HYDROLOGIC AND HYDRAULIC FINAL REPORT

FOR ESTRELLA FREEWAY INTERIM ROADWAY

Prepared by Cella Bar Associates, Inc.

Segment 1 - dated Feb. 1, 1990

Segment 2 - dated Aug. 31, 1990

For: Arizona Department of Transportation

Compiled for: Flood Control District
Watershed Management Library

ESTRELLA FREEWAY INTERIM ROADWAY
SEGMENT "1" - CACTUS RD. to GRAND AVE.
HYDROLOGIC AND HYDRAULIC FINAL REPORT

PREPARED FOR:
ARIZONA DEPARTMENT OF TRANSPORTATION

Submitted By:

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ARIZONA, U.S.A.

ESTRELLA FREEWAY INTERIM ROADWAY
SEGMENT "1" - CACTUS RD. to GRAND AVE.
HYDROLOGIC AND HYDRAULIC FINAL REPORT

INTRODUCTION

This is an "abbreviated" hydrologic and hydraulic report for Segment "1" of the Estrella Freeway Interim Roadway that presents an evaluation of existing and proposed drainage conditions adjacent to the roadway alignment. It is a design intention that the Interim Roadway drainage scheme be formulated in a manner that will not disrupt the natural sheet flow conditions in the overall area during major storms, while providing a system for low flow drainage (1-year to 2-year return period) to be accommodated without flooding the roadway itself. At several locations, the Interim Roadway will need to be elevated several feet above natural grade for other design reasons, and thus, selected cross drainage culverts have been sized to accommodated a 50-year storm to preclude significant alterations to natural drainage conditions.

The "low-flow" drainage design concept has been implemented for the Interim Roadway to minimize interference to historical drainage patterns in consideration of funding constraints.

PROCEDURES

Alignment Description:

Segment "1" is located approximately one-half mile east of Cotton Lane along the west side of the mid-section line and extends northerly from Cactus Road to just south of Union Hills Road where the alignment bends northeasterly to intersect Grand Avenue just south of the Deer Valley Road alignment (see Figure 1). This segment of the Interim Roadway will traverse 6 miles of arid desert and agricultural land to the west and north of Phoenix. The southerly portion of Segment "1" passes primarily through terraced agricultural fields while the northern portion is located within undeveloped desert.

Climate:

The climate is temperate with summer highs reaching as much as 120 degrees and winter lows dipping below freezing. Rainfall in the area averages 7.1 inches per year (verbal reference, National Weather Service).

Watersheds:

Watersheds impacting this segment of the Interim Roadway extend upstream to the northwest and consist of a combination of graded farm fields and undeveloped desert. The Trilby Wash and SCS White Tanks detention basins are effective flood control structures that define upstream limits for several watersheds during extreme flooding events. The Beardsley Canal is significantly elevated throughout the study area and also serves as an upstream boundary for selected watersheds during extreme flooding events. Due to the complexity of drainage across agricultural lands, watershed boundaries were determined by detailed field inspection of the area. Arterial roadways form the most common east-west "low flow" watershed boundaries with Cotton Lane and various parallel roadways forming some north-south "low flow" watershed boundaries.

For the purpose of this study, Cotton Lane south of Union Hills Road is considered to be a practical westerly watershed boundary that has been utilized in the "low flow" drainage design. The local watershed boundaries are shown on Figure 2 and are considered to be generally valid for low flow, however, during extreme storm events,

ESTRELLA FREEWAY INTERIM ROAD

SEGMENT 1

VICINITY MAP

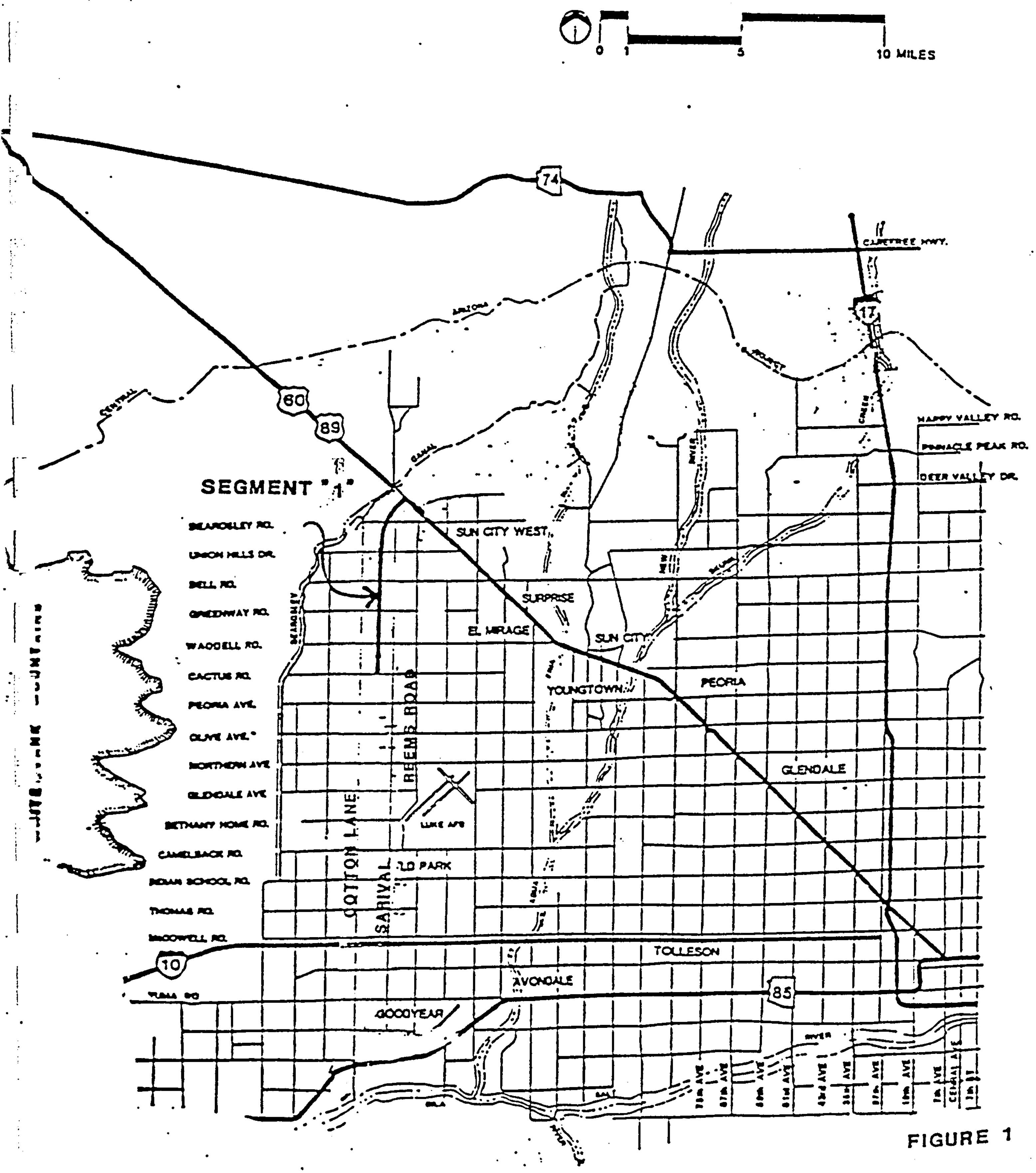


FIGURE 1

spillover from one watershed to another will occur, including flow entering the system from the upstream extension of primary watersheds west of Cotton Lane (Reference 5).

North of Union Hills Road, watershed boundaries are less influenced by man-made facilities and have been determined for design purposes based on more clearly defined topographic variations.

Discharge Computations:

Approximate 2-year and 50-year discharges have been estimated utilizing an approach discussed in a meeting with Mr. Ray Jordan and Mr. Art May of the Arizona Department of Transportation (ADOT) held on May 28, 1987 and referenced in the "Estrella Freeway Hydrologic Investigation Report" (Reference 5). The procedures outlined in the U.S. Department of Agriculture, Soil Conservation Service Technical Release No. 55, entitled, Urban Hydrology for Small Watersheds (TR-55, Reference 3) were implemented to determine the 2-year and 50-year peak discharges for a sample set of watersheds. Rainfall data used in the TR-55 computations were obtained from the Arizona Highway Department publication entitled, Hydrologic Design for Highway Drainage in Arizona (Reference 1). Six sample watersheds were evaluated for the 2-year event and four sample watersheds for the 50-year event.

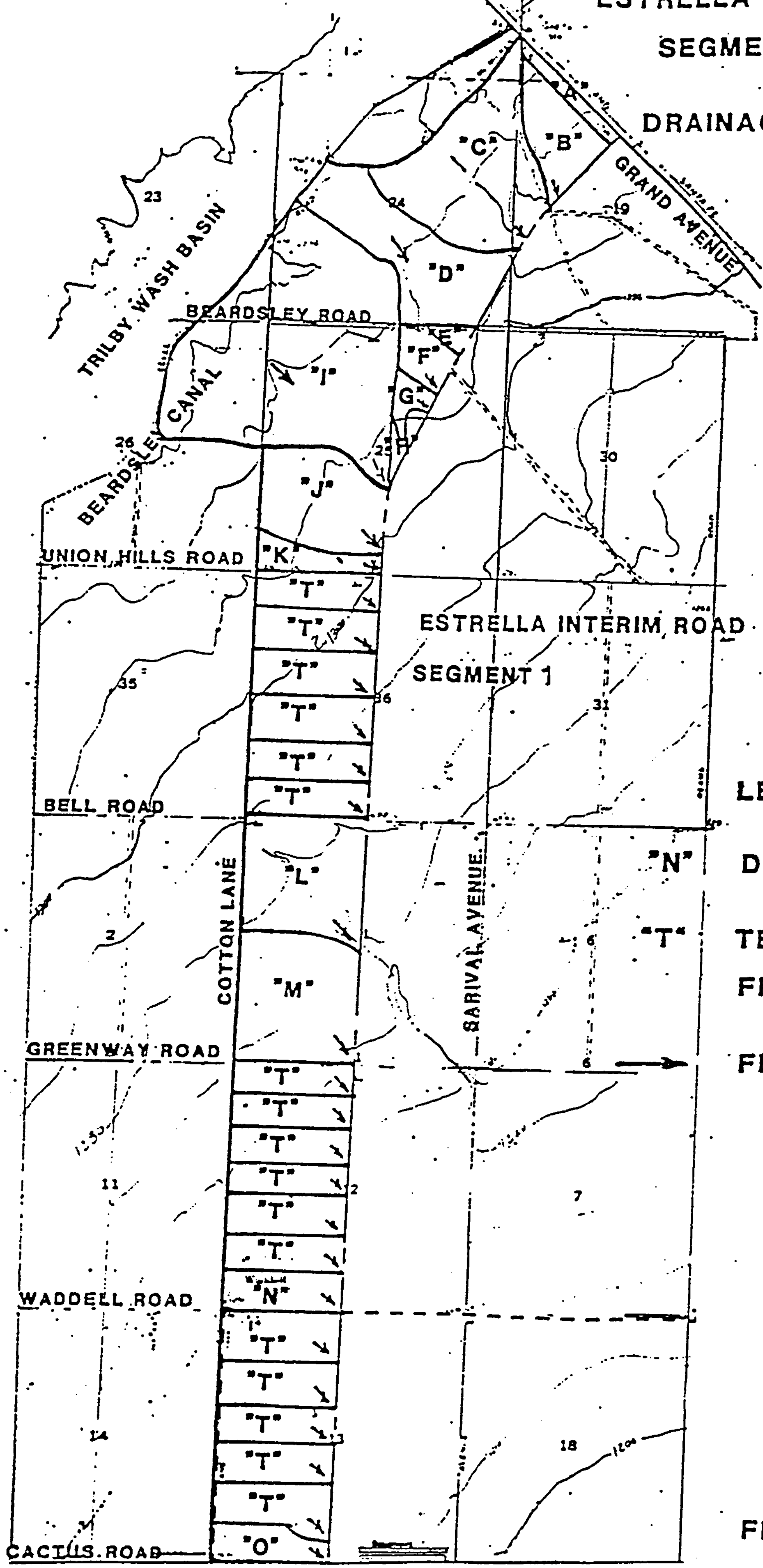
The resultant discharges derived from the TR-55 computations were plotted on log-log paper and a curve of best fit was drawn for each group of values (Figures 3 and 4). The curves have been used to estimate discharges based on watershed area. For the 50-year curve (Figure 4) a second curve was added at 20% above the actual computed values to apply a reasonable factor of safety. The 50-year curve shown on Figure 4 was taken directly from Reference 5 which was submitted previously to the Arizona Department of Transportation. The 2-year curve simply provides a common base for evaluation of "low-flow" discharge magnitudes, and thus, the 20% factor of safety was irrelevant and not used.

Discharges for the 50-year storm for drainage areas of 100 acres or less were obtained by use of the Rational Formula, Q = C.I.A. (Appendix C).

ESTRELLA INTERIM ROAD

SEGMENT 1

DRAINAGE AREA MAP



Not To Scale

LEGEND:

"N" DRAINAGE AREA

"T" TERRACED FARM FIELD

→ FLOW ARROW

FIGURE 2

ESTRELLA FREEWAY INTERIM ROAD

SEGMENT 1

2-YEAR DRAINAGE AREA/DISCHARGE CURVES

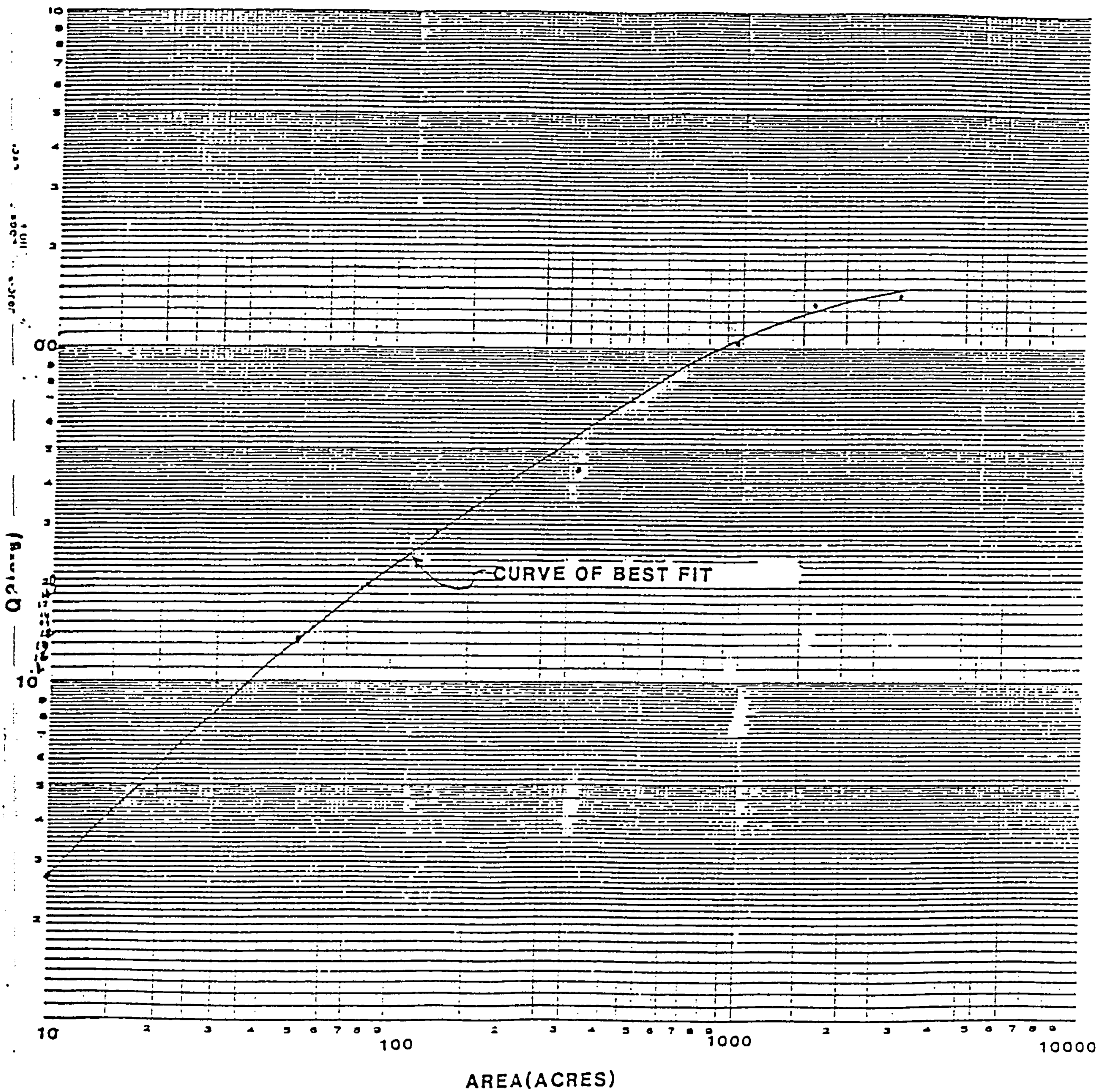


FIGURE 3

ESTRELLA FREEWAY

COTTON LANE SECTION

50-YEAR DRAINAGE AREA/DISCHARGE CURVES

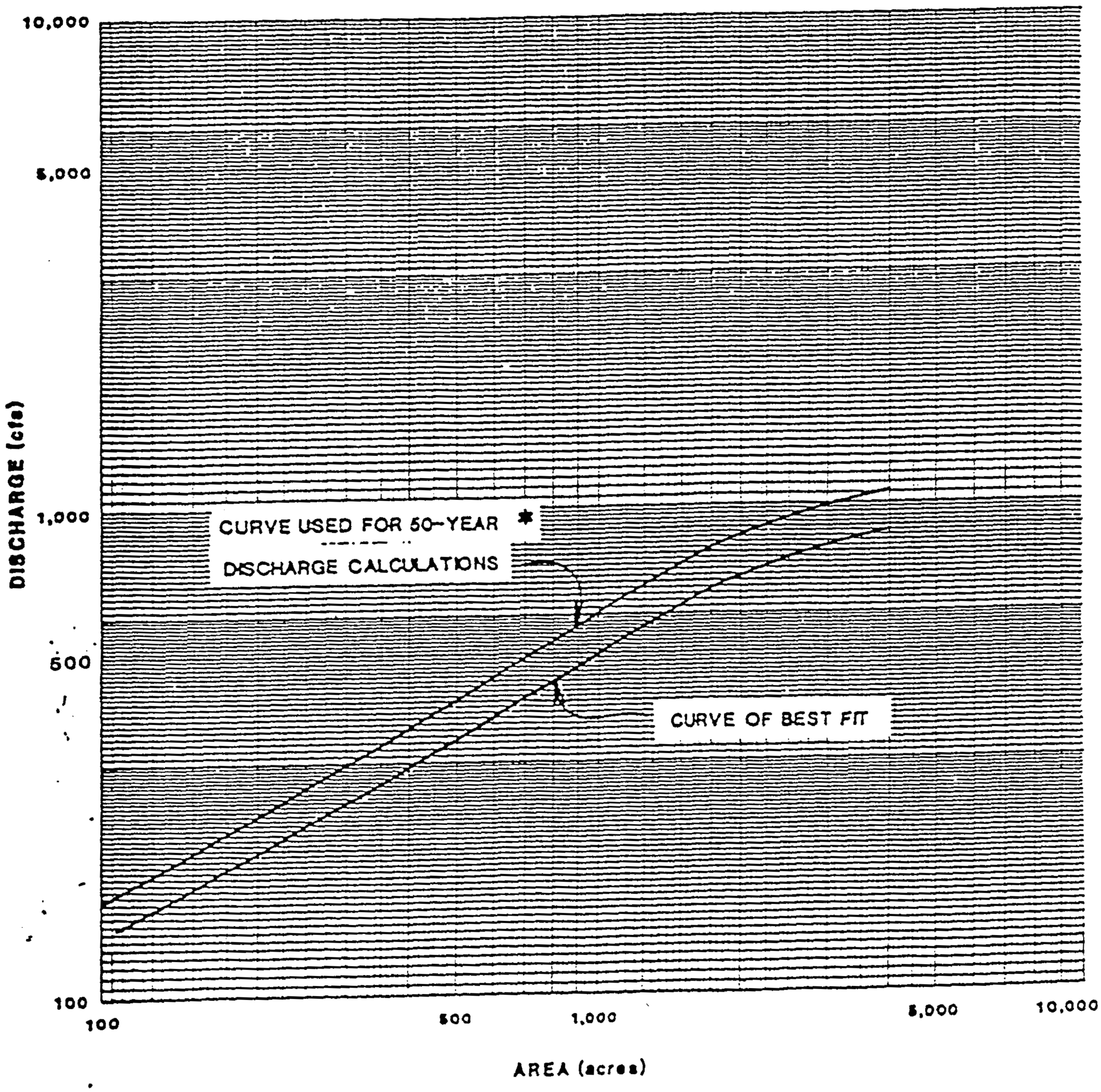


FIGURE 4

(Taken From Reference 5)

* DERIVED BY ADDING 20% SAFETY FACTOR TO CURVE OF BEST FIT

Drainage Crossings of Agricultural Land:

The agricultural lands that are traversed by Segment "1" of the Interim Roadway are subdivided into approximately 50 acre parcels and are bounded by maintenance roads and concrete lined irrigation canals. The fields are typically graded and terraced in such a manner that irrigation tailwater and any storm runoff water is concentrated at the southeast corner of the field and then drained off by pipe under the maintenance road into the adjacent field's concrete lined irrigation canal for re-use.

Segment "1" of the Interim Roadway will be located approximately 40 feet west of the eastern boundary of approximately 3½ miles of these terraced fields. It is proposed that the east one-half of the roadway be drained easterly onto the remaining portion of field to accumulate as it currently does, and no significant grading is proposed to be performed outside the east toe of slope of the roadway. The additional runoff generated by the east half of the new roadway is minimal and will not adversely affect current conditions.

A swale will be constructed along the west side of the roadway to deliver street drainage southerly to the new southeast corner of agricultural fields. Adjacent to the swale, the natural ground will again be allowed to remain undisturbed except for a strip at the new southeast corner of each typical field, adjacent to the roadway toe-of-slope, where a shallow graded depression will be constructed for storage of "low flow" runoff. The existing east-west farm maintenance road at the south end of the field will be elevated as necessary to provide a reasonable volume of storage. An 18" corrugated metal pipe will be installed under the maintenance road to bleed off stored runoff in the graded depression into the concrete irrigation ditch of the adjacent field. The inlet of the pipe will be 1 foot above the bottom of the graded depression to account for sedimentation and reduce the incidence of surface runoff being discharged directly into irrigation facilities. This will allow low flows to mimic current conditions with the minimal additional runoff generated by the roadway being stored within the available right-of-way.

In the event of a large storm, the above drainage system will allow sheet flooding to occur across the Interim Roadway. Currently, runoff from a large storm event concentrates in the southeast corner of a typical field, and as pipe capacities discharging into adjacent irrigation ditches are exceeded, runoff spills out into and over adjoining irrigation ditches to spread out and flow to the southeast as sheet flow. The Interim Roadway is elevated through most of the agricultural area except for the southeast corner of the fields where the roadway profile is at approximately existing grade, thereby allowing a continuation of the natural drainage condition. The applicable watersheds pertinent to this design are the "T" watersheds depicted on Figure 2.

Arterial streets (Cactus Road, Waddell Road, Greenway Road, Bell Road, and Union Hills Road) have been evaluated immediately west of the Interim Roadway crossings to determine their current capacities for carrying runoff. Since all the Interim Roadway crossings of arterial streets are to be elevated above the natural ground (except for Bell Road) the culvert crossings at these locations have been sized to convey the arterial streets' existing capacity or the runoff from a 50-year storm event, whichever is lowest, to contain backwater ponding at these crossings within public right-of-way.

Bell Road has existing curb and gutter on both sides of the street, and the Interim Roadway profile will match at the existing gutter at the intersection of the Interim Roadway grades. Concrete valley gutters will be installed in Bell Road to allow current drainage patterns in Bell Road to continue.

Drainage Crossings of Desert Land:

The northern portion of the Segment "1" alignment passes predominantly through undeveloped desert. An attempt has been made to maintain the profile of the Interim Roadway as close as possible to existing grade so that low flows generated by storm events of roughly a 2-year return period or less may cross beneath the roadway with storms of greater magnitude overtopping it. This approach has proved possible at several drainage crossings, however, certain locations required elevation of the roadway above natural ground based on other engineering constraints. At these locations, the drainage crossings where sized to convey runoff from a 50-year storm event to avoid an obstructive or "damming" effect to drainage flow.

Two major drainage crossings bear special note:

1. The drainage crossing located approximately 0.4 miles north of Union Hills Road has the largest contributing local watershed, approximately 421 acres. This is the only "low flow" watershed that extends west (upstream) of Cotton Lane. Storm runoff concentrates at the southeast corner of the watershed at the alignment of the Interim Roadway. Low flows are presently diverted southerly along the mid-section line in a wide but shallow drainage swale, with runoff from larger events spilling southeasterly as sheet flow. This situation will be mimicked in design by constructing a drainage swale along the west side of the Interim Roadway to convey low flow southerly to a location just north of Union Hills Road where it will cross under the Roadway via two 24" RCP culverts to outlet directly into the existing low flow ditch. The absence of a culverted crossing at the watershed's primary concentration point will permit the Interim Roadway profile to be lowered close to existing grade, allowing overtopping of the roadway to occur during storm events in excess of roughly the 1-year to 2-year event.

2. The other major crossing bearing special description is located approximately 0.5 miles south of Bell Road. This is a major wash crossing with a current watershed area of approximately 162 acres at this location. The current watershed area has been reduced from what it formerly was by the construction of Bell Road and the development of Happy Trails Resort at the northwest corner of Bell Road and Cotton Lane. The wash has a well defined channel and banks downstream of the Interim Roadway alignment. Placing concrete pipe with minimum cover at this crossing creates the need to design for the 50-year storm and results in multiple pipes. However, by using a 1 cell 6'x3' concrete box culvert with an overflow section, the profile can be lowered and lesson the possibility of ponding to a higher elevation than under natural conditions.

Drainage Structures:

Drainage structure locations and sizes for Segment "1" of the Interim Roadway are presented on the Drainage Structure Table, Figure 5. With the exception of the box culvert one-half mile south of Bell Road, all the structures are reinforced concrete pipe

(RCP) culverts and were sized per Chart 2, "Headwater Depth for Concrete Pipe Culverts with Inlet Control"; Hydraulic Charts for the Selection of Highway Culverts (Reference 4), assuming projecting pipe inlets. The minimum pipe diameter selected is 24".

At pipe crossings where pipe inlets are recessed below natural ground due to engineering constraints, the natural flow line will be altered to create a slope from existing ground to the pipe inlets and the slope will be gunite or concrete protected to control headcutting.

DRAINAGE STRUCTURE TABLE

APPROXIMATE STATION	DRAINAGE AREA	DESIGN STORM	DRAINAGE AREA (ACRES)	CFS	SIZE OF PIPE
809 + 82	0	Q50	49	11*	1-24" RCP
862 + 60	N	Q50	51.2	29	2-24" RCP'S
915 + 60	M	Q50	154	146*	3-36" RCP'S
943 + 00	L	Q50	162	207***	1-6'x3' CBC
1021 + 20	K	Q50	16.6	19	1-24" RCP
1024 + 18	J	Q2	126	29**	2-24" RCP'S
1048 + 30	H	Q50	4.9	7	1-24" RCP
1059 + 00	G	Q50	22.5	33	3-24" RCP'S
1064 + 00	F	Q50	18.6	25	2-24" RCP'S
1075 + 85	E	Q50	9.3	16	2-24" RCP'S
1078 + 30	D	Q50	169.3	215	4-42" RCP'S
1098 + 00	C	Q2	217.1	43	2-24" RCP'S
1115 + 50	B	Q2	55.2	14	2-24" RCP'S
1130 + 40	A	Q2	15	4	****
N/A	T	Q2	53±	14±	1-24" RCP

* Existing upstream arterial street capacity controls discharge.

** Low flows from a 421 acre watershed (Drainage Area "I") that concentrate at the upper limits of this watershed and the Interim Roadway are also diverted to this crossing. Large flows overtop the roadway.

*** 150 cfs is conveyed by the CBC and the remaining discharge overtops the depressed roadway section as weir flow.

**** Route to Grand Avenue roadway drainage ditch.

FIGURE 5

REFERENCES

1) Arizona Highway Department, "Hydrologic Design for Highway Drainage in Arizona," December 1968, (Revised June 1975).

2) Sergent, Hauskins and Beckwith, "McMicken Dam Restoration Study", 1983.

3) U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, "Urban Hydrology for Small Watersheds," June 1986.

4) U.S. Department of Transportation, Hydraulic Engineering Circular No. 5, "Hydraulic Charts for the Selection of Highway Culverts," December 1965.

5) Cella Barr Associates, "Estrella Freeway Hydrologic Investigation Report," July 14, 1987.

6) U.S. Geological Survey, Avondale SW, Baldy Mountain, Biscuit Flat, Calderwood Butte, Daisy Mountain, Hedgepeth Hills, Hieroglyphic Mountains SW, McMicken Dam, New River, New River SE, Perryville, Union Hills, and Waddell 7.5 Minute Quadrangle Maps.

APPENDIX A

Sample TR-55 Calculations and Watersheds for Drainage Area/Discharge Curves.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By MKC Date 4/14/87

Location Thomas Rd. & Cotton Ln Checked ____ Date ____

Circle one: **Present** (circled) Developed — conc. pt. 4

Circle one: **T_c** (circled) T_t through subarea — figures 2 & 4

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Unit	Segment ID		
1. Surface description (table 3-1)		Cult. Soil Res. ≤20%		
2. Manning's roughness coeff., n (table 3-1)		0.06		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.41		
5. Land slope, s	ft/ft	0.008		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.41	+	= 0.41

Shallow concentrated flow	Unit	Segment ID		
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	5,600		
9. Watercourse slope, s	ft/ft	0.006		
10. Average velocity, V (figure 3-1)	ft/s	1.23		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	1.26	+	= 1.26

Channel flow	Unit	Segment ID		
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 1.67

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln /NW Loop By MKC Date 4/14/87

Location Thomas Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 4 - figures 2 & 4

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	Fig. 2-3	Fig. 2-4	Area ☐acres ☒mi² ☐%	Product of CN x area
C	SR Crops, good	85			0.5	42.5
				Totals =	0.5	42.5

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{42.5}{0.5} = 85.0$; Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50	2	
Rainfall, P (24-hour)	in	3.49	1.41	
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.01	0.39	

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 4/14/87

Location Thomas Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed conc. pt. 4 – figures 2&4

1. Data:

Drainage area .... A_m = 0.5 mi^2 (acres/640)

Runoff curve number .... CN = 85 (From worksheet 2)

Time of concentration .. T_c = 1.67 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	50	2	
3.	Rainfall, P (24-hour)	in	3.49	1.41	
4.	Initial abstraction, I_a (Use CN with table 4-1.)	in	0.353	0.353	
5.	Compute I_a/P		0.10	0.25	
6.	Unit peak discharge, q_u (Use T_c and I_a/P with exhibit 4-II)	csm/in	258	223	
7.	Runoff, Q (From worksheet 2).	in	2.01	0.39	
8.	Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0	1.0	
9.	Peak discharge, q_p (Where $q_p = q_u A_m Q F_p$)	cfs	259	43	

Interim Roadway

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 4/16/87

Location Camelback Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 12 - figures 2&4

1. Data:

Drainage area .... A_m = 4.50 mi^2 (acres/640)

Runoff curve number .... CN = 85 (From worksheet 2)

Time of concentration .. T_c = 6.86 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50	2	
3. Rainfall, P (24-hour)	in	3.56	1.46	
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.353	0.353	
5. Compute I_a/P		0.10	0.24	
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	84	~~[illegible]~~ 77	
7. Runoff, Q .... (From worksheet 2).	in	2.06	0.41	
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0	1.0	
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	779	142	

Interim Roadway

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop   By MKC   Date 4/14/87

Location Camelback Rd. & Cotton Ln   Checked ____   Date ____

Circle one: (Present) Developed   Conc. pt. 12

Circle one: (T_c) T_t through subarea   figures 2 & 4

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Unit	Segment 1	Segment 2	Total
Segment ID				
1. Surface description (table 3-1)		Scattered brush, weeds		
2. Manning's roughness coeff., n (table 3-1) ..		0.035		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.46		
5. Land slope, s	ft/ft	0.01		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.24	+	= 0.24

Shallow concentrated flow	Unit	Segment 1	Segment 2	Total
Segment ID				
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	29,300		
9. Watercourse slope, s	ft/ft	0.006		
10. Average velocity, V (figure 3-1)	ft/s	1.23		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	6.62	+	= 6.62

Channel flow	Unit	Segment 1	Segment 2	Total
Segment ID				
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 6.86

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loop By MKC Date 9/16/87

Location Camelback Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed conc. pt. 12 - figures 2 & 4

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☐acres ☒mi² ☐%	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
C	Desert Shrub, poor	85			2.50	212.50
C	SR Crops, good	85			2.00	170.0
				Totals =	4.50	382.50

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{382.50}{4.50}$ = 85.0; Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50	2	
Rainfall, P (24-hour)	in	3.56	1.46	
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.06	0.41	

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 4/15/87

Location McDowell Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 3 - figures 2&4

1. Data:

Drainage area .... A_m = 2.50 mi^2 (acres/640)

Runoff curve number .... CN = 87 (From worksheet 2)

Time of concentration .. T_c = 4.26 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0.1 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50	2	
3. Rainfall, P (24-hour)	in	3.49	1.41	
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.299	0.299	
5. Compute I_a/P		0.09	0.21	
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	127	116	
7. Runoff, Q .... (From worksheet 2).	in	2.17	0.48	
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		0.985	0.985	
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	679	137	

Interim Roadway

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By MKC Date 4/15/87

Location McDowell Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed — Conc. pt. 3

Circle one: (T_c) T_t through subarea — figures 2 & 4

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Unit	Segment ID		
1. Surface description (table 3-1)		Cult. Soil res. ≤ 20%		
2. Manning's roughness coeff., n (table 3-1) ..		0.06		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.41		
5. Land slope, s	ft/ft	0.009		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.39	+	= 0.39

Shallow concentrated flow	Unit	Segment ID		
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	17,160		
9. Watercourse slope, s	ft/ft	0.006		
10. Average velocity, V (figure 3-1)	ft/s	1.23		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	3.87	+	= 3.87

Channel flow	Unit	Segment ID		
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 4.26

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loops By MKC Date 4/14/87

Location McDowell Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed conc. pt. 3 - figures 2 & 4

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Fig. 2-3	CN [1/] Fig. 2-4	Area ☐acres ☒mi² ☐%	Product of CN x area
C	SR Crops, good	85			1.75	148.75
C	Fallow, bare soil	91			0.67	60.97
C	Prison Bldgs. & yards	86			0.08	6.88
				Totals =	2.50	216.60

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{216.60}{2.50} =$ 86.6; Use CN = 87

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50	2	
Rainfall, P (24-hour)	in	3.49	1.41	
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.17	0.48	

Worksheet 4: Graphical Peak Discharge method

Project COTTON LANE By MKC Date 4/9/87

Location COTTON S Checked ____ Date ____

Circle one: (Present) Developed

Lat 33° 30' 00"

Long 112° 27' 30"

(1)

1. Data:

Drainage area .... A_m = 1.5 mi^2 (acres/640)

Runoff curve number .... CN = 85 (From worksheet 2) TR-55 CN

Time of concentration .. T_c = 2.30 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50	2	
3. Rainfall, P (24-hour) .... (2.17)	in	3.49/3.51	1.41	
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.353	0.353	
5. Compute I_a/P .... ([illegible])		0.10/0.10	0.25	
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in (175)	205	177	
7. Runoff, Q .... (From worksheet 2).	(0.[illegible]) in	2.01	0.39	
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0	1.0	
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	618.1	104	

([illegible] - 1 hr)

Interim Roadway

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project COTTON LANE By MKC Date 4/9/87

Location COTTON S Checked ____ Date ____

Circle one: (Present) Developed

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

		Segment ID			
1. Surface description (table 3-1)		Cult. Soil Res <20%			
2. Manning's roughness coeff., n (table 3-1) ..		0.06			
3. Flow length, L (total L ≤ 300 ft)	ft	300			
4. Two-yr 24-hr rainfall, P_2	in	~~1.40~~/con 1.41			
5. Land slope, s	ft/ft	.008			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ .0707/.172 Compute T_t	hr	.411	+	=	.411

Shallow concentrated flow

		Segment ID			
7. Surface description (paved or unpaved)		unpaved			
8. Flow length, L	ft	9100			
9. Watercourse slope, s	ft/ft	.007			
10. Average velocity, V (figure 3-1)	ft/s	1.34			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	1.89	+	=	1.89

Channel flow

		Segment ID			
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft				
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s				
18. Flow length, L	ft				
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr				2.30

Worksheet 2: Runoff curve number and runoff

Project COTTON LANE By MKC Date 4/9/87

Location COTTON S Checked ____ Date ____

Circle one: (Present) Developed ________

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	Fig. 2-3	Fig. 2-4	Area ☐acres ☒mi² ☐%	Product of CN x area
C	Straight Row Crops good	85			1.5	127.5

1/ Use only one CN source per line. Totals = 1.5 | 127.5

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{127.5}{1.5} = 85$; Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50	2	
Rainfall, P (24-hour)	in (2.17)	3.47/3.51	1.41	
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.01 (0.73)	0.39	

.55 CN

Worksheet 4: Graphical Peak Discharge method

Project: Cotton Ln / NW Loop   By: MKC   Date: 10/17/88

Location: ______   Checked: ______   Date: ______

Circle one: (Present) Developed   ______

1. Data:

   Drainage area .... A_m = 0.0156 mi^2 (acres/640)

   Runoff curve number .... CN = 85 (From worksheet 2)

   Time of concentration .. T_c = 0.55 hr (From worksheet 3)

   Rainfall distribution type = II (I, IA, II, III)

   Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	2		
3. Rainfall, P (24-hour)	in	1.41		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.353		
5. Compute I_a/P		0.25		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	445		
7. Runoff, Q .... (From worksheet 2).	in	0.39		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	2.7		

Interim Roadway

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project: Cottin Ln/NW Loop   By: MKC   Date: 10/17/88

Location: ______   Checked: ______   Date: ______

Circle one: **(Present)** Developed ______

Circle one: **(T_c)** T_t through subarea ______

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

		Unit	Segment ID			Total
1.	Surface description (table 3-1)		Cult. soil res ≤20%			
2.	Manning's roughness coeff., n (table 3-1) ..		0.06			
3.	Flow length, L (total L ≤ 300 ft)	ft	300			
4.	Two-yr 24-hr rainfall, P_2	in	1.41			
5.	Land slope, s	ft/ft	0.008			
6.	$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.41	+		= 0.41

Shallow concentrated flow

		Unit	Segment ID			Total
7.	Surface description (paved or unpaved)		Unpaved			
8.	Flow length, L	ft	633			
9.	Watercourse slope, s	ft/ft	0.006			
10.	Average velocity, V (figure 3-1)	ft/s	1.23			
11.	$T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.14	+		= 0.14

Channel flow

		Unit	Segment ID			Total
12.	Cross sectional flow area, a	ft^2				
13.	Wetted perimeter, p_w	ft				
14.	Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15.	Channel slope, s	ft/ft				
16.	Manning's roughness coeff., n					
17.	$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s				
18.	Flow length, L	ft				
19.	$T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+		=
20.	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr				0.55

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln/NW Loop By MKC Date 10/17/95

Location ______ Checked ____ Date ______

Circle one: (Present) Developed ______

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☒ acres ☐ mi^2 ☐ %	Product of CN x area
			Totals =		10	

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ______ = ______; Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	2		
Rainfall, P (24-hour)	in	1.41		
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	0.39		

Worksheet 4: Graphical Peak Discharge method

Project Cotta Ln/NW Loop By KC Date 10/17/88

Location ______ Checked ____ Date ____

Circle one: (Present) Developed ______

1. Data:

Drainage area .... A_m = 0.078 mi^2 (acres/640)

Runoff curve number .... CN = 85 (From worksheet 2)

Time of concentration .. T_c = 0.64 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	2		
3. Rainfall, P (24-hour)	in	1.46		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.353		
5. Compute I_a/P		0.24		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	420		
7. Runoff, Q .... (From worksheet 2).	in	0.41		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	13.4		

Interim Roadway

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By MKC Date 10/17/88

Location ______ Checked ______ Date ______

Circle one: **(Present)** Developed

Circle one: **(T_c)** T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Units	Segment ID		
1. Surface description (table 3-1)		Scattered brush/weeds		
2. Manning's roughness coeff., n (table 3-1)		0.035		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.46		
5. Land slope, s	ft/ft	0.01		
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr	0.24	+	= 0.24

Shallow concentrated flow	Units	Segment ID		
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	1787		
9. Watercourse slope, s	ft/ft	0.006		
10. Average velocity, V (figure 3-1)	ft/s	1.23		
11. $T_t = \frac{L}{3600 V}$ Compute T_t	hr	0.40	+	= 0.40

Channel flow	Units	Segment ID		
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.64

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln/NW Loop By MKC Date 10/17/88

Location ______ Checked ____ Date ______

Circle one: (Present) Developed

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
				Totals =	50	

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ______ = ______; Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	2		
Rainfall, P (24-hour)	in	1.46		
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	0.41		

APPENDIX B

Calculation Sheets Indicating Design Q, and RCP Culvert Sizing Charts.

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

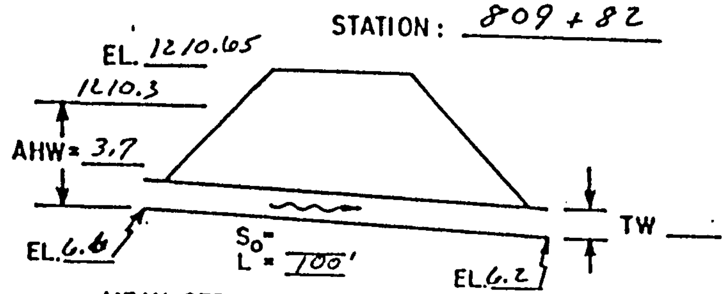
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50 ± 11 cfs * TW$_1$ = 2d
Q_2 = TW$_2$ =

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 809+82



MEAN STREAM VELOCITY =
MAX. STREAM VELOCITY =

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
RCP	27	24"	1.85	3.7												

SUMMARY & RECOMMENDATIONS:

Existing upstream arterial street capacity controls discharge.
* Roadway profile is elevated above natural ground at this location

Form 81-734-3917

DESIGN NOTES AND COMPUTATIONS

Rev. 4/86

SUBJECT INTERIM ROADWAY ; Seg. 1

JOB NUMBER 20995-08-07

TYPICAL TERRACED FARM FIELDS

AREAS VARY ; AVERAGE 53 ACRES

Q_2 = 14 cfs per the 2-year drainage area/discharge curve

PREPARED BY JCC DATE 12-14-88 CHECKED BY JHN SHEET NO. OF FIGURE #

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401
5062 North 19th Avenue
Phoenix, Arizona 85015
(602) 242-2999

ESTRELLA FREEWAY INTERIM ROADWAY
SEGMENT "2" - THOMAS RD. TO GLENDALE AVE.
HYDROLOGIC & HYDRAULIC REPORT; FINAL

PREPARED FOR:
ARIZONA DEPARTMENT OF TRANSPORTATION

Cella Barr Associates
5062 North 19th Avenue
Phoenix, Arizona 85015
August 31, 1990

CBA File No. 40955-08-77
JLR00124.77R

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ESTRELLA FREEWAY INTERIM ROADWAY
SEGMENT "2" - THOMAS RD to GLENDALE AVE.
HYDROLOGIC & HYDRAULIC REPORT
FINAL SUBMITTAL

INTRODUCTION

This is an "abbreviated" hydrologic and hydraulic report for Segment "2" of the Estrella Freeway Interim Roadway that presents an evaluation of existing and proposed drainage conditions adjacent to the roadway alignment. As a part of the design process for Segment "2", a strong effort was made to maintain a roadway grade at or near existing ground elevations, while providing a system for low flow drainage (1-year to 2-year return period) to be accommodated without flooding the roadway itself. However, the Interim Roadway is required to be elevated several feet above natural grade at existing points of low flow drainage concentration for reasons including minimum cover over irrigation lateral crossings and super-elevated curves, and thus, cross drainage culverts have been sized to accommodate 50-year storm runoff volumes generated within the effective contributing watersheds identified herein to preclude significant alterations to natural drainage conditions and/or backing up of drainage flows beyond right-of-way boundaries. Additional provisions are included to allow excess runoff to spill easterly across the roadway at locations where the roadway profile is at or near existing grade. Graded depressions are also provided for collection of low flow at several locations where runoff has historically and will continue to discharge into tailwater ditches. These drainage provisions are described in greater detail in this report and serve to maintain existing drainage patterns to the extent possible after Interim Roadway construction.

PROCEDURES

Alignment Description:

Segment "2" commences eastward from Cotton Lane along the alignment of Thomas Road for a distance of approximately 1,000 feet, then turns northward/northeastward, transitioning through agricultural fields to a northward alignment approximately 2,515 feet east of Cotton Lane at Camelback Road. Segment "2" then continues northerly from Camelback Road to Glendale Avenue along an alignment varying from 75 feet to 200 feet west of the mid-section line between Cotton Lane and Sarival Avenue (Figure 1). The total length of this segment of the Interim Roadway is roughly 4 miles and passes through agricultural land to the west of Phoenix.

Climate:

The climate is temperate with summer highs reaching as much as 120 degrees and winter lows dipping below freezing. Rainfall in the area averages 7.1 inches per year (verbal reference, National Weather Service).

Watersheds:

Watersheds impacting this segment of the Interim Roadway extend upstream to the west and consist of natural alluvial fan areas and graded farm fields on the east face of the White Tank Mountains. Due to the complexity of drainage across agricultural lands, watershed boundaries were determined by detailed field inspection of the area. Arterial roadways form the most common east-west "low flow" watershed boundaries with Cotton Lane and various parallel roadways forming some north-south "low flow" watershed boundaries. Sheet flow is the predominant type of flooding that occurs in the area.

For the purpose of this study, Cotton Lane is considered to be a practical westerly, local watershed boundary that has been utilized in the drainage design. Additional watershed areas extending upstream to the west of Cotton lane exist, but were not considered to be directly relevant to the drainage design concept due to differences in time to peak and the opportunity for excess runoff to spill across the Interim Roadway at numerous locations. This is excepted at the proposed crossing of the major drainage ditch extending easterly along the north side of Camelback Road where the entire contributing

ESTRELLA FREEWAY INTERIM ROAD

SEGMENT 2

VICINITY MAP

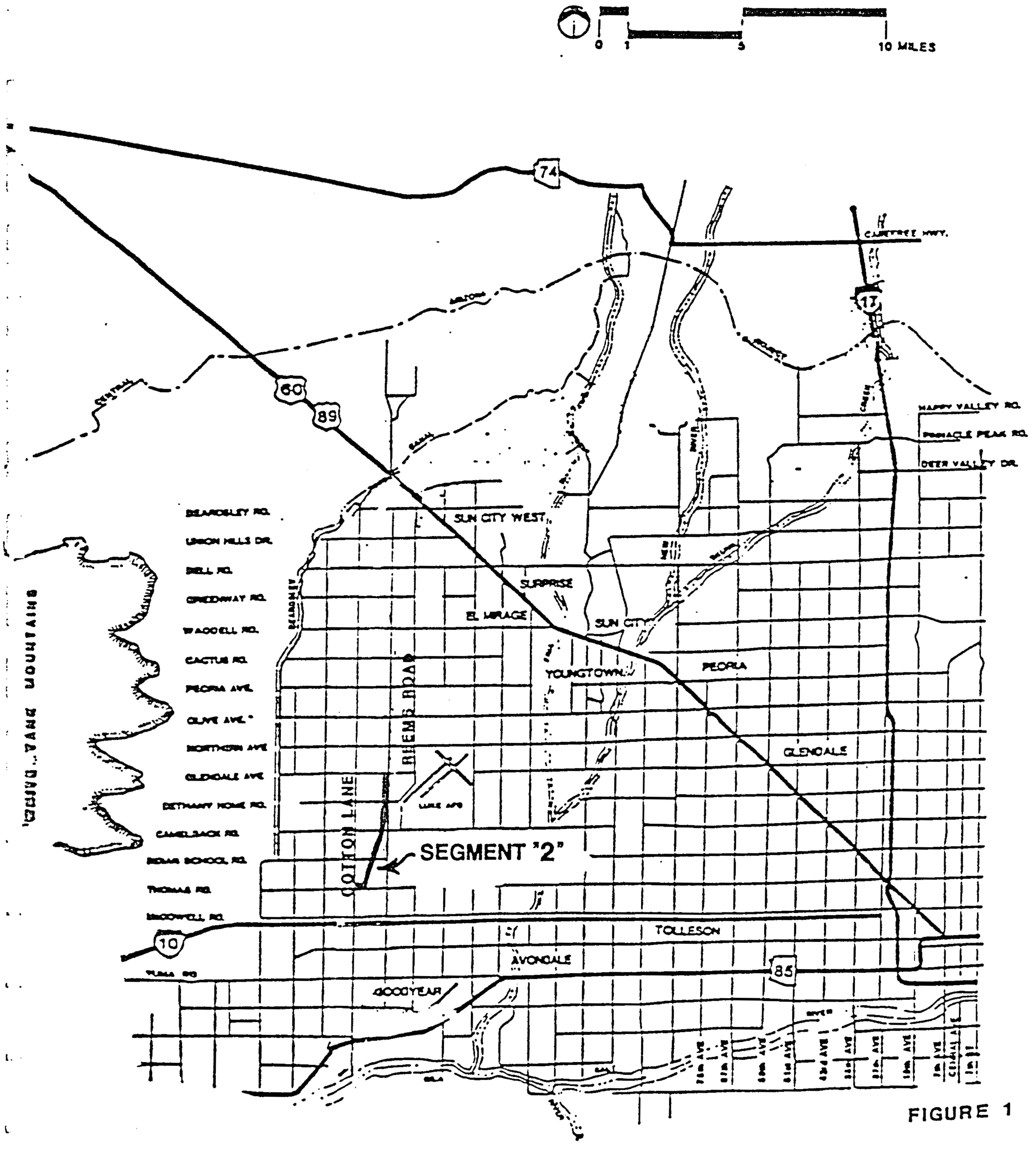


FIGURE 1

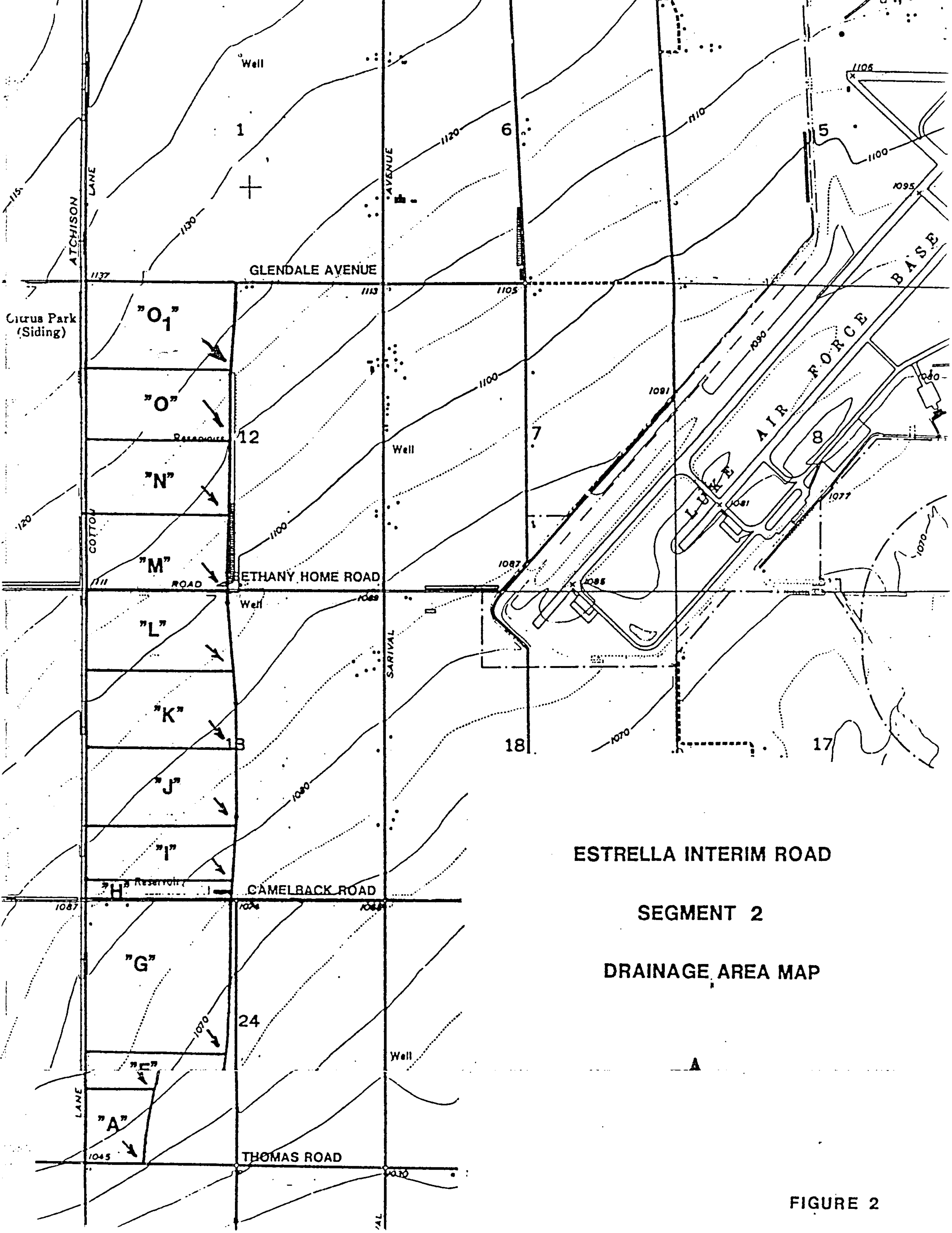
watershed, the capacity of the ditch, and the size of upstream and downstream drainage crossings required consideration. The local watershed boundaries are shown on Figure 2 and are considered to be generally valid for low flow; however, during major storm events, spillover from one watershed to another will occur. The low flow watersheds consist of agricultural fields with very flat grades.

Discharge Computations:
Discharges for the 50-year storm were obtained by use of the Rational Formula, Q = C.I.A.

Drainage Crossings:
The agricultural lands that are traversed by the Interim Roadway are bounded by maintenance roads, concrete lined irrigation canals and irrigation tailwater ditches. The fields are typically graded in such a manner that irrigation tailwater and any storm runoff water currently concentrates at the southeast corner of the field as defined by east-west maintenance roads and maintenance roads along the north-south mid-section line. The proposed Interim Roadway is located west of the north-south mid-section line, and future runoff will now be concentrated at the southeast corner of the field at the new roadway alignment. Low flow runoff from the fields will then be conveyed underneath the Interim Roadway to the current downstream concentration point at the north-south maintenance road.

It is proposed that the east one-half of the Interim Roadway be drained easterly onto the existing agricultural fields and surface water ditches to accumulate as it currently does. No significant grading is proposed to be performed outside the east toe of slope of the roadway. The additional runoff generated by the east half of the new roadway is minimal and will not adversely effect current conditions.

On the west side, a shallow graded depression will be constructed for storage of "low flow" runoff at most points of collection prior to release downstream to the east via cross-drainage structures. The purpose of the location specific graded depressions is to minimize the quantity of runoff derived from the west one-half of the roadway that will be introduced directly into irrigation tailwater ditches. These graded depressions will aid



ESTRELLA INTERIM ROAD

SEGMENT 2

DRAINAGE AREA MAP

FIGURE 2

in the storage of the additional runoff generated by the roadway, with said storage being provided within the available right-of-way. An 18" corrugated metal pipe will be installed at a minimum of 1 foot above the bottom of each graded depression to discharge surface runoff directly into irrigation facilities. This will allow low flows to mimic current conditions with the minimal additional runoff generated by the roadway being stored within available right-of-way. Large flows will overtop the depressed area and be conveyed easterly underneath the Interim Roadway in Q50 design culverts.

It was the design intent to maintain the profile of the Interim Roadway as close as possible to existing grade so that low flows generated by storm events of roughly a 2-year return period or less could cross beneath the roadway, while storms of greater magnitude overtopped it. However, this approach has proved to be unsuccessful for Segment "2" due to the need to elevate the Interim Roadway at existing points of drainage concentration to cross irrigation ditches and other physical features, coupled with the capacity of the westerly half of the Interim Roadway typical section to carry roughly 99 cfs of runoff prior to overtopping the roadway profile when it is set at existing grade. The capacity of the westerly half of the roadway section is created by the shoulder ditch and the average depth of 2.3 feet required before overtopping of the roadway crown occurs and is considerably higher than the discharges generated by a 50-year storm at the selected drainage crossings. This condition results from the requirement to create a typical ditch section having an invert elevation that is a minimum of 1.0 foot below the bottom of the Interim Roadway design subgrade as a provision to protect the subgrade from becoming saturated by storm water runoff.

The Interim Roadway required elevating at arterial streets and irrigation crossings to accommodate irrigation pipe sizes and minimum cover requirements over these pipes. Due to these elevated crossings and the high runoff capacity of the westerly typical ditch, drainage crossings were sized to convey runoff from a 50-year storm event as one provision to avoid an obstructive or "damming" effect to drainage flow, and to contain backwater ponding within public right-of-way. As a second provision to ensure against roadway obstruction and "damming" during a wide range of storm events, berms are proposed to be constructed at selected locations across the typical ditch section along the west side of the Interim Roadway where the proposed roadway profile nears natural ground. Corrugated metal pipes (24") are proposed to be placed in a special ditch section at the proposed berms in such a fashion as to allow low flows to pass thru and proceed to design concentration points, and flows of greater magnitude to spill over the top of the Interim Roadway as sheet flow in a southeasterly direction. The inclusion of both of the above provisions in the drainage design for the Interim Roadway will tend to allow existing drainage conditions to prevail as closely as possible, after construction.

The Adaman Drainage Ditch is located 85 feet to 210 feet east of the Interim Roadway along the segment between Glendale Avenue and Camelback Road, and would at first appear to be a reasonable drainage outlet for the Interim Roadway pipe crossings. However, irrigation sumps and irrigation tailwater ditches that drain to sumps, are located within a strip of land between the Interim Roadway and the Adaman Drainage Ditch. Since irrigation runoff may currently be collected and stored in these sumps for re-use in irrigation, it was necessary to continue discharges into tailwater ditches or directly into sumps. Larger flows will overtop the tailwater ditches and spill into adjacent sumps or the Adaman Drainage Ditch as currently happens. Relocating all sumps to the west side of the Interim Roadway does not appear to be warranted at this stage.

Most arterial streets (Thomas Road, Indian School Road, and Bethany Home Road) have been evaluated immediately west of the Interim Roadway crossings to determine their current capacities for carrying runoff. Since all the Interim Roadway crossings of arterial streets are to be elevated above the natural ground, the culvert crossings at these locations have been sized to convey the arterial streets' existing capacity or the runoff from a 50-year storm event, whichever is lowest.

The Interim Roadway crosses a large existing drainage channel located along the north side of Camelback Road. Field investigation identified existing channel crossings to the west and east include a 2 cell 8' x 3' concrete box culvert with a capacity of 336 cfs located upstream of the Interim Roadway at Cotton Lane, and two 57" x 76" CMP's and two 48" CMP's with a combined capacity of 582 cfs located downstream of the Interim Roadway at Sarival Avenue. Field cross-sections of the channel between the above mentioned structures were hydraulically rated using the Manning equation and were found to generally have less capacity than the existing structures. A steel grated bridge also crosses this channel, immediately downstream of the Interim Roadway to access the maintenance road of the Adaman Drainage Ditch. However, this bridge was determined to have little impact on the channel's top of bank capacity. A 2 cell 8' x 3' concrete box culvert with equivalent capacity to the existing 2 cell 8' x 3' concrete box culvert (336 cfs) located upstream of the Interim Roadway at Cotton Lane was chosen for the Interim Roadway crossing of this drainage channel since there are no significant drainage contributions from Cotton Lane to the Interim Roadway to maintain a capacity that is compatible with the existing drainage system.

Drainage Structures:
Cross drainage structure locations and sizes for Segment "2" of the Interim Roadway are presented on the Drainage Structure Table, Figure 3. With the exception of the box culvert proposed at Camelback Road, all of the structures are reinforced concrete pipe (RCP) culverts and were sized per Chart 2, "Headwater Depth for Concrete Pipe Culverts with Inlet Control"; Hydraulic Charts for the Selection of Highway Culverts (Reference 4), assuming projecting pipe inlets. The minimum pipe diameter selected is 24". The box culvert at Camelback Road was sized utilizing Chart 1 (Reference 4).

Pipe crossings of the proposed berms across the westerly shoulder ditches for the Interim Roadway are 24" corrugated metal pipes (CMPs). Outlet pipes into irrigation and tailwater ditches from graded depression areas are 18" corrugated metal pipes (CMPs).

At pipe crossings where pipe inlets are recessed below natural ground due to engineering constraints, the natural flow line will be altered to create a slope from existing ground to the pipe inlets and the slope will be concrete protected to control headcutting.

REFERENCES

1) Arizona Highway Department, "Hydrologic Design for Highway Drainage in Arizona," December 1968, (Revised June 1975).

2) Sergent, Hauskins and Beckwith, "McMicken Dam Restoration Study", 1983.

3) U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, "Urban Hydrology for Small Watersheds," June 1986.

4) U.S. Department of Transportation, Hydraulic Engineering Circular No. 5, "Hydraulic Charts for the Selection of Highway Culverts," December 1965.

5) Cella Barr Associates, "Estrella Freeway Hydrologic Investigation Report," July 14, 1987.

6) U.S. Geological Survey, Avondale SW, Baldy Mountain, Biscuit Flat, Calderwood Butte, Daisy Mountain, Hedgepeth Hills, Hieroglyphic Mountains SW, McMicken Dam, New River, New River SE, Perryville, Union Hills, and Waddell 7.5 Minute Quadrangle Maps.

DRAINAGE STRUCTURE TABLE

Station	Drainage Areas	Design Storm	Drainage Area (Acres)	Design CFS	Size of Pipe
386 + 60	A	Q50	32.4	22	2-24" RCP's
399 + 33	B	Q50	38.3	26	2-24" RCP's
413 + 01	C	Q50	46.9	30	2-30" RCP's
426 + 38	D	Q50	56.3	35	2-30" RCP's
440 + 12	E	Q50	59.8	41	3-24" RCP's
452 + 95	E1	Q50	37.0	26	3-24" RCP's
459 + 66	F	Q50	34.9	24	3-24" RCP's
466 + 50	G	Q50*	152.0	70	3-24" RCP's
492 + 96	H	N/A	N/A	336	2-8'x3' CBC's
496 + 43	I	Q50	54.7	31	2-24" RCP's
506 + 10	J	Q50	77.7	45	3-24" RCP's
519 + 25	K	Q50	77.0	45	3-24" RCP's
532 + 67	L	Q50	75.5	44	5-24" RCP's
545 + 94	M	Q50	76.7	45	1-36" RCP
558 + 93	N	Q50	75.5	45	3-24" RCP's
573 + 00	O	Q50	77.0	46	4-24" RCP's
582 + 50	O1	Q50	87.0	50	4-24" RCP's

* Capacity achieved as a function of culvert flow and weir flow (see appendix).

FIGURE 3

APPENDIX A

Hydrologic and Hydraulic Calculation Sheets for Drainage Culverts

SUBJECT:
INTERIM ROADWAY, SEGMENT 2

JOB NO.: 4095508-77

DRAINAGE AREA : A

STATION: 386 + 60

ACRES = 32.4

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 1325' @ .3% = 19 MIN (Kirpich; Typical)
900' @ 3fps = 5 MIN
24 MIN

I = 3.4
C = 0.20

Q_{50} = 22 cfs

* RATIONAL FORMULA Q = C.I.A.

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DATE: 3-28-89
CHECKED BY: JHN
SHEET NO.: OF

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

CULVERT DESIGN SHEET

PROJECT: SEGMENT 2

DESIGNER: JCC

DATE: 2-12-90

HYDROLOGIC AND CHANNEL INFORMATION

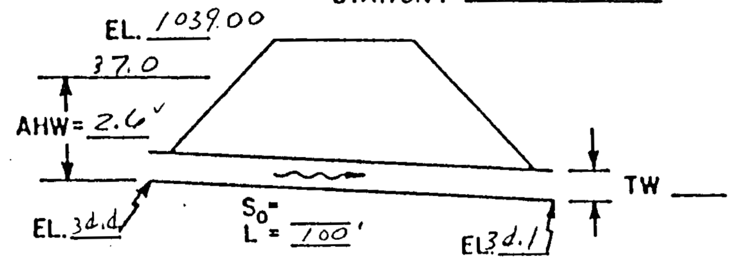
Q_1 = Q50 = 22 cfs TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 386+60



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL $HW = H + h_0 - LS_0$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_0	LS_0	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 - RCP's	38	24"	1.3	2.6												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

SUBJECT:
INTERIM ROADWAY, SEGMENT 2 JOB NO.: 4095508-77

DRAINAGE AREA : B

STATION: 399+33

ACRES = 38.3

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 1325' @ 0.3% = 19 MIN.
1100' @ 3 fps = 6 MIN.
25 MIN.

I = 3.35
C = 0.20

Q_{50} = 26 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY: JCC DATE: 3-29-89 CHECKED BY: JLN SHEET NO.: OF

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PROJECT: *Segment 2*

CULVERT DESIGN SHEET

DESIGNER: *JCC*

DATE: *2-14-90*

HYDROLOGIC AND CHANNEL INFORMATION

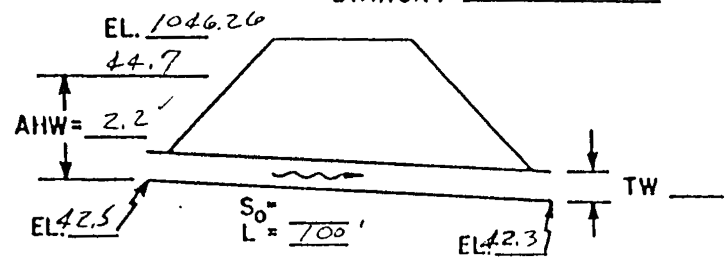
Q_1 = *950 = 26 cfs* TW$_1$ = ______

Q_2 = ______ TW$_2$ = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: *399+33*



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 - RCP's	32	24"	1.1	2.2												

SUMMARY & RECOMMENDATIONS:

SUBJECT: INTERIM ROADWAY, SEGMENT 2

JOB NO.: 4095508-77

DRAINAGE AREA : C

STATION: 413 + 01

ACRES = 46.9

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 1325 @ .3% = 19 MIN.
1400' @ 3fps = 8 MIN.
27 MIN.

I = 3.15

C = 0.20

Q_{50} = 29.5 cfs

* RATIONAL FORMULA Q = C.I.A.

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PROJECT: Segment 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-14-90

HYDROLOGIC AND CHANNEL INFORMATION

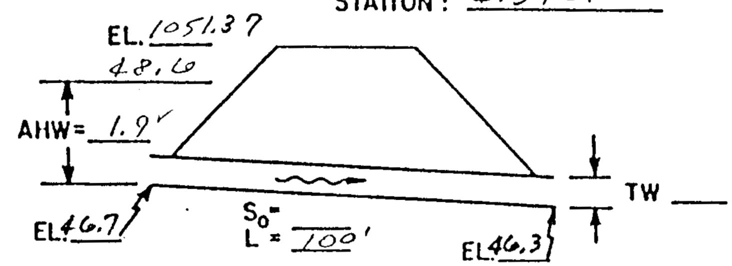
Q_1 = Q50 = 30 cfs TW$_1$ = ______

Q_2 = ______ TW$_2$ = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 413+01



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 - RCP's	31	30"	.76	1.9												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

DESIGN NOTES AND COMPUTATIONS

SUBJECT:
INTERIM ROADWAY, SEGMENT 2 JOB NO.: 4095508-77

DRAINAGE AREA : D

STATION: 426 + 38

ACRES = 56.3

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 1325' @ 0.3% = 19 MIN.
1600' @ 3 fps = 9 MIN.
28 MIN.

I = 3.1
C = 0.20

Q_{50} = 35 cfs

* RATIONAL FORMULA Q = C.I.A.

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PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-14-90

HYDROLOGIC AND CHANNEL INFORMATION

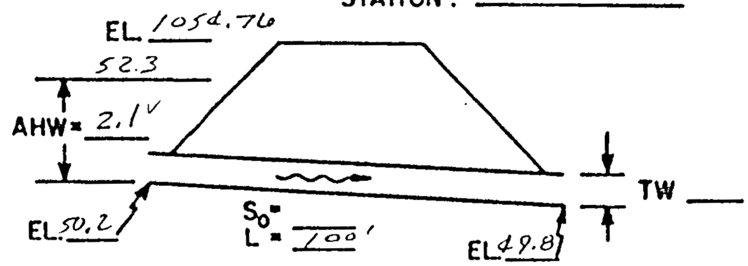
Q_1 = Q50 = 35 cfs TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 426+38



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
2-RCP's	37	30"	.84	2.1												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

SUBJECT:

INTERIM ROADWAY, SEGMENT 2 JOB NO.: 4095508-77

DRAINAGE AREA : E

STATION: 440 +12

ACRES = 59.8

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 1200' @ 0.3% = 13 MIN.
1900' @ 3 fps = 11 MIN
24 MIN.

I = 3.4

C = 0.20

Q_{50} = 41 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY: JCC

DATE: 3-29-89

CHECKED BY: JHN

SHEET NO.: OF

Revised 8-22-90

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
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PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-14-90

Revised 8-22-90

HYDROLOGIC AND CHANNEL INFORMATION

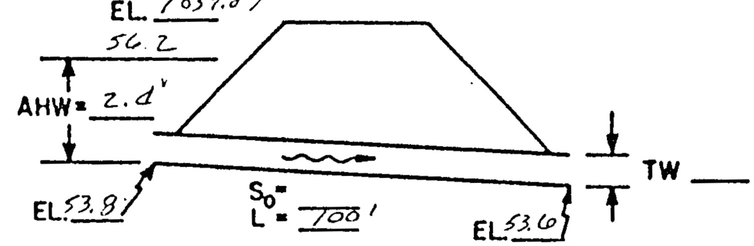
Q_1 = Q50 = 41 cfs TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 240+12



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
3 - RCP'S	54 ✓	24"	1.2 ✓	2.4 ✓												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

SUBJECT:
INTERIM ROADWAY, SEGMENT 2

JOB NO.: 4095508-77

DRAINAGE AREA : E,

STATION: 452 + 95

ACRES = 37.0 Acres

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 700' @ 0.3% = 11 MIN.
2200' @ 3 fps = 12 MIN.
23 MIN.

I = 3.5

C = 0.20

Q_{50} = 26 cfs

* RATIONAL FORMULA Q = C.I.A.

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DATE: 8-22-90
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SHEET NO.: OF

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Tucson, Arizona 85705
(602) 624-7401

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 8-23-90

HYDROLOGIC AND CHANNEL INFORMATION

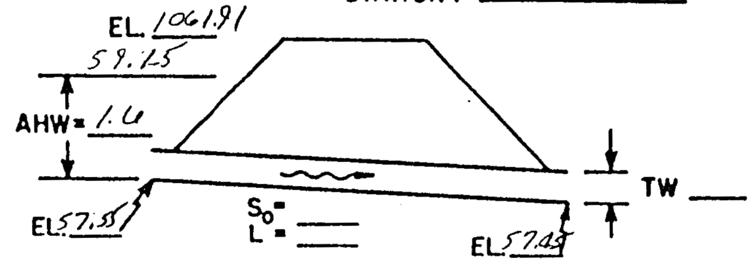
Q_1 = Q50 = 26 cfs TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 452+95



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
3 - RCP'S	27	24"	0.8	1.6												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

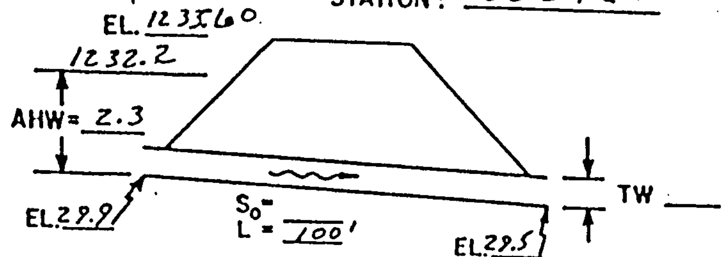
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50 * = 29 cfs TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 862+60



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION — INLET CONT. $\frac{HW}{D}$	HW	OUTLET CONTROL $HW = H + h_o - LS_o$ — K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2-RCP's	34	24"	1.15	2.3												

SUMMARY & RECOMMENDATIONS:

* Roadway is elevated above natural ground at this elevation

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

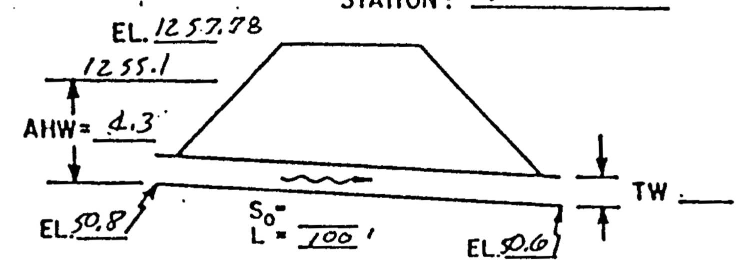
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50* = 146 cfs TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 915+60



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
3- RCP'S	180	36"	1.43	4.3												

SUMMARY & RECOMMENDATIONS:

Existing upstream arterial street capacity controls discharge.
* Roadway is elevated above natural ground at this location

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

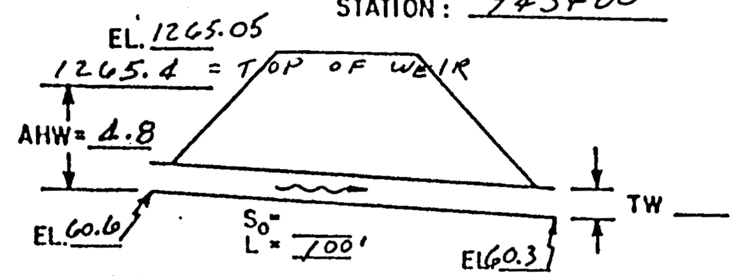
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50 = 207cfs TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 943+00



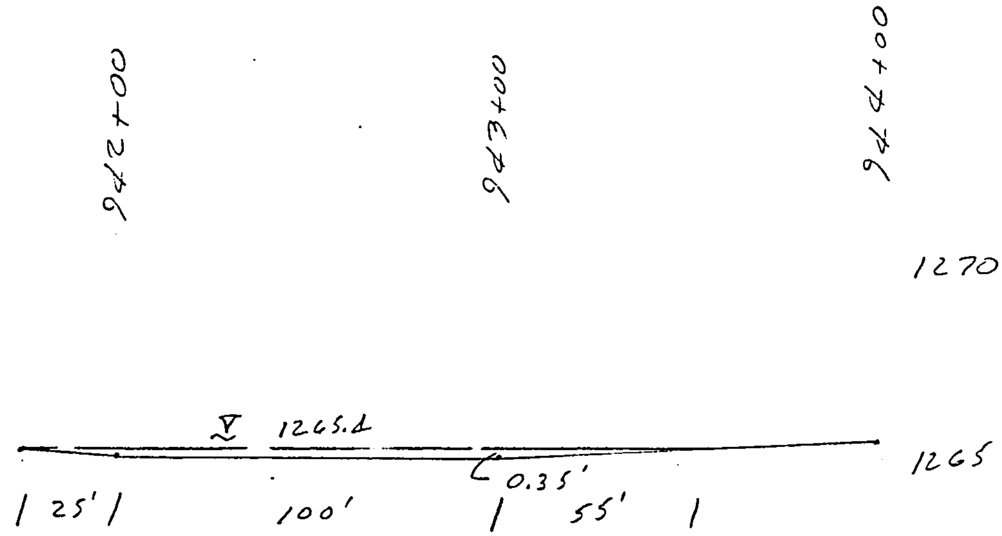
MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
6'x3' CBC	150		1.6	4.8												
Weir Flow*	73															
	223															

SUMMARY & RECOMMENDATIONS:
* See Attached Sheet

Form 81-734-3917

SUBJECT: SEGMENT NO. 1
Weir Flow Station 9d3+00 (Proposed Roadway) JOB NO.: 40955.08.07



1" = 50'

L = 25'; 100'; 55'

H = .17; .35; .17

C = 2.8

$$Q = C L H^{3/2}$$

$.17^{1.5} \times 2.8 \times 25 = 4.9$

$.35^{1.5} \times 2.8 \times 100 = 58.0$

$.17^{1.5} \times 2.8 \times 55 = 10.8$

Q = 73.7 cfs

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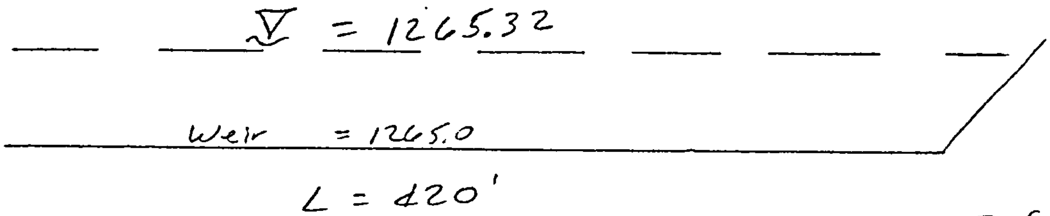
(602) 624-7401

DESIGN NOTES AND COMPUTATIONS

SUBJECT: SEGMENT NO. 1
EXISTING CONDITION, STA 943+00

JOB NO.: 40955.08.07

Location: Existing Road @ Wash



$Q_{50} = 207$ cfs

$Q = C L H^{3/2}$

$C = 2.8$

$L = 420$

$H = .32$

$Q = 213$ cfs

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DATE: 2.12.90
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SHEET NO.: OF

CBA CELLA BARR ASSOCIATES
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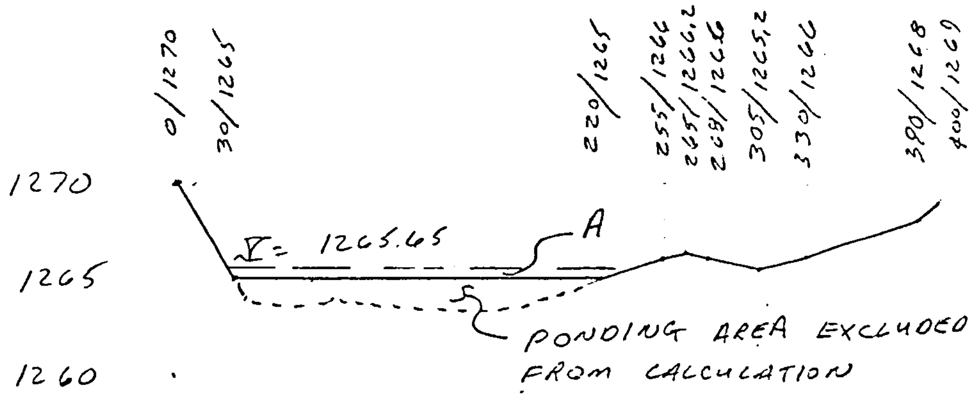
Tucson, Arizona 85705
(602) 624-7401

DESIGN NOTES AND COMPUTATIONS

SUBJECT: SEGMENT No. 1
EXISTING CONDITION, STA. 943+00 Lt.

JOB NO.: 40955·08·07

Manning's Hydraulic Rating of Wash Roughly 200' up stream of Existing Road in visinity of proposed R/W.



$N = .04$
$S = .3\%$
$A = 132.0$
$WP = 217.6$

$Q_{50} = 207 \text{cfs}$

$$Q = \frac{1.486}{n} \times A \times \frac{A}{WP}^{2/3} \times S^{1/2}$$

$$Q = \frac{1.486}{.04} \times 132 \times \frac{132}{217.6}^{2/3} \times .003^{1/2}$$

$$Q = 37.15 \times 132 \times .717 \times .055$$

$$Q = 193$$

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Tucson, Arizona 85705
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PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

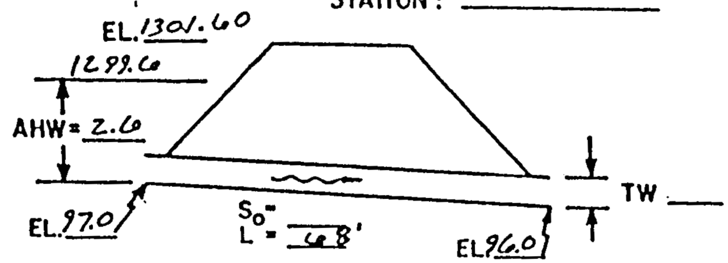
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50* = 19cfs TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 1021+20



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL HW=H + h_o - LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
RCP	19	24"	1.3	2.6												

SUMMARY & RECOMMENDATIONS:

* Roadway is elevated above natural ground at this location.

Form 81-734-3917

PROJECT: *SEGMENT No. 1*
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: *JCC*
Rev. 2-12-90
DATE: *4-10-89*

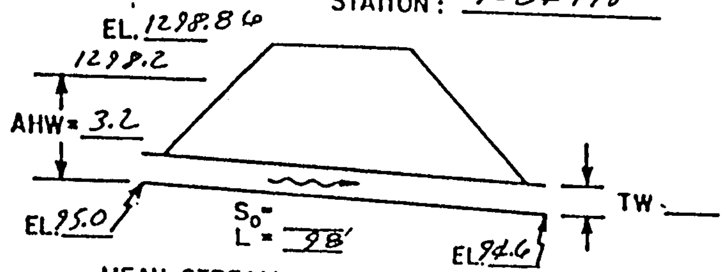
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = *Q2* = 29cfs* TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: *1024+18*



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL HW=H+h_o-LS_o											
			HW/D	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
2-RCP's	*48*	*24"*	*1.6*	*3.2*												

SUMMARY & RECOMMENDATIONS:

*Low flows from a 421 acre watershed that concentrates at the upper limits of this watershed and the Interim Roadway are also diverted to this crossing. * Roadway profile is approx. equal to n.g.*

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 4-10-89

HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50* = 7cfs TW_1 = ____

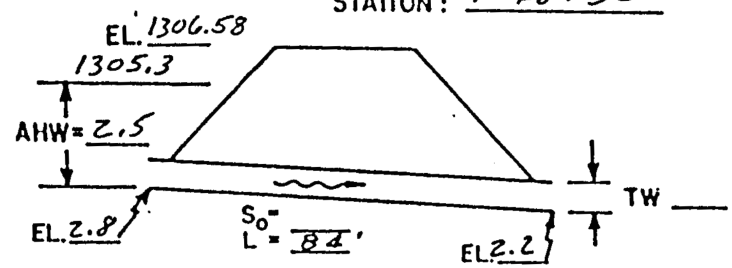
Q_2 = ____ TW_2 = ____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

Rev. 2-12-90

STATION: 1048+30



MEAN STREAM VELOCITY = ____
MAX. STREAM VELOCITY = ____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$											
			HW/D	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
RCP	19	24"	1.25	2.5												

SUMMARY & RECOMMENDATIONS:

* Roadway profile is elevated above natural ground at this location.

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
REV. 2-12-90
DATE: 4-10-89

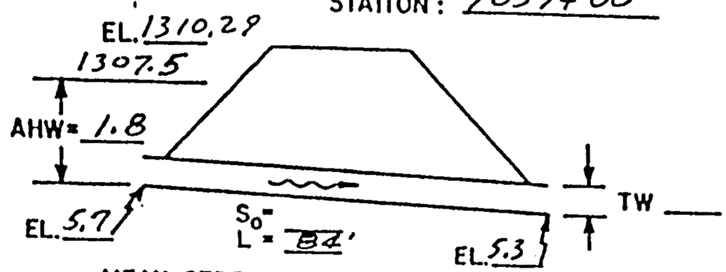
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50 Y = 33 cfs TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 1059+00



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
3- RCP's	33	24"	0.9	1.8												

SUMMARY & RECOMMENDATIONS:

* Roadway profile is elevated above natural ground at this location

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

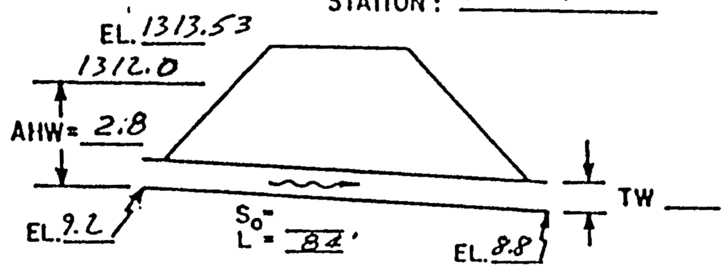
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50* = 25 cfs TW_1 = ____
Q_2 = ____ TW_2 = ____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 106d+00



MEAN STREAM VELOCITY = ____
MAX. STREAM VELOCITY = ____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2-RCP's	42	24"	1.4	2.8												

SUMMARY & RECOMMENDATIONS:

* Roadway profile is elevated above natural ground at this location.

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

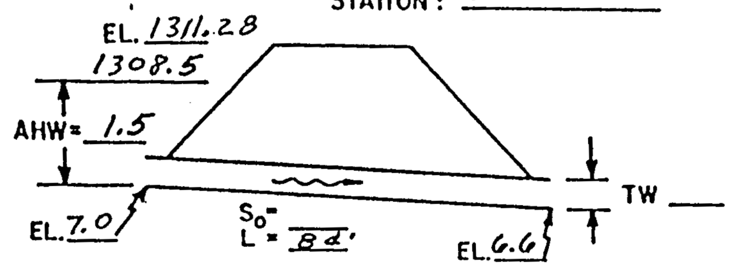
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50* = 16cfs TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 1075+85



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
2-RCP's	17	24"	.75	1.5												

SUMMARY & RECOMMENDATIONS:
* Roadway profile is elevated above natural ground at this location.

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Revised 2-12-90
DATE: 4-10-89

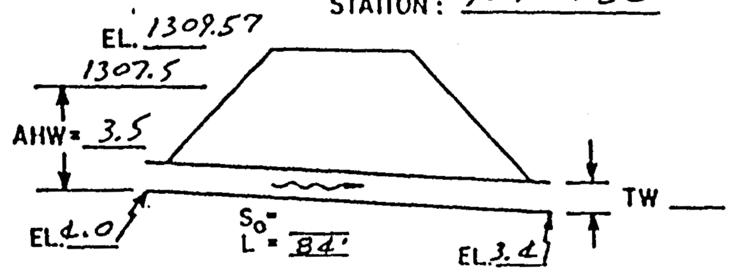
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50* = 215 cfs TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 1078+30



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$											
			HW/D	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
4-RCP's	220	42"	1.0	3.5												

SUMMARY & RECOMMENDATIONS:
* Roadway profile is elevated above natural ground at this elevation.

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

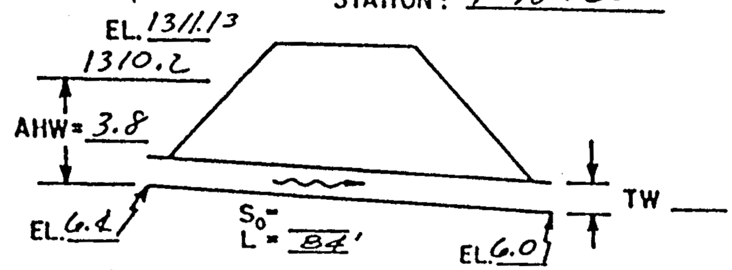
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q2 * = 43 cfs TW_1 = ____
Q_2 = ____ TW_2 = ____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 1098+00



MEAN STREAM VELOCITY = ____
MAX. STREAM VELOCITY = ____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2-RCP's	56	24"	1.9	3.8												

SUMMARY & RECOMMENDATIONS:

* Roadway profile is approximately equal to natural ground at this location.

Form 81-734-3917

PROJECT: SEGMENT No. 1
ESTRELLA INTERIM ROADWAY

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 2-12-90
DATE: 4-10-89

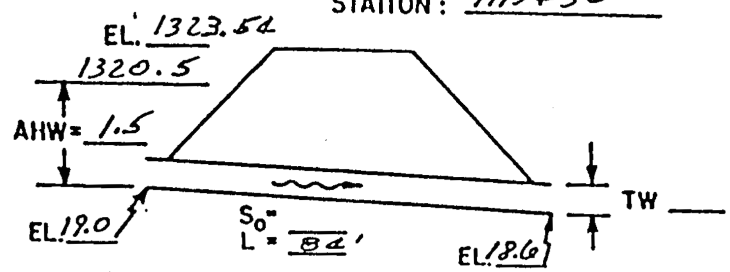
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q2 * = 14 cfs TW$_1$ = ______
Q_2 = ______ TW$_2$ = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 1115+50



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c + D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2-RCP's	17	24"	.75	1.5												

SUMMARY & RECOMMENDATIONS:
* Roadway profile is approximately equal to natural ground along the majority of the drainage area's south boundary.

Form 81-734-3917

Rev. 4/86

SUBJECT INTERIM ROAD, SEGMENT 1, PIPE SIZING JOB NUMBER 40953-08-07

LOCATION: STA. 1130+40 ±
DRAINAGE AREA "A"

DRAINAGE AREA = 15.0 Acres

ROADWAY IS AT APPROXIMATELY THE SAME ELEVATION AS NATURAL GROUND AT THIS LOCATION. DESIGN FOR Q_2

* $Q_2 = 4.1$ CFS

REQUIRED PIPE = **

** DRAIN TO GRAND AVENUE ROADWAY DRAINAGE DITCH.

* PER 2-YEAR DRAINAGE AREA/DISCHARGE CURVE

PREPARED BY JCC DATE 12-12-88 CHECKED BY SHEET NO. OF FIGURE #

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401
5062 North 19th Avenue
Phoenix, Arizona 85015
(602) 242-2999

SUBJECT: INTERIM ROADWAY, SEGMENT 2

JOB NO.: 4095508-77

DRAINAGE AREA : F

STATION: 459+66

ACRES = 34.9

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 600' @ .3% = 10 MIN.
2100' @ 3fps = 12 MIN.
22 MIN.

I = 3.5

C = 0.20

Q_{50} = 24 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY: JCC | DATE: 3-29-89 | CHECKED BY: JHN | SHEET NO.: OF

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-14-90

HYDROLOGIC AND CHANNEL INFORMATION

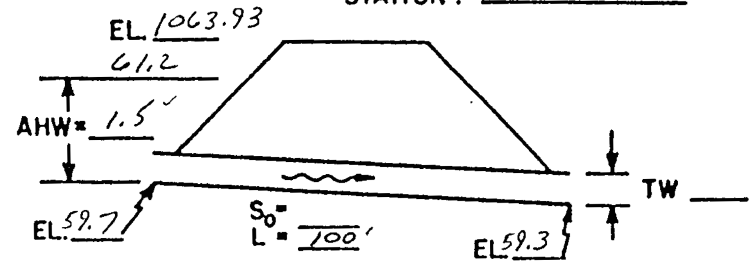
Q_1 = Q50 = 24 cfs ✓ TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 459+66



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
3 − RCP's	26 ✓	24"	.75	1.5 ✓												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

SUBJECT:
INTERIM ROADWAY, SEGMENT 2

JOB NO.: 4095508-77

DRAINAGE AREA : G

STATION: 446+50

ACRES = 152

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 2800' @ 0.3% = 32 MIN.
2300' @ 3 fps = 13 MIN.
45 MIN.

I = 2.3

C = 0.20

Q_{50} = 70 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY: JCC
DATE:
CHECKED BY:
SHEET NO.: OF

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

PROJECT: SEGMENT No. 2

CULVERT DESIGN SHEET

DESIGNER: JCC
Rev. 8-31-90
DATE: 2-14-90

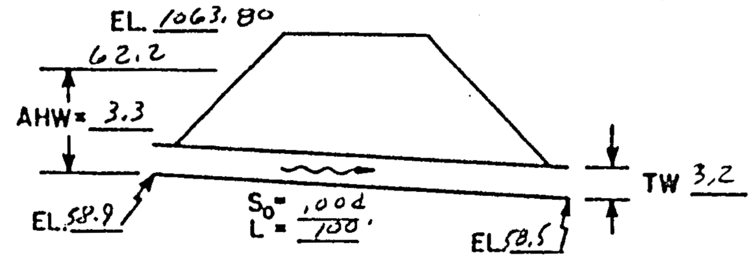
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q50 = 70 cfs TW_1 = ______
Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 466+50



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_0 - LS_0$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_0	LS_0	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
3-RCP's	72	24	1.65	3.3	0.2	.68	1.75	1.88	3.2	3.2	0.4	4.8				outlet Control
3-RCP's	33	24			0.2	.85	1.2	1.6	3.2	3.2	0.4	3.65				
3-RCP's	42*	24			0.2	.70	1.4	1.7	3.2	3.2	0.4	3.5				*

SUMMARY & RECOMMENDATIONS:
* Balance of runoff will spill south across adjacent maintenance road as weir flow, to be picked up by the Interim Roadway ditch and then be diverted across the Interim Rdwy at a designed berm location.

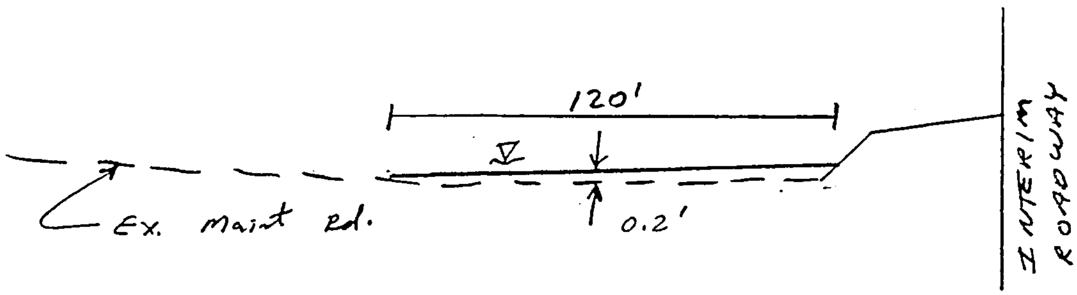
Form 81-734-3917

Refer to next page for weir flow calculation over the south maintenance road. H = 3.5 − 3.3 = 0.2

DESIGN NOTES AND COMPUTATIONS

SUBJECT: SEGMENT No. 2

STA. 466+50 Weir Flow over ex. south Maint. Rd. JOB NO.: 40955-08-77



$Q = C L H^{3/2}$

$L = 120'$

$C = 2.7$

$H = .2^{1.5} = .089$

$Q_{WEIR} = 28.8$ cfs

$Q_{CULVERT} = 42$ cfs

$Q_{TOTAL} = 70.8$ cfs

PREPARED BY: JCC | DATE: 8-31-90 | CHECKED BY: JHN | SHEET NO.: OF

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

DESIGN NOTES AND COMPUTATIONS

Rev. 4/86

SUBJECT Interim Road Segment B, Camelback Road | JOB NUMBER 40955-08-77

DRAINAGE AREA H

STA. 4 92+96

CAPACITY OF EXISTING UPSTREAM 2-8'X3' CBC AT COTTON LANE

$\frac{HW}{D} = \frac{4}{3} = 1.33$

21cfs X 2 X 8 = 336 cfs

NEW CULVERT AT Interim & Camelback

Top of Road = 71.7
Flow Line = 67.7
4.0

$\frac{HW}{D} = \frac{4}{3} = 1.33$

2 Cell 8'X3' CBC

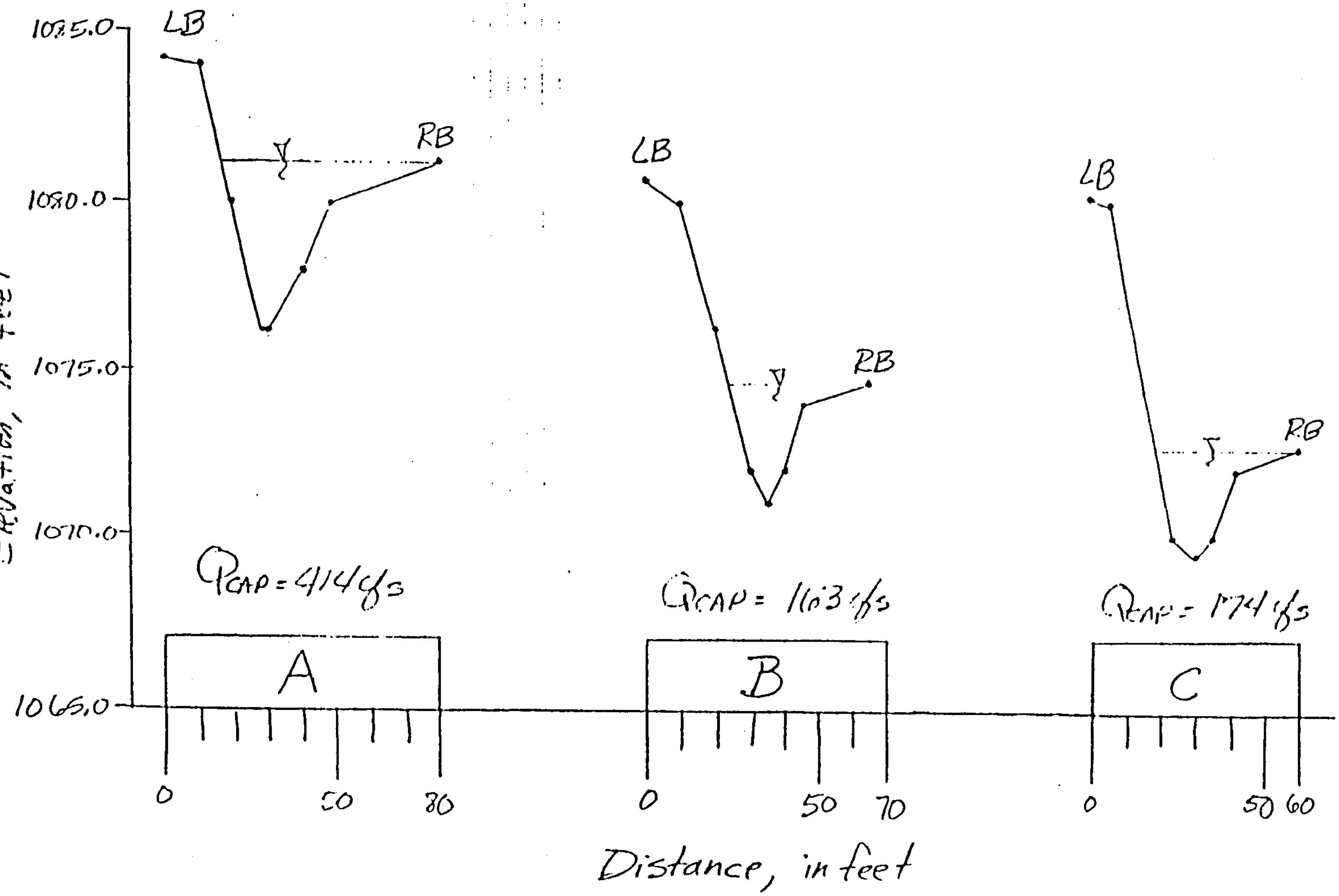
PREPARED BY JCC DATE 2-23-8? CHECKED BY JLW SHEET NO. OF FIGURE #

CELLA BARR ASSOCIATES
2075 North Sixth Avenue, Tucson, Arizona 85705, (602) 624-7401
5062 North 19th Avenue, Phoenix, Arizona 85015, (602) 242-2999

DESIGN NOTES AND COMPUTATIONS

SUBJECT Estrella Freeway / Drainage

JOB NUMBER



(500' East of ℄ of Cotton Lane)

(1700' East of ℄ of Cotton Lane)

(2100' East of ℄ of Cotton Lane)

PREPARED BY DATE CHECKED BY

SHEET NO. 1 OF 1

FIGURE #

CELLA BARR ASSOCIATES

2075 North Sixth Avenue Tucson, Arizona 85705 (602) 624-7401

5062 North 19th Avenue Phoenix, Arizona 85015 (602) 242-2999

Rev. 4/86

FILE:GP4095503 GP4095502 5 STATION DATE:1018 1988

(A)

NO.	CROSS-SECTION TYPE	STATION	WATER SURFACE ELEVATION	CHANNEL SLOPE
2	EXIST	2 +00	81.20 ft	.39%

SUBSECTIONS FROM LEFT TO RIGHT

LEFT OFFSET (ft)	RIGHT OFFSET (ft)	TOP WIDTH (ft)	n VALUE	AREA (sqft)	WETTED PERIMETER (ft)	DISCHARGE (cfs)	VELOCITY (ft/sec)	FROUDE NUMBER
16.60	80.00	63.40	.040	119.0	64.90	414	3.48	.447
						414		

FILE:GP4095503 GP4095502 5 STATION DATE:1018 1988

(B)

NO.	CROSS-SECTION TYPE	STATION	WATER SURFACE ELEVATION	CHANNEL SLOPE
3	EXIST	3 +00	74.70 ft	.39%

SUBSECTIONS FROM LEFT TO RIGHT

LEFT OFFSET (ft)	RIGHT OFFSET (ft)	TOP WIDTH (ft)	n VALUE	AREA (sqft)	WETTED PERIMETER (ft)	DISCHARGE (cfs)	VELOCITY (ft/sec)	FROUDE NUMBER
23.72	65.00	41.28	.040	57.3	42.37	163	2.84	.424
						163		

FILE:GP4095503 GP4095502 5 STATION DATE:1018 1988

(C)

NO.	CROSS-SECTION TYPE	STATION	WATER SURFACE ELEVATION	CHANNEL SLOPE
4	EXIST	4 +00	72.70 ft	.39%

SUBSECTIONS FROM LEFT TO RIGHT

LEFT OFFSET (ft)	RIGHT OFFSET (ft)	TOP WIDTH (ft)	n VALUE	AREA (sqft)	WETTED PERIMETER (ft)	DISCHARGE (cfs)	VELOCITY (ft/sec)	FROUDE NUMBER
18.41	60.00	41.59	.040	59.8	42.66	174	2.91	.427
						174		

Rev. 4/86

SUBJECT INTERIM ROADWAY, SEGMENT 2 JOB NUMBER 40955-08-77

DRAINAGE AREA : I

STATION : 496 + 43

ACRES : 54.7

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.
DESIGN FOR Q50.*

TC = 900' @ .3% = 14 Min
2560' @ 3 fps = 14 Min.
28 Min.

I = 2.8
C = 0.20

Q_{50} = 31 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY JCC DATE 3-7-90 CHECKED BY JHN SHEET NO. OF FIGURE #

CELLA BARR ASSOCIATES
2075 North Sixth Avenue Tucson, Arizona 85705 (602) 624-7401
5062 North 19th Avenue Phoenix, Arizona 85015 (602) 242-2999
666 Arroyo Boulevard Nogales, Arizona 85621 (602) 287-2341

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-14-90

HYDROLOGIC AND CHANNEL INFORMATION

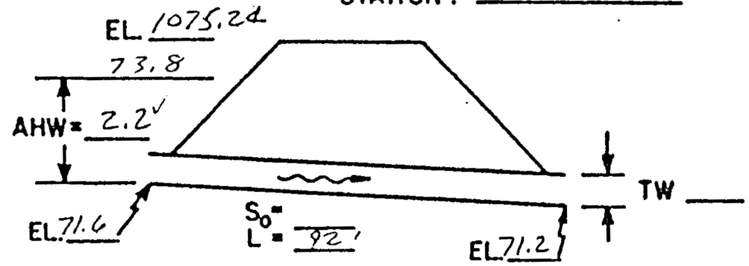
Q_1 = Q50 = 31 cfs TW$_1$ = ______

Q_2 = ______ TW$_2$ = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 496+43



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 RCP's	32	24"	1.1	2.2												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

DESIGN NOTES AND COMPUTATIONS

SUBJECT:
INTERIM ROADWAY, SEGMENT 2

JOB NO.: 6095508-77

DRAINAGE AREA : J

STATION: 506+10

ACRES = 77.7

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 1300' @ 0.3% = 18 MIN.
2600' @ 3fps = 14 MIN.
32 MIN.

I = 2.9
C = 0.20

Q_{50} = 45 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY: JCC
DATE: 3-29-89
CHECKED BY: JHN
SHEET NO.: OF

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-14-90

HYDROLOGIC AND CHANNEL INFORMATION

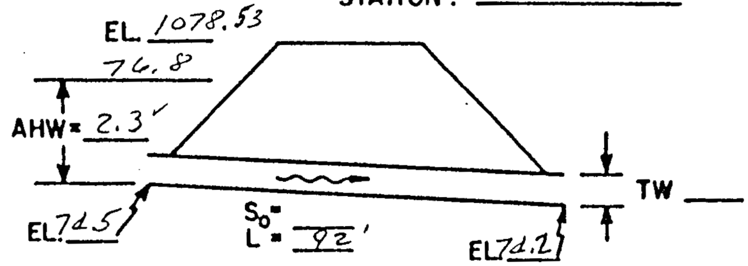
Q_1 = Q50 = 45 cfs ✓ TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 506+10



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL HW=H + h_o − LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
3 RCP'S	51	24"	1.15	2.3 ✓												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

SUBJECT:
INTERIM ROADWAY, SEGMENT 2 JOB NO.: 4095508-77

DRAINAGE AREA : K

STATION: 519+25

ACRES = 77

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 1300' @ .3% = 18 MIN.
2640' @ 3fps = 14 MIN.
32 MIN.

I = 2.9

C = 0.20

Q_{50} = 45 cfs

*RATIONAL FORMULA Q = C.I.A.

PREPARED BY: JCC DATE: 3-29-89 CHECKED BY: JHN SHEET NO.: OF

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-14-90

HYDROLOGIC AND CHANNEL INFORMATION

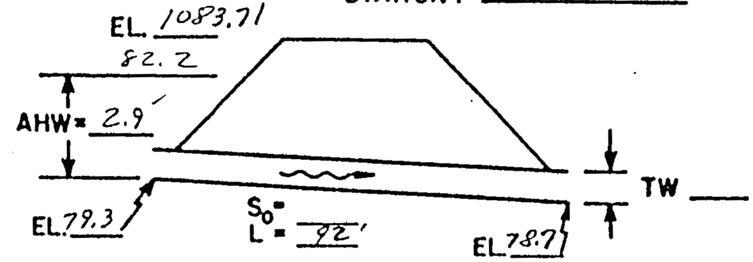
Q_1 = Q50 = 45 TW$_1$ = ______

Q_2 = ______ TW$_2$ = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 519+25



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o											
			HW/D	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
3 - RCP'S	63	24"	1.45	2.9												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

SUBJECT: INTERIM ROADWAY, SEGMENT 2

JOB NO.: 4095508-77

DRAINAGE AREA : L

STATION: 532+67

ACRES = 75.5

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q_{50}*

$TC = 1300' @ .3\% = 18$ MIN.
$2640' @ 3fps = 14$ MIN.
32 MIN.

$I = 2.9$

$C = 0.20$

$Q_{50} = 44$ cfs ✓

* RATIONAL FORMULA $Q = C.I.A.$

PREPARED BY: JCC | DATE: 3-29-89 | CHECKED BY: JHN | SHEET NO.: OF

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-12-90

HYDROLOGIC AND CHANNEL INFORMATION

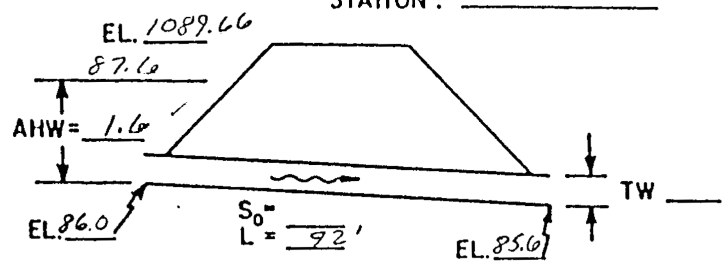
Q_1 = 950 = 44 cfs ✓ TW_1 = ____

Q_2 = ____ TW_2 = ____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 532+67



MEAN STREAM VELOCITY = ____

MAX. STREAM VELOCITY = ____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
5-RCP's	47 ✓	24"	0.8 ✓	1.6 ✓												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

SUBJECT: INTERIM ROADWAY, SEGMENT 2

JOB NO.: 4095508-77

DRAINAGE AREA : M

STATION: 545+94

ACRES = 76.7

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q_{50}*

TC = 1300' @ 0.3% = 18 MIN.
2400' @ 3 fps = 13 MIN.
31 MIN.

I = 2.9

C = 0.20

Q_{50} = 45 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY: JCC | DATE: 2-23-89 | CHECKED BY: JHN | SHEET NO.: OF

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-14-90

HYDROLOGIC AND CHANNEL INFORMATION

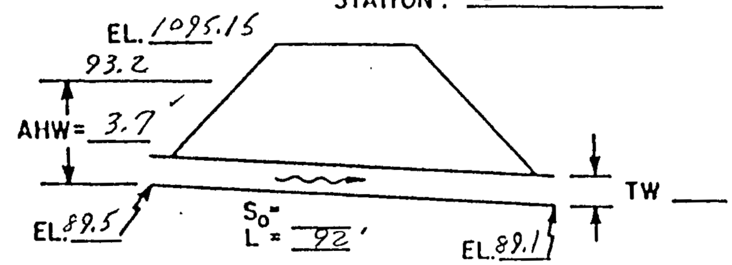
Q_1 = Q50 = 45 cfs TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 545+94



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
1-RCP	50	36"	1.23	3.7												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

Rev. 4/86

SUBJECT INTERIM ROADWAY, SEGMENT 2 JOB NUMBER 40955-08-77

DRAINAGE AREA : N

STATION : 558 + 93

ACRES : 75.5

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.
DESIGN FOR Q50.*

TC = 1250' @ .4% = 16 MIN.
2450' @ 3fps = 14 MIN.
30 MIN.

I = 3.0
C = 0.20

Q_{50} = 45 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY JCC DATE 3-7-90 CHECKED BY JHN SHEET NO. OF FIGURE #

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-12-90

HYDROLOGIC AND CHANNEL INFORMATION

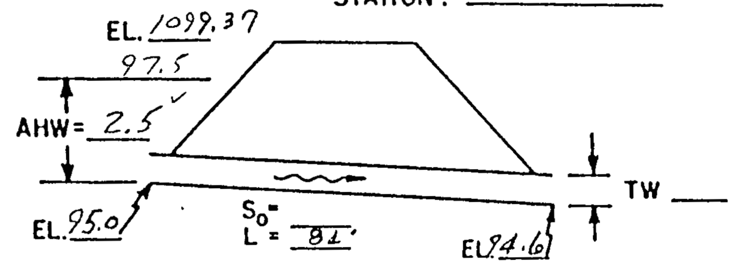
Q_1 = Q50 = 45 cfs TW$_1$ = ______

Q_2 = ______ TW$_2$ = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 558+93



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL $HW=H+h_o-LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
3-RCP's	54	24"	1.25	2.5												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

DESIGN NOTES AND COMPUTATIONS

Rev. 4/86

SUBJECT INTERIM ROADWAY, SEGMENT 2 JOB NUMBER 40955-08-77

DRAINAGE AREA : O

STATION : 573+00

ACRES : 77

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.
DESIGN FOR Q_{50}.*

TC = 1250' @ .4% = 16 MIN.
2450' @ 3fps = 14 MIN.
30 MIN.

I = 3.0
C = 0.20

Q_{50} = 46 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY JCC DATE 3-7-90 CHECKED BY JHN SHEET NO. OF FIGURE #

CELLA BARR ASSOCIATES
2075 North Sixth Avenue Tucson, Arizona 85705 (602) 624-7401
5062 North 19th Avenue Phoenix, Arizona 85015 (602) 242-2999
666 Arroyo Boulevard Nogales, Arizona 85621 (602) 287-2341

PROJECT: SEGMENT 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-12-90

HYDROLOGIC AND CHANNEL INFORMATION

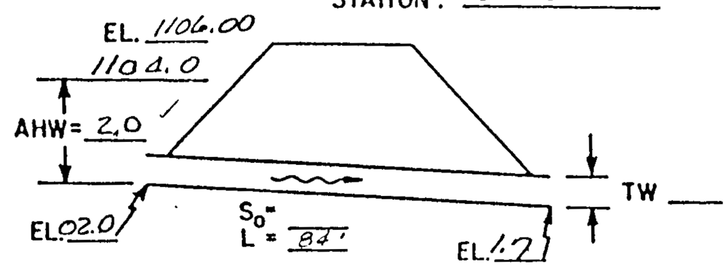
Q_1 = Q50 = 46 cfs TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 573+00



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
4 - RCP's	56	24"	1.0	2.0												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

SUBJECT: INTERIM ROADWAY, SEGMENT 3 JOB NO.: 4095508-87

DRAINAGE AREA: O_1

STATION: 582+50

ACRES = 87

ROADWAY IS ELEVATED ABOVE NATURAL GROUND AT THIS LOCATION.

DESIGN FOR Q50*

TC = 1700' @ .5% = 19 MIN.
1500' @ 2fps = 13 MIN.
32 MIN.

I = 2.9
C = 0.20

Q_{50} = 50 cfs

* RATIONAL FORMULA Q = C.I.A.

PREPARED BY: JCC DATE: 2-16-90 CHECKED BY: SHEET NO.: OF

CELLA BARR ASSOCIATES
2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

PROJECT: Segment 2

CULVERT DESIGN SHEET

DESIGNER: JCC

DATE: 2-16-90

HYDROLOGIC AND CHANNEL INFORMATION

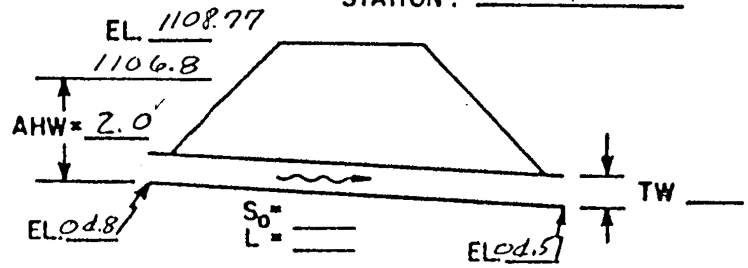
Q_1 = Q50 = 50cfs ✓ TW$_1$ = ______

Q_2 = ______ TW$_2$ = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 582+50



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

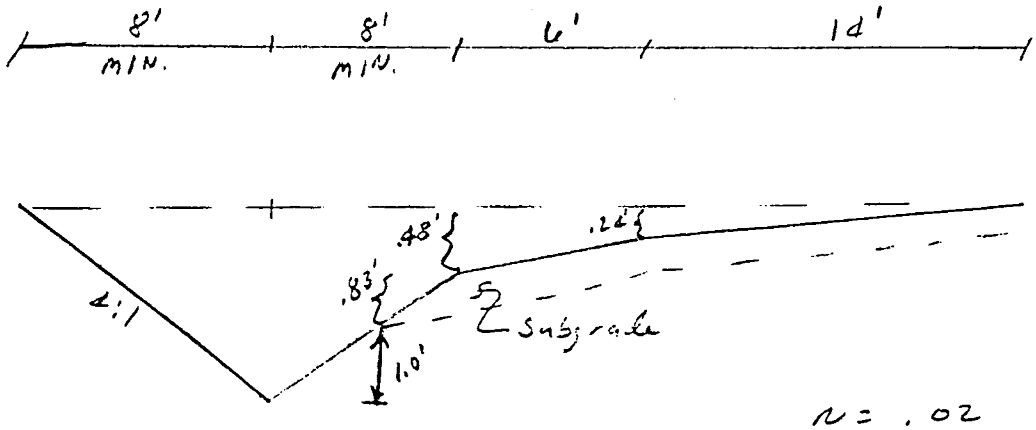
CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c + D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
4 - RCP's	56	24"	1.0	2.0												

SUMMARY & RECOMMENDATIONS:

Form 81-734-3917

DESIGN NOTES AND COMPUTATIONS

SUBJECT: SEGMENT 2 & 3
CAPACITY of West Rdwy Sec.; Profile = N.G.   JOB NO.:



$n = .02$

$S = .005$

$$Q = \frac{1.486}{n} \times A \times \frac{A}{wp}^{2/3} \times S^{1/2}$$

$$Q = 74.3 \times 24.7 \times \frac{24.7}{37.1}^{2/3} \times .005^{1/2}$$

$$Q = 74.3 \times 24.7 \times .762 \times .071$$

$$Q = 99 \text{ cfs}$$

PREPARED BY: JCC   DATE: 3-20-90   CHECKED BY: SHEET NO.:   OF

CELLA BARR ASSOCIATES
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