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CONCEPT ENGINEERING AND PLANNING REPORT

FOR THE

32ND STREET BRIDGE AT THE ACDC
PHOENIX, ARIZONA

PREPARED FOR:

THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BY:

CREEGAN + D'ANGELO
ENGINEERS • PLANNERS • SURVEYORS
650 NORTH 2ND AVENUE
PHOENIX, ARIZONA 85003

JULY 1989

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July 26, 1989

Mr. Dan Sagramoso
Flood Control District of Maricopa County
3335 West Durango Street
Phoenix, Arizona 85009

Attention: Mr. Ed Raleigh

Reference: Concept Engineering and Planning Report
32nd Street Bridge over ACDC
Contract FCD 88-42

Gentlemen:

This report is submitted in fulfillment of Phase I of Creegan + D'Angelo's contract with the Flood Control District dated May 1, 1989. Six copies of the report and its attachments are submitted as required by the contract. Attachments include the Bolduc, Smiley Traffic Report and the ATL Testing Laboratories Geotechnical Investigation Report.

This submittal completes Phase I engineering for the Project. We would be pleased to meet with you to answer any questions you may have regarding our findings. We look forward to an early decision with regard to Phase II.

Very truly yours,

CREEGAN + D'ANGELO

Thor L. Anderson

Thor L. Anderson, P.E.
Vice President

TLA:jp
Attached

Registered Professional Engineer (Civil)
CERTIFICATE NO. 9271
THOR L. ANDERSON
DATE SIGNED 7-26-89
Arizona U. S. A.

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- A. Bolduc Smiley Traffic Report
- B. ATL Testing Laboratory Soils Report

EXECUTIVE SUMMARY:

This concept study evaluates the various construction alternatives and options for the installation of the Arizona Canal Diversion Channel at 32nd Street and along Stanford Drive. Alternatives were developed for detours, the 32nd Street bridge, the 35th Street wash culvert and for the 10-inch sanitary sewer crossing the ACDC.

Evaluation of each alternative considered four elements: 1) physical site constraints such as existing traffic volumes, topographic features and subsurface conditions; 2) construction impacts on the surrounding property; 3) engineering design criteria of the affected agencies; and 4) comparative construction and life-cycle costs. Concept drawings are included as part of this report showing construction locations and right-of-way requirements.

Two construction packaging options evolved for the three construction contracts required.

Option 1 - 32nd Street Bridge constructed by the Flood Control District

Option 2 - 32nd Street Bridge constructed by the U.S. Army Corps of Engineers

Option 1 is preferred by the City of Phoenix because of traffic maintenance and traffic safety considerations. Under this option, two separate closures of Stanford Drive will be required.

The comparative estimated cost to the Flood Control District for Option 1 is as follows:

Detour Scheme III -	$ 161,400.
Bridge Alternative 1 -	316,200.
Conduit Alternative 4 -	545,200.
Sewer Alternative 2 -	138,400.
	$1,161,200.

Option 2 is preferred by the U.S. Army Corps of Engineers as it uses the standard Corps rigid box ACDC channel section at 32nd Street. Under this option, only one closure of Stanford Drive will be required. The comparative estimated cost to the Flood Control District for Option 2 is as follows:

Detour Scheme I -	$ 445,400.
Bridge Alternative 2 -	119,000.
Conduit Alternative 4 -	545,200.
Sewer Alternative 2 -	138,400.
	$1,248,000.

These comparative costs do not include those construction items that would be the same for both options.

No firm recommendations can be made as the Flood Control District is engaged in discussions and negotiations with the affected agencies and property owners. The final concept selected will depend on the outcome of these discussions.

CONCEPT PLANNING REPORT

FOR

THE 32ND STREET BRIDGE AND RELOCATIONS AT THE ACDC

I. INTRODUCTION

The purpose of this report is to present the results of a study to evaluate the feasibility and comparative costs of alternative schemes for construction of the 32nd Street Bridge over the Arizona Canal Diversion Channel (ACDC) at 32nd Street and Stanford Drive. The U.S. Army Corps of Engineers will be responsible for the construction of the ACDC. The Flood Control District of Maricopa County (FCD) is responsible for the bridge and relocations to clear the ACDC right-of-way prior to its construction.

At 32nd Street and Stanford Drive the principal items affected by construction of the ACDC include:

1. Approximately 30,000 vehicles daily traffic on 32nd Street and 4,000 vehicles daily traffic on Stanford Drive;
2. Utility relocations including a 10-inch sanitary sewer in 32nd Street and a 12-inch water main in Stanford Drive;
3. The 35th Street wash culvert connecting to the ACDC; and
4. Restoration of 32nd Street and Stanford Drive after all work is complete.

The proposed alignment of the ACDC is immediately north of the Arizona Canal as it crosses 32nd Street. It is located within the

Stanford Drive right-of-way from 32nd Street to approximately 1,100 feet east.

This section of the ACDC will be a covered rectangular channel (36 feet in width and approximately 22 feet in depth). In the Corps of Engineers' preliminary plan for the ACDC, the alignment provided a clearance of 50 feet minimum between the ACDC and the northern water line of the Arizona Canal. At the advice of the FCD, that clearance has been reduced to 30 feet minimum. In preparation of this study, the new alignment of the ACDC has been assumed to be 30 feet north of the Arizona Canal.

II. STUDY INVESTIGATIONS

In the course of this study the team gathered data from the City of Phoenix, Town of Paradise Valley, affected utilities and available topographic and existing subsurface investigations. Traffic impacts, utility sizes, horizontal and vertical constraints (including rights-of-way) and subsurface conditions were all addressed to determine feasible alternatives and their comparative costs. In addition, the team conducted additional traffic counts, subsurface investigations and topographic surveys to supplement the data available.

Construction of this project will create traffic impacts for both 32nd Street and Stanford Drive. Traffic counts were conducted by Bolduc, Smiley and Associates to establish the basis for traffic

control and routing during construction. Discussions were held with officials of the City of Phoenix and the Town of Paradise Valley to determine their concerns and to advise them of the project impacts. Alternative schemes for traffic control during construction were presented for their review.

Relocation of water and sewer facilities will be necessary to clear the construction area for the ACDC. Sewer flow measurements have been provided by the City of Phoenix for the sewer line serving the area north of the Arizona Canal. Discussions have been held with the staff of the Water and Sewer Department to establish design criteria for the various sewer relocation alternatives. The existing 12-inch water main in Stanford Drive will be relocated within the existing right-of-way.

Impact upon facilities of private utility companies is minimal. There is a 2-inch gas main crossing the ACDC alignment on the east side of 32nd Street. An underground telephone line (6 4-inch ducts) located 17 feet north of the monument line of Stanford Drive may require some shoring during the excavation of the ACDC.

ATL Testing Laboratories, Inc. has conducted a geotechnical investigation for this project. Soil borings have been made at the ACDC crossing at 32nd Street, the proposed detour crossing of the Arizona Canal, and along the proposed alignment of the 35th Street wash culvert. (Refer to ATL Report, attached).

Engineering Design Consultants have reviewed the electrical requirements of the proposed lift station sewer pumping system with the Salt River Project and assisted in estimated power requirements.

C.F. Shuler, Inc. has investigated areas within the project site that may require revegetation following construction and has developed estimated landscaping costs.

III. ALTERNATIVE STUDIES

The following alternatives are considered in this study:

A. Three detour alternatives.

B. Two alternative bridge structures.

C. Five alternatives for the 35th Street wash culvert.

D. Four alternative reroutings of the 10-inch sanitary sewer crossing.

Comparative cost estimates for each alternative are included in Appendix A.

A. DETOUR

To permit vehicular traffic to be maintained along 32nd Street during construction of the ACDC, three schemes have been considered. (Refer to Appendix B.)

Detour Scheme I:

Under this scheme, a four-lane, paved detour will be constructed along the west side of 32nd Street commencing south of the Arizona Canal near Missouri Avenue and extending north of the ACDC to near San Miguel Avenue. This alignment would require a new temporary bridge crossing the Arizona Canal with a span of approximately 100 feet. The temporary bridge would be precast prestressed concrete box girders (4' wide x 4.5' deep x 100' long) salvaged from the Dunlap Avenue ACDC temporary crossing. Girders would be supported on concrete abutment cap beams on 42-inch drilled caissons. To

provide sufficient bridge width for the four lane detour, three new girders will be required for this scheme.

North of the Arizona Canal, the detour would be constructed on Lot 17 of Alta Vista Park (20/11). This lot will be acquired by the FCD to permit construction of the ACDC. South of the Arizona Canal, the detour will cross a portion of the landscaped common area adjoining Lot 1 of Biltmore Shores (282/29). The detour would be 50 feet in width permitting two lanes of traffic each way along 32nd Street.

Stanford Drive will be closed to through traffic during construction of the ACDC. A twelve-foot wide detour with a four-foot pedestrian way is proposed for local access only during construction of the ACDC. A 10-foot wide temporary construction easement will be necessary along the north side of Stanford Drive for this access.

Upon review of this scheme, the Traffic Department of the City of Phoenix stated that left-turn and right-turn lanes at the dead end streets (i.e., Marshall Avenue and San Miguel) will be necessary to provide local residents safe ingress and egress. Although not shown on the detour drawings, these turning lanes can be provided. At San Miguel (north of the Arizona Canal) left and right-turn lanes can be incorporated with additional widening.

South of the Arizona Canal, the detour alignment can be shifted 11 feet easterly requiring the removal and replacement of approximately 500 feet of the existing frontage road divider. One constraint, however, is that the southbound right-turn lane at Marshall Avenue would have a substandard length of less than 100 feet.

The estimated cost for Detour Scheme I, including the widening for right and left-turn lanes at Marshall Avenue and San Miguel is $ 445,400. (See Appendix A for Cost Estimates.)

Detour Scheme II:

In this scheme, a two-lane detour is proposed along the west side of 32nd Street following the same general alignment as described in Scheme I. As in Scheme I, the temporary bridge would be the precast prestressed concrete box girders salvaged from the Dunlap Avenue temporary crossing. Because of the narrower detour, no new girders will be required.

The detour would be 30 feet wide for southbound traffic only during the construction of the ACDC. Northbound traffic would remain within the existing 32nd Street right-of-way. Construction of the 32nd Street/ACDC crossing would be performed in two phases to permit maintenance of two lanes of northbound traffic.

As in Scheme I, Stanford Drive would be closed to through traffic during the construction of the ACDC. A twelve-foot wide detour

with a four-foot pedestrian way is proposed for local access only during the construction of the ACDC. A 10-foot temporary construction easement will be required along the north side of Stanford Drive.

Comments noted for Scheme I by the City of Phoenix Traffic Engineers regarding left and right-turn lanes applies to Scheme II as well.

The estimated cost for Detour Scheme II, including widening for right and left-turn lanes at Marshall Avenue and San Miguel is $ 326,500.

Detour Scheme III:

Under this scheme, northbound and southbound traffic will remain in the existing 32nd Street right-of-way. Construction of the 32nd Street/ACDC crossing will be performed in two stages.

During the first stage the bridge foundations, consisting of drilled caissons and abutment cap beam, will be constructed. The bridge contractor will be required to maintain a minimum of four lanes of traffic during peak hours by installing steel traffic plates over caisson shafts and abutment cap beam construction. During off-peak hours traffic lanes can be restricted to one lane each way.

During the second stage, the bridge deck will be constructed. Weekend closure of 32nd Street and restriction to three lanes of traffic for peak hour traffic will be permitted. The center lane will be reversible to permit two lanes of traffic one-way during peak demands. Stanford Drive will be closed to through traffic during construction of the ACDC. A 12-foot wide detour with a four-foot pedestrian way is proposed. A 10-foot temporary construction easement will be required along the north side of Stanford Drive.

The City of Phoenix traffic engineers expressed a preference for Scheme III. Traffic, would be restricted primarily during off-peak hours and would remain on 32nd Street with familiar turn lanes and sight distances. The estimated cost for Detour Scheme III is $161,400.

B. BRIDGES

Two alternatives were considered for the 32nd Street bridge structure over the ACDC:

1. Precast prestressed bridge deck units (21-inch deep x 48-inch wide voided slab) with abutment cap beam supported on drilled caissons.
2. Reinforced concrete rigid frame box matching the ACDC Corps of Engineers' structure.

Bridge Alternative 1: Precast Bridge Girders (Figure 1)

Description:

Foundation - 36-inch diameter reinforced concrete caissons drilled to El. 1210. Spacing is 10-feet on center.

Abutments - Cast-in-place concrete spanning between drilled caissons. Total width of bridge is 127 feet to provide for a right angle connection to the ACDC being constructed by the Army Corps of Engineers. Bottom of abutments is at El 1242 to make contact with cemented clayey gravels.

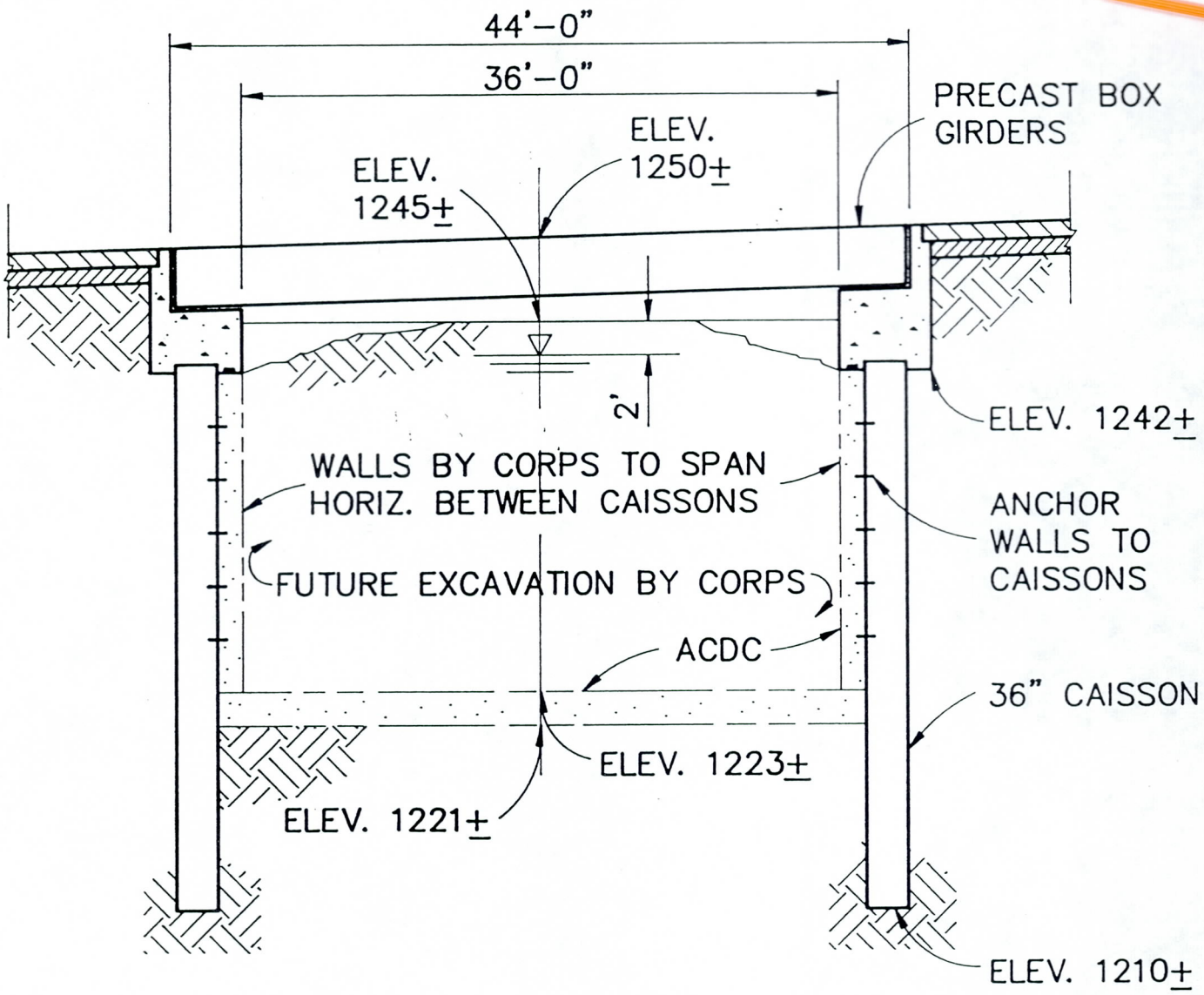
Deck Beams - Precast prestressed concrete beams designed for HS20-44 loading. Top slab is cast-in-place concrete to tie beams together and to provide a wearing surface. Cast-in-place concrete edge beams are placed intergally with the top slab.

Approach Slabs - Cast-in-place concrete at each end of bridge and temporarily at Stanford Drive.

ACDC Walls - Cast-in-place concrete anchored to the caisson sides. Wall and base slab construction will be by the Corps. The estimated cost for this bridge alternative is $316,200.

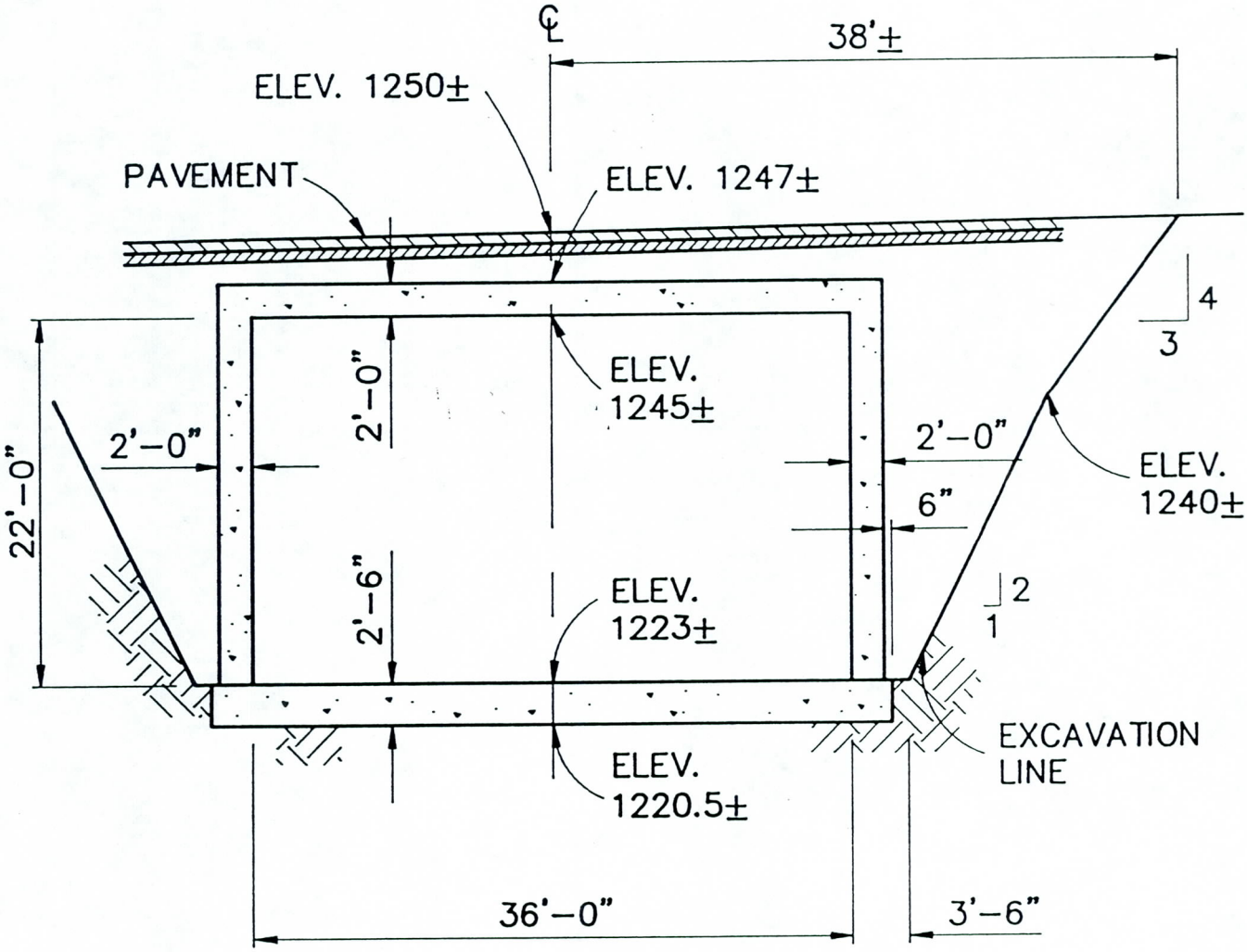
Bridge Alternative 2: Rigid Box Channel (Figure 2)

This alternative would be designed by the Corps of Engineers. Estimated quantities for this structure are based upon 24-inch thick top slab and walls and a bottom slab of 28-inches average thickness. The estimated total cost for this alternative structure is $505,200. The Corps of Engineers' share for excavation, backfill, concrete walls and bottom slab is estimated to be $386,200. The net FCD share is estimated at $119,000.



CAISSON SUPPORTED
PRECAST BRIDGE GIRDERS

CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	BRIDGE ALTERNATIVE 1 32ND STREET BRIDGE OVER ACDC FIGURE 1



RIGID BOX CHANNEL

CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	BRIDGE ALTERNATIVE 2 32ND STREET BRIDGE OVER ACDC FIGURE 2

C. 35TH STREET WASH CULVERT

The 35th Street wash currently crosses Stanford Drive and flows into the Arizona Canal at approximately 600 feet east of 32nd Street. The contributing drainage area of this wash lies approximately between 32nd Street on the west and Christy Drive on the east and extends approximately 1,500 feet north of Lincoln Drive in the North Phoenix Mountains. The total drainage area of the wash is approximately 1.35 square miles (860 acres). There are four principal sub-drainage areas within the watershed. The confluence of these sub-drainage washes is located approximately 500 feet north of Stanford Drive and 1,200 feet east of 32nd Street. As a part of this project, a drainage culvert is proposed to intercept the flow from the confluence of these washes. The Corps of Engineers established a design flow of 2,000 cfs for this culvert.

The following alternative culvert types have been analyzed hydraulically and comparative cost estimates have been prepared to determine the "best fit" system for this project:

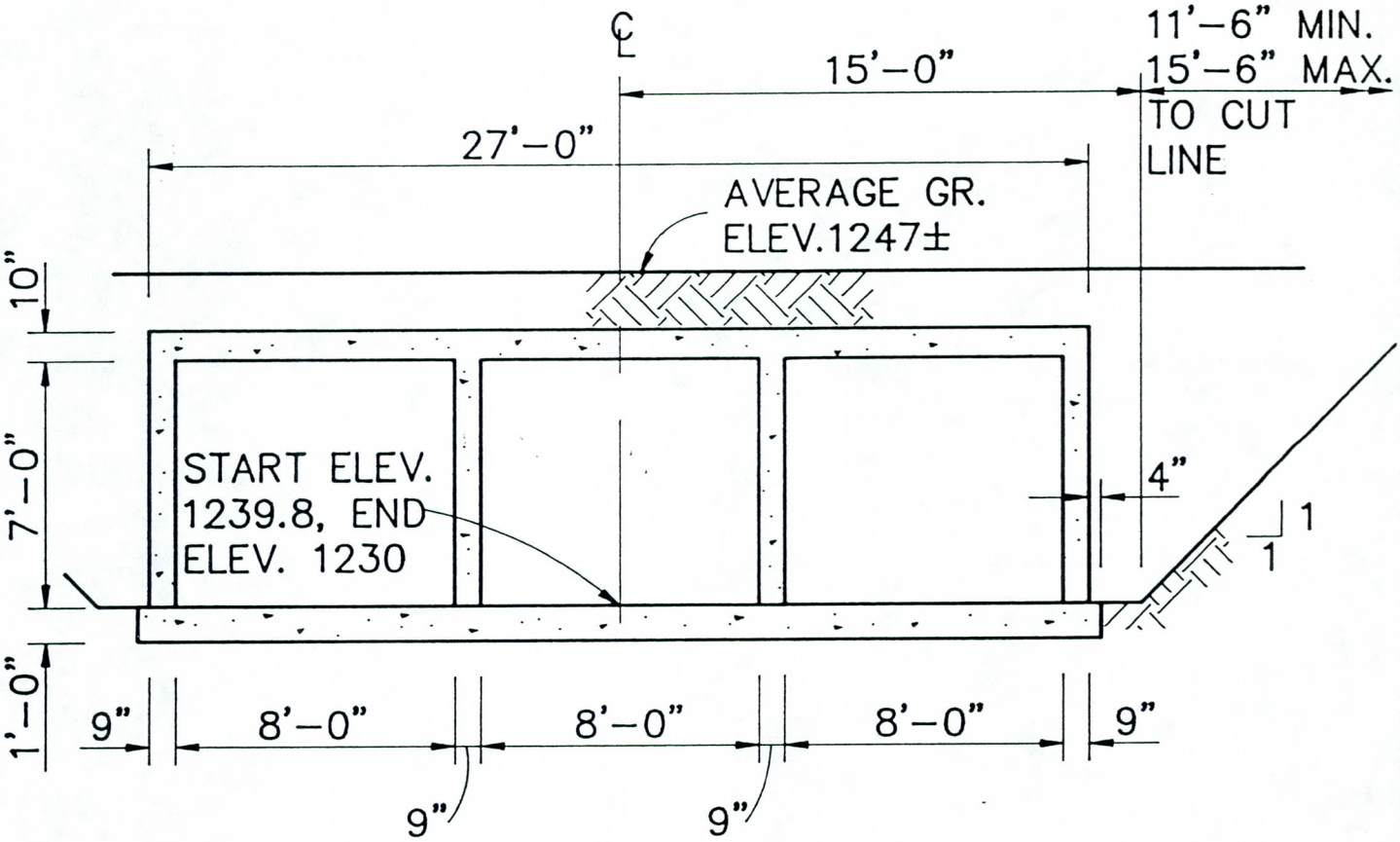
Alternative	Estimated Cost
1. 3 - 8 x 7 concrete box culvert	$ 573,200
2. 1 - 16 x 10 concrete box culvert	652,900
3. 2 - 10 x 8 concrete box culvert	556,200
4. 2 - 10' diameter reinforced concrete pipes (RCP)	545,200
5. 2 - 11' diameter corrugated metal pipes (CMP)	384,200

(See Appendix A for Detailed Cost Estimates.)

Although the CMP alternative estimated cost is the least, the ground surface above the culvert will be irrigated to provide revegetation. The irrigated soil would reduce the longevity of the pipe.

The culvert will be located on private property and will require temporary construction easements and permanent drainage easements. As the property is presently improved with residences and other amenities, the impact of temporary construction easements upon the property owners will be significant. Revegetation of these areas will be a significant cost item. The mature trees on the site should be salvaged and replanted after construction.

Because of limited easement availability excavated earth must be stockpiled off-site. The 2-10 foot diameter RCPs are the least cost of the concrete alternatives and will have the least impact on property owners as backfilling operations can follow closely behind the installation of the conduit.

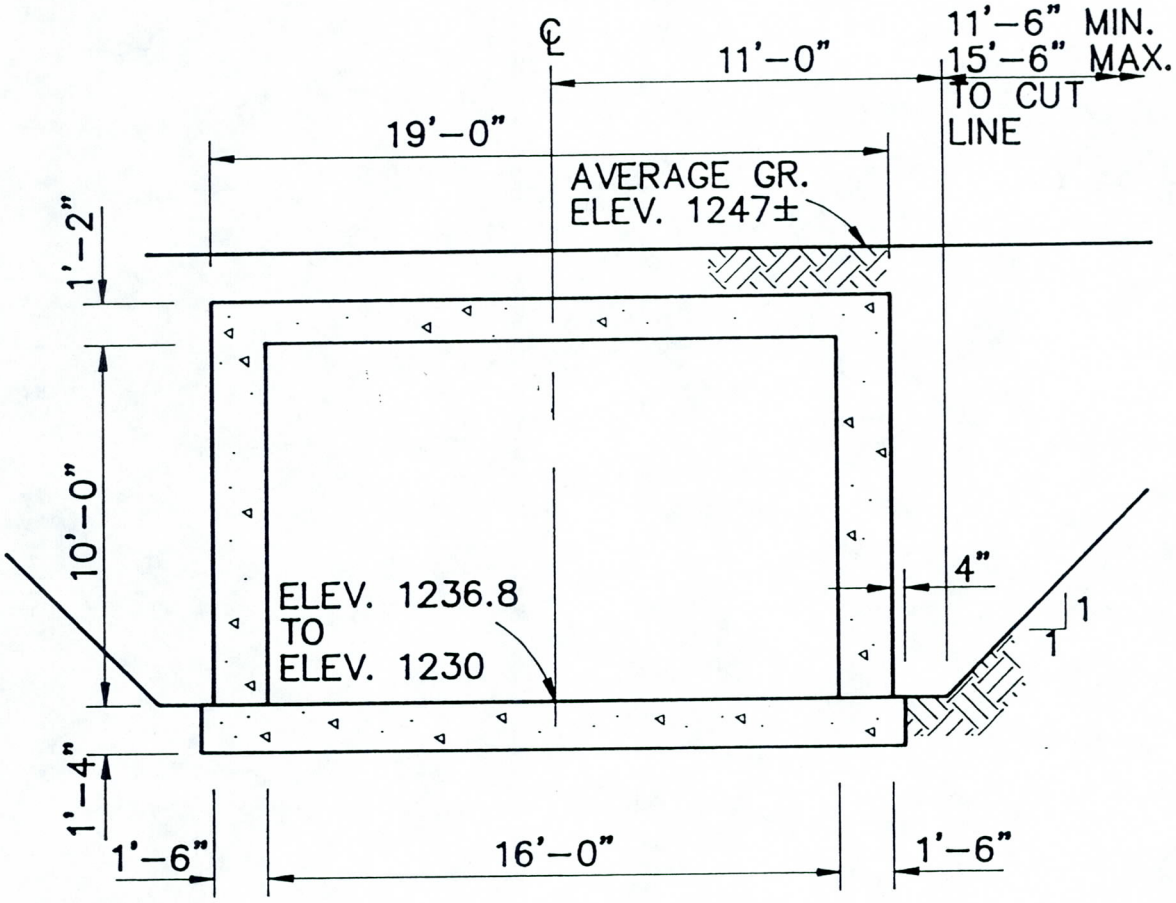


CONC.=2.46 CY/LF

REINF.=415#/LF
(1.28%)

STD. ADOT TRIPLE BARREL BOX CULVERT

CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	CONDUIT ALTERNATIVE 1 35TH ST. WASH CONDUIT TO ACDC FIGURE 3

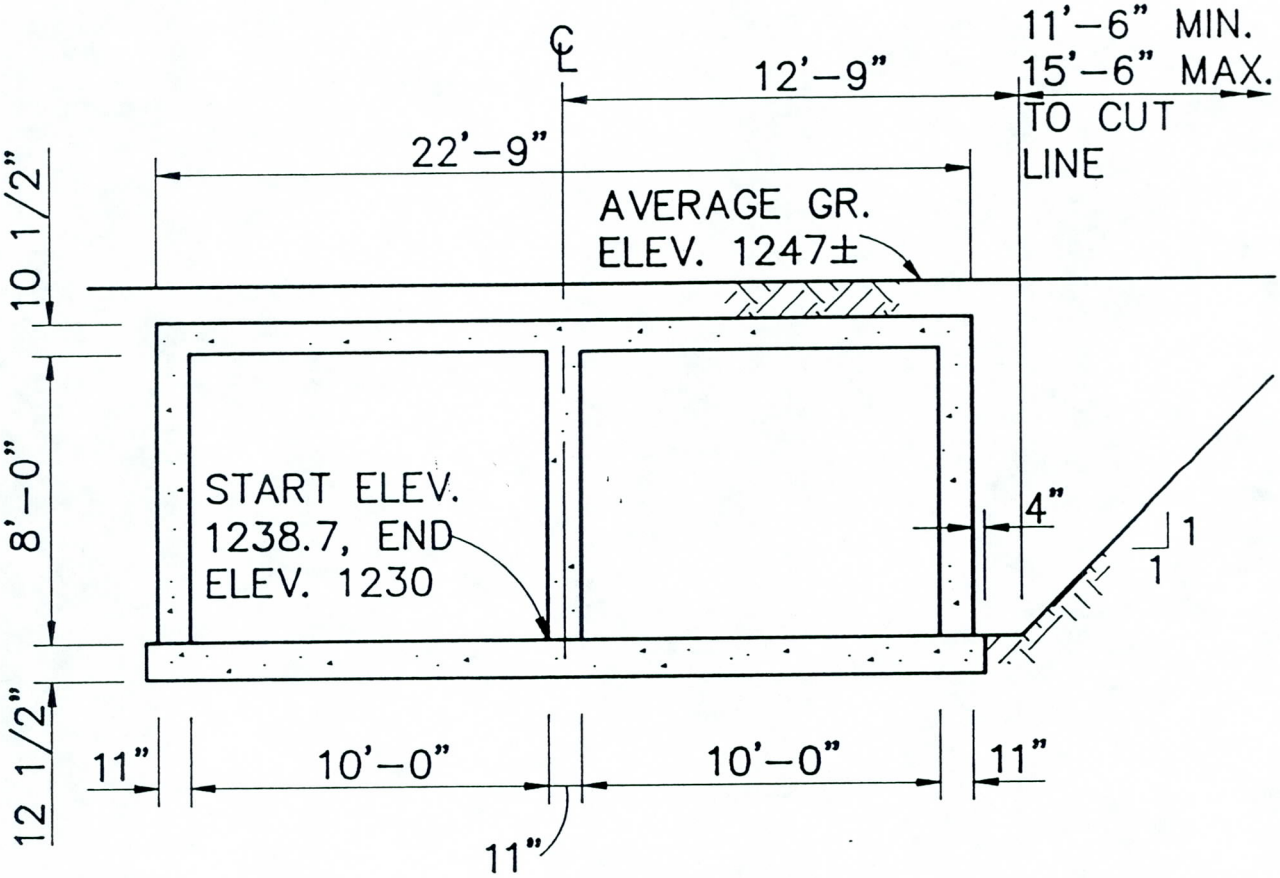


CONC.=2.9 CY/LF

REINF.=500#/LF
(1.3%)

SINGLE BARREL

CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	CONDUIT ALTERNATIVE 2 35TH ST. WASH CONDUIT TO ACDC FIGURE 4

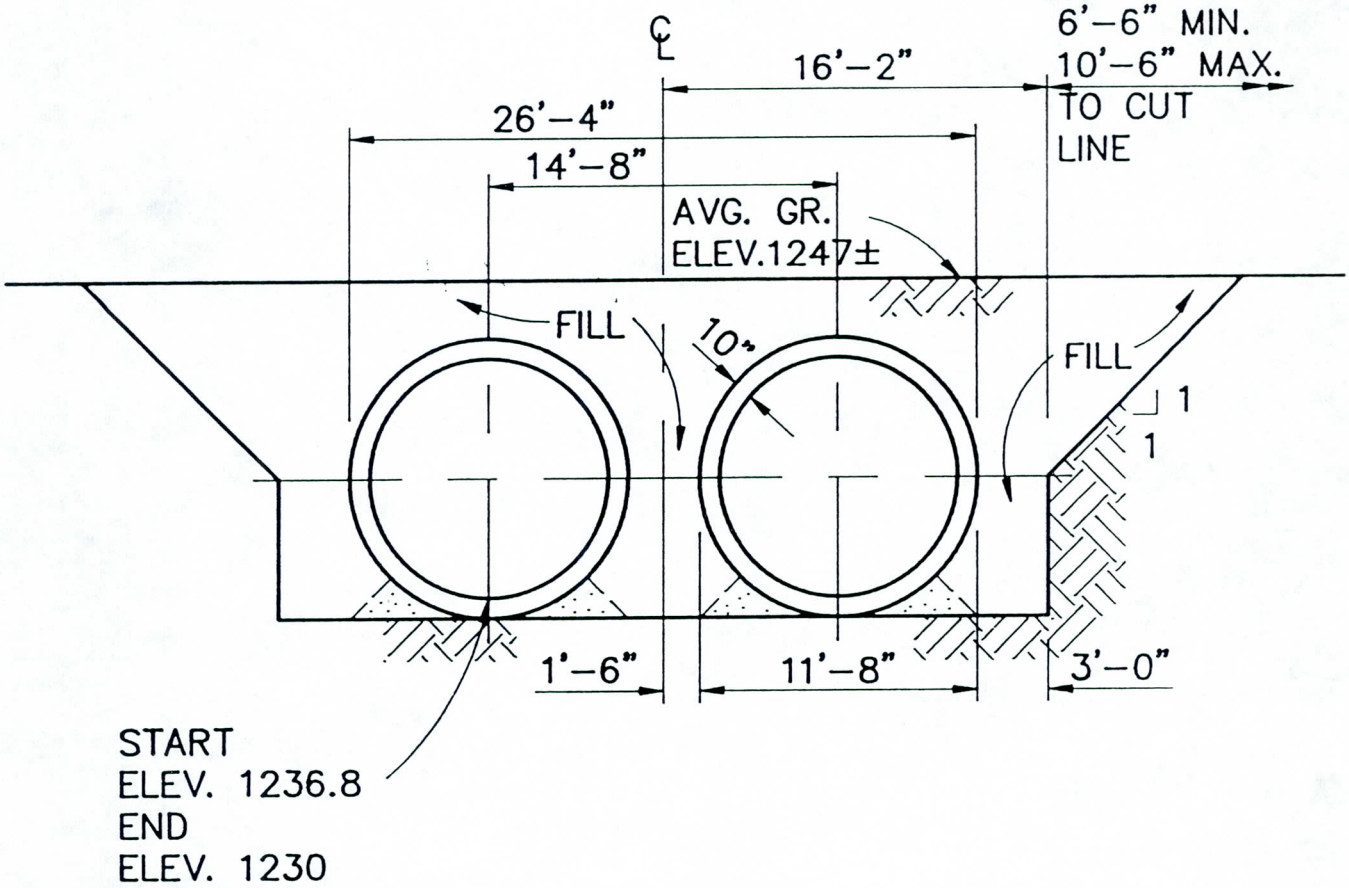


CONC.=2.46 CY/LF

REINF.=423 #/LF
(1.3%)

STD. ADOT DOUBLE BARREL BOX CULVERT

CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	CONDUIT ALTERNATIVE 3 35TH ST. WASH CONDUIT TO ACDC FIGURE 5



DOUBLE RCP – 10' DIA.

CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	CONDUIT ALTERNATIVE 4 35TH ST. WASH CONDUIT TO ACDC FIGURE 6

D. SANITARY SEWER

An existing 10-inch sanitary sewer is located along the east side of 32nd Street at Stanford Drive. The sewer must be relocated to permit construction of the ACDC.

The existing 10-inch sewer crosses Stanford Drive to a drop manhole on the north side of the Arizona Canal. The invert of the sewer at the manhole is El. 1234.50. The 10-inch sanitary sewer continues south under the Arizona Canal and along the east side of 32nd Street. The average slope of this sewer is 1.0 percent. The capacity of the 10-inch sewer is 2.18 cfs (or 1.41 MGD). However, flow measurements provided by the City of Phoenix that were taken at MH #222 located midway between Missouri and Vermont Avenues indicate that the average flow currently is 0.16 cfs (0.102 MGD). The current peak flow is 0.46 cfs (0.295 MGD).

The area served by this sewer is approximately 400 acres consisting of one-acre size lots or parcels. Sewer mains are currently available to approximately one-half of this area. Zoning for the area is R-43. Land use consists of residences, the Hermosa Inn and a few churches. The approximate boundaries of the area are 32nd Street on the west, 36th-38th Street on the east, Lincoln Drive on the north and Stanford Drive on the south. The City of Phoenix estimates a future peak flow of 0.578 MGD (0.89 cfs) from the area served by this 10-inch sewer at 32nd Street.

Four alternative schemes for relocation of the sewer are considered in this study:

1. Inverted sewer siphon under the ACDC;
2. Lift station with force main over the ACDC;
3. Gravity sewer main under ACDC extending 2,400 feet south along 32nd Street; or
4. Gravity sewer main along the north side of ACDC west 2,800 feet to Biltmore Gates subdivision.

Sewer Alternative No. 1: Inverted Siphon (Figure 7)

The inverted siphon would be located between MH #105 (Inv. El. 1239.95) on the north side of Stanford Drive and drop MH #104 (Inv. El. 1234.50) on the south side of Stanford Drive. The available head is 5.45 feet (El. 1239.95 - 1234.50). For a siphon length of 103 feet, a three-barrel siphon consisting of two 6-inch and one 8-inch pipes will provide a capacity of 1.16 cfs (0.75 MGD) with either the two 6-inch or the one 8-inch barrel in operation. This capacity is adequate to meet the future peak flow of 0.578 MGD estimated by the City of Phoenix.

However, the existing flow measurements furnished by the City of Phoenix are somewhat less than that capacity:

	MGD	GPM	CFS
Peak Flow	0.295	205	0.46
Average Flow	0.102	71	0.16
Minimum Flow	0	0	0

The average flow velocity through a 6-inch barrel would be 0.81 fps which does not meet the minimum velocity criteria of 3 fps required by the Arizona Department of Health Services. An inverted siphon at this location will require excessive maintenance.

The estimated cost of the inverted sewer siphon (including maintenance costs capitalized over 30 years) is $122,650.

Sewer Alternative No. 2: Lift Station With Force Main (Figure 8)

This alternative would consist of constructing a lift station on the north side of the proposed ACDC and a 6-inch force main over the top of the ACDC. A site for a lift station is available on the west side of 32nd Street in a parcel of land to be acquired for the ACDC right-of-way. Flow will be piped westerly across 32nd Street from MH #105 located at the northeast corner of 32nd Street and Stanford to the lift station site. The lift station will pump the flow over the ACDC to a new manhole where it will enter the existing 10-inch sewer under the ACDC. The pumping system would consist of two factory-assembled non-clog submersible pumps installed in a six-foot diameter wet well. The estimated cost for the lift station with force main is $138,350, including an estimated capitalized operation/maintenance charge of $72,000 to be negotiated with the City of Phoenix.

Sewer Alternative No. 3: Gravity Sewer Under ACDC and South Along 32nd Street (Figure 9)

This scheme consists of a 10-inch gravity sewer connecting to the existing MH #105 at the northeast corner of Stanford Drive and 32nd Street, and extending south along 32nd Street to MH #126 located at the alley north of Medlock Drive. To cross under the ACDC, a 30-foot deep manhole would be constructed at the north side of the ACDC. The invert at that manhole would be El. 1218.30. The invert of the existing MH #126 is El. 1212.80, providing a fall of 5.50 feet (El. 1218.30 - 1212.80). The gradient of the proposed line would be 0.0024. The capacity of the proposed sewer would be 1.09 cfs (0.71 MGD). A gravity sewer line would require less maintenance than Alternatives 1 or 2 above.

Construction scheduling of this deep sewer line must be coordinated with the annual Arizona Canal dry-up.

The estimated cost for the gravity sewer under the ACDC and south along 32nd Street to the alley north of Medlock Drive is $226,750.

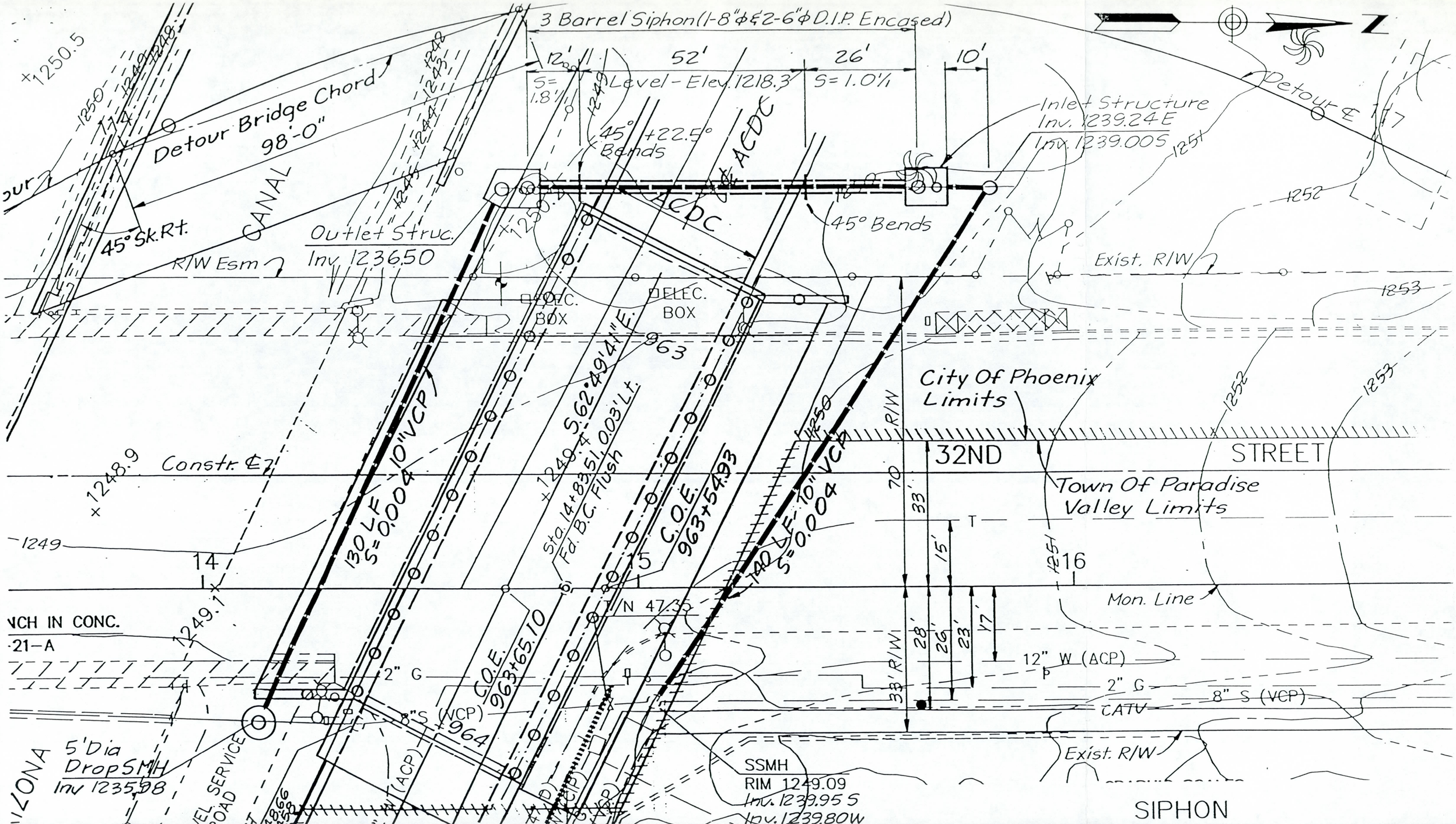
Sewer Alternative No. 4: Gravity Sewer Westerly Along the North Side of the ACDC (Figure 10)

The sanitary sewer, extending east from 24th Street along the north side of the Arizona Canal that serves the Arizona Biltmore Hotel and vicinity, is to be relocated in an adjacent project.

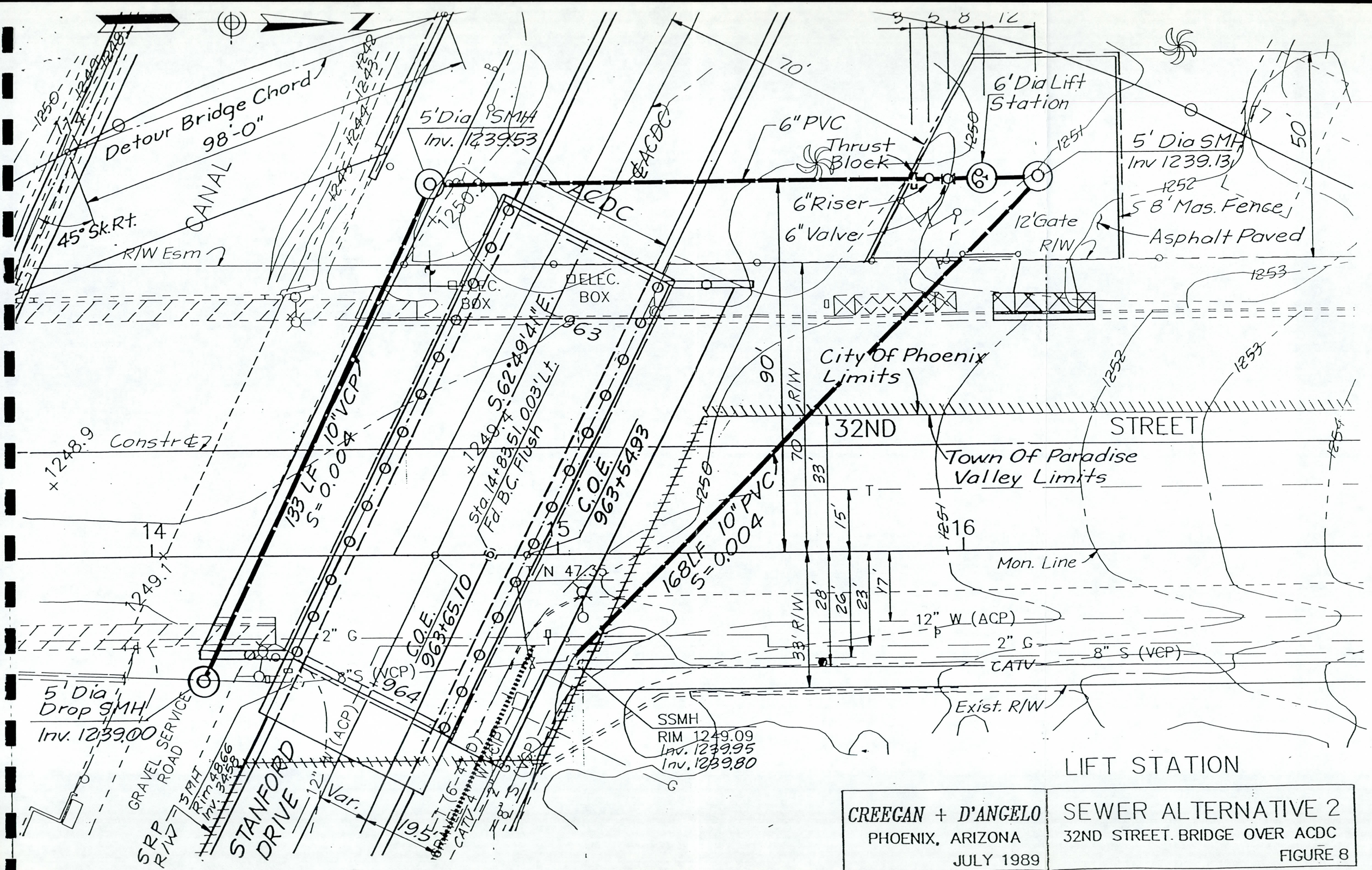
That relocated sewer will extend to the Biltmore Gates subdivision approximately 2,600 feet west of 32nd Street. In this alternative, a 10-inch gravity sewer would be constructed to the end of the 24th Street project at a slope of 0.0024, providing a capacity of 1.09 cfs (0.71 MGD). At that gradient, the new sewer would be approximately 2.5 feet below the existing sewer at Biltmore Gates. This added flow would require modification of the pipe size and grade line of the sewer project to the west. The additional flow from this project may exceed the capacity of the existing trunk sewer line in 24th Street.

The estimated cost for the gravity sewer westerly along the north side of the ACDC is $104,000. Plus, the additional cost of lowering the sewer from Biltmore Gates to 24th Street (approximately 3,300 feet).

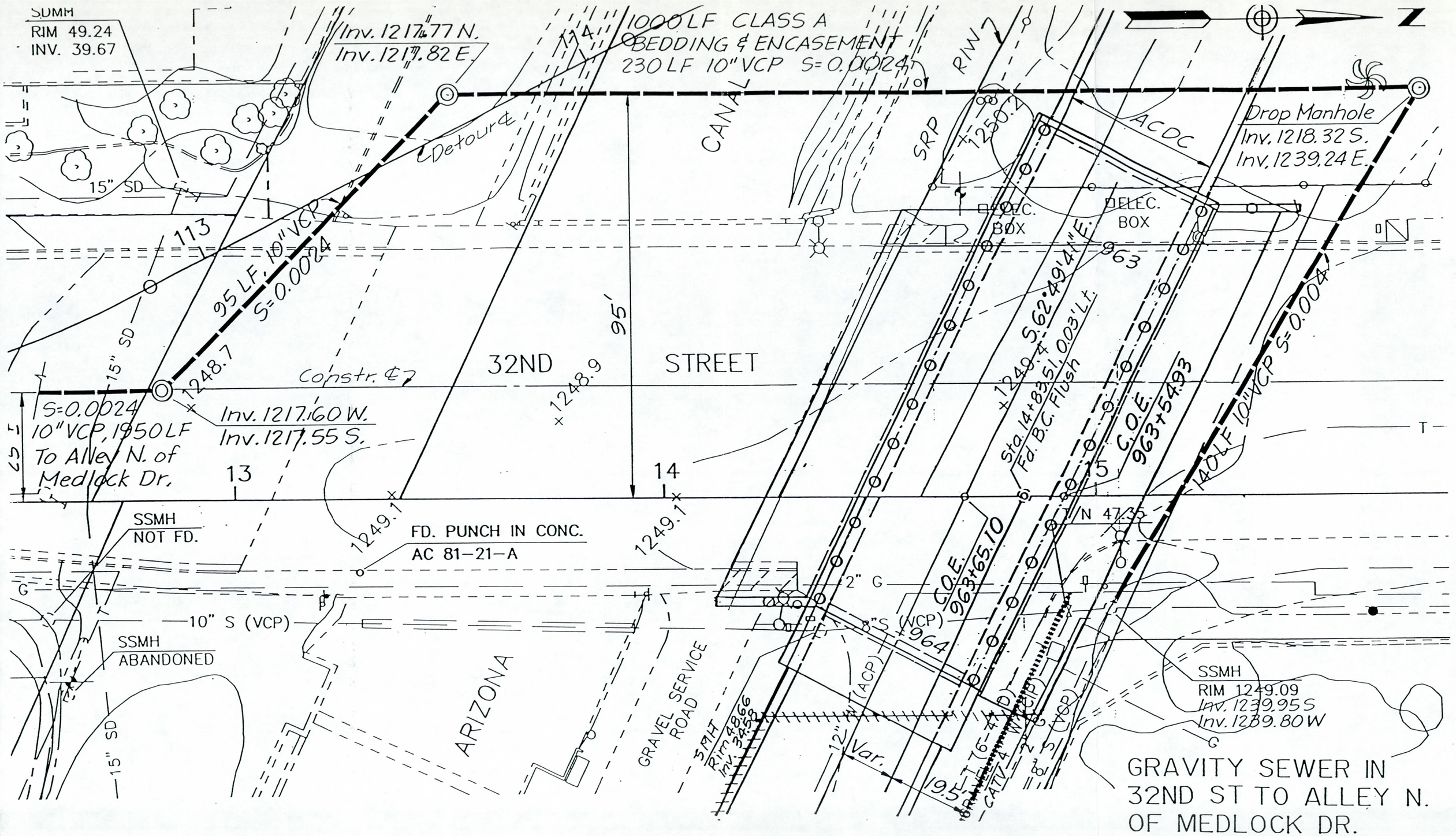
As this alternative involves sewerage system modifications beyond the scope of this study, it is presented as a secondary alternative to be considered by the Flood Control District.



CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	SEWER ALTERNATIVE I 32ND STREET BRIDGE OVER ACDC FIGURE 7

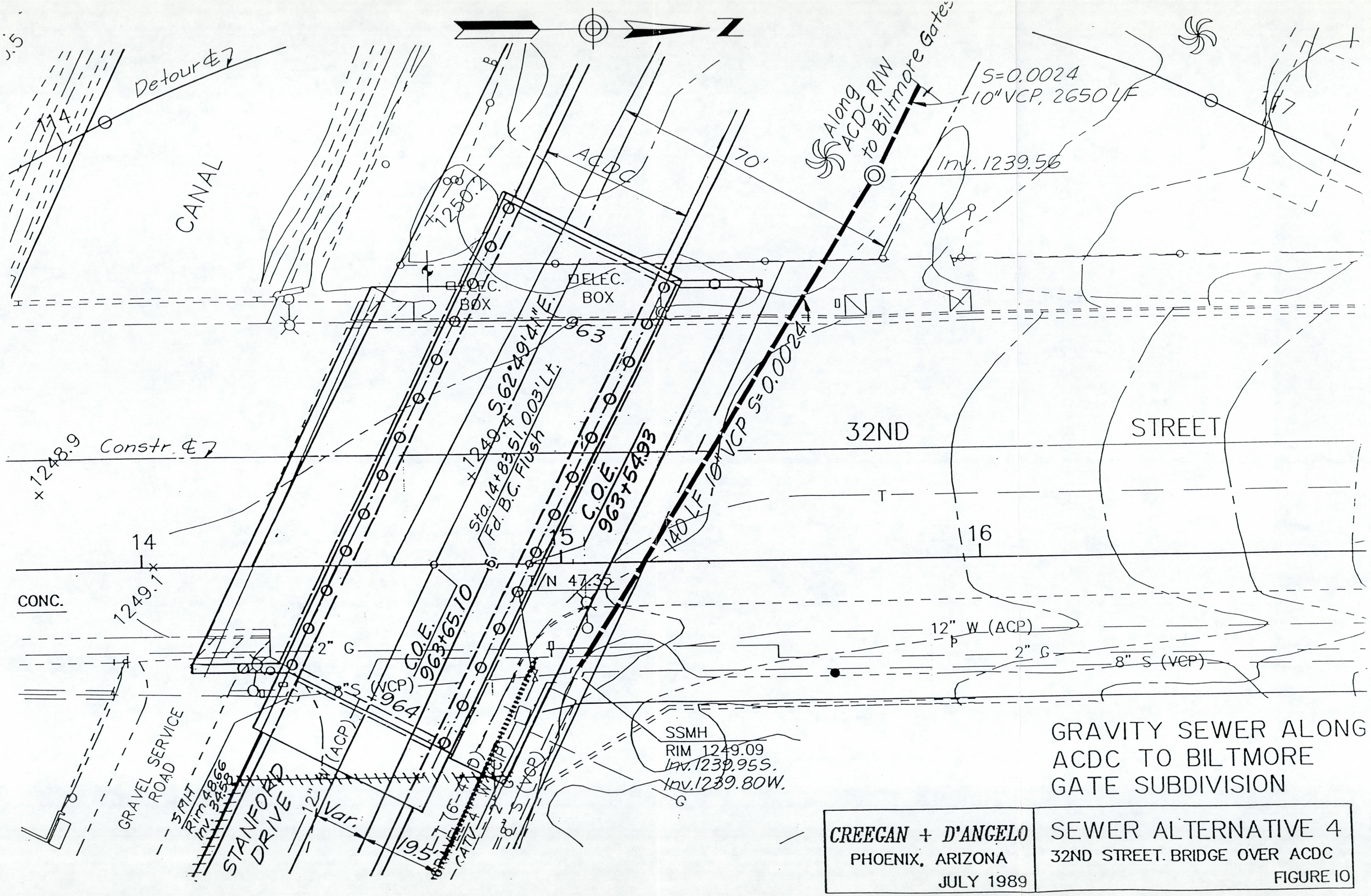


CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	SEWER ALTERNATIVE 2 32ND STREET BRIDGE OVER ACDC FIGURE 8



GRAVITY SEWER IN 32ND ST TO ALLEY N. OF MEDLOCK DR.

CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	SEWER ALTERNATIVE 3 32ND STREET BRIDGE OVER ACDC FIGURE 9



GRAVITY SEWER ALONG ACDC TO BILTMORE GATE SUBDIVISION

CREEGAN + D'ANGELO PHOENIX, ARIZONA JULY 1989	SEWER ALTERNATIVE 4 32ND STREET. BRIDGE OVER ACDC FIGURE 10

IV. CONCLUSIONS

A. Alternative Combinations

The various alternative concepts and costs proposed are not mutually independent and must be combined appropriately to arrive at the most feasible and cost effective alternative. Further, the Flood Control District, in continuing discussions and negotiations with other affected agencies and parties, has encountered continuously changing constraints of construction scheduling and costs. These constraints will influence the final combinations of alternatives selected. Therefore, this study cannot make a firm recommendation at this time.

The study does, however, combine the various alternatives to show the following:

1. Construction sequencing options;
2. Concept drawings showing the location of finished elements; and
3. Required permanent and temporary easements.

Bridge Alternative 1 (Precast Bridge Girders) can be constructed with any of the three detour schemes. Bridge Alternative 2 (Rigid Frame Box), on the other hand, can only be constructed using Detour Scheme I. Any of the culvert and sewer alternatives can be constructed with any of the bridge and detour alternatives.

It is our understanding that the Corps of Engineers has expressed a desire to construct Bridge Alternative 2 at 32nd Street to match their design section for the ACDC. On the other hand, the City of

Phoenix, from a traffic perspective, prefers Detour Scheme III. The comparative cost impact to the Flood Control District for each of these preferences is as follows:

Corps Preference:

Detour Scheme I	$ 445,400.
Bridge Alternative 2	119,000.
Total	$ 564,400.

City of Phoenix Preference:

Detour Scheme III	$ 161,400.
Bridge Alternative 1	316,200.
Total	$ 477,600.

From a cost perspective, Detour Scheme III combined with Bridge Alternative 1 appears to be the most advantageous to the District.

With respect to the sewer and the 35th Street wash conduit, we would recommend the following:

Sewer Alternative 2-Lift Station	$ 138,350
Conduit Alternative 4 - Two 10'-RCPs	545,200

The sewer lift station, including operation and maintenance costs capitalized at 3% (8% interest - 5% escalation) over 30 years, offers the least cost alternative that is technically feasible. The siphon concept is not feasible because of the low flows expected.

The two 10-foot diameter RCP conduits for the 35th Street wash provide the least cost alternative as well as the least construction impact on the adjacent property owners. CMP conduit,

although less expensive, was eliminated from consideration because of durability.

B. CONSTRUCTION SEQUENCING

Three separate construction contracts are anticipated to complete the ACDC under 32nd Street and Stanford Drive. As the 32nd Street bridge may be constructed by either the Flood Control District or the U.S. Army Corps of Engineers, two packaging options are available:

Option 1 - 32nd Street bridge constructed by the Flood Control District

Option 2 - 32nd Street bridge constructed by the Corps.

The construction sequence for each of these options is as follows:

OPTION 1 - CONTRACT I (By Flood Control District)

1. Install traffic control program
2. a. Relocate water line in Stanford Drive to clear new construction,
   b. Construct selected sanitary sewer alternative,
   c. Relocate private utilities by U.S. West and Southwest Gas.
3. Close Stanford Drive.
4. Construct 32nd Street bridge over ACDC. (Bridge Alt. 1)
   a. Phase I:
      (1) Fabricate bridge deck girders,
      (2) Excavate and construct caissons and abutment cap beam. Place steel traffic plates over excavation and construction during peak hour traffic schedule,

B. CONSTRUCTION SEQUENCING

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The construction sequence for each of these options is as follows:

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2. a. Relocate water line in Stanford Drive to clear new construction,
   b. Construct selected sanitary sewer alternative,
   c. Relocate private utilities by U.S. West and Southwest Gas.
3. Close Stanford Drive.
4. Construct 32nd Street bridge over ACDC. (Bridge Alt. 1)
   a. Phase I:
      (1) Fabricate bridge deck girders,
      (2) Excavate and construct caissons and abutment cap beam. Place steel traffic plates over excavation and construction during peak hour traffic schedule,

b. Phase II:

(1) Stripe 32nd Street pavement for Detour Scheme III (3 lanes with reversible center lane),

(2) Construct one-half of bridge deck,

(3) Re-stripe 32nd Street pavement to direct traffic over completed portion of bridge;

(4) Construct remaining half of bridge deck,

5. Restore 32nd Street and Stanford Drive and open to traffic.

OPTION 1 - CONTRACT II (By Corps)

1. Close Stanford Drive.
2. Excavate for ACDC by open cut.
3. Excavate under 32nd Street Bridge by mining between caisson abutments.
4. Construct channel base slab.
5. Construct walls between shafts.
6. Construct walls and cover east and west of 32nd Street.
7. Construct 35th Street Wash junction structure.
8. Backfill.
9. Reconstruct Stanford Drive.
10. Open Stanford Drive to traffic.

OPTION 1 - CONTRACT III (By Flood Control District)

1. Construct 35th Street wash culvert.

   a. Clear temporary construction easement,

b. Excavate and stockpile top soil,

c. Construct selected culvert alternative.

2. Restore construction easement and landscape.

3. Project complete.

OPTION 2 - CONTRACT I (By Flood Control District)

1. Install traffic control program.

2. a. Relocate water line in Stanford Drive.

   b. Construct selected sanitary sewer alternative.

   c. Relocate private utilities by U.S. West and Southwest Gas.

3. Construct 4-lane Detour Scheme I and temporary bridge over Arizona Canal.

   a. Construct caissons and abutment cap beam on north and south canal bank,

   b. Install 100-foot precast box girders from Dunlap Avenue/ACDC crossing,

   c. Construct approach embankment on north and south sides of Arizona Canal.

OPTION 2 - CONTRACT II (By Corps)

1. Install traffic control program.

2. Complete Detour Scheme I.

   a. Remove 500 feet of frontage road divider island on 32nd Street from Marshall Avenue to Vermont Avenue and pave for Detour Scheme I,

b. Complete pavement for Detour Scheme I over temporary bridge and detour embankment,

c. Stripe detour and close Stanford Drive,

3. Construct ACDC across 32nd Street and along Stanford Drive. (Bridge Alt. 2)

4. Restore 32nd Street and Stanford Drive.

5. Open 32nd Street and Stanford Drive.

6. Remove detour and temporary bridge over Arizona Canal,

7. Complete construction of ACDC west of 32nd Street.

OPTION 2 - CONTRACT III (By Flood Control District)

1. Construct 35th Street wash culvert.

   a. Clear temporary construction easement.

   b. Excavate and stockpile top soil.

   c. Construct selected culvert alternative.

2. Restore construction easement and landscape.

3. Project complete.

C. RIGHT-OF-WAY REQUIREMENTS

Temporary construction easements and permanent drainage easements have been shown on the accompanying concept plans.

Should Detour Scheme I be used, a temporary easement will be required over the landscaped common area adjoining Lot 1 of Biltmore Shores (282/29) and Lot 17 of Alta Vista Park (20/11).

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
32ND ST BRIDGE OVER ACDC
COST ESTIMATES

26-Jul-89
TLA

FILE: FCDCOSTS.WK1

	UNIT	QTY	UNIT PRICE	TOTAL
DETOUR SCHEME I - FOUR LANE				
Demolition	Job	1	$27,600	$27,600
Excavation- Roadway	CY	1000	$3	$3,000
Fill- Roadway	CY	2000	$4	$8,000
Precast Girders (Used)	EA	12	$500	$6,000
Precast Girders (New)	EA	3	$24,800	$74,400
Excavation- Foundation	CY	205	$8	$1,640
Drilled Shafts (42")	LF	390	$123	$47,970
Concrete- Foundation	CY	80	$300	$24,000
Aggregate Base	T	4670	$14	$65,380
Paving	T	1480	$28	$41,440
Curb & Gutter	LF	1165	$8	$9,320
Barriers Furnish/Install	LF	1700	$15	$25,500
Striping	LF	7000	$1.35	$9,450
Traffic Control- Temp	MO	5	$9,000	$45,000
Removal of Detour	Job	1	$23,700	$23,700
Landscaping	Job	1	$33,000	$33,000
		Total		$445,400
DETOUR SCHEME II - TWO LANE				
Demolition	Job	1	$20,100	$20,100
Excavation- Roadway	CY	460	$3	$1,380
Fill- Roadway	CY	930	$4	$3,720
Precast Girders (Used)	EA	12	$500	$6,000
Precast Girders (New)	EA	0	$0	$0
Excavation- Foundation	CY	140	$8	$1,120
Drilled Shafts (42")	LS	270	$123	$33,210
Concrete- Foundation	CY	53	$300	$15,900
Aggregate Base	T	4880	$14	$68,320
Paving	T	1520	$28	$42,560
Curb & Gutter	LF	1165	$8	$9,320
Barriers Furnish/ Install	LF	1500	$15	$22,500
Striping	LF	7100	$1.35	$9,585
Traffic Control- Temp	MO	6	$8,400	$50,400
Removal of Detour	Job	1	$14,400	$14,400
Landscaping	Job	1	$28,000	$28,000
		Total		$326,515

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
32ND ST BRIDGE OVER ACDC
COST ESTIMATES

26-Jul-89
TLA

FILE: FCDCOSTS.WK1

	UNIT	QTY	UNIT PRICE	TOTAL
DETOUR SCHEME III - THREE LANES 32ND ST				
Demolition	Job	1	$15,000	$15,000
Excavation- Roadway	CY	0	$3	$0
Fill- Roadway	CY	0	$4	$0
Precast Girders (Used)	EA	0	$500	$0
Precast Girders (New)	EA	0	$0	$0
Excavation- Foundation	CY	0	$8	$0
Concrete- Foundation	CY	0	$300	$0
Aggregate Base	T	1280	$14	$17,920
Paving	T	550	$28	$15,400
Barriers Furnish/ Install	LF	1700	$15	$25,500
Striping	LF	5000	$2.10	$10,500
Traffic Control- Temp	MO	7	$9,000	$63,000
Removal of Detour	Job	1	$11,100	$11,100
Landscaping	Job	1	$3,000	$3,000
		Total		$161,420

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
32ND ST BRIDGE OVER ACDC
COST ESTIMATES

26-Jul-89
TLA

FILE: FCDCOSTS.WK1

	UNIT	QTY	UNIT PRICE	TOTAL
BRIDGE ALTERNATIVE 1				
PRECAST BRIDGE DECK				
Excavation	CY	220	$10	$2,200
Drilled Shafts 36"	LF	990	$89	$88,110
Concrete incl form/reinf	CY	400	$200	$80,000
Reinforcing	LBS	80000	$0.50	$40,000
Precast Bridge Beams	EA	29	$3,650	$105,850
		Total		$316,160
BRIDGE ALTERNATIVE 2				
RIGID BOX BRIDGE				
Excavation	CY	7700	$10	$77,000
Backfill	CY	3600	$12	$43,200
Concrete incl forms/reinf	CY	1150	$200	$230,000
Reinforcing	LBS	300000	$0.50	$150,000
Aggregate Base	T	260	$14	$3,640
Paving	T	50	$28	$1,400
		Subtotal		$505,240
Less portion paid by Corps of Engineers				($386,200)
		Total		$119,040

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
32ND ST BRIDGE OVER ACDC
COST ESTIMATES

26-Jul-89
TLA

FILE: FCDCOSTS.WK1

	UNIT	QTY	UNIT PRICE	TOTAL
BRIDGE ALTERNATIVE 1				
PRECAST BRIDGE DECK				
Excavation	CY	220	$10	$2,200
Drilled Shafts 36"	LF	990	$89	$88,110
Concrete incl form/reinf	CY	400	$200	$80,000
Reinforcing	LBS	80000	$0.50	$40,000
Precast Bridge Beams	EA	29	$3,650	$105,850
		Total		$316,160
BRIDGE ALTERNATIVE 2				
RIGID BOX BRIDGE				
Excavation	CY	7700	$10	$77,000
Backfill	CY	3600	$12	$43,200
Concrete incl forms/reinf	CY	1150	$200	$230,000
Reinforcing	LBS	300000	$0.50	$150,000
Aggregate Base	T	260	$14	$3,640
Paving	T	50	$28	$1,400
		Subtotal		$505,240
Less portion paid by Corps of Engineers				($386,200)
		Total		$119,040

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
32ND ST BRIDGE OVER ACDC
COST ESTIMATES

26-Jul-89
TLA

FILE: FCDCOSTS.WK1

	UNIT	QTY	UNIT PRICE	TOTAL
35TH ST WASH ALTERNATIVES				
CONDUIT ALTERNATIVE 1				
TRIPLE BARREL BOX 3-8x7				
Clearing	Job	1	$5,000	$5,000
Utility Support	Job	1	$30,000	$30,000
Excavation	CY	9300	$8	$74,400
Backfill	CY	4600	$10	$46,000
Backfill- Granular	CY	0	$14	$0
Concrete	CY	1400	$200	$280,000
Reinforcing	LBS	223000	$0.50	$111,500
Riprap- Grouted	SY	600	$25	$15,000
Headwall- Conc & Reinf	Job	1	$4,600	$4,600
Misc. Removals	Job	1	$5,000	$5,000
Earth Berm	CY	430	$4	$1,720
		Total		$573,220
CONDUIT ALTERNATIVE 2				
SINGLE BOX 1- 16x10				
Clearing	Job	1	$5,000	$5,000
Utility Support	Job	1	$30,000	$30,000
Excavation	CY	11600	$8	$92,800
Backfill	CY	6800	$10	$68,000
Backfill- Granular	CY	0	$14	$0
Concrete	CY	1560	$200	$312,000
Reinforcing	LBS	239000	$0.50	$119,500
Riprap- Grouted	SY	600	$25	$15,000
Headwall- Conc & Reinf	Job	1	$3,900	$3,900
Misc. Removals	Job	1	$5,000	$5,000
Earth Berm	CY	430	$4	$1,720
		Total		$652,920
CONDUIT ALTERNATIVE 3				
DOUBLE BOX 2- 10x8				
Clearing	Job	1	$5,000	$5,000
Utility Support	Job	1	$30,000	$30,000
Excavation	CY	9900	$8	$79,200
Backfill	CY	5400	$10	$54,000
Backfill- Granular	CY	0	$14	$0
Concrete	CY	1320	$200	$264,000
Reinforcing	LBS	196000	$0.50	$98,000
Riprap- Grouted	SY	600	$25	$15,000
Headwall- Conc & Reinf	Job	1	$4,250	$4,250
Misc. Removals	Job	1	$5,000	$5,000
Earth Berm	CY	430	$4	$1,720
		Total		$556,170

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
32ND ST BRIDGE OVER ACDC
COST ESTIMATES

26-Jul-89
TLA

FILE: FCDCOSTS.WK1

	UNIT	QTY	UNIT PRICE	TOTAL
CONDUIT ALTERNATIVE 4				
DOUBLE RCP - 10' DIAMETER				
Clearing	Job	1	$5,000	$5,000
Utility Support	Job	1	$30,000	$30,000
Excavation	CY	11000	$8	$88,000
Backfill	CY	2770	$10	$27,700
Backfill- Granular	CY	3870	$14	$54,180
Conduit- RCP	LF	1075	$290	$311,750
Riprap- Grouted	SY	600	$25	$15,000
Headwall- Conc & Reinf	Job	1	$6,850	$6,850
Misc. Removals	Job	1	$5,000	$5,000
Earth Berm	CY	430	$4	$1,720
		Total		$545,200
CONDUIT ALTERNATIVE 5				
DOUBLE CMP - 11' DIAMETER				
Clearing	Job	1	$5,000	$5,000
Utility Support	Job	1	$30,000	$30,000
Excavation	CY	10260	$8	$82,080
Backfill	CY	2860	$10	$28,600
Backfill- Granular	CY	3500	$14	$49,000
Conduit- 3x1 CMP	LF	1075	$150	$161,250
Riprap- Grouted	SY	600	$25	$15,000
Headwall- Conc. & Reinf.	Job	1	$6,550	$6,550
Misc. Removals	Job	1	$5,000	$5,000
Earth Berm	CY	430	$4	$1,720
		Total		$384,200

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
32ND ST BRIDGE OVER ACDC
COST ESTIMATES

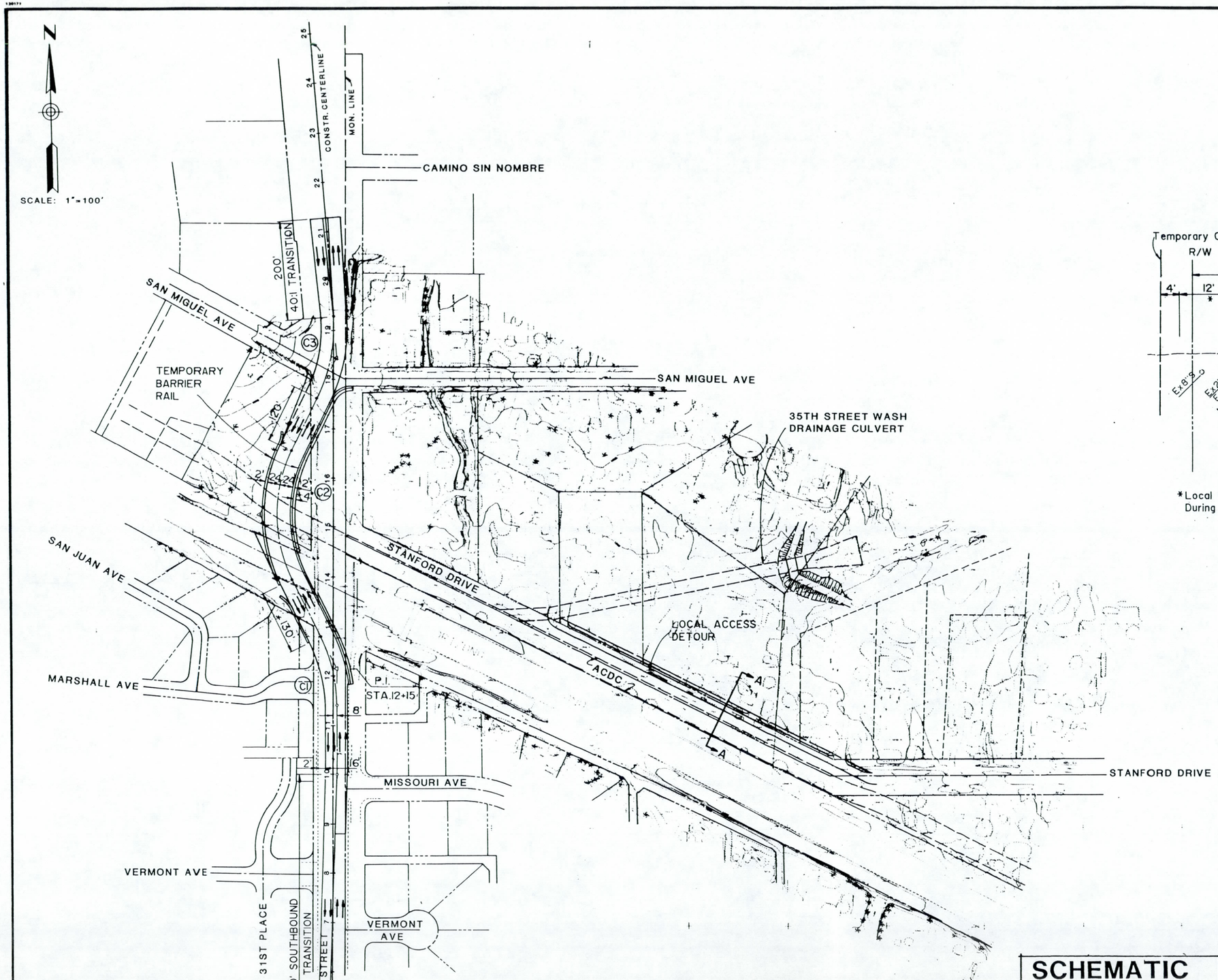
26-Jul-89
TLA

FILE: FCDCOSTS.WK1

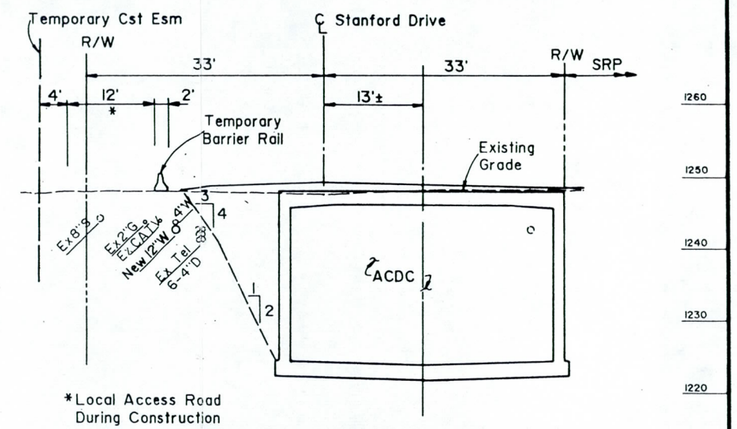
	UNIT	QTY	UNIT PRICE	TOTAL
SEWER ALTERNATIVE 1 - SIPHON				
VCP - 10"	LF	270	$25	$6,750
Manholes- Special 5'	EA	2	$2,200	$4,400
Siphon Structure	EA	2	$10,000	$20,000
Siphon Pipe- Encased	LF	115	$380	$43,700
Pavemt Removal/ Replacmt	SY	50	$36	$1,800
Misc Removals	Job	1	$10,000	$10,000
Maint (3% over 30 yrs)	Job	1	$36,000	$36,000
		Total		$122,650
SEWER ALTERNATIVE 2 - LIFT STATION				
VCP - 10"	LF	300	$25	$7,500
Package Pump Sta	EA	1	$34,000	$34,000
Manhole- 5'	EA	3	$2,500	$7,500
PVC Pipe 6"	LF	150	$18	$2,700
Masonry Wall	LF	190	$65	$12,350
Gate	EA	1	$500	$500
Pavement Removal/ Replacemt	SY	50	$36	$1,800
Oper Maint(3% over 30 yrs)	Job	1	$72,000	$72,000
		Total		$138,350
SEWER ALTERNATIVE 3				
GRAVITY SEWER IN 32ND ST TO ALLEY S. OF MEDLOCK DR				
VCP- 10"-500' Encased	LF	2550	$65	$165,750
Manholes	EA	8	$3,000	$24,000
Pavement Removal/ Replacemt	SY	600	$36	$21,600
Canal Lining	SY	270	$20	$5,400
Misc Removals	Job	1	$10,000	$10,000
		Total		$226,750
SEWER ALTERNATIVE 4				
GRAVITY SEWER ALONG ACDC TO BILTMORE GATE SUBDIVISION				
VCP- 10"	LF	2800	$25	$70,000
Manhole- Under 15-ft	EA	8	$2,500	$20,000
Pavement Removal/ Replacemt	SY	110	$36	$3,960
Misc Removals	Job	1	$10,000	$10,000
		Total		$103,960 *

* Costs to increase sewer capacity to 24th Street (if required) are not included.

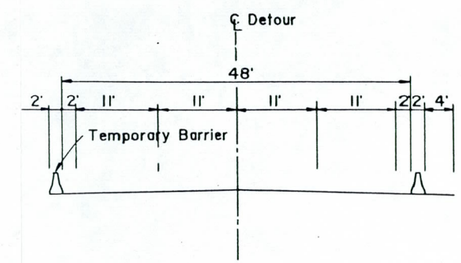
	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
	ARIZ.				



CURVE DATA				
NO.	Δ	R	T	L
C1	26°32'07.1"	300'	70.7382'	138.9385'
C2	52°30'00"	300'	147.9400'	274.8900'
C3	30°57'52.9"	300'	83.0978'	162.1308'



STANFORD DRIVE
SECTION A-A
LOOKING EAST
SCALE: 1"=10'



32ND STREET
TYPICAL DETOUR CROSS SECTION

NOTE: THIS PRINT 1/2 SIZE. ALL SCALES 1/2 OF SCALE INDICATED.

SCHEMATIC
NOT FOR CONSTRUCTION USE

DETOUR SCHEME I

DESIGN	HEG
DRAWN	VAD
CHECKED	
APPROVED	

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Ave. Phoenix, AZ 85003 Phone: 602 258 3175

32ND STREET BRIDGE
OVER THE ACDC
CONCEPT DESIGN STUDY PHASE I
MCFCD

APPENDIX B

DWG. NO. 1

STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
ARIZ.				

SCALE: 1"=100'

CAMINO SIN NOMBRE

CONSTR CENTERLINE

MON. LINE

360' 40:1 TRANSITION

SAN MIGUEL AVE

TEMPORARY BARRIER RAIL

ACDC

PHASE I

PHASE II

SEE NOTE B

SEE NOTE A

SAN JUAN AVE

STANFORD DRIVE

35TH STREET WASH DRAINAGE CULVERT

LOCAL ACCESS DETOUR

MARSHALL AVE

P.I. STA.12+40

MISSOURI AVE

STANFORD DRIVE

VERMONT AVE

31ST PLACE

440' 40:1 TRANSITION

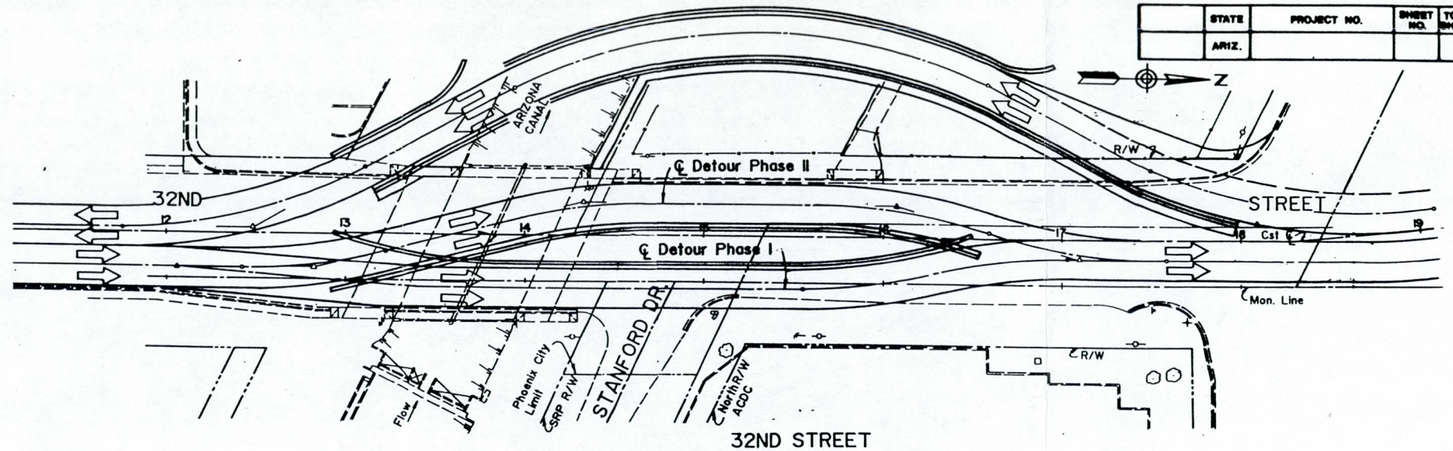
32ND STREET

VERMONT AVE

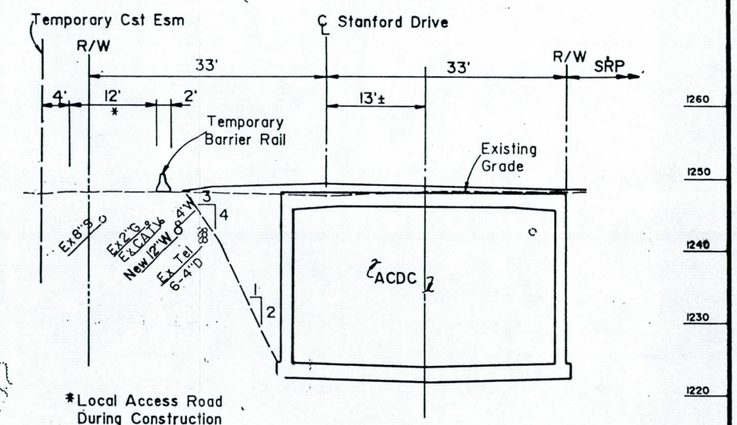
Note A: Southbound Only - Two Lanes

Note B: Construct ACDC Structure in two phases. Alternate Northbound traffic (2 lanes) on east side and west side of existing 32nd Street alignment.

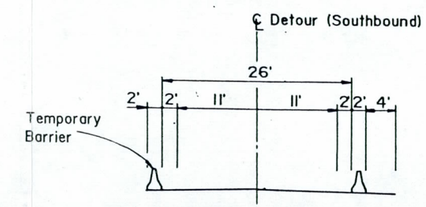
SCHEMATIC
NOT FOR CONSTRUCTION USE



32ND STREET
DETOUR ALIGNMENT
SCALE: 1" = 40'



STANFORD DRIVE
SECTION A-A
LOOKING EAST
SCALE: 1"=10'



32ND STREET
TYPICAL DETOUR CROSS SECTION

NOTE: THIS PRINT 1/2 SIZE. ALL SCALES 1/2 OF SCALE INDICATED.

CURVE DATA

NO.	Δ	R	T	L
C1	26°32'07.1"	300'	70.7382'	138.9385'
C2	52°30'00"	300'	147.9400'	274.8900'
C3	30°57'52.9"	300'	83.0978'	162.1308'

DESIGN HEG
DRAWN VAD
CHECKED
APPROVED

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Ave. Phoenix, AZ 85003 Phone: 602 258 3175

32ND STREET BRIDGE
OVER THE ACDC
CONCEPT DESIGN STUDY PHASE I
MCFCD

DETOUR
SCHEME II

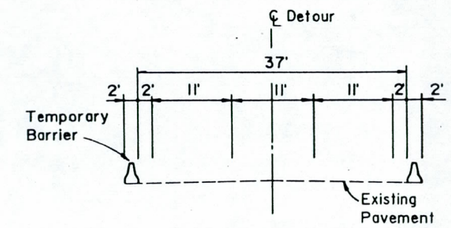
APPENDIX B

DWG. NO. 2

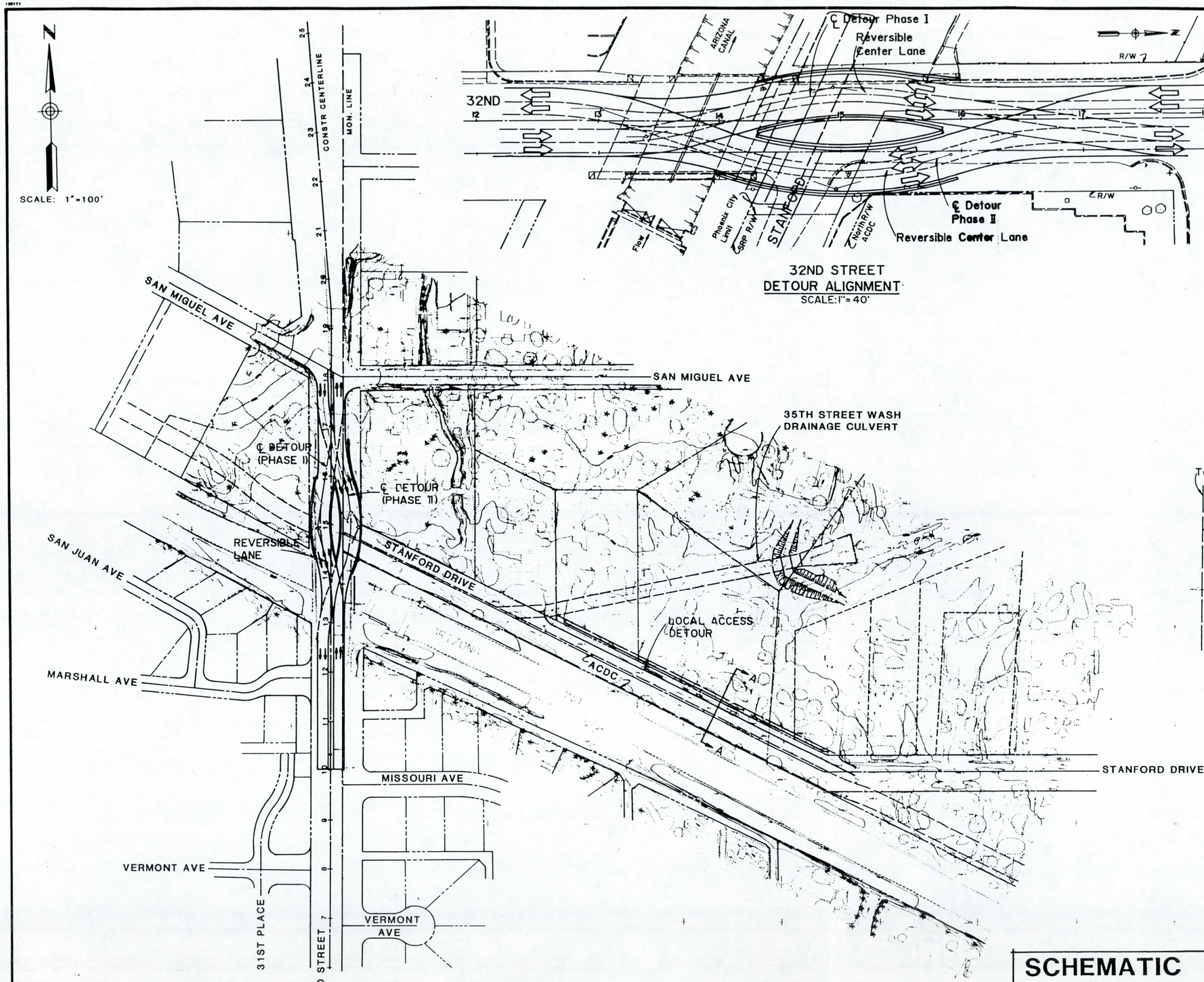
	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
	ARIZ.				

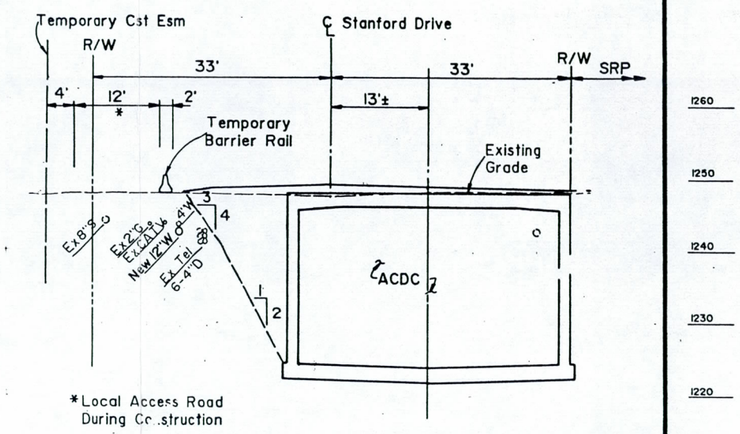
SCALE: 1"=100'

32ND STREET
DETOUR ALIGNMENT
SCALE: 1"=40'



32ND STREET
TYPICAL DETOUR CROSS SECTION





*Local Access Road During Construction

STANFORD DRIVE
SECTION A-A
LOOKING EAST
SCALE: 1"=10'

NOTE: THIS PRINT 1/2 SIZE. ALL SCALES 1/2 OF SCALE INDICATED.

SCHEMATIC
NOT FOR
CONSTRUCTION USE

DETOUR
SCHEME III

DESIGN	HEG
DRAWN	VAD
CHECKED	
APPROVED	

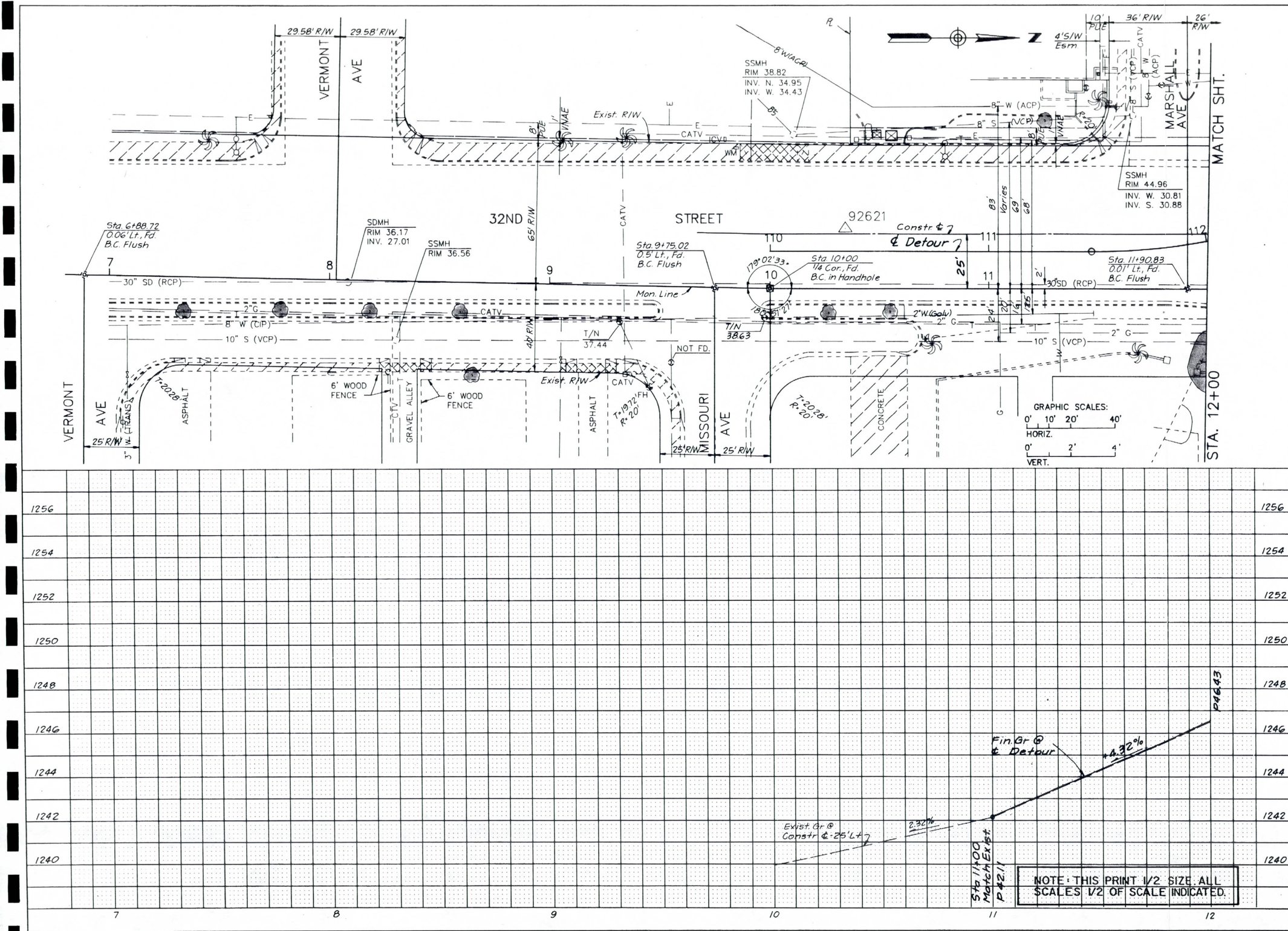
CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Ave. Phoenix, AZ 85003 Phone: 602 258 3175

32ND STREET BRIDGE
OVER THE ACDC
CONCEPT DESIGN STUDY PHASE I
MCFCD

APPENDIX B

DWG. NO. 3

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			



NOTE: THIS PRINT 1/2 SIZE. ALL SCALES 1/2 OF SCALE INDICATED.

SCHEMATIC
NOT FOR CONSTRUCTION USE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

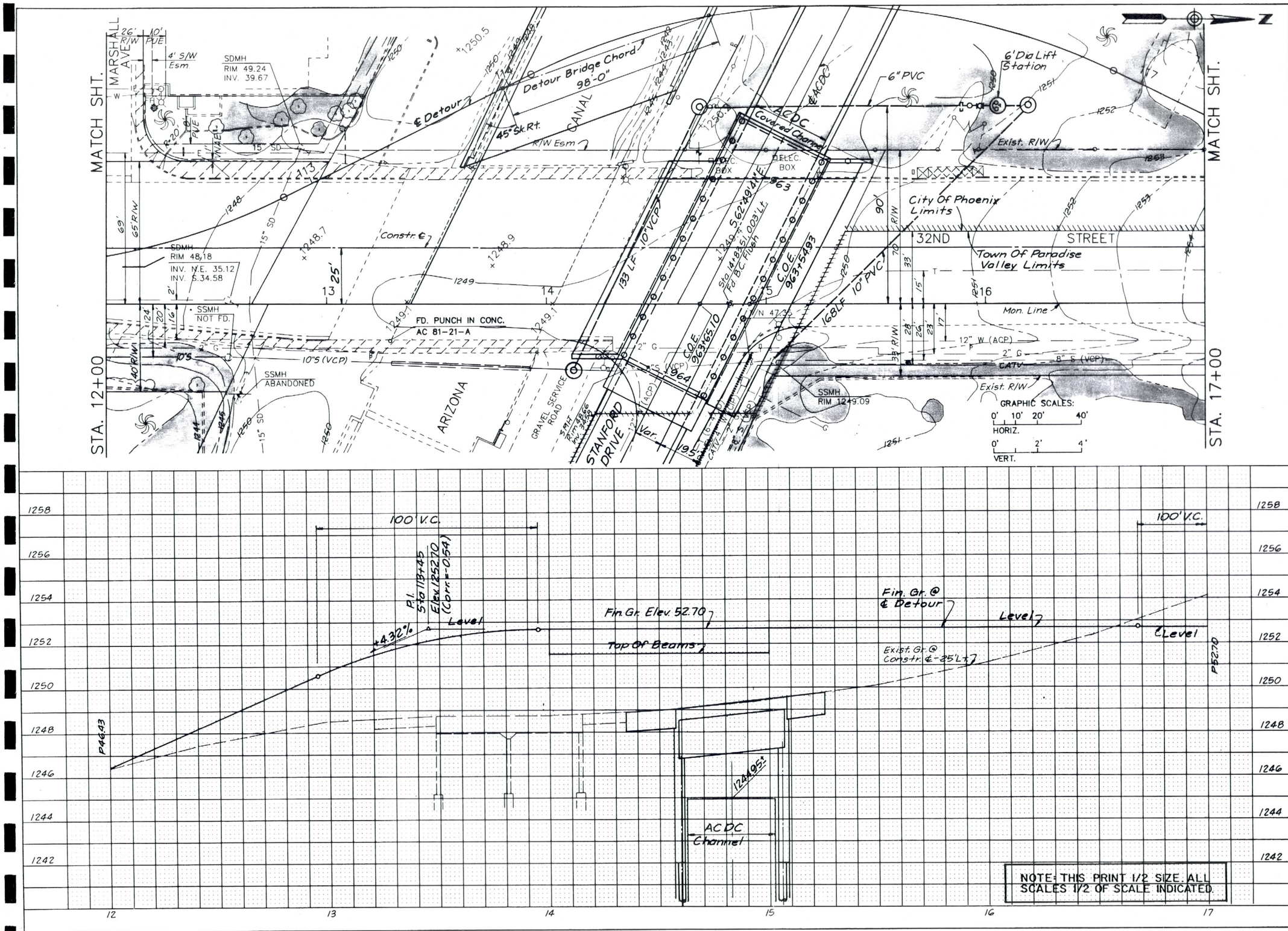
PROJECT DESCRIPTION:
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

SHEET TITLE:
32ND STREET

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD DATE: 7/89	SCALE	SHEETS
DES: VAD DATE: 7/89	1" = 20' HORIZONTAL	
CKD: HEG DATE: 7/89	1" = 2' VERTICAL	NO. 1 OF 8

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			



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FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

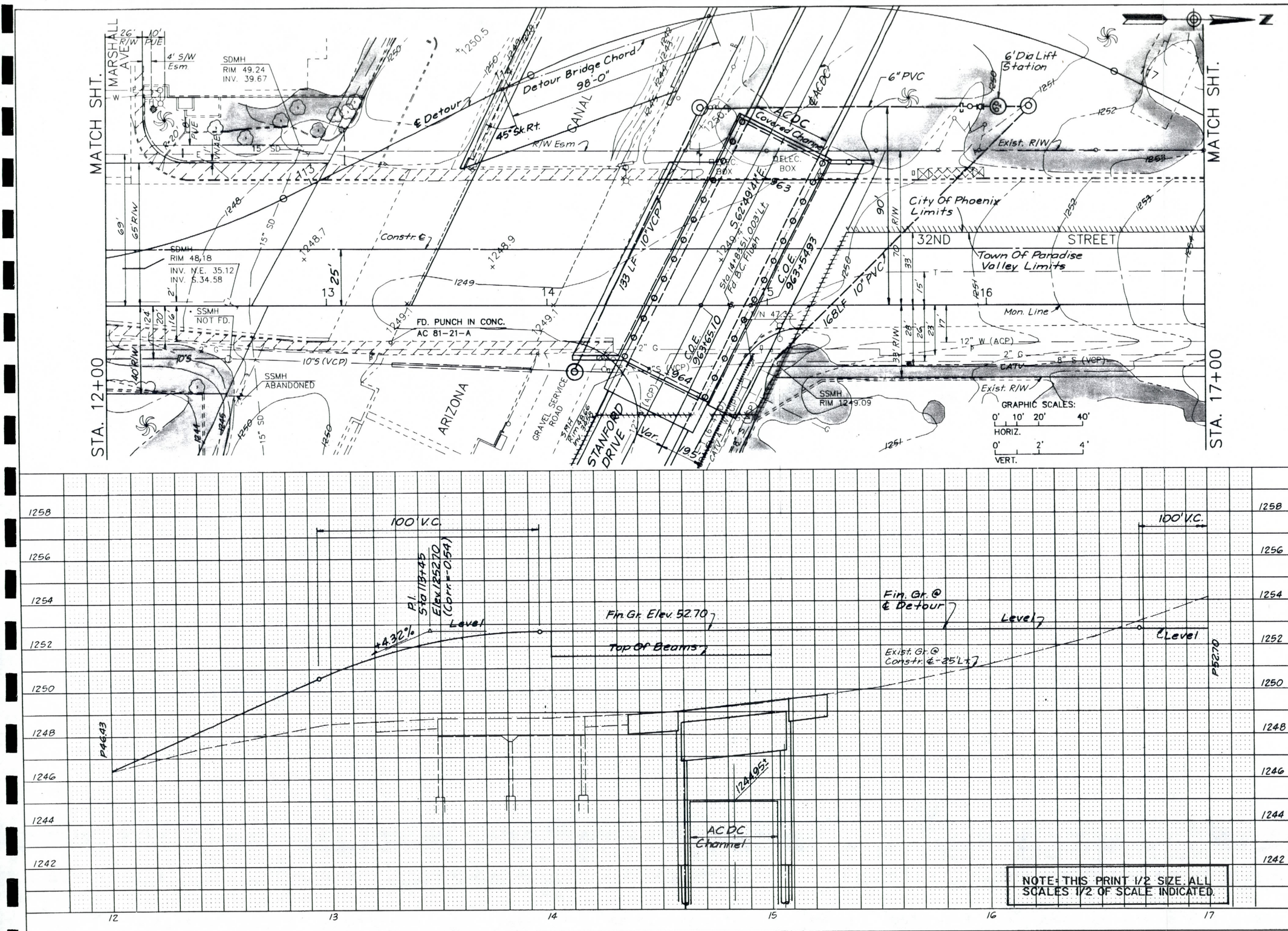
PROJECT DESCRIPTION:
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

SHEET TITLE:
32ND STREET

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD	DATE: 7/89	SCALE	SHEETS
DES: VAD	DATE: 7/89	1" = 20' HORIZONTAL	NO. 2 OF 8
CKD: HEG	DATE: 7/89	1" = 2' VERTICAL	

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			



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FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

PROJECT DESCRIPTION
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

SHEET TITLE
32ND STREET

CREEGAN + D'ANGELO
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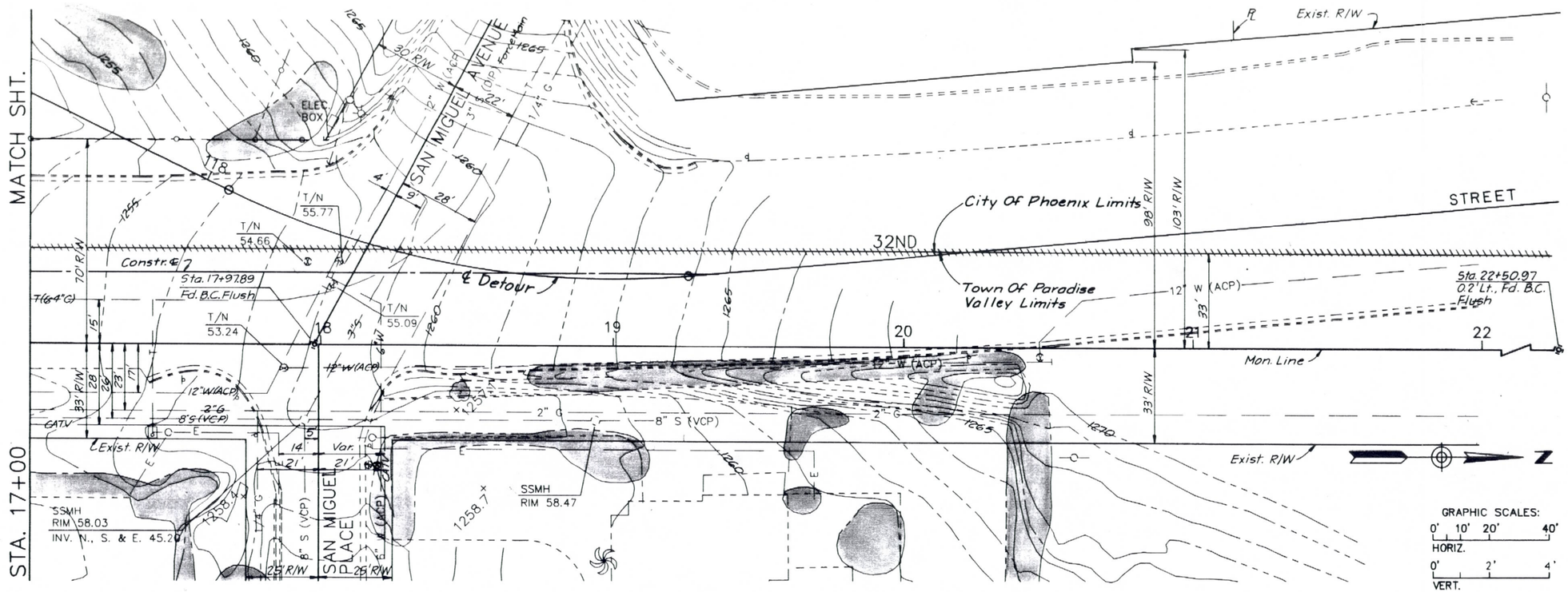
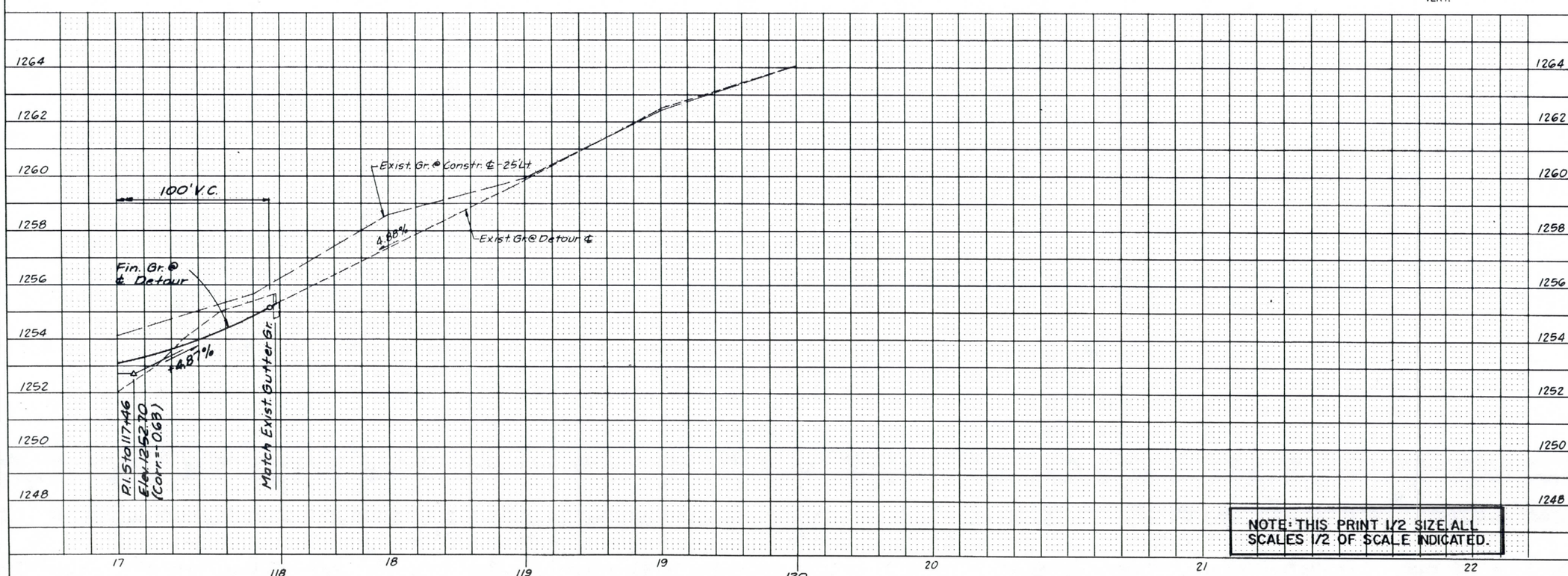
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD DATE: 7/89	SCALE	SHEETS
DES: VAD DATE: 7/89	1" = 20' HORIZONTAL	
CKD: HEG DATE: 7/89	1" = 2' VERTICAL	NO. 2 OF 8

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			





SCHEMATIC
NOT FOR CONSTRUCTION USE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

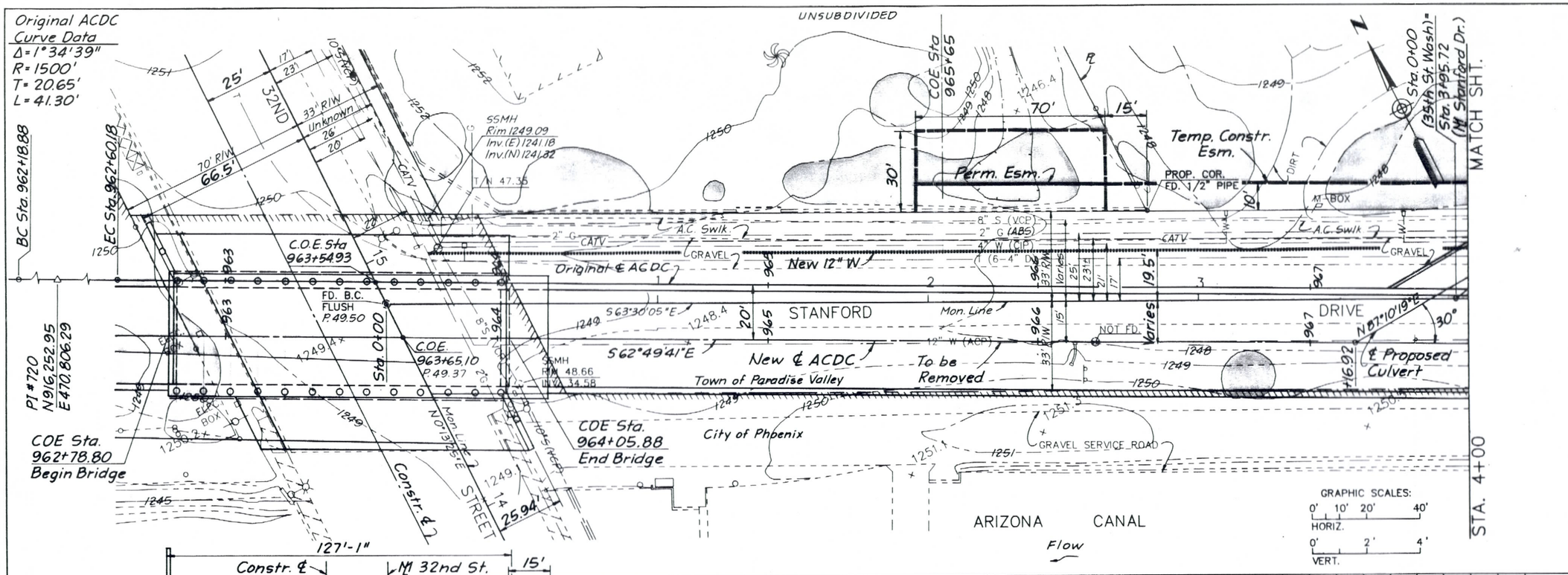
PROJECT DESCRIPTION
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

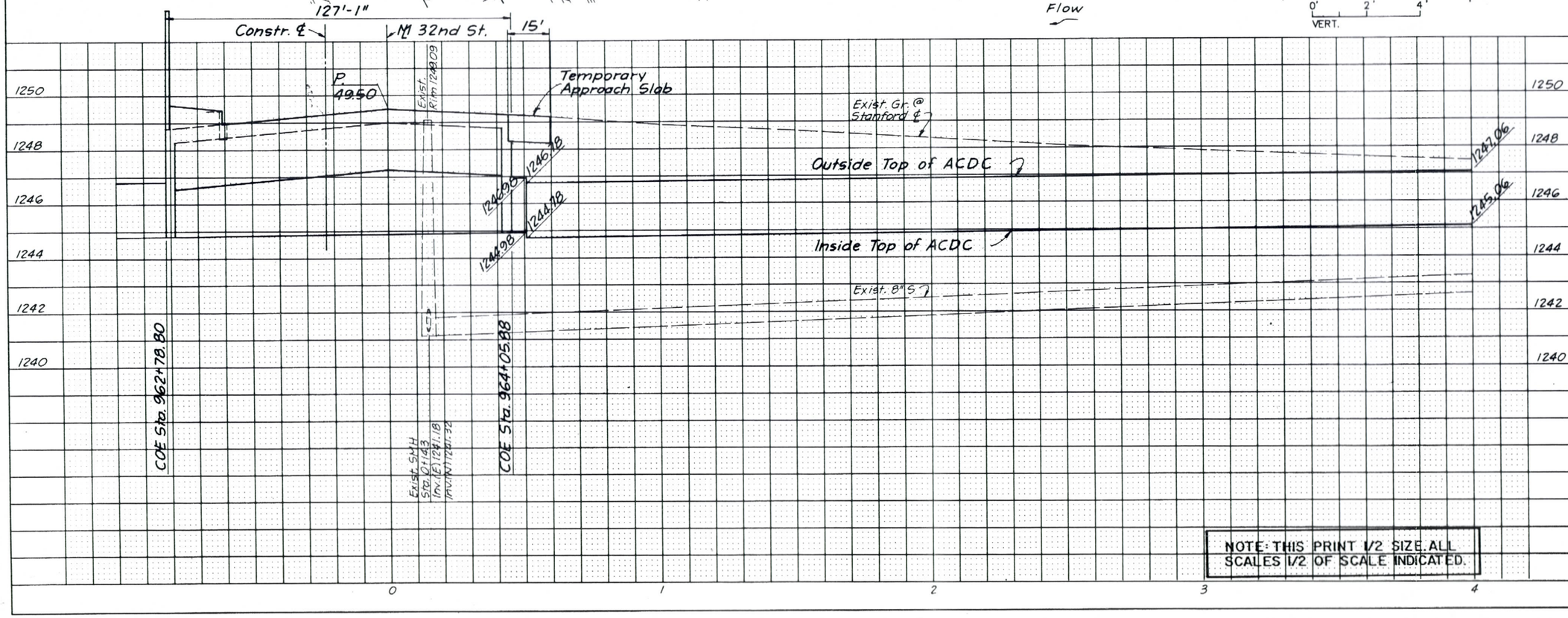
SHEET TITLE
32ND STREET

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD	DATE: 7/89	SCALE	SHEETS
DES: VAD	DATE: 7/89	1" = 20' HORIZONTAL	
CKD: HEG	DATE: 7/89	1" = 2' VERTICAL	NO. 3 OF 8

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			





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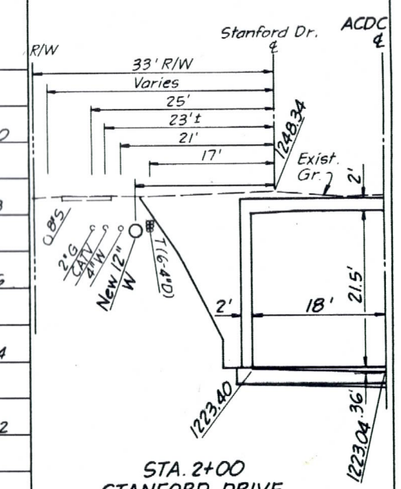


STA. 2+00
STANFORD DRIVE
(Looking East)
Scale: 1"=10'

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

PROJECT DESCRIPTION
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

SHEET TITLE
STANFORD DRIVE

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD DATE: 7/89	SCALE	SHEETS
DES: VAD DATE: 7/89	1" = 20' HORIZONTAL	
CKD: HEG DATE: 7/89	1" = 2' VERTICAL	NO. 4 OF 8

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			

Original ACDC Curve Data
Δ = 1°34'39"
R = 1500'
T = 20.65'
L = 41.30'

UNSUBDIVIDED

BC Sta. 962+18.88
EC Sta. 962+60.18
PI #720
N916,252.95
E470,806.29
COE Sta. 962+78.80
Begin Bridge

25' 17' 23' 32ND 33' R/W Unknown 26' 20' 70' R/W 66.5'

SSMH Rim 1249.09 Inv.(E) 1241.18 Inv.(N) 1241.32

T.N. 47.35

C.O.E. Sta 963+54.93

FD. B.C. FLUSH P.49.50

C.O.E. 963+65.10 P.49.37

Sta. 0+00

SSMH RIM 48.66 INV. 34.58

Mon. Line N0°13'35"E

Constr. ℄

COE Sta. 964+05.88 End Bridge

City of Phoenix

STREET

Perm. Esm.

COE Sta 965+65

70' 15' 30'

Temp. Constr. Esm.

PROP. COR. FD. 1/2" PIPE

DIRT

M-BOX

Sta. 0+00 (35th St. Wash) = Sta. 3+95.72 (M Stanford Dr.)

MATCH SHT.

A.C. Swlk.

CATV

GRAVEL

2" G

8" S (VCP)
2" G (ABS)
4" W (CIP)
(6-4" D)

Original ℄ ACDC

New 12" W

S63°30'05"E

STANFORD DRIVE

Mon. Line

S62°49'41"E

New ℄ ACDC

Town of Paradise Valley

12" W (ACP)

To be Removed

NOT FD.

Varies 19.5' 25' 23'± 21' 17' 15' 20'

N87°10'19"E 30°

℄ Proposed Culvert

GRAVEL SERVICE ROAD

ARIZONA CANAL

Flow

STA. 4+00

GRAPHIC SCALES:
HORIZ. 0' 10' 20' 40'
VERT. 0' 2' 4'

127'-1"

Constr. ℄ M 32nd St. 15'

P. 49.50

Exist. Rim 1249.09

Temporary Approach Slab

Exist. Gr. @ Stanford ℄

Outside Top of ACDC

Inside Top of ACDC

Exist. 8" S

1250 1248 1246 1244 1242 1240

1246.18 1244.98 1244.18 1247.06 1245.06

COE Sta. 962+78.80

Exist. SMH Sta. 0+143 Inv.(E) 1241.18 Inv.(N) 1241.32

COE Sta. 964+05.88

0 1 2 3 4

NOTE: THIS PRINT 1/2 SIZE. ALL SCALES 1/2 OF SCALE INDICATED.

SCHEMATIC
NOT FOR CONSTRUCTION USE

Stanford Dr. ℄ ACDC ℄
R/W 33' R/W Varies 25' 23'± 21' 17'
1248.34
Exist. Gr.
2' 2' 18' 21.5'
0.85
2" G CATV 4" W
New 12" W
T(6-4" D)
1223.40
1223.04.36

STA. 2+00
STANFORD DRIVE
(Looking East)
Scale: 1" = 10'

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

PROJECT DESCRIPTION
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

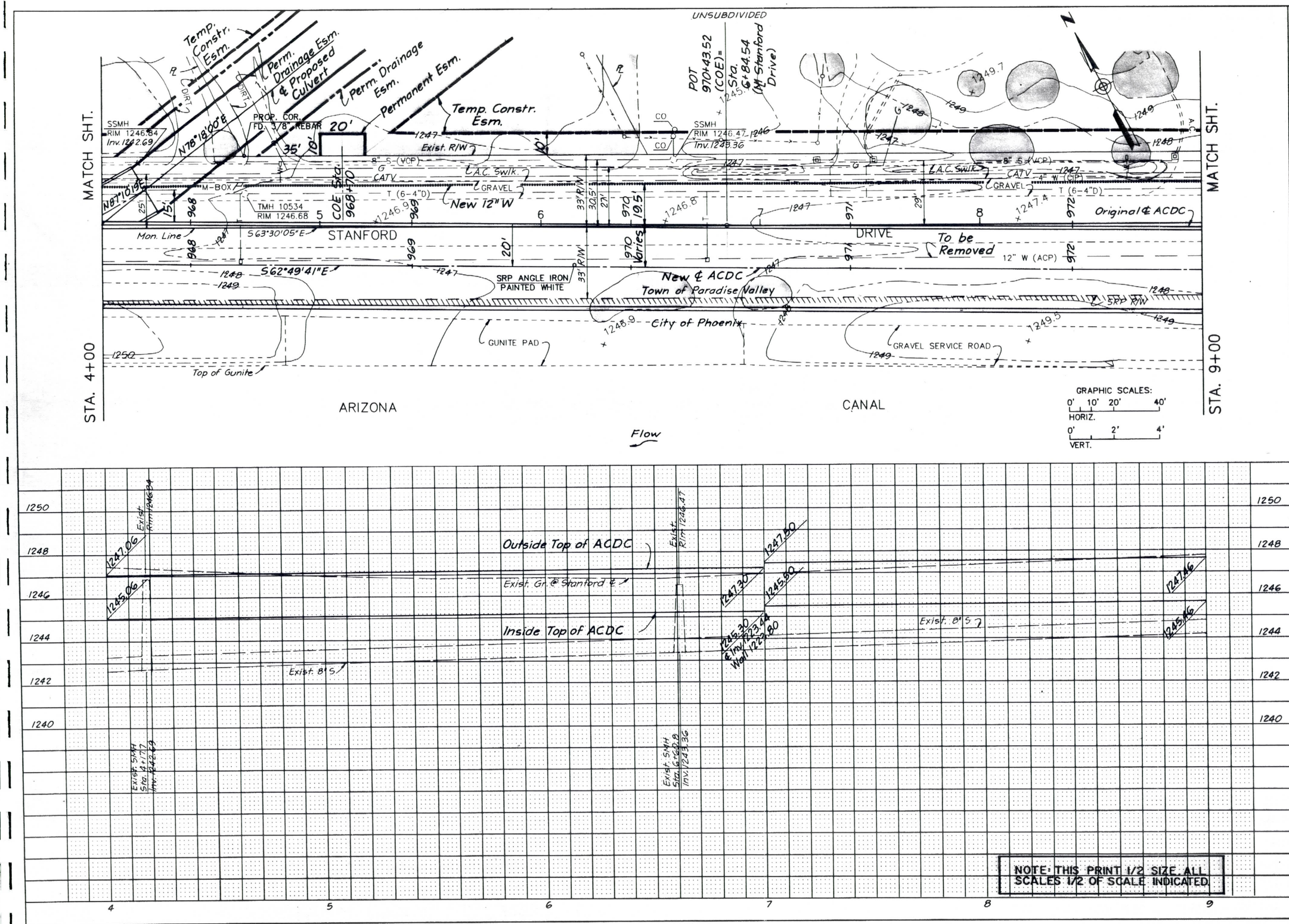
SHEET TITLE
STANFORD DRIVE

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 256-3175

DRN: CD DATE: 7/89	SCALE		SHEETS
DES: VAD DATE: 7/89	1" = 20'	HORIZONTAL	NO. 4 OF 8
CKD: HEG DATE: 7/89	1" = 2'	VERTICAL	

APPENDIX C

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			



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SCHEMATIC
NOT FOR CONSTRUCTION USE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

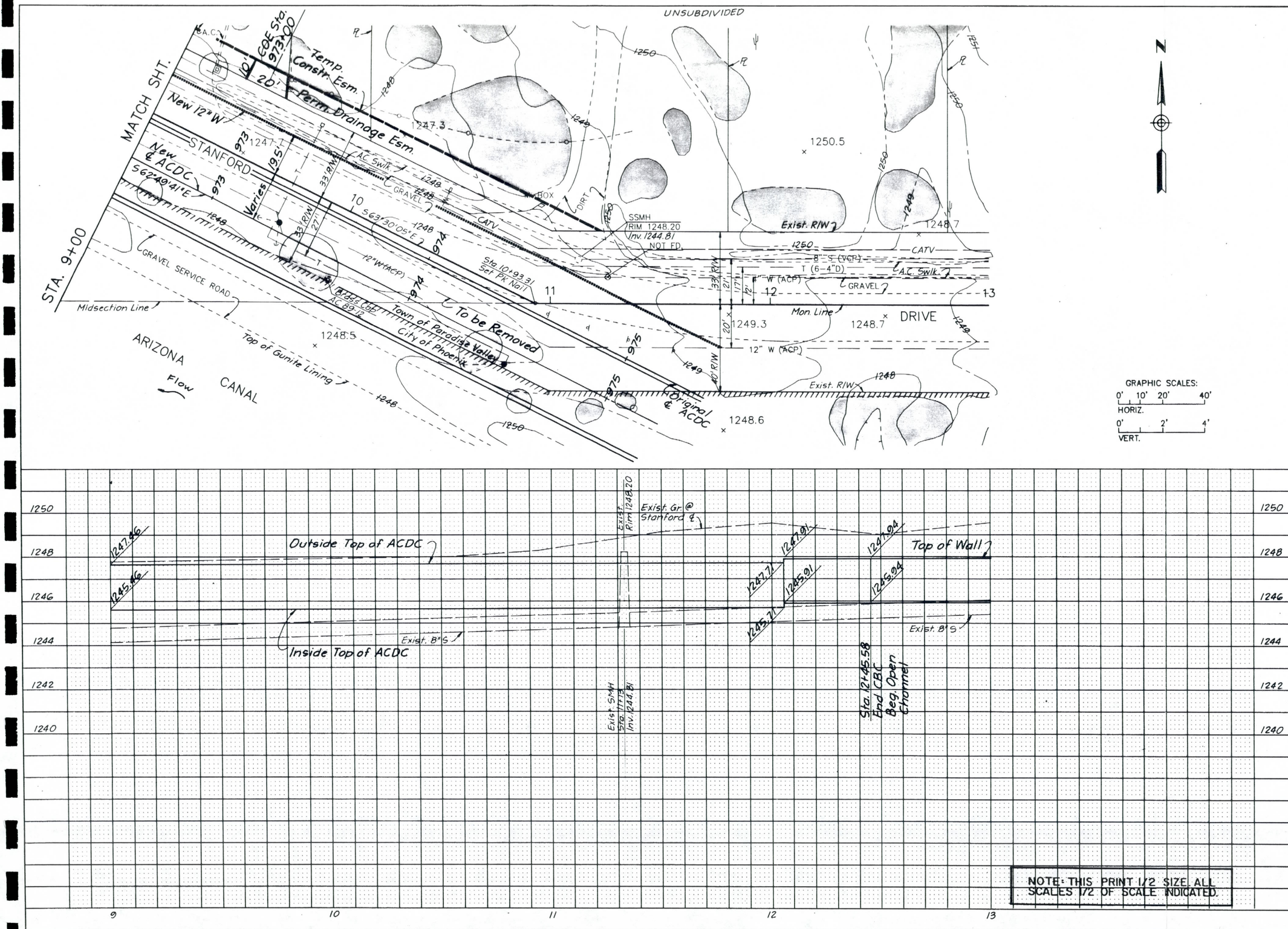
PROJECT DESCRIPTION:
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

SHEET TITLE:
STANFORD DRIVE

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD DATE: 7/89	SCALE	SHEETS
DES: VAD DATE: 7/89	1" = 20' HORIZONTAL	NO. 5 OF 8
CKD: HEG DATE: 7/89	1" = 2' VERTICAL	

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			



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NOT FOR CONSTRUCTION USE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

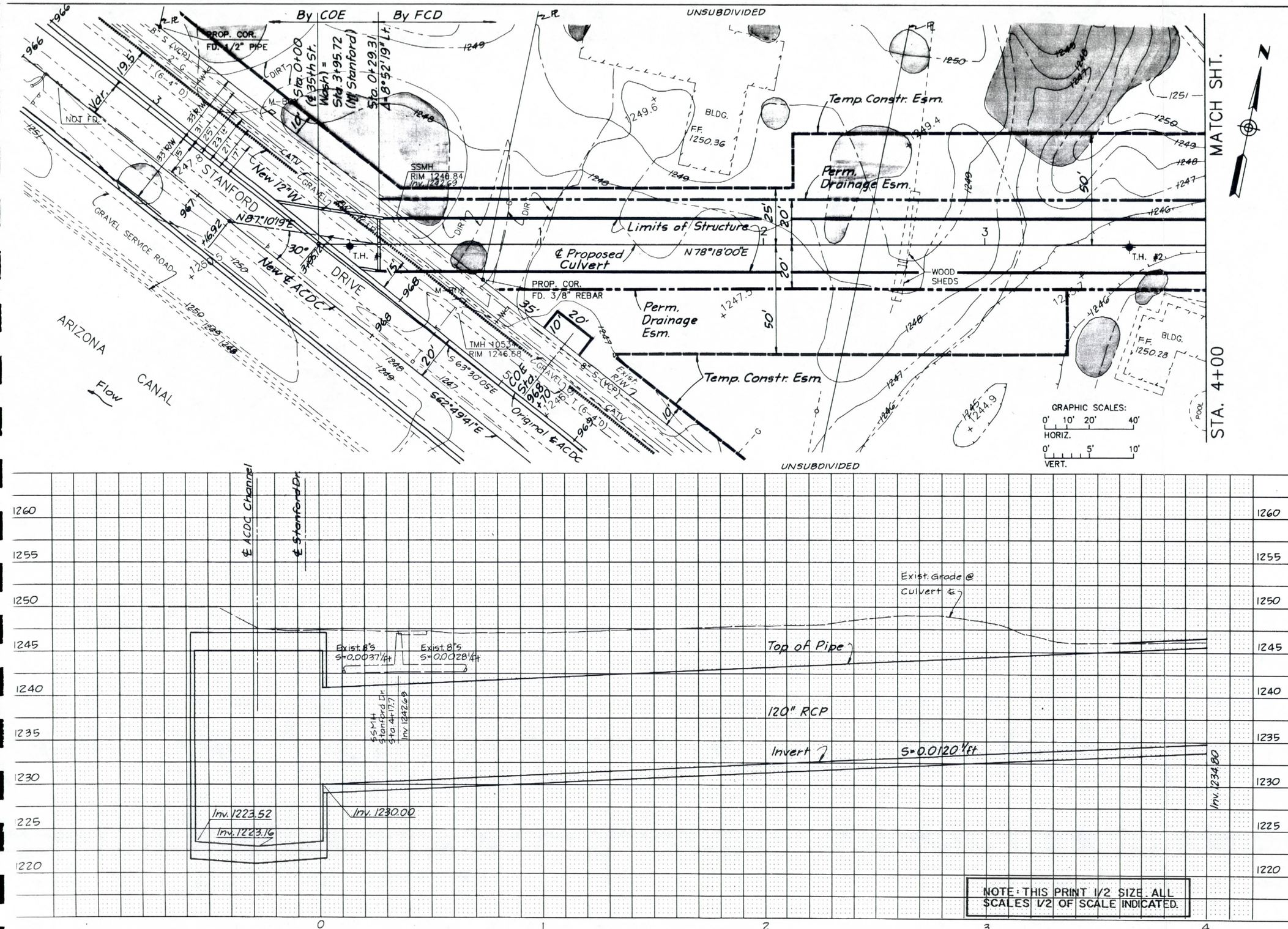
PROJECT DESCRIPTION
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

SHEET TITLE
STANFORD DRIVE

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD DATE: 7/89	SCALE	SHEETS
DES: VAD DATE: 7/89	1" = 20' HORIZONTAL	
CKD: HEG DATE: 7/89	1" = 2' VERTICAL	NO. 6 OF 8

PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			



SCHEMATIC
NOT FOR CONSTRUCTION USE

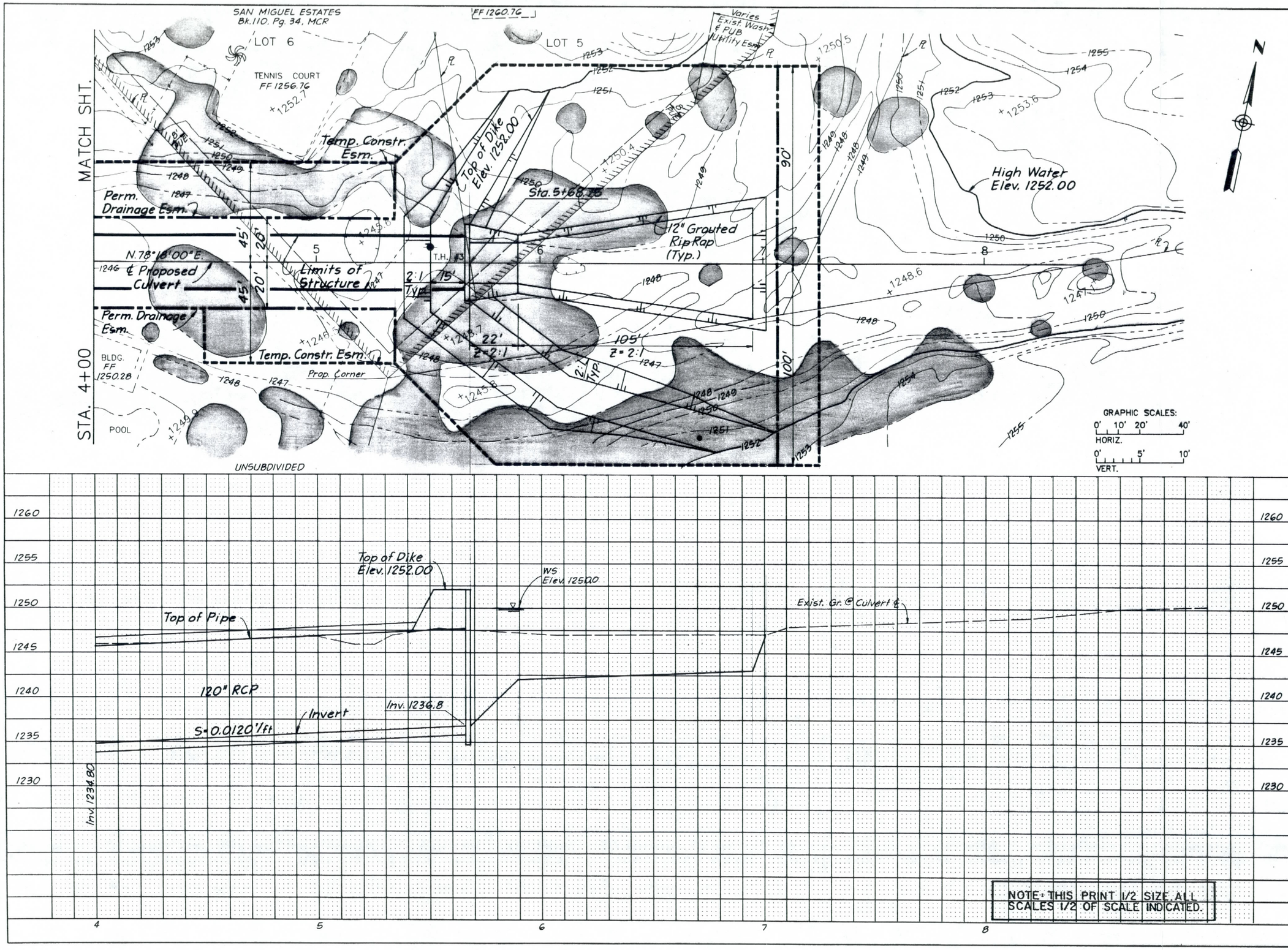
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

PROJECT DESCRIPTION
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

SHEET TITLE
35TH STREET WASH CULVERT

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD DATE: 7/89	SCALE		SHEETS
DES: VAD DATE: 7/89	1" = 20'	HORIZONTAL	
CKD: HEG DATE: 7/89	1" = 5'	VERTICAL	NO. 7 OF 8



PROJ. NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
F.C.D. 88-42			

SCHEMATIC
NOT FOR
CONSTRUCTION USE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

PROJECT DESCRIPTION
RELOCATIONS FOR THE ARIZONA CANAL DIVERSION CHANNEL AT 32ND STREET

SHEET TITLE
35TH STREET WASH CULVERT

CREEGAN + D'ANGELO
Engineers · Planners · Surveyors
650 North Second Avenue Phoenix, AZ 85003 Phone: 602 258-3175

DRN: CD DATE: 7/89	SCALE	SHEETS
DES: VAD DATE: 7/89	1" = 20' HORIZONTAL	
CKD: HEG DATE: 7/89	1" = 5' VERTICAL	NO. 8 OF 8

APPENDIX C

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET BRIDGE		JOB NO. 889013.45	
		BY VAD	DATE 1/12/90
		REVWD. MS	DATE 1/15/90
		REVISED	

32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE

SUPPLEMENT TO
INLET HYDRAULICS
FOR
FLOOD CONTROL DISTRICT OF MARICOPA CO.

JANUARY 1990

FLOOD CONTROL DISTRICT
RECEIVED
JAN 17 1990

	CH ENG		P & PM
	DEP		HYDRO
	ADMIN		LMGT
	FINANCE		FILE
	C & O		
	ENGR		

REMARKS

PREPARED BY:

CREEGAN + D'ANGELO
650 N. 2ND AVE
PHOENIX, ARIZONA 85003

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND ST - RECONSTRUCTION OF STANFORD DRIVE		JOB NO. 88901B.45
		BY VAD DATE 1/12/90
		REVWD. MJS DATE 1/15/90
		REVISED

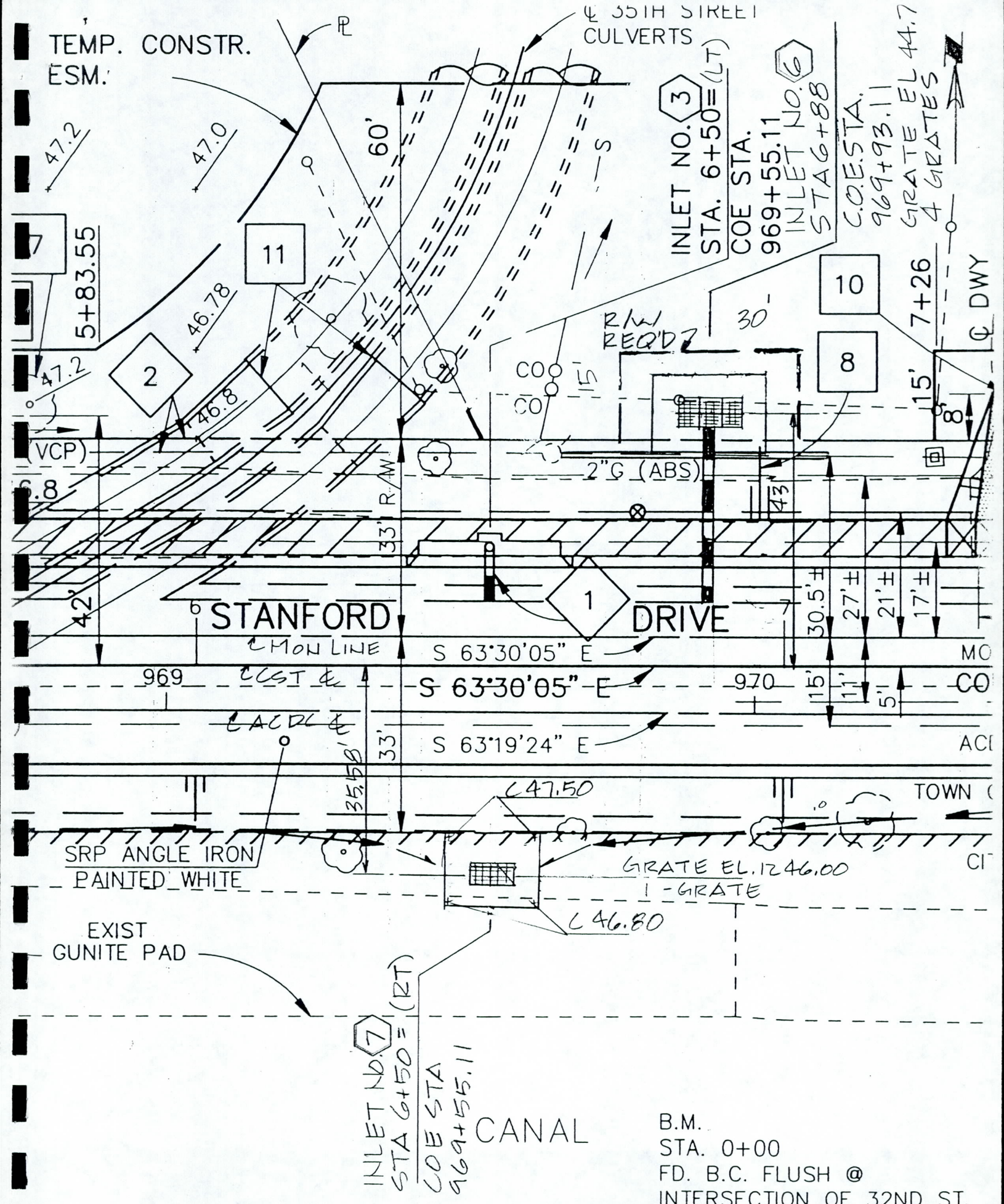
TABLE OF CONTENTS

1. CULVERT ANALYSIS & SIZING FOR INLET SOUTH OF NEW STANFORD AT SUMP, STA 6+50 RT, (NO. 7)

2. CULVERT ANALYSIS & SIZING FOR DRAINAGE AREA 'C' INLET (NO. 6) NORTH OF STANFORD @ E/W

3. ADDITIONAL ANALYSIS FOR INLET NO. 1 FLOW CHARACTERISTICS

NOTE: SEE DRAINAGE AREA MAP IN HYDROLOGY STUDY DEC. 1989 FOR INLET LOCATIONS.


TEMP. CONSTR. ESM.
℄ 35TH STREET CULVERTS
INLET NO. 3 STA. 6+50 = (LT)
COE STA. 969+55.11
INLET NO. 6 STA 6+88
C.O.E. STA. 969+93.11
GRATE EL 44.7
4 GRATES
5+83.55
7+26
℄ DWY
R/W REQ'D
30'
15'
2"G (ABS)
43'
33' R/W
60'
42'
30.5'±
27'±
21'±
17'±
STANFORD DRIVE
℄ MON LINE
S 63°30'05" E
969
℄ CST ℄
970
℄ ACDC ℄
S 63°19'24" E
35.58'
℄ 47.50
SRP ANGLE IRON PAINTED WHITE
GRATE EL. 1246.00
1-GRATE
℄ 46.80
EXIST GUNITE PAD
INLET NO. 7 STA 6+50 = (RT)
COE STA 969+55.11
CANAL
TOWN
B.M.
STA. 0+00
FD. B.C. FLUSH @
INTERSECTION OF 32ND ST.
& STANFORD DRIVE
ELEV. 1249.37 (C.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET BRIDGE		JOB NO. 889013
		BY VAD DATE 1-12-90
		REVWD. JSS DATE 1/15/90
		REVISED

SECTION 1

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013.45
OF STANFORD DRIVE		BY VAD DATE 1/12/90
INLET NO. 7 6+50 RT		REVWD. MJS DATE 1/15/90
		REVISED

SCS METHOD

LOCATION DATA:

AREA DESIGNATION: 7

DESIGN DATA:

	7A	7B	
DESIGN FREQUENCY	100	100	YRS
DRAINAGE AREA	.0006	.0005	SQ.MI.
DRAINAGE LENGTH	550	475	FT
ELEVATION	—	—	
TOP ELEV.	49.5	48.5	
OUTLET ELEV	46.8	46.8	
DRAINAGE AREA SLOPE	.005	.004	1/FT
DRAINAGE WIDTH	28	27	
WIDTH FACTOR W_f	1.24	1.24	
VEGITATIVE COVER TYPE	D.B.	D.B.	
VEGITATIVE DENSITY	0	0	
SOIL GROUP	C	C	
PRECIPITATION			
P = 6 HOUR	3.2	3.2	INCH
P = 24 HOUR	3.83	3.83	INCH

DESIGN COMPUTATIONS:

PRECIPITATION		2.51	2.51	INCH
CURVE NUMBER		90	90	
RUNOFF	$Q =$	1.55	1.55	
TIME OF CONCENTRATION	$T_c =$	0.13	0.13	HRS
TIME OF PEAK	$T_p = T_c W_f$	0.16	0.16	HRS
PEAK DISCHARGE	$Q_p = \frac{484AQ}{T_p}$	2.81	2.34	CFS

$$T_{c_{7A}} = \frac{(550)^{1.15}}{7700(2.7)^{.38}} = 0.13 \text{ HRS}$$

$$T_{c_{7B}} = \frac{(475)^{1.15}}{7700(1.7)^{.38}} = 0.13 \text{ HRS}$$

$Q_{P\,TOTAL} = 2.81 + 2.34 = 5.15$ CFS

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013.45
OF STANFORD DRIVE		BY VAD DATE 1/12/90
INLET NO. 7 6+50 RT		REVWD. DATE 1/15/90
		REVISED

RATIONAL METHOD

LOCATION DATA:

AREA DESIGNATION: 7

DESIGN DATA:

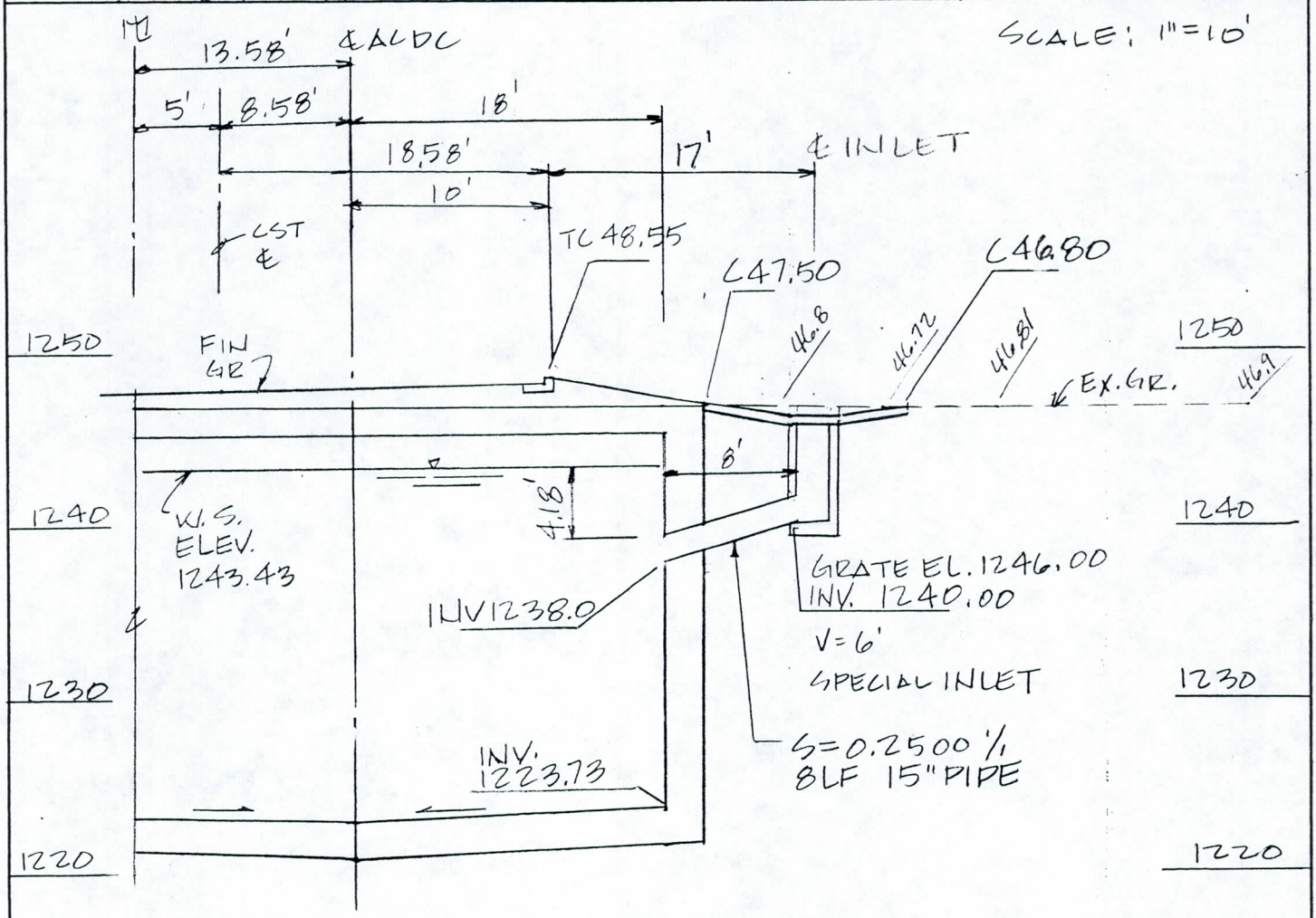
		7A	7B	
DESIGN FREQUENCY				
DRAINAGE AREA	A	0.35	0.29	ACRES
DRAINAGE LENGTH	L	550	475	FT
ELEVATION				
TOP		49.5	48.5	
OUTLET		46.8	46.8	
DRAINAGE AREA SLOPE	S	0.49	0.36	%
PRECIPITATION				
P = 6 HOUR		3.2	3.2	INCH
P = 24 HOUR		3.83	3.83	INCH
DESIGN COMPUTATIONS				
P = 1 HOUR		2.51	2.51	INCH
TIME OF CONCENTRATION	Tc	7.79	7.83	
RAINFALL INTENSITY	I	7.4	7.4	
RUNOFF COEFFICIENT	C	0.30	0.30	
PEAK DISCHARGE	$Q_p = CIA$	0.78	0.64	

$Q_{p\,TOTAL} = 0.78 + 0.64 \cong 1.42$ CFS

$$T_c = \frac{.04593L^{.77}}{S^{.385}}$$

SUMMARY:	RATIONAL	SCS	DESIGN Q
Q	1.42 CFS	5.15 CFS	∴ USE 5.15 cfs

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013.45	
OF STANFORD DRIVE		BY VAD	DATE 1/12/90
INLET NO. 7 6+50 RT		REVWD.	DATE 1/15/90
		REVISED	



INLET NO. 7

STA. 6+50 RT

LOOKING EAST

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET & RECONSTRUCTION OF STANFORD DRIVE INLET NO. 7		JOB NO. 889013
		BY VAD DATE 1/12/90
		REVWD. DATE 1/15/90
		REVISED

CK THE FLOW CONDITIONS TO DETERMINE THE ∡ OF ENTRY ALLOWED BY C.O.E. INTO ACDC (REFER TO "STANDARDS FOR ANGLE OF ENTRY OF STORM DRAINS", FIG 11A)

PER CHART 6:
15" PIPE
$S = 0.2500\%$
$Q = 5.15$ CFS

CRITICAL VEL:
$V_c^2/D = 22$
$V_c = \sqrt{(22)(1.25)} = 5.24$ FPS

CRITICAL DEPTH:
$Y_c/D = 0.72$
$Y_c = (0.72)(1.25') = 0.90$ FT

DETERMINE THE ACTUAL FLOW DEPTH & VELOCITY FROM FLOWING FULL CONDITION & CHART 5:

$$Q_{FULL} = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}A$$

$n = 0.012$
$R = D/4 = 1.25'/4 = .3125$
$R^{2/3} = 0.4603$
$S = .2500$
$S^{1/2} = (.2500)^{1/2} = 0.500$
$A = \frac{\pi D^2}{4} = \frac{\pi\, 1.25^2}{4}$ 1.227

$$Q_F = \frac{1.49}{.012}(.4603)(.500)(1.227)$$

$Q_F = 35.06$ CFS

$V_F = Q_F/A = 35.06/1.227 = 28.6$ FPS

$Q/Q_F = 5.15/35.06 = 0.15$

$V/V_F = 0.66$, $V = V_F(0.66) = (28.6)(0.66) = 18.9$ FPS $> V_c$ (5.24)

$d/d_F = 0.26$, $d = d_F(0.26) = (1.25)(0.26) = 0.33$ FT $< Y_c$ (.90)

∴ SUPERCRITICAL FLOW CONDITIONS EXIST. ∴ ∡ OF ENTRY INTO ACDC FOR 15" PIPE IS 90°

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013
OF STANFORD DRIVE		BY VAD DATE 1/12/90
		REVWD. DATE 1/15/90
INLET NO. 7		REVISED

Q_{SCS} = 5.15 CFS
$Q_{RATIONAL}$ = 1.42 CFS

EX. GR. @ INLET = 1246.8

GRATE EL. = 1246.0

Δ ELEV = 0.8'

USING A SUMPED DEPTH OF 0.8', DETERMINE THE NO. OF GRATES REQUIRED TO ACCEPT Q = 5.15 CFS

FROM CHART 1 $Q/_{A}$ = 3.0 CFS/SF

$$\frac{3.0 \text{ CFS}}{2 \text{ CLOGGING FACTOR}} = 1.50 \text{ CFS}/_{\text{SF EFF}}$$

$$\frac{5.15 \text{ CFS}}{1.50 \text{ CFS}/_{\text{SF EFF}}} = 3.43 \text{ SF}$$

$$\frac{3.43 \text{ SF}}{3.78 \ \frac{\text{SF}}{\text{GRATE}}} \cong 1 \text{ GRATES}$$

1 - TYPE 1 GRATE REQ'D PER C.O.P. OR EQUAL

SIZE THE CONNECTOR PIPE USING THE AVAILABLE HEAD, Q = 5.15 CFS, $L_{F\ CONN\ PIPE}$ = 8 FT & CHART 2

HEAD = H = GRATE EL − 0.5' FREEBOARD − ACDC W.S.
= 1246.0 − 0.5' − 1243.43
= 2.07'

CONN. MIN. SIZE = 15" DIA.

MIN INLET DEPTH FROM CHART 3 = V = 3.0'
DESIGN DEPTH = 6' > 3.0' ∴ GOOD

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET-		JOB NO. 889013
RECONSTR. OF STANFORD		BY VAD DATE 1/12/90
		REVWD. RSS DATE 1/15/90
		REVISED

SECTION 2

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTRUCTION OF STANFORD DRIVE		JOB NO. 889013	
		BY VAD	DATE 1/12/90
		REVWD. MS	DATE 1/15/90
INLET NO. 6	STA 6+88 LT	REVISED	

ASSUME SOME PONDING WILL BE ALLOWED, SUMPED CONDITION

EX GRADE
BEFORE CONSTR. = 1246.5

SEE HYDROLOGY STUDY DEC. 1989
FOR DRAINAGE AREA LIMITS & Q CALCS. (D.A. "C" = D.A. "6")

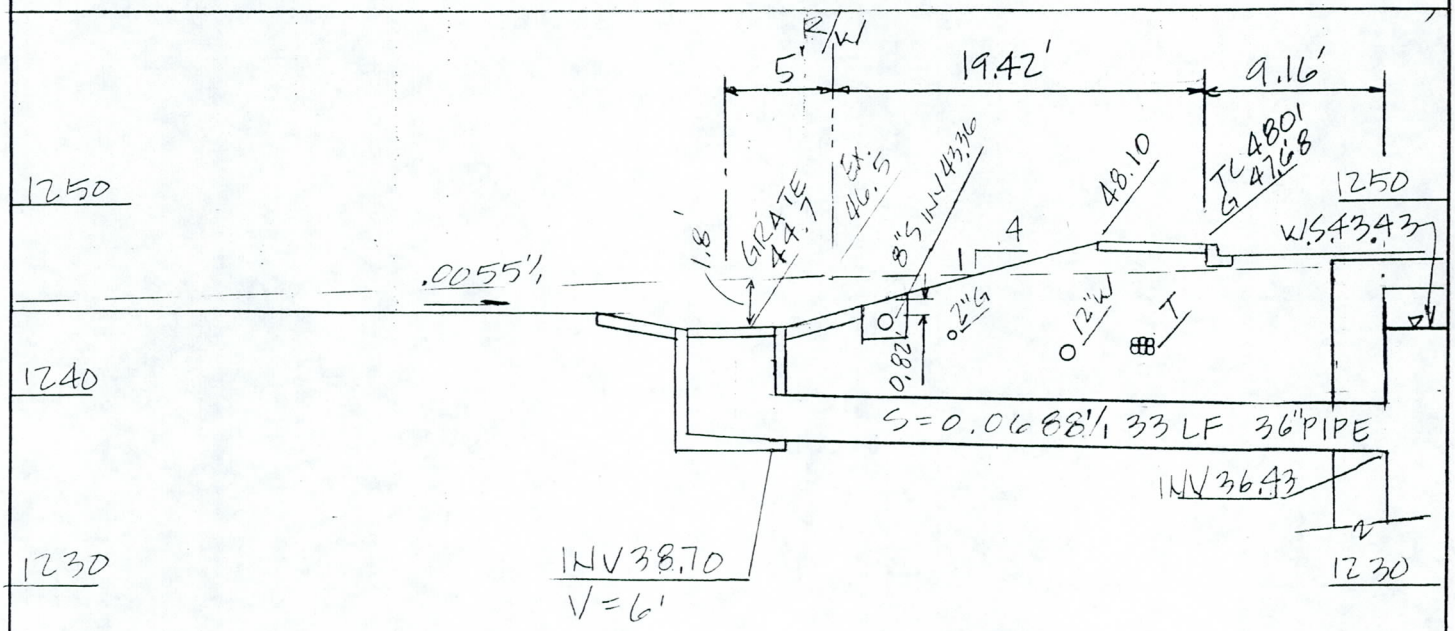
SIZE THE CONN. PIPE
USING THE AVAIL HEAD,
Q = 41 CFS, L = 33 LF, CHART 2

HEAD = H = GRATE ELEV (1244.70)
- FREEBOARD (-0.5)
- ALDC W.S. ELEV (1243.43)
= 0.77 FT

∴ CONN. PIPE MIN SIZE = 36" DIA

PER FORMULA
36" PIPE @ L = 33', H = .77'
Q = 42.26 CFS
∴ OK

FROM
CHART 3, MIN. INLET DEPTH = 5'
DESIGN DEPTH = 6' 75.06' GOOD



STA 6+88 LT
LOOKING EAST
(= COE STA 969+93.11)

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013.45	
OF STANFORD DRIVE		BY VAD	DATE 1/12/90
INLET NO. 6	STA 6+88LT	REVWD. WS	DATE 1/15/90
		REVISED	

THE FACTORS INVOLVED WITH THIS DESIGN/SYSTEM ARE AS FOLLOWS:

1- HIGH ACDC WATER SURFACE ELEVATION
2- HIGH DRAINAGE AREA FLOW = 41 CFS
3- LENGTH OF PIPE REQUIRED
4.- NEED TO REGRADE LOW SPOT IN DRAINAGE AREA TO OUTFALL AT THE R/W LINE VS. DRYWELL
5 - DESIRE TO MINIMIZE OVERALL EXPOSED GRATES FOR AESTHETICS FOR ADJACENT PROPERTY.
6 - DESIRE TO MAINTAIN A 4:1 OR FLATTER SLOPE OFF BACK OF SIDEWALK FOR SAFETY
7 - NEED TO MAINTAIN COVER OVER 8" SEWER LINE & 2" GAS LINE
8 - DESIRE TO KEEP CONNECTOR PIPE AT A MINIMUM, REASONABLE DIAMETER.

RESULTS ARE AS FOLLOWS:

1. HEAD AVAIL. W/ FREEBOARD CONSIDERED = 0.77' (LOW)
1. DESIREABLE GRATE ELEV. MIN. = 1244.70
2.

	No. GRATES	DEPTH OF WATER OVER GRATE = d	GRATE ELEV + d = PONDED W.S.EL.	COMMENTS
COMPARE GRATES	4 ✓	1.4' ✓	44.7 + 1.4 = 46.1 ✓	23' LONG x 11' WIDE POTENTIAL TO BACK UP FLOW.
	5	1.1'	44.7 + 1.1 = 45.8	26' LONG MORE REASONABLE
	6	0.9'	44.7 + 0.9 = 45.6 (SEE EX. CALC. FOLLOWING PG)	BETTER YET - PUT SIDE BY SIDE RESULT IS A SYSTEM 29' LONG x 11' WIDE OR 20' L x 13' W/

3. SUGGEST UPGRADING SEWER TO D.I.P., CONC. ENCASED, ETC. TO PROTECT IT IN PLACE
4. SUGGEST 4 GRATES FOR UNIFORMITY IN INLET CONSTRUCTION & DESIGN TO COORDINATE WITH REMAINDER OF PROJECT.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013.45	
OF STANFORD DRIVE		BY VAD	DATE 1/12/89
INLET NO. 6	CITA GH 88LT	REVWD. MKS	DATE 1/15/90
		REVISED	

USE C.O.P. TYPE - 1 GRATE, A = 3.78 SF, OR EQUAL

CALC. 'd' (DEPTH OF WATER OVER GRATE)
FOR 4, 5 AND 6 GRATES, AREA GOVERNS:

A- 4 GRATES $\left(\frac{3.78\ SF}{GRATE}\right) = 15.12\ SF$

$\frac{41\ CFS}{15.12\ SF} \times 2$ CLOGGING FACTOR $= 5.42\ \frac{CFS}{SF}$

FROM CHART 1, d = 1.4'
W.S. ELEV. = GRATE ELEV + d = 1244.7 + 1.4 = 1246.1

B- 5 GRATES $\left(\frac{3.78\ SF}{GRATE}\right) = 18.90\ SF$

$\frac{41\ CFS}{18.9\ SF} \times 2$ CLOG FACTOR $= 4.34\ CFS/SF$

FROM CHART 1, d = 1.1'
W.S. ELEV. = GRATE ELEV + d = 1244.7 + 1.1 = 1245.8

C- 6 GRATES $\left(\frac{3.78\ SF}{GRATE}\right) = 22.68\ SF$

$\frac{41\ CFS}{22.68\ SF} \times 2$ CLOG FACTOR $= 3.62\ CFS/SF$

FROM CHART 1 d = 0.9'
W.S. ELEV. = GRATE ELEV. + d = 1244.7 + 0.9 = 1245.6

NTS
CURVE
NO.
Δ
C1
60°00'00"
C2
55°26'24"
STANFORD DRIVE
S.63°19'24"E
S.63°30'05"E
N.86°40'36"E
℄ ACDC
ACDC LIMITS
TEMPORARY CONSTR. ESM.
TEMPORARY CONSTR. ESM.
WOOD SHEDS
TO BLDG.
EXIST. DRYWELL
AREA OF PONDING EL. 46.1
P.C. STA. 0+64.93
P.O.C. - BEG 10"DIA. RCP-LT. STA. 0+94.63-7.5' LT.
P.O.C. - BEG 10"DIA RCP-RT. STA. 1+09.05-7.5' RT.
P.C. STA. 2+22.06
P.T. STA. 2+01.07
P.L. STA. 1+39.99
P.L. STA. 2+90.35
N.26°40'36"E
N.82°00'00"E
R
50'
30'
10'
C1
C2
1
2
3
4
5
1247
1248
1246
1245
969
970

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET -		JOB NO. 889013.45	
RECONSTR. OF STANFORD DR		BY VAD	DATE 1/12/90
		REVWD.	DATE 1/15/90
		REVISED	

SECTION 3

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTR. OF STANFORD DRIVE INLET NO. 1		JOB NO. 889013.45	
		BY VAD	DATE 1/12/90
		REVWD. MSS	DATE 1/15/90
		REVISED	

FROM PREVIOUS STUDY (OF DEC. 1989):

1- CHANNEL CROSS SECTION NO. 1, IMMEDIATELY UPSTREAM, FOR Q=103 CFS ; d_{N_4} = 1.3'

V_4 = 2.2 FPS

W.S. EL.$_4$ = 1247.7

2- LOSSES DUE TO THE TRASH RACK

$$h_t = \frac{cV^2}{2g} = 0.12'$$

3- FLOW THROUGH TRASH RACK AT 50% CLOGGED ; V_1 = 3.84 FPS

WALL OPEN AREA = 34 SF (1.7 SF * 20 LF)

TRASH RACK OPEN AREA = 36 SF (1.8 SF * 20 LF)

APPROACH VEL.

REF: CIVIL ENG. REVIEW MANUAL, REV. MANNING EQN 5.54 → $Q = C_o b (H + V^2/2g)^{3/2}$

SOLVING FOR THE APPROACH VEL.

$103 = (3.33)(20)(1.34 + V^2/64.4)^{3/2}$

$1.547 = [1.34 + V^2/64.4]^{3/2}$

$V = 3.65$ FPS $= V_4$

WIER ANALYSIS

$Q_{CFS} = 3.33 (B)(H)^{3/2}$

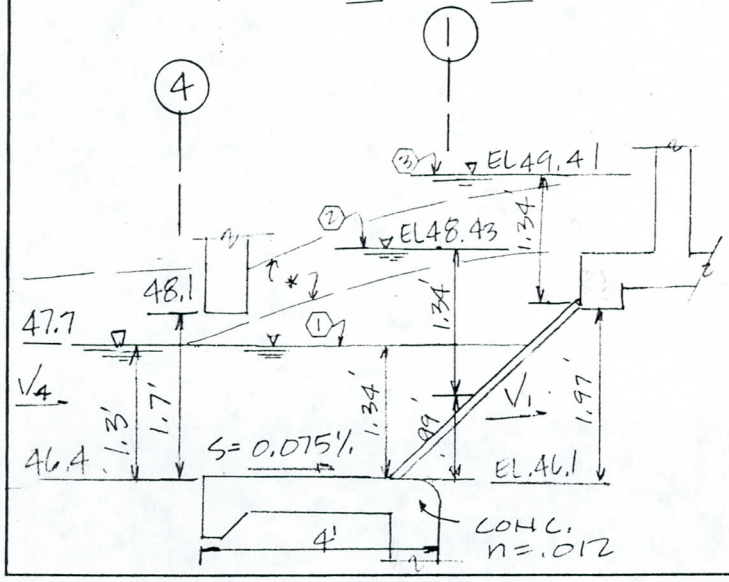
$103 = 3.33 (20)(H)^{3/2}$

$H = 1.34'$

WHERE:

B = LENGTH OF WEIR = 20 LF

Q = 103 CFS



① W.S. EL. @ 0% CLOGGED = 1247.44

② W.S. EL. @ 50% CLOGGED

③ W.S. EL. @ 100% CLOGGED (FLOW IS DIVERTED EASTERLY ALONG STANFORD RD.)

* BACKWATER CURVES

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32nd Street & Reconstr of Stanford Drive		JOB NO. 889013.45
		BY MSS DATE 1/15/90
Inlet No. 1		REVWD. VAD DATE 1/15/90
		REVISED

Check WSEL @ section ④ using the direct step method, Open-Channel Hydraulics, Chow P. 262-265

$$S_o \Delta x + y_4 + \alpha_4 \frac{V_4^2}{2g} = y_1 + \alpha_1 \frac{V_1^2}{2g} + S_f \Delta x + h_f + h_e$$

losses due to trash rack

entrance loss @ wall opening

assume $\alpha_4 = \alpha_1$

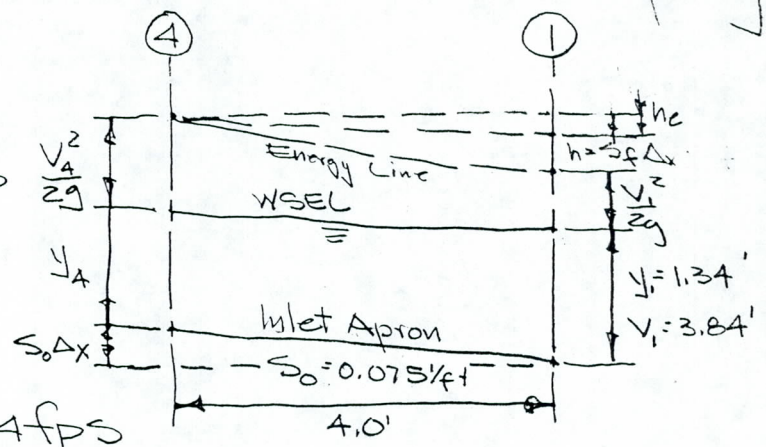
where $\Delta_x = 4$ ft

$S_o = 0.075$ ft/ft

$y_4 = ?$ $Q = 103$ cfs

$V_4 = ?$

$y_1 = 1.34$ ft



$$V_1 = \frac{103 \text{ cfs}}{1.34 \times 20} = 3.84 \text{ fps}$$

$$S_f = \frac{n^2 V_1^2}{2.22 R^{4/3}} \quad \text{where } n = 0.012$$

$$R = \frac{A}{WP} = \frac{20' \times 1.34'}{2(1.34)' + 20'} = 1.182$$

$$= \frac{(.012)^2 (3.84)^2}{2.22 (1.182)^{1.33}}$$

$$h_f = 0.12 \text{ ft}$$

$$= \frac{0.0021}{2.7729}$$

$$S_f = 0.0008$$

$$h_e = K_e \frac{V_4^2}{2g} \quad \text{where } K_e = 0.5$$

assume $b = 20$ ft outside wall (conservative)

$$\therefore V_4 = \frac{Q}{A} = \frac{Q}{20 y_4}$$

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32nd Street & Reconstr. of Stanford Drive Inlet No. 1		JOB NO. 889013.45
		BY M.SS DATE 1/15/90
		REVWD. VAD DATE 1/15/90
		REVISED

so.

$$S_o \Delta x + y_4 + \frac{\left(\frac{Q}{20y_4}\right)^2}{64.32} = 1.34 + \frac{(3.84)^2}{64.32} + .0008(4) + 0.12 + 0.5\frac{\left(\frac{Q}{20y_4}\right)^2}{64.32}$$

$$0.3 + y_4 + \frac{\left(\frac{103}{20y_4}\right)^2}{64.32} = 1.34 + 0.229 + 0.0032 + 0.12 + 0.5\frac{\left(\frac{103}{20y_4}\right)^2}{64.32}$$

$$y_4 + \frac{\left(\frac{103}{20y_4}\right)^2}{64.32} - 0.5\frac{\left(\frac{103}{20y_4}\right)^2}{64.32} = 1.3922$$

try $\underline{\underline{y_4 = 1.26 \text{ ft}}}$

$$1.26 + \frac{\left(\frac{103}{20(1.26)}\right)^2}{64.32} - 0.5\frac{\left(\frac{103}{20(1.26)}\right)^2}{64.32} = 1.3922$$

$$1.26 + 0.2597 - 0.1299 = 1.3922$$

$$1.3898 \leq 1.3922$$

therefore WSEL @ section 4 is equal to

1246.4 + 1.26 = 1247.66 which is less than 1247.7 therefore inlet will not cause any additional backwater.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RELOCATE.		JOB NO. 889013.45	
OF STANFORD DRIVE		BY VAL	DATE 1/12/90
INLET NO. 1		REVWD. MJS	DATE 1/15/90
		REVISED	

@ 50% CLOGGED, SUBMERGED INLET, ORIFICE FLOW TAKES OVER

RESOLVE IF TRASH RACK CAN ACCEPT 100 CFS @ 50% CLOGGED UNDER ORIFICE FLOW CONDITIONS:

$$Q_{ORIF.} = 0.6 \left(\begin{matrix}\text{FREE}\\ \text{OPEN}\\ \text{AREA}\end{matrix}\right)\left(\sqrt{2gH}\right)$$

$$= 0.6 \left(\frac{36\,SF}{2\ \text{CLOG. FACTOR}}\right)\left(\sqrt{2(32.2)(.99+1.34')}\right)$$

$$= 132.3\ \text{CFS ACCEPTED}$$

CONCLUSIONS: (@ 50% CLOGGED)

1- WATER SHOULD NOT BACK UP UPSTREAM

2- ALL FLOW ACCEPTED IN 20' LONG SYSTEM AS DESIGNED

TRASH RACK ANALYSIS

REF. OPEN CHANNEL FLOW
BY VEN TE CHOW, PH.D., 1959
(pg 506 & 507)

PRIMARY CONCERN WITH INLET NO. 1 IS THE AMOUNT OF HEADLOSS DUE TO THE TRASH RACK

h_f = HEADLOSS DUE TO THE RESISTENCE OF THE TRASH RACK

$h_f = \frac{cV^2}{2g}$ WHERE: V = VEL. OF APPROACH

c = COEFFICIENT DEPENDENT ON X-SECTION FORM, S, L, b, δ, α, β, μ

X-SEC. = 1/2" WIDE X 2" DEEP

S = THICKNESS OF BAR = 1/2" = .042'

b = CLR DISTANCE BETWEEN BARS
4 3/8" O.C. - 2(1/4") = 3-7/8" = 0.32'

δ = ANGLE OF INCLINATION OF BAR FROM HORIZ. = 45°

α = ANGLE BETWEEN LENGTH OF FLOW & LENGTH OF BAR = 45°

β = SQUARE NOSE & SQUARE TAIL = 2.42

L = LENGTH OF BAR = 1.88'

μ = COEF. BASED ON RACK BAR FORM = 7.1

X = COEF BASED ON RACK BAR FORM = 1.6

$c = \beta\left(\frac{S}{b}\right)^{4/3}\sin\delta$ (FOR $\alpha = 0°$) OR $c = \mu\left(\frac{S}{S+b}\right)\sin^x\delta$ (FOR $\alpha = 45°$)

$c = (2.42)\left(\frac{.042}{.32}\right)^{4/3}\sin 45°$

$\underline{c = 0.1142}$

$c = (7.1)\left(\frac{.042}{.042+.32}\right)\sin^1 45°$

$\underline{c = 0.58}$

$h_f = (.1142)\left(\frac{3.65^2}{2(32.2)}\right) = \underline{.02'}$

$h_f = (.58)\left(\frac{3.65^2}{2(32.2)}\right) = \underline{0.12'}$

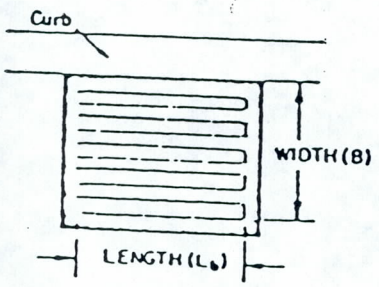
CONCLUSION: HEAD LOSS THROUGH TRASH RACK FOR THE GIVEN SIZE, BAR SPACE & SHAPE IS MINIMAL.

* APPROACH VELOCITY (REF: CIVIL ENG. REVIEW MANUAL)
EQN. 5.54 → $Q = C_s b(H + V^2/2g)^{3/2}$
$103 = (3.33(20)(1.34 + V^2/64.4)^{3/2}$
$V = 3.65$ FPS

HYDRAULIC DATA SHEETS USED

IN

DETERMINING FLOW QUANTITIES

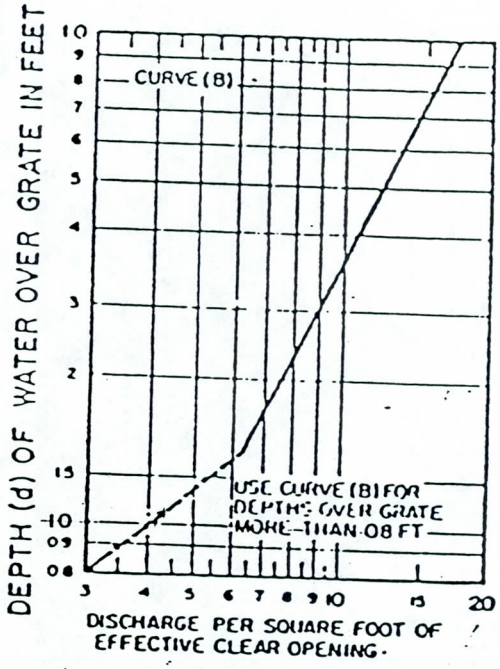


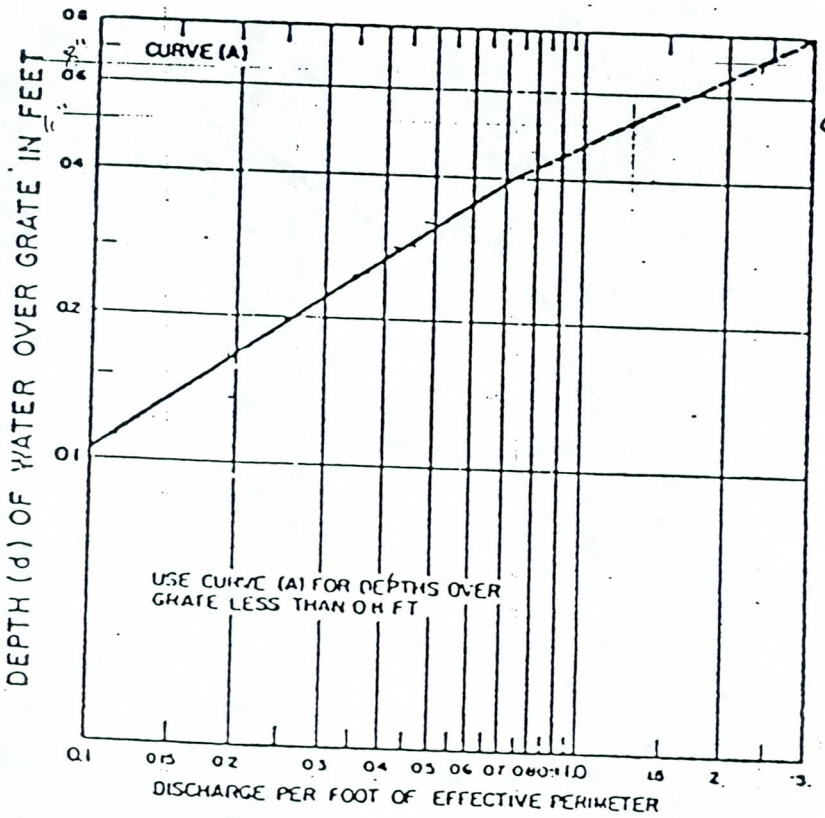
$P = 2B + L_b$

A = AREA OF CLEAR OPENING IN GRATE

TO ALLOW FOR CLOGGING DIVIDE P OR A BY 2 BEFORE OBTAINING d.

WITHOUT CURB $P = 2(B + L_b)$





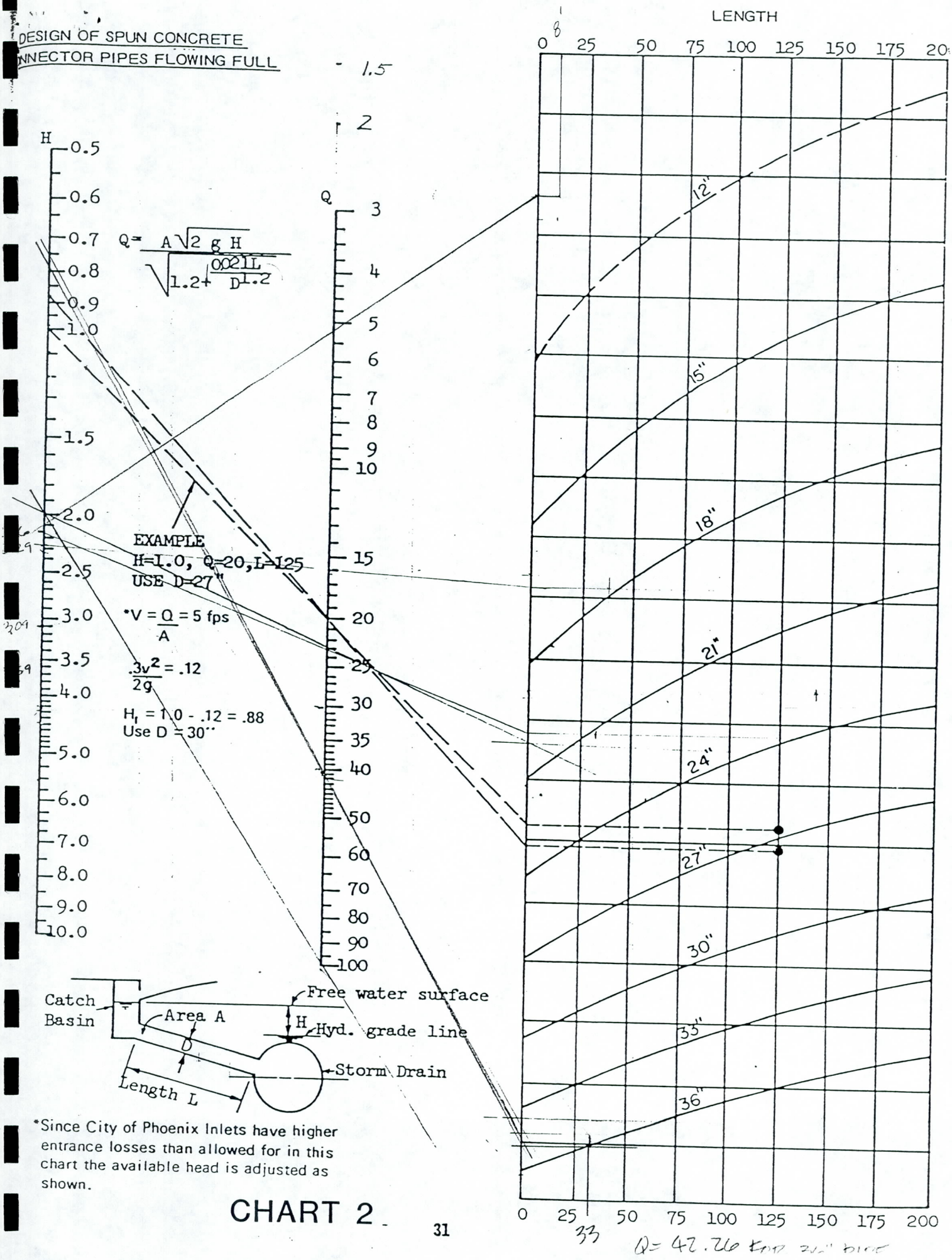
GRATE TYPE	AREA	P
1	3.78	10.66
2	2.56	9.41

BUREAU OF PUBLIC ROADS
REV. AUG. 1968

HYDRAULIC CAPACITY OF GRATE INLET IN SUMP

CHART 1

DESIGN OF SPUN CONCRETE
NNECTOR PIPES FLOWING FULL



$$Q = \frac{A\sqrt{2gH}}{\sqrt{1.2 + \frac{0.021L}{D^{1.2}}}}$$

EXAMPLE
H=1.0, Q=20, L=125
USE D=27"

*$V = \frac{Q}{A} = 5$ fps

$\frac{.3v^2}{2g} = .12$

$H_1 = 1.0 - .12 = .88$
Use D = 30"

*Since City of Phoenix Inlets have higher entrance losses than allowed for in this chart the available head is adjusted as shown.

CHART 2

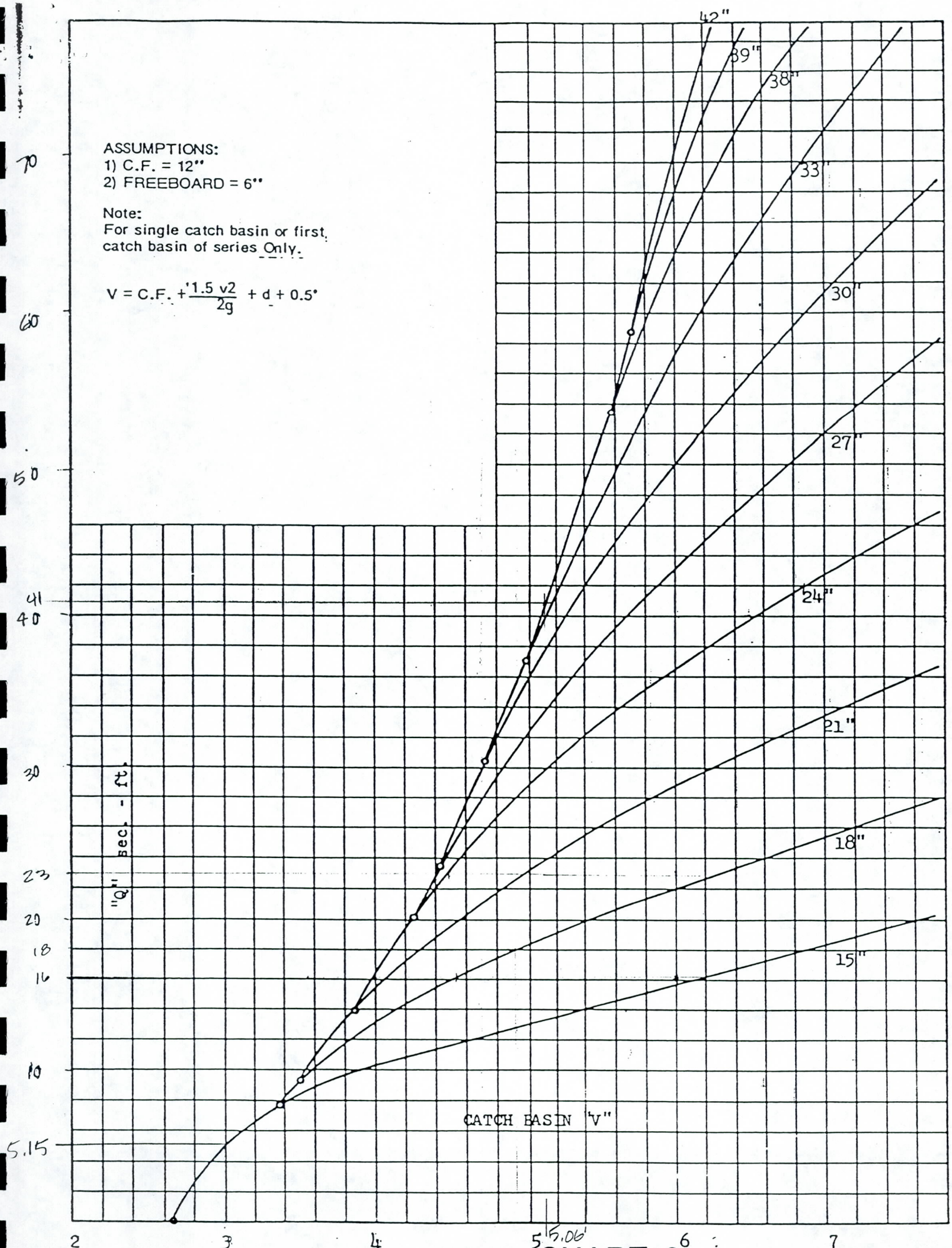
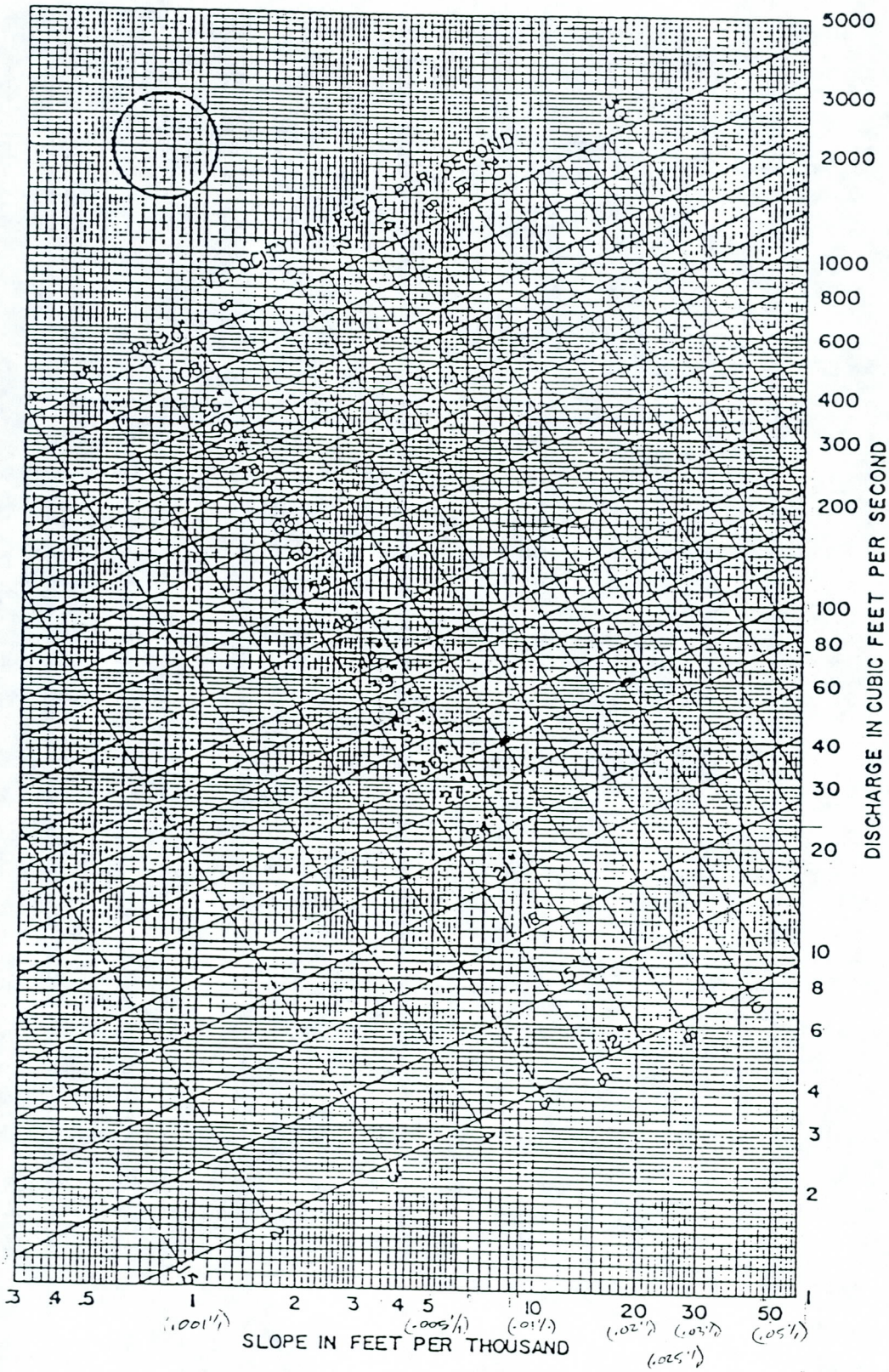

ASSUMPTIONS:
1) C.F. = 12"
2) FREEBOARD = 6"
Note:
For single catch basin or first catch basin of series Only.
V = C.F. + 1.5 v2/2g + d + 0.5'
42"
39"
38"
33"
30"
27"
24"
21"
18"
15"
70
60
50
41
40
30
23
20
18
16
10
5.15
"Q" sec. - ft.
CATCH BASIN "V"
2
3
4
5
5.06'
6
7

CHART 3

COMPUTED FROM MANNING'S FORMULA
n=0.012



PIPE CAPACITIES FLOWING FULL

CHART 4

Appendix C: Circular Channel Ratios

Experiments have shown that n varies slightly with depth. This figure gives velocity and flow rate ratios for varying n (solid line) and constant n (broken line) assumptions.

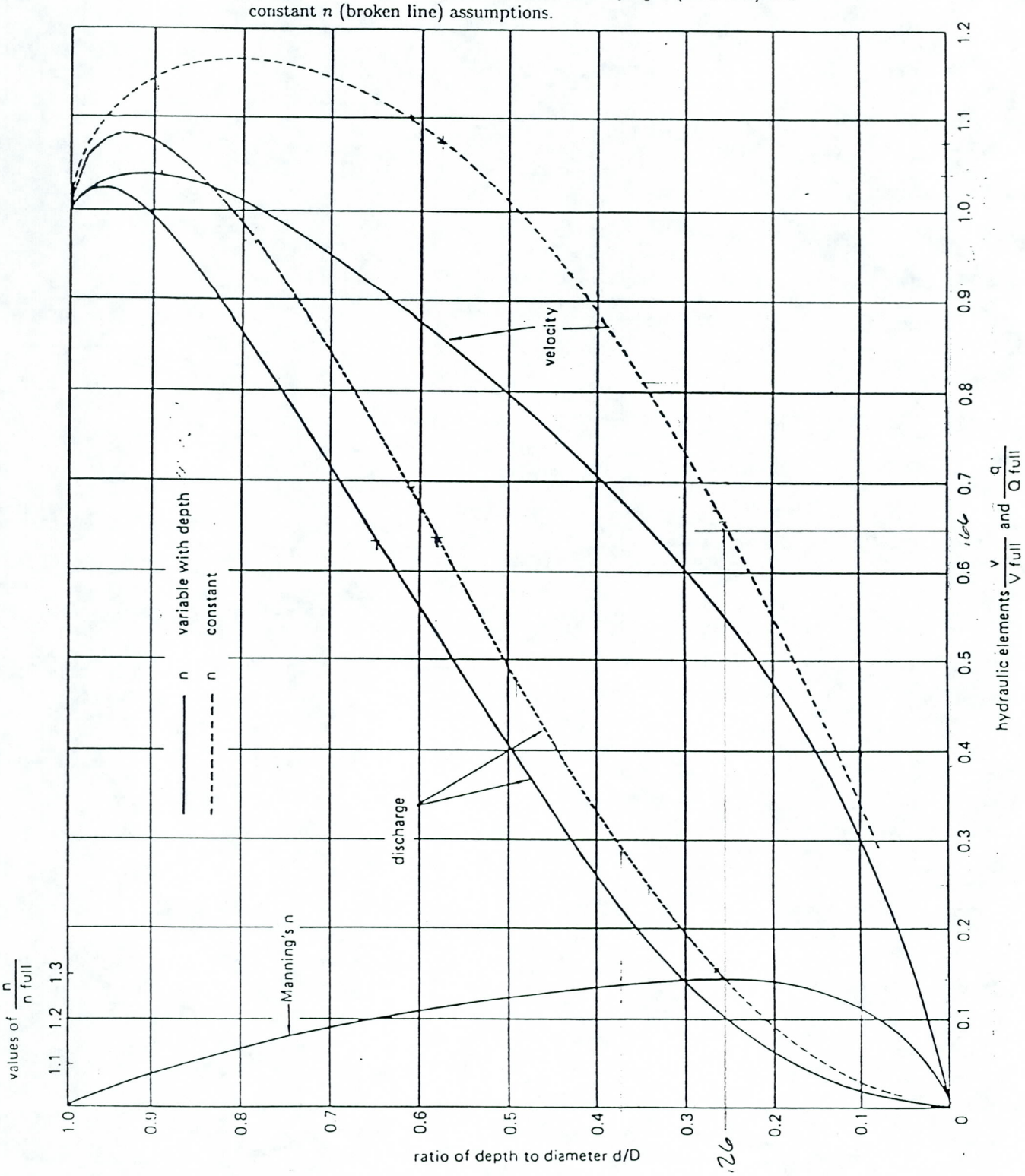


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CHART 5

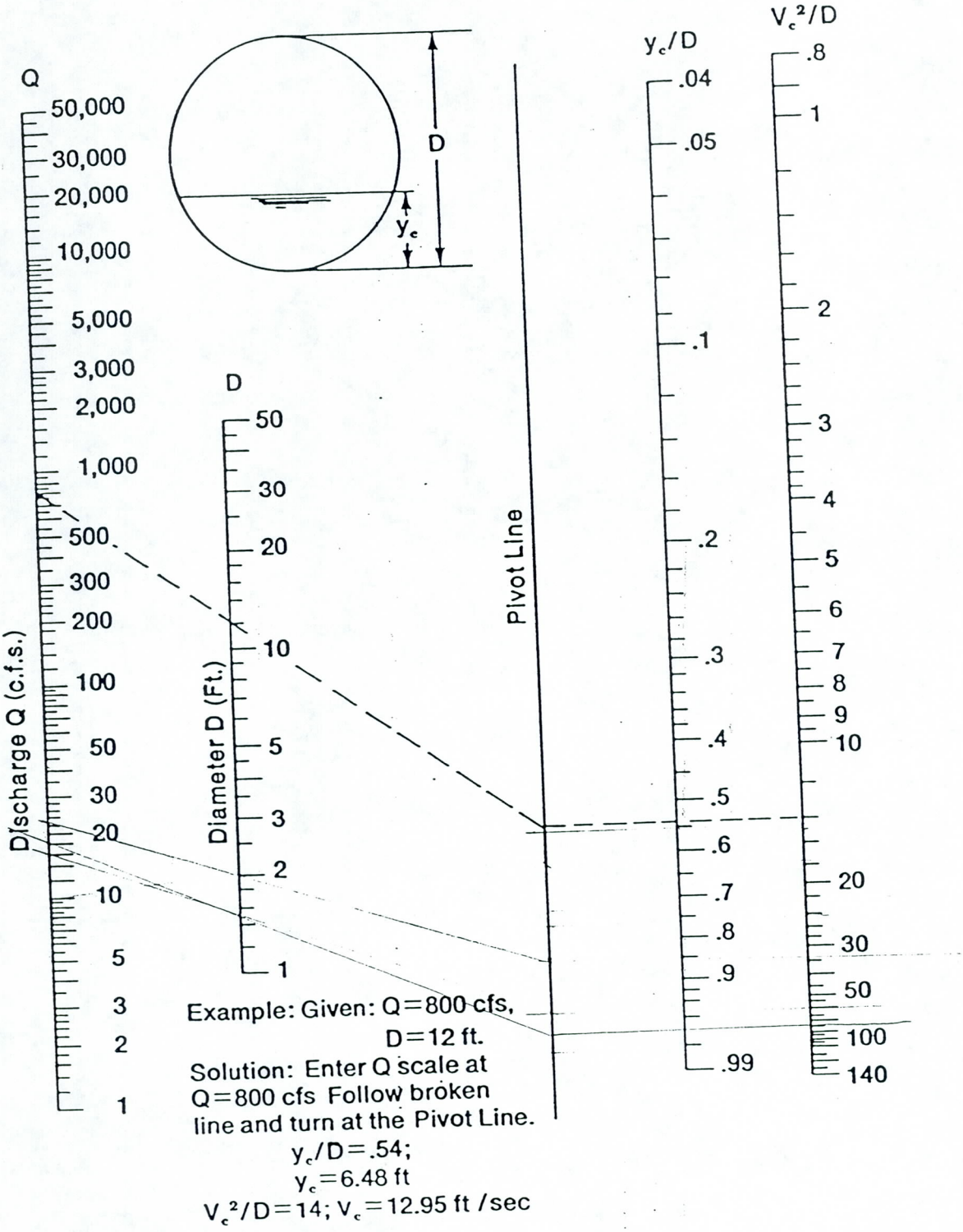


Figure 3-24 Critical flow and critical velocity in circular conduits.

CHART 6

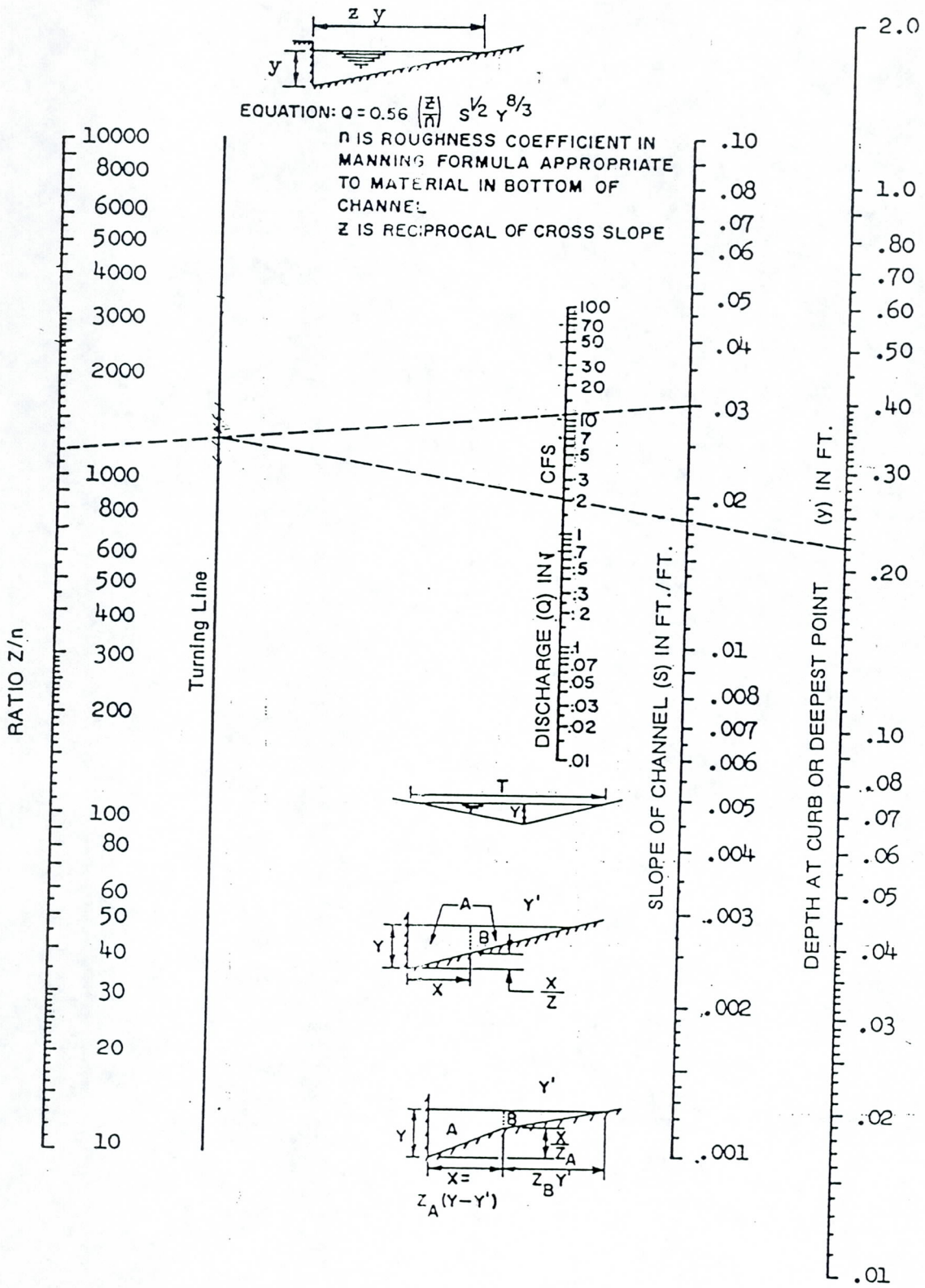

z y
y
EQUATION: Q = 0.56 (z/n) S^1/2 Y^8/3
n IS ROUGHNESS COEFFICIENT IN MANNING FORMULA APPROPRIATE TO MATERIAL IN BOTTOM OF CHANNEL
Z IS RECIPROCAL OF CROSS SLOPE
RATIO Z/n
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
Turning Line
DISCHARGE (Q) IN CFS
100
70
50
30
20
10
7
5
3
2
1
.7
.5
.3
.2
.1
.07
.05
.03
.02
.01
SLOPE OF CHANNEL (S) IN FT./FT.
.10
.08
.07
.06
.05
.04
.03
.02
.01
.008
.007
.006
.005
.004
.003
.002
.001
DEPTH AT CURB OR DEEPEST POINT (y) IN FT.
2.0
1.0
.80
.70
.60
.50
.40
.30
.20
.10
.08
.07
.06
.05
.04
.03
.02
.01
T
Y
A
Y'
B
Y
X
X/Z
Y'
A
B
Y
X
Z_A
X = Z_A (Y−Y')
Z_B Y'

CHART 7

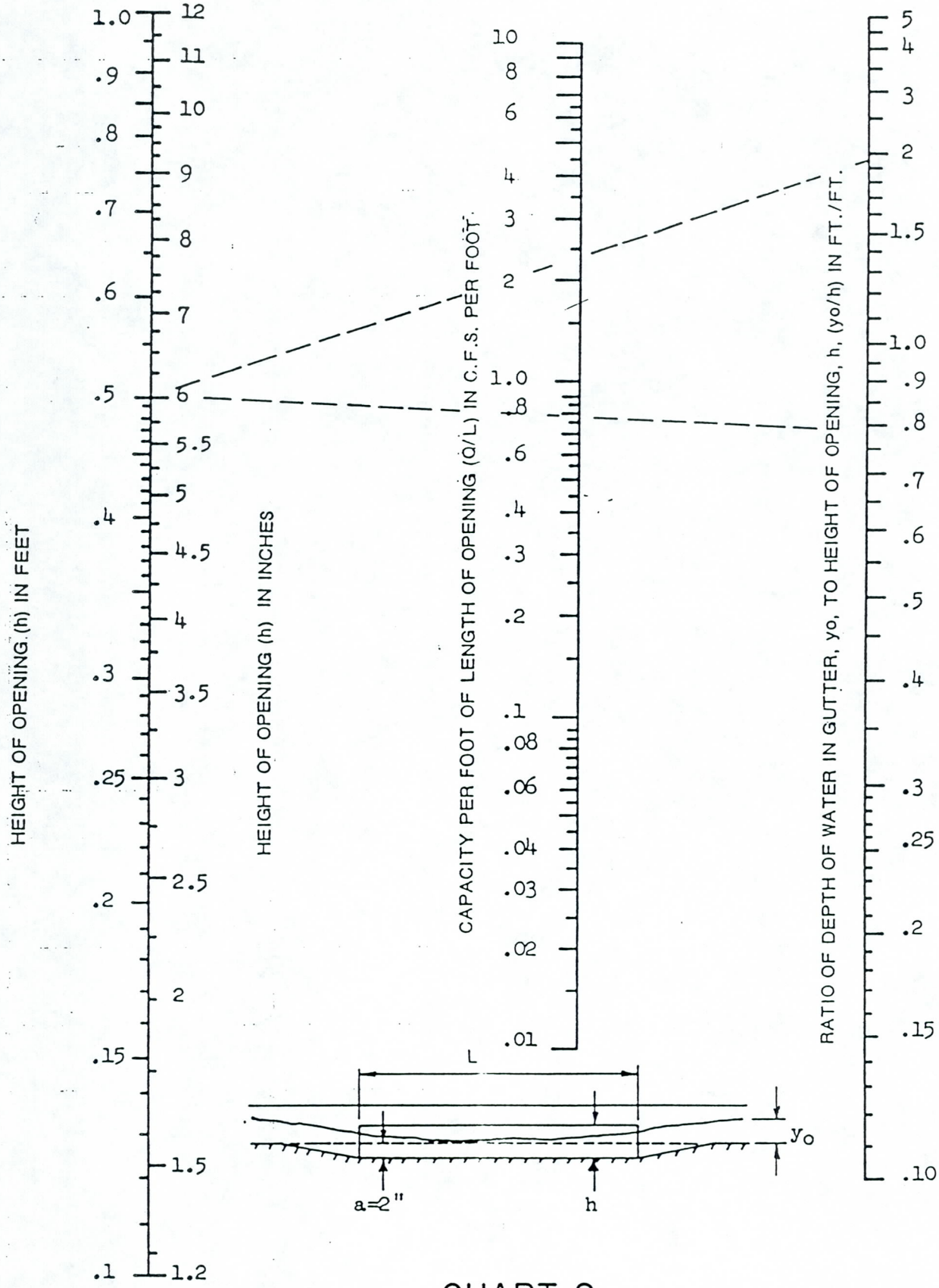


CHART 8

NOMOGRAPH FOR CAPACITY OF CURB OPENING INLETS IN SUMPS, DEPRESSION DEPTH 2"

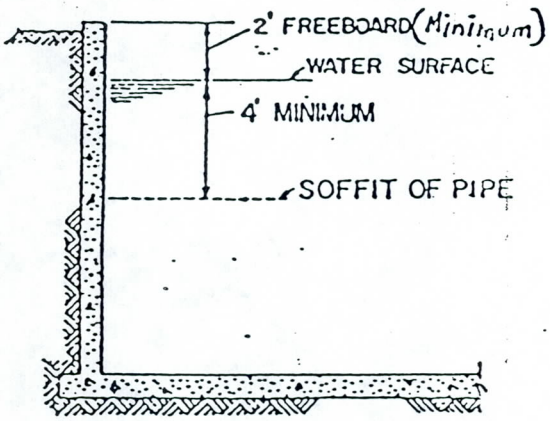
SUPER-CRITICAL FLOW
(HIGH VELOCITY)

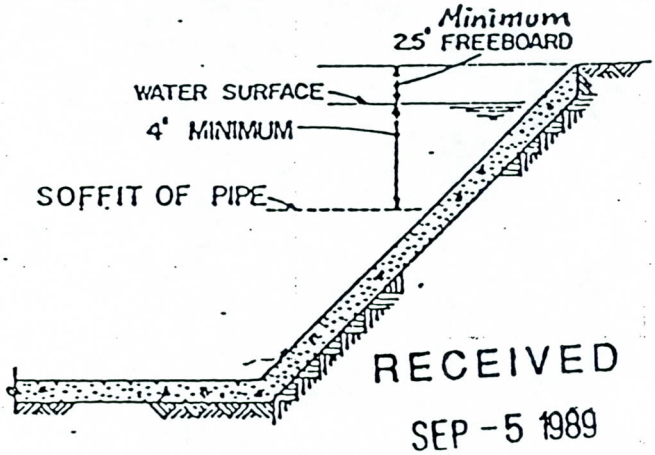
PIPE SIZE	ANGLE OF ENTRY
21"	90°
24"-33"	60°
36"-57"	45°
60" and over	30°

SUB-CRITICAL FLOW
(LOW VELOCITY)

PIPE SIZE	ANGLE OF ENTRY
up to 36"	90°
36"-57"	45°
60" and over	30°

SUBMERGENCE





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SEP - 5 1989
CREEGAN + D'ANGELO

NOTE: BEFORE USING STANDARD EACH PROJECT MUST BE VERIFIED WITH THE CORPS OF ENGINEERS

PERMIT MANUAL

STANDARDS FOR ANGLE OF ENTRY OF STORM DRAINS

OFFICE OF THE DISTRICT ENGINEER
LOS ANGELES, CALIFORNIA

Figure A-11

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
		JOB NO.	
		BY	DATE
		REVWD.	DATE
		REVISED	

32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE

HYDROLOGY STUDY FOR FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

DECEMBER 1989

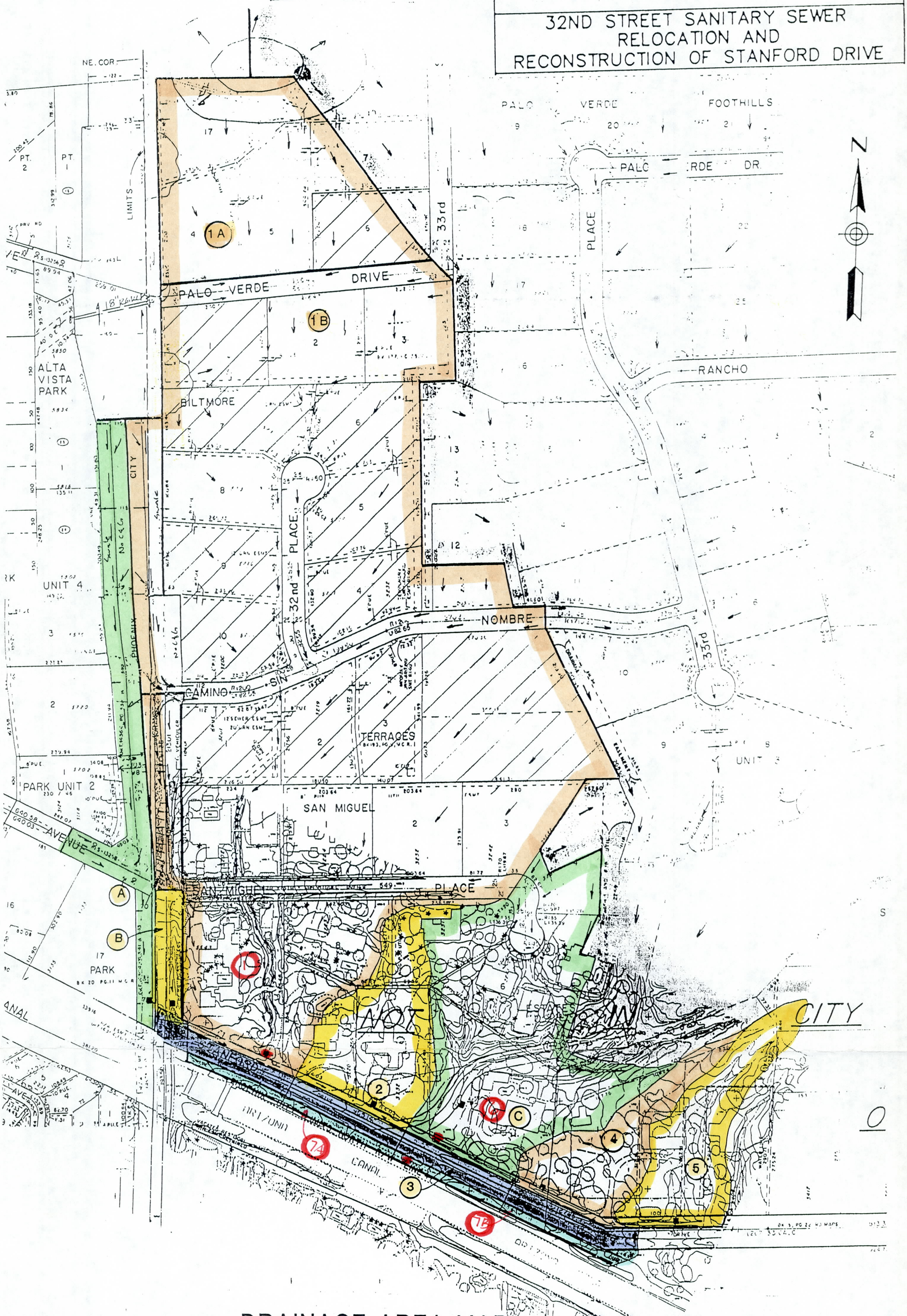
Prepared by:

CREEGAN + D'ANGELO
650 North 2nd Avenue
Phoenix, Arizona 85003

CREEGAN + D'ANGELO
Engineers • Planners • Surveyors
650 North Second Ave. Phoenix, AZ 85003 Phone: 602 258 3175

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE



DRAINAGE AREA MAP

SCALE : 1" = 200'

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE		JOB NO. 889 013
		BY VAD DATE 9/89
		REVWD. HEG DATE 10/17/89
		REVISED

ADDENDUM to "HYDROLOGIC DESIGN FOR HIGHWAY DRAINAGE IN ARIZONA" April 1975

Steps to be used to determine precipitation values for various durations and return periods.

STEP 1. From the precipitation maps in the manual "Hydrologic Design for Highway Drainage in Arizona", determine the precipitation values for the 6 and 24 hour duration storms for return periods of 2, 5, 10, 25, 50 and 100 years. Tabulate these values in Table 1 in the column headed 'Map Values'

TABLE 1

Return Period (Years)	Precipitation Values (inches)				
	6 hour duration		24 hour duration		1HC
	Map Value	Corrected Value	Map Value	Corrected Value	
2	1.2	$X_1 = 1.20$	1.40	$X_2 = 1.40$	0.96
5	1.7	1.70	2.00	2.00	1.31
10	2.1	2.05	2.40	2.40	1.59
25	2.45	2.45	3.00	2.92	1.91
50	2.81	2.85	3.40	3.39	2.21
100	3.2	$X_3 = 3.20$	3.80	$X_4 = 3.63$	2.51

NOTE: There is a possibility of making an error while reading the maps because, (1) a site is not easy to locate precisely on a series of 12 maps, (2) there may be some slight registration differences in printing, and (3) precise interpolation between isolines is difficult. In order to minimize any errors in reading the maps, these values should be plotted on the diagram "Precipitation Depth versus Return Period" Fig. 1.

$Y_2 = (2YR, 1HR) = (-0.511) + (0.942[X_1 (X_1/X_2)]$

$= (-0.511) + (0.942)[1.20(1.20/1.40)] = 0.96$

$Y_{100} = (100YR, 1HR) = (0.494) + (0.755)[X_3 (X_3/X_4)]$

$= (0.494) + (0.755)[3.20(3.20/3.63)] = 2.51$

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE		JOB NO. 889013
		BY VAD DATE 9/89
		REVWD. HEG DATE 10/17/89
		REVISED

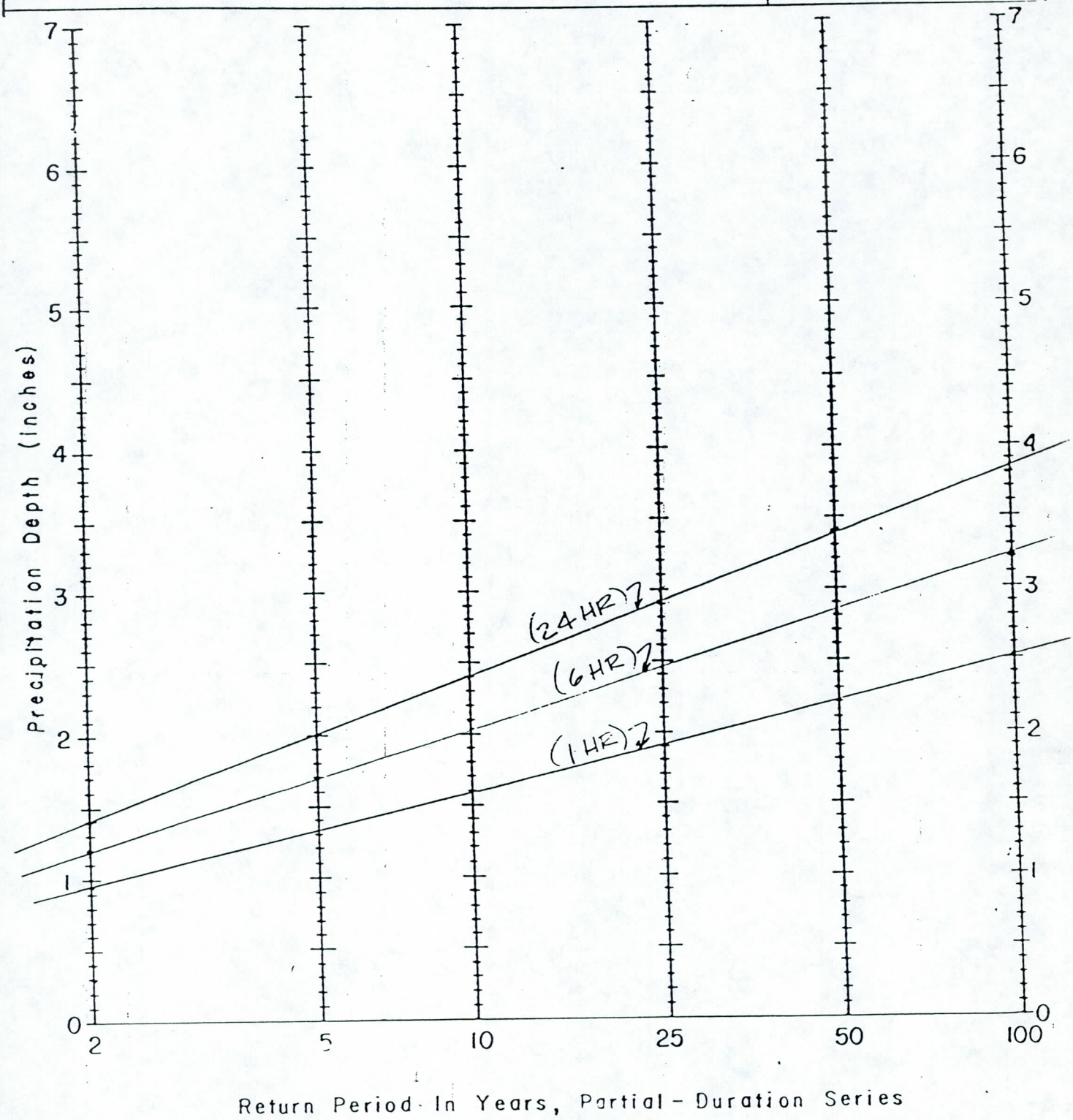


Figure 1 Precipitation Depth Versus Return Period for Partial-Duration Series

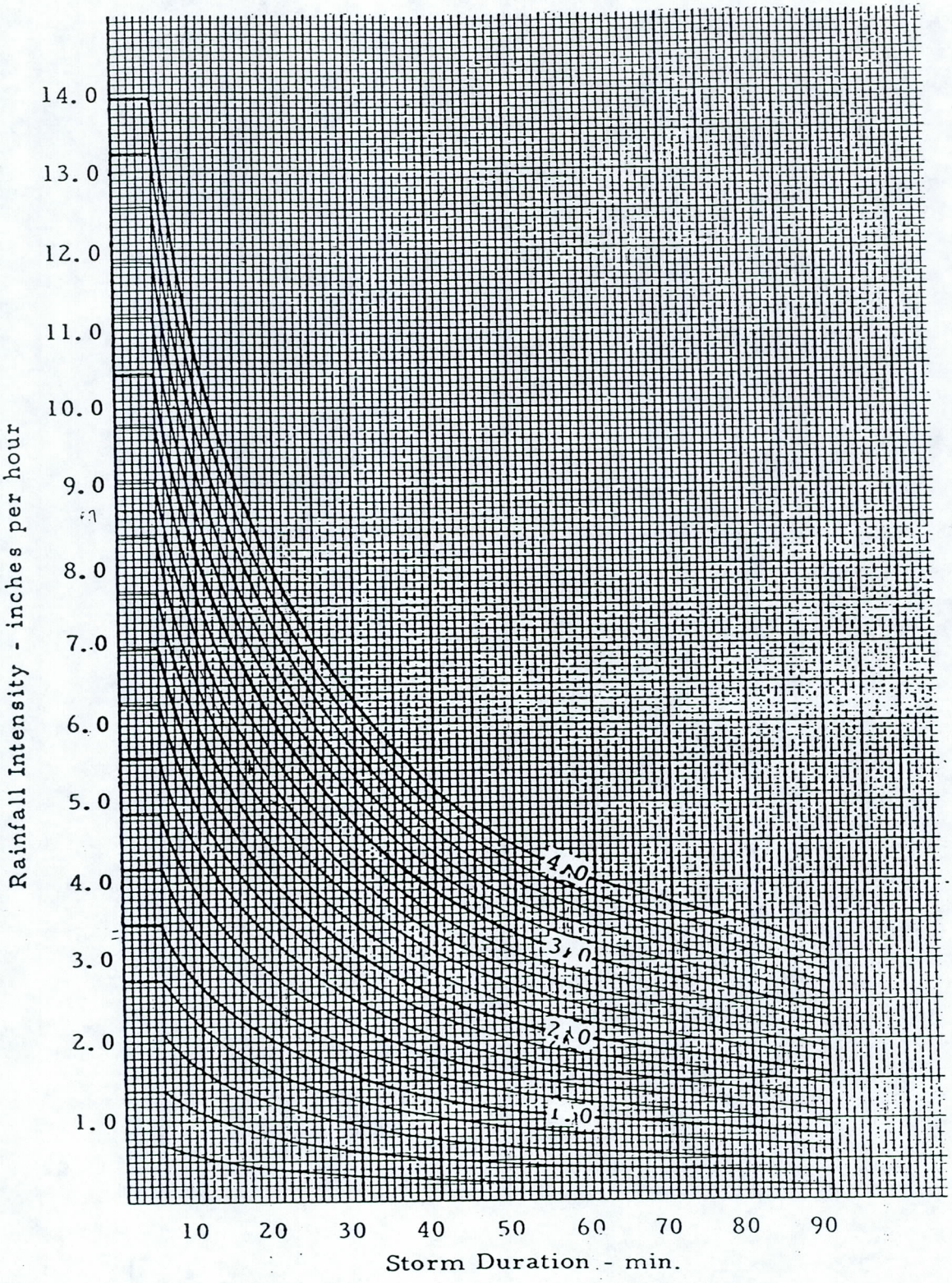
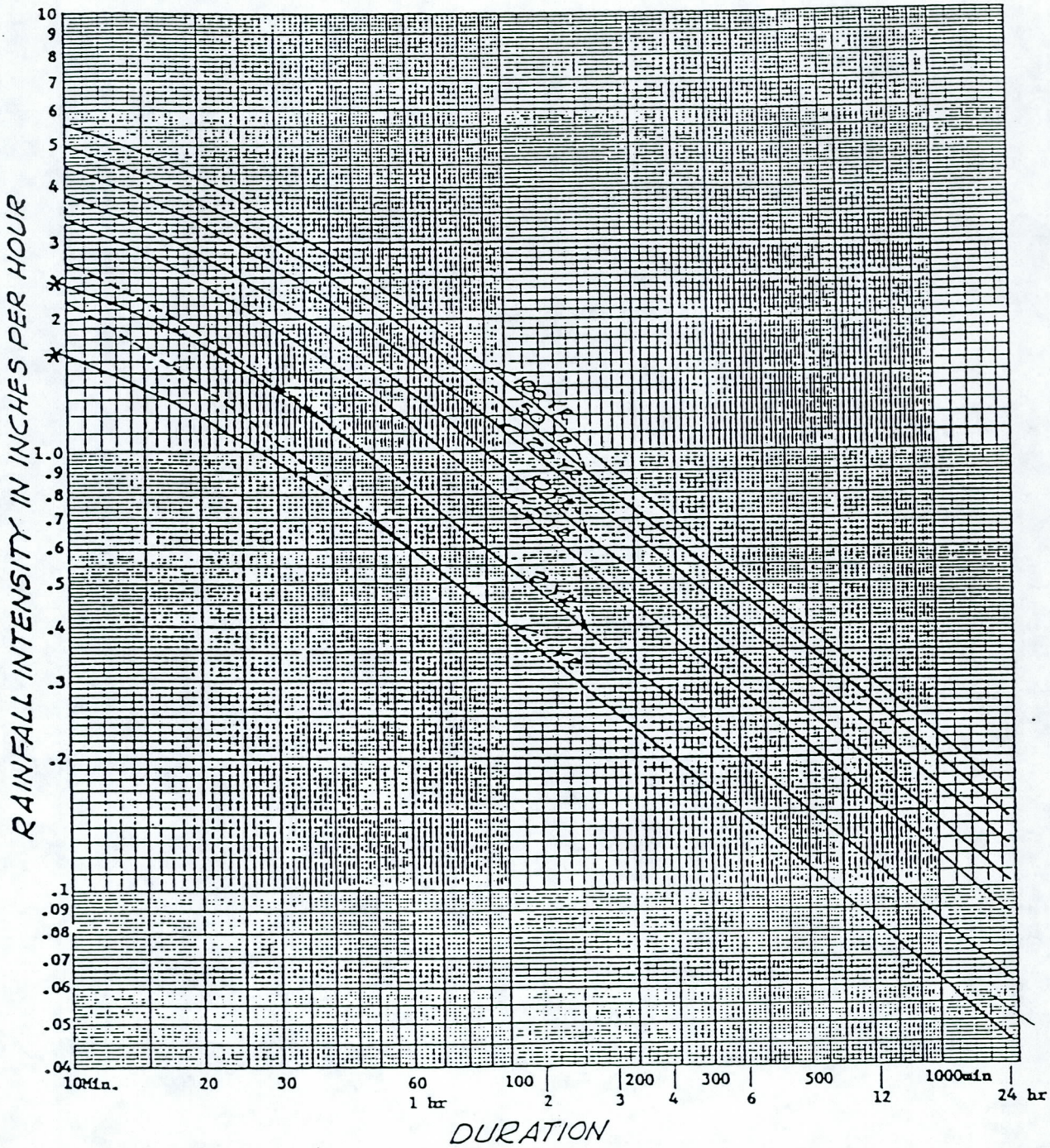


Fig. 3-2

STANDARD DURATION RAINFALL - INTENSITY CURVES

Based on:
Weather Bureau
Technical Paper No. 40



RAINFALL INTENSITY-DURATION-FREQUENCY RELATION
FOR PHOENIX, ARIZONA
(Partial Duration Series)

Curves are based on methods of U.S. Weather Bureau Technical Papers Nos. 28 and 40 and rainfall data prepared by U.S. Weather Bureau Office of Hydrology for the Soil Conservation Service, March 1967

* Curves revised June 1975 to reflect new information from WR-44.

RUNOFF CO-EFFICIENTS FOR USE WITH THE RATIONAL FORMULA Q = CIA

Land Use	"C" Value
Paved Street or Parking Lot	0.95
Commercial Areas	0.90
Residential Areas (Average lot zoning)	0.45
Townhouses	0.55
Apartments and Condominiums	0.65
Parks and Grassed Areas (no irrigation)	0.20
Railroad Yards	0.25
Undeveloped Desert	0.35
Mountain Terrain — slopes greater than 10%	0.70
Industrial Areas	0.90
Agricultural Areas	0.20

Streets	
Asphaltic	0.70 - 0.95
Concrete	0.80 - 0.95
Gravel roadways & shoulders	0.40 - 0.60
Industrial Areas	
Flat commercial - about 90% of area impervious	0.80
Heavy areas	0.60 - 0.90
Light areas	0.50 - 0.80
Business Areas	
Downtown areas	0.70 - 0.95
Neighborhood areas	0.50 - 0.70
Residential Areas	
Lawns - flat	0.05 - 0.15
- steep	0.15 - 0.35
Suburban areas	0.25 - 0.40
Single family areas	0.30 - 0.50
Multi-unit areas	0.40 - 0.60
Apartment areas	0.50 - 0.70
Parks, Cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.35

Fig. 3-3

VALUES OF RUNOFF COEFFICIENT C

P&PM INTEROFFICE MEMO ROUTING SLIP

Originator: Don Rerick

Topic: FCD 89-60 35th Street Side Drain Final Calculations for Review/Comment

Date Sent: 03/19/90 Reply Required By: 03/26/90 Follow: 03/22/90

X	Initial	Date Received	Date Returned	Reviewers
X	JMK	03/19/90		P&PM Adm. Coord.(All Memos for Logging)
X	RC	03/19/90		Division Chief, Engineering Division
				Division Chief, _____ Division
				Division Chief, _____ Division
				_____, _____ Division
				_____, _____ Division

Remarks:

FLOOD CONTROL DISTRICT

MEMORANDUM

March 19, 1990

SUBJECT: Final Calculations for the 35th Street Side Drain, Per Your Discussions with Bill Creagor of Creegan + D'Angelo.

TO: Nick Karan

FROM: Don Rerick

The attached calculations have been submitted in response to the telephone conversation review you had with Bill Creagor of C&D on March 7, 1990.

I have attached a copy of the March 7, 1990 memo which outlines the remaining review items for this contract. Included are the comments you had for Bill.

Please proceed to review these calcs. Also, please complete your review of the drawings for the side drain and the Special Provisions for the 32nd Street Sewer and Reconstruction of Stanford Drive, as we discussed on March 7, 1990.

Any comments you may have on the calcs, drawings or Special Provisions should be given to me by March 26, 1990.

Thank you for your assistance.

FLOOD CONTROL DISTRICT

MEMORANDUM

March 7, 1990

SUBJECT: Remaining Review Items for Contract FCD 89-60 32nd Street; Review of Special Provisions for 32nd Street Sewer and Stanford Drive Reconstruction, Review of Pre-Final Check Prints and Calculations for the 35th Street Side Drain.

TO: Nick Karan

FROM: Don Rerick

The final set of Special Provisions for Contract II "32nd Street Sewer Relocation and Reconstruction of Stanford Drive" were provided to you this morning.

The 90% submittal and pre-final submittal of these specs were provided to engineering for review along with the plans. I have received comments on the plans I still need comments on the specs.

Although these specs will be incorporated into the Corps Reach 4 specs as an appendix for construction by the Corps, the District must still review the specs. As a minimum, engineering should review the appropriate technical sections. In the attached specs I have marked the technical sections (concrete, etc.) for your review. Please review these special provisions and provide me with your comments by March 14, 1990.

This morning you and I spoke with Bill Creager of Creegan + D'Angelo regarding outstanding calculations they still need to submit for the 35th Street Side Drain.

The remaining calculations to be submitted are as follows:

1. Retaining walls -
   a. heal design
   b. overstress at bottom of stem wall
   c. rebar pattern in the wall

2. Trash rack purlin -
   a. calculate the biaxial loading on the channel support.
   b. may be necessary to "beef-up" the channel support.

Bill said these calculations will be submitted early next week.

Upon receipt of the calcs, please proceed to review them and complete your review of the check prints for the 35th Street Side Drain as soon as possible. You and I began review of the check prints yesterday afternoon and I have incorporated those comments.

The target date for completion of this review, contingent upon receipt of the calcs, is Friday, March 16, 1990.

This morning you and I reviewed the Special Provisions for the Contract III "35th Street Side Drain". Your only comments applied to backfill criteria for the structure, and I have incorporated your comments into the master comments set for submittal to the consultant.

I will get with you for signoff of the plans and Special Provisions if this becomes required. Thank you.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 1 OF 14
ACDC		JOB NO. 889013
35th STREET INLET STRUCTURE		BY RS DATE 12/89
		REVWD. BCB DATE 1-3-90
		REVISED

CLIENT:

CODE: AISC (ASD) 9th EDITION, ACI 318-83

ADDRESS OF JOB: MARICOPA COUNTY, ARIZONA

SPRINKLER SYSTEM: N/A

CONSTRUCTION: CAST-IN-PLACE CONCRETE (DRAINAGE INLET STRUCTURE)

ALLOWABLE STRESSES

SOIL BEARING: 3000 PSF ASSUMED W/ 1.33 TOE PRESSURE INCREASE

CONCRETE - FOUNDATIONS: 4000 PSI @ 28 DAYS

SLABS: 4000 PSI @ 28 DAYS

ELEVATED (STRUCTURAL): 4000 PSI @ 28 DAYS

REINFORCING STEEL: F_y=40KSI (#5 & SMALLER); F_y=60 KSI (#6 & LARGER)

STRUCTURAL STEEL: ASTM A36

WELDING: E70XX

BOLTS: ASTM A307, A36

MASONRY: N/A

GLULAMS: N/A

PURLINS: N/A

JOISTS: N/A

OTHER DIM. LUMBER: N/A

PLYWOOD: N/A

FLOOD CONTROL DISTRICT
RECEIVED
MAR 16 1990

	CH ENG		P & PM
	DEP		HYDRO
	ADMIN		MGT
	FINANCE		FILE
	C & O	1	DJR
	PRES		

REMARKS

TABLE OF CONTENTS:

PAGE	DESCRIPTION
2-4	TRASHRACK
5-14	RETAINING WALLS

CREEGAN + D'ANGELO

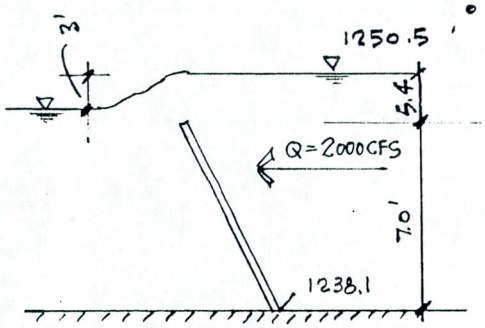
Engineers · Planners · Surveyors

650 North Second Ave.
Phoenix, AZ 85003
Phone: 602 258 3175
Fax: 602 258 4683

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 2 OF
ACDC 35TH ST. INLET STRUCTURE		JOB NO. 889013.45
TRASH RACK		BY WBC DATE 19FEB90
		REVWD. TLA DATE 21 FEB 90
		REVISED

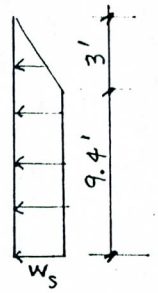
TRASH RACK

- ASSUME TRASH RACK IS 50% CLOGGED (EL 1250.45)
- ASSUME 3 FT. HEAD DIFFERENTIAL ACROSS RACK



ELEV. @ RACK

STATIC HEAD



$W_s = 62.4\ PCF \times 3' = 187\ PSF$.

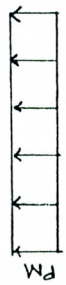
FOR Q = 2000 CFS AND 50% CLOGGED

$H = 5.4' + \frac{7'}{2} = 8.9'$;

$V = \frac{Q}{A} = \frac{2000CFS}{8.9' \times 39'}$

$= 5.76\ fps$.

DYNAMIC HEAD (REF. AASHTO TP 3.18.1)



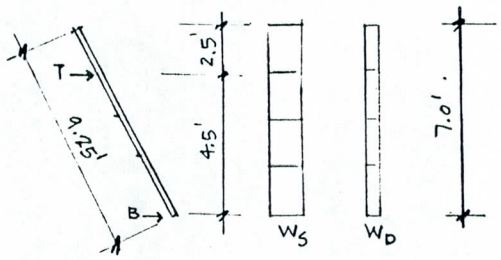
$p = kV^2$ WHERE $K = 1.375$

$= 45.6\ PSF$. $V = 5.76\ fps$.

$\therefore W_D = 45.6\ PSF$ FOR CLOGGED AREA.

$\therefore W_D = 45.6 \times 50\% = 22.8\ PSF$ NET LOADING.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 3 OF
ACDC 35TH ST. INLET		JOB NO. 889013.
TRASH RACK		BY WBC DATE 19 FEB 90
		REVWD. TLA DATE 21 FEB 90
		REVISED



BARS (NEGLECT LOAD DECREASE DUE TO SLOPE)

$W_T = W_S + W_D = 210$ PSF. SAY $W_T = 220$ PSF

$T = \frac{220}{2 \times 4.5}(4.5+2.5)^2 = 1200^{\#}$ PER FT.

$B =$ " $(4.5^2 - 2.5^2) = 345^{\#}$ " "

$1545^{\#}/7' = 220$ PLF. O.K.

$-M_c = \frac{1}{2} w_T L_c^2 = 0.69$ K-FT/FT

$+M_s = \frac{w_T}{8L^2}(L+L_c)^2(L-L_c)^2 = 0.27$ K-FT/FT

TRY $\frac{5}{8}$" x 3.0" BARS — $A = 1.88$ in^2 $I_x = 1.41$ in^4 $r_x = 0.86$

$S = 0.94$ in^3 $I_{yc} = 0.031$ in^4 $r_{yc} = 0.13$

UNBRACED L ⇒ $L_b = L\left(1 - \frac{L_c^2}{L^2}\right) = 3.1' = 37"$

$\frac{L_b}{r_{yc}} = \frac{37"}{0.13} = 285$ ∴ $F_b' = \frac{170 \times 10^3}{(L/r)^2} = 2.1$ KSI ALLOWABLE BENDING STRESS

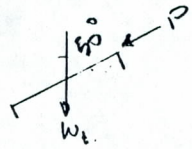
$S_R = \frac{M}{F_b'} = \frac{0.27 \times 12}{2.1} = 1.54$ in^3 PER LF

$S_{BARS} = 0.94$ in$^3 \times \frac{12}{4.5} = 2.50$ in^3 PER LF > 1.54 in^3 O.K.

$\frac{1}{2}$" x 3" Bar ; $S = 0.75$ in^3

USE BAR STOCK PL $\frac{1}{2}$" x 3" @ 4.5" ℄ – A36
LATERAL STAYS @ BOT., EL. 2.25', EL. 4.5', TOP

SUPPORT BEAM $L = 20'$ $L_b = 6.5'$



P: (FROM PREVIOUS PAGE) = 1.2 KLF

W_t: (BEAM WEIGHT) ≅ .034 KLF

$$M_x = \frac{P\ell^2}{8} + W_t(\cos 50°)\tfrac{1}{8}(\ell^2) = 61.1 \text{ k'}$$

$$F_{b_x} = \frac{12\times10^3(1)}{6.79(6.5)(12)} = 22.7 \quad \therefore F_{b_x} = 22 \text{ ksi}$$

$$S_{R_x} = \frac{M}{F_{b_x}} = \frac{61.1^{k'}(12)}{22} = 33.3 \text{ in}^3 < 42 \text{ OK}$$

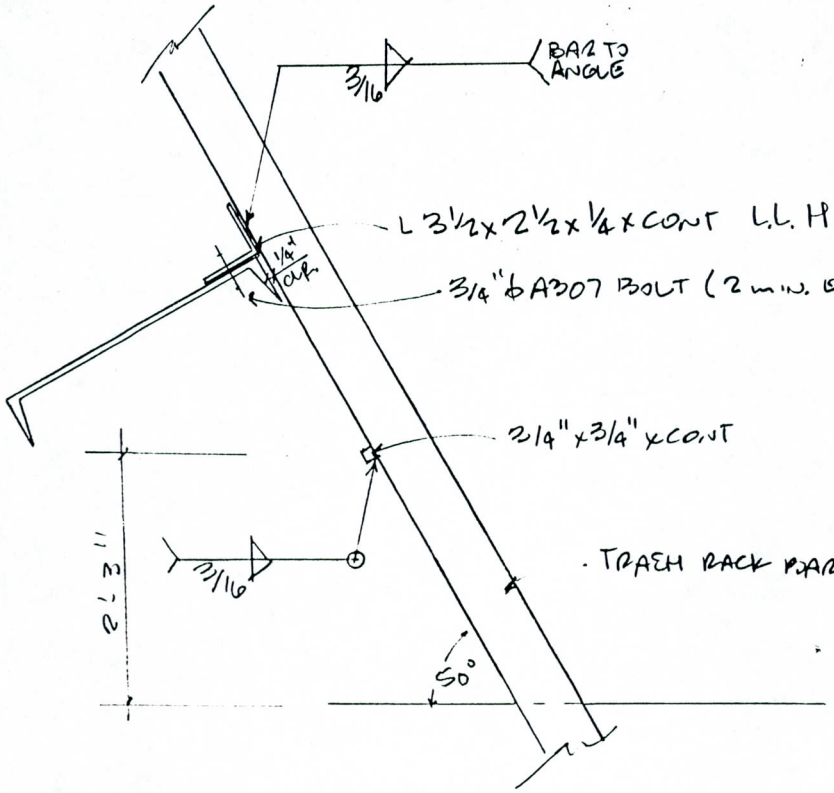
$$\Delta_x = \frac{180(61.1)(20)^2}{(315)\,29000} = .48'' \text{ OK}$$

$$M_y = W_t(\sin 50°)\tfrac{1}{8}(\ell^2) = 1.3 \text{ k'} \qquad F_{b_y} = 22 \text{ ksi}$$

$$S_{R_y} = \frac{1.3(12)}{22} = .71 \text{ in}^3 < 3.11 \text{ OK}$$

$$\frac{33.3}{42} + \frac{.71}{3.11} = 1.0 \text{ OK}$$

$$\boxed{\text{USE C15x33.9}}$$



· TRASH RACK BARS ½"x3" @ 4½" O.C.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 4B OF
ACDC		JOB NO. 889012
35th ST INLET STRUCTURE		BY RS DATE 12/89
		REVWD. WBC DATE 5 JAN 89
		REVISED WBC 21 FEB 90 △1
		RS 15 MAR 90 △2

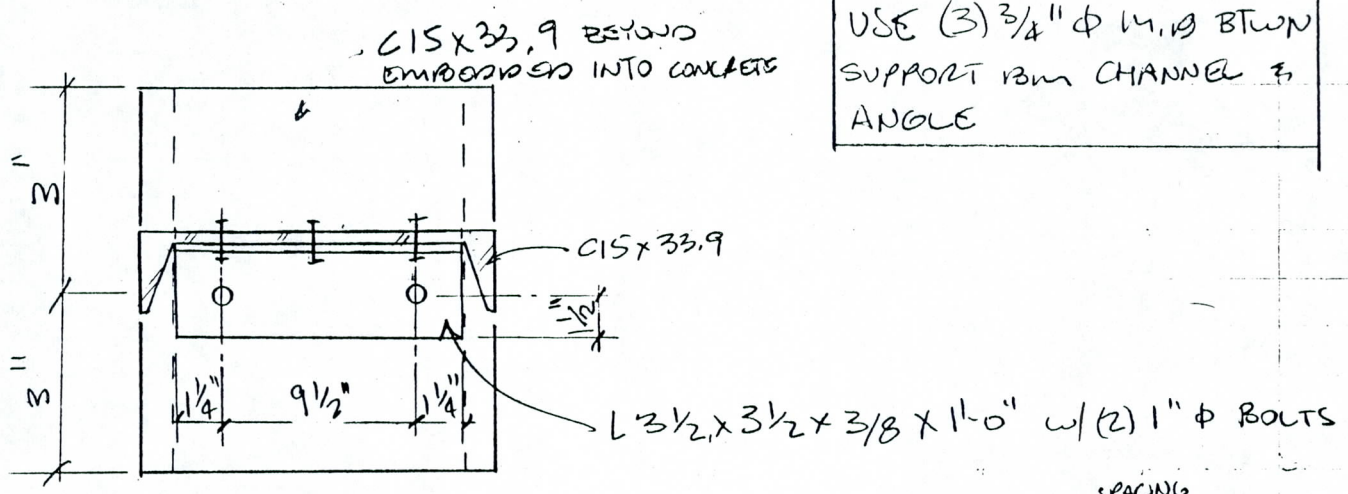
$$R_{RESULTANT}^2 = \left[\left[1.2 + .034\cos 50^\circ\right]\frac{20}{2}\right]^2 + \left[\left[.034\sin 50^\circ\right]\frac{20}{2}\right]^2$$ △2

$$R_{RESULTANT} = 14^k$$

BOLTS BTWN CHANNEL + STEM OF TEE

$$\frac{12.0^k}{4.4^k/\text{BOLT}} = 2.7 \Rightarrow \text{USE 3 BOLTS}$$ △1

USE (3) 3/4" Φ MIN BTWN SUPPORT BEAM CHANNEL & ANGLE



THRU (2) 1" Φ BOLTS @ 9 1/2"

$$V_{ALLOW/BOLT} = .79(4150^\#) = 3285^\#$$ (SPACING REDUCTION)

$$V_{TOTAL\ FOR\ BOLTS\ IN\ CONC} = (2)(3285) = 6571^\#$$

$$V_{NET} = 12.0 - 6.6 = 5.4^k$$ THIS MUST BE CARRIED BY EMBED CHANNEL. △1

ASSUME 2" OF 3.4" FLANGE WIDTH FOR EMBED CHANNEL IS EFFECTIVE IN BRG. AGAINST CONCRETE. △1

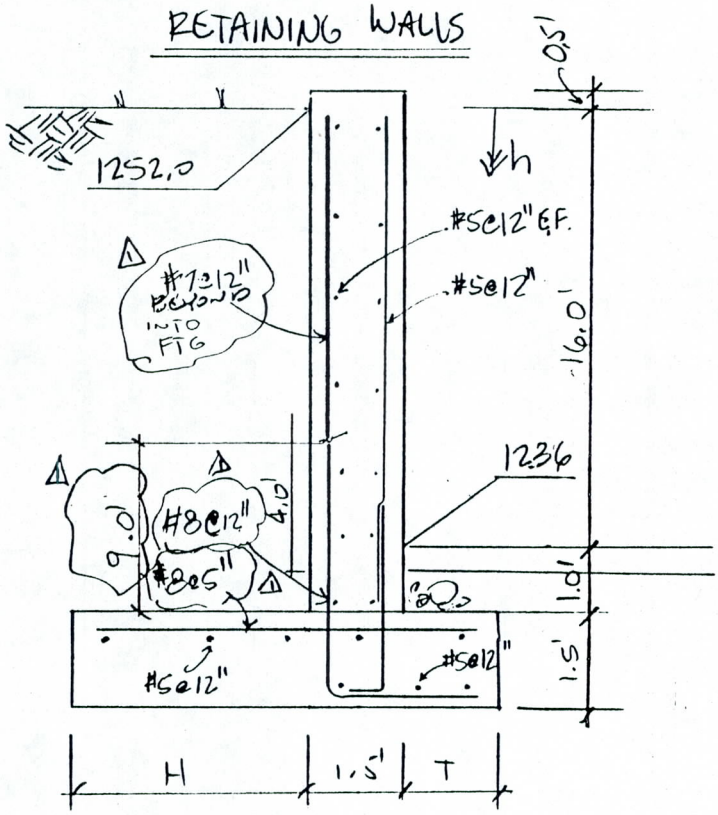
$$A = 2"(6") \times 2 = 24\ in^2$$ (2 FLANGE FACES) $$P_{BRG\ ALLOW} = 4000\ psi(24) = 96^k$$ △1

$$T_{BOLT\ PRYING} = \frac{12.^k(2.25")}{9.5"} = 2.8^k < 3.2^k$$ OK

USE (3) 1" Φ BOLTS W/ C15x33.9x 0'-6" LG. EMBEDS INTO WALLS △1

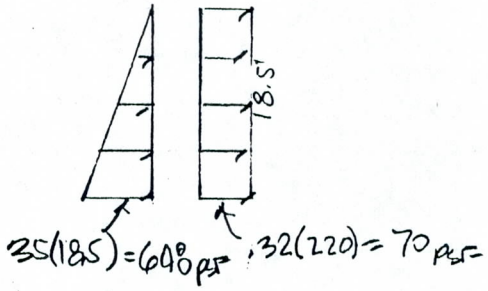
CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 5 OF
ACDC		JOB NO. 889013
35th ST. INLET STRUCTURE		BY RS DATE 12/89
		REVWD. RCB/GB DATE 12-27-89
		REVISED Δ 3/12/90 RS

RETAINING WALLS



ASSUMPTIONS:

1. $\gamma = 110$ PCF, $\gamma k_A = 35$ PSF/FT
2. 220 PSF SURCHARGE
3. NO RESTRAINT FROM SLAB
4. PASSIVE PRESSURE = 400 PSF/FT
5. FRICTION FACTOR = .35



TRY $H = 6'$ $T = 3'$

$$M_{OT} = \tfrac{1}{2}(648)(18.5)^2(\tfrac{1}{3}) + 70(18.5)^2(\tfrac{1}{2}) = 48.9^{k'}$$

$$M_R = 150(1.5)(10.5)^2(\tfrac{1}{2}) + 150(17.5)(1.5)(3.75) + 110(17.0)(6)(7.5) + 220(6)(7.5) = 121.2^{k'}$$

OTSF = 2.5 > 1.5 OK

DUE TO BOX SHAPE OF STRUCTURE SLIDING IS NOT CRITICAL WHEN INTERSECTING WALLS ARE USED IN SLIDING RESISTANCE.

$$\tfrac{1}{2}P = 150(1.5)(10.5) + 150(17.5)(1.5) + 110(17.0)(6) + 220(6) = 18.8^{k}$$

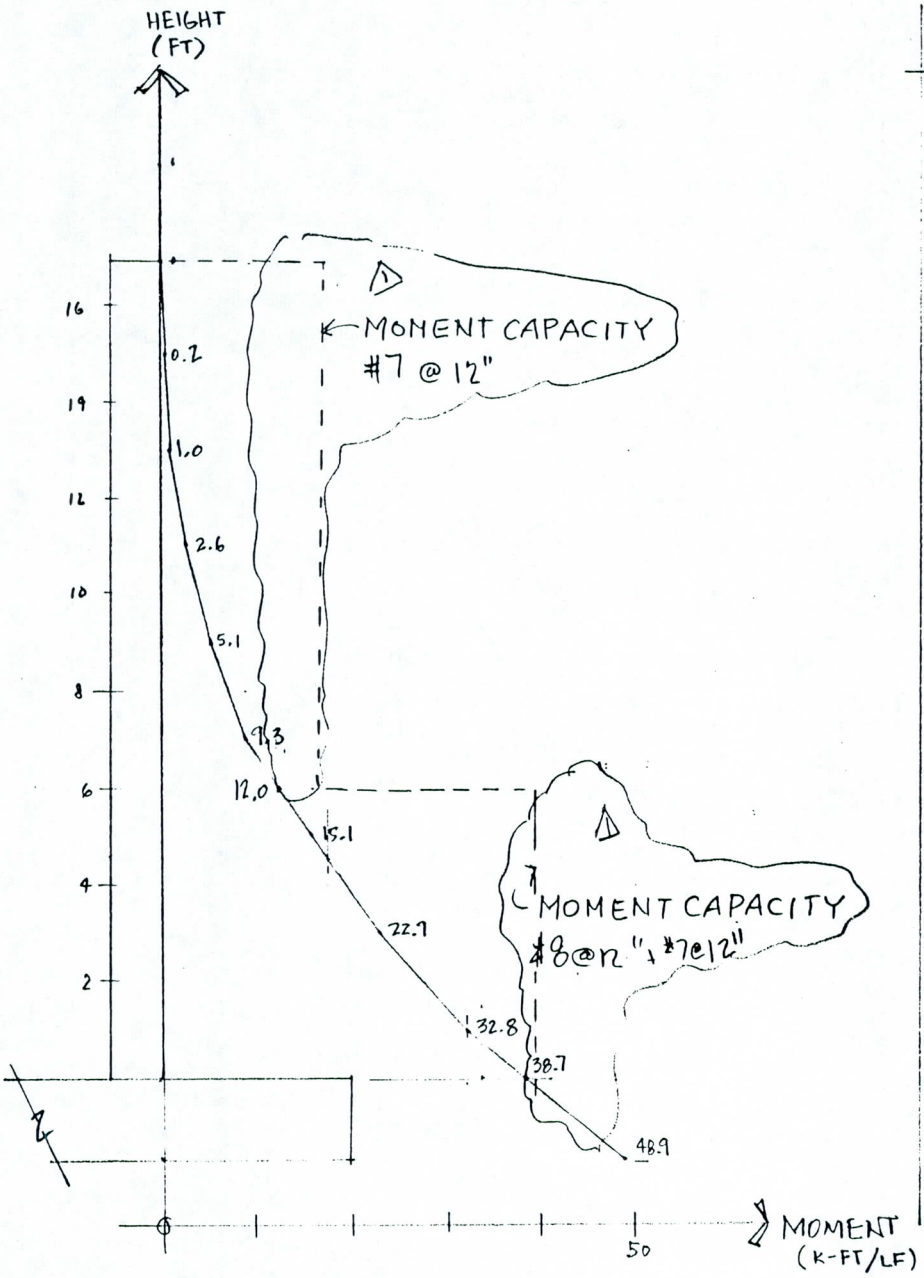
$$e = \frac{121.2 - 48.9}{18.8} = 3.05' > 3.5'$$

$$q_1 = 18.8\left[\frac{4(10.5) - 6(3.85)}{10.5^2}\right] = 3.2 \text{ KSF} \quad \text{OK}$$

$$q_2 = 18.8\left[\frac{6(3.85) - 2(10.5)}{10.5^2}\right] = .36 \text{ KSF} \quad \text{OK}$$

$$\boxed{\text{USE } H = 6' \quad T = 3'}$$

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 5A OF
35TH ST. WASH INLET STRUCTURE		JOB NO. 889013.
RETAINING WL's		BY WBC DATE 21 FEB 90
		REVWD. 98 DATE 2-22-90
		REVISED 1 3-12-90 RS



$(A_s)_{REQ'D}$ (WSD) d = 15.5" a = 1.76	$(A_s)_{PROVIDED}$
–	
–	
0.03 in²	
0.10 in²	
0.20 in²	
0.34 in²	
0.55 in²	
0.83 in²	
1.20 in²	#7@12" #8@12"

AASHTO 8.24.1.2.1 – (1) d = 15.5" or (2) $15 d_b$ < #7 - 13.1" / #8 - 15.0" 1 OR (3) $\frac{H}{20} \doteq 10.2" \pm$

BEYOND PT. WHERE NO LONGER REQ'D TO RESIST FLEXURE

ACDC

35th ST. INLET STRUCTURE

WALL REINF:

h	M_{WALL}
6'	2.5 k/1
8'	5.2 k/1
10'	9.3 k/1
12'	15.1 k/1
15'	27.6 k/1
17'	38.8 k/1

$M_{WALL} = \frac{1}{2}(35)(h)^3(\frac{1}{3}) + 70(h)^2(\frac{1}{2})$
$= 5.833h^3 + 35h^2$

MIN VERT. STL = (.0015)(18)(12) = .32 in²/FT
MIN. HORIZ STL = (.0025)(18)(12) = .54 in²/FT

USE #5 @ 12" HORIZ EA FACE OF WALL

$f'_c = 4000$ psi @ 28 days

$F_y = 40$ KSI FOR #5 & SMALLER
$F_y = 60$ KSI FOR #6 & LARGER

BASE: TRY #8 @ 12" & #7 @ 12"

$d = 15.5" \pm$ $n = \frac{29 \times 10^6}{57000\sqrt{4000}} = 8.0$

Δ

AS = 1.39 np = .060 j = .9029 2/kj = 7.60

$f_c = 1224$ psi $M_c = .45(4000)(12)(15.5)^2(\frac{1}{7.60}) \div 12000 = 56.9$ k/1 OK
$f_s = 23.9$ KSI < 24 KSI O.K. $M_s = 1.39(24)(.9029)(15.5) \div 12 = 38.9$ k/1 OK

USE #8 @ 12" VERTS FOR BOTTOM OF WALL

UPPER: TRY #7 @ 12" As = .60 np = .026 j = .9321 2/kj = 10.55

$f_c = 527$ psi $M_c = .45(4000)(12)(15.5)^2(\frac{1}{10.55}) \div 12000 = 41$ k/1 OK
$f_s = 16.6$ KSI < 24 KSI O.K. $M_s = .60(24)(.9321)(15.5) \div 12 = 17.3$ k/1 OK

USE #7 @ 12" VERTS FOR UPPER PORTION OF WALL

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 7 OF
ACDC		JOB NO. 889013
35TH ST. INLET STRUCTURE		BY RS DATE 12/89
		REVWD. BCB/GB DATE 12-29-89
		REVISED RS 26 FEB 90 △1
		RS 3/12/90 △2

FTG REINF:

$M_{HEEL}' = [150(1.5) + (110)(17.0) + 220](6.25^2)(1/2) = 45.2$ K/'

∴ USE STEM M FOR DESIGN

$M_{DESIGN} = 38.7$ K/'

△2

TRY #8@6" d = 15" ± $A_s = 1.58$ $\rho = .070$

$j = .8965$ $k j = 7.19$

$f_c = 1237$ psi $M_c = .45(4000)(12)(15)^2(\frac{1}{7.19}) \div 12000 = 56.3$ K/'

$f_s = 21.9$ KSI < 24 KSI O.K. $M_s = 1.58(24)(.8965)(15) \div 12 = 42.5$ K/'

$l_{d\,REQ'D} = 30"$

$l_{PROVIDED} = 51"$

~~USE #8@6"~~ = SEE CHECK

△1 CHECK FTG THICKNESS $V_{DESIGN} = 6.25'\left(\frac{M_{DESIGN}(2)}{6.25^2}\right) = 12.38^k$ M_{DESIGN} = STEM DESIGN MOMENT

$V_c = .9\sqrt{4000} + 1100\left(\frac{1.58}{12(15.5)}\right)\left(\frac{12.38(15.5)}{38.7}\right)^{-1} = 66.3$ psi N.G.

TRY #8@5" $A_s = 1.896$

$V_c = .9\sqrt{4000} + 1100\left(\frac{1.896}{12(15.5)}\right)(1) = 68.1$ psi

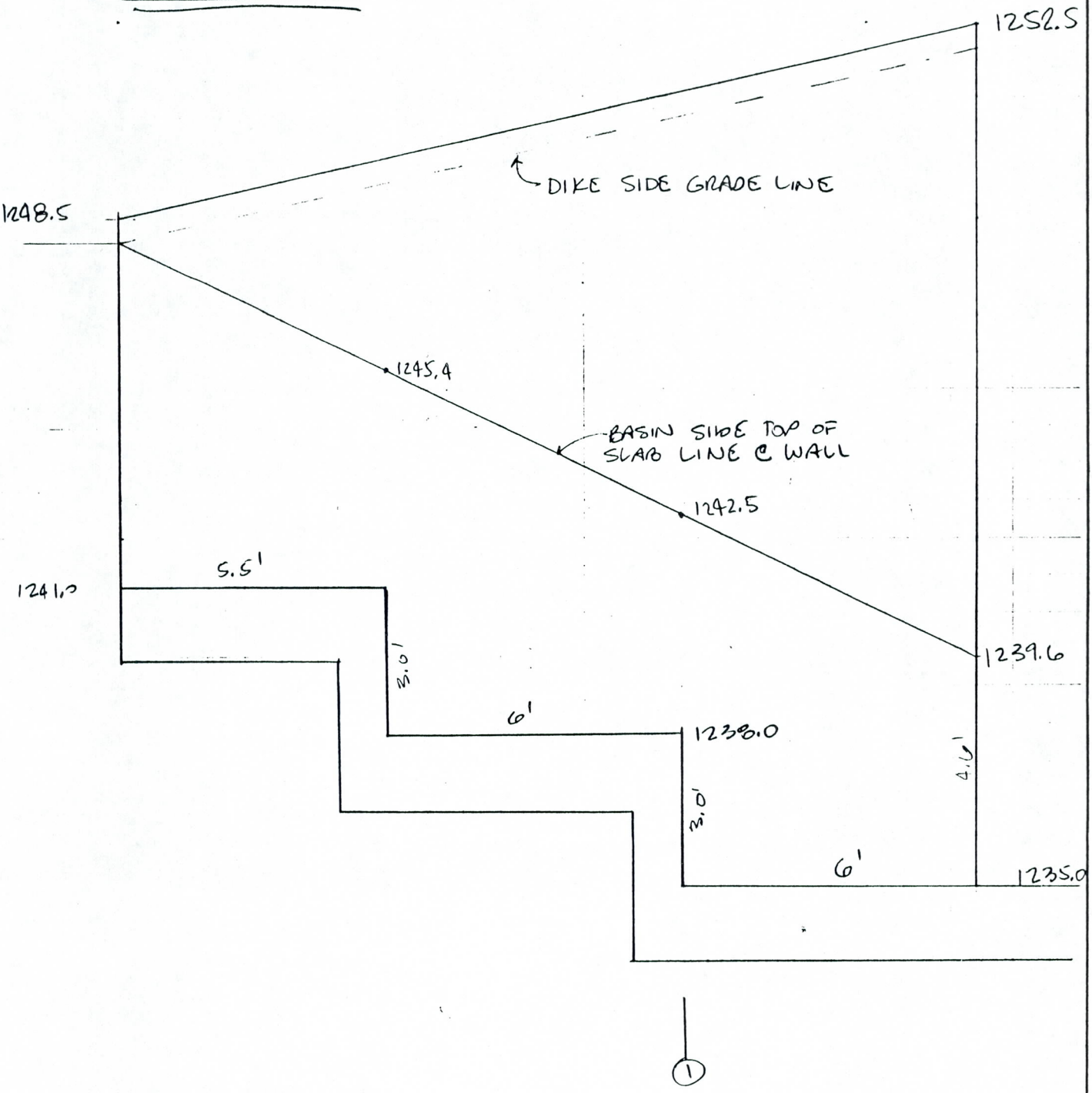
$V_{ALLOW} = 68.1(15.5)(12) = 12.7^k > 12.4^k$ OK

USE #8@5"

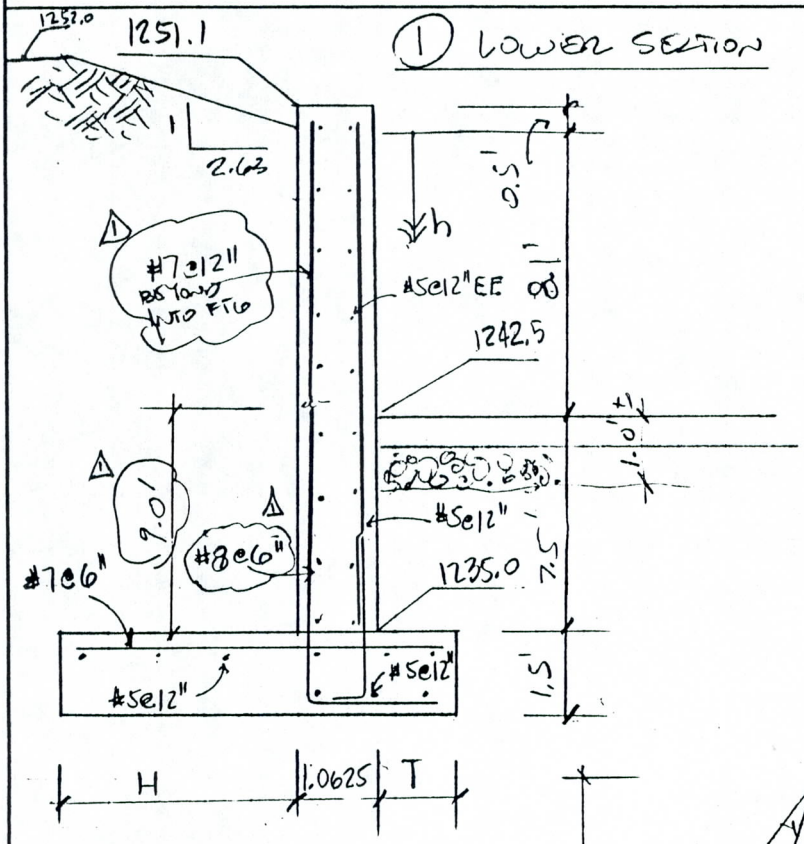
USE 18" THK FTG

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 8 OF
ACDC		JOB NO. 889013
35th ST INLET STRUCTURE		BY RS DATE 12/89
		REVWD. DATE
		REVISED

WING WALLS

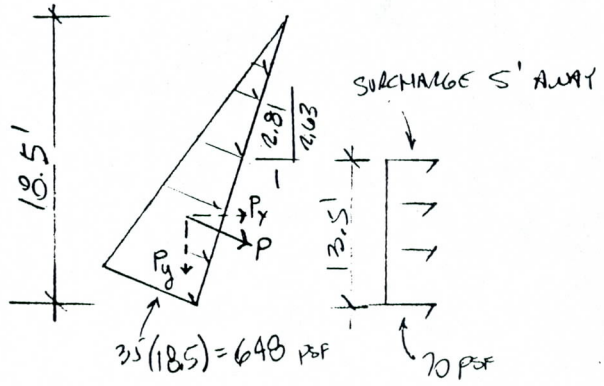


CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 9 OF
ACDC		JOB NO. 889013
35th ST. INLET STRUCTURE		BY RS DATE 12/89
		REVWD. BCB DATE 1-3-90
		REVISED 3/11/90 KS



ASSUME 6' OF WING WALL STIFFENED BY 1.5' THICK INLET WALL ∴ CRITICAL SECTION IS 6' FROM 1.5' THICK INLET WALL

NOTE: BACKFILLING OF BOTH SIDES OF WALL REQ'D AT SAME TIME



$$P = \tfrac{1}{2}(648)\left(\tfrac{2.81}{2.63}\right)(13.5) = 6404^{\#}$$

$$P_x = P\left(\tfrac{2.63}{2.81}\right) = 5994^{\#} \qquad P_y = P\left(\tfrac{1}{2.81}\right) = 2279^{\#}$$

$$M_{OT} = 5994(13.5)(\tfrac{1}{3}) + 70(13.5)^2(\tfrac{1}{2}) = 43.3^{k'}$$

TRY H = 5' T = 3'

$$M_R = 150(1.5)(9.0625)^2(\tfrac{1}{2}) + 150(16.1)(1.0625)(2.53) + 110(16.1)(5)(6.56) + 2279(4.0625) = 85.6^{k'}$$

OTSF = 2.0 > 1.5 OK

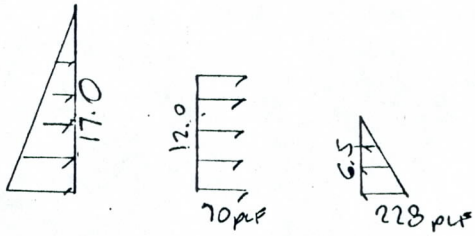
$$\Sigma P = 150(1.5)(9.0625) + 150(16.1)(1.0625) + 110(16.1)(5) + 2279 = 15.7^{k}$$

$$e = \frac{85.6 - 43.3}{15.7} = 2.7' < 3.0' \qquad p_{max} = \tfrac{2}{3}\left[\frac{85.6 - 43.3}{2.7^2}\right] = 3.9^{KSF}$$ OK

USE H = 5' T = 3'

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 10 OF
AC DC		JOB NO. 889013
35th ST. INLET STRUCTURE		BY RS DATE 12/89
		REVWD. BCB DATE 1-3-90
		REVISED Δ 3/12/90 RS

WALL REINF:



h	M_{WALL}
8.1'	5.4 k'/'
10.0'	9.5 k'/'
12.0'	15.5 k'/'
14.0'	23.0 k'/'
15.6'	30.3 k'/'

$$M = \tfrac{1}{2}\left(\frac{2.603}{2.81}\right)(35)(h+1.4)^3(\tfrac{1}{3}) + 70(h-3.6)^2(\tfrac{1}{2}) - \tfrac{1}{2}(35)(h-9.1)^3(\tfrac{1}{3})$$

$$M = 5.46(h+1.4)^3 + 35(h-3.6)^2 - 5.83(h-9.1)^3$$

BY INSPECTION

USE #5 @ 12" HORIZ E.F.

$f'_c = 4000$ psi @ 28 days

$F_y = 40$ ksi FOR #5 & SMALLER
$F_y = 60$ ksi FOR #6 & LARGER

BASE: $d = 12.75" - 2" - .5" = 10" \pm$ $n = 8.0$

Δ TRY #8 @ 6" + #7 @ 12" $A_s = 2.18$ $np = .145$ $j = .8624$ $^2/_{kj} = 5.62$

$f_c = 1702$ psi
$f_s = 19.3$ ksi
$l_{d\,req'd} = 38"$

$M_c = .45(4000)(12)(10)^2(\frac{1}{5.62}) \div 12000 = 32.0$ k'/'
$M_s = 2.18(24)(.8624)(10) \div 12 = 37.6$ k'/'

USE #8 @ 6" + #7 @ 12"

CREEGAN + D'ANGELO PHONE (602) 258-3175

SHT. NO. 11 OF

JOB NO. 889013

BY RS DATE 12/89

REVWD. BCB/GS DATE 1-3-90

REVISED 26 FEB 90 RS △1

12 MAR 90 RS △2

ACDC

35th ST. INLET STRUCTURE

UPPER: TRY #7 @12" $A_s = .60$ $n\rho = .04$ $j = .9181$ $\frac{2}{kj} = 8.89$

△2

$f_c = 978$ psi

$f_s = 24$ ksi

$M_c = .45(4000)(12)(10)^2\left(\frac{1}{8.89}\right) \div 12000 = 20.2^{k'}/_1$

$M_s = .60(24)(10)(.9181) \div 12 = 11.0^{k'}/_1$

$\frac{10-12}{9.5-15.5} = \frac{10-x}{9.5-11}$ $x = 10.5'$ $15.6 - 10.5 = 5.1$

$5.1' + 3.2' = 8.3'$

FOR CONSISTENCY OF MATL USE SAME #8 DOWELS AS IN 1.5' THICK WALLS

$\boxed{\text{USE \#7 @ 12" VERTS FOR UPPER WALL PORTION}}$

FTG REINF:

$M_{HEEL} = 150(1.5)(5.25)^2(1/2) + 110(16.1)(5.25)^2(1/2) + 2279(.25)$

$= 28.1^{k'}/_1$ (CONSERVATIVE)

△2 TRY #7 @ 6"

$f_c = 995$ psi

$f_s = 20.6$ ksi

$l_{REQD} = 23"$ $l_{AVAIL} = 45"$

$M_c = .45(4000)(12)(15)^2\left(\frac{1}{7.97}\right) \div 12000 = 50.8^{k'}/_1$

$M_s = 1.20(24)(15)(.9077)\left(\frac{1}{12}\right) = 32.7^{k'}/_1$

$\boxed{\text{USE \#7 @ 6"}}$

△1 CHECK FTG. THICKNESS

$V_{HEEL} = 150(5.25)(1.5) + 110(16.1)(5.25) = 10.5^k$

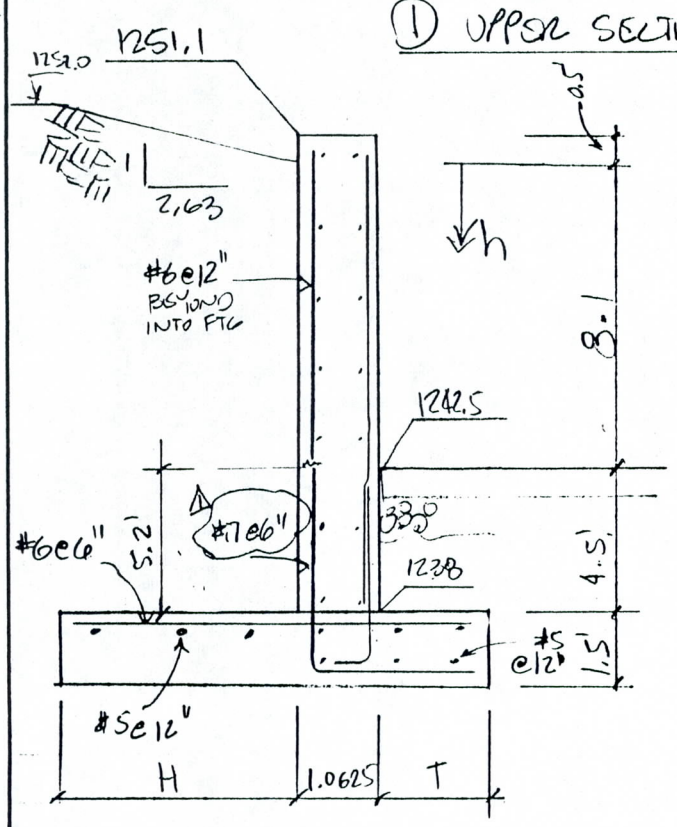
$v_c = .9\sqrt{4000} + 1100\left(\frac{1.20}{12(15.5)}\right)(1) = 64$ psi

$V_{ALLOW} = 64(15.5)(12) = 11.9^k > 10.5^k$ OK

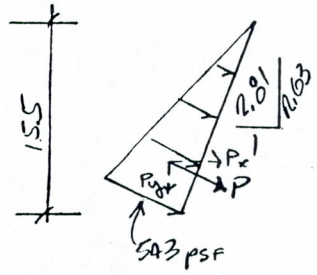
$\boxed{\text{USE 18" THK FTG}}$

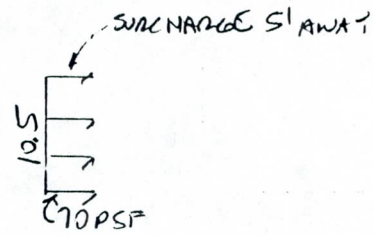
CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 12 OF
ACDC		JOB NO. 889013
35th ST. INLET STRUCTURE		BY RS DATE 12/89
		REVWD. BCB/GS DATE 1-3-90
		REVISED △1 3/12/90 RS

① UPPER SECTION



NOTE: BACKFILLING OF BOTH SIDE OF WALL REQ'D AT SAME TIME





$P = \frac{1}{2}(543)\left(\frac{2.81}{2.63}\right)(15.5) = 4496^{\#}$

$P_x = P\left(\frac{2.63}{2.81}\right) = 4208^{\#}$ $\quad P_y = P\left(\frac{1}{2.01}\right) = 1600^{\#}$

$M_{OT} = 4208(15.5)(1/3) + 70(10.5)^2(1/2) = 25.6^{k'}$

TRY $H = 4'$ $T = 3'$

$M_R = 150(1.5)(8.0625)^2(1/2) + 150(13.1)(1.0625)(3.53) + 110(12.6)(4)(6.0625) + 1600(4.0625) = 54.8^{k'}$

$OTSF = 2.0 > 1.5$ OK

$\Sigma P = 150(1.5)(8.0625) + 150(13.1)(1.0625) + 110(12.6)(4) + 1600 = 11.1^{k}$

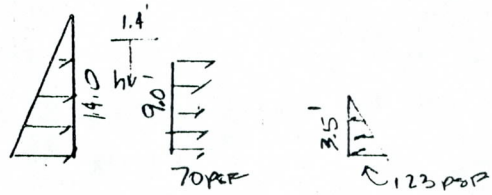
$e = \frac{54.8 - 25.6}{11.1} = 2.6' < 2.69'$ $\quad p_{MAX} = \frac{2}{3}\left[\frac{54.8 + 2.6}{2.6^2}\right] = 2.9^{KSF}$ OK

$\boxed{\text{USE } H = 4' \quad T = 3'}$

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 13 OF
ACDC		JOB NO. 889013
35th St. INLET STRUCTURE		BY RS DATE 12/89
		REVWD. BCB/as DATE 1-3-90
		REVISED Δ 3/12/90 RS

WALL REINF: BY INSPECTION | USE #5 @ 12" HORZ. E.F. |

h	M
8.1'	5.4 k/'
10.0'	9.5 k/'
12.6'	17.6 k/'



$$M = \tfrac{1}{2}\left(\frac{2.63}{2.81}\right)(35)(h+1.4)^3(\tfrac{1}{3}) + 70(h-3.6)^2(\tfrac{1}{2}) - \tfrac{1}{2}(35)(h-9.1)^3(\tfrac{1}{3})$$

$$M = 5.46(h+1.4)^3 + 35(h-3.6)^2 - 5.83(h-9.1)^3$$

BASE: d = 10" ± n = 8.0

TRY #7 @ 6" + #6 @ 12"

$A_s = 1.64$ $np = .109$, $j = .8765$ $2/kj = 6.16$

$f_c = 1084$ psi $M_c = .45(4000)(12)(10)^2(1/6.16) \div 12000 = 29.2$ k/'

Δ $f_s = 14.7$ ksi $M_s = 1.64(24)(.8765)(10) \div 12 = 28.7$ k/'

USE #7 @ 6" VERTS

UPPER:

TRY #6 @ 12"

$A_s = .44$ $np = .029$ $j = .9288$ $2/kj = 10.08$

$f_c = 827$ psi $M_c = .45(4000)(12)(10)^2\left(\frac{1}{10.08}\right) \div 12000 = 17.9$ k/'

$f_s = 24$ ksi $M_s = .44(24)(.9288)(10) \div 12 = 3.2$ k/'

$\frac{8.1-10}{5.4-9.5} = \frac{8.1-x}{5.4-8.2}$ $x = 9.4'$ $12.6 - 9.4 = 3.2$ $3.2 + 1.9 = 5.1'$

USE #6 @ 12" VERTS

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 10 OF 14
ACDC		JOB NO. 889013
35th ST INLET STRUCTURE		BY RS DATE 12/89
		REVWD. BCB/GS DATE 1-3-90
		REVISED RS 26 FEB 90 △ RS 12 MAR 90 △

FTG REINF:

$M_{HEEL} = 150(1.5)(4.25)^2(\frac{1}{2}) + 110(12.6)(4.25)^2(\frac{1}{2}) + 1600(.25) = 14.9^{K'/'}$

(CONSERVATIVE)

TRY #6@6" $A_s = .88$ $\rho = .039$ $j = .919$ $\frac{1}{kj} = 8.98$

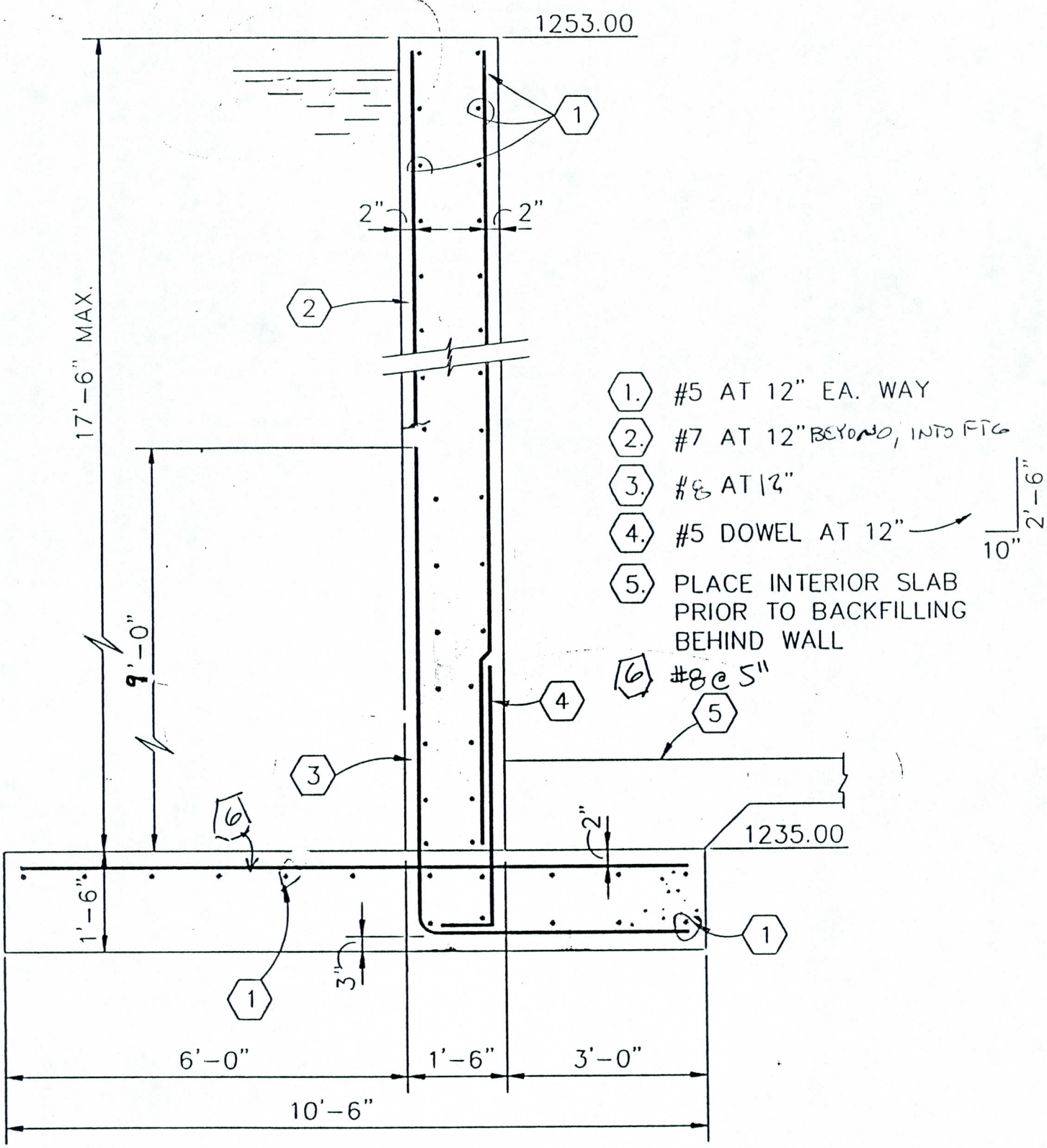
△ $f_c = 595$ psi
$f_s = 14.7$ KSI

$M_c = .45(4000)(12)(15)^2(\frac{1}{8.98}) \div 12000 = 45.1^{K'/'}$

$M_s = .88(24)(15)(.919) \div 12 = 24.3^{K'/'}$

USE #6@6"

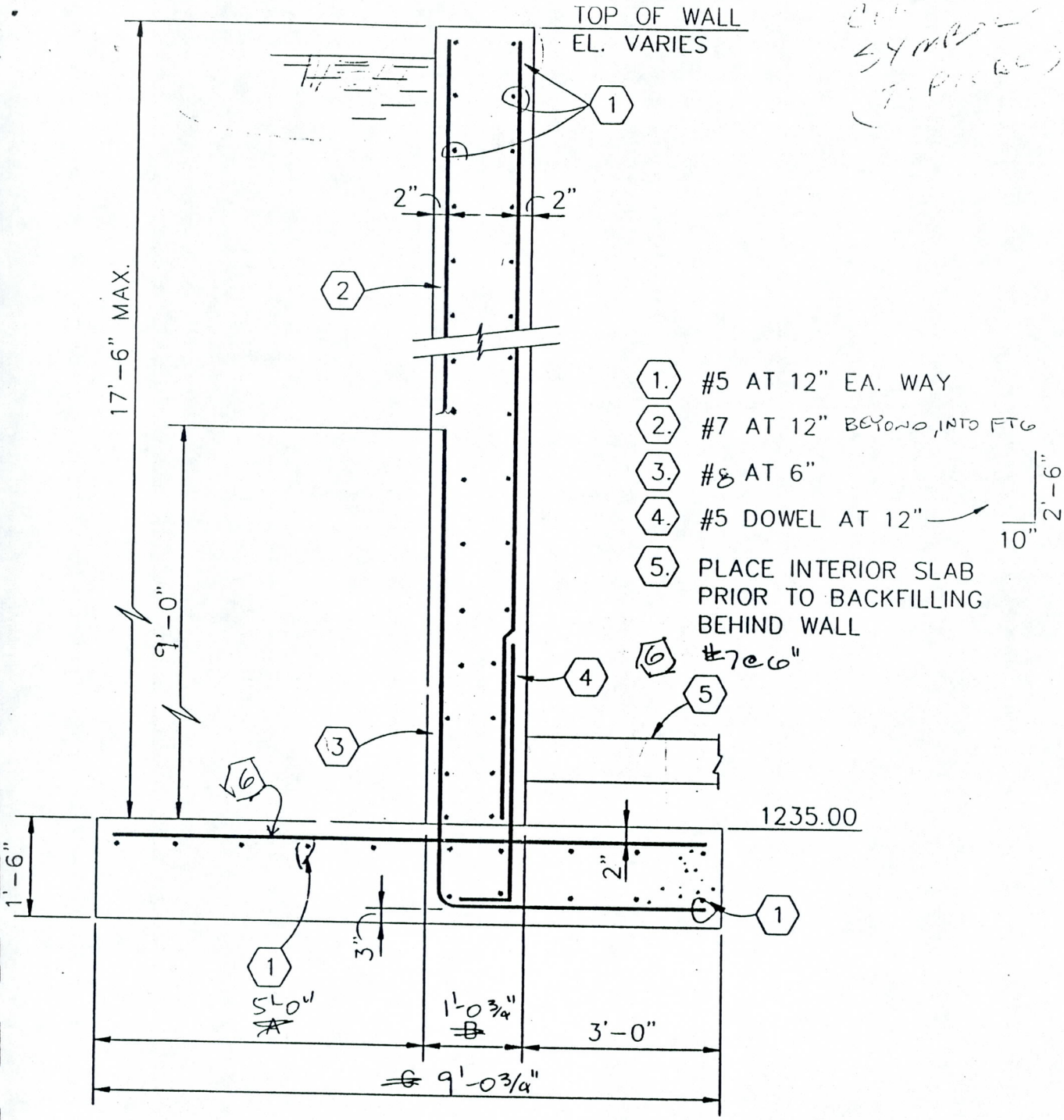
△ BY INSPECTION USE 18" THIK FTG



SECTION C-C

SECTION B-B

SCALE: 1/2"=1'-0"

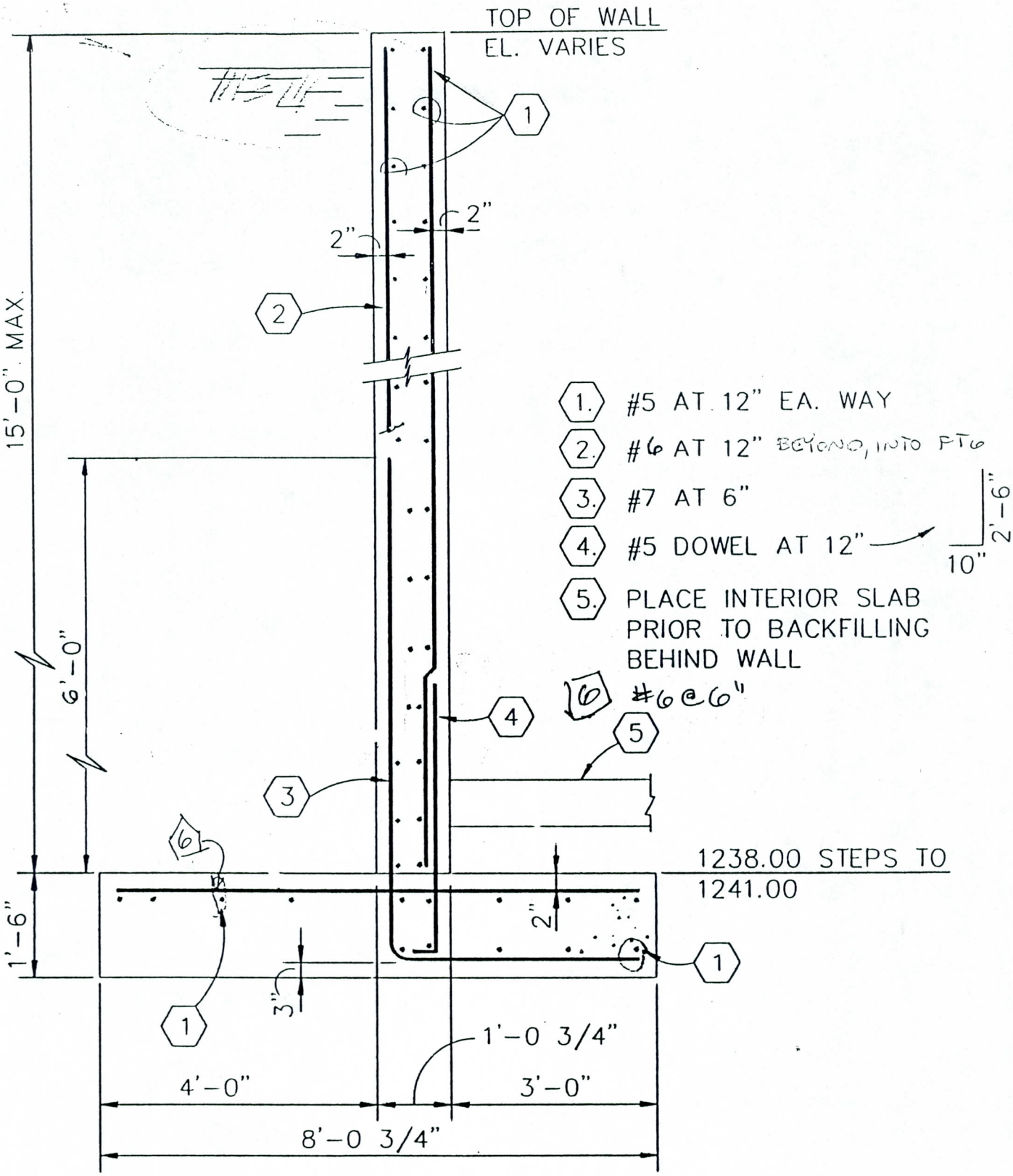


	A	B	C
~~SECTION C–C~~	~~6'–0"~~	~~1'–6"~~	~~10'–6"~~
~~SECTION C_1–C_1~~	~~5'–0"~~	~~1'–0 3/4"~~	~~9'–0 3/4"~~

~~SECTION C–C~~

SECTION C_1–C_1

SCALE: 1/2"=1'–0"



SECTION D-D

SCALE: 1/2"=1'-0"

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET BRIDGE		JOB NO. 889013.45	
		BY VAD	DATE 1/12/90
		REVWD. MS	DATE 1/15/90
		REVISED	

32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE

SUPPLEMENT TO
INLET HYDRAULICS
FOR
FLOOD CONTROL DISTRICT OF MARICOPA CO.

JANUARY 1990

FLOOD CONTROL DISTRICT
RECEIVED
JAN 17 1990

	CH ENG		P & PM
	DEP		HYDRO
	ADMIN		LMGT
	FINANCE		FILE
	C & O		
	ENGR		

REMARKS

PREPARED BY:

CREEGAN + D'ANGELO
650 N. 2ND AVE
PHOENIX, ARIZONA 85003

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND ST - RECONSTRUCTION OF STANFORD DRIVE		JOB NO. 89012.45	
		BY VAD	DATE 1/12/90
		REVWD. MS	DATE 1/15/90
		REVISED	

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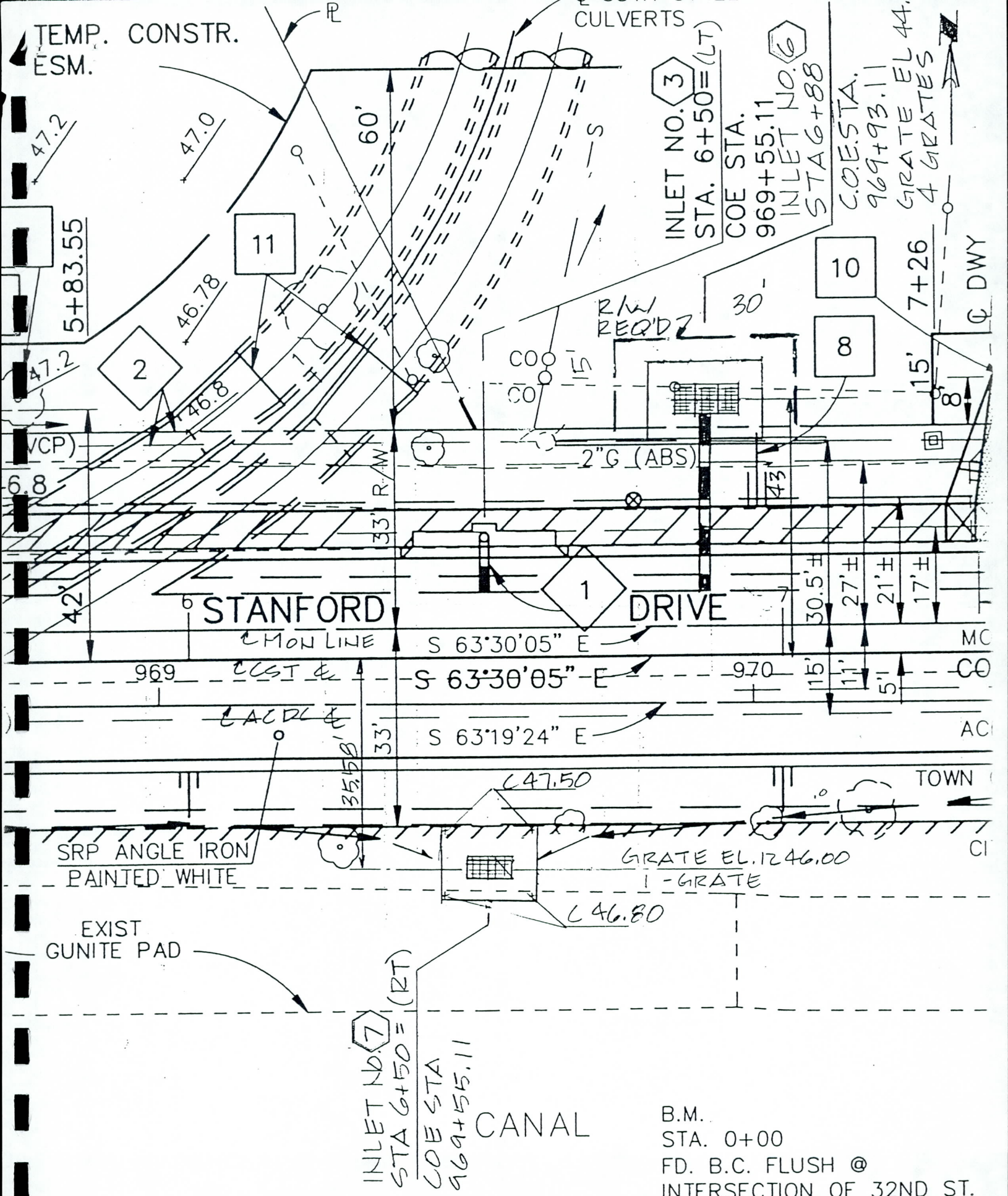
2. CULVERT ANALYSIS & SIZING FOR DRAINAGE AREA 'C' INLET (NO. 6) NORTH OF STANFORD & N/W

3. ADDITIONAL ANALYSIS FOR INLET NO. 1 FLOW CHARACTERISTICS

NOTE: SEE DRAINAGE AREA MAP IN HYDROLOGY STUDY DEC. 1989 FOR INLET LOCATIONS.



B.M.
STA. 0+00
FD. B.C. FLUSH @
INTERSECTION OF 32ND ST.
& STANFORD DRIVE
ELEV. 1249.37 (C

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET BRIDGE		JOB NO. 889013	
		BY VAD	DATE 1-12-90
		REVWD. 2/55	DATE 1/15/90
		REVISED	

SECTION 1

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013.45	
OF STANFORD DRIVE		BY VAD	DATE 1/12/90
INLET NO. 7 6+50 RT		REVWD. MJS	DATE 1/15/90
		REVISED	

SCS METHOD

LOCATION DATA:

AREA DESIGNATION: 7

DESIGN DATA:	7A	7B	
DESIGN FREQUENCY	100	100	YRS
DRAINAGE AREA	.0006	.0005	SQ.MI.
DRAINAGE LENGTH	550	475	FT
ELEVATION	—	—	
TOP ELEV.	49.5	48.5	
OUTLET ELEV	46.8	46.8	
DRAINAGE AREA SLOPE	.005	.004	1/FT
DRAINAGE WIDTH	28	27	
WIDTH FACTOR W_f	1.24	1.24	
VEGITATIVE COVER TYPE	D.B.	D.B.	
VEGITATIVE DENSITY	0	0	
SOIL GROUP	C	C	
PRECIPITATION			
P = 6 HOUR	3.2	3.2	INCH
P = 24 HOUR	3.83	3.83	INCH

DESIGN COMPUTATIONS:				
PRECIPITATION		2.51	2.51	INCH
CURVE NUMBER		90	90	
RUNOFF	Q =	1.55	1.55	
TIME OF CONCENTRATION	T_c =	0.13	0.13	HRS
TIME OF PEAK	$T_p = T_c W_f$	0.16	0.16	HRS
PEAK DISCHARGE	$Q_p = \frac{484AQ}{T_p}$	2.81	2.34	CFS

$$T_{c_{7A}} = \frac{(550)^{1.15}}{7700(2.7)^{.38}} = 0.13 \text{ HRS}$$

$$T_{c_{7B}} = \frac{(475)^{1.15}}{7700(1.7)^{.38}} = 0.13 \text{ HRS}$$

$Q_{P\,TOTAL}$ = 2.81 + 2.34 = 5.15 CFS

CREEGAN + D'ANGELO PHONE (602) 258-3175

SHT. NO.	OF
JOB NO.	889013.45
BY	VAD DATE 1/12/90
REVWD.	DATE 1/15/90
REVISED	

32ND STREET & RECONSTRUCTION
OF STANFORD DRIVE
INLET NO. 7 6+50 RT

RATIONAL METHOD

LOCATION DATA:

AREA DESIGNATION: 7

DESIGN DATA:

		7A	7B	
DESIGN FREQUENCY				
DRAINAGE AREA	A	0.35	0.29	ACRES
DRAINAGE LENGTH	L	550	475	FT
ELEVATION				
TOP		49.5	48.5	
OUTLET		46.8	46.8	
DRAINAGE AREA SLOPE	S	0.49	0.36	%
PRECIPITATION				
P = 6 HOUR		3.2	3.2	INCH
P = 24 HOUR		3.83	3.83	INCH
DESIGN COMPUTATIONS				
P = 1 HOUR		2.51	2.51	INCH
TIME OF CONCENTRATION	Tc	7.79	7.83	
RAINFALL INTENSITY	I	7.4	7.4	
RUNOFF COEFFICIENT	C	0.30	0.30	
PEAK DISCHARGE	$Q_P = CIA$	0.78	0.64	

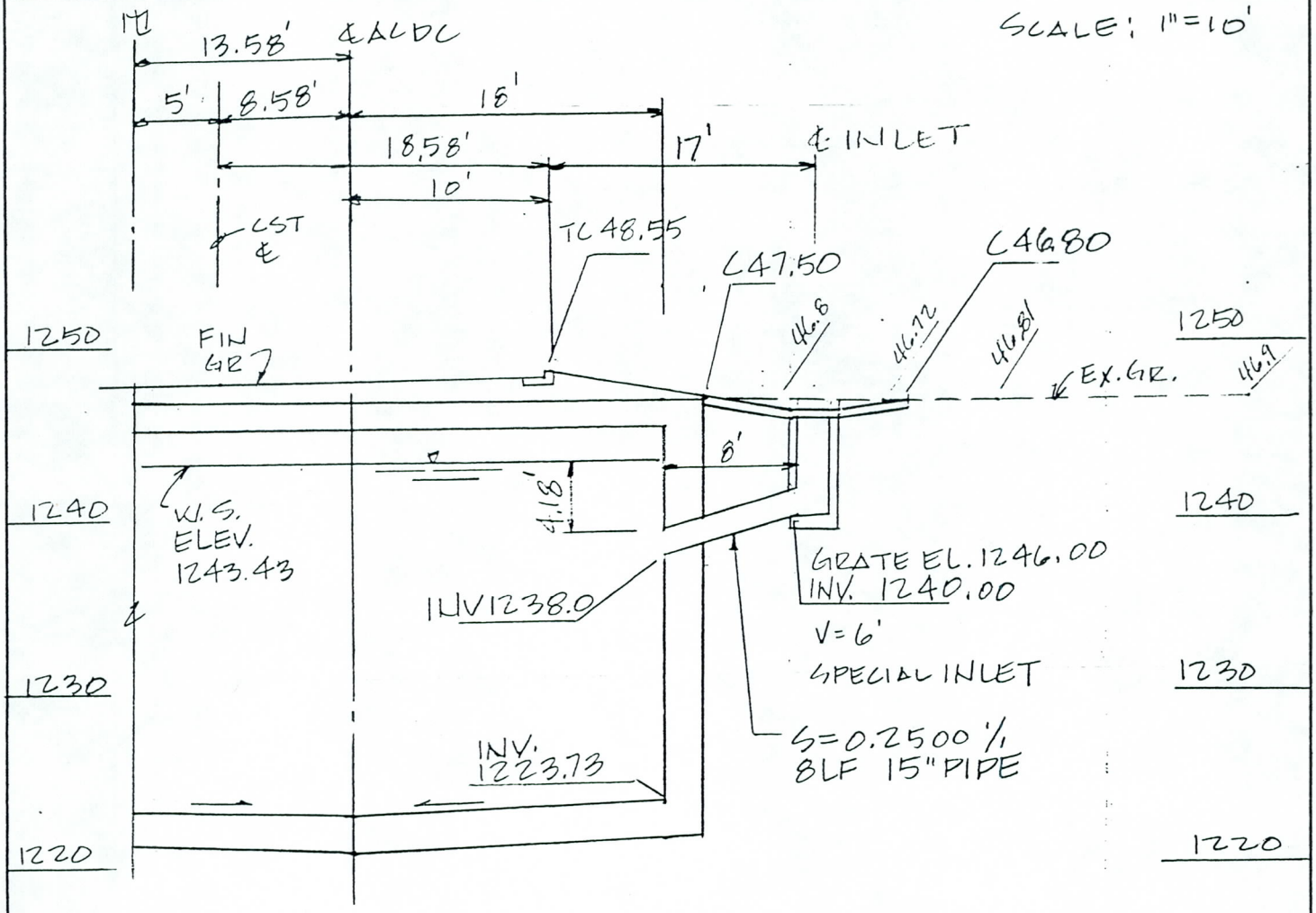
$Q_{P\,TOTAL} = 0.78 + 0.64 \cong 1.42$ CFS

$$T_c = \frac{.04593 L^{.77}}{S^{.1385}}$$

SUMMARY:		RATIONAL	SCS	DESIGN Q
	Q	1.42 CFS	5.15 CFS	∴ USE 5.15 cfs

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTRUCTION OF STANFORD DRIVE INLET NO. 7 6+50 RT		JOB NO. 889013.45	
		BY VAD	DATE 1/12/90
		REVWD.	DATE 1/15/90
		REVISED	

SCALE: 1" = 10'



INLET NO. 7

STA. 6+50 RT

LOOKING EAST

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET & RECONSTRUCTION OF STANFORD DRIVE INLET NO. 7		JOB NO. 889013
		BY VAD DATE 1/12/90
		REVWD. 2155 DATE 1/15/90
		REVISED

CK THE FLOW CONDITIONS TO DETERMINE THE % OF ENTRY ALLOWED BY C.O.E. INTO ACDC (REFER TO "STANDARDS FOR ANGLE OF ENTRY OF STORM DRAINS", FIG 11A)

PER CHART 6:
15" PIPE
$S = 0.2500\%$
$Q = 5.15$ CFS

CRITICAL VEL:
$V_c^2/D = 22$
$V_c = \sqrt{(22)(1.25)} = 5.24$ FPS

CRITICAL DEPTH:
$Y_c/D = 0.72$
$Y_c = (0.72)(1.25') = 0.90$ FT

DETERMINE THE ACTUAL FLOW DEPTH & VELOCITY FROM FLOWING FULL CONDITION & CHART 5:

$$Q_{FULL} = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}A$$

$$Q_F = \frac{1.49}{.012}(.4603)(.500)(1.227)$$

$$Q_F = 35.06 \text{ CFS}$$

$$V_F = Q_F/A = 35.06/1.227 = 28.6 \text{ FPS}$$

$n = 0.012$
$R = D/4 = 1.25/4 = .3125$
$R^{2/3} = 0.4603$
$S = .2500$
$S^{1/2} = (.2500)^{1/2} = 0.500$
$A = \frac{\pi D^2}{4} = \frac{\pi\, 1.25^2}{4}$ 1.227

$Q/Q_F = 5.15/35.06 = 0.15$

$V/V_F = 0.66$, $V = V_F(0.66) = (28.6)(0.66) = 18.9$ FPS $> V_c$ (5.24)

$d/d_F = 0.26$, $d = d_F(0.26) = (1.25)(0.26) = 0.33$ FT $< Y_c$ (.90)

SUPERCRITICAL FLOW CONDITIONS EXIST. ∴ % OF ENTRY INTO ACDC FOR 15" PIPE IS 90°

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013
OF STANFORD DRIVE		BY VAD DATE 1/12/90
		REVWD. DATE 1/15/90
INLET NO. 7		REVISED

Q_{SCS} = 5.15 CFS
$Q_{RATIONAL}$ = 1.42 CFS

EX. GR. @ INLET = 1246.8

GRATE EL. = 1246.0

Δ ELEV = 0.8'

USING A SUMPED DEPTH OF 0.8', DETERMINE THE NO. OF GRATES REQUIRED TO ACCEPT Q = 5.15 CFS

FROM CHART 1 $Q/_{A}$ = 3.0 CFS/SF

$$\frac{3.0 \text{ CFS}}{2 \text{ CLOGGING FACTOR}} = 1.50 \text{ CFS}/_{\text{SF EFF}}$$

$$\frac{5.15 \text{ CFS}}{1.50 \text{ CFS}/_{\text{SF EFF}}} = 3.43 \text{ SF}$$

$$\frac{3.43 \text{ SF}}{3.78 \ \frac{\text{SF}}{\text{GRATE}}} \cong 1 \text{ GRATES}$$

1 - TYPE 1 GRATE REQ'D PER C.O.P. OR EQUAL

SIZE THE CONNECTOR PIPE USING THE AVAILABLE HEAD, Q = 5.15 CFS, $L_{F\ CONN\ PIPE}$ = 8 FT & CHART 2

HEAD = H = GRATE EL − 0.5' FREEBOARD − ACDC W.S.
= 1246.0 − 0.5' − 1243.43
= 2.07'

CONN. MIN. SIZE = 15" DIA.

MIN INLET DEPTH FROM CHART 3 = V = 3.0'
DESIGN DEPTH = 6' > 3.0' ∴ GOOD

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET-		JOB NO. 889013
RECONSTR. OF STANFORD		BY VAD DATE 1/12/90
		REVWD. DATE 1/15/90
		REVISED

SECTION 2

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013	
OF STANFORD DRIVE		BY VAD	DATE 1/12/90
		REVWD. WS	DATE 1/15/90
INLET NO. 6	STA 6+88 LT	REVISED	

ASSUME NOME PONDING WILL BE ALLOWED, SUMPED CONDITION

EX GRADE
BEFORE CONSTR. = 1246.5

SEE HYDROLOGY STUDY DEC. 1989 FOR DRAINAGE AREA LIMITS & Q CALCS. (D.A. "C" = D.A. "6")

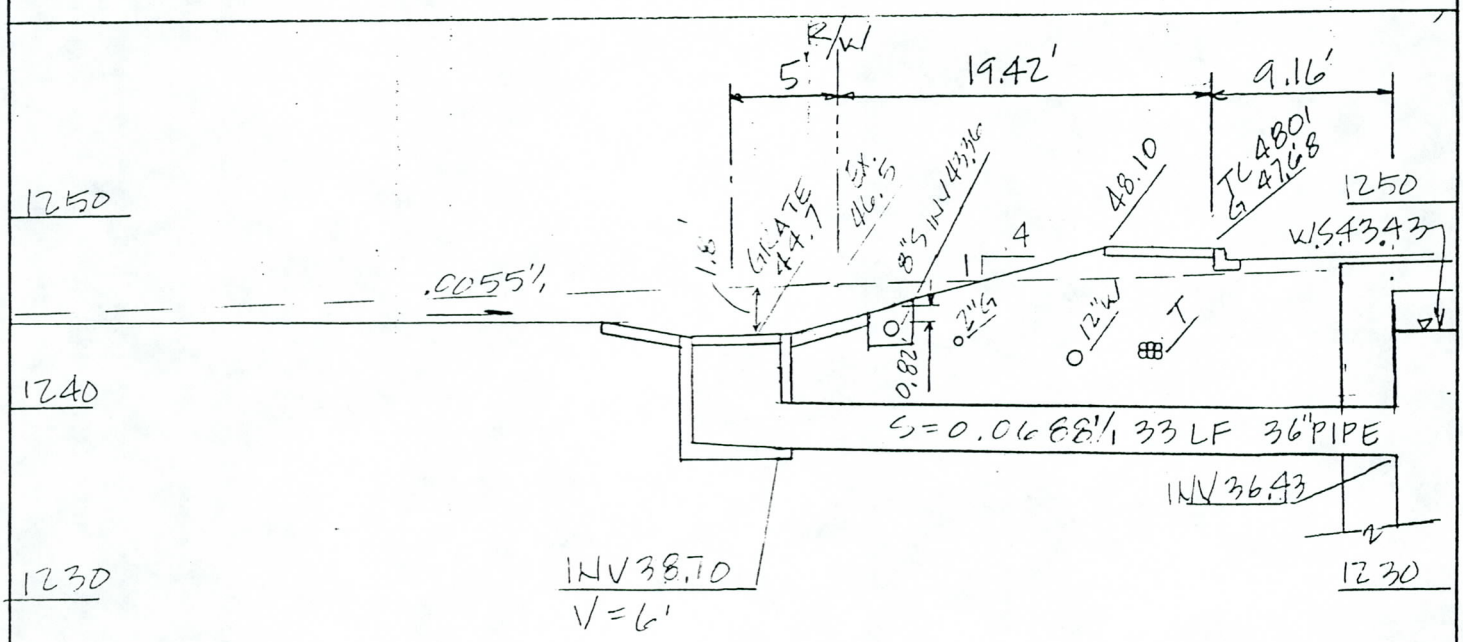
SIZE THE CONN. PIPE
USING THE AVAIL HEAD,
Q = 41 CFS, L = 33 LF, CHART 2

HEAD = H = GRATE ELEV (1244.70)
− FREEBOARD (−0.5)
− ALDC W.S. EL (1243.43)
= 0.77 FT

∴ CONN. PIPE MIN SIZE = 36" DIA

PER FORMULA
36" PIPE @ L = 33', H = .77'
Q = 42.26 CFS
∴ OK

FROM
CHART 3, MIN. INLET DEPTH = 5'
DESIGN DEPTH = 6' 75.06' GOOD



STA 6+88 LT
LOOKING EAST
(= COE STA 969+93.11)

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET & RECONSTRUCTION OF STANFORD DRIVE INLET NO. 6 STA 6+88LT		JOB NO. 889013.45
		BY VAD DATE 1/12/90
		REVWD. WS DATE 1/15/90
		REVISED

THE FACTORS INVOLVED WITH THIS DESIGN/SYSTEM ARE AS FOLLOWS:

1- HIGH ACDC WATER SURFACE ELEVATION
2- HIGH DRAINAGE AREA FLOW = 41 CFS
3- LENGTH OF PIPE REQUIRED
4.- NEED TO REGRADE LOW SPOT IN DRAINAGE AREA TO OUTFALL AT THE R/W LINE VS. DRYWELL
5 - DESIRE TO MINIMIZE OVERALL EXPOSED GRATES FOR AESTHETICS FOR ADJACENT PROPERTY.
6 - DESIRE TO MAINTAIN A 4:1 OR FLATTER SLOPE OFF BACK OF SIDEWALK FOR SAFETY
7 - NEED TO MAINTAIN COVER OVER 8" SEWER LINE & 2" GAS LINE
8 - DESIRE TO KEEP CONNECTOR PIPE AT A MINIMUM, REASONABLE DIAMETER.

RESULTS ARE AS FOLLOWS:

1. HEAD AVAIL. W/ FREEBOARD CONSIDERED = 0.77' (LOW)
1. DESIREABLE GRATE ELEV. MIN. = 1244.70
2.

	No. GRATES	DEPTH OF WATER OVER GRATE = d	GRATE ELEV + d = PONDED W.S.EL.	COMMENTS
COMPARE GRATES	4 ✓	1.4' ✓	44.7 + 1.4 = 46.1 ✓	22' LONG x 11' WIDE POTENTIAL TO BACK UP FLOW.
	5	1.1'	44.7 + 1.1 = 45.8	26' LONG MORE REASONABLE
	6	0.9'	44.7 + 0.9 = 45.6 (SEE EX. CALC. FOLLOWING PG)	BETTER YET - PUT SIDE BY SIDE RESULT IS A SYSTEM 29' LONG x 11' WIDE OR 20' L x 13' W

3. SUGGEST UPGRADING SEWER TO D.I.P., CONC. ENCASED, ETC. TO PROTECT IT IN PLACE
4. SUGGEST 4 GRATES FOR UNIFORMITY IN INLET CONSTRUCTION & DESIGN TO COORDINATE WITH REMAINDER OF PROJECT.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32ND STREET & RECONSTRUCTION		JOB NO. 889013.45
OF STANFORD DRIVE		BY VAD DATE 1/12/89
INLET NO. 6 CITA GRAFT		REVWD. MKS DATE 1/15/90
		REVISED

USE C.O.P. TYPE - 1 GRATE, A = 3.78 SF, OR EQUAL

CALC. 'd' (DEPTH OF WATER OVER GRATE)
FOR 4, 5 AND 6 GRATES, AREA GOVERNS:

A- 4 GRATES $\left(3.78 \frac{SF}{GRATE}\right) = 15.12$ SF

$\frac{41 \text{ CFS}}{15.12 \text{ SF}} \times 2$ CLOGGING FACTOR $= 5.42$ CFS/SF

FROM CHART 1, d = 1.4'
W.S. ELEV. = GRATE ELEV + d = 1244.7 + 1.4 = 1246.1

B- 5 GRATES $\left(3.78 \frac{SF}{GRATE}\right) = 18.90$ SF

$\frac{41 \text{ CFS}}{18.9 \text{ SF}} \times 2$ CLOG FACTOR $= 4.34$ CFS/SF

FROM CHART 1, d = 1.1'
W.S. ELEV. = GRATE ELEV + d = 1244.7 + 1.1 = 1245.8

C- 6 GRATES $\left(3.78 \frac{SF}{GRATE}\right) = 22.68$ SF

$\frac{41 \text{ CFS}}{22.68 \text{ SF}} \times 2$ CLOG FACTOR $= 3.62$ CFS/SF

FROM CHART 1 d = 0.9'
W.S. ELEV. = GRATE ELEV. + d = 1244.7 + 0.9 = 1245.6

CURVE
NO.
Δ
C1
60°00'00"
C2
55°26'24"
NTS
STANFORD DRIVE
S.63°19'24"E.
S.63°30'05"E.
N.86°10'36"E.
℄ ACDC
ACDC LIMITS
969
970
TEMPORARY CONSTR. ESM.
TEMPORARY CONSTR. ESM.
STA. 0+64.93
P.C.
P.O.C. -BEG 10"DIA RCP-LT.
STA. 0+94.63-7.5' LT.
P.O.C. -BEG 10"DIA RCP-RT.
STA. 1+09.05-7.5' RT.
P.C.
STA. 2+01.07
P.T.
STA. 2+22.06
P.C.
WOOD SHEDS
30'
50'
STA. 1+39.99
P.L.
EXIST DRYWELL
AREA OF PONDING
EL. 46.1
TO BLDG.
EXIST BLDG.
N.26°10'36"E.
N.83°10'36"E.
2+90.39
P.T.
STA. 1+87
P.C.
STA. 1+60
P.L.
ORCP LT.
1247
1248
1246
1245

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET -		JOB NO. 889013.45	
RECONSTR. OF STANFORD DR		BY VAD	DATE 1/12/90
		REVWD.	DATE 1/15/90
		REVISED	

SECTION 3

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RECONSTR. OF STANFORD DRIVE INLET NO. 1		JOB NO. 689013.45	
		BY VAD	DATE 1/12/90
		REVWD.	DATE 1/15/90
		REVISED	

FROM PREVIOUS STUDY (OF DEC. 1989):

1- CHANNEL CROSS SECTION NO. 1, IMMEDIATELY DOWNSTREAM, FOR Q = 103 CFS ; d_{N_4} = 1.3'

V_4 = 2.2 FPS

W.S. EL.$_4$ = 1247.7

2- LOSSES DUE TO THE TRASH RACK

$$h_L = \frac{CV^2}{2g} = 0.12'$$

3- FLOW THROUGH TRASH RACK AT 50% CLOGGED ; V_1 = 3.84 FPS

WALL OPEN AREA = 34 SF (1.7 SF * 20 LF)

TRASH RACK OPEN AREA = 36 SF (1.8 SF * 20 LF)

APPROACH VEL.

REF: CIVIL ENG. REVIEW MANUAL, REV. MANNING EQN 5.54 → $Q = C_d b (H + V^2/2g)^{3/2}$

SOLVING FOR THE APPROACH VEL.

$$103 = (3.33)(20)(1.34 + V^2/64.4)^{3/2}$$

$$1.547 = [1.34 + V^2/64.4]^{3/2}$$

$$V = 3.65 \text{ FPS} = V_4$$

WEIR ANALYSIS

$$Q_{CFS} = 3.33 (B)(H)^{3/2}$$

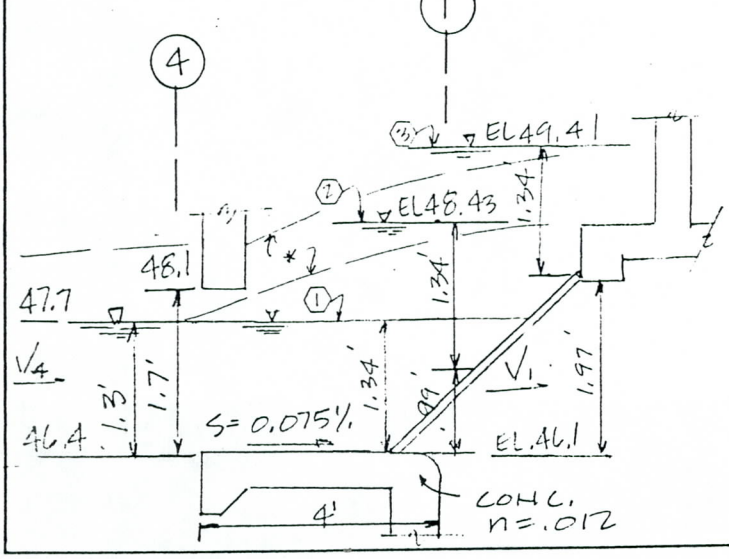
$$103 = 3.33 (20)(H)^{3/2}$$

$$\underline{H} = \underline{1.34'}$$

WHERE:

B = LENGTH OF WEIR = 20 LF

Q = 103 CFS



① W.S. EL. @ 0% CLOGGED = 1247.44

② W.S. EL. @ 50% CLOGGED

③ W.S. EL. @ 100% CLOGGED (FLOW IS DIVERTED EASTERLY ALONG STANFORD DR.)

* BACKWATER CURVES

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32nd Street & Reconstr of Stanford Drive		JOB NO. 889013.45
		BY MSS DATE 1/15/90
		REVWD. VAD DATE 1/15/90
Inlet No. 1		REVISED

Check WSEL @ section ④ using the direct step method, Open-Channel Hydraulics, Chow P. 262-265

$$S_o \Delta x + y_4 + \alpha_4 \frac{V_4^2}{2g} = y_1 + \alpha_1 \frac{V_1^2}{2g} + S_f \Delta x + h_f + h_e$$

losses due to trash rack

entrance loss @ wall opening

assume $\alpha_4 = \alpha_1$

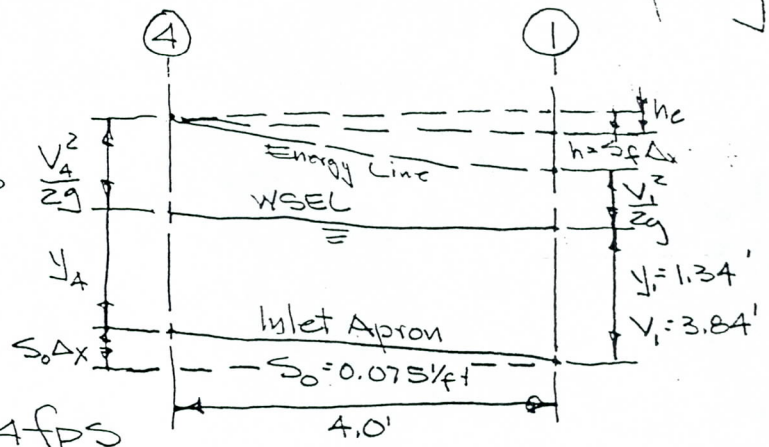
where $\Delta_x = 4$ ft

$S_o = 0.075$ ft/ft

$y_4 = ?$ $Q = 103$ cfs

$V_4 = ?$

$y_1 = 1.34$ ft



$$V_1 = \frac{103 \text{ cfs}}{1.34 \times 20} = 3.84 \text{ fps}$$

$$S_f = \frac{n^2 V_1^2}{2.22 R^{4/3}} \quad \text{where } n = 0.012$$

$$R = \frac{A}{WP} = \frac{20' \times 1.34'}{2(1.34)' + 20'} = 1.182$$

$$= \frac{(.012)^2 (3.84)^2}{2.22 (1.182)^{1.33}}$$

$$h_f = 0.12 \text{ ft}$$

$$= \frac{0.0021}{2.7729}$$

$$S_f = 0.0008$$

$$h_e = K_e \frac{V_4^2}{2g} \quad \text{where } K_e = 0.5$$

assume $b = 20$ ft outside wall (conservative)

$$\therefore V_4 = \frac{Q}{A} = \frac{Q}{20 y_4}$$

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. OF
32nd Street & Reconstr. of Stanford Drive Inlet No. 1		JOB NO. 889013.45
		BY M.SS DATE 1/15/90
		REVWD. VAD DATE 1/15/90
		REVISED

so.

$$S_o \Delta x + y_4 + \frac{\left(\frac{Q}{20y_4}\right)^2}{64.32} = 1.34 + \frac{(3.84)^2}{64.32} + .0008(4) + 0.12 + 0.5\frac{\left(\frac{Q}{20y_4}\right)^2}{64.32}$$

$$0.3 + y_4 + \frac{\left(\frac{103}{20y_4}\right)^2}{64.32} = 1.34 + 0.229 + 0.0032 + 0.12 + 0.5\frac{\left(\frac{103}{20y_4}\right)^2}{64.32}$$

$$y_4 + \frac{\left(\frac{103}{20y_4}\right)^2}{64.32} - 0.5\frac{\left(\frac{103}{20y_4}\right)^2}{64.32} = 1.3922$$

try $\underline{\underline{y_4 = 1.26 \text{ ft}}}$

$$1.26 + \frac{\left(\frac{103}{20(1.26)}\right)^2}{64.32} - 0.5\frac{\left(\frac{103}{20(1.26)}\right)^2}{64.32} = 1.3922$$

$$1.26 + 0.2597 - 0.1299 = 1.3922$$

$$1.3898 \leq 1.3922$$

therefore WSEL @ section 4 is equal to

1246.4 + 1.26 = 1247.66 which is less than 1247.7 therefore inlet will not cause any additional backwater.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET & RELOCATE.		JOB NO. 8890125.45	
OF STANFORD DRIVE		BY VAN	DATE 1/12/90
INLET NO. 1		REVWD. MJS	DATE 1/15/90
		REVISED	

@ 50% CLOGGED, SUBMERGED INLET, ORIFICE FLOW TAKES OVER

REVISE IF WATER BACK CAN ACCEPT [illegible] CLOGGED UNDER ORIFICE FLOW CONDITIONS:

$$Q_{ORIF.} = 0.6 \left(\begin{matrix}\text{FREE}\\ \text{OPEN}\\ \text{AREA}\end{matrix}\right)\left(\sqrt{2gH}\right)$$

$$= 0.6 \left(\frac{36\,SF}{2\ \text{CLOG. FACTOR}}\right)\left(\sqrt{2(32.2)(.99+1.34')}\right)$$

$$= 132.3\ \text{CFS ACCEPTED}$$

CONCLUSIONS: (@ 50% CLOGGED)

1- WATER WOULD NOT BACK UP UPSTREAM

2- ALL FLOW ACCEPTED IN 20' LONG SYSTEM AS DESIGNED

TRASH RACK ANALYSIS

REF: OPEN CHANNEL FLOW
BY VEN TE CHOW, PH.D., 1959
(pg 506 & 507)

PRIMARY CONCERN WITH INLET NO. 1 IS THE AMOUNT OF HEADLOSS DUE TO THE TRASH RACK

h_f = HEADLOSS DUE TO THE RESISTENCE OF THE TRASH RACK

$h_f = \frac{cV^2}{2g}$ WHERE: V = VEL. OF APPROACH

c = COEFFICIENT DEPENDENT ON X-SECTION FORM, S, L, b, δ, α, β, μ

X-SEC. = 1/2" WIDE X 2" DEEP

S = THICKNESS OF BAR = 1/2" = .042'

b = CLR DISTANCE BETWEEN BARS
4 3/8" O.C. - 2(1/4") = 3-7/8" = 0.32'

δ = ANGLE OF INCLINATION OF BAR FROM HORIZ. = 45°

α = ANGLE BETWEEN LENGTH OF FLOW & LENGTH OF BAR = 45°

β = SQUARE NOSE & SQUARE TAIL = 2.42

L = LENGTH OF BAR = 1.88'

μ = COEF. BASED ON RACK BAR FORM = 7.1

X = COEF BASED ON RACK BAR FORM = 1.0

$c = \beta\left(\frac{s}{b}\right)^{4/3}\sin\delta$ (FOR $\alpha = 0°$) OR $c = \mu\left(\frac{s}{s+b}\right)\sin^2\delta$ (FOR $\alpha = 45°$)

$c = (2.42)\left(\frac{.042}{.32}\right)^{4/3}\sin 45°$

$\underline{c = 0.1142}$

$c = (7.1)\left(\frac{.042}{.042+.32}\right)\sin^2 45°$

$\underline{c = 0.58}$

$h_f = (.1142)\left(\frac{3.65^2}{2(32.2)}\right) = \underline{.02'}$

$h_f = (.58)\left(\frac{3.65^2}{2(32.2)}\right) = \underline{0.12'}$

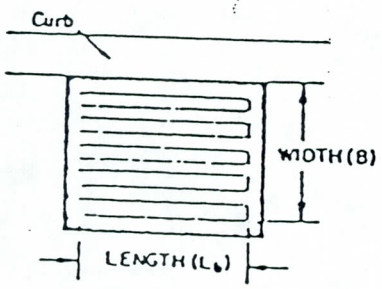
CONCLUSION: HEAD LOSS THROUGH TRASH RACK FOR THE GIVEN SIZE, BAR SPACE & SHAPE IS MINIMAL.

* APPROACH VELOCITY (REF: CIVIL ENG. REVIEW MANUAL)
EQN. 5.54 → $Q = C_d b(H + V^2/2g)^{3/2}$
$103 = (3.33(20)(1.34 + V^2/64.4)^{3/2}$
$V = 3.65$ FPS

HYDRAULIC DATA SHEETS USED

IN

DETERMINING FLOW QUANTITIES

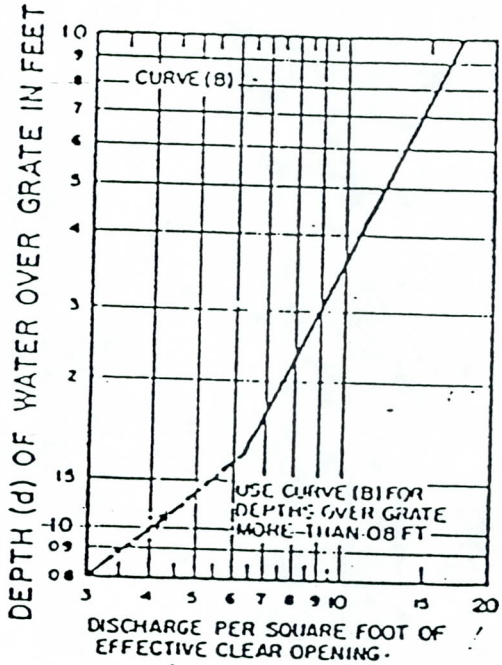


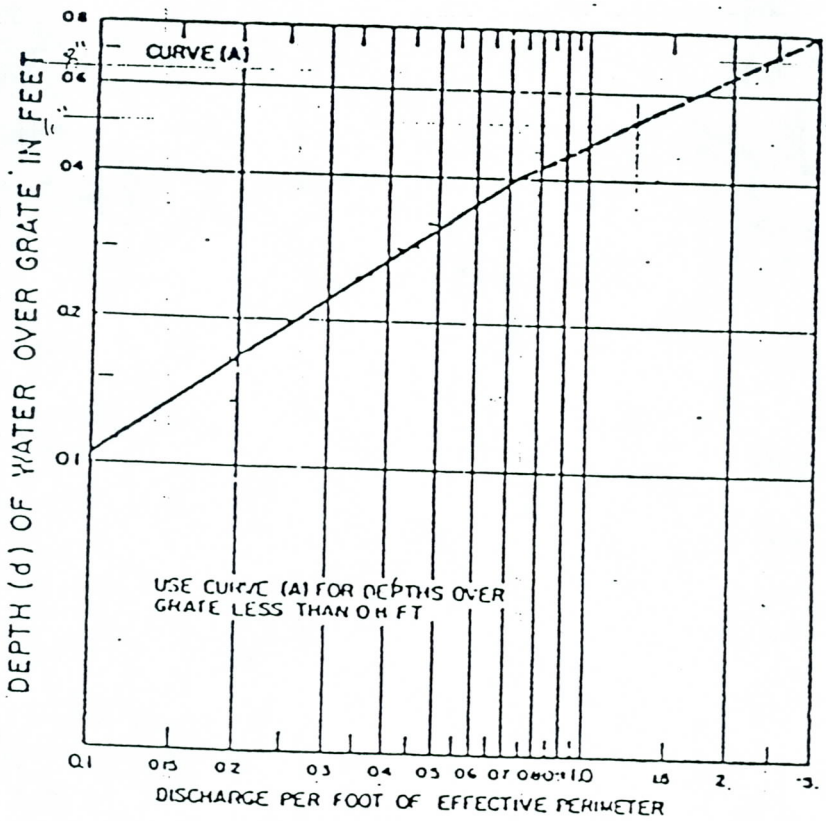
$P = 2B + L_b$

A = AREA OF CLEAR OPENING IN GRATE

TO ALLOW FOR CLOGGING DIVIDE P OR A BY 2 BEFORE OBTAINING d.

WITHOUT CURB $P = 2(B + L_b)$





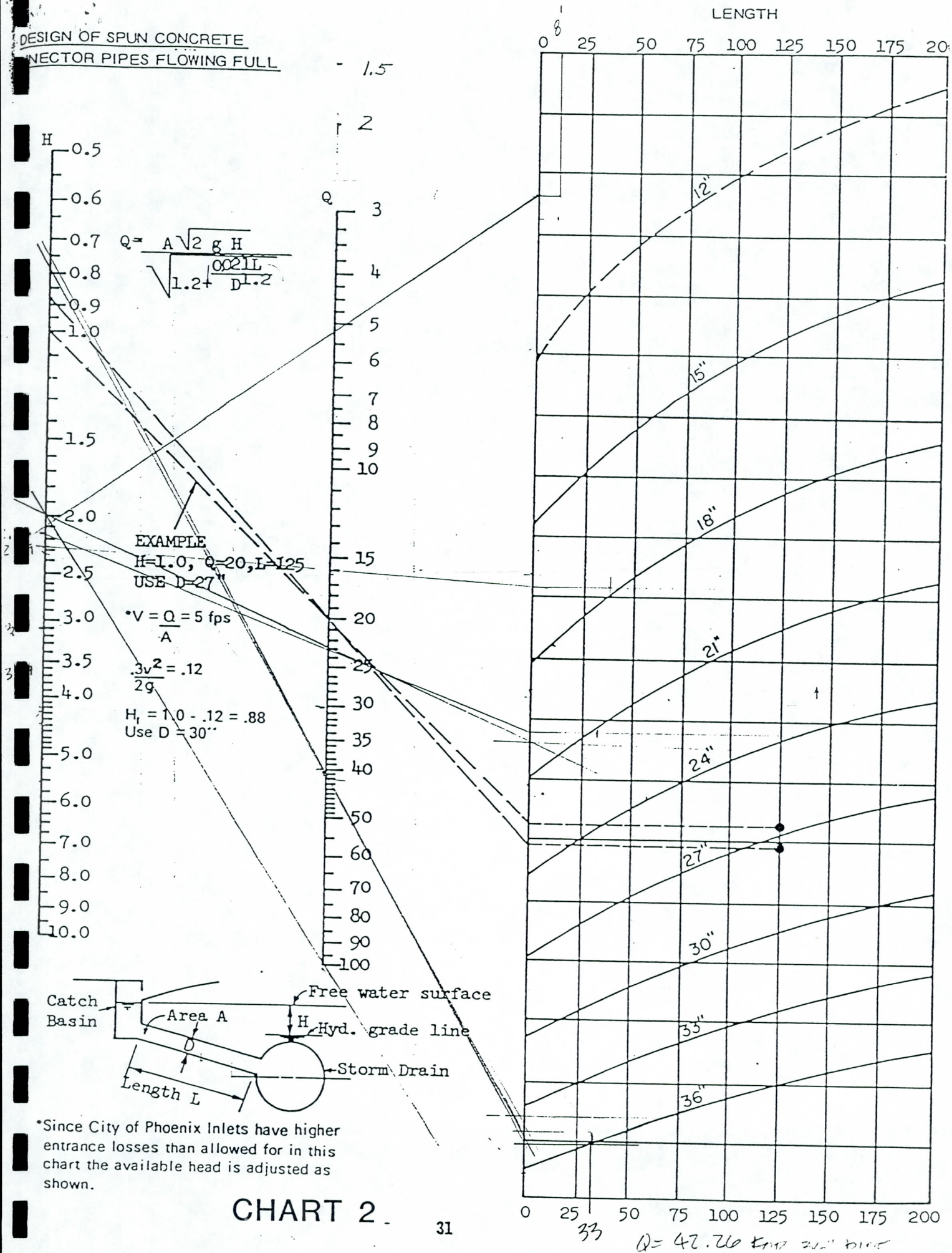
GRATE TYPE	AREA	P
1	3.78	10.66
2	2.56	9.41

BUREAU OF PUBLIC ROADS
REV. AUG. 1968

HYDRAULIC CAPACITY OF GRATE INLET IN SUMP

CHART 1

DESIGN OF SPUN CONCRETE
NECTOR PIPES FLOWING FULL



*Since City of Phoenix Inlets have higher entrance losses than allowed for in this chart the available head is adjusted as shown.

CHART 2

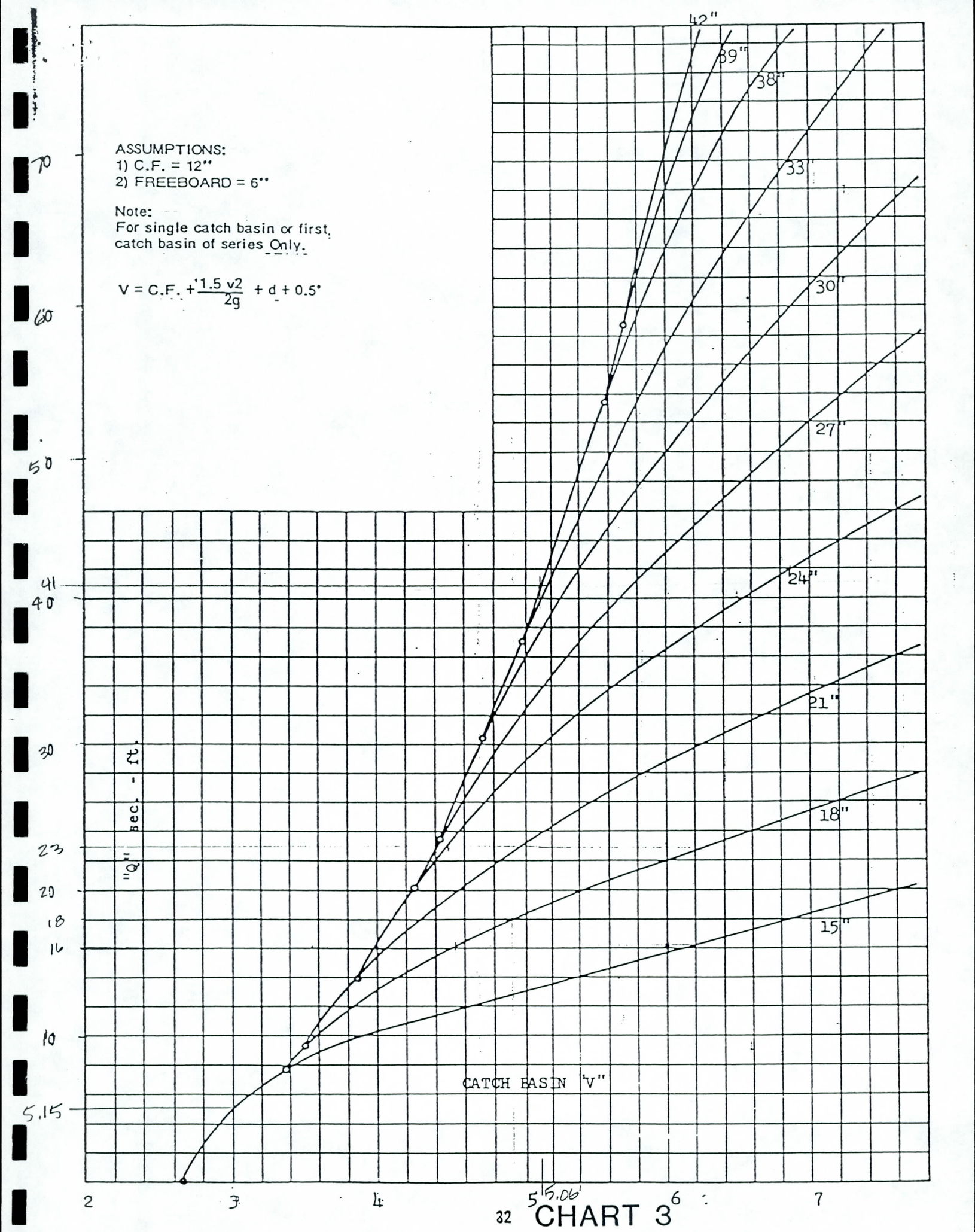
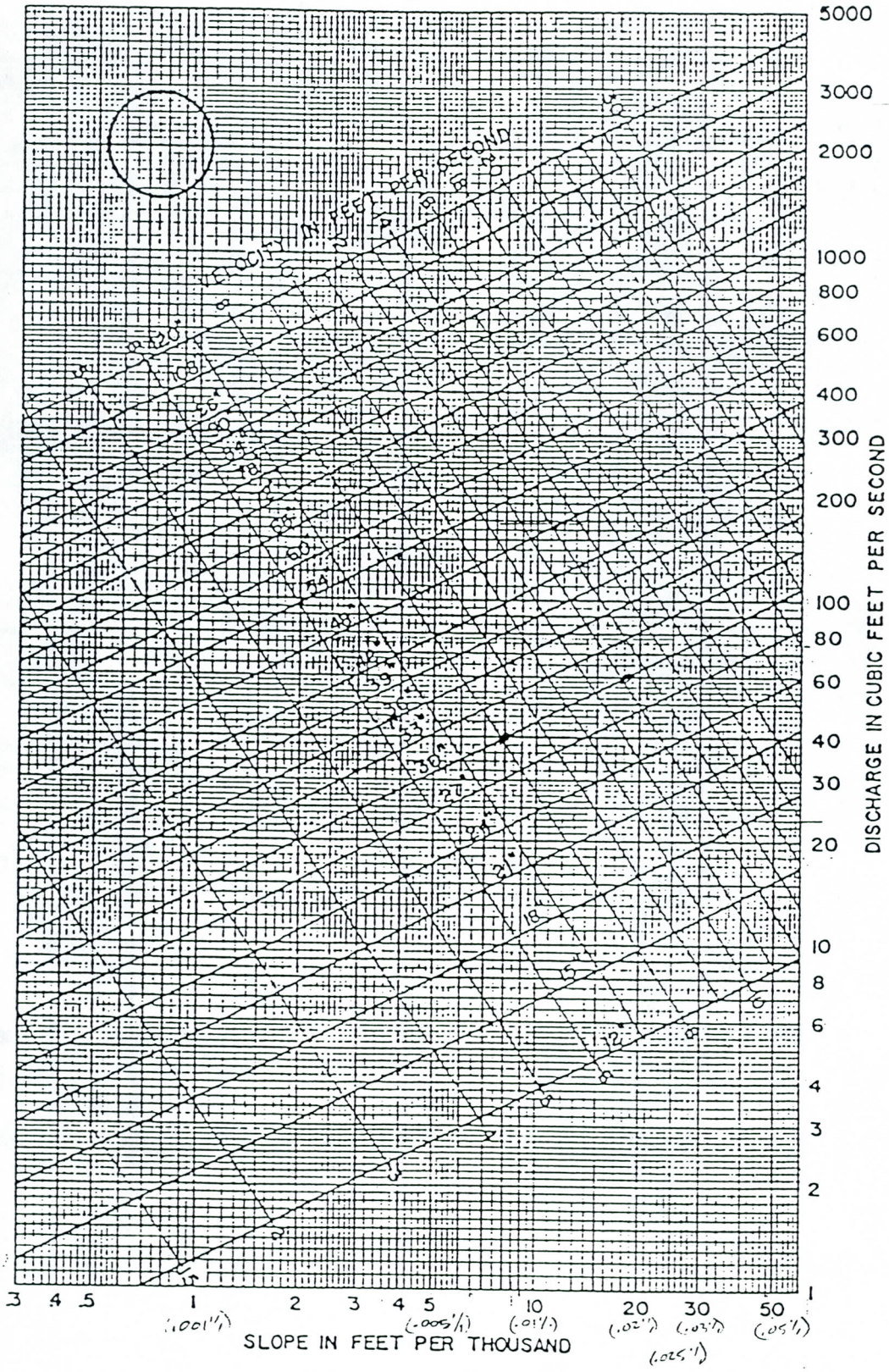

ASSUMPTIONS:
1) C.F. = 12"
2) FREEBOARD = 6"
Note:
For single catch basin or first catch basin of series Only.
V = C.F. + 1.5 v2 / 2g + d + 0.5'
42"
39"
38"
33"
30"
27"
24"
21"
18"
15"
70
60
50
41
40
30
23
20
18
16
10
5.15
"Q" - sec. - ft.
CATCH BASIN "V"
2
3
4
5
5.06
6
7

CHART 3

COMPUTED FROM MANNING'S FORMULA
n=0.012



PIPE CAPACITIES
FLOWING FULL

CHART 4

Appendix C: Circular Channel Ratios

Experiments have shown that n varies slightly with depth. This figure gives velocity and flow rate ratios for varying n (solid line) and constant n (broken line) assumptions.

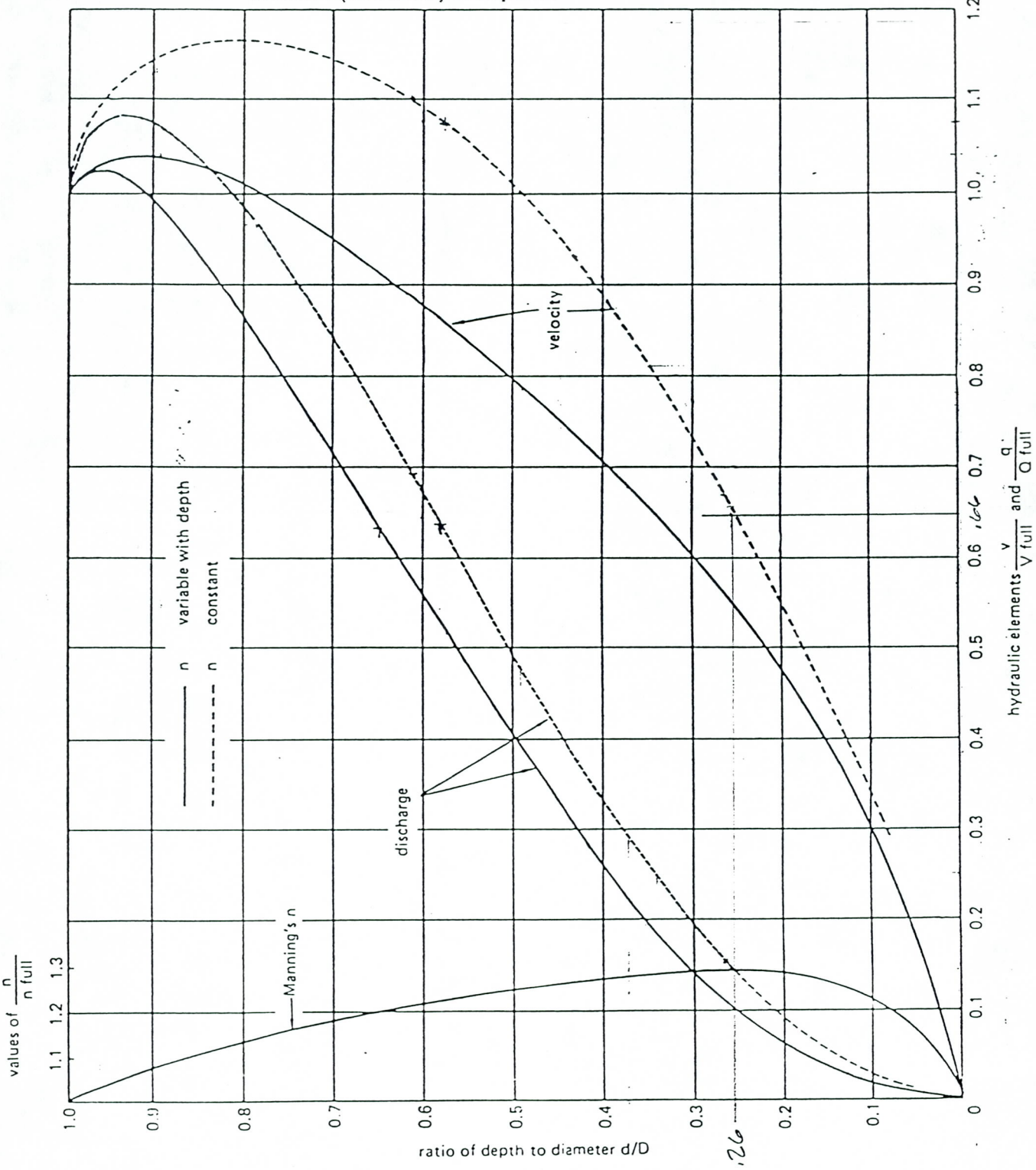


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CHART 5

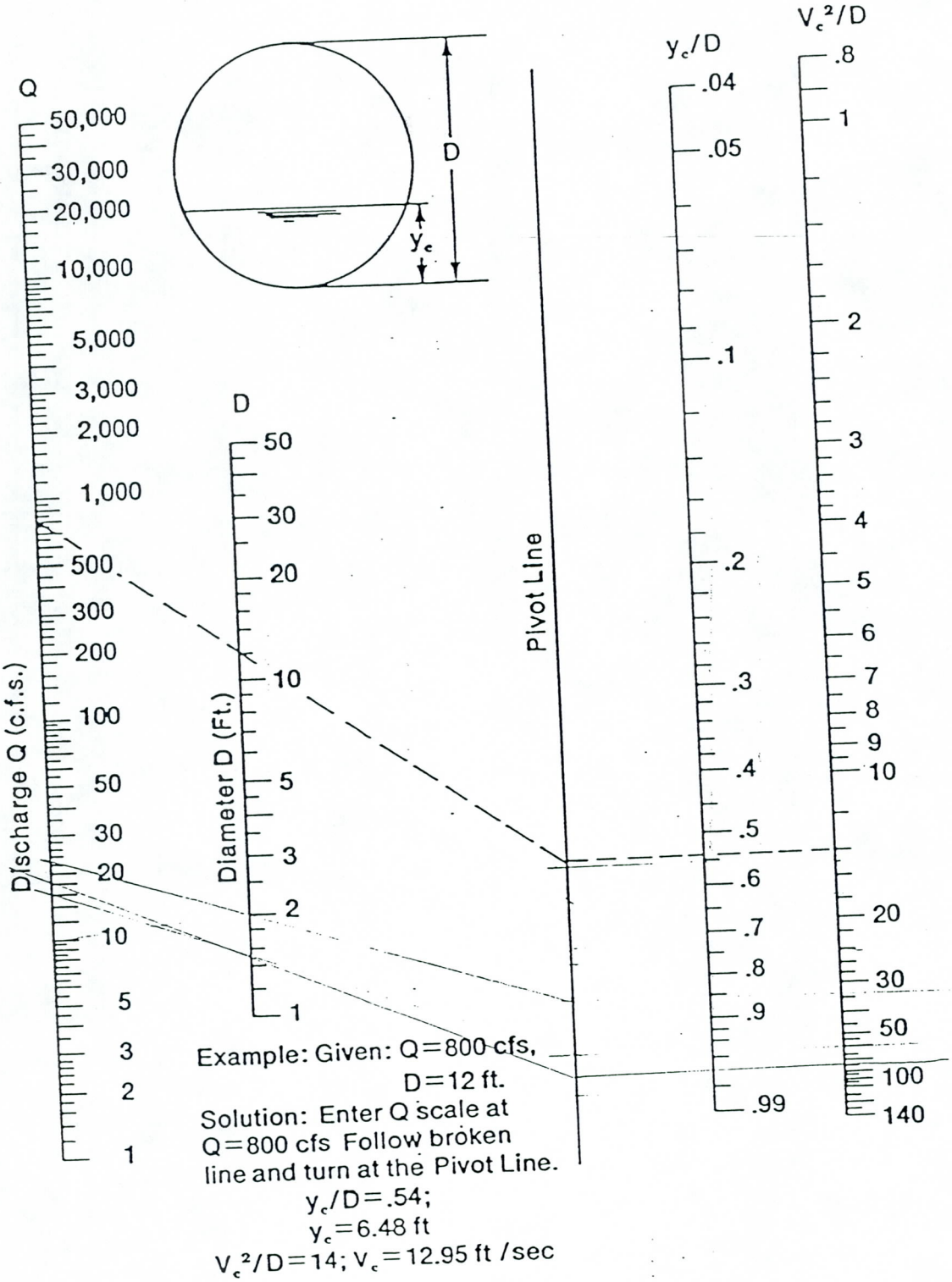


Figure 3-24 Critical flow and critical velocity in circular conduits.

CHART 6

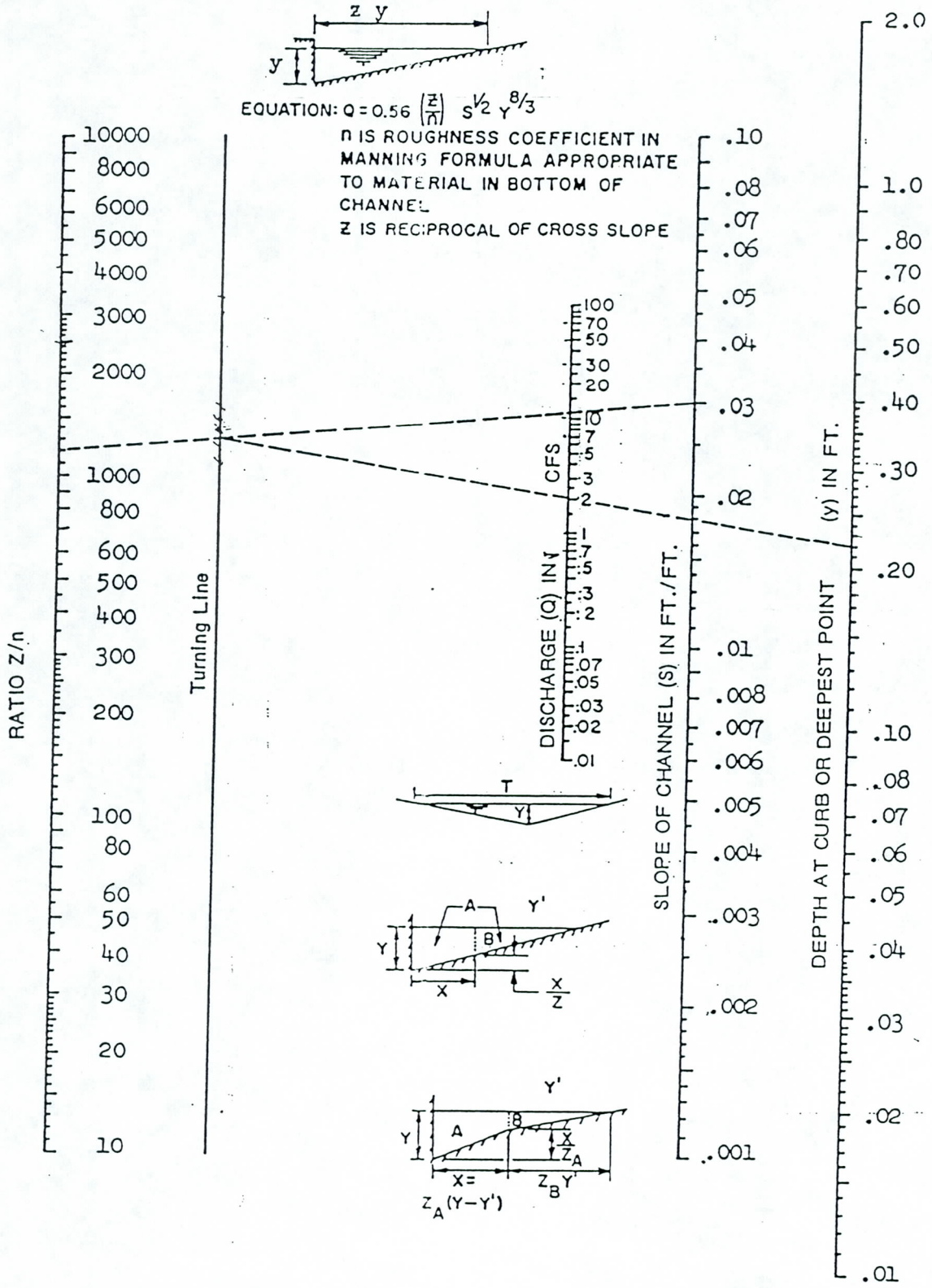

z y
y
EQUATION: Q = 0.56 (z/n) S^1/2 Y^8/3
n IS ROUGHNESS COEFFICIENT IN MANNING FORMULA APPROPRIATE TO MATERIAL IN BOTTOM OF CHANNEL
Z IS RECIPROCAL OF CROSS SLOPE
RATIO Z/n
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
Turning Line
DISCHARGE (Q) IN CFS
100
70
50
30
20
10
7
5
3
2
1
.7
.5
.3
.2
.1
.07
.05
.03
.02
.01
SLOPE OF CHANNEL (S) IN FT./FT.
.10
.08
.07
.06
.05
.04
.03
.02
.01
.008
.007
.006
.005
.004
.003
.002
.001
DEPTH AT CURB OR DEEPEST POINT (y) IN FT.
2.0
1.0
.80
.70
.60
.50
.40
.30
.20
.10
.08
.07
.06
.05
.04
.03
.02
.01
T
Y
A
Y'
B
X
X/Z
Z_A
Z_B
X = Z_A (Y−Y')

CHART 7

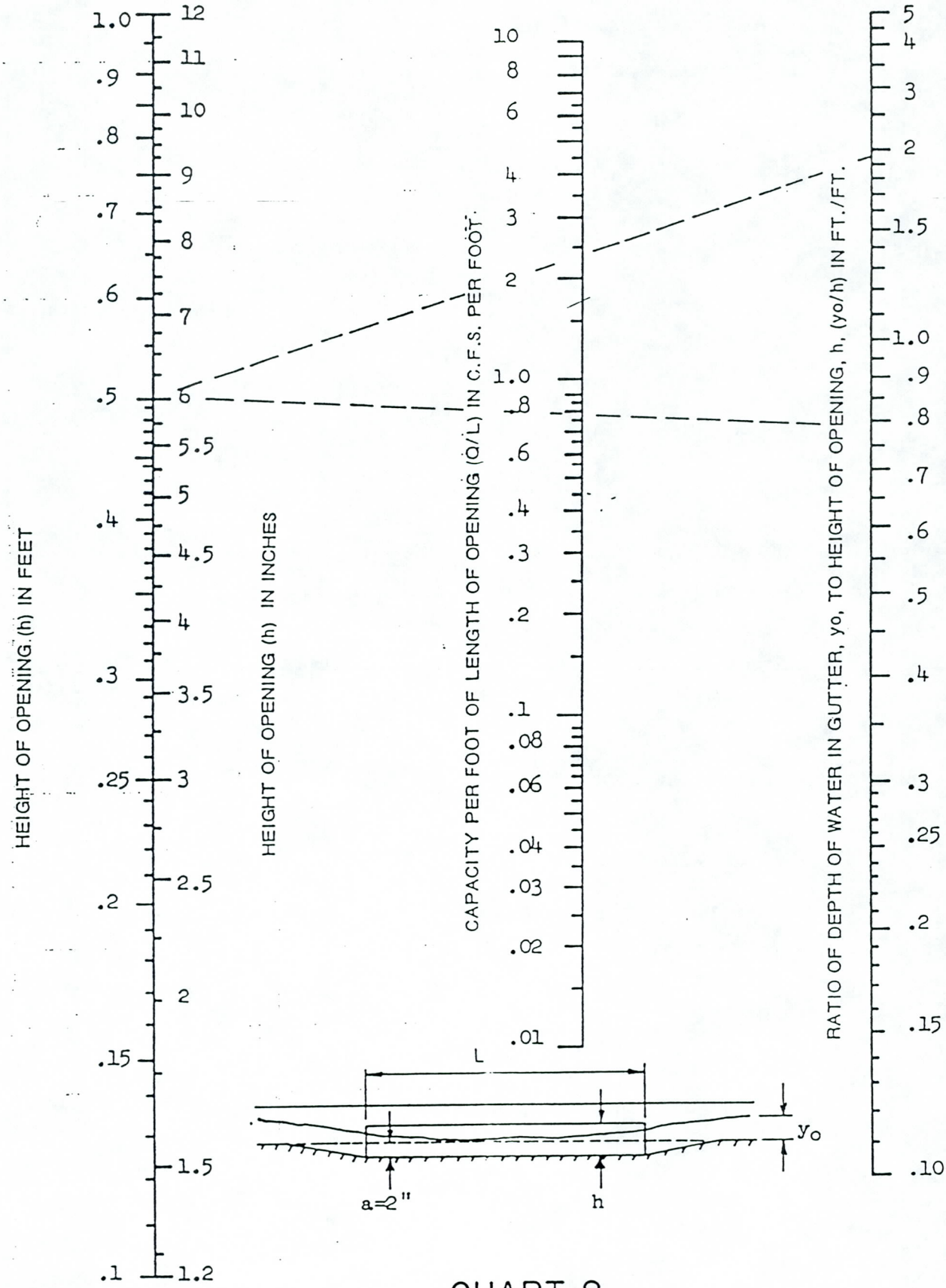


CHART 8

NOMOGRAPH FOR CAPACITY OF CURB OPENING INLETS IN SUMPS, DEPRESSION DEPTH 2"

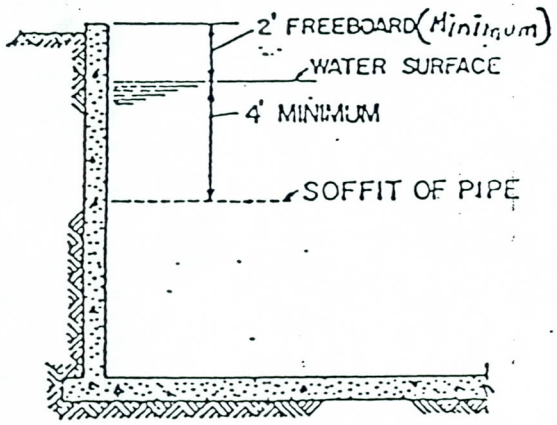
SUPER-CRITICAL FLOW
(HIGH VELOCITY)

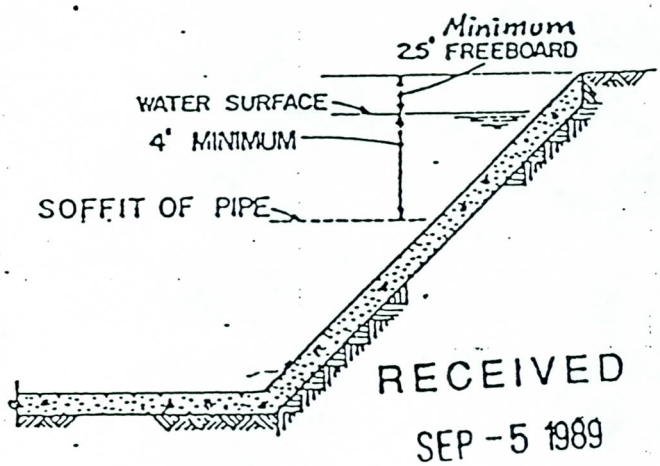
PIPE SIZE	ANGLE OF ENTRY
21"	90°
24"-33"	60°
36"-57"	45°
60" and over	30°

SUB-CRITICAL FLOW
(LOW VELOCITY)

PIPE SIZE	ANGLE OF ENTRY
up to 36"	90°
36"-57"	45°
60" and over	30°

SUBMERGENCE





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NOTE: BEFORE USING STANDARD EACH PROJECT MUST BE VERIFIED WITH THE CORPS OF ENGINEERS

PERMIT MANUAL

STANDARDS FOR ANGLE OF ENTRY OF STORM DRAINS

OFFICE OF THE DISTRICT ENGINEER
LOS ANGELES, CALIFORNIA

Figure A-11

CREEGAN + D'ANGELO

PHONE (602) 258-3175

SHT. NO.	OF
JOB NO.	
BY	DATE
REVWD.	DATE
REVISED	

32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE

HYDROLOGY STUDY FOR FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

DECEMBER 1989

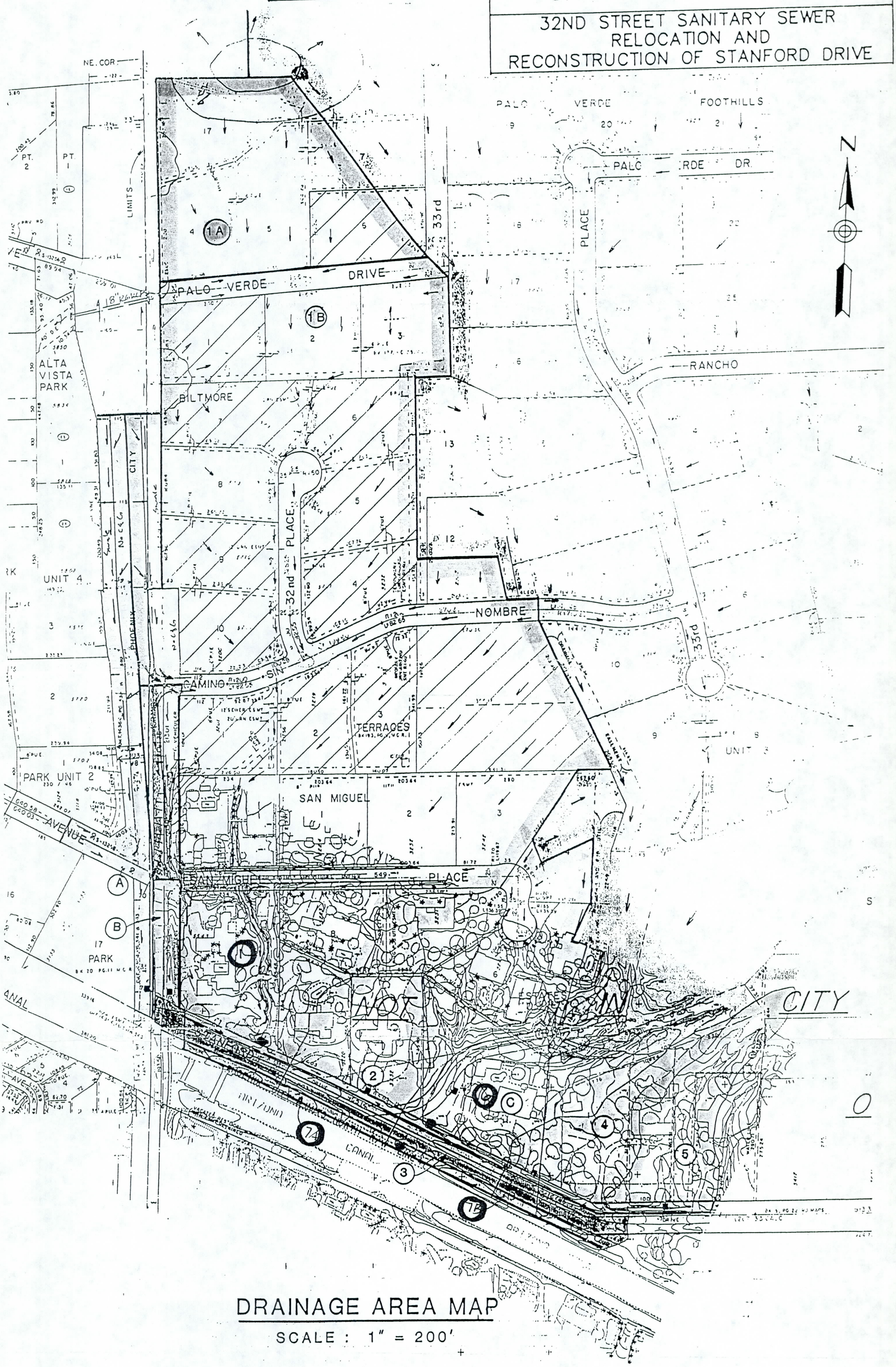
Prepared by:

CREEGAN + D'ANGELO
650 North 2nd Avenue
Phoenix, Arizona 85003

CREEGAN + D'ANGELO
Engineers • Planners • Surveyors
650 North Second Ave. Phoenix, AZ 85003 Phone 602 258 3175

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE



DRAINAGE AREA MAP

SCALE : 1" = 200'

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE		JOB NO. 889 013	
		BY VAD	DATE 9/89
		REVWD. HEG	DATE 10/17/89
		REVISED	

ADDENDUM to "HYDROLOGIC DESIGN FOR HIGHWAY DRAINAGE IN ARIZONA" April 1975

Steps to be used to determine precipitation values for various durations and return periods.

STEP 1. From the precipitation maps in the manual "Hydrologic Design for Highway Drainage in Arizona", determine the precipitation values for the 6 and 24 hour duration storms for return periods of 2, 5, 10, 25, 50 and 100 years. Tabulate these values in Table 1 in the column headed 'Map Values'

TABLE 1

Return Period (Years)	Precipitation Values (inches)				
	6 hour duration		24 hour duration		1HC
	Map Value	Corrected Value	Map Value	Corrected Value	
2	1.2	$x_1 = 1.20$	1.40	$x_2 = 1.40$	0.96
5	1.7	1.70	2.00	2.00	1.31
10	2.1	2.05	2.40	2.40	1.59
25	2.45	2.45	3.00	2.92	1.91
50	2.81	2.85	3.40	3.39	2.21
100	3.2	$x_3 = 3.20$	3.80	$x_4 = 3.83$	2.51

NOTE: There is a possibility of making an error while reading the maps because, (1) a site is not easy to locate precisely on a series of 12 maps, (2) there may be some slight registration differences in printing, and (3) precise interpolation between isolines is difficult. In order to minimize any errors in reading the maps, these values should be plotted on the diagram "Precipitation Depth versus Return Period" Fig. 1.

$Y_2 = (2YR, 1HR) = (-0.011) + (0.942)[x_1 (x_1/x_2)]$

$= (-0.011) + (0.942)[1.20(1.20/1.40)] = 0.96$

$Y_{100} = (100YR, 1HR) = (0.494) + (0.755)[x_3 (x_3/x_4)]$

$= (0.494) + (0.755)[3.20(3.20/3.83)] = 2.5$

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO.	OF
32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE		JOB NO. 889013	
		BY VAD	DATE 9/89
		REVWD. HEG	DATE 10/17/89
		REVISED	

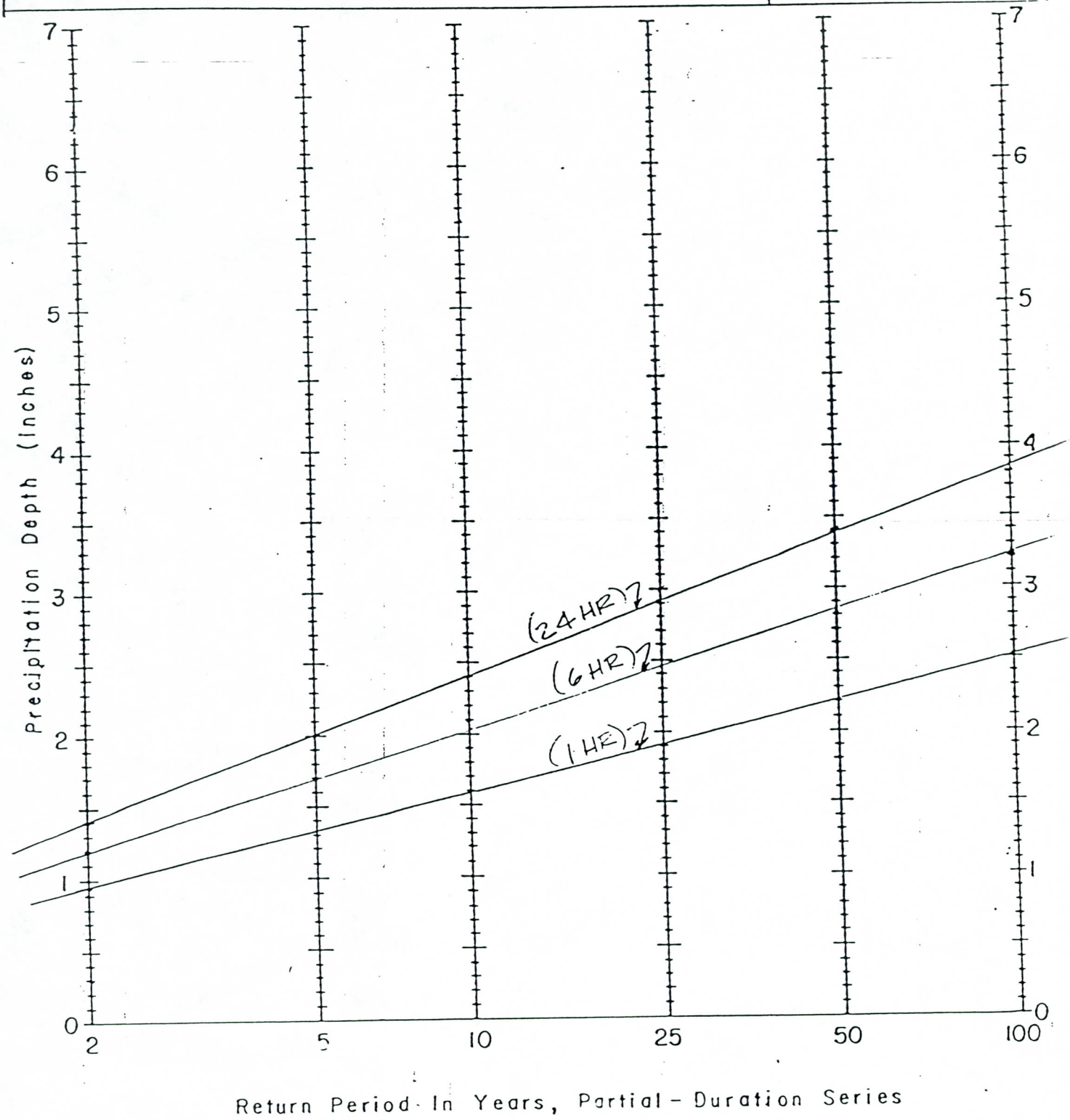


Figure 1 Precipitation Depth Versus Return Period for Partial-Duration Series

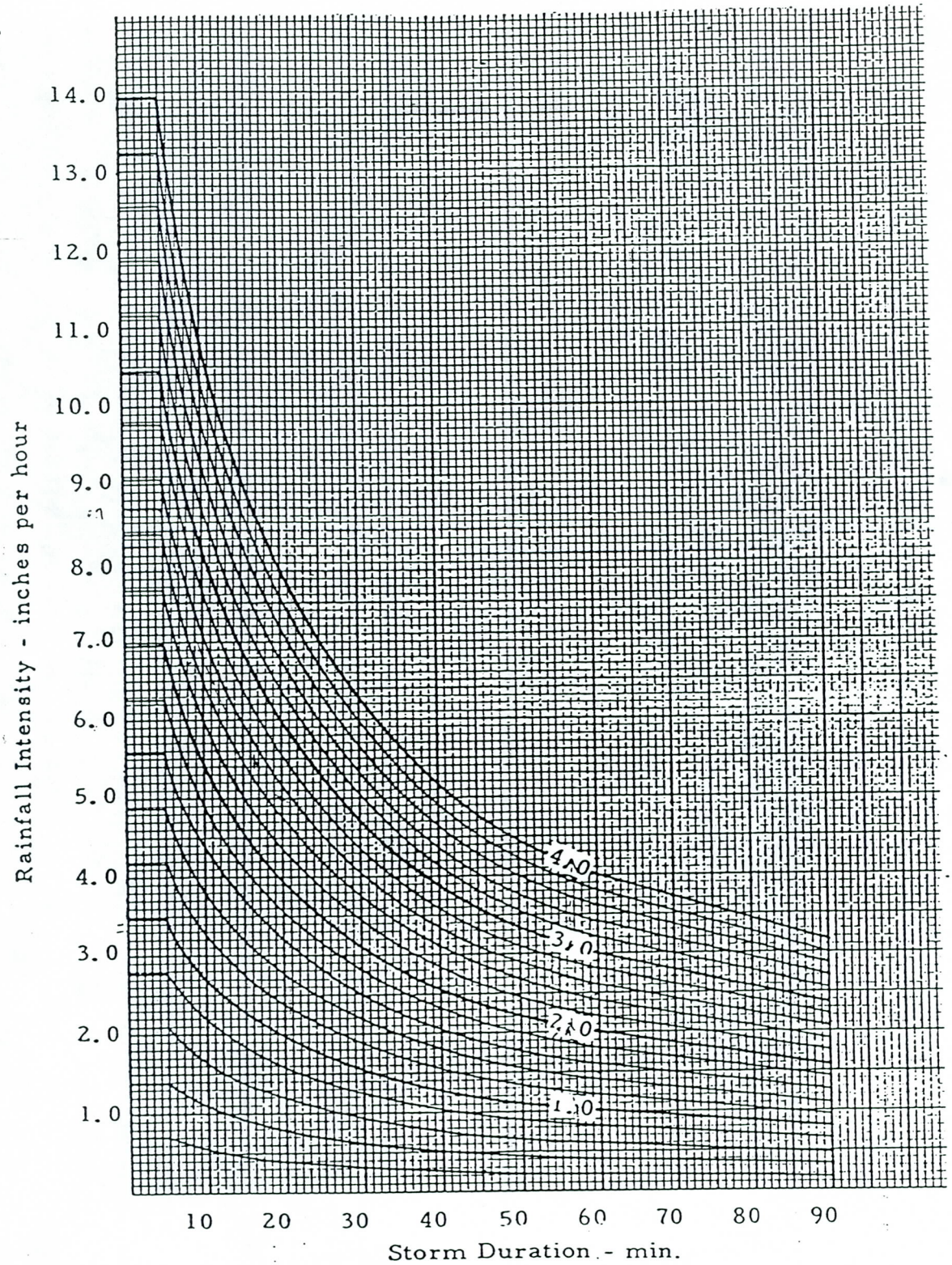
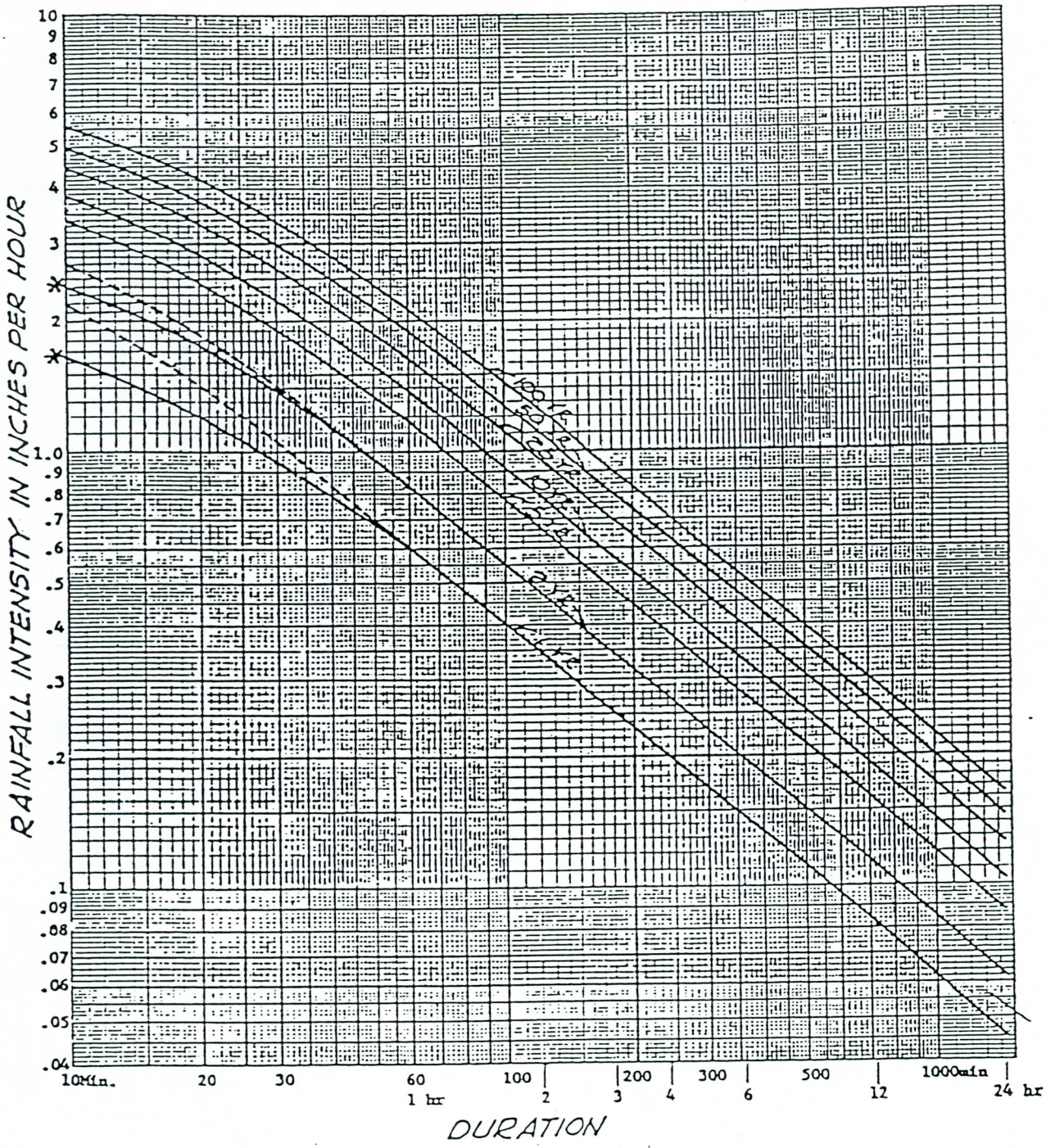


Fig. 3-2

STANDARD DURATION RAINFALL - INTENSITY CURVES

Based on:
Weather Bureau
Technical Paper No. 40



RAINFALL INTENSITY-DURATION-FREQUENCY RELATION
FOR PHOENIX, ARIZONA
(Partial Duration Series)

Curves are based on methods of U.S. Weather Bureau Technical Papers Nos. 28 and 40 and rainfall data prepared by U.S. Weather Bureau Office of Hydrology for the Soil Conservation Service, March 1967

* Curves revised June 1975 to reflect new information from WR-44.

C.O.P. STORM DRAIN DESIGN MANUAL
JULY 1987

RUNOFF CO-EFFICIENTS FOR USE WITH THE RATIONAL FORMULA Q = CIA

Land Use	"C" Value
Paved Street or Parking Lot	0.95
Commercial Areas	0.90
Residential Areas (Average lot zoning)	0.45
Townhouses	0.55
Apartments and Condominiums	0.65
Parks and Grassed Areas (no irrigation)	0.20
Railroad Yards	0.25
Undeveloped Desert	0.35
Mountain Terrain — slopes greater than 10%	0.70
Industrial Areas	0.90
Agricultural Areas	0.20

Streets	
Asphaltic	0.70 - 0.95
Concrete	0.80 - 0.95
Gravel roadways & shoulders	0.40 - 0.60
Industrial Areas	
Flat commercial - about 90% of area impervious	0.80
Heavy areas	0.60 - 0.90
Light areas	0.50 - 0.80
Business Areas	
Downtown areas	0.70 - 0.95
Neighborhood areas	0.50 - 0.70
Residential Areas	
Lawns - flat	0.05 - 0.15
- steep	0.15 - 0.35
Suburban areas	0.25 - 0.40
Single family areas	0.30 - 0.50
Multi-unit areas	0.40 - 0.60
Apartment areas	0.50 - 0.70
Parks, Cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.35

Fig. 3-3

VALUES OF RUNOFF COEFFICIENT C

PROJECT
32ND STREET BRIDGE
& UTILITY RELOCATIONS

INLET HYDRAULICS
FOR
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

JANUARY 1990

UPDATED FEB 21, 1990

FLOOD CONTROL DISTRICT
RECEIVED
FEB 22 1990

	CH ENG		P & PM
	DEP		HYDRO
	ADMIN		MNGT
	FINANCE		FILE
	C.A.O.		
	ENGR.		

REMARKS

Prepared by:

CREEGAN + D'ANGELO
650 North 2nd Avenue
Phoenix, Arizona 85003

I. INTRODUCTION

A. OBJECTIVE

The objective was to design two catch basins with a connector pipe system in series to adequately handle the design flow for a 100 year frequency storm.

B. BOUNDARIES

The drainage area is within the 32nd street right of way from Stanford Drive mon. line to approximately 0.26 miles north of Stanford.

C. DESIGN

Three basic methods were used for deriving the runoff values from this drainage area, the Rational Method, Soil Conservation Service Method (SCS), and the Corps of Engineers Study (COE).
The COE's Study was performed in order to define the project scope and substantiate the basis and need for further design.

As a result of analysis two inlets are to be installed as follows:

1. Inlet "A" is to be located north of the Stanford Drive monument line, north of the new bridge structure and west of the 32nd street monument line. The standard City of Phoenix, type "M" catch basin will be used. Excess flow-by will be routed down the new inverted SRP driveway and spillover the open channel section of the ACDC. The design surface runoff into this inlet was 22cfs. The connector pipe system from the inlet to the ACDC wall should handle a total of 40cfs.

2. Inlet "B" is to be located on the northeast corner of 32nd Street and Stanford Drive, north of the return. The east half of 32nd Street is not a fully developed roadway to date and currently overland flow is captured in roadside swales and routed easterly down both Camino Sin Nombre and San Miguel Streets with a minimum amount of flow (10cfs) reaching the inlet. If roadway improvements occur in the future, the design flow value could double. Therefore, the inlet design is based on 10cfs connector pipe is based on 20cfs. The COE value of 40cfs was not substantiated by C+D's study and therefore, not considered for the basis of design.

D. ASSUMPTIONS

For all concrete pipes, n=0.012.

The ACDC water surface elevations were provided by the COE. These values were used to determine the available head and size the connector pipes.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 2A OF 15
32ND STREET @ STANFORD		JOB NO. 889013.45
DESIGN DISCUSSION		BY VAD DATE 2/21/90
ADDENDUM TO HYDR. CALCS		REVWD. DATE 2/21/90
		REVISED

REF: REVIEW COMMENTS FROM CONTRACT I HYDRAULICS, LETTER OF JAN 30, 1990

NOTE:
LOCATION OF INLET "A" HAS BEEN REVISED ON THE PLANS FROM STA 15+83 TO 15+74 (APPROXIMATELY 9FT SOUTH). OTHER REVISIONS ON THE PLANS INCLUDE SHORTENING OF THE CONNECTOR PIPE BETWEEN INLET "A" AND ITS OUTLET AT THE ACDC FROM 60FT TO 58FT AND HORIZONTAL REALIGNMENT OF THE CONNECTOR PIPES BETWEEN INLETS "A" AND "B" WHICH SHORTENED THE CONNECTOR PIPE FROM 89FT TO 82FT AND FLATTENED THE SLOPE IN 36FT OF PIPE FROM 0.0667'/FT TO 0.0056'/FT. ALL OTHER CONDITIONS HAVE REMAINED THE SAME INCLUDING AVAILABLE HEAD, PEAK FLOW RATES, NUMBER OF BENDS AND PIPE SIZES. THEREFORE THE CALCULATIONS FOR THE CONNECTOR PIPES HAVE NOT BEEN REVISED, ONLY THE PLAN REVISIONS HAVE BEEN NOTED

SOURCES

"Hydrologic Design for Highway Drainage in Arizona"
AZ Hwy Dept. Bridge Division, December 1, 1968

"Storm Drain Design Manual, Storm Drains with Paving of Major Streets", City of Phoenix, Revised July 1987

"Neenah Inlet Grate Capacities for Gutter Flow and Ponded Water", Neenah Foundry Company, 1985

"Hydraulic Charts for the Selection of Highway Culverts", Hydraulic Engineering Circular No. 5, U.S. Dept. of Transportation Federal Hwy Admin., Reprinted June 1980

"Hydrologic and Hydraulic Training Session", Arizona Highway Department Structures Section Hydraulics Division, Revised December 1973

CREEGAN + D'ANGELO — PHONE (602) 258-3175

SHT. NO. 4 OF 15
JOB NO. 889013
BY VAD DATE 12/12/89
REVWD. HEG DATE 12/12/89
REVISED VAD 2/21/90

32ND STREET SANITARY SEWER RELOCATION AND RECONSTRUCTION OF STANFORD DRIVE

ARIZONA DEPARTMENT OF TRANSPORTATION

STORM SEWER RUNOFF CALCULATION RECORD

LOCATION DATA

Highway _____

Location _____

Project No. 889013

DESIGN DATA

Frequency 100 years

P_6= 3.2 in. P_{24}= 3.83 in. P_1= 2.51 in.

RUNOFF CALCULATIONS

			SCS METHOD						RATIONAL METHOD					COE	COP	
No.	C&D STATION	COE STATION	A Sq MI	CN	Tc hrs	Tp hrs	Q_r in.	Q_p cfs	A	C	Tc min	I in/hr	Q cfs	Q cfs	Q cfs	Q2yr cfs
1	STANFORD 2+60.97	965+02.39 ACDC INTERCEPT	.0508	87.64	0.273	0.339	1.40	102 *	32.49	0.45	11.11	6.5	95	100	—	—
2	STANFORD 5+45	968+50.11	.0034	86	0.077	0.095	1.30	23 *	2.16	0.40	4.70	8.7	8	12	—	—
3	STANFORD 6+50	969+55.11	.0016	93	0.14	0.17	1.85	8 *	1.08	0.95	8.78	7.2	8	—	6	3
4	STANFORD 10+01	973+05.90	.0027	87	0.092	0.114	1.35	16 *	1.70	0.44	5.67	8.4	6	13	—	—
5	STANFORD 12+65	975+70.95	.0031	87	0.09	0.112	1.30	18 *	1.96	0.40	5.61	8.3	7	12	—	—
A	15+83 32ND ST	961+63.04	.0033	93	0.110	0.136	1.85	22 *	2.12	0.95	4.30	8.7	18	20	12	5
B	15+39 32ND ST	—	.0006	88	0.036	0.045	1.45	(2) 10 *	0.40	0.69	2.21	8.7	3	(1) 40	—	—
C	2+06 35TH ST	—	.0083	86	0.102	0.127	1.3	41 *	5.33	0.40	6.27	8.1	17.3	—	—	—

Not INCLUDED W/60% SUBMITTAL

Computed by: VAD Checked by: HEG Date: 12/1/89

* DESIGN FLOW USED FOR INLET GRATE DESIGN

(1) COE VALUE NOT SUBSTANTIATED AND THEREFOR NOT USED.

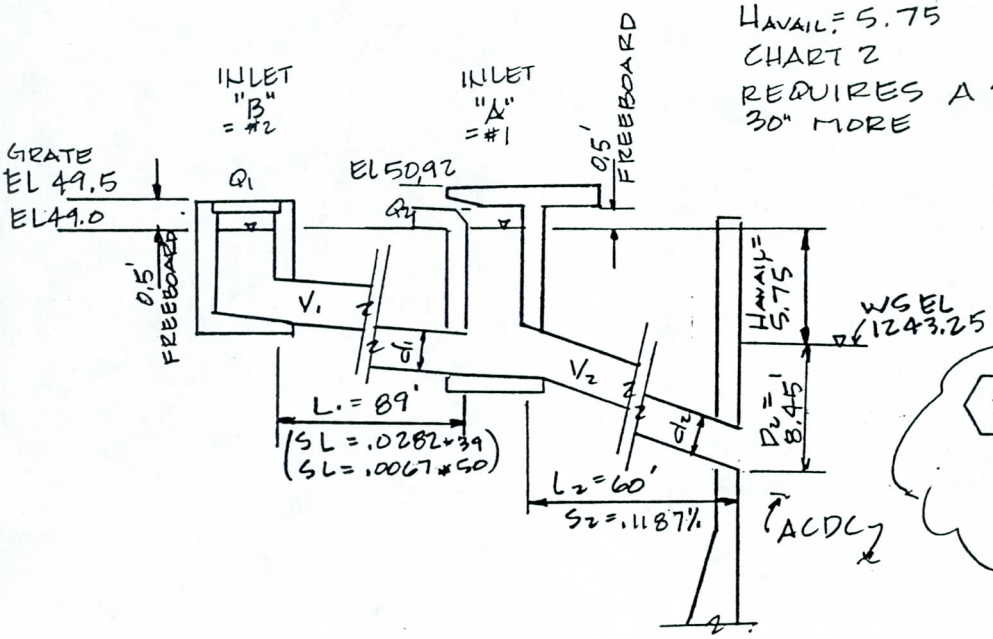
(2) DESIGN Q = 10CFS x 2 = 20CFS FOR FUTURE RDWY IMPROVEMENTS. FOR CONN. PIPE SYSTEM FROM "A" TO "B"

CONNECTOR PIPE SYSTEM

I.A. DETERMINE THE AVAILABLE HEAD FOR THE SYSTEM : $H_{AVAIL.}$ = 1249.5 (GRATE ELEV. INLET "B")
− 0.5 (FREEBOARD)
−1243.25 (ACDC W.S. ELEV.) (PER C.O.E. SUBCRITICAL W.S. COMPUTATIONS)
5.75'

B. SIZE CONN. PIPE AS A WHOLE BASED ON TOTAL LENGTH & $H_{AVAIL.}$: (ASSUME ALL SURFACE FLOW IS CAPTURED.)

L = 149 LF, Q = 42 CFS
$H_{AVAIL.}$ = 5.75
CHART 2
REQUIRES A 27" MIN DIA. PIPE
30" MORE



(1) SEE SHT 7 & 14 FOR PLAN UPDATES & REVISIONS
MS 2/21/90

C. CALCULATE MIN. DEPTH OF INLETS & CONN. PIPE SIZES :

MIN DEPTH FOR "B" (TRY 24" PIPE FROM "A" TO "B")

$A_{FULL} = \pi 2^2/4 = 3.14$ SF
WP = 6.28
R = A/WP = 3.14/6.28 = .5

Q = 20 CFS
$V_1 = Q/A_F$ = 20/3.14 = 6.37 FPS

FROM CHART 4, THE HYDRAULIC SLOPE OF PIPE NEEDED (MIN), = S_f = .0067%

INLET DEPTH $D_1 = 1.16 + 1.5\frac{V_1^2}{2g} + d = 1.16 + 1.5\frac{(6.37)^2}{64.4} + 2 = 4.1$ (LOP REQUIRES 4' MIN DEPTH DESIGN IS 6', ∴ OK)

CALC THE HEAD LOSS & PIPE SIZE

FOR PIPE FLOWING FULL, CULVERT EQN YIELDS:

$H_1 = \left[1 + K_e + \frac{29 n^2 L}{R^{1.33}}\right] V^2/2g + H_{MINOR}$

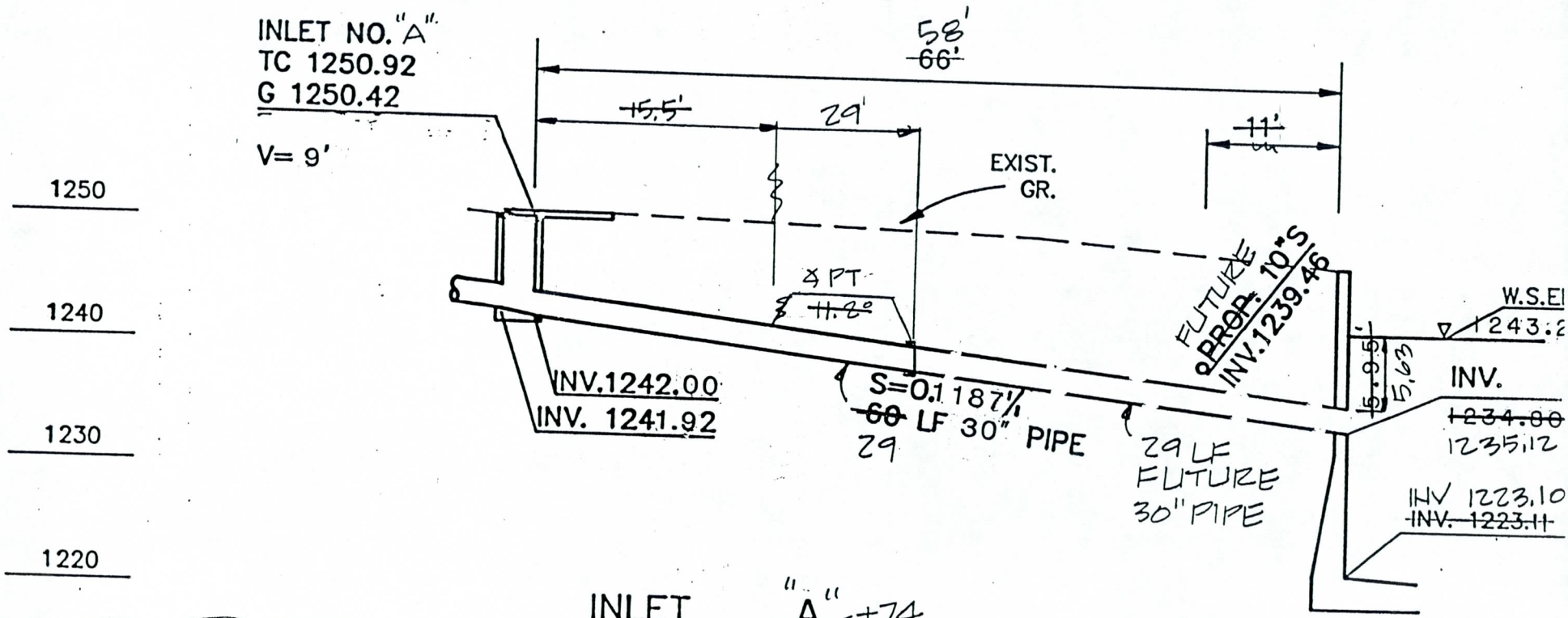
WHERE: K_e = .3 (ENTRANCE LOSS PER L.O.P. CHART 2)

$H_1 = \left[1 + .3 + \frac{29(.012)^2 89}{(.5)^{1.33}}\right] 6.37^2/64.4 + 0.07'$

H_1 = 1.48 FT < 4' ∴ OK

$H_{MINOR} = H_{\#pt}$ #pt = 34.5
= 0.0033 @ $\frac{V^2}{2g}$ #pt
= 0.007'

CREEGAN + D'ANGELO PHONE (602) 258-3175	SHT. NO. 7 OF 15
32ND STREET BRIDGE AND	JOB NO. 889013
UTILITY RELOCATIONS	BY VAD DATE 12/12/89
	REVWD. [illegible] DATE 1/05/90
INLET "A" = No. 1 ON PLAN/PROFILE SHTS	REVISED VAD 2/21/90



INLET "A" +74
STA. 15~~+83~~ (32.~~12~~'LT.) 32ND ST.
~~STA. 961+63.04 ACDC ℄ INTERCEPT STA.)~~
LOOKING EAST SCALE ~~1"=10' V & H~~ NTS

1 PLAN REVISIONS AND CHANGES ARE NOTED IN SKETCH ABOVE

[illegible] 2/21/90

CONNECTOR PIPE SYSTEM (CONT.)

II.A. MIN DEPTH FOR PIPE FROM INLET "A" TO ACDC:

TOTAL Q_2 = 22 CFS + 20 CFS = 42 CFS (ASSUME ALL SURFACE FLOW IS CAPTURED)
DIA = 30" PIPE

$V_2 = Q_2/A_F = 42/4.91 = 8.55$ FPS

PER CHART 4, MIN HYDRAULIC SLOPE REQ'D FOR 30" ⌀ PIPE, $S_F = .0091$/FT
DUE TO UTILITY CONFLICTS DESIGN USES $S_o = 0.1187$
HEAD LOSS IN PIPE = 60 * .1187 = 7.12'

$\frac{V_2^2}{2g} = \frac{(8.55\text{ FPS})^2}{64.4} = 1.14$

$H_{MINOR} = .0033(11.2°)(1.14) = 0.04$ FT

$H_2 = \left[1 + .3 + \frac{29(.012)^2(60)}{0.63^{1.33}}\right] 1.14 + 0.04 = 2.05$ FT

THEREFORE:

$H_1 + H_2 = 1.48 + 2.05 = 3.53$ FT

1243.25 + 3.53 = 1246.78 < 1249.5 ∴ OK

DEPTH = V_2 = $1.16 + H_1 + 1.5\frac{V^2}{2g} + d_2$ - CURB HEIGHT

= 1.16 + 1.33 + 1.71 + 2 - (+1.42)

= 4.78 FT (DESIGNED AT '9' DEPTH TO CLEAR UTILITIES ∴ OK)

REFER TO CHART 2. (H = 3.53', Q = 42 CFS), DIA = 27" MIN
i.e. DESIGN SELECTION OF 30" DIA IS GOOD

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 9 OF 15
32ND STREET BRIDGE AND		JOB NO. 889013
UTILITY RELOCATIONS		BY VAD DATE 12/21/89
		REVWD. DATE 1/05/90
		REVISED

Creegan + D'Angelo

JOB NO.: 889013
PROJECT: 32ND STREET BRIDGE
DATE: 10/25/89
BY: VAD

==========

TYPE 'M' CATCH BASIN DESIGN PER CITY OF PHOENIX STORM DRAIN DESIGN MANUAL

(RATIONAL METHOD Q=18CFS)
DRAINAGE AREA DA- A
100YR STORM FREQUENCY

INLET #1

$Q_{100\,max}$ = 18.00 CFS (1/2 Street Flow) 22

S = 0.0163 '/FT
Sx = 0.0180 '/FT
n = .015

1/2 STREET = 40.0 FEET
SPREAD = 20.3 FEET
DRY PVMT = 19.7 FEET

a-inlet = 2.0 INCHES
Lcurb = 20.0 FEET
Leff = 16.0 FEET (20% Clogging Factor Used)

Z = 55.56
Z/n = 3704
Ycurb = 0.365 FEET (CHART 7)

a/Yc = 0.47
Qa/La = 0.26
Qa = 18.00
La = 69.71
L/La = 0.23
Q/Qa = 0.37

Qby = 11.38 CFS
Qin = 6.62 CFS

CREEGAN + D'ANGELO	
32ND STREET BRIDGE	JOB NO. 889013.45
	BY VAD DATE 2/21/90
	REVWD. DATE
	REVISED

BENSON AND GERDIN ENGINEERS
A Division of Creegan + D'Angelo

JOB NO.: 889013
PROJECT: 32ND STREET BRIDGE
DATE: 2/1/90
BY: VAD

==========

TYPE 'M' CATCH BASIN DESIGN PER CITY OF PHOENIX STORM DRAIN DESIGN MANUAL

INLET 32ND STREET (WEST SIDE)#1 DRAINAGE AREA A(#1)

Q = 22.00 CFS (1/2 Street Flow)

Missdesign

S = 0.0284 '/FT
Sx = 0.0173 '/FT
n = .015

1/2 STREET = 40.0 FEET
SPREAD = 20.2 FEET
DRY PVMT = 19.8 FEET

a-inlet = 2.0 INCHES
Lcurb = 20.0 FEET
Leff = 16.0 FEET (0.8 Clogging Factor Used)

Z = 57.80
Z/n = 3854
Ycurb = 0.349 FEET

a/Yc = 0.49
Qa/La = 0.25
Qa = 22.00
La = 89.68
L/La = 0.18
Q/Qa = 0.29

Qby = 15.58 CFS
Qin = 6.42 CFS

For Yc, See Page 27, City of Phoenix Storm Drain Design Manual.
For Qa/La and Q/Qa,
See Page 28, City of Phoenix Storm Drain Design Manual.

JOB NO.: 888013
PROJECT: 32ND STREET BRIDGE
DATE: 9-21-89
BY: VAD

==========

HYDROLOGIC ANALYSIS PER CITY OF PHOENIX STORM DRAIN DESIGN MANUAL

100 YR STORM FREQUENCY

DRAINAGE AREA DA- A
INLET #1

SUBAREA	% IMPERVIOUS (i)	TRIB. AREA (A)
R/W	1.00	2.12 Acres

n= 0.015

High Elev = 1304.0 FEET
Low Elev = 1251.0 FEET
Reach = 1300.0 FEET

Avg Slope = 0.0408 '/FT

Slope = Delta Elev / Reach

Avg Vel = 5.0 fps

Per Phoenix Storm Drain Design Manual, Page 26
Assuming: n = 0.015
Q = 3.0 CFS
Sx= 32 : 1

Tc = 4.3 MIN

Tc = Reach / (Velocity x 60)

I_{100} = 5.5 IN/HR

Per Phoenix Storm Drain Design Manual, Page 24

Impervious Area (Ai) = 2.12 ACRES

Total Area = 2.12 ACRES

✓ Q = 11.66 CFS *

Q = Ai x I

---

* NOTE: THIS 'Q' VALUE IS BASED ON C.O.P. RAINFALL INTENSITY CHARTS FOR A 100 YR STORM DUE TO INLET BEING WITHIN C.O.P. LIMITS.

Creegan + D'Angelo

JOB NO.: 889013
PROJECT: 32ND STREET BRIDGE
DATE: 10/25/89
BY: VAD

==========

TYPE 'M' CATCH BASIN DESIGN PER CITY OF PHOENIX STORM DRAIN DESIGN MANUAL

(C.O.P. METHOD Q=11.66 CFS)
DRAINAGE AREA DA-A
100 YR STORM FREQUENCY

INLET (M-1, L=17') #1

✓ Q_{100yr} = 11.66 CFS (1/2 Street Flow)

S = 0.0163 '/FT
Sx = 0.0180 '/FT
n = .015

1/2 STREET = 40.0 FEET
✓ SPREAD = 17.2 FEET ✓ → USING C.O.P. CRITERIA THIS SHOWS SPREAD IN STREET TO BE 17'
DRY PVMT = 22.8 FEET 40 - 17 = 23/2, YIELDS 2-11½' DRY PVMT LANES IN A 100-YR STORM

a-inlet = 2.0 INCHES
Lcurb = 20.0 FEET ✓
Leff = 16.0 FEET (70% Clogging Factor Used)

Z = 55.56
Z/n = 3704
Ycurb = 0.310 FEET (CHART 7)

a/Yc = 0.55
Qa/La = 0.22
Qa = 11.66
La = 54.12
L/La = 0.30
Q/Qa = 0.44

Qby = 6.48 CFS FLOW-BY TO BE ROUTED DOWN SRP RDWY INTO ACDC
✓ Qin = 5.18 CFS

JOB NO.: 889013
PROJECT: 32ND STREET BRIDGE
DATE: 10/24/89
BY: VAD

==========

HYDROLOGIC ANALYSIS PER CITY OF PHOENIX STORM DRAIN DESIGN MANUAL

DRAINAGE AREA DA-A = #1

SUBAREA	% IMPERVIOUS (i)	TRIB. AREA (A)
R/W	1.00	2.12 Acres

n= 0.015

High Elev = 1304.0 FEET
Low Elev = 1251.0 FEET
Reach = 1300.0 FEET

Avg Slope = 0.0408 '/FT

Slope = Delta Elev / Reach

Avg Vel = 5.0 fps

Per Phoenix Storm Drain Design Manual, Page 26
Assuming: n = 0.015
Q = 3.0 CFS
Sx= 32 : 1

Tc = 4.3 MIN

Tc = Reach / (Velocity x 60)

I_2 = 2.4 IN/HR

Per Phoenix Storm Drain Design Manual, Page 24

Impervious Area (Ai) = 2.12 ACRES

Total Area = 2.12 ACRES

✓ Q_2 = 5.09 CFS *

Q = Ai x I

---

* NOTE: THIS Q VALUE IS BASED ON C.O.P. RAINFALL INTENSITY CHARTS FOR A 2YR STORM DUE TO INLET BEING WITHIN C.O.P. LIMITS.

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 13 OF 15
32ND STREET BRIDGE AND		JOB NO. 889013
UTILITY RELOCATIONS		BY VAD DATE 12/26/89
		REVWD DATE 1/05/90
		REVISED

JOB NO.: 889013
PROJECT: 32ND STREET BRIDGE
DATE: 10/25/89
BY: VAD

==========

TYPE 'M' CATCH BASIN DESIGN PER CITY OF PHOENIX STORM DRAIN DESIGN MANUAL

(L.O.P. METHOD Q = 5.09 CFS)
DRAINAGE AREA DA-A
2YR STORM FREQUENCY

INLET (M-1, L=17') #1

✓ Q_{2yr} = 5.09 CFS (1/2 Street Flow)

S = 0.0163 '/FT
Sx = 0.0180 '/FT
n = .015

1/2 STREET = 40.0 FEET
✓ SPREAD = 12.6 FEET*
DRY PVMT = 27.4 FEET

*40 - 13 = 27/2 = 13.5' DRY PVMT LANES IN A 2YR STORM
(2-12' DRY LANES MIN. REQ'D.)

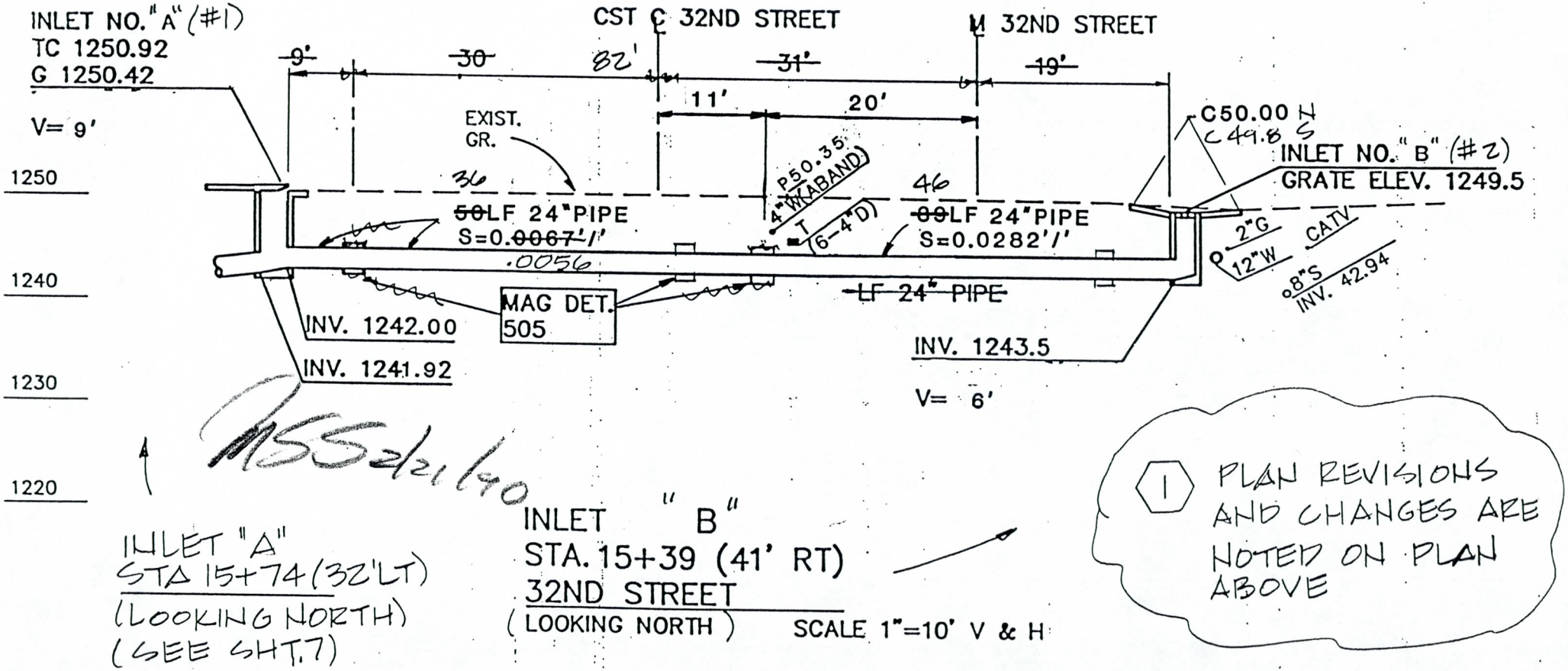
a-inlet = 2.0 INCHES
Lcurb = 20.0 FEET
Leff = 16.0 FEET (0.8 Clogging Factor Used)

Z = 55.56
Z/n = 3704
Ycurb = 0.227 FEET

a/Yc = 0.75
Qa/La = 0.15
Qa = 5.09
La = 33.00
L/La = 0.48
Q/Qa = 0.63

Qby = 1.87 CFS FLOW-BY TO BE ROUTED DOWN SRP RDWY INTO ACDL
✓ Qin = 3.22 CFS

CREEGAN + D'ANGELO	PHONE (602) 258-3175	SHT. NO. 14 OF 15
32ND STREET BRIDGE AND		JOB NO. 889013
UTILITY RELOCATIONS		BY VAD DATE 12/16/89
		REVWD. MSS DATE 1/05/90
INLET 'B' = No. 2 ON PLAN/PROFILE SHTS		REVISED VAD 2/21/90



INLET 'B' (NORTH EAST CORNER OF 32ND ST & STANFORD DR.)

STA 15+39 (41' RT)

EX. GR. EL. = 1250.0

GRATE EL. = 1249.5
$\Delta = 0.5'$

SIZING THE GRATE SYSTEM: DEPTH OF 0.5' OVER GRATE PERIMETER GOVERNS (CHART 1)

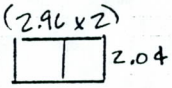
ASSUMPTIONS:
INLET GRATE SYSTEM DESIGNED FOR EXIST. FLOW OF 10 CFS.
CONNECTOR PIPE SYSTEM DESIGNED FOR FUTURE FLOW FROM 'B' TO 'A' OF 20 CFS.

Q/LF = 1.3 CFS/LF

$\frac{1.3 \text{ CFS/LF}}{2 \text{ CLOGGING FACTOR}} = 0.65 \text{ CFS/LF}$

USE Q = 10 CFS FOR SIZING GRATE

$\frac{10 \text{ CFS}}{0.65 \text{ CFS/LF}} = 15.38 \text{ LF}$

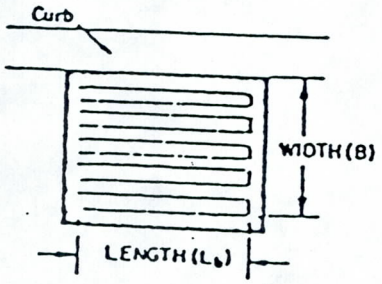
→ 

$\frac{15.38 \text{ LF} - (2.04 \times 2)}{2} = 5.65 \text{ LF} \approx 6 \text{ LF}$ MIN REQ'D LENGTH

$\frac{6}{2.96} = 2$ GRATES REQ'D

INLET DEPTH MIN = 4.1 FT
DESIGN DEPTH = 6' ∴ OK
DIA 24" OK

(REFER TO CONN. PIPE SYSTEM SHTS, INLET "A" FOR CALCS.)

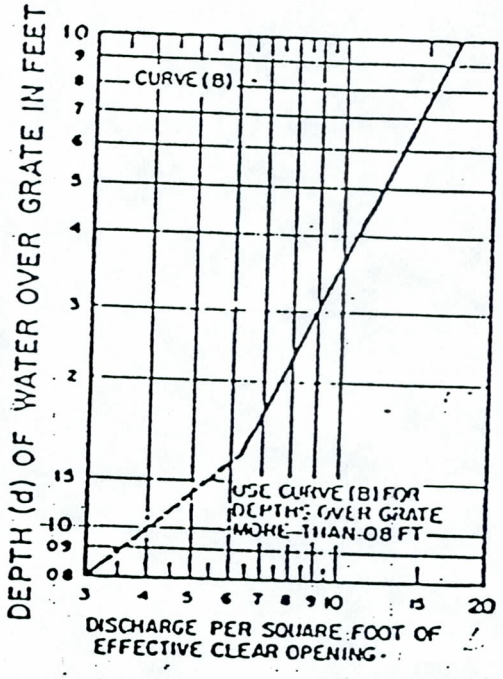


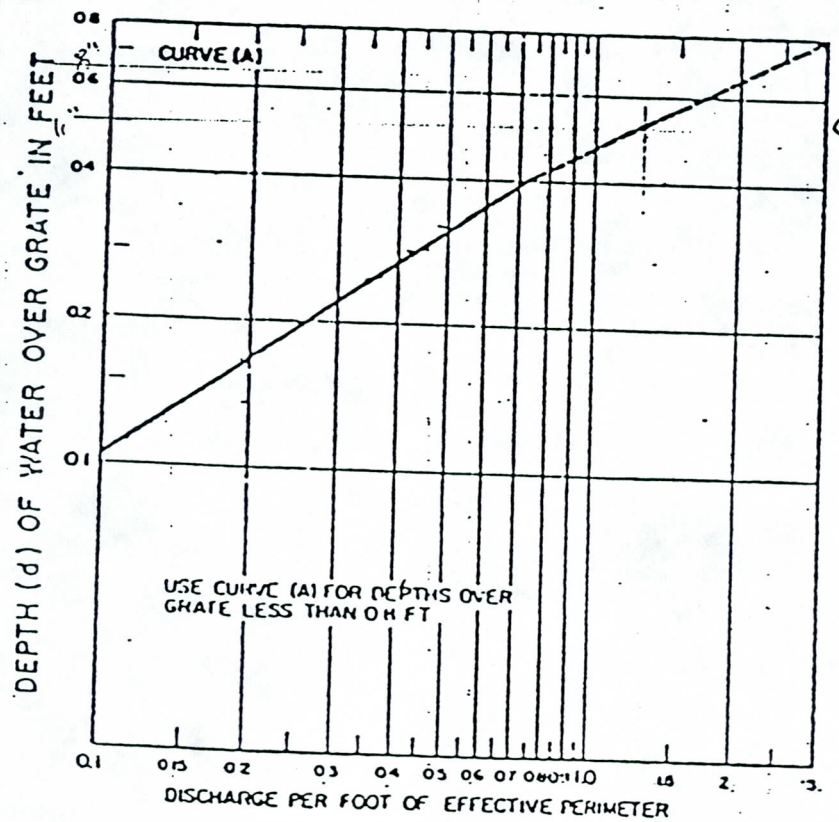
$P = 2B + L_b$

A = AREA OF CLEAR OPENING IN GRATE

TO ALLOW FOR CLOGGING DIVIDE P OR A BY 2 BEFORE OBTAINING d.

WITHOUT CURB $P = 2(B + L_b)$





GRATE TYPE	AREA	P
1	3.78	10.66
2	2.56	9.41

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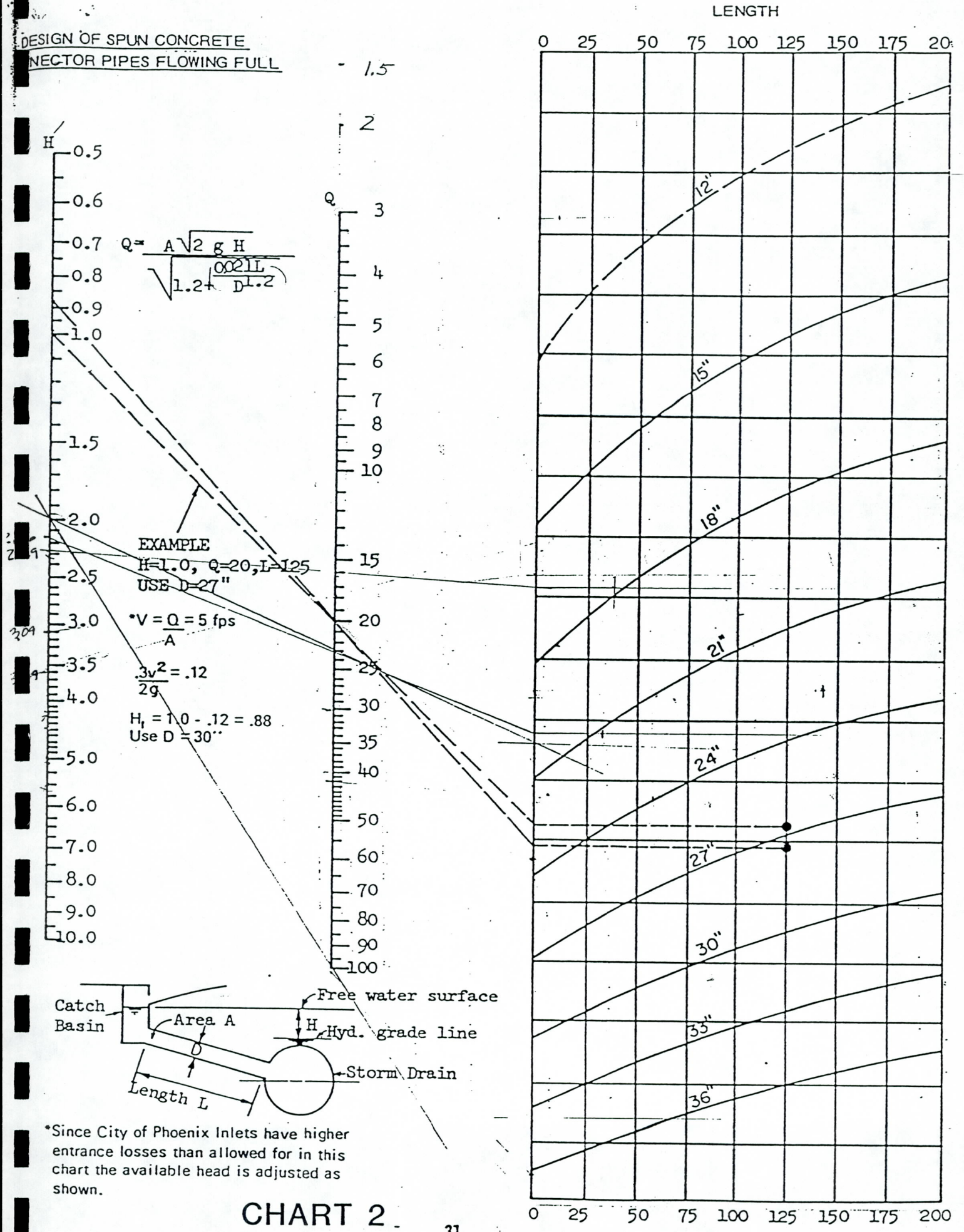
HYDRAULIC CAPACITY OF GRATE INLET IN SUMP

CHART 1

DESIGN OF SPUN CONCRETE
NECTOR PIPES FLOWING FULL



$$Q = \frac{A\sqrt{2gH}}{\sqrt{1.2 + \frac{0.021L}{D^{1.2}}}}$$

*Since City of Phoenix Inlets have higher entrance losses than allowed for in this chart the available head is adjusted as shown.

CHART 2

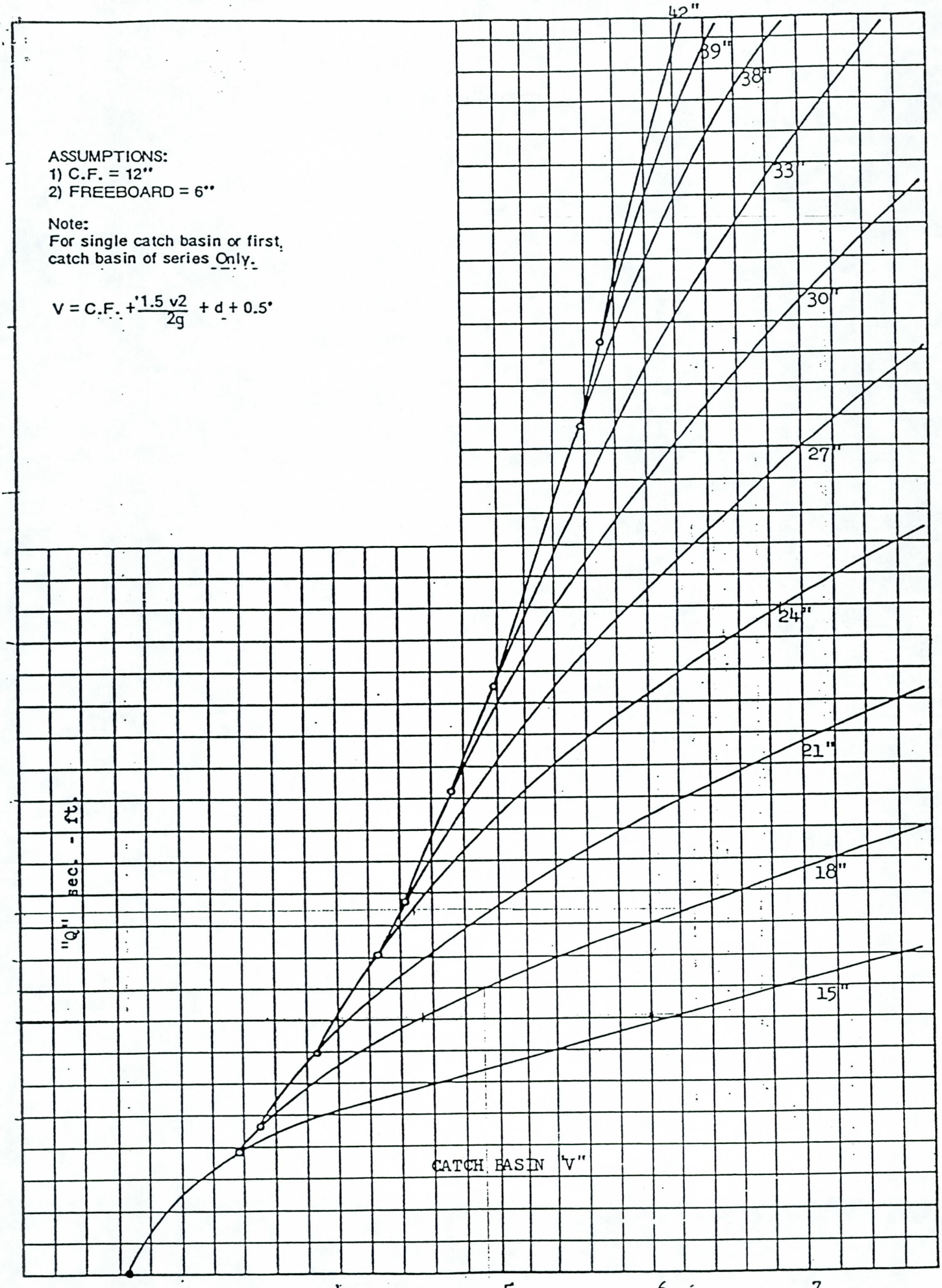
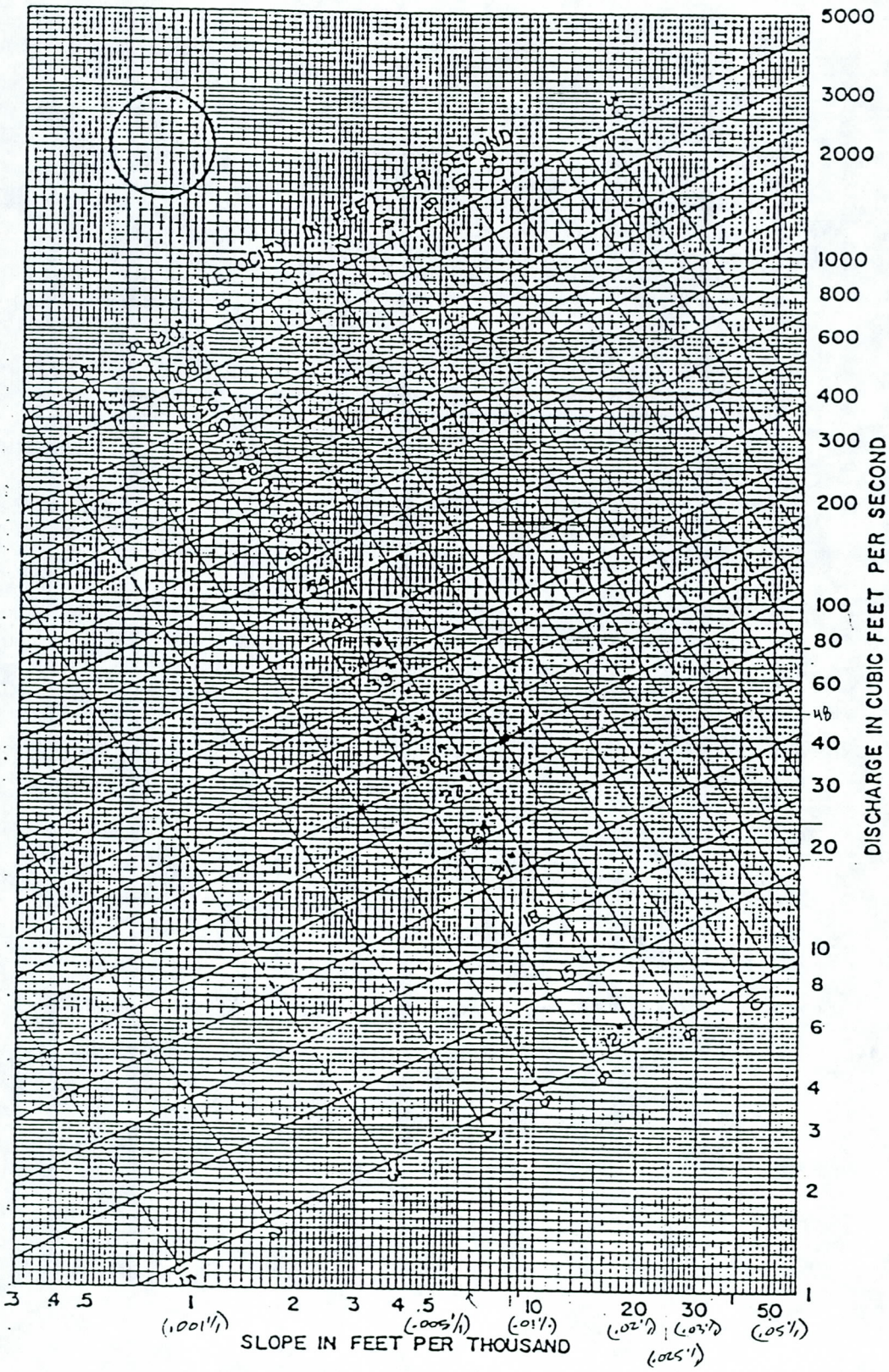

ASSUMPTIONS:
1) C.F. = 12"
2) FREEBOARD = 6"
Note:
For single catch basin or first catch basin of series Only.
V = C.F. + 1.5 v2/2g + d + 0.5'
42"
39"
38"
33"
30"
27"
24"
21"
18"
15"
"Q" sec. - ft.
70
60
50
40
30
23
20
18
16
10
2
3
4
5
6
7
CATCH BASIN "V"

CHART 3

COMPUTED FROM MANNING'S FORMULA
n=0.012



PIPE CAPACITIES FLOWING FULL

CHART 4

Appendix C: Circular Channel Ratios

Experiments have shown that n varies slightly with depth. This figure gives velocity and flow rate ratios for varying n (solid line) and constant n (broken line) assumptions.

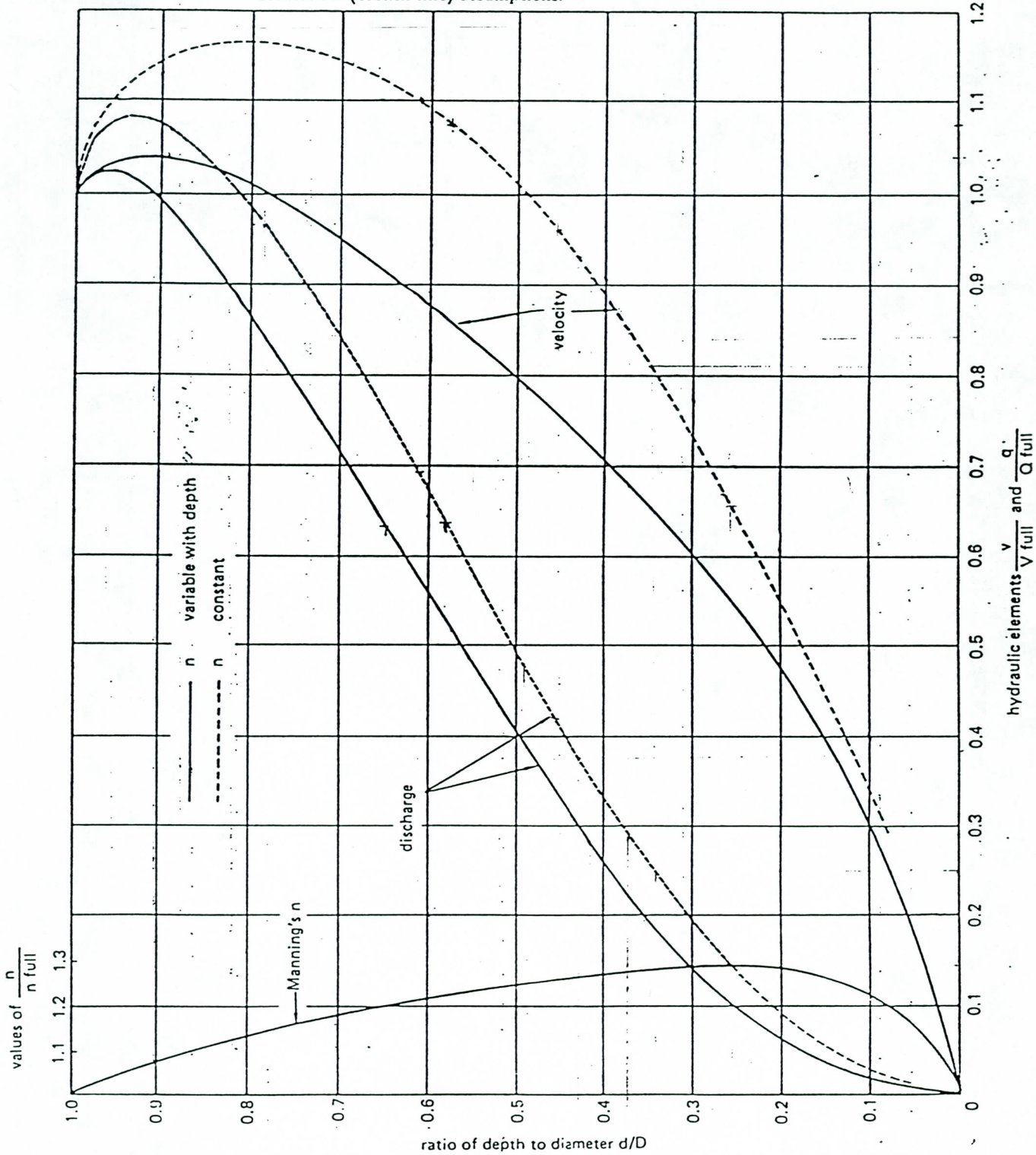


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CHART 5

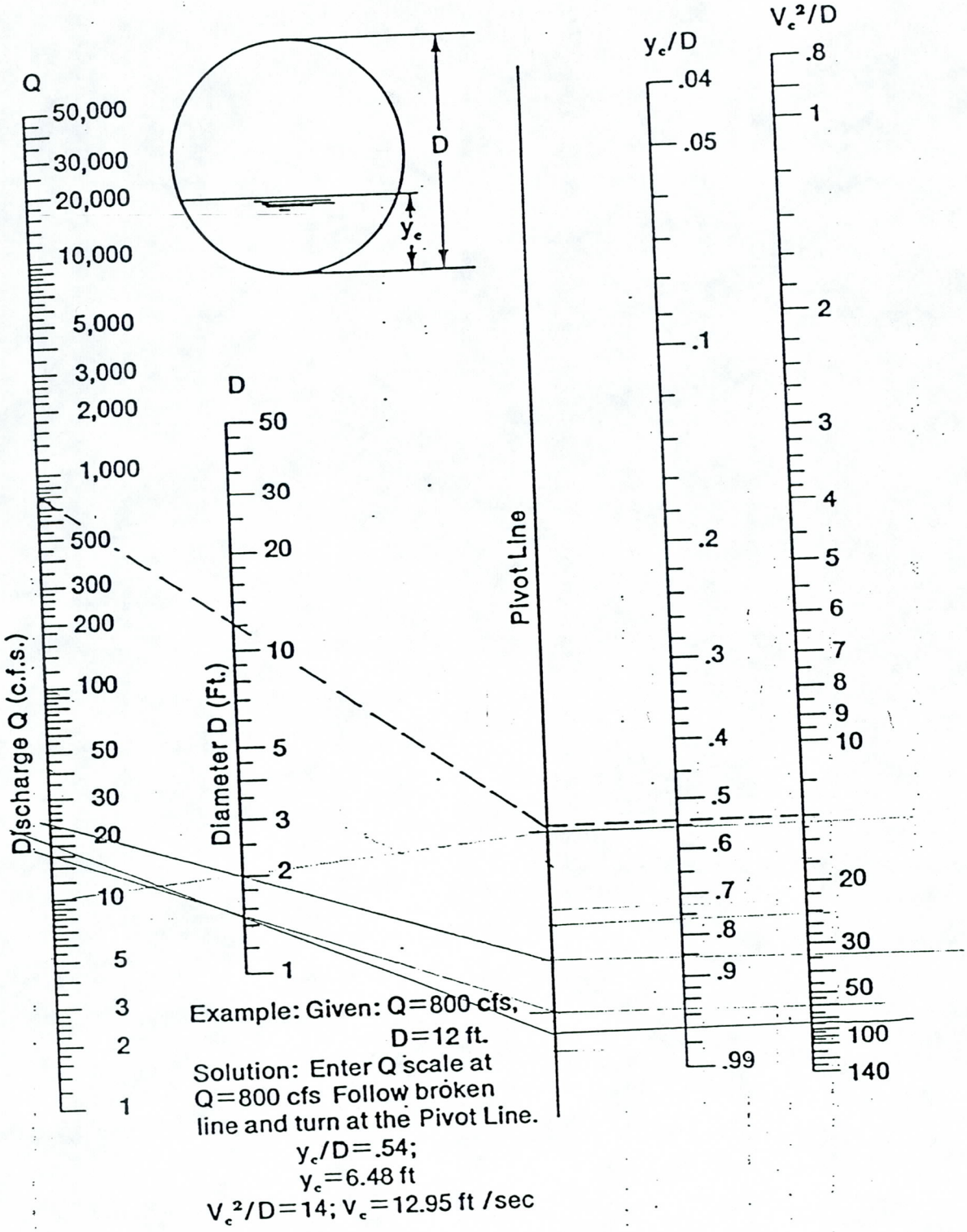


Figure 3-24 Critical flow and critical velocity in circular conduits.

CHART 6

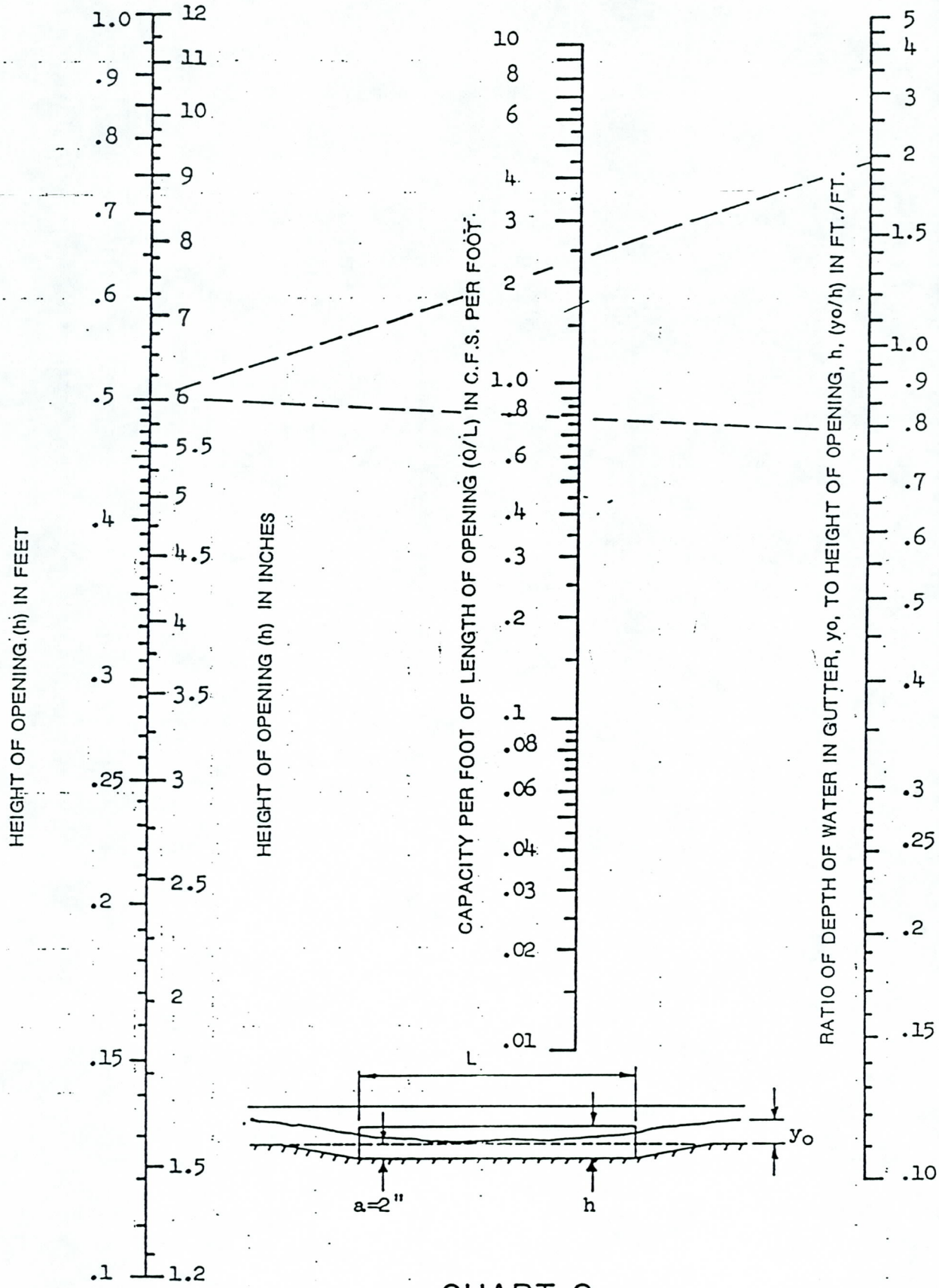


CHART 8

NOMOGRAPH FOR CAPACITY OF CURB OPENING INLETS IN SUMPS, DEPRESSION DEPTH 2"

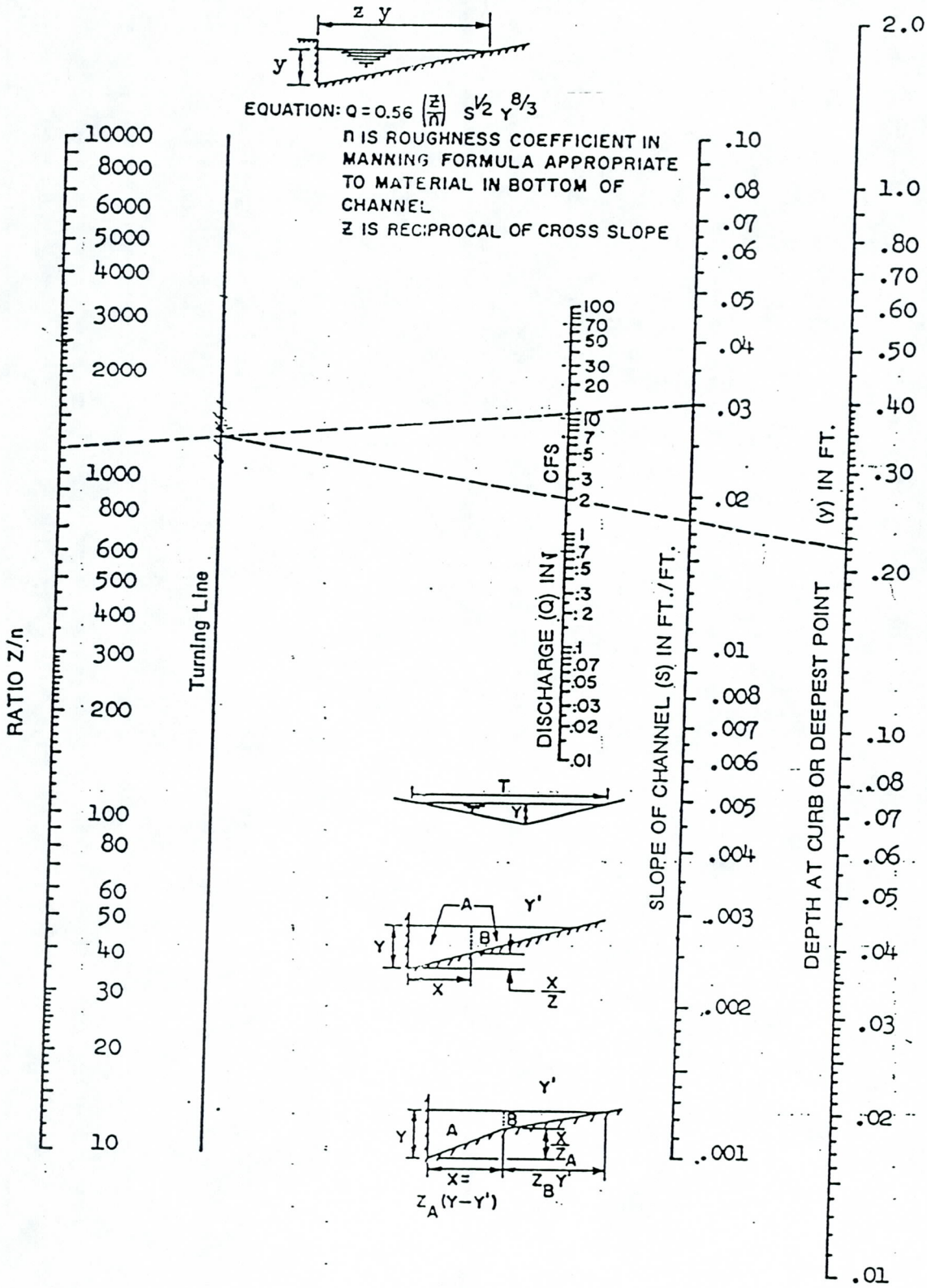

z y
y
EQUATION: Q = 0.56 (z/n) S^1/2 Y^8/3
n IS ROUGHNESS COEFFICIENT IN MANNING FORMULA APPROPRIATE TO MATERIAL IN BOTTOM OF CHANNEL
Z IS RECIPROCAL OF CROSS SLOPE
RATIO Z/n
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
Turning Line
DISCHARGE (Q) IN CFS
100
70
50
30
20
10
7
5
3
2
1
.7
.5
.3
.2
.1
.07
.05
.03
.02
.01
SLOPE OF CHANNEL (S) IN FT./FT.
.10
.08
.07
.06
.05
.04
.03
.02
.01
.008
.007
.006
.005
.004
.003
.002
.001
DEPTH AT CURB OR DEEPEST POINT (y) IN FT.
2.0
1.0
.80
.70
.60
.50
.40
.30
.20
.10
.08
.07
.06
.05
.04
.03
.02
.01
T
Y
A
Y'
B
X
X/Z
Z_A
Z_B
X = Z_A (Y−Y')

CHART 7

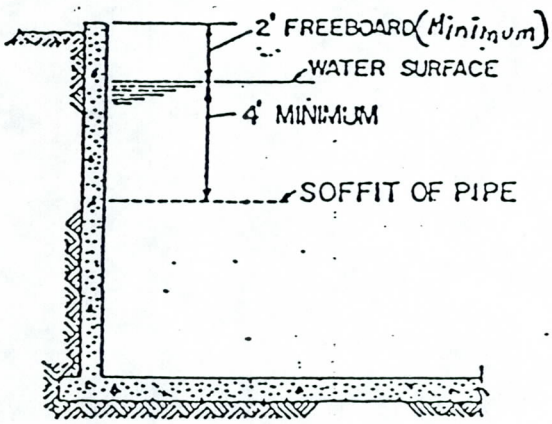
SUPER-CRITICAL FLOW
(HIGH VELOCITY)

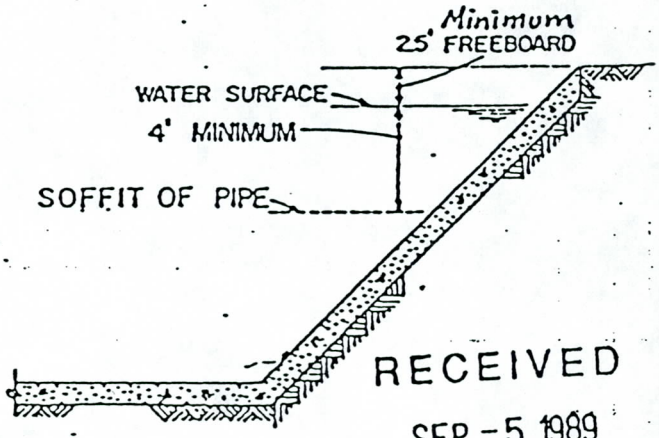
PIPE SIZE	ANGLE OF ENTRY
21"	90°
24"-33"	60°
36"-57"	45°
60" and over	30°

SUB-CRITICAL FLOW
(LOW VELOCITY)

PIPE SIZE	ANGLE OF ENTRY
up to 36"	90°
36"-57"	45°
60" and over	30°

SUBMERGENCE





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NOTE: BEFORE USING STANDARD EACH PROJECT MUST BE VERIFIED WITH THE CORPS OF ENGINEERS

PERMIT MANUAL

STANDARDS FOR ANGLE OF ENTRY OF STORM DRAINS

OFFICE OF THE DISTRICT ENGINEER
LOS ANGELES, CALIFORNIA

Figure A-11