP	48	160.6	0.0031	619.61	618.18	6.4	6.9	0.629	0.732	0.75	0.26	FRIC	619.61	617.38	615.88	626.62	7.01
849.7	830.0	19.70	LAT C4	0.843	11.855	10.6	0.36	17.2	100	7.28	86.3	0.0125	1	RCP	48	160.6	0.0038	618.92	618.85	6.9	4.5	0.732	0.311	0.75	-0.24	FRIC	618.92	615.88	615.43	624.05	5.13
830.0	695.0	135.02	JBOX	0.000	11.855	-	0.05	17.2	100	7.26	86.1	0.0050	2	RCP	42	142.3	0.0018	619.09	618.84	4.5	4.6	0.311	0.333	0.50	0.18	FRIC	619.09	615.31	614.63	-	-
695.0	679.1	15.85	LAT C3	0.584	12.438	10.6	0.50	17.7	100	7.16	89.1	0.0050	2	RCP	42	142.3	0.0020	618.67	618.64	4.6	5.0	0.333	0.383	0.75	0.13	FRIC	618.67	614.63	614.55	621.03	2.36
679.1	615.5	63.67	LAT C2	0.900	13.338	10.3	0.06	17.8	100	7.16	95.5	0.0050	2	RCP	42	142.3	0.0023	618.50	618.36	5.0	5.4	0.383	0.451	0.75	0.16	FRIC	618.50	614.55	614.23	621.95	3.45
615.5	277.6	337.88	LAT C24	1.229	14.567	10.6	0.21	18.0	100	7.12	103.7	0.0050	2	RCP	42	142.3	0.0027	618.20	617.30	5.4	5.4	0.451	0.458	0.75	0.12	FRIC	618.20	614.23	612.54	622.13	3.93
277.6	266.6	11.00	LAT C1A	0.469	15.036	10.6	1.04	19.0	100	6.95	104.5	0.0050	2	RCP	42	142.3	0.0027	617.18	617.15	5.4	5.5	0.458	0.470	0.75	0.13	FRIC	617.18	612.54	612.49	618.21	1.03
266.6	139.0	127.58	LAT C1B	0.189	15.225	11.5	0.03	19.1	100	6.95	105.8	0.0050	2	RCP	42	142.3	0.0028	617.02	616.67	5.5	4.2	0.470	0.271	0.75	-0.08	FRIC	617.02	612.49	611.85	618.28	1.26
139.0	0.0	139.00	GBRK	0.000	15.225	-	0.39	19.4	100	6.89	104.9	0.0090	2	CMP,PLN	48	147.6	0.0045	616.75	616.12	4.2	4.1	0.271	0.263		0.00	FRIC	616.75	611.85	610.60	-	-
0.0	0.0	0.00	-	0.000	15.225	#N/A	0.56	20.0	100	6.80	103.5	0.0090	2	CMP,PLN	48	147.6	0.0044	616.12	616.12	4.1	0.0	0.263	0.000		0.00	FRIC	616.12	610.60	610.60	-	-
LINE D																															
302	292	10.00	LAT D1A	1.214	1.214	10.1	0.0	10.1	100	8.72	10.8	0.005	1	RCP	24	16.0	0.0022	618.30	618.28	3.4	6.7	0.176	0.705	0.75	0.57	FRIC	618.30	615.27	615.22	618.92	0.62
292	205	67.00	LAT D1B	1.214	2.428	10.1	0.0	10.2	100	8.72	21.2	0.005	1	RCP	24	16.0	0.0088	617.71	616.95	6.7	6.7	0.705	0.697	0.75	0.17	FRIC	617.71	615.22	614.78	618.91	1.20
205	166	39.00	GBRK	0.000	2.428	-	0.2	10.4	100	8.67	21.0	0.023	1	RCP	24	34.2	0.0087	616.78	616.44	6.7	2.4	0.697	0.090		0.00	FRIC	616.78	614.78	613.89	-	-
166	0	166.00	GBRK	0.000	2.428	-	0.1	10.5	100	8.64	21.0	0.005	1	CMP,PLN	40	33.8	0.0019	616.44	616.12	2.4	2.3	0.090	0.083		0.00	FRIC	616.44	612.56	611.73	-	-
0	0	0.00	-	0.000	2.428	0.0	1.2	11.6	100	8.32	20.2	0.005	1	CMP,PLN	40	33.8	0.0018	616.12	616.12	2.3	0.0	0.083	0.000		0.00	FRIC	616.12	611.73	611.73	-	-

1 In two locations the Town of Addison Drainage Manual shows subtracting the two velocity heads and multiplying the difference by the loss coefficient. However on *Figure 5-4*, the standard way of multiplying the loss coefficient and the upstream velocity head and then subtracting the product from the downstream velocity head is shown. Because the latter is a more conservative approach, it was used in these calculations.

2 This column has been included to help identify pipes flowing in partial flow. If the pipe is flowing under partial flow, the spreadsheet looks up a ratio of design flow to full pipe flow to determine the ratio of design depth to full depth. This depth ratio is then used to determine the depth of the design flow in the pipe. If this depth is less than the computed HGL using the friction slope, then the depth based on the proportional flows is used to set the HGL at that point. The information used to determine the proportional flow can be found in numerous sources, this spreadsheet consulted *Concrete Pipe Design Manual, Figure 20* and *Open Channel Hydraulics by Chow, Figure 6-5*.

APPENDIX F

PROPOSED STORM SEWER ANALYSIS

MIDWAY ROAD RECONSTRUCTION
COMMON VARIABLES USED IN ANALYSIS

PROPOSED STORM SEWER SYSTEM

Mannings "n"		
Pipe Mat'l	**Recommended n-value**	**Source**
RCP	0.013	Per the Town of Addison Drainage Manual
CMP,PLN	0.024	(Plain or Coated) Per the Town of Addison Drainage Manual
CMP,PVD	0.020	(Paved Invert) Per the Town of Addison Drainage Manual

Outfall Information				
	Storm Sewer	**HGL (tailwater)**	**Outfall Location**	**Comments**
LINE A	610.50	616.12	9'x5'	HGL shown based on "tailwater" elevation shown on as-built plans, associated storm event not listed.
LINE B	610.93	616.86	LINE A	
LINE C	610.60	616.12	9'x5'	HGL shown based on "tailwater" elevation shown on as-built plans, associated storm event not listed.
LINE D	611.73	616.12	9'x5'	HGL shown based on "tailwater" elevation shown on as-built plans, associated storm event not listed.
LINE E			Unknown	Plans for this system could not be found, only one inlet located within the limits of pavement reconstruction

MIDWAY ROAD RECONSTRUCTION
DRAINAGE AREA CALCULATIONS

PROPOSED STORM SEWER SYSTEM

DRAINAGE AREA CALCULATIONS								
DRAINAGE AREA NO.	INLET		DESIGN STORM FREQUNCY	AREA RUNOFF (Q=CIA)				
	NO.	PAVING STATION		TIME OF CONC.	RUNOFF COEFF. "C"	MULTIPLIER "Ca"	AREA	C*Ca*A
			(years)	(min)			(acres)	
1			100	10	0.8	1	2.09	1.672
Combined	B1			10				1.672
2			100	10	0.9	1	0.36	0.324
Combined	B2			10				0.324
3			100	10	0.8	1	1.56	1.248
Combined	A1			10				1.248
4			100	10	0.9	1	0.46	0.414
Combined	B3			10				0.414
5A			100	10	0.8	1	0.51	0.408
Combined	D1A			10				0.408
5B			100	10	0.8	1	0.47	0.376
Combined	D1B			10				0.376
5C			100	10	0.8	1	0.7	0.560
Combined	D2			10				0.560
6A			100	10	0.9	1	0.5	0.450
Combined	C1A			10				0.450
6B			100	10	0.9	1	0.21	0.189
Combined	C1B			10				0.189
7			100	10	0.8	1	1.27	1.016
Combined	C2			10				1.016
8			100	10	0.9	1	0.67	0.603
Combined	C3			10				0.603
9			100	10	0.8	1	1.39	1.112
Combined	C4			10				1.112
10			100	10	0.8	1	0.52	0.416
Combined	C5			10				0.416
10a			100	10	0.8	1	4.25	3.400
Combined	C5A			10				3.400
11			100	10	0.8	1	1	0.800
Combined	C6			10				0.800
12			100	10	0.8	1	0.74	0.592
Combined	C7			10				0.592
13			100	10	0.8	1	0.85	0.680
Combined	C10			10				0.680
14			100	10	0.9	1	0.61	0.549
Combined	C11			10				0.549
15			100	10	0.8	1	1.47	1.176
Combined	C12			10				1.176
16			100	10	0.8	1	0.64	0.512
Combined	C13			10				0.512
29			100	10	0.9	1	0.35	0.315
Combined	C14			10				0.315

MIDWAY ROAD RECONSTRUCTION
DRAINAGE AREA CALCULATIONS

PROPOSED STORM SEWER SYSTEM

DRAINAGE AREA CALCULATIONS								
DRAINAGE AREA NO.	INLET		DESIGN STORM FREQUNCY	AREA RUNOFF (Q=CIA)				
	NO.	PAVING STATION		TIME OF CONC.	RUNOFF COEFF. "C"	MULTIPLIER "Ca"	AREA	C*Ca*A
			(years)	(min)			(acres)	
17			100	10	0.8	1	0.95	0.760
Combined	C15			10				0.760
18			100	10	0.8	1	0.42	0.336
Combined	C16			10				0.336
19			100	10	0.8	1	1.05	0.840
Combined	C17			10				0.840
20			100	10	0.9	1	0.69	0.621
Combined	C18			10				0.621
21			100	10	0.8	1	1.2	0.960
Combined	C19			10				0.960
30			100	10	0.9	1	0	0.000
Combined	C20			10				0.000
22			100	10	0.8	1	1.04	0.832
Combined	C22			10				0.832
23			100	10	0.8	1	0.79	0.632
Combined	C21			10				0.632
25			100	10	0.8	1	0.57	0.456
Combined	C23			10				0.456
26			100	10	0.8	1	0.61	0.488
Combined	C24			10				0.488
26A			100	10	0.8	1	1.4	1.120
Combined	C24A			10				1.120
24			100	10	0.8	1	4.29	3.432
Combined	E1			10				3.432
27			100	10	0.8	1	0.42	0.336
Combined	C8			10				0.336
28			100	10	0.8	1	1.52	1.216
Combined	C9			10				1.216
31			100	10	0.8	1	0.85	0.680
Combined	C26			10				0.680
32			100	10	0.8	1	0.46	0.368
Combined	C25			10				0.368
33			100	10	0.8	1	0.82	0.656
Combined	C27			10				0.656

MIDWAY ROAD RECONSTRUCTION
INLET CALCULATIONS

PROPOSED STORM SEWER SYSTEM

INLET CALCULATIONS

INLET		DRAINAGE AREA NO.	DESIGN STORM FREQUNCY	AREA RUNOFF (Q=CIA)				CARRY-OVER FROM	TOTAL FLOW	CROSS SLOPE	GUTTER DEPTH	ALLOWABLE DEPTH	GUTTER SLOPE	ON-GRADE/ LOWPT	CAPACITY PER FOOT OF INLET	LENGTH OF INLET REQ'D	INLET LENGTH/ AREAg	TYPE OF INLET	CARRY-OVER TO		FLOW INTO INLET	C*Ca*A INTO INLET
NO.	PAVING STATION			TIME OF CONC.	INTENSITY	C*Ca*A	"Q"												INLET NO.	FLOW "Q"		
			(years)	(min)	(in/hr)	(acres)	(c.f.s.)	(c.f.s.)	(c.f.s.)	%	ft	ft	ft / ft		(cfs/ft)	(ft)	(ft) / (ft^2)			(cfs)	(cfs)	
B1	4+25	1	100	10	8.74	1.67	14.6	0.0	14.6	2.120	0.35	0.42	0.021	GRADE	0.57	25.6	20	CURB	A1	3.3	11.3	1.30
B2	4+45	2	100	10	8.74	0.32	2.8	0.0	2.8	2.160	0.20	0.42	0.017	GRADE	0.43	6.6	10	CURB	B3	0.0	2.8	0.32
B3	6+60	4	100	10	8.74	0.41	3.6	0.0	3.6	2.000	0.21	0.42	0.017	LOWPT	0.29	12.6	10	CURB	LOWPT	0.7	2.9	0.33
A1	6+65	3	100	10	8.74	1.25	10.9	3.3	14.2	1.940	0.35	0.42	0.017	LOWPT	0.61	23.2	20	CURB	LOWPT	1.9	12.3	1.40
D1A	10+65	5A	100	10	8.74	0.41	3.6	0.0	3.6	1.820	0.24	0.40	0.008	LOWPT	0.36	10.0	10	CURB	D1B	0.0	3.6	0.41
D1B	10+65	5B	100	10	8.74	0.38	3.3	0.0	3.3	1.820	0.23	0.40	0.008	LOWPT	0.34	9.6	10	CURB	LOWPT	0.0	3.3	0.38
D2		5C	100	10	8.74	0.56	4.9	0.0	4.9	1.820	0.27	0.40	0.008	GRADE	0.50	9.9	10	CURB	D1A	0.0	4.9	0.56
C1A	11+10	6A	100	10	8.74	0.45	3.9	0.0	3.9	4.390	0.35	0.42	0.008	LOWPT	0.63	6.3	10	CURB	C1B	0.0	3.9	0.45
C1B	11+10	6B	100	10	8.74	0.19	1.7	0.0	1.7	4.390	0.25	0.42	0.008	LOWPT	0.39	4.3	10	CURB	LOWPT	0.0	1.7	0.19
C2	15+30	7	100	10	8.74	1.02	8.9	0.0	8.9	2.080	0.38	0.42	0.008	GRADE	0.58	15.4	20	CURB	D1A	0.0	8.9	1.02
C3	15+31	8	100	10	8.74	0.60	5.3	0.0	5.3	4.170	0.34	0.42	0.013	GRADE	0.56	9.5	10	CURB	C1A	0.0	5.3	0.60
C4	17+05	9	100	10	8.74	1.11	9.7	3.8	13.5	2.080	0.32	0.42	0.026	GRADE	0.54	24.9	20	CURB	D5	2.6	10.9	1.25
C5	16+40	10	100	10	8.74	0.42	3.6	12.7	16.4	2.080	0.41	0.42	0.010	GRADE	0.63	26.1	20	CURB	C4	3.8	12.6	1.44
C5A		10A	100	10	8.74	3.40	29.7	0.0	29.7	2.080	-	0.42	OFF RD	LOWPT	1.06	28.0	16	DROP	C5	12.7	17.0	1.84
C6	19+90	11	100	10	8.74	0.80	7.0	2.7	9.7	2.080	0.34	0.42	0.010	GRADE	0.56	17.4	14	CURB	C5	1.9	7.8	0.69
C7	21+05	12	100	10	8.74	0.59	5.2	0.0	5.2	4.170	0.34	0.42	0.012	GRADE	0.56	9.3	10	CURB	C3	0.0	5.2	0.59
C8	WP[2]	27	100	10	8.74	0.34	2.9	0.0	2.9	6.250	0.32	0.42	0.013	GRADE	0.54	5.5	10	CURB	C6	0.0	2.9	0.34
C9	WP[2]	28	100	10	8.74	1.22	10.6	0.0	10.6	4.050	0.41	0.42	0.018	GRADE	0.62	17.0	14	CURB	C8	1.9	8.7	1.00
C10	23+15	13	100	10	8.74	0.68	5.9	2.4	8.4	2.080	0.32	0.42	0.010	GRADE	0.64	15.5	14	CURB	C8	0.8	7.6	0.67
C11	23+10	14	100	10	8.74	0.55	4.8	0.0	4.8	4.170	0.35	0.42	0.008	GRADE	0.57	8.4	10	CURB	C7	0.0	4.8	0.55
C12	24+90	15	100	10	8.74	1.18	10.3	0.1	10.3	2.080	0.35	0.42	0.010	GRADE	0.56	18.3	14	CURB	C10	2.4	7.9	0.90
C13	27+15	16	100	10	8.74	0.51	4.5	0.5	4.9	2.080	0.26	0.42	0.010	GRADE	0.49	10.1	10	CURB	C12	0.1	4.9	0.56
C14	27+80	29	100	10	8.74	0.32	2.8	0.0	2.8	-	-	0.42	OFF RD	LOWPT	1.08	2.6	6	CURB	C13	0.0	2.8	0.32
C15	28+45	17	100	10	8.74	0.76	6.6	1.3	7.9	2.080	0.31	0.42	0.010	GRADE	0.53	14.9	14	CURB	C13	0.5	7.5	0.86
C16	26+60	18	100	10	8.74	0.34	2.9	0.0	2.9	4.170	0.28	0.42	0.012	GRADE	0.50	5.9	10	CURB	C11	0.0	2.9	0.34
C17	30+35	19	100	10	8.74	0.84	7.3	1.1	8.4	2.080	0.29	0.42	0.020	GRADE	0.51	16.5	14	CURB	C15	1.3	7.1	0.81
C18	31+40	20	100	10	8.74	0.62	5.4	0.0	5.4	4.170	0.34	0.42	0.013	GRADE	0.58	9.7	10	CURB	C16	0.0	5.4	0.62
C19	32+10	21	100	10	8.74	0.96	8.4	0.0	8.4	2.080	0.30	0.42	0.014	GRADE	0.52	16.0	14	CURB	C17	1.1	7.3	0.84
C20[1]	GR[2]	30	100	10	8.74	0.00	0.0	0.0	0.0	0.000	-	0.00	OFF RD	LOWPT	2.2	0.0	4	GRATE	C19	0.0	0.0	0.00
C21	35+90	23	100	10	8.74	0.63	5.5	0.0	5.5	4.360	0.42	0.42	0.005	GRADE	0.63	8.7	10	CURB	C18	0.0	5.5	0.63
C22	36+20	22	100	10	8.74	0.83	7.3	0.0	7.3	2.080	0.35	0.42	0.005	GRADE	0.57	12.8	14	CURB	C19	0.0	7.3	0.63
C25		32	100	10	8.74	0.37	3.2	0.3	3.6	2.080	0.27	0.42	0.005	GRADE	0.49	7.3	10	CURB	C22	0.0	3.6	0.41
C26		31	100	10	8.74	0.68	5.9	0.0	5.9	4.360	0.43	0.42	0.005	GRADE	0.64	9.2	10	CURB	C21	0.0	5.9	0.68
C27		33	100	10	8.74	0.66	5.7	0.0	5.7	2.080	0.32	0.42	0.005	GRADE	0.54	10.6	10	CURB	C26	0.3	5.4	0.62
C23	LB[2]	25	100	10	8.74	0.46	4.0	0.0	4.0	3.400	0.27	0.42	0.016	GRADE	0.49	8.1	10	CURB	D2	0.0	4.0	0.46
C24	LB[2]	26	100	10	8.74	0.49	4.3	0.0	4.3	3.700	0.29	0.42	0.014	GRADE	0.52	8.3	10	CURB	D2	0.0	4.3	0.49
C24A	LB[2]	26A	100	10	8.74	1.12	9.8	0.0	9.8	3.700	0.40	0.42	0.014	GRADE	0.62	15.9	10	CURB	D4	3.6	6.2	0.71
E1	54+15	24	100	10	8.74	3.43	30.0	0.0	30.0	3.970	0.57	0.42	0.022	GRADE	0.80	37.7	10	CURB	LOWPT	22.0	8.0	0.91

1 COULD NOT VERIFY EXISTENCE IN FIELD OR FROM FIELD SURVEY; THEREFORE, ASSUME FOR CONSERVATIVENESS THAT THE FLOW ENTERS THE STREET AND ENTERS THE SYSTEM AT INLET C19.
ALSO, SINCE THE PLANS CALL THIS A DOUBLE GRATE INLET, IT IS POSSIBLE THAT IT WILL BE CLOGGED BY DEBRIS DURING THE STORM AND THEREFORE, BE INEFFECTIVE.

2 INLETS OFF OF MIDWAY:

WP	WILEY POST
LB	LINDBERG
GR	GRATE INLET

MIDWAY ROAD RECONSTRUCTION
LATERAL CALCULATIONS

PROPOSED STORM SEWER SYSTEM

STORM SYSTEM CALCULATIONS - LATERAL LINES ON MAIN LINE

		MANHOLE OR INLET					TIME OF CONCENTRATION						PIPE DESCRIPTION				HYDRAULIC GRADIENT ELEV.		HEAD LOSS AT CHANGE IN SECTION											ELEV. OF INVERT AT DESIGN POINT	
		DESIGN POINT																													
LATERAL NUMBER	INLET NUMBER	UP-STREAM	DOWN-STREAM	DISTANCE BETWEEN POINTS	C*Ca*A	TOTAL C*Ca*A	INLET TIME	TIME IN SEWER	DOWN-STREAM TIME	DESIGN FREQUENCY	INTENSITY	TOTAL DESIGN DISCHARGE	SLOPE PER PLANS	MATERIAL	SIZE	FRICTION GRADIENT SLOPE Sf	UP-STREAM	DOWN-STREAM	UP-STREAM VELOCITY V_1	DOWN-STREAM VELOCITY V_2	$V_1^2/2g$	$V_2^2/2g$	Kj	hj	H.G. ELEV. AT DESIGN POINT	ELEV. OF TOP OF CURB AT DESIGN POINT	TOTAL C*Ca*A INTO MAIN LINE	TOTAL INLET TIME TO MAIN LINE	TOP OF CURB - H.G. ELEV.	UP-STREAM PIPE	DOWN-STREAM PIPE
				(ft)			(min)	(min)	(min)	(years)	(in/hr)	(cfs)	(ft/ft)		(in)	(%)	(ft)	(ft)	(fps)	(fps)	(ft)	(ft)		(ft)	(ft)	(ft)	(cfs)	(min)	(ft)	(ft)	(ft)
LAT A1	A1	21	0	21	1.403	1.403	10	0.0	10.0	100	8.74	12.3	0.103	RCP	21	0.0060	617.09	616.96	5.1	5.1	0.4	0.4	0.5	0.2	617.09	618.00	1.403	10.069	0.91	613.78	611.62
		0	0	0		1.403	-	0.1	10.1	100	8.74	12.3	0.103	RCP	21	0.0060	616.96	616.96	5.1	2.5	0.4	0.1	0.5	0	616.96	618.00	1.403	10.069	1.04	611.62	611.62
LAT B1	B1	88	0	88	1.296	1.296	10	0.0	10.0	100	8.74	11.3	0.033	RCP	21	0.0051	618.33	617.88	4.7	4.7	0.3	0.3	0.5	0.2	618.33	622.00	1.296	10.311	3.67	618.21	615.30
		0	0	0		1.296	-	0.3	10.3	100	8.67	11.2	0.033	RCP	21	0.0050	617.88	617.88	4.7	4.5	0.3	0.3	0.5	0.2	617.88	622.00	1.296	10.311	4.12	615.30	615.30
LAT B2	B2	10	0	10	0.324	0.324	10	0.0	10.0	100	8.74	2.8	0.065	RCP	18	0.0007	618.19	618.18	1.6	1.6	0.0	0.0	0.5	0.0	618.19	621.50	0.324	10.104	3.31	616.60	615.95
		0	0	0		0.324	-	0.1	10.1	100	8.72	2.8	0.065	RCP	18	0.0007	618.18	618.18	1.6	1.2	0.0	0.0	0.5	0.0	618.18	621.50	0.324	10.104	3.32	615.95	615.95
LAT B3	B3	10	0	10	0.331	0.331	10	0.0	10.0	100	8.74	2.9	0.08	RCP	21	0.0003	617.07	617.07	1.2	1.2	0.0	0.0	0.5	0.0	617.07	618.00	0.331	10.139	0.93	612.97	612.17
		0	0	0		0.331	-	0.1	10.1	100	8.72	2.9	0.08	RCP	21	0.0003	617.07	617.07	1.2	3.4	0.0	0.2	0.5	0.1	617.07	618.00	0.331	10.139	0.93	612.17	612.17
LAT C1A	C1A	62	0	62	0.45	0.45	10	0.0	10.0	100	8.74	3.9	0.023	RCP	21	0.0006	617.43	617.39	1.6	1.6	0.0	0.0	0.5	0.0	617.43	618.50	0.450	10.632	1.07	614.65	613.42
		0	0	0		0.45	-	0.6	10.6	100	8.60	3.9	0.023	RCP	21	0.0006	617.39	617.39	1.6	6.0	0.0	0.6	0.5	0.3	617.39	618.50	0.450	10.632	1.11	613.42	613.42
LAT C1B	C1B	62	0	62	0.189	0.189	10	0.0	10.0	100	8.74	1.7	0.023	RCP	21	0.0001	617.21	617.20	0.7	0.7	0.0	0.0	0.5	0.0	617.21	618.50	0.189	11.505	1.29	614.80	613.36
		0	0	0		0.189	-	1.5	11.5	100	8.35	1.6	0.023	RCP	21	0.0001	617.20	617.20	0.7	6.0	0.0	0.6	0.5	0.3	617.20	618.50	0.189	11.505	1.30	613.36	613.36
LAT C2	C2	61	0	61	1.016	1.016	10	0.0	10.0	100	8.74	8.9	0.038	RCP	21	0.0031	618.94	618.75	3.7	3.7	0.2	0.2	0.5	0.1	618.94	620.50	1.016	10.275	1.56	619.79	617.49
		0	0	0		1.016	-	0.3	10.3	100	8.69	8.8	0.038	RCP	21	0.0031	618.75	618.75	3.7	1.8	0.2	0.1	0.5	0.0	618.75	620.50	1.016	10.275	1.75	617.49	617.49
LAT C3	C3	31	0	31	0.603	0.603	10	0.0	10.0	100	8.74	5.3	0.034	RCP	21	0.0011	618.92	618.88	2.2	2.2	0.1	0.1	0.5	0.0	618.92	620.00	0.603	10.236	1.08	616.57	615.51
		0	0	0		0.603	-	0.2	10.2	100	8.69	5.2	0.034	RCP	21	0.0011	618.88	618.88	2.2	6.0	0.1	0.6	0.5	0.3	618.88	620.00	0.603	10.236	1.12	615.51	615.51
LAT C4	C4	64	0	64	1.245	1.245	10	0.0	10.0	100	8.74	10.9	0.053	RCP	21	0.0047	619.61	619.31	4.5	4.5	0.3	0.3	0.5	0.2	619.61	625.00	1.245	10.236	5.39	620.20	616.81
		0	0	0		1.245	-	0.2	10.2	100	8.69	10.8	0.053	RCP	21	0.0047	619.31	619.31	4.5	8.9	0.3	1.2	0.5	0.6	619.31	625.00	1.245	10.236	5.69	616.81	616.81
LAT C5	C5	64	0	64	1.438	1.438	10	0.0	10.0	100	8.74	12.6	0.065	RCP	21	0.0063	621.13	620.73	5.2	5.2	0.4	0.4	0.5	0.2	621.13	627.00	1.438	10.204	5.87	622.66	618.51
		0	0	0		1.438	-	0.2	10.2	100	8.69	12.5	0.065	RCP	21	0.0062	620.73	620.73	5.2	8.2	0.4	1.0	0.5	0.5	620.73	627.00	1.438	10.204	6.27	618.51	618.51
LAT C5A	C5A	200	0	200	1.942	1.942	10	0.0	10.0	100	8.74	17.0	0.01	RCP	21	0.0115	623.37	621.08	7.1	7.1	0.8	0.8	0.5	0.4	623.37	627.00	1.942	10.472	3.63	621.76	619.76
		0	0	0		1.942	-	0.5	10.5	100	8.64	16.8	0.01	RCP	21	0.0112	621.08	621.08	7.0	8.5	0.8	1.1	0.5	0.6	621.08	627.00	1.942	10.472	5.92	619.76	619.76
LAT C6	C6	64	0	64	0.893	0.893	10	0.0	10.0	100	8.74	7.8	0.062	RCP	21	0.0024	621.66	621.50	3.2	3.2	0.2	0.2	0.5	0.1	621.66	628.50	0.893	10.329	6.84	624.33	620.39
		0	0	0		0.893	-	0.3	10.3	100	8.67	7.7	0.062	RCP	21	0.0024	621.50	621.50	3.2	7.4	0.2	0.9	0.5	0.4	621.50	628.50	0.893	10.329	7.00	620.39	620.39
LAT C7	C7	34	0	34	0.592	0.592	10	0.0	10.0	100	8.74	5.2	0.071	RCP	21	0.0011	622.89	622.86	2.2	2.2	0.1	0.1	0.5	0.0	622.89	629.00	0.592	10.263	6.11	624.39	621.98
		0	0	0		0.592	-	0.3	10.3	100	8.69	5.1	0.071	RCP	21	0.0011	622.86	622.86	2.1	6.9	0.1	0.7	0.5	0.4	622.86	629.00	0.592	10.263	6.14	621.98	621.98
LAT C8	C8	34	0	34	0.336	0.336	10	0.0	10.0	100	8.74	2.9	0.008	RCP	18	0.0008	624.78	624.75	1.7	1.7	0.0	0.0	0.5	0.0	624.78	631.12	0.336	10.341	6.34	629.27	628.99
		0	0	0		0.336	-	0.3	10.3	100	8.67	2.9	0.008	RCP	18	0.0008	624.75	624.75	1.6	4.8	0.0	0.4	0.5	0.2	624.75	631.12	0.336	10.341	6.37	628.99	628.99
LAT C9	C9	114.32	81	33.32	0.999	0.999	10	0.0	10.0	100	8.74	8.7	0.02	RCP	21	0.0030	624.85	624.75	3.6	3.6	0.2	0.2	0.5	0.1	624.85	631.28	1.335	10.622	6.43	628.15	627.49
	C8	81	0	81	0.336	1.335	10.3	0.2	10.3	100	8.67	11.6	0.0500	RCP	21	0.0053	624.75	624.32	4.8	4.8	0.4	0.4	0.5	0.2	624.75	631.12	1.335	10.622	6.37	627.49	623.44
		0	0	0		1.335	-	0.3	10.6	100	8.60	11.5	0.0500	RCP	21	0.0000	624.32	624.32	4.8	6.6	0.4	0.7	0.5	0.3	624.32	631.28	1.335	10.622	6.96	623.44	623.44
LAT C10	C10	64	0	64	0.865	0.865	10	0.0	10.0	100	8.74	7.6	0.049	RCP	21	0.0023	625.46	625.31	3.1	3.1	0.2	0.2	0.5	0.1	625.46	631.00	0.865	10.339	5.54	627.59	624.44
		0	0	0		0.865	-	0.3	10.3	100	8.67	7.5	0.049	RCP	21	0.0022	625.31	625.31	3.1	5.8	0.2	0.5	0.5	0.3	625.31	631.00	0.865	10.339	5.69	624.44	624.44
LAT C11	C11	34	0	34	0.549	0.549	10	0.0	10.0	100	8.74	4.8	0.039	RCP	21	0.0009	625.57	625.54	2.0	2.0	0.1	0.1	0.5	0.0	625.57	630.50	0.549	10.284	4.93	625.93	624.60
		0	0	0		0.549	-	0.3	10.3	100	8.69	4.8	0.039	RCP	21	0.0009	625.54	625.54	2.0	5.3	0.1	0.4	0.5	0.2	625.54	630.50	0.549	10.284	4.96	624.60	624.60
LAT C12	C12	64	0	64	0.905	0.905	10	0.0	10.0	100	8.74	7.9	0.035	RCP	21	0.0025	627.73	627.57	3.3	3.3	0.2	0.2	0.5	0.1	627.73	633.00	0.905	10.325	5.27	628.74	626.48
		0	0	0		0.905	-	0.3	10.3	100	8.67	7.8	0.035	RCP	21	0.0024	627.57	627.57	3.3	6.6	0.2	0.7	0.5	0.3	627.57	633.00	0.905	10.325	5.43	626.48	626.48
LAT C13	C13	64	0	64	0.558	0.558	10	0.0	10.0	100	8.74	4.9	0.04	RCP	21	0.0009	629.87	629.81	2.0	2.0	0.1	0.1	0.5	0.0	629.87	635.00	0.558	10.526	5.13	631.30	628.72
		0	0	0		0.558	-	0.5	10.5	100	8.62	4.8	0.04	RCP	21	0.0009	629.81	629.81	2.0	6.0	0.1	0.6	0.5	0.3	629.81	635.00	0.558	10.526	5.19	628.72	628.72
LAT C14	C14	70	0	70	0.315	0.315	10	0.0	10.0	100	8.74	2.8	0.038	RCP	21	0.0003	631.02	631.00	1.1	1.1	0.0	0.0	0.5	0.0	631.02	636.00	0.315	11.019	4.98	632.25	629.61
		0	0	0		0.315	-	1.0	11.0	100	8.50	2.7	0.038	RCP	21	0.0003	631.00	631.00	1.1	7.6	0.0	0.9	0.5	0.4	631.00	636.00	0.315	11.019	5.00	629.61	629.61

MIDWAY ROAD RECONSTRUCTION
LATERAL CALCULATIONS

PROPOSED STORM SEWER SYSTEM

STORM SYSTEM CALCULATIONS - LATERAL LINES ON MAIN LINE

LATERAL NUMBER	INLET NUMBER	MANHOLE OR INLET DESIGN POINT		DISTANCE BETWEEN POINTS	C*Ca*A	TOTAL C*Ca*A	TIME OF CONCENTRATION			DESIGN FREQUENCY	INTENSITY	TOTAL DESIGN DISCHARGE	PIPE DESCRIPTION			FRICTION GRADIENT SLOPE Sf	HYDRAULIC GRADIENT ELEV.		HEAD LOSS AT CHANGE IN SECTION						H.G. ELEV. AT DESIGN POINT	ELEV. OF TOP OF CURB AT DESIGN POINT	TOTAL C*Ca*A INTO MAIN LINE	TOTAL INLET TIME TO MAIN LINE	TOP OF CURB - H.G. ELEV.	ELEV. OF INVERT AT DESIGN POINT	
		UP-STREAM	DOWN-STREAM				INLET TIME	TIME IN SEWER	DOWN-STREAM TIME				SLOPE PER PLANS	MATERIAL	SIZE		UP-STREAM	DOWN-STREAM	UP-STREAM VELOCITY V_1	DOWN-STREAM VELOCITY V_2	$V_1^2/2g$	$V_2^2/2g$	Kj	hj						UP-STREAM PIPE	DOWN-STREAM PIPE
				(ft)			(min)	(min)	(min)	(years)	(in/hr)	(cfs)	(ft/ft)		(in)	(%)	(ft)	(ft)	(fps)	(fps)	(ft)	(ft)		(ft)	(ft)	(ft)	(cfs)	(min)	(ft)	(ft)	(ft)
LAT C15	C15	64	0	64	0.856	0.856	10	0.0	10.0	100	8.74	7.5	0.039	RCP	21	0.0022	631.81	631.66	3.1	3.1	0.2	0.2	0.5	0.1	631.81	637.00	0.856	10.343	5.19	632.76	630.27
		0	0	0		0.856	-	0.3	10.3	100	8.67	7.4	0.039	RCP	21	0.0022	631.66	631.66	3.1	7.2	0.1	0.8	0.5	0.4	631.66	637.00	0.856	10.343	5.34	630.27	630.27
LAT C16	C16	34	0	34	0.336	0.336	10	0.0	10.0	100	8.74	2.9	0.035	RCP	21	0.0003	632.17	632.16	1.2	1.2	0.0	0.0	0.5	0.0	632.17	636.00	0.336	10.464	3.83	631.60	630.60
		0	0	0		0.336	-	0.5	10.5	100	8.64	2.9	0.035	RCP	21	0.0003	632.16	632.16	1.2	6.3	0.0	0.6	0.5	0.3	632.16	636.00	0.336	10.464	3.84	630.60	630.60
LAT C17	C17	64	0	64	0.813	0.813	10	0.0	10.0	100	8.74	7.1	0.046	RCP	21	0.0020	634.88	634.75	3.0	3.0	0.1	0.1	0.5	0.1	634.88	640.50	0.813	10.361	5.62	636.24	633.30
		0	0	0		0.813	-	0.4	10.4	100	8.67	7.0	0.046	RCP	21	0.0020	634.75	634.75	2.9	9.1	0.1	1.3	0.5	0.6	634.75	640.50	0.813	10.361	5.75	633.30	633.30
LAT C18	C18	34	0	34	0.621	0.621	10	0.0	10.0	100	8.74	5.4	0.053	RCP	21	0.0012	636.38	636.34	2.3	2.3	0.1	0.1	0.5	0.0	636.38	641.00	0.621	10.251	4.62	636.93	635.14
		0	0	0		0.621	-	0.3	10.3	100	8.69	5.4	0.053	RCP	21	0.0012	636.34	636.34	2.2	7.7	0.1	0.9	0.5	0.5	636.34	641.00	0.621	10.251	4.66	635.14	635.14
LAT C19	C19	64	0	64	0.839	0.839	10	0.0	10.0	100	8.74	7.3	0.047	RCP	21	0.0021	637.28	637.14	3.0	3.0	0.1	0.1	0.5	0.1	637.28	642.50	0.839	10.350	5.22	639.13	636.12
		0	0	0		0.839	-	0.3	10.3	100	8.67	7.3	0.047	RCP	21	0.0021	637.14	637.14	3.0	6.6	0.1	0.7	0.5	0.3	637.14	642.50	0.839	10.350	5.36	636.12	636.12
LAT C21	C21	38	0	38	0.632	0.632	10	0.0	10.0	100	8.74	5.5	0.014	RCP	21	0.0012	643.25	643.20	2.3	2.3	0.1	0.1	0.5	0.0	643.25	645.00	0.632	10.276	1.75	641.29	640.74
		0	0	0		0.632	-	0.3	10.3	100	8.69	5.5	0.014	RCP	21	0.0012	643.20	643.20	2.3	8.1	0.1	1.0	0.5	0.5	643.20	645.00	0.632	10.276	1.80	640.74	640.74
LAT C22	C22	57	0	57	0.832	0.832	10	0.0	10.0	100	8.74	7.3	0.008	RCP	21	0.0021	644.09	643.97	3.0	3.0	0.1	0.1	0.5	0.1	644.09	646.00	0.832	10.314	1.91	641.41	640.97
		0	0	0		0.832	-	0.3	10.3	100	8.67	7.2	0.008	RCP	21	0.0021	643.97	643.97	3.0	6.5	0.1	0.7	0.5	0.3	643.97	646.00	0.832	10.314	2.03	640.97	640.97
LAT C25	C25	60	0	60	0.408	0.408	10	0.0	10.0	100	8.74	3.6	0.007	RCP	21	0.0005	645.26	645.23	1.5	1.5	0.0	0.0	0.5	0.0	645.26	647.00	0.408	10.675	1.74	642.83	642.41
		0	0	0		0.408	-	0.7	10.7	100	8.60	3.5	0.007	RCP	21	0.0005	645.23	645.23	1.5	2.7	0.0	0.1	0.5	0.1	645.23	647.00	0.408	10.675	1.77	642.41	642.41
LAT C26	C26	40	0	40	0.68	0.68	10	0.0	10.0	100	8.74	5.9	0.01	RCP	21	0.0014	645.03	644.97	2.5	2.5	0.1	0.1	0.5	0.0	645.03	646.50	0.680	10.270	1.47	642.57	642.17
		0	0	0		0.68	-	0.3	10.3	100	8.69	5.9	0.01	RCP	21	0.0014	644.97	644.97	2.5	4.4	0.1	0.3	0.5	0.2	644.97	646.50	0.680	10.270	1.53	642.17	642.17
LAT C27	C27	60	0	60	0.616	0.616	10	0.0	10.0	100	8.74	5.4	0.007	RCP	21	0.0012	645.46	645.40	2.2	2.2	0.1	0.1	0.5	0.0	645.46	648.00	0.616	10.447	2.54	644.03	643.61
		0	0	0		0.616	-	0.4	10.4	100	8.64	5.3	0.007	RCP	21	0.0011	645.40	645.40	2.2	1.7	0.1	0.0	0.5	0.0	645.40	648.00	0.616	10.447	2.60	643.61	643.61
LAT C23	C23	48	0	48	0.456	0.456	10	0.0	10.0	100	8.74	4.0	0.029	RCP	18	0.0014	618.89	618.82	2.3	2.3	0.1	0.1	0.5	0.0	618.89	621.99	0.456	10.355	3.10	620.07	618.67
		0	0	0		0.456	-	0.4	10.4	100	8.67	4.0	0.029	RCP	18	0.0014	618.82	618.82	2.2	5.6	0.1	0.5	0.5	0.2	618.82	621.99	0.456	10.355	3.17	618.67	618.67
LAT 24A	C24A	200	0	200	0.706	0.706	10	0.0	10.0	100	8.74	6.2	0.01	RCP	21	0.0015	617.51	617.21	2.6	2.6	0.1	0.1	0.5	0.1	617.51	621.99	0.706	11.300	4.48	618.73	614.73
		0	0	0		0.706	-	1.3	11.3	100	8.44	6.0	0.01	RCP	21	0.0014	617.21	617.21	2.5	4.1	0.1	0.3	0.5	0.1	617.21	621.99	0.706	11.300	4.78	614.73	614.73
LAT C24	C24	99.3	85	14.3	0.488	0.488	10	0.0	10.0	100	8.74	4.3	0.029	RCP	21	0.0007	618.83	618.82	1.8	1.8	0.0	0.0	0.5	0.0	618.83	622.13	1.618	11.588	3.30	619.09	618.67
	C24A	85	52	33	0.706	1.162	11.3	0.1	11.3	100	8.44	9.8	0.028	RCP	21	0.0038	618.95	618.82	4.1	4.1	0.3	0.3	0.5	0.1	618.95	622.13	1.618	11.588	3.18	619.64	618.67
	C23	52	0	52	0.456	1.618	10.4	0.1	11.4	100	8.38	13.6	0.029	RCP	21	0.0073	618.82	618.44	5.6	5.6	0.5	0.5	0.5	0.2	618.82	622.13	1.618	11.588	3.31	618.67	617.14
		0	0	0		1.618	-	0.2	11.6	100	8.35	13.5	0.029	RCP	21	0.0073	618.44	618.44	5.6	4.5	0.5	0.3	0.5	0.2	618.44	622.13	1.618	11.588	3.69	617.14	617.14
LAT D2	D2	32	0	32	0.56	0.56	10	0.0	10.0	100	8.74	4.9	0.015	RCP	21	0.0010	617.48	617.45	2.0	2.0	0.1	0.1	0.5	0.0	617.48	620.50	0.560	10.262	3.02	616.21	615.73
		0	0	0		0.56	-	0.3	10.3	100	8.69	4.9	0.015	RCP	21	0.0009	617.45	617.45	2.0	3.0	0.1	0.1	0.5	0.1	617.45	620.50	0.560	10.262	3.05	615.73	615.73
LAT D1A	D1A	32	0	32	0.408	0.408	10	0.0	10.0	100	8.74	3.6	0.015	RCP	21	0.0005	617.22	617.21	1.5	1.5	0.0	0.0	0.5	0.0	617.22	619.00	0.408	10.360	1.78	615.21	614.73
		0	0	0		0.408	-	0.4	10.4	100	8.67	3.5	0.015	RCP	21	0.0005	617.21	617.21	1.5	3.3	0.0	0.2	0.5	0.1	617.21	619.00	0.408	10.360	1.79	614.73	614.73
LAT D1B	D1B	32	0	32	0.376	0.376	10	0.0	10.0	100	8.74	3.3	0.013	RCP	21	0.0004	617.13	617.12	1.4	1.4	0.0	0.0	0.5	0.0	617.13	619.00	0.376	10.390	1.87	615.09	614.68
		0	0	0		0.376	-	0.4	10.4	100	8.67	3.3	0.013	RCP	21	0.0004	617.12	617.12	1.4	3.7	0.0	0.2	0.5	0.1	617.12	619.00	0.376	10.390	1.88	614.68	614.68

MIDWAY ROAD RECONSTRUCTION
STORM SEWER CALCULATIONS

PROPOSED STORM SEWER SYSTEM

STORM SYSTEM CALCULATIONS - MAIN LINE

MANHOLE OR INLET						TIME OF CONCENTRATION												HYDRAULIC GRADIENT ELEV.		HEAD LOSS AT CHANGE IN SECTION								ELEV. OF INVERT AT DESIGN POINT			
DESIGN POINT		DISTANCE BETWEEN POINTS	INCOMING LATERAL NUMBER	C*Ca*A (ENTERING INLET)	TOTAL C*Ca*A (ENTERING INLET)	INLET TIME	TIME IN SEWER	DOWN-STREAM TIME	DESIGN FREQUENCY	INTENSITY	TOTAL DESIGN DISCHARGE	SELECTED PIPE SLOPE	NUMBER OF BARRELS	PIPE MAT'L	SELECTED SIZE OF PIPE	FULL FLOW CAPACITY OF PIPE	FRICTION GRADIENT SLOPE Sf	UP-STREAM	DOWN-STREAM	UP-STREAM VELOCITY V1	DOWN-STREAM VELOCITY V2	$V1^2/2g$	$V2^2/2g$	K	^1h_L	^{2}HGL BASED ON FRICTION OR PROP. Q	H.G. ELEV. AT DESIGN POINT (U/S)	UP-STREAM PIPE	DOWN-STREAM PIPE	TOP OF CURB ELEVATION	TOP OF CURB - H.G. ELEV.
UP-STREAM	DOWN-STREAM	(ft)				(min)	(min)	(min)	(years)	(in/hr)	(cfs)	(ft/ft)			(in)	(cfs)	(%)	(ft)	(ft)	(fps)	(fps)	(ft)	(ft)		(ft)	FRIC / PROP	(ft)	(ft)	(ft)	(ft)	(ft)
LINE A																															
158	39.98	118.02	LAT A1	1.403	1.403	10.1	0.0	10.1	100	8.74	12.3	0.005	1	RCP	30	27.6	0.0009	616.96	616.86	2.5	5.7	0.097	0.502	0.75	0.43	FRIC	616.96	611.24	610.70	618.00	1.04
39.98	0	39.98	LINE B	1.951	3.354	11.6	0.6	11.6	100	8.32	27.9	0.005	1	RCP	30	29.0	0.0048	616.43	616.24	5.7	5.7	0.502	0.498	0.76	0.12	FRIC	616.43	610.70	610.50	-	-
0	0	0.00		0.000	3.354	0.0	0.1	11.8	100	8.29	27.8	0.005	1	RCP	30	29.0	0.0048	616.12	616.12	5.7	0.0	0.498	0.000		0.00	FRIC	616.12	610.50	610.50	-	-
LINE B																															
322	303	19.00	LAT B2	0.324	0.324	10.1	0.0	10.1	100	8.72	2.8	0.021	1	RCP	21	23.0	0.0003	618.18	618.16	1.2	4.5	0.021	0.310	0.75	0.29	FRIC	618.18	615.83	615.43	621.50	3.32
303	200	103.00	LAT B1	1.296	1.620	10.3	0.3	10.4	100	8.67	14.0	0.021	1	RCP	24	33.0	0.0039	617.88	617.49	4.5	4.4	0.310	0.304	0.75	0.07	FRIC	617.88	615.18	612.98	622.00	4.12
200	108	92.00	GBRK	0.000	1.620	-	0.4	10.8	100	8.57	13.9	0.008	1	RCP	24	19.6	0.0036	617.42	617.07	4.4	3.4	0.304	0.178		0.00	FRIC	617.42	612.98	612.29	-	-
108	0	108.00	LAT B3	0.331	1.951	10.1	0.3	11.1	100	8.47	16.5	0.009	1	RCP	30	36.7	0.0018	617.07	616.89	3.4	3.3	0.178	0.170	0.75	0.04	FRIC	617.07	611.79	610.93	618.00	0.93
0	0	0.00		0.000	1.951	0.0	0.5	11.6	100	8.32	16.2	0.008	1	RCP	30	36.7	0.0018	616.88	616.86	3.3	0.0	0.170	0.000		0.00	FRIC	616.88	610.93	610.93		
																									0.00						
LINE C																															
3111.6	2961.6	150.00	LAT C27	0.616	0.616	10.4	0.00	10.4	100	8.64	5.3	0.0080	1	RCP	24	20.2	0.0006	645.40	645.31	1.7	2.7	0.045	0.112	0.75	0.08	FRIC	645.40	643.49	642.29	648.00	2.60
2961.6	2931.6	30.00	LAT C25	0.408	1.024	10.7	1.47	11.9	100	8.23	8.4	0.0080	1	RCP	24	20.2	0.0014	645.23	645.19	2.7	4.4	0.112	0.306	0.75	0.22	FRIC	645.23	642.29	642.05	647.00	1.77
2931.6	2781.6	150.00	LAT C26	0.680	1.704	10.3	0.19	12.1	100	8.18	13.9	0.0080	1	RCP	24	20.2	0.0038	644.97	644.40	4.4	6.5	0.306	0.661	0.75	0.43	FRIC	644.97	642.05	640.85	646.50	1.53
2781.6	2752.8	28.78	LAT C22	0.832	2.536	10.3	0.58	12.7	100	8.08	20.5	0.0080	1	RCP	24	20.2	0.0082	643.97	643.73	6.5	8.1	0.661	1.026	0.75	0.53	FRIC	643.97	640.85	640.62	646.00	2.03
2752.8	2600.0	152.84	LAT C21	0.632	3.168	10.3	0.07	12.7	100	8.06	25.5	0.0080	1	RCP	24	20.2	0.0127	643.20	641.26	8.1	8.1	1.026	1.011	0.75	0.24	FRIC	643.20	640.62	639.40	645.00	1.80
2600.0	2381.2	238.80	GBRK	0.000	3.168	-	0.31	13.1	100	8.00	25.3	0.0132	1	RCP	24	26.0	0.0126	641.02	637.14	8.1	6.6	1.011	0.679		0.00	PROP	641.02	639.40	636.24	-	-
2381.1	2298.2	82.89	LAT C19	0.839	4.007	10.3	0.49	13.6	100	8.10	32.5	0.0156	1	RCP	30	51.2	0.0063	637.14	636.74	6.6	7.7	0.679	0.915	0.75	0.41	PROP	637.14	635.74	634.76	642.50	5.36
2298.2	2180.7	117.51	LAT C18	0.621	4.628	10.3	0.16	13.7	100	8.14	37.7	0.0156	1	RCP	30	51.2	0.0084	636.34	635.34	7.7	9.1	0.915	1.277	0.75	0.59	FRIC	636.34	634.76	632.93	641.00	4.66
2180.7	2023.7	157.00	LAT C17	0.813	5.441	10.4	0.26	14.0	100	8.18	44.5	0.0156	1	RCP	30	51.2	0.0118	634.75	631.82	9.1	6.3	1.277	0.622	0.75	-0.34	PROP	634.75	632.93	630.48	640.50	5.75
2023.7	1990.7	33.00	LAT C16	0.336	5.777	10.5	0.29	14.3	100	7.74	44.7	0.0100	1	RCP	36	66.7	0.0045	632.16	632.01	6.3	7.2	0.622	0.814	0.75	0.35	FRIC	632.16	629.98	629.65	636.00	3.84
1990.7	1924.5	66.20	LAT C15	0.856	6.633	10.3	0.09	14.3	100	7.72	51.2	0.0100	1	RCP	36	66.7	0.0059	631.66	631.27	7.2	7.6	0.814	0.887	0.75	0.28	FRIC	631.66	629.65	628.99	637.00	5.34
1924.5	1860.7	63.80	LAT C14	0.315	6.948	11.0	0.15	14.5	100	7.69	53.4	0.0100	1	RCP	36	66.7	0.0064	631.00	629.69	7.6	6.0	0.887	0.550	0.75	-0.11	PROP	631.00	628.99	628.35	636.00	5.00
1860.7	1636.7	224.00	LAT C13	0.558	7.505	10.5	0.14	14.6	100	7.63	57.3	0.0100	1	RCP	42	100.6	0.0032	629.81	627.83	6.0	6.6	0.550	0.668	0.75	0.26	PROP	629.81	627.85	625.81	635.00	5.19
1636.7	1473.7	163.03	LAT C12	0.905	8.410	10.3	0.63	15.3	100	7.51	63.1	0.0100	1	RCP	42	100.6	0.0039	627.57	625.48	6.6	5.3	0.668	0.441	0.75	-0.06	PROP	627.57	625.81	623.98	633.00	5.43
1473.7	1460.2	13.43	LAT C11	0.549	8.959	10.3	0.41	15.7	100	7.48	67.0	0.0125	1	RCP	48	160.6	0.0022	625.54	625.51	5.3	5.8	0.441	0.530	0.75	0.20	FRIC	625.54	623.48	623.31	630.50	4.96
1460.2	1380.8	79.41	LAT C10	0.865	9.824	10.3	0.04	15.7	100	7.47	73.4	0.0125	1	RCP	48	160.6	0.0026	625.31	624.60	5.8	6.6	0.530	0.681	0.75	0.28	PROP	625.31	623.31	622.32	631.00	5.69
1380.8	1263.7	117.08	LAT C9	1.335	11.159	10.6	0.23	15.9	100	7.46	83.2	0.0125	1	RCP	48	160.6	0.0034	624.32	623.09	6.6	6.9	0.681	0.748	0.75	0.24	PROP	624.32	622.32	620.86	631.28	6.96
1263.7	1136.2	127.51	LAT C7	0.592	11.751	10.3	0.29	16.2	100	7.42	87.2	0.0125	1	RCP	48	160.6	0.0037	622.86	621.60	6.9	7.4	0.748	0.855	0.75	0.29	PROP	622.86	620.86	619.26	629.00	6.14
1136.2	1086.2	50.00	LAT C6	0.893	12.644	10.3	0.31	16.5	100	7.38	93.3	0.0125	1	RCP	48	160.6	0.0042	621.50	621.14	7.4	8.2	0.855	1.046	0.75	0.41	PROP	621.50	619.26	618.64	628.50	7.00
1086.2	986.2	100.00	LAT C5A	1.942	14.586	10.5	0.11	16.7	100	7.36	107.4	0.0125	1	RCP	48	160.6	0.0056	621.08	619.69	8.5	8.9	1.133	1.224	0.75	0.37	PROP	621.08	618.64	617.39	627.00	5.92
986.2	849.7	136.50	LAT C5	1.436	14.082	10.2	0.20	16.9	100	7.33	103.2	0.0125	1	RCP	48	160.6	0.0052	620.73	620.03	8.2	8.9	1.048	1.224	0.75	0.44	FRIC	620.73	617.39	615.68	627.00	6.27
849.7	830.0	19.70	LAT C4	1.245	15.328	10.2	0.28	17.1	100	7.28	111.6	0.0125	1	RCP	48	160.6	0.0060	619.31	619.19	8.9	5.8	1.224	0.522	0.75	-0.40	FRIC	619.31	615.68	615.43	625.00	5.69
830.0	695.0	135.02	JBOX	0.000	15.328	-	0.04	17.2	100	7.28	111.6	0.0050	2	RCP	42	142.3	0.0031	619.59	619.17	5.8	6.0	0.522	0.552	0.50	0.29	FRIC	619.59	615.31	614.63	-	-
695.0	277.6	417.36	LAT C3	0.603	15.931	10.2	0.39	17.6	100	7.20	114.7	0.0050	2	RCP	42	142.3	0.0032	618.88	617.53	6.0	6.0	0.552	0.551	0.75	0.14	FRIC	618.88	614.63	612.54	620.00	1.12
277.6	266.6	11.00	LAT C1A	0.450	16.381	10.6	1.17	18.7	100	7.00	114.6	0.0050	2	RCP	42	142.3	0.0032	617.39	617.35	6.0	6.0	0.551	0.563	0.75	0.15	FRIC	617.39	612.54	612.49	618.50	1.11
266.6	139.0	127.58	LAT C1B	0.189	16.570	11.5	0.03	18.8	100	7.00	115.9	0.0050	2	RCP	42	142.3	0.0033	617.20	616.78	6.0	4.6	0.563	0.325	0.75	-0.10	FRIC	617.20	612.49	611.85	618.50	1.30
139.0	0.0	139.00	GBRK	0.000	16.570	-	0.35	19.1	100	6.94	114.0	0.0090	2	CMP,PLN	48	147.5	0.0055	616.88	616.12	4.6	4.5	0.325	0.318		0.00	FRIC	616.88	611.85	610.60	-	-
0.0	0.0	0.00	-	0.000	16.570	0.0	0.51	19.6	100	6.86	113.7	0.0090	2	CMP,PLN	48	147.5	0.0053	616.12	616.12	4.5	0.0	0.318	0.000		0.00	FRIC	616.12	610.60	610.60	-	-
LINE D																															
772	702	70.00	LAT C2	1.016	1.016	10.3	0.0	10.3	100	8.69	8.8	0.005	1	RCP	30	29.0	0.0005	618.75	618.72	1.8	4.5	0.050	0.312	0.75	0.27	FRIC	618.75	617.12	616.77	620.50	1.75
702	502	200.00	LAT C24	1.618	2.634	11.6	0.6	11.8	100	8.35	22.0	0.005	1	RCP	30	29.0	0.0029	618.44	617.36	4.5	3.0	0.312	0.138	0.75	-0.10	PROP	618.44	616.77	615.77	622.13	3.69
502	302	200.00	LAT D2	0.560	3.194	10.3	0.7	12.3	100	8.14	26.0	0.005	1	RCP	40	62.5	0.0009	617.45	617.28	3.0	3.3	0.138	0.173	0.75	0.07	FRIC	617.45	614.93	613.93	620.50	3.05
302	292	10.00	LAT D1A	0.408	3.602	10.4	1.1	13.5	100	8.08	29.1	0.005	1	RCP	40	62.5	0.0011	617.21	617.20	3.3	3.7	0.173	0.212	0.75	0.06	FRIC	617.21	613.93	613.88	619.00	1.79
292	205	87.00	LAT D1B	0.376	3.978	10.4	0.0	13.5	100	8.10	32.2	0.005	1	RCP	40	62.5	0.0013	617.12	617.00	3.7	3.7	0.212	0.215	0.75	0.06	FRIC	617.12	613.88	613.45	619.00	1.88
205	166	39.00	GBRK	0.000	3.978	-	0.4	13.9	100	8.18	32.5	0.023	1	RCP	40	133.4	0.0014	616.94	616.89	3.7	3.6	0.215	0.196	0.75	0.04	FRIC	616.94	613.45	612.56	-	-
166	0	166.00	GBRK	0.000	3.978	-	0.2	14.1	100	7.80	31.0	0.005	1	CMP,PLN	40	33.8	0.0042	616.86	616.16	3.6	3.5	0.196	0.185	0.75	0.04	FRIC	616.86	612.56	611.73	-	-
0	0	0.00	-	0.000	3.978	0.0	0.8	14.8	100	7.58	30.1	0.005	1	CMP,PLN	40	33.8	0.0040	616.12	616.12	3.5	0.0	0.185	0.000	0.75	-0.14	FRIC	616.12	611.73	611.73	-	-

1 In two locations the Town of Addison Drainage Manual shows subtracting the two velocity heads and multiplying the difference by the loss coefficient. However on Figure 5-4, the standard way of multiplying the loss coefficient and the upstream velocity head and then subtracting the product from the downstream velocity head is shown. Because the latter is a more conservative approach, it was used in these calculations.

2 This column has been included to help identify pipes flowing in partial flow. If the pipe is flowing under partial flow, the spreadsheet looks up a ratio of design flow to full pipe flow to determine the ratio of design depth to full depth. This depth ratio is then used to determine the depth of the design flow in the pipe. If this depth is less than the computed HGL using the friction slope, then the depth based on the proportional flows is used to set the HGL at that point. The information used to determine the proportional flow can be found in numerous sources, this spreadsheet consulted *Concrete Pipe Design Manual, Figure 20* and *Open Channel Hydraulics by Chow, Figure 6-5*.

APPENDIX G

HY-8 ANALYSIS
EXISTING 9' X 5' BOX CULVERT
(WITH AND WITHOUT OVERTOPPING)

```
CURRENT DATE: 12-06-2001                                   FILE DATE: 12-06-2001
CURRENT TIME: 13:45:40                                     FILE NAME: MIDWAY

**********************************************************************************
**************************    FHWA CULVERT ANALYSIS    ***************************
**************************     HY-8, VERSION 6.1       ***************************
**********************************************************************************
| C |          SITE DATA          |       CULVERT SHAPE, MATERIAL, INLET           |
| U |-----------------------------|------------------------------------------------|
| L |  INLET   OUTLET  CULVERT    | BARRELS                                        |
| V |  ELEV.    ELEV.  LENGTH     | SHAPE         SPAN   RISE  MANNING   INLET     |
|NO.|  (ft)     (ft)    (ft)      | MATERIAL      (ft)   (ft)     n      TYPE      |
| 1 | 611.60   609.54   165.01    | 1 RCB         9.00   5.00   .013  CONVENTIONAL|
| 2 |                             |                                                |
| 3 |                             |                                                |
| 4 |                             |                                                |
| 5 |                             |                                                |
| 6 |                             |                                                |
**********************************************************************************

**********************************************************************************
SUMMARY OF CULVERT FLOWS (cfs)        FILE: MIDWAY           DATE: 12-06-2001

 ELEV (ft)    TOTAL       1       2       3       4       5       6  ROADWAY ITR
   611.60       0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.00  1
   614.42     133.4   133.4     0.0     0.0     0.0     0.0     0.0     0.00  1
   616.26     266.8   266.8     0.0     0.0     0.0     0.0     0.0     0.00  1
   618.05     400.2   400.2     0.0     0.0     0.0     0.0     0.0     0.00  1
   619.71     533.6   508.8     0.0     0.0     0.0     0.0     0.0    21.89  8
   619.98     667.0   524.7     0.0     0.0     0.0     0.0     0.0   138.36  4
   620.03     700.0   527.2     0.0     0.0     0.0     0.0     0.0   168.53  3
   620.33     933.8   545.4     0.0     0.0     0.0     0.0     0.0   380.12  3
   620.49    1067.2   554.3     0.0     0.0     0.0     0.0     0.0   507.79  3
   620.63    1200.6   562.2     0.0     0.0     0.0     0.0     0.0   634.52  3
   620.79    1334.0   533.6     0.0     0.0     0.0     0.0     0.0   788.60  3
   619.60     502.0   502.0     0.0     0.0     0.0     0.0     0.0 OVERTOPPING
**********************************************************************************

**********************************************************************************
  SUMMARY OF ITERATIVE SOLUTION ERRORS   FILE: MIDWAY          DATE: 12-06-2001

          HEAD            HEAD             TOTAL          FLOW           % FLOW
        ELEV (ft)      ERROR (ft)       FLOW (cfs)     ERROR (cfs)       ERROR
        611.60           0.000             0.00           0.00            0.00
        614.42           0.000           133.40           0.00            0.00
        616.26           0.000           266.80           0.00            0.00
        618.05           0.000           400.20           0.00            0.00
        619.71          -0.005           533.60           2.88            0.54
        619.98          -0.005           667.00           3.95            0.59
        620.03          -0.005           700.00           4.27            0.61
        620.33          -0.008           933.80           8.26            0.88
        620.49          -0.005          1067.20           5.15            0.48
        620.63          -0.003          1200.60           3.85            0.32
        620.79          -0.009          1334.00          11.80            0.88
**********************************************************************************
  <1> TOLERANCE (ft) = 0.010                        <2> TOLERANCE (%) = 1.000
**********************************************************************************
```

```
CURRENT DATE: 12-06-2001                                FILE DATE: 12-06-2001
CURRENT TIME: 13:43:30                                  FILE NAME: MIDWAY

*********************************************************************************
**************************    FHWA CULVERT ANALYSIS    **************************
**************************     HY-8, VERSION 6.1       **************************
*********************************************************************************
| C |          SITE DATA          |       CULVERT SHAPE, MATERIAL, INLET        |
| U |-----------------------------|---------------------------------------------|
| L |  INLET   OUTLET  CULVERT    | BARRELS                                     |
| V |  ELEV.    ELEV.  LENGTH     | SHAPE        SPAN   RISE  MANNING   INLET   |
|NO.|  (ft)     (ft)    (ft)      | MATERIAL     (ft)   (ft)     n      TYPE    |
| 1 | 611.60   609.54   165.01    | 1 RCB        9.00   5.00   .013  CONVENTIONAL|
| 2 |                             |                                             |
| 3 |                             |                                             |
| 4 |                             |                                             |
| 5 |                             |                                             |
| 6 |                             |                                             |
*********************************************************************************

*********************************************************************************
SUMMARY OF CULVERT FLOWS (cfs)         FILE: MIDWAY            DATE: 12-06-2001

 ELEV (ft)   TOTAL       1       2       3       4       5       6  ROADWAY ITR
   611.60      0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   614.42    133.4     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   616.26    266.8     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   618.05    400.2     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   620.13    533.6     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   622.66    667.0     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   623.37    700.0     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   629.74    933.8     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   634.53   1067.2     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   639.96   1200.6     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
   646.03   1334.0     0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
     0.00      0.0     0.0     0.0     0.0     0.0     0.0     0.0 OVERTOPPING
*********************************************************************************

*********************************************************************************
  SUMMARY OF ITERATIVE SOLUTION ERRORS   FILE: MIDWAY          DATE: 12-06-2001

        HEAD            HEAD             TOTAL           FLOW           % FLOW
        ELEV (ft)       ERROR (ft)       FLOW (cfs)      ERROR (cfs)     ERROR
        611.60           0.000             0.00           0.00            0.00
        614.42           0.000           133.40           0.00            0.00
        616.26           0.000           266.80           0.00            0.00
        618.05           0.000           400.20           0.00            0.00
        620.13           0.000           533.60           0.00            0.00
        622.66           0.000           667.00           0.00            0.00
        623.37           0.000           700.00           0.00            0.00
        629.74           0.000           933.80           0.00            0.00
        634.53           0.000          1067.20           0.00            0.00
        639.96           0.000          1200.60           0.00            0.00
        646.03           0.000          1334.00           0.00            0.00
*********************************************************************************
  <1> TOLERANCE (ft) = 0.010                       <2> TOLERANCE (%) = 1.000
*********************************************************************************
```

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CURRENT DATE: 12-06-2001                                    FILE DATE: 12-06-2001
CURRENT TIME: 13:43:30                                      FILE NAME: MIDWAY
*********************************************************************************
      PERFORMANCE CURVE FOR CULVERT 1 - 1(  9.00 (ft) BY   5.00 (ft)) RCB
*********************************************************************************
   DIS-     HEAD-  INLET  OUTLET
  CHARGE    WATER CONTROL CONTROL FLOW NORMAL  CRIT. OUTLET   TW   OUTLET   TW
   FLOW     ELEV.  DEPTH   DEPTH  TYPE  DEPTH  DEPTH  DEPTH  DEPTH   VEL.   VEL.
  (cfs)     (ft)   (ft)    (ft)   <F4>  (ft)   (ft)   (ft)   (ft)   (fps)  (fps)
*********************************************************************************
    0.00   611.60   0.00    0.00 0-NF   0.00   0.00   0.00   0.00   0.00   0.00
  133.40   614.43   2.83    2.83 1-S2n  1.19   1.90   1.24   1.69  11.95   5.91
  266.80   616.26   4.66    4.66 1-S2n  1.90   3.02   2.06   2.46  14.41   7.26
  400.20   618.05   6.45    6.45 5-S2n  2.52   3.95   2.79   3.05  15.92   8.15
  533.60   620.13   8.53    8.53 5-S2n  3.09   4.79   3.47   3.54  17.09   8.82
  667.00   622.66  11.06    8.50 6-S2n  3.63   5.00   4.09   3.97  18.12   9.37
  700.00   623.37  11.77    9.06 6-S2n  3.76   5.00   4.20   4.07  18.52   9.50
  933.80   629.74  18.14   13.84 6-S2n  5.00   5.00   4.90   4.70  21.17  10.26
 1067.20   634.53  22.93   17.18 4-S2n  5.00   5.00   4.90   5.01  24.20  10.63
 1200.60   639.96  28.36   21.26 4-S2n  5.00   5.00   4.90   5.31  27.22  10.97
 1334.00   646.03  34.43   25.76 4-S2n  5.00   5.00   4.90   5.59  30.25  11.27
*********************************************************************************
        El. inlet face invert     611.60 ft  El. outlet invert   609.54 ft
        El. inlet throat invert     0.00 ft  El. inlet crest       0.00 ft
*********************************************************************************

***** SITE DATA ***** CULVERT INVERT **************
      INLET STATION                          165.00 ft
      INLET ELEVATION                        611.60 ft
      OUTLET STATION                           0.00 ft
      OUTLET ELEVATION                       609.54 ft
      NUMBER OF BARRELS                        1
      SLOPE (V/H)                              0.0125
      CULVERT LENGTH ALONG SLOPE             165.01 ft

***** CULVERT DATA SUMMARY ************************
      BARREL SHAPE         BOX
      BARREL SPAN            9.00 ft
      BARREL RISE            5.00 ft
      BARREL MATERIAL      CONCRETE
      BARREL MANNING'S n   0.013
      INLET TYPE           CONVENTIONAL
      INLET EDGE AND WALL  1:1 BEVEL (45 DEG. FLARE)
      INLET DEPRESSION     NONE

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CURRENT DATE: 12-06-2001                                FILE DATE: 12-06-2001
CURRENT TIME: 13:43:30                                  FILE NAME: MIDWAY

********************************************************************************
**************************          TAILWATER         **************************
********************************************************************************

******* REGULAR CHANNEL CROSS SECTION ****************
        BOTTOM WIDTH                             10.00 ft
        SIDE SLOPE  H/V (X:1)                     2.0
        CHANNEL SLOPE V/H (ft/ft)                 0.010
        MANNING'S n (.01-0.1)                     0.030
        CHANNEL INVERT ELEVATION                609.54 ft
        CULVERT NO.1 OUTLET INVERT ELEVATION    609.54 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

        FLOW     W.S.E.  FROUDE   DEPTH    VEL.   SHEAR
        (cfs)     (ft)   NUMBER    (ft)   (f/s)   (psf)
         0.00    609.54   0.000    0.00    0.00    0.00
       133.40    611.23   0.803    1.69    5.91    1.07
       266.80    612.00   0.816    2.46    7.26    1.57
       400.20    612.59   0.822    3.05    8.15    1.94
       533.60    613.08   0.826    3.54    8.82    2.25
       667.00    613.51   0.829    3.97    9.37    2.53
       700.00    613.60   0.830    4.07    9.50    2.59
       933.80    614.23   0.834    4.70   10.26    2.99
      1067.20    614.55   0.837    5.01   10.63    3.19
      1200.60    614.85   0.839    5.31   10.97    3.38
      1334.00    615.13   0.841    5.59   11.27    3.56

********************************************************************************
**************************  ROADWAY OVERTOPPING DATA  **************************
********************************************************************************

      ROADWAY SURFACE                           PAVED
      EMBANKMENT TOP WIDTH                     155.00 ft
      CREST LENGTH                             200.00 ft
      OVERTOPPING CREST ELEVATION              619.60 ft

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