Task A.5.b.6
Location Hydraulic Report

TAMPA INTERSTATE STUDY

State Project No. 99007-1402, WPI No. 7140004, FAP No. IR-9999(43)

Interstate 275 (I-275) from the Howard Frankland Bridge/Kennedy Boulevard ramps to the Dale Mabry Highway interchange on the east and just north of Cypress Street on Memorial Highway (S.R. 60), Hillsborough County.

Prepared For The

FLORIDA DEPARTMENT OF TRANSPORTATION

Prepared By

GREINER, INC.

In Association With

KNIGHT APPRAISAL SERVICES, INC.
PIPER ARCHAEOLOGICAL SERVICES

MAY 1991

Task A.5.b.6
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EXECUTIVE SUMMARY

This report documents the evaluation of existing and proposed cross-drain structures within the Tampa Interstate Study Environmental Assessment (EA) project limits. The project limits include I-275 (from the eastern terminus of the Howard Frankland Bridge to east of Dale Mabry Highway) and Memorial Highway (S.R. 60) (from the I-275/Memorial Highway interchange to Cypress Street) in the City of Tampa. The methodology used in this evaluation was established in Executive Order 11988 "Floodplain Management" and Federal-Aid Highway Program Manual (FHPM) 6-7-3(2), Paragraph 7.

Currently, I-275 provides a four-lane facility from the Howard Frankland Bridge to Memorial Highway (S.R. 60) and six lanes from Memorial Highway (S.R. 60) to east of the Dale Mabry Highway interchange. An auxiliary lane is also provided for the eastbound weaving section between the Westshore Boulevard and Lois Avenue interchanges.

The proposed improvements consist of a four-roadway system made up of interstate express lanes and separated local access freeway lanes. High Occupancy Vehicle (HOV)/Transitway lanes will be included within the interstate alignment and Trask Street with an envelope reserved to carry the HOV/Transitway across the Howard Frankland Bridge. HOV priority ramps will be provided to and from the east on I-275 at Trask Street. A fully directional interchange will be included for the I-275 connection to the Northwest Expressway, and direct ramping will be provided from Memorial Highway (S.R. 60) and Kennedy Boulevard to the Northwest Expressway. Existing interchange locations will remain at Westshore Boulevard, Lois Avenue and Dale Mabry Highway. New at-grade improvements include the Sherill Street extension

north from Memorial Highway and Kennedy Boulevard through I-275 to Spruce Street, and the new Lemon Street Connector to Westshore Boulevard from Occident Street.

Within the project limits, the existing roadway traverses the Federal Emergency Management Agency (FEMA) flood zones A, B and C. Although a drainage system (Lemon Street Canal) parallels the project corridor, no longitudinal encroachments are within the project corridor. No floodways are designated within the project corridor. All encroachments to the 100-year floodplain (Zone A) will be mitigated according to local and regional regulations.

Six existing cross-drain structures were analyzed within the project corridor. Four structures will be lengthened without increasing the headloss significantly. These structures are considered Category 3 structures in accordance with the requirements set forth in FHPM 6-7-3(2), Paragraph 7. Two structures, rated as Category 4 and 5, will require upgrading to minimize adverse upstream flood impacts.

The modification and replacement of existing structures are needed due to the proposed improvements. The proposed roadway project should not significantly contribute to an increase in flood elevations and will not cause incompatible floodplain development. The proposed project should improve the use of the facility for emergency services and evacuation purposes.

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INTRODUCTION

Purpose

The majority of the Tampa interstate system was designed and constructed in the late 1950's and early 1960's. Realizing the need to upgrade the antiquated interstate system, the Florida Department of Transportation (FDOT) began a study in 1983 to evaluate reconstruction and High Occupancy Vehicle (HOV) improvements on the urban interstate system in Hillsborough County. The study established year 2010 traffic for the interstate system and described some potential short-term safety and geometric solutions for the existing interstate. Additionally, the study identified long-term, HOV-related improvements to accommodate year 2010 traffic volumes.

A significant conclusion from the completed study was that efforts must be expanded to consider all transportation needs within the corridor, including any concurrent highway, rail, or transit improvements to the area which may impact the corridor, and to recommend improvements to the interstate system to accommodate those needs.

Utilizing the 1983 justification as a documented base, the Tampa Interstate Study (TIS) began in late 1987. Generally, the purpose of TIS was to produce a Master Plan, conceptual design, and an environmental impact data base for improvements to I-4, I-75, and I-275. Those recommended improvements are intended to serve traffic and transportation needs through the year 2010. Specifically, the objectives of TIS are to prepare a series of reports documenting the requirements for conceptual design,

including existing and predicted conditions, typical sections, right-of-way requirements, environmental constraints, and costs of the recommended alternatives.

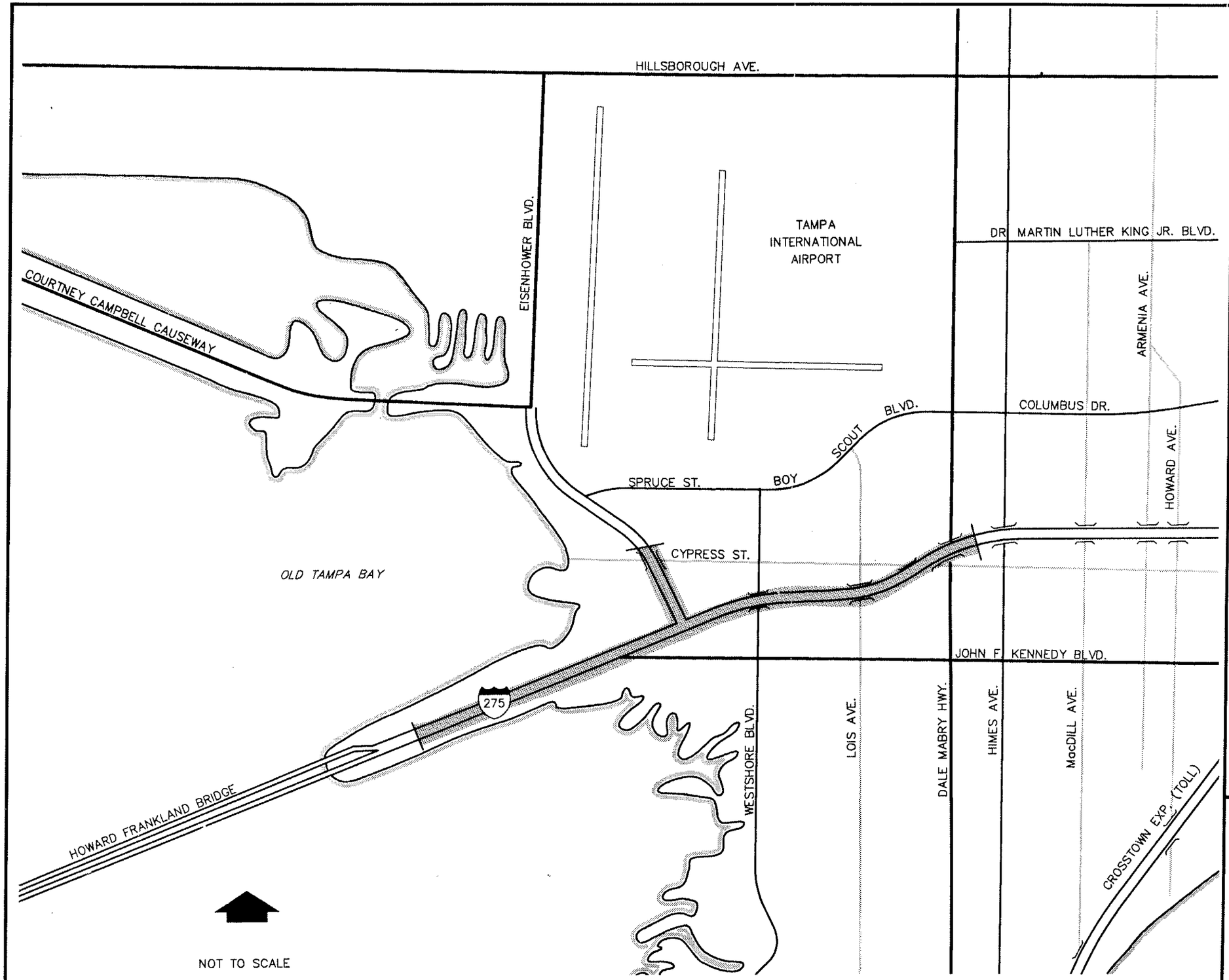
Following acceptance of the Master Plan, provisions were set forth by the FDOT to implement Phase II of the TIS. Phase II of TIS is intended to satisfy those requirements necessary to fully complete the environmental documentation for the recommended Master Plan. Completion of Phase II activities will enable the FDOT to proceed with final design and construction of the Tampa interstate system.

This Location Hydraulic Report (LHR) was completed in accordance with the requirements set forth in Executive Order 11988 "Floodplain Management" and FHPM 6-7-3(2), Paragraph 7. It provides supporting data, calculations and discussions of potential floodplain impacts due to the TIS proposed improvements along I-275 (from the Howard Frankland Bridge to Dale Mabry Highway) and Memorial Highway (S.R. 60) (from the I-275/Memorial Highway interchange to Cypress Street) in the City of Tampa, Florida.

Project Description

The project limits are I-275 from the Howard Frankland Bridge to just east of the Dale Mabry Highway interchange and S.R. 60 (Northwest Expressway) between I-275 and Cypress Street. The project limits are shown on Exhibit 1.

Currently, I-275 provides a four-lane facility from the Howard Frankland Bridge to Memorial Highway (S.R. 60) and six lanes from Memorial Highway to east of the Dale



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LOCATION HYDRAULIC REPORT

TAMPA INTERSTATE STUDY
PHASE II

Hillsborough County, Florida

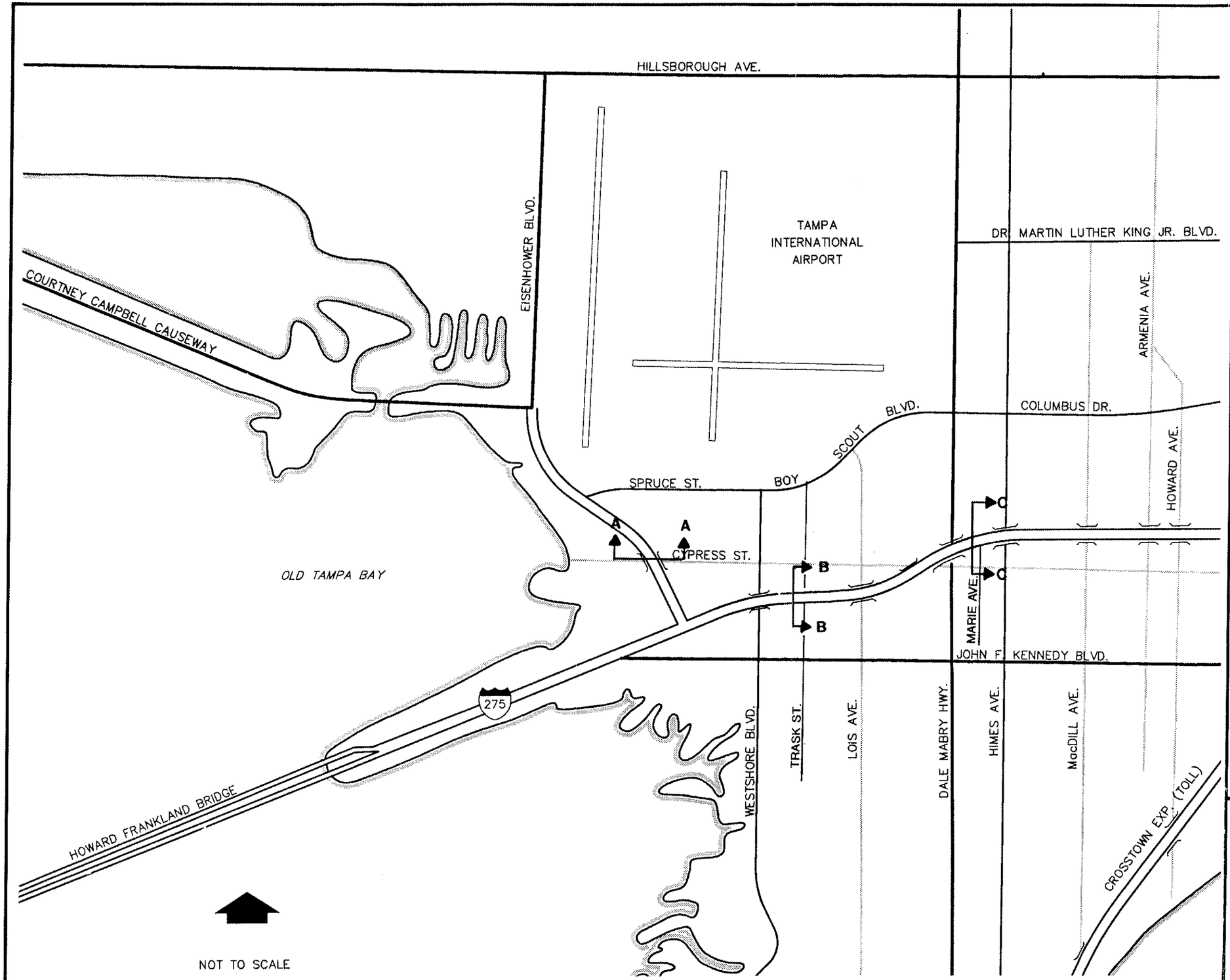
LOCATION MAP

EXHIBIT 1

Mabry Highway interchange. An auxiliary lane is also provided for the eastbound weaving section between the Westshore Boulevard and Lois Avenue interchanges.

Year 2010 traffic projections show I-275 carrying approximately 124,000 vehicles per day west of the proposed Northwest Expressway and 157,000 vehicles per day east of the Northwest Expressway. Using the 2010 forecast traffic volumes, along with other critical factors, research was conducted to consider, develop and evaluate various roadway design concepts for the study area. As a result of the evaluation process, a Master Plan Report (Ref. 5) was recommended for this facility.

The recommended concept consists of a four-roadway system made up of interstate express lanes and separated local access freeway lanes. High Occupancy Vehicle (HOV)/Transitway lanes will be included within the interstate alignment and Trask Street with an envelope reserved to carry the HOV/Transitway across the Howard Frankland Bridge. HOV priority ramps will be provided to and from the east on I-275 at Trask Street. A fully directional interchange will be included for the I-275 connection to the Northwest Expressway, and direct ramping will be provided from Memorial Highway and Kennedy Boulevard to the Northwest Expressway. Existing interchange locations will remain at Westshore Boulevard, Lois Avenue and Dale Mabry Highway. New at-grade improvements include the Sherrill Street extension north from Memorial Highway and Kennedy Boulevard through I-275 to Spruce Street, and the new Lemon Street Connector to Westshore Boulevard from Occident Street. Exhibits 2-1 through 2-4 show the typical cross-sections location and cross-sections of the proposed improvements to I-275 and Memorial Highway.



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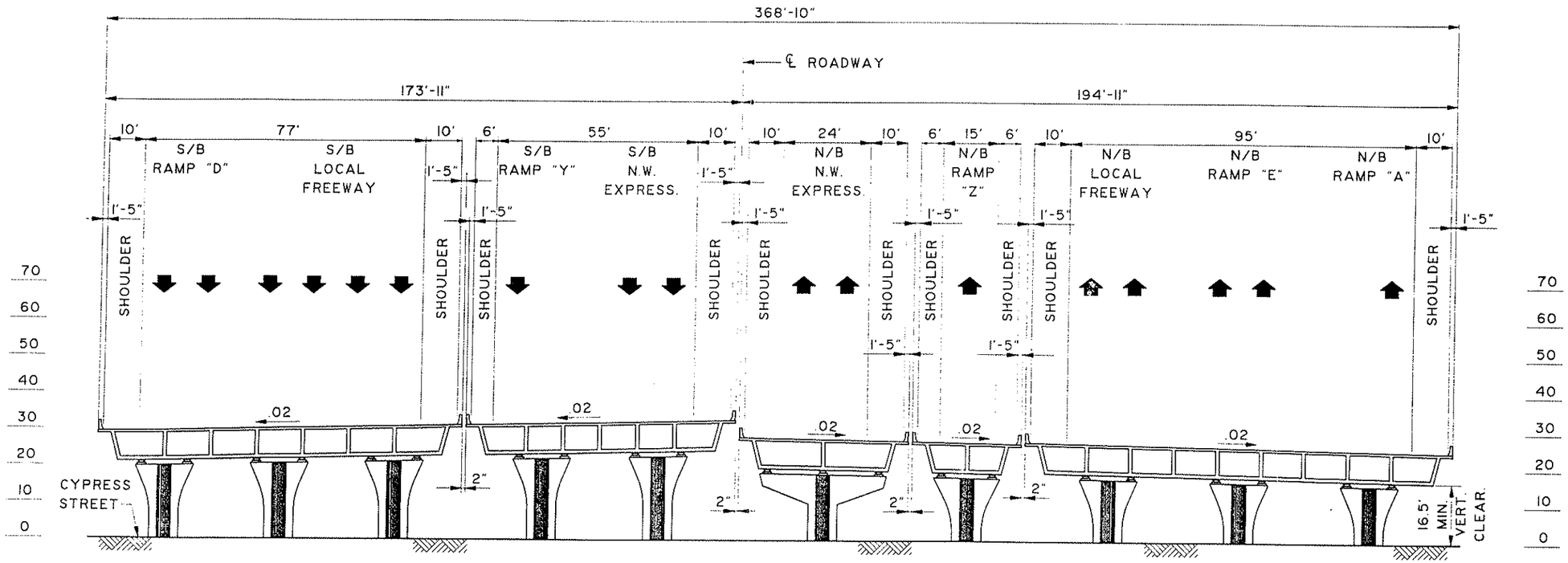
TAMPA INTERSTATE STUDY
PHASE II

Hillsborough County, Florida

TYPICAL SECTION LOCATION MAP

EXHIBIT 2-1



STATION 234+50

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LOCATION HYDRAULIC REPORT

TAMPA INTERSTATE STUDY

PHASE II

Hillsborough County, Florida

NORTHWEST EXPRESSWAY CROSS SECTION A-A AT CYPRESS ST.

EXHIBIT 2-2

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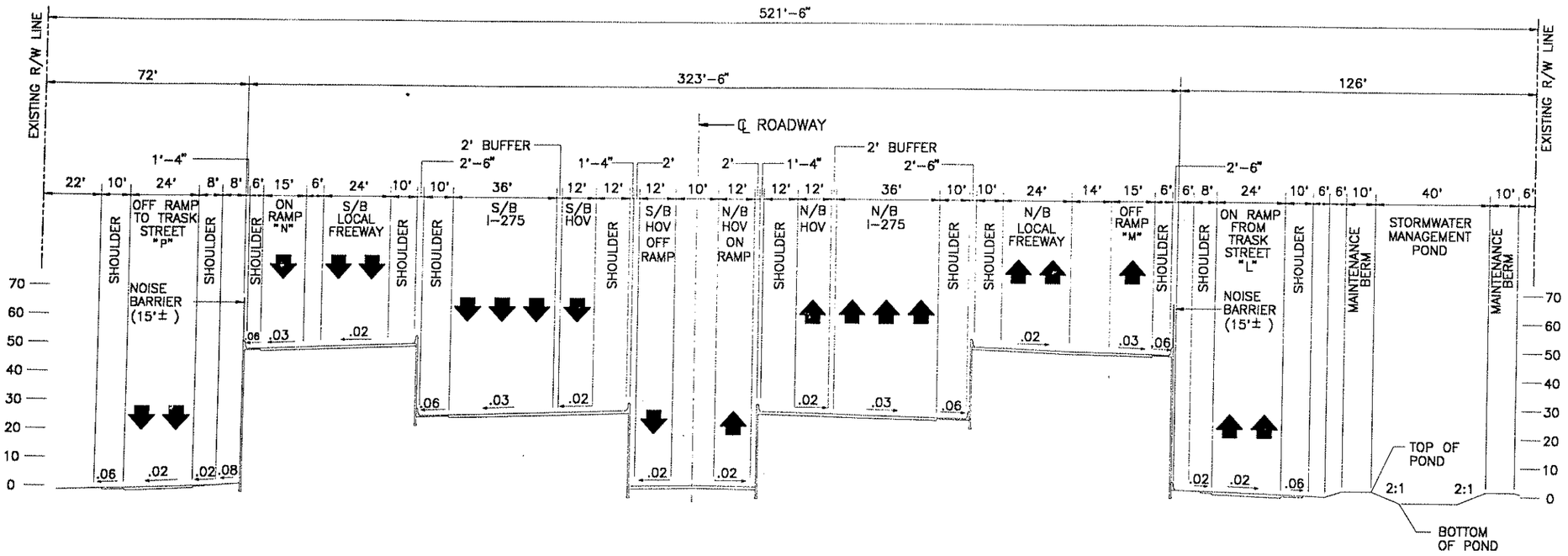

STA. 190+00

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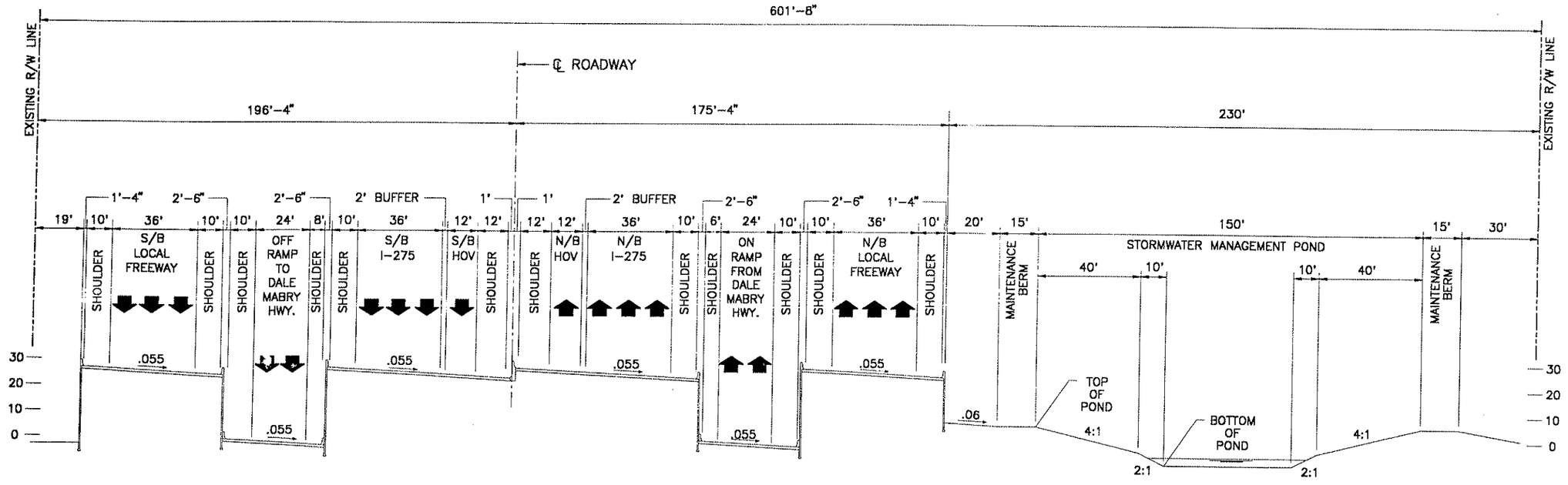
PHASE II

Hillsborough County, Florida

I-275 CROSS SECTION B-B AT TRASK ST.

EXHIBIT 2-3



STATION 249+00

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LOCATION HYDRAULIC REPORT
TAMPA INTERSTATE STUDY
PHASE II
Hillsborough County, Florida

I-275 CROSS SECTION C-C AT MARIE AVE.

EXHIBIT 2-4

The sources of information used in the preparation of this LHR include the following:

* USGS Quadrangle Maps
* Southwest Florida Water Management District's (SWFWMD) Aerials with Contours
* City of Tampa Drainage Atlas
* FEMA Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS) for the City of Tampa, Florida.
* USGS Soil Conservation Service, Soil Survey of Hillsborough County.
* Cypress/Memorial Area Drainage Study, City of Tampa (1989).
* FDOT Plans for existing roadway

Existing structures data were obtained from the City of Tampa Drainage Atlas (Ref. 1) and FDOT drainage maps and design data (Ref. 6) of the project corridor as well as other sources. This report contains general information and is intended for planning purposes only. Specific, detailed studies will be required for each cross-drain structure before construction of any improvements.

Flood Zone Designations

A floodplain map, prepared for the project corridor from the FEMA Flood Insurance Rate Maps (FIRM, Ref. 2) and Flood Insurance Studies (FIS, Ref. 3), is illustrated in Exhibits 3-1 through 3-8. This information was taken from the City of Tampa FIRM Community Panel Numbers 120114 0021C and 120114 0022C, dated September 30, 1982.

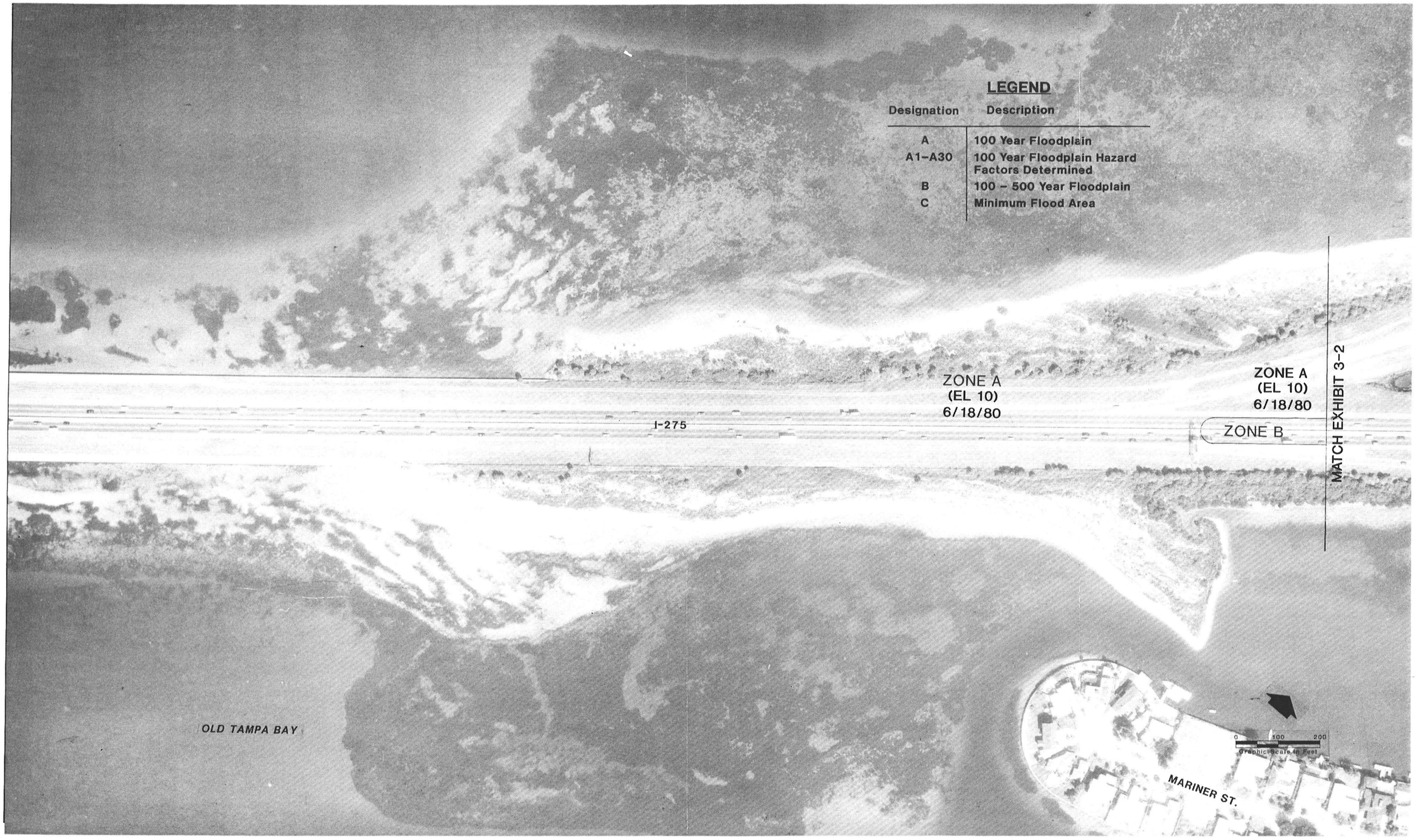

Photo Date: August 1987

PROJECT No. C2380				
PROJECT DATES				
DATES	DESCRIPTION			

PLANNING FOR TOMORROW — I-4 I-275 I-75 TAMPA INTERSTATE STUDY

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LOCATION HYDRAULIC REPORT
FLOODPLAINS

TAMPA INTERSTATE STUDY
FLORIDA DEPARTMENT OF TRANSPORTATION

STATE PROJECT No. 99007-1402 | EXHIBIT 3-1

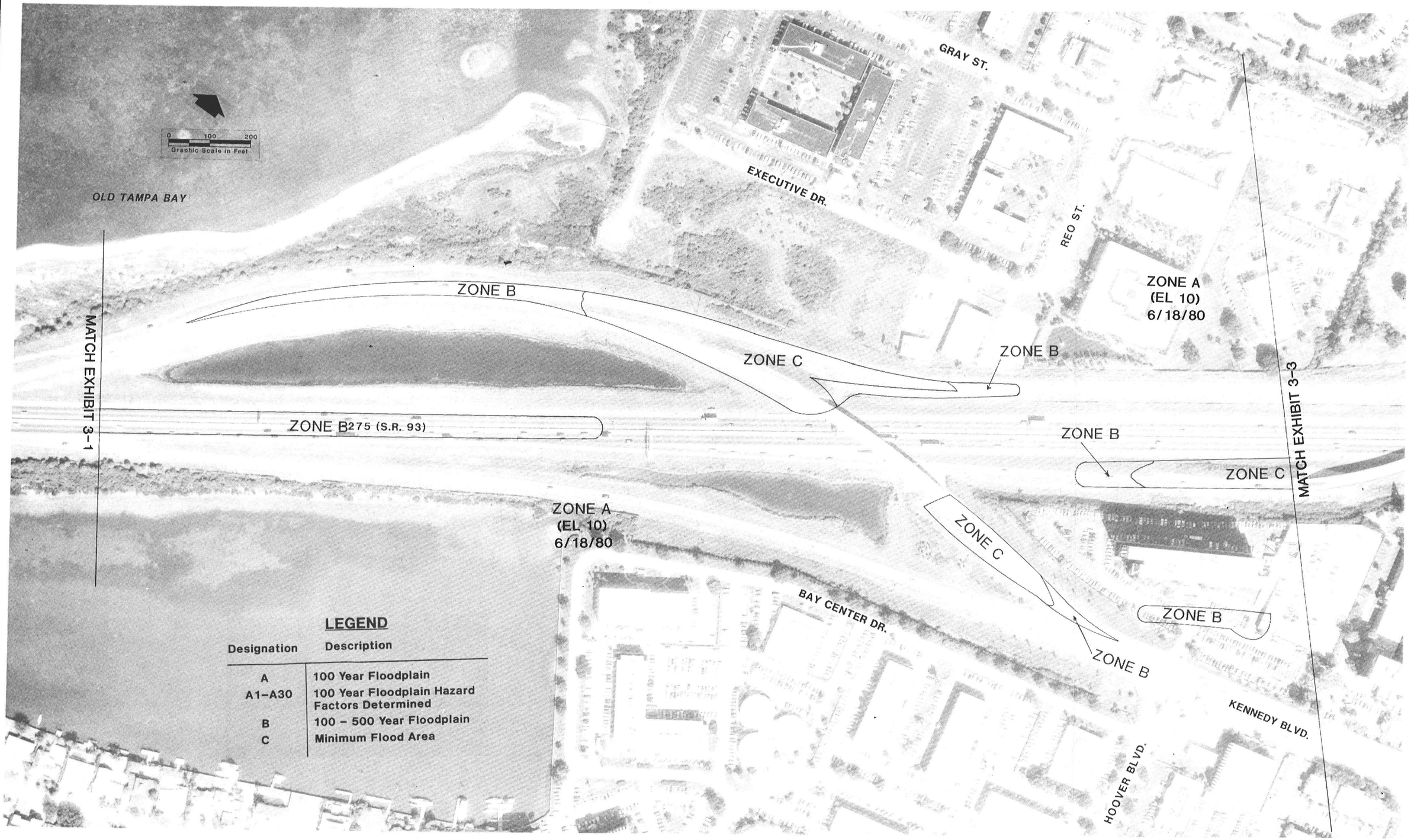

Photo Date: August 1987

PROJECT No. C2380

PROJECT DATES	
DATES	DESCRIPTION

PLANNING FOR TOMORROW
I-4 I-275 I-75
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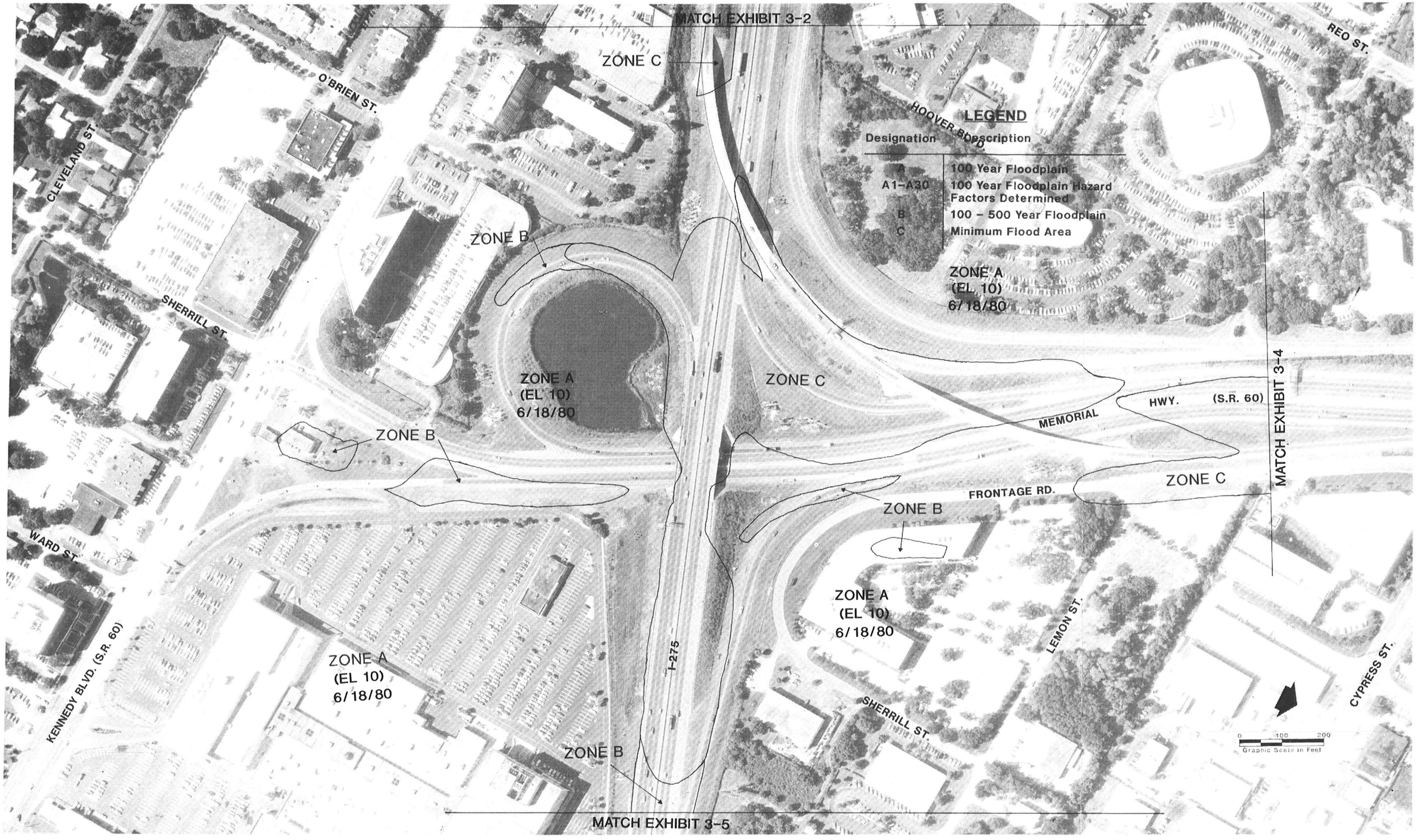

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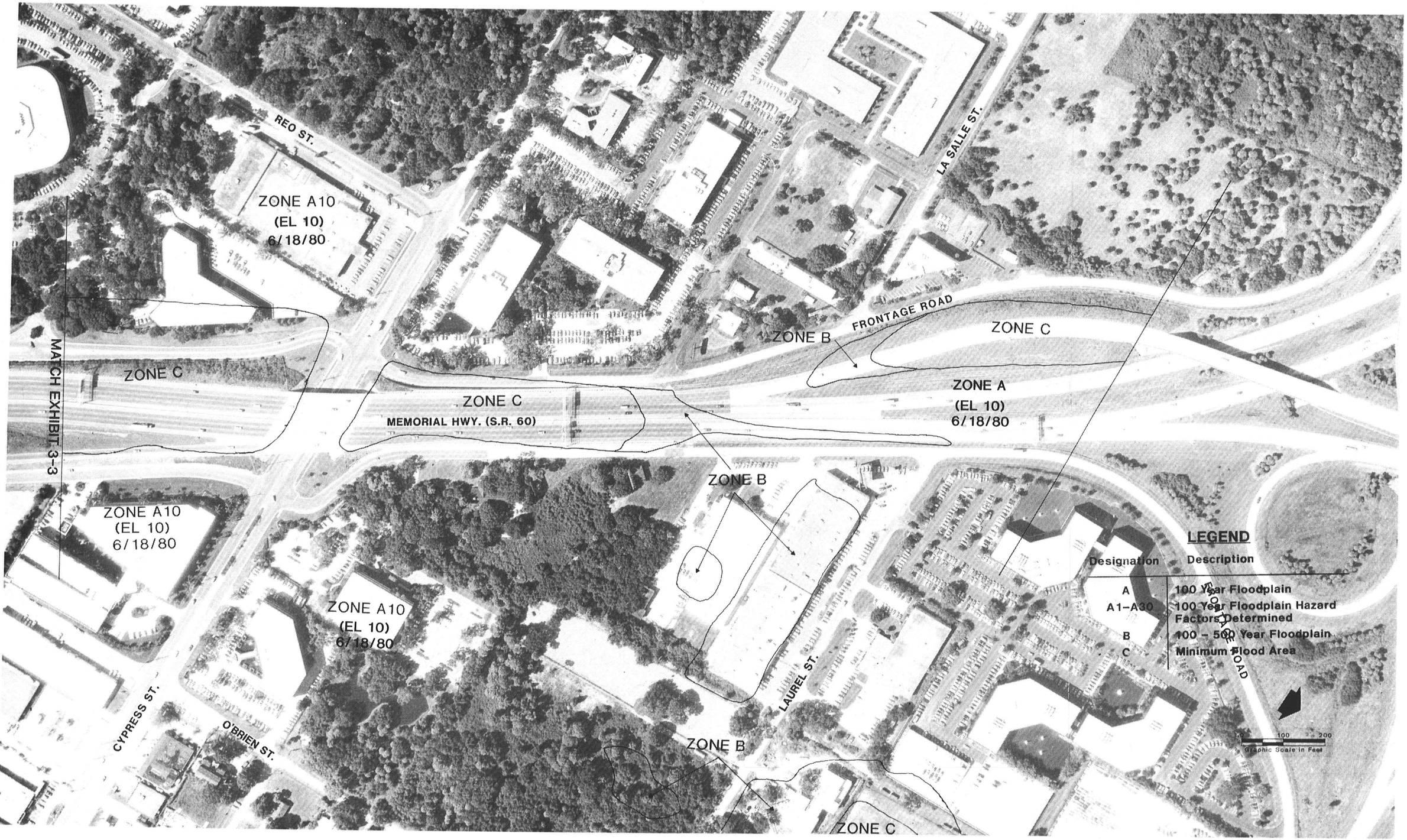

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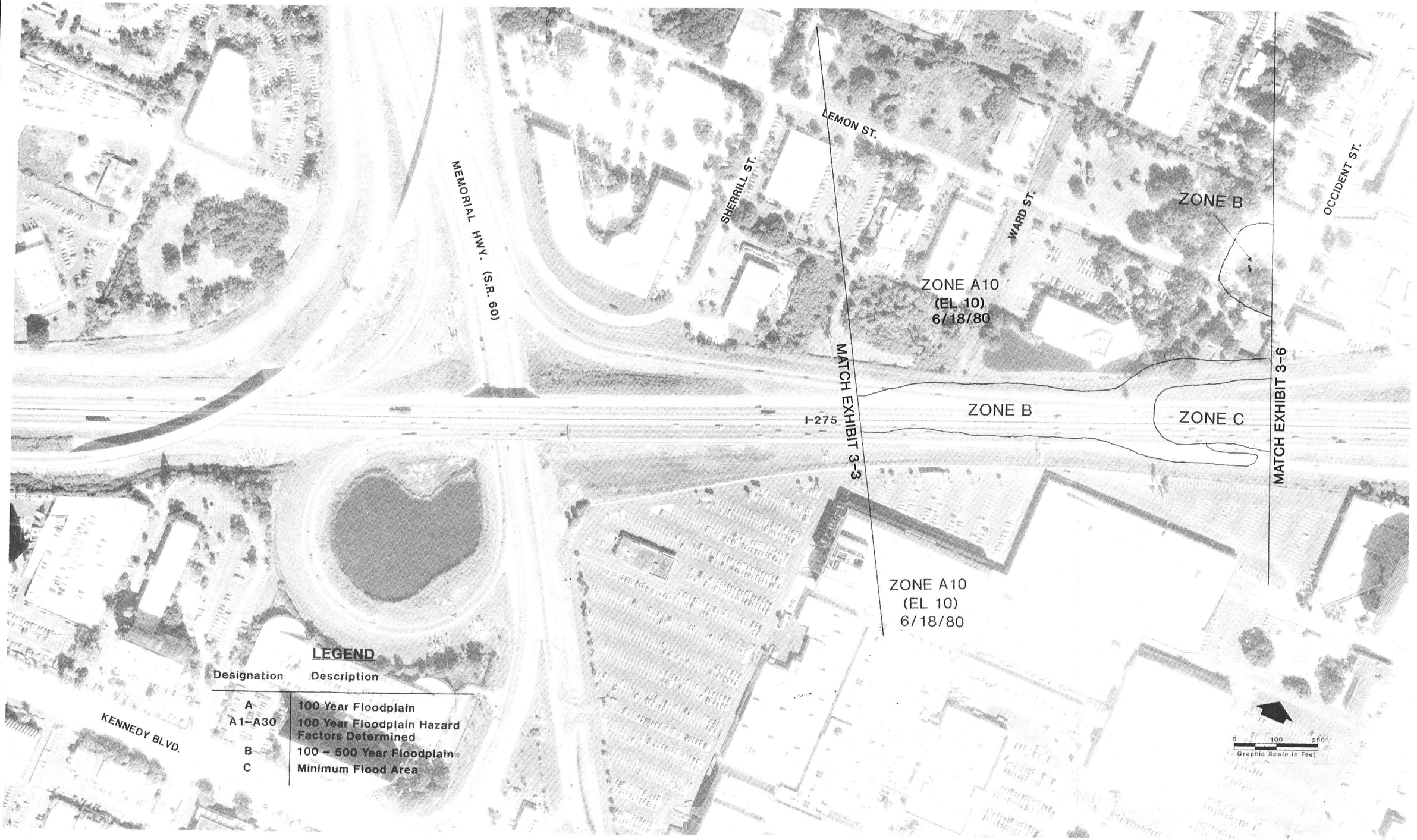

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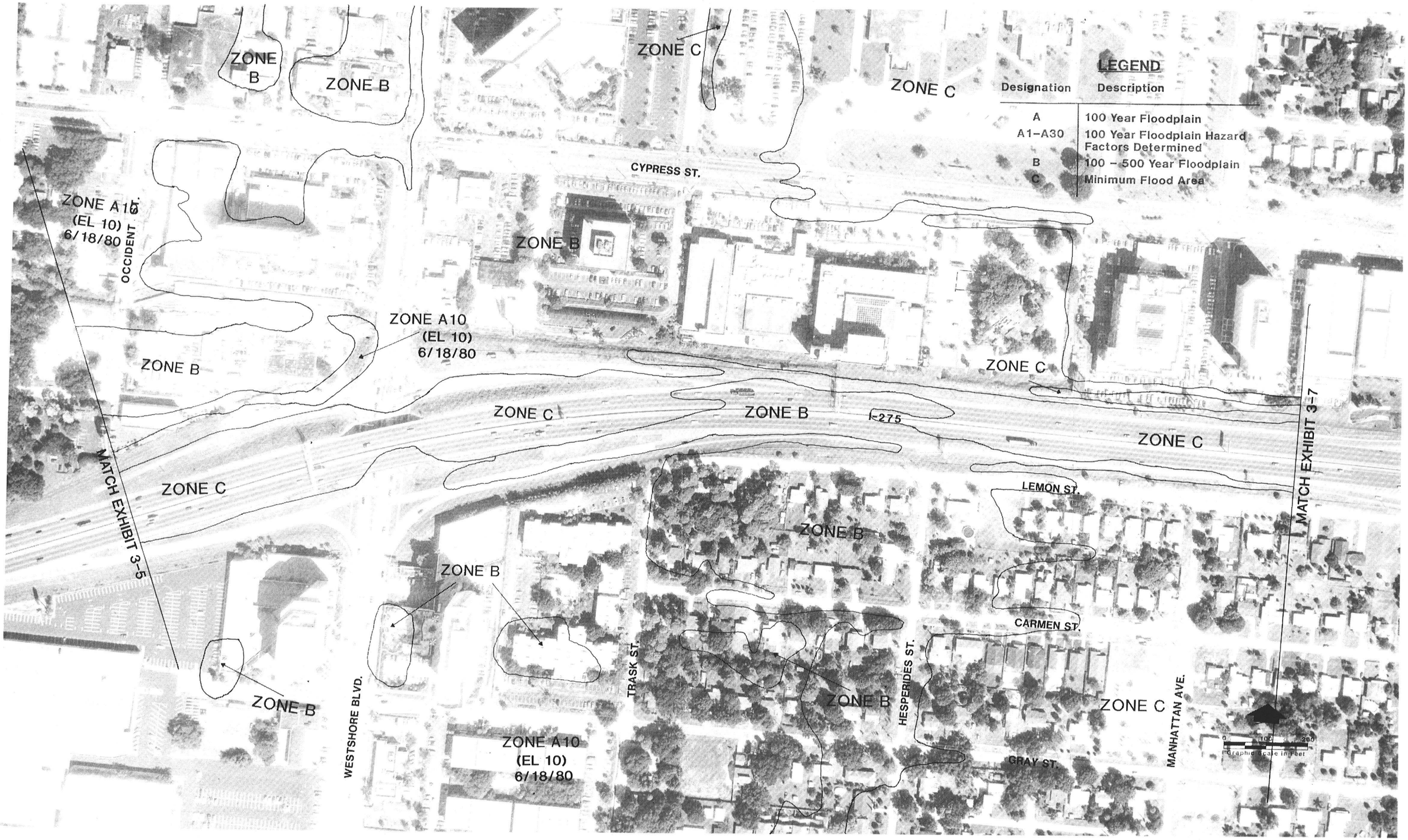

Photo Date: August 1987

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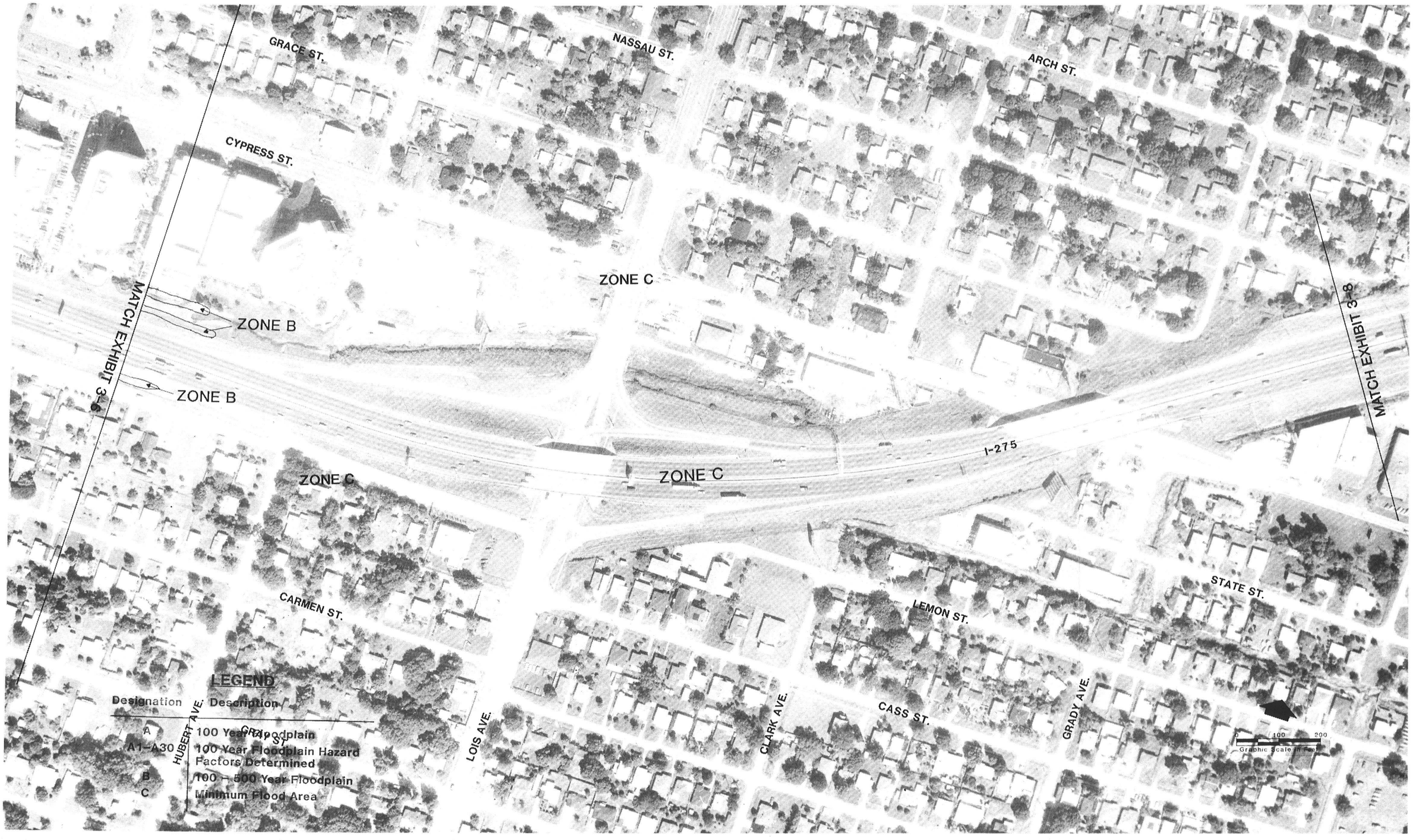

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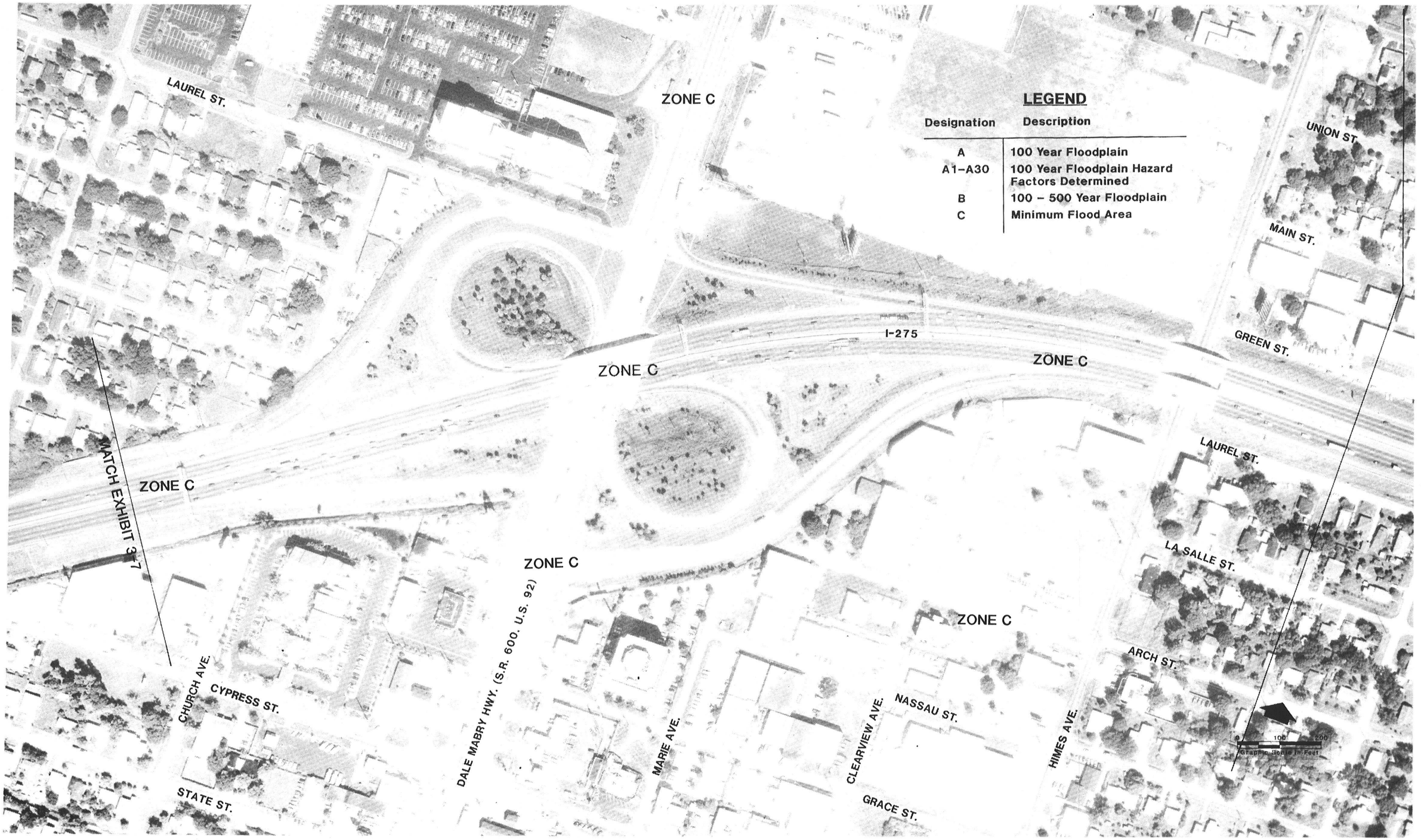

Photo Date: August 1987

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PLANNING FOR TOMORROW
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FLORIDA DEPARTMENT OF TRANSPORTATION
STATE PROJECT No. 99007-1402 | EXHIBIT 3-8

The base floodplain within this area results from the storm surge associated with a tropical storm or hurricane. The base floodplain (Zone A10) in the project corridor extends from the eastern terminus of the Howard Frankland Bridge east to North Hesperides Street. The segment of the interstate within this project corridor from Hesperides Street to Dale Mabry Highway is in Zone C. A few areas are defined as Zone B and Zone C along the project corridor within the interstate where it is elevated above the storm surge. Explanations of the flood zone designations are listed in Table 1.

TABLE 1

FEMA FLOOD ZONE DESIGNATIONS

Zone	Explanation
A	Area of 100-year flood; base flood elevations and flood hazard factors not determined.
A1-A30	Area of 100-year flood; base flood elevations and flood hazard factors determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood.
C	Area of minimal flooding.

Although the project corridor parallels the Lemon Street Canal, the proposed improvements to the project corridor will not cause longitudinal encroachment. No floodways are designated within the project corridor. Due to the degree of existing development within the project, the proposed roadway improvements should not cause an incompatible floodplain development.

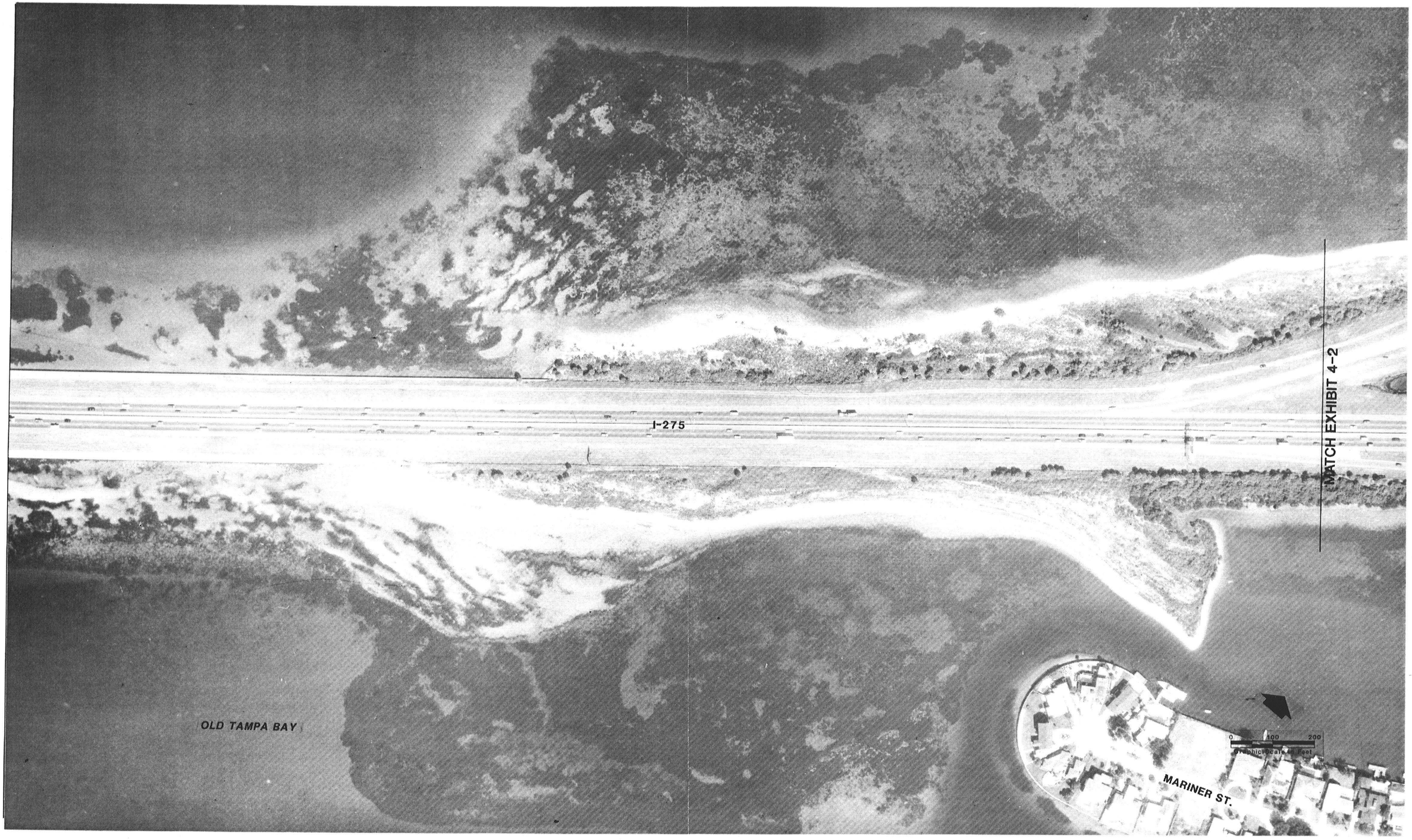
Existing Drainage Problems

Historically, flooding has occurred in the Cypress/Memorial Basin (Ref. 7). The primary cause of severe flooding within the project corridor is due to the overtaxing of the Lemon Street Canal which is the major drainage system for the entire Cypress/Memorial Basin. Sheets 1 through 8 of Exhibit 4 show the location of each cross-drain structure along the project corridor. Structures along the Lemon Street Canal outside the project corridor are also included.

The Lemon Street Canal from Memorial Highway (S.R. 60) to Westshore Boulevard, see Exhibit 4, is identified as a chronic flood problem area by the City of Tampa. Heavy summer stormwater can cause sufficient inundation at the Westshore Boulevard ramps of I-275 and prevent access to the interstate. Flooding is frequently reported in a segment of the Lemon Street Canal behind the Holiday Inn (see Exhibit 4).

DESCRIPTION OF DRAINAGE STRUCTURES

Drainage structures within the study area have been identified utilizing information from the City of Tampa Drainage Atlas, Cypress/Memorial Area Drainage Study, site inspections and FDOT as-built plans (Exhibits 4-1 through 4-8). This includes cross-drain structures under I-275 and drainage structures along the Lemon Street Canal. A list of these structures is presented in Table 2.



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EXIST R/W | LAND USE | DEST FDOT R/W | PROP R/W | ROMAN | FP 2

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PLANNING FOR TOMORROW — I-4 I-275 I-75 — TAMPA INTERSTATE STUDY

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LOCATION HYDRAULIC REPORT
DRAINAGE STRUCTURE LOCATIONS

TAMPA INTERSTATE STUDY
FLORIDA DEPARTMENT OF TRANSPORTATION

STATE PROJECT No. 99007-1402 | EXHIBIT 4-1

EXIST R/W | LAND USE | SECT 106 a 4F | PROP R/W | DRAIN | FP
#3 | | | | 3 |

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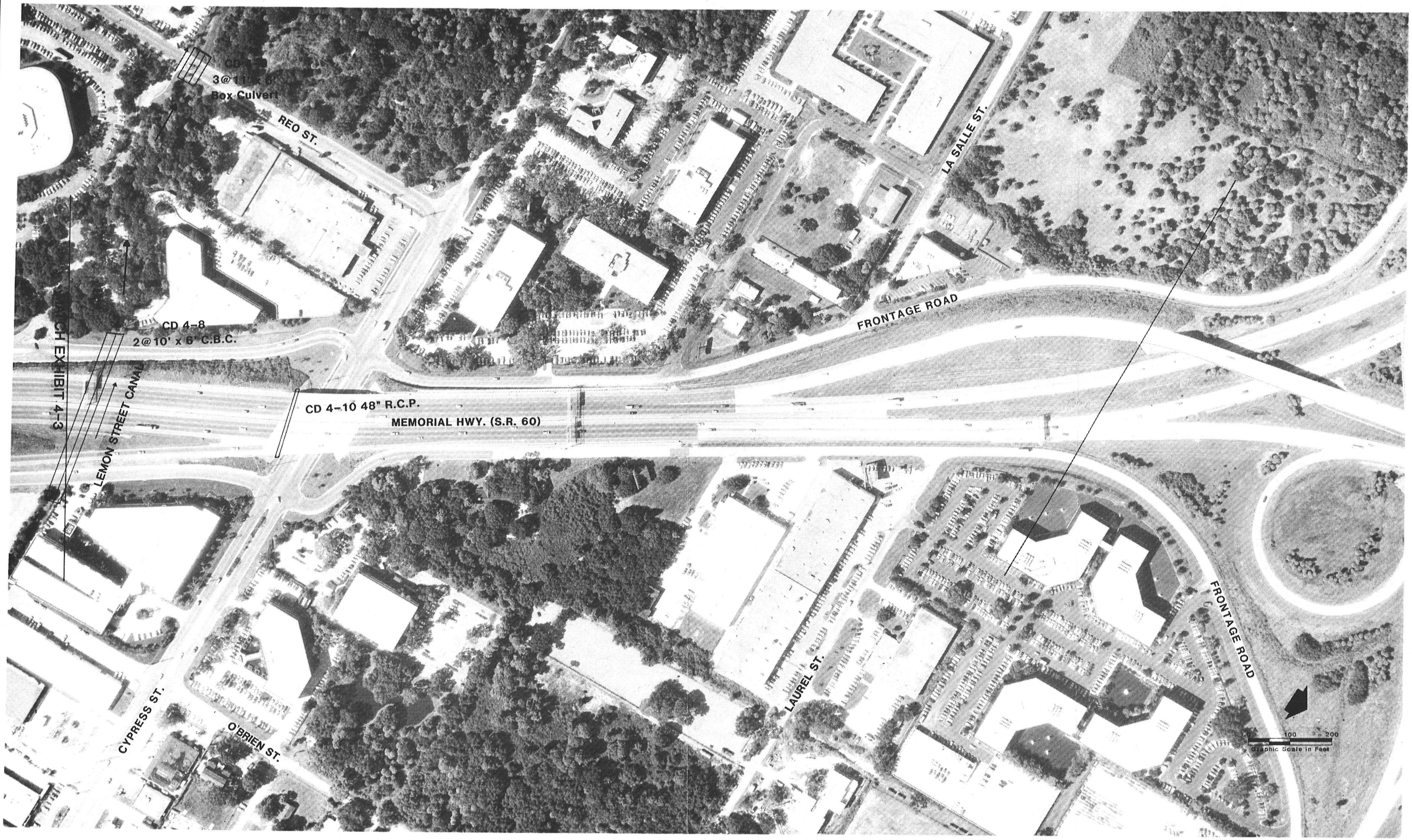

Photo Date: August 1987

EXIST R/W | LAND USE | SECT 106 & 4F | PROP R/W | DRAIN 5

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LOCATION HYDRAULIC REPORT

DRAINAGE STRUCTURE LOCATIONS

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EXIST. R/W	LAND USE	SECT. 106 & 4F	PROP. R/W	DRAIN 6	F.P.

#6

Photo Date: August 1987

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STATE PROJECT No. 99007-1402 | EXHIBIT 4-5

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EXIST R/W | LAND USE | SECT 106 & 4F | PROP R/W | DRAIN. | P D

#7

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EXIST R/W | LAND USE | SECT 105.9.4F | PROP R/W | MAIN | FP
10

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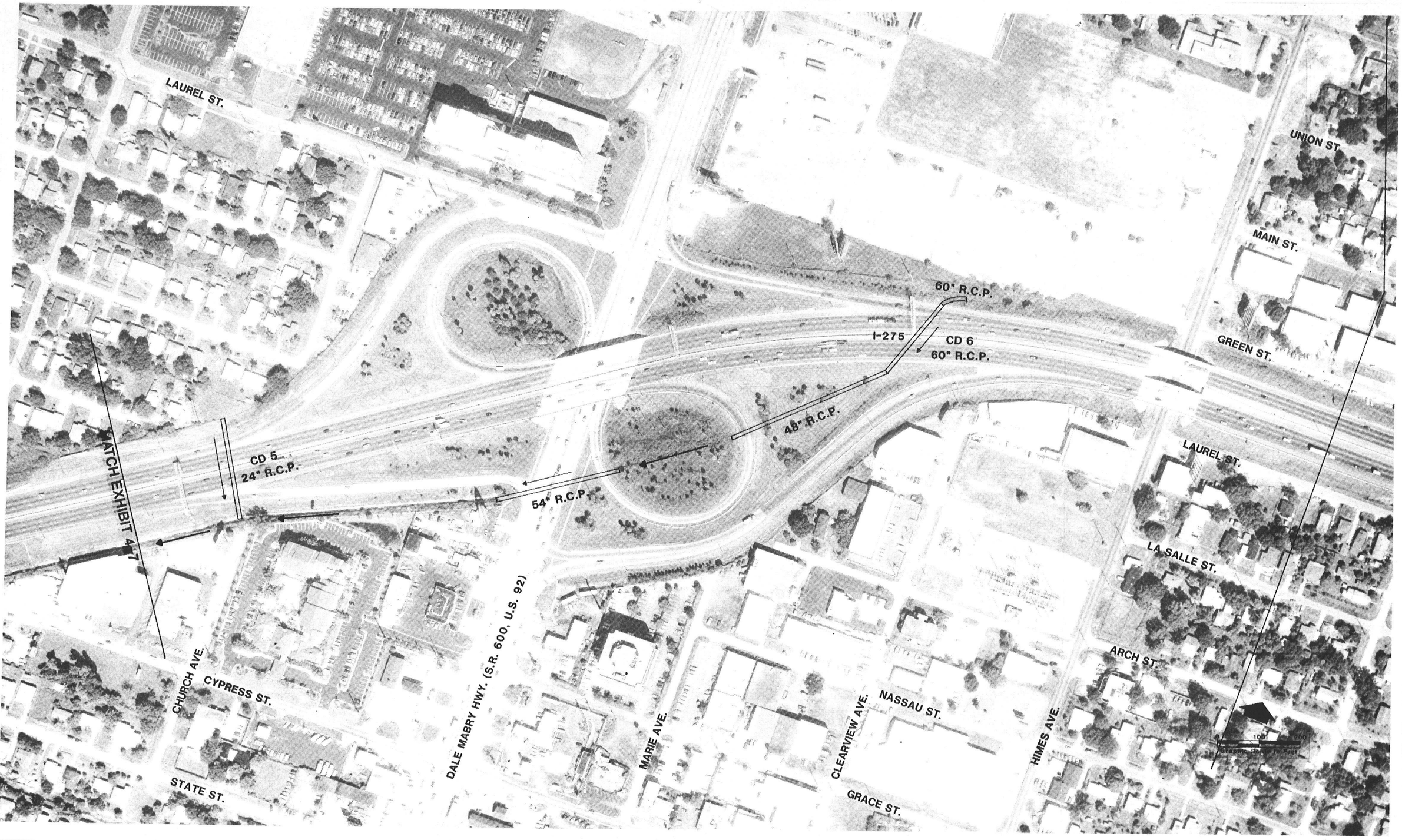

EXIST R/W | LAND USE | SECT 106 & 4F | PROP R/W | DRAIN | FP

11

Photo Date: August 1987

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LOCATION HYDRAULIC REPORT
DRAINAGE STRUCTURE LOCATIONS

TAMPA INTERSTATE STUDY
FLORIDA DEPARTMENT OF TRANSPORTATION

STATE PROJECT No. 99007-1402 | EXHIBIT 4-8

TABLE 2

DRAINAGE STRUCTURES

Structure ID	Location	Size	Type	Length	Invert (HW/TW)	Source	Rating*
CD1-1	Memorial Hwy.	24"	RCP	190'	2.67/2.41	FDOT	B
CD1-2	Memorial Hwy.	24"	RCP	190'	1.74/1.60	FDOT	B
CD2	Westshore Blvd.	24"	RCP	240'	N/A	FDOT	B
CD3	West Hubert	36"	RCP	260'	N/A	FDOT	A
CD4-1	(Lemon Street Canal) Clark Street	12'x6'	CBC	270'	8.8/8.8	City of Tampa	A
CD4-2	North Louis	12'x6'	CBC	90'	7.6/7.6	City of Tampa	D
CD4-3	behind Citibank	12'x6'	CBC	675'	6.32/5.78	City of Tampa	D
CD4-4	behind Holiday Inn	(2) 84"	CMP	260'	5.20/2.30	City of Tampa	D
CD4-5	Westshore Blvd.	12'x6'	CBC	90'	1.78/1.75	City of Tampa	D
CD4-6	Austin Center	26.2'x7.2'	CBC	610'	1.75/1.35	City of Tampa	D
CD4-7	Occident Street	12'x6.5'	CBC	45'	2.15/1.68	City of Tampa	D
CD4-8	Memorial Hwy.	(2) 10'x6'	CBC	470'	0.01/0.00	City of Tampa	A
CD4-9	Reo Street	(3) 11'x6'	CBC	80'	-1.51/-1.55	City of Tampa	D
CD4-10	Cypress Street	48"	RCP	275'	N/A	FDOT	A
CD5	Church Avenue	24"	RCP	210'	N/A	FDOT	A
CD6	Dale Mabry Hwy.	60"	RCP	330'	18.44/17.99	FDOT	A

NOTE: RCP = Reinforced Concrete Pipe
CBC = Concrete Box Culvert
CMP = Corrugated Metal Pipe
* See Table 3

A rating system was developed to categorize all identified structures. This rating system separates structures within the project corridor (Levels A, B and C) from those structures identified downstream of the project corridor (Level D). It also classifies the structures within the project corridor into four levels (Levels A, B, C and D). Level A structures will be analyzed, while no analysis is required for Level B, Level C and Level D structures. For Level B structures, the proposed roadway will cover the entire existing drainage basin. Stormwater in these areas will be collected and drained into the proposed TIS stormwater ponds. A complete description of the rating system is provided in Table 3.

TABLE 3

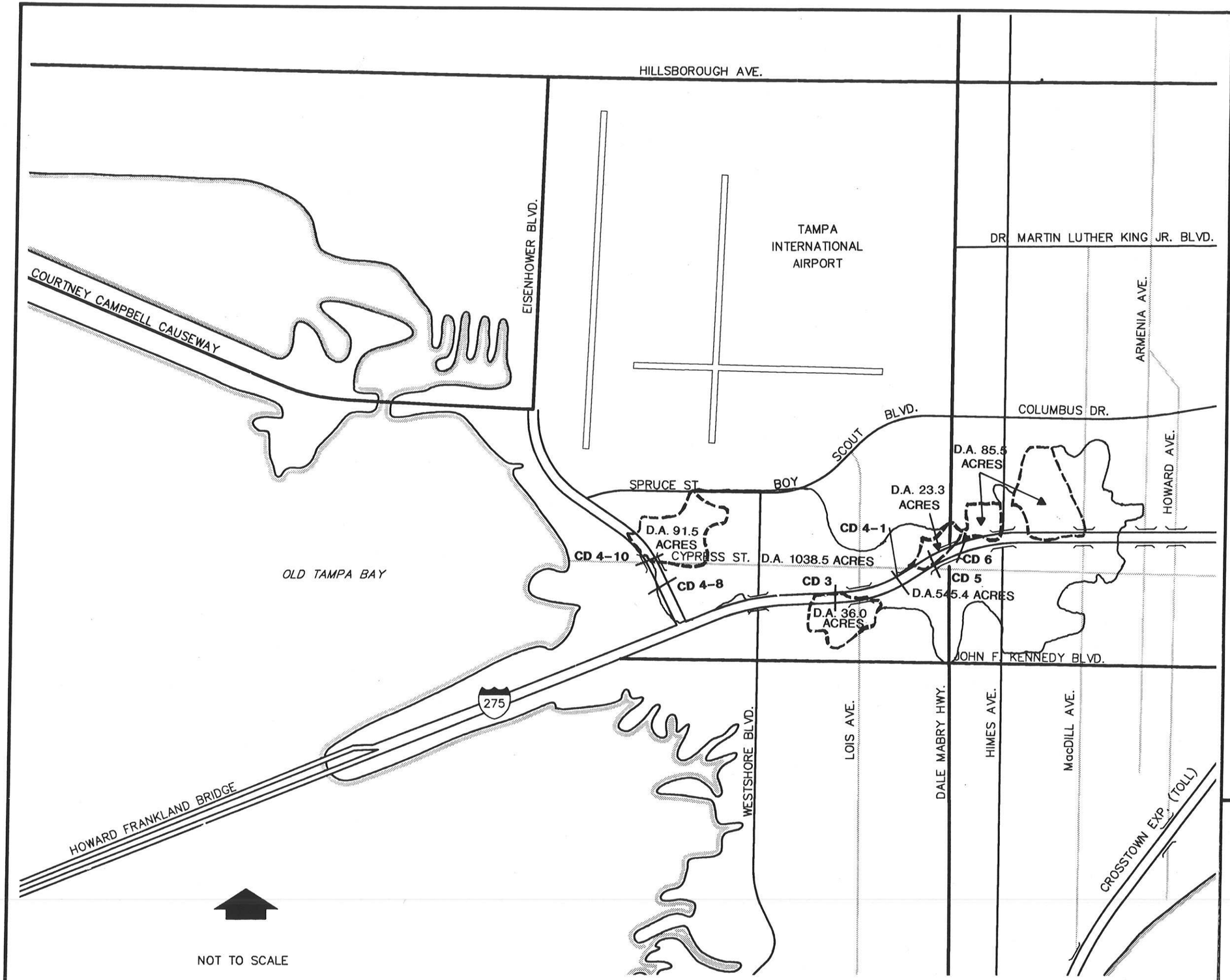
STRUCTURE RATING STANDARDS

Rating Level	Rating Standard
A	The structure should be lengthened or replaced due to the roadway improvements.
B	Proposed roadway will cover the entire existing drainage basin area; therefore, it is no longer a cross-drain.
C	Cross-drain is part of a storm sewer network and is placed along the central line of a road which is spanned by I-275 in the existing and proposed roadway improvements. Therefore, the storm sewer system below the existing road will not be affected by the widening of I-275.
D	The structure does not cross the project corridor directly although it drains along the project corridor. This structure will be analyzed in the Master Drainage Plan report.

Level C has been established for other portions of the TIS project corridor.

The drainage basin areas and existing structures as shown in Exhibit 5 were located using the best available information and on-site inspections.

The first three structures listed in Table 2 are rated as Level B because they do not convey flow from off-site areas after the project improvement. In the improved condition, these pipes will not need to be analyzed. Six structures: CD3, CD4-1, CD4-8, CD4-10, CD5 and CD6 are analyzed in this report. The remaining seven structures listed in Table 2 are not within the project corridor and will not be analyzed in this report.



LEGEND

- Basin Boundaries
- Subbasin Boundaries

Greiner, Inc.

FLORIDA DEPARTMENT OF TRANSPORTATION

LOCATION HYDRAULIC REPORT

TAMPA INTERSTATE STUDY
PHASE II

Hillsborough County, Florida

DRAINAGE BASIN AREAS

EXHIBIT 5

STRUCTURE ANALYSIS

The analysis of cross-drain structures included a determination of 50-year and 100-year peak runoff rates and associated headwater elevations at the structures for the calculated peak flow. Basin characteristics such as basin area, basin slope, and basin development factor and structure information were determined from the City of Tampa Drainage Atlas, SWFWMD contour aerials (Ref. 8), USGS Quadrangle Maps (Ref. 10), USGS Soil Survey Maps (Ref. 11) as well as other available information. Peak runoff rates were determined using the regression equations for the Tampa Bay area from the FDOT Drainage Manual (Ref. 4). Headwater elevations were calculated by the FHWA HY-8 culvert analysis program (Ref. 12) based on the peak rate of runoff obtained from the Tampa Bay Area Regression Method. These computations are contained in Appendix.

The six structures analyzed in this report are described below. The lengths of the proposed structures are estimated from the Master Plan Report.

CD4-8 (Drainage Structure for Lemon Street Canal Crossing Memorial Highway)

This structure is a 10-foot by 6-foot double box culvert and drains approximately 1038.5 acres. The drainage area includes the entire Lemon Street Canal Basin east of Memorial Highway, including areas from CD3, CD4-1, CD5, and CD6. Although the tailwater elevation at the structure is tidally affected by Old Tampa Bay, the tailwater elevation computed from normal depth for Q_{50} and Q_{100} is still higher than the season high water level at Old Tampa Bay. Therefore, the normal depth of the downstream ditch is used as tailwater condition. The calculated flows for the

watershed are 980 and 1239 cfs for Q_{50} and Q_{100}, respectively. Flooding of the upstream bank is predicted for the 50-year peak discharge with the two existing 10-foot by 6-foot box culverts. Existing flooding of streets and residential/commercial property upstream of the Memorial Highway (S.R. 60) crossing is due to undersized channels and structures. This structure should be extended from the existing 470 feet to 480 feet. Although the extension of the existing structure will not cause a significant rise in backwater elevations (headloss increases 0.02 feet for Q_{50} and 0.03 feet for Q_{100}), future improvements are proposed to minimize flooding in this area.

Two possible solutions for the existing flooding are: 1) detention storage of stormwater runoff, or 2) drainage structure improvements. Due to the extent of development in this area, no suitable storage sites are available. Therefore, drainage structure improvements are recommended. Preliminary sizing of structure improvements indicates that an additional 10-foot by 6-foot concrete box culvert in addition to the existing two 10-foot by 6-foot box culverts will provide a sufficient cross-sectional area to convey the flow. The downstream existing channel from Memorial Highway to Reo Street is 20 feet wide at the bottom and 580 feet long. The channel is located along Cypress Center Drive and has 60 feet of right-of-way. The flows in the Lemon Street Canal are then conveyed through a triple box culvert (11-foot by 4-foot) at Reo Street and follow a 35-foot-wide by 2,000-foot-long channel toward the mouth and outfall to Old Tampa Bay. Detailed analysis of the structures at Reo Street and the channel to Old Tampa Bay will be addressed in the master drainage plan. It was estimated that the downstream channel of Memorial Highway structures should be widened from the existing 20 feet to 30 feet and the channel

banks will have 1 to 1 sideslope as in the existing condition. The preliminary analysis also indicates that the proposed structure and channel improvements will be sufficient to convey the 100-year design flow and alleviate flooding in the upstream channel. The channel may be designed with milder side slopes for safety purposes. The additional one 10-foot by 6-foot CBC for the proposed condition should be blocked until the downstream channel improvements are completed to prevent adverse downstream flood impacts.

CD4-10 (Structure at Cypress Street and Memorial Highway Intersection)

This 48-inch reinforced concrete pipe drains a 91.5-acre area which extends west to Memorial Highway, east to North Ward Street, south to Cypress Street and north to Boy Scout Boulevard. The design peak runoff is 65 and 78 cfs for Q_{50} and Q_{100}, respectively. With the proposed improvements, the structure will be extended from 275 feet to 300 feet. This structure is connected downstream to the 10-foot by 6-foot double box culverts (CD4-8) and is influenced completely. Structure CD4-10 cannot be analyzed properly by using tailwater conditions associated with the existing structure CD4-8. For practical reasons, structure CD4-10 will be analyzed under the proposed condition of structure CD4-8 as described above. The crown of the downstream box culvert (CD4-8) was used as tailwater condition to analyze the structure's capacity. The computation indicates the existing structure and extended structure will not cause upstream bank flooding for the 50-year and 100-year design peak flows and has an insignificant increase in headwater.

CD3 (Structure West of Hubert Avenue Crossing I-275)

This 36-inch structure drains a 36-acre basin south of I-275 which extends from Manhatten Avenue to Clark Avenue. The runoff from the basin flows north through this cross-drain and outfalls into the Lemon Street Canal. The structure is perpendicular to the Lemon Street Canal and the downstream invert is elevated above the channel bottom. Both existing and proposed structures were analyzed with constant tailwater elevations. This constant water elevation is based on the Q_{50} normal depth at the Lemon Street Canal. In the proposed condition, the structure will be lengthened from 260 feet to 480 feet. The peak discharge from this basin is approximately 25 and 30 cfs for Q_{50} and Q_{100}, respectively. Both the existing and lengthened structures are sufficient to convey the design 50-year and 100-year peak flows without impacting upstream areas.

CD4-1 (Lemon Street Canal Crossing I-275)

This 12-foot by 6-foot box culvert is the primary structure for the Lemon Street Canal to cross Interstate 275. It drains a 545.4-acre area of the Lemon Street Canal Basin which includes areas from CD5 and CD6. Upstream of the structure, the channel runs along Lemon Street. Downstream of the structure, the channel runs along I-275.

Design flows obtained from the regression method for the 50-year and 100-year events are 520 cfs and 650 cfs, respectively. Preliminary analysis of the structure at CD4-1 shows that this structure is able to convey the 520 cfs and 650 cfs in both the existing and proposed conditions without impacting upstream areas. Therefore, the structure

will not require upgrading. However, due to the proposed roadway improvements, the existing structure should be extended from 270 feet to 360 feet.

CD5 (Crossing Near Church Avenue)

Cross-drain structure CD5 is located at Church Avenue and is a 24-inch RCP which drains a 23.3-acre basin north of I-275. Runoff is conveyed beneath I-275 to a major roadside ditch which conveys flow westward to the Lemon Street Canal. A constant tailwater computed from normal depth of Q_{50} at the downstream main ditch is used to analyze the structure because the structure is elevated and perpendicular to the downstream main ditch. The structure is able to convey the 50-year (15 cfs) and 100-year (18 cfs) storm in the existing condition. The structure should be extended from the existing 210 feet to 410 feet. The extension of the existing structure will cause adverse flood impacts to upstream areas. Preliminary sizing of a replacement structure indicates that a 30-inch RCP will be required for adequate conveyance without significantly impacting upstream property. Based on the preliminary design analysis, the Q_{50} water surface eleation downstream of the upgraded CD-5 increases by only 0.2 feet. Therefore, the proposed 30-inch RCP should not cause downstream impacts.

CD6 (Crossing at Dale Mabry Highway)

This 60-inch RCP conveys runoff from a 85.5-acre drainage basin. The basin extends from north of Laurel Street to east of MacFarlane Park, but excludes a small portion of land near Himes Avenue where the runoff is drained south along Himes Avenue

via a 42-inch enclosed storm sewer system under I-275. The eastern part of this sub-basin drains westward through a 48-inch RCP and crosses Himes Avenue and joins the 60-inch RCP (CD-6). The predicted peak flows are 94 cfs and 114 cfs for the 50-year and 100-year storm event, respectively. The preliminary analysis indicates that the existing (330 feet) and proposed extended (410 feet) structures are both sufficient to carry the 50-year and 100-year peak runoff without impacting upstream areas.

DRAINAGE STRUCTURE CATEGORIZATION

In accordance with the requirements set forth in FHPM 6-7-3(2), Paragraph 7, the project corridor was evaluated to determine the impact of the proposed roadway improvements. Required hydraulic improvements as a result of the roadway improvements are categorized into seven categories based on the type of the hydraulic improvements and estimated floodplain impacts. Within the project corridor, I-275 represents a transverse encroachment on the floodplain associated with the cross-drain structures. This encroachment should remain at existing levels or be reduced to an insignificant level if the proposed hydraulic improvements are implemented.

As analyzed above, the hydraulic structures in the project corridor were divided into three categories depending on hydraulic performance: Category 3, Category 4 and Category 5. These categories describe the type of individual modification or replacement required for each structure.

Category 3: Projects Involving Modification to Existing Drainage Structures

Category 3 projects include activities which will not involve the replacement of any existing drainage structures or the construction of any new drainage structure. This category applies only to projects which involve modification to existing structures (i.e., extending cross-drains, adding headwalls). In regards to the project corridor, the following cross-drains fall within this category: CD3, CD4-1, CD4-10 and CD6.

The following standard statement applies to Category 3 projects:

> "Drainage structure modifications included in this project will result in an insignificant change in their capacity to carry floodwater. This change will cause minimal increases in flood heights and flood limits. These minimal increases will not result in any significant adverse impacts on the natural and beneficial floodplain volumes or any significant change in flood risks or damage. There will not be a significant change in the potential for interruption or termination of emergency service or emergency evacuation routes. Therefore, it has been determined that this encroachment is not significant." (FDOT Drainage Manual, 1987).

Category 4: Projects on Existing Alignment Involving Replacement of Existing Drainage Structures with no Record of Drainage Problems

Category 4 excludes replacement activities that would reduce the hydraulic performance of existing facilities. For this category to be applicable, there should be

no record of drainage problems with no unresolved drainage complaints from residents in the area. Within the project limits, structure CD5 falls within this category.

An analysis to determine the impacts on headwater elevations for the existing and proposed structures is included in the Appendix. Using the flows generated, the culverts were evaluated using the FHWA HY-8 (Ref. 12) computer program. The replacement structures were also evaluated using flow rates for the 100-year flood.

A detailed culvert analysis should be performed during the final design phase of the project to identify the exact culvert inverts, dimensions, and design headwater elevations. The following statement can be made for Category 4 projects:

> "The proposed structure will perform hydraulically in a manner equal to or greater than the existing structure, and backwater surface elevations are not expected to increase. As a result, there will be no significant adverse impacts on natural and beneficial floodplain values. There will be no significant change in flood risk, and there will not be a significant change in the potential for interruption or termination of emergency service or emergency evacuation routes. Therefore, it has been determined that this encroachment is not significant." (FDOT Drainage Manual, 1987).

Category 5: Projects on Existing Alignment Involving Replacement of Drainage Structures in Heavily Urbanized Floodplains

Category 5 addresses those replacement projects in flood sensitive, heavily urbanized floodplains, where the conditions of flooding are largely attributable to the low-lying terrain. Other secondary flood-contributing considerations could be density of floodplain development, and degree and amount of downstream flow constrictions.

Replacement drainage structures in this category are limited to hydraulically equivalent structures in most instances. As in Category 4 projects, conveyance increases due to the improved structures may impact downstream tailwater levels. As a result, downstream channel improvements have been proposed when applicable. In regards to the project corridor, the following structure falls in this category: CD4-8.

The following standard statement applies to Category 5 projects:

> "Replacement drainage structures for this project are limited to hydraulically equivalent structures. The limitations to the hydraulic equivalency being proposed are basically due to restrictions imposed by the geometrics of design, existing development, cost feasibility, or practicability. An alternative encroachment location is not considered in this category since it defeats the project purpose or is economically unfeasible. Since flooding conditions in the project area are inherent in the topography or are a result of other outside

contributing sources, and there is no practical alternative to totally eradicate flood impacts or even reduce them in any significant amount, existing flooding will continue, but not be increased. The proposed structure will be hydraulically equivalent to or greater than the existing structure, and backwater surface elevations are not expected to increase. As a result, the project will not affect existing flood heights or floodplain limits. This project will not result in any new or increased adverse environmental impacts. There will be no significant change in the potential for interruption or termination of emergency service or emergency evacuation routes. Therefore, it has been determined that this encroachment is not significant."

REGULATORY AGENCY COORDINATION

Local Agencies

The City of Tampa is the only local agency with jurisdiction for the proposed improvements to I-275 and Memorial Highway. The Cypress/Memorial Area Drainage Basin Study was utilized extensively in determining basin areas and characteristics. The Basin Study was conducted by a private consulting firm for the City of Tampa during the years 1982, 1983 and 1989. Coordination with this agency will be required during preliminary and final design to address floodplain and stormwater quality impacts as well as proposed modifications to the existing drainage section.

State Agencies

State agencies that have permitting responsibilities relevant to the proposed I-275 and Memorial Highway drainage facility improvements include the Florida Department of Environmental Regulation (FDER), Florida Department of Natural Resources (FDNR), and the Southwest Florida Water Management District (SWFWMD).

FDER requires permits for all dredge and fill activities conducted in areas either in or connected to waters of the State, pursuant to Chapter 17-4.28, F.A.C.

FDNR requires easements for any crossing of state-owned lands. Coordination for easements should be accomplished during final design.

SWFWMD requires surface water management permits for the construction or alteration of any surface water system pursuant to Chapter 40D-40, F.A.C. This permit considers the impacts on floodplains, stormwater quantity, and wetlands from public roadway projects. In addition, pursuant to Chapter 17-25, F.A.C., SWFWMD regulates the discharge of untreated stormwater runoff which could be a potential source of pollution of the state. All new stormwater discharge facilities must comply with the design and performance standards set forth in Chapter 17-25.025, F.A.C.

Federal Agencies

The Federal agency which could require permits for the proposed I-275 improvements is the U.S. Army Corps of Engineers (COE).

The COE also issues permits relevant to dredge and fill activities in waters of the United States based on COE, Section 404. To simplify the dredge and fill permitting procedures, the FDER and COE have developed a joint application form.

CONCLUSIONS

With the roadway improvements proposed for I-275, the modification and replacement of existing drainage structures will be required. The proposed improvements to the project corridor will require the replacement of two cross-drain structures and the lengthening of four cross-drains. Three structures will be eliminated because the roadway improvements will engulf the entire cross-drain basin.

Within the project limits, the existing roadway traverses FEMA flood zones A, B, and C. Although the Lemon Street Canal parallels the project corridor, no longitudinal floodplain encroachments are within the project corridor. No floodways are designated within the project corridor. The proposed improvements should not significantly contribute to an increase in flood elevations. Due to the degree of existing urbanization within the project corridor, the proposed project should not increase the potential for development within the floodplain. Modifications to the roadway width and drainage structures should improve the use of the facility for emergency services and evacuation purposes.

REFERENCES

1. Drainage Atlas, City of Tampa.

2. Flood Insurance Rate Maps, Federal Emergency Management Agency; for following community panel numbers in the City of Tampa, Hillsborough County, Florida; 120114 0021C and 120114 0022C; September 30, 1982.

3. Flood Insurance Study, Federal Emergency Management Agency; for the City of Tampa, Florida; Community Number 120114; March 1980.

4. Drainage Manual, Volume II, Florida Department of Transportation; 1987.

5. Tampa Interstate Study Master Plan Report, Florida Department of Transportation; 1989.

6. Plan of Proposed State Highway, Florida Department of Transportation, I-4-1-10, I-4-1(33)-12 and I-4-1(39)-14.

7. Cypress/Memorial Area Drainage Study, Stormwater Management Division, Department of Public Works, City of Tampa, Florida; August 1989.

8. Aerial Photography with Contours, Southwest Florida Water Management District.

9. Management and Storage of Surface Waters Permit Information Manual, Volume I, Southwest Florida Water Management District; March, 1988.

10. Quadrangle Maps, USGS; Revised 1981.

11. Soil Survey Hillsborough County, Florida, USGS Soil Conservation Service; 1989.

12. HY-8 Culvert Analysis Program; Federal Highway Administration; 1987.

APPENDIX

CALCULATIONS

APPENDIX

Cross-drains within the project corridor are associated with three risk categories: Category 3, Category 4 and Category 5. A preliminary hydraulic analysis was performed to categorize each structure. Each structure's headwater and tailwater elevations were evaluated by determining basin characteristics and peak runoff rates.

Basin areas were determined using FDOT as-built roadway plans, City of Tampa Drainage Atlas, Cypress/Memorial Area Drainage Study, quad maps, field reviews, and SWFWMD contour aerials. Basin characteristics such as basin slope and basin development factor were estimated from the contour aerials and USGS Soil Survey maps. Basin peak runoff rates were evaluated using the Tampa Bay Area Regression Method equations from the FDOT Design Manual Volume 2, Chapter 5. In the Cypress/Memorial Area Drainage Basin Study, the EPA Stormwater Management Model, Version 3.0 (SWMM III) was used. The 1-year/2.5-hour, 2-year/2.5-hour, 5-year/2.5-hour and 25-year/24-hour design storm rainfall events were studied. Although this model is capable of simulating the entire drainage system both in hydrological and hydraulic computation, the simulation processes also allow water to flow out of structures when the system under flooding (Ref. 7). The computed discharge at structures downstream will not count the water escaping from structures in the upstream areas. In Greiner's opinion, the results from SWMM III are not suitable for the hydraulic analysis in this Location Hydraulic Report. The regression equation values were compared to those available results from the Cypress/Memorial Area Drainage Study. All results are listed in Table A-1.

TABLE A-1

PEAK RUNOFF COMPUTED FROM VARIOUS METHODS

Outfall Structure ID	Basin Area Acres/Mile^2	BDF*	Channel Slope (feet/miles)	Regression Method (cfs) $Q_{25}/Q_{50}/Q_{100}$	SWIM 3.0** existing/master plan (cfs)
CD3	36.0/0.056	10	8.7	21	N/A
				25	N/A
				30	N/A
CD4-1	545.4/0.085	10	8.0	426	625/625
				520	N/A
				650	N/A
CD4-8	1038.5/1.6	10	7.0	801	601/962
				980	N/A
				1239	N/A
CD4-10	91.5/0.14	10	8.7	54	75/79
				65	N/A
				78	N/A
CD5	233/0.036	10	13.7	13	N/A
				15	N/A
				18	N/A
CD6	85.5/0.13	10	7.5	78	120/--
				94	N/A
				114	N/A

* BDF - Basin Development Factor as defined in FDOT Design Manual Volume 2
**SWMM 3.0 modeling results excluded the upstream flooding.

Culvert information such as invert elevations, lengths and sizes were obtained from the Cypress/Memorial Area Drainage Study, City of Tampa Drainage Atlas, FDOT as-built plans, SWFWMD contour aerials and field reviews. Additional information required for the culvert analyses (HY-8) of the structures such as roadway elevations and channel geometry was obtained by the same process. The tailwater elevation was determined by assuming the normal depth in the downstream channel. The constant

tailwater elevation computed from Q_{50} at the main channel normal depth will be used when the cross- drain structure is elevated, perpendicular, and confluent to this downstream main channel.

The backwater effect to the upstream area is compared with the ground elevation taken from SWFWMD aerials. The upstream area ground elevations are listed in Table A-2.

TABLE A-2

UPSTREAM GROUND ELEVATION IN EACH STRUCTURE

Structure ID	CD3	CD4-1	CD4-8	CD4-10	CD5	CD6
Upstream Invert elevation (ft.NGVD)	9.50	8.8	0.01	0.23	18.10	18.44
Upstream Region ground elevation (ft.NGVD)	13.9	20.5	8.5	8.5	22.0	30.0

Each structure was evaluated using HY-8 for the peak flow of the 50-year and 100-year floods. The FDOT requires a design standing headwater (more than 24 hours) to be 2 feet below the roadway base for the design storm. The allowable headwater for the design storm is edge of pavement. The allowable headwater for the 100-year flood must leave at least one lane dry. If the culvert failed to meet this criteria then a replacement structure was sized using HY-8. Culverts which did meet the requirements for existing conditions were evaluated as a group to determine the effects of lengthening the structures to accommodate the additional lanes of traffic.

Category 3 Structures

Category 3 structures are those which require only lengthening of the culvert. This group of structures include CD3, CD4-1, CD4-10 and CD6. The headwater and tailwater conditions for each structure were evaluated for the existing and proposed conditions. All these pipes performed satisfactorily to carry the runoff generated from the 50-year and 100-year, floods. The headloss increase due to lengthening of structures in this category is listed in Table A-3. The worst-case occurred in structure CD3 at both Q_{50} and Q_{100}.

TABLE A-3

HEADLOSS INCREASE DUE TO STRUCTURE LENGTHENING

	Structure ID			
	CD3	CD4-1	CD4-10	CD6
Headloss Increase for Q_{50} (ft)	0.26	0.12	0.04	0.06
Headloss Increase for Q_{100} (ft)	0.26	0.20	0.05	0.06

Category 4 Structures

Category 4 structures require structure replacement and analysis. The difference between Category 4 and Category 5 is the history of flooding at the structure. Category 4 structures do not have a history of flooding but need to be replaced due to the roadway improvements.

The HY-8 analysis of structure CD5 for existing and proposed conditions is summarized below:

Structure ID	Q_{50} (cfs)	Q_{100} (cfs)	EXISTING CONDITION (Q_{100}) Pipe Size (inch)	Length (ft)	Headwater (ft. NGVD)	Tailwater (ft. NGVD)	PROPOSED (Q_{100}) Pipe Size (inch)	Length (ft)	Headwater (ft. NGVD)	Tailwater (ft. NGVD)
CD5	15	18	24	210	21.5	18.5	30	410	20.8	18.5

The upgraded 30-inch pipe will reduce the Q_{100} headwater from 22.5 feet NGVD (if extended only, see printout in the following pages) to 20.8 feet NGVD. This will prevent the upstream areas from flooding.

Category 5 Structures

Category 5 structures are those pipes which require replacement and which exhibited a tendency to flood during the design event. These culverts were analyzed individually to determine a replacement structure. The design flows for the Category 5 structures are listed in the table below. A summary of the HY-8 analysis in Structure CD4-8 for the pre- and post-conditions follows.

Structure ID	Q_{50} (cfs)	Q_{100} (cfs)	EXISTING CONDITION (Q_{100}) Pipe Size	Length (ft)	Headwater (ft. NGVD)	Tailwater (ft. NGVD)	PROPOSED (Q_{100}) Pipe Size	Length (ft)	Headwater (ft. NGVD)	Tailwater (ft. NGVD)
CD4-8	980	1230	2@10'x6'	470	11.86	7.82	3@10'x6'	480	8.12	6.31

From the computed results, the proposed additional box culvert will reduce the headwater from 11.86 feet NGVD to 8.12 feet NGVD. In this situation, it will prevent the upstream areas from flooding. As described in the text, the proposed additional box culverts will be blocked until the downstream channel improvements are completed.

The results from the HY-8 computations are provided in the following pages.

CULVERT ANALYSIS 1.1 **CD3 EXISTING**
CULVERT FILE NAME: C3.DAT

DATE: 12-12-90
SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	9.50	9.32	260	1 -RCP	36	36	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	10.37	10.37	0.00	0.87	1.05	0.00	
5.00	10.65	10.37	0.95	1.15	1.05	2.26	
10.00	11.05	10.37	1.37	1.55	1.05	4.52	
15.00	11.40	10.37	1.73	1.90	1.23	5.49	
20.00	11.75	10.37	2.04	2.25	1.42	6.05	
25.00	12.08	10.37	2.32	2.58	1.60	6.51	← Q50
30.00	12.41	10.37	2.58	2.91	1.77	6.91	← Q100
35.00	12.72	10.37	2.83	3.22	1.92	7.35	
40.00	13.19	10.37	3.09	3.69	2.06	7.75	
45.00	13.65	10.37	3.36	4.15	2.18	8.20	
50.00	14.15	10.37	3.66	4.65	2.29	8.64	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD3 PROPOSED** DATE: 12-12-90
CULVERT FILE NAME: C3P.DAT SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS	SHAPE	MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	9.54	9.28	480	1	-RCP		36	36	0.012	CONVENTIONAL
2										
3										
4										
5										
6										

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	10.37	10.37	0.00	0.83	1.09	0.00	
5.00	10.71	10.37	0.95	1.17	1.09	2.15	
10.00	11.18	10.37	1.37	1.64	1.09	4.31	
15.00	11.57	10.37	1.73	2.04	1.23	5.49	
20.00	11.92	10.37	2.04	2.38	1.42	6.05	
25.00	12.34	10.37	2.32	2.80	1.60	6.51	← Q50
30.00	12.67	10.37	2.58	3.14	1.77	6.91	← Q100
35.00	13.26	10.37	2.83	3.72	1.92	7.35	
40.00	13.84	10.37	3.09	4.30	2.06	7.75	
45.00	14.48	10.37	3.36	4.95	2.18	8.20	
50.00	15.18	10.37	3.66	5.64	2.29	8.64	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD4-1** **EXISTING** DATE: 12-12-90
CULVERT FILE NAME: C41.DAT SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	8.80	8.79	270	1 -RCB	144	72	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	8.80	8.79	0.00	-0.01	0.00	0.00	
130.00	12.16	11.85	2.64	3.36	3.06	3.53	
260.00	13.83	13.18	4.15	5.03	4.39	4.94	
390.00	15.10	14.17	5.42	6.30	5.38	6.05	
520.00	16.56	14.97	6.63	7.76	6.18	7.22	← Q50
650.00	18.14	15.67	7.93	9.34	6.88	9.03	← Q100
780.00	19.85	16.29	9.40	11.05	7.50	10.83	
910.00	21.69	16.85	11.11	12.89	8.06	12.64	
1040.00	23.68	17.36	13.09	14.88	8.57	14.44	
1170.00	25.84	17.84	15.36	17.04	9.05	16.25	
1300.00	28.16	18.29	17.92	19.36	9.50	18.06	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD4-1 PROPOSED** DATE: 12-12-90
CULVERT FILE NAME: C41P.DAT SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	8.80	8.79	360	1 -RCB	144	72	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	8.80	8.79	0.00	-0.01	0.00	0.00	
130.00	12.24	11.85	2.64	3.44	3.07	3.53	
260.00	13.84	13.18	4.15	5.03	4.39	4.93	
390.00	15.17	14.17	5.42	6.37	5.38	6.04	
520.00	16.68	14.97	6.63	7.88	6.18	7.22	← Q50
650.00	18.34	15.67	7.93	9.54	6.88	9.03	← Q100
780.00	20.12	16.29	9.40	11.32	7.50	10.83	
910.00	22.06	16.85	11.11	13.26	8.06	12.64	
1040.00	24.17	17.36	13.09	15.37	8.58	14.44	
1170.00	26.45	17.84	15.36	17.65	9.06	16.25	
1300.00	28.92	18.29	17.92	20.12	9.50	18.06	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD4-8 EXISTING** DATE: 12-12-90
CULVERT FILE NAME: C48.DAT SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	0.01	0.00	470	2 -RCB	120	72	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 2 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	0.01	0.00	0.00	-0.01	0.00	0.00	
140.00	2.50	2.17	1.98	2.49	2.17	3.22	
280.00	3.87	3.28	3.13	3.86	3.28	4.27	
420.00	4.91	4.16	4.07	4.90	4.16	5.05	
560.00	5.90	4.92	4.91	5.89	4.92	5.69	
700.00	6.73	5.60	5.70	6.72	5.60	6.25	
840.00	8.02	6.22	6.48	8.01	6.22	7.00	
980.00	9.23	6.79	7.30	9.22	6.79	8.17	← Q50
1120.00	10.51	7.32	8.17	10.50	7.32	9.33	
1260.00	11.86	7.82	9.11	11.85	7.82	10.50	← Q100
1400.00	13.27	8.30	10.16	13.26	8.30	11.67	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD4-8 EXTENDED ONLY** DATE: 12-12-90
CULVERT FILE NAME: C48E.DAT SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	0.01	0.00	480	2 -RCB	120	72	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 2 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	0.01	0.00	0.00	-0.01	0.00	0.00	
140.00	2.50	2.17	1.98	2.49	2.17	3.22	
280.00	3.87	3.28	3.13	3.86	3.28	4.27	
420.00	4.91	4.16	4.07	4.90	4.16	5.05	
560.00	5.90	4.92	4.91	5.89	4.92	5.69	
700.00	6.80	5.60	5.70	6.79	5.60	6.25	
840.00	8.03	6.22	6.48	8.02	6.22	7.00	
980.00	9.25	6.79	7.30	9.24	6.79	8.17	← Q50
1120.00	10.53	7.32	8.17	10.52	7.32	9.33	
1260.00	11.89	7.82	9.11	11.88	7.82	10.50	← Q100
1400.00	13.31	8.30	10.16	13.30	8.30	11.67	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD4-8 PROPOSED** DATE: 12-12-90
CULVERT FILE NAME: C48P.DAT SUMMARY TABLE

CU LV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	0.01	0.00	480	3 -RCB	120	72	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 3 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	0.01	0.00	0.00	-0.01	0.00	0.00	
140.00	1.97	1.70	1.51	1.96	1.70	2.74	
280.00	3.05	2.58	2.39	3.04	2.58	3.62	
420.00	3.87	3.29	3.13	3.86	3.29	4.26	
560.00	4.60	3.91	3.77	4.59	3.91	4.78	
700.00	5.33	4.46	4.35	5.32	4.46	5.23	
840.00	5.94	4.97	4.91	5.93	4.97	5.64	
980.00	6.51	5.44	5.44	6.50	5.44	6.00	← Q50
1120.00	7.29	5.89	5.96	7.28	5.89	6.34	
1260.00	8.12	6.31	6.48	8.11	6.31	7.00	← Q10(
1400.00	8.94	6.71	7.02	8.93	6.71	7.78	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD4-10 EXISTING** DATE: 12-12-90
CULVERT FILE NAME: C410.DAT SUMMARY TABLE

CU LV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	0.23	0.14	275	1 -RCP	48	48	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	6.00	6.00	0.00	5.77	5.86	0.00	
9.50	6.03	6.00	1.21	5.80	5.86	0.76	
19.00	6.09	6.00	1.75	5.86	5.86	1.51	
28.50	6.20	6.00	2.20	5.97	5.86	2.27	
38.00	6.34	6.00	2.61	6.11	5.86	3.02	
47.50	6.53	6.00	2.96	6.30	5.86	3.78	
57.00	6.76	6.00	3.29	6.53	5.86	4.54	
66.50	7.03	6.00	3.60	6.80	5.86	5.29	← Q50
76.00	7.34	6.00	3.91	7.11	5.86	6.05	← Q100
85.50	7.70	6.00	4.23	7.47	5.86	6.80	
95.00	8.09	6.00	4.58	7.86	5.86	7.56	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD4-10** **PROPOSED** DATE: 12-12-90
CULVERT FILE NAME: C410P.DA SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	0.23	0.14	300	1 -RCP	48	48	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	6.00	6.00	0.00	5.77	5.86	0.00	
9.50	6.02	6.00	1.21	5.79	5.86	0.76	
19.00	6.09	6.00	1.75	5.86	5.86	1.51	
28.50	6.20	6.00	2.20	5.97	5.86	2.27	
38.00	6.35	6.00	2.61	6.12	5.86	3.02	
47.50	6.54	6.00	2.96	6.31	5.86	3.78	
57.00	6.78	6.00	3.29	6.55	5.86	4.54	
66.50	7.07	6.00	3.60	6.84	5.86	5.29	← Q50
76.00	7.39	6.00	3.91	7.16	5.86	6.05	← Q100
85.50	7.76	6.00	4.23	7.53	5.86	6.80	
95.00	8.18	6.00	4.58	7.95	5.86	7.56	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD5** **EXISTING** DATE: 12-12-90
CULVERT FILE NAME: C5.DAT SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	18.10	18.00	210	1 -RCP	24	24	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	18.50	18.50	0.00	0.40	0.50	0.00	
3.00	19.09	18.50	0.83	0.99	0.60	3.75	
6.00	19.51	18.50	1.22	1.41	0.86	4.64	
9.00	19.88	18.50	1.54	1.78	1.06	5.30	
12.00	20.32	18.50	1.82	2.22	1.24	5.86	
15.00	20.87	18.50	2.11	2.77	1.40	6.41	← Q50
18.00	21.51	18.50	2.42	3.41	1.52	7.03	← Q100
21.00	22.21	18.50	2.79	4.11	1.63	7.66	
24.00	22.99	18.50	3.22	4.89	1.72	8.37	
27.00	23.91	18.50	3.72	5.81	2.00	8.59	
30.00	24.82	18.50	4.28	6.72	2.00	9.55	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD5 EXTENDED ONLY** DATE: 12-12-90
CULVERT FILE NAME: C5E.DAT SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	18.15	17.95	410	1 -RCP	24	24	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	18.50	18.50	0.00	0.35	0.55	0.00	
3.00	19.14	18.50	0.83	0.99	0.60	3.75	
6.00	19.64	18.50	1.22	1.49	0.86	4.64	
9.00	20.09	18.50	1.54	1.94	1.06	5.30	
12.00	20.76	18.50	1.82	2.61	1.24	5.86	
15.00	21.57	18.50	2.11	3.42	1.40	6.41	← Q50
18.00	22.53	18.50	2.42	4.38	1.52	7.03	← Q100
21.00	23.63	18.50	2.79	5.48	1.63	7.66	
24.00	24.86	18.50	3.22	6.71	1.72	8.37	
27.00	26.27	18.50	3.72	8.12	2.00	8.59	
30.00	27.75	18.50	4.28	9.60	2.00	9.55	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD5 PROPOSED** DATE: 12-12-90
CULVERT FILE NAME: C5P.DAT SUMMARY TABLE

CU LV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	18.15	17.95	410	1 -RCP	30	30	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	18.50	18.50	0.00	0.35	0.55	0.00	
3.00	19.08	18.50	0.77	0.93	0.56	3.64	
6.00	19.48	18.50	1.11	1.33	0.80	4.39	
9.00	19.81	18.50	1.39	1.66	1.00	4.91	
12.00	20.10	18.50	1.65	1.95	1.15	5.43	
15.00	20.38	18.50	1.88	2.23	1.30	5.83	← Q50
18.00	20.75	18.50	2.08	2.60	1.43	6.20	← Q100
21.00	21.15	18.50	2.28	3.00	1.55	6.56	
24.00	21.62	18.50	2.48	3.47	1.66	6.93	
27.00	22.13	18.50	2.69	3.98	1.77	7.27	
30.00	22.69	18.50	2.91	4.54	1.86	7.68	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD6 EXISTING** DATE: 12-12-90

CULVERT FILE NAME: C6.DAT SUMMARY TABLE

CULV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	18.44	17.99	330	1 -RCP	60	60	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	18.44	17.99	0.00	-0.45	0.00	0.00	
15.00	19.98	19.07	1.44	1.54	1.08	4.80	
30.00	20.63	19.48	2.08	2.19	1.52	5.95	
45.00	21.17	19.78	2.59	2.73	1.86	6.73	
60.00	21.66	20.02	3.07	3.22	2.16	7.37	
75.00	22.10	20.23	3.49	3.66	2.43	7.92	
90.00	22.53	20.41	3.88	4.09	2.68	8.42	← Q50
105.00	22.95	20.58	4.23	4.51	2.91	8.85	
120.00	23.35	20.73	4.58	4.91	3.12	9.32	← Q100
135.00	23.75	20.87	4.94	5.31	3.32	9.78	
150.00	24.16	21.00	5.31	5.72	3.51	10.19	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

CULVERT ANALYSIS 1.1 **CD6** **PROPOSED**
CULVERT FILE NAME: C6P.DAT

DATE: 12-12-90
SUMMARY TABLE

CU LV NO.	A - SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	B - CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (IN)	RISE (IN)	MANN. N	INLET TYPE
1	18.50	17.90	410	1 -RCP	60	60	0.012	CONVENTIONAL
2								
3								
4								
5								
6								

TO EDIT DATA PRESS (A) FOR SITE DATA
(B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
(C) FOR DISCHARGE RANGE,
(D) FOR TAILWATER DATA,
(E) FOR OVERTOPPING DATA,
(F) TO ADD OR DELETE CULVERTS,
(RET) TO CONTINUE ANALYSIS.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q (cfs)	HW (ft)	TWE (ft)	ICH (ft)	OCH (ft)	TWH (ft)	VO (fps)	
0.00	18.50	17.99	0.00	-0.51	0.09	0.00	
15.00	20.04	19.07	1.44	1.54	1.17	4.27	
30.00	20.70	19.48	2.08	2.20	1.58	5.63	
45.00	21.24	19.78	2.59	2.74	1.88	6.67	
60.00	21.72	20.02	3.07	3.22	2.16	7.37	
75.00	22.16	20.23	3.49	3.66	2.43	7.92	
90.00	22.59	20.41	3.88	4.09	2.68	8.42	← Q50
105.00	23.01	20.58	4.23	4.51	2.91	8.85	
120.00	23.41	20.73	4.58	4.91	3.12	9.32	← Q100
135.00	23.81	20.87	4.94	5.31	3.32	9.78	
150.00	24.29	21.00	5.31	5.79	3.51	10.19	

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE