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REPORT ON CHANGES TO MC CORMICK RANCH MASTER DRAINAGE PLAN

SCOTTSDALE, ARIZONA

PROJECT: 106-2

Registered Professional Engineer (Civil)
CERTIFICATE EXPIRES
9234
ROLF
ERIKSON
DEC. 31, 19 79
ARIZONA U.S.A.

Dashney and Associates, Inc.
2801 North 24th Street
Phoenix, Arizona 85008

July 3, 1979

Dashney and Associates, Inc.
engineers · planners · surveyors

Rolf Erikson, P.E.
Michael D. Salmon, P.E.

July 3, 1979

Mr. George Ianella
Engineering Services Director
City of Scottsdale
3939 Civic Center Plaza
Scottsdale, Arizona 85251

Re: Report on Changes to McCormick Ranch Master Drainage Plan

Dear Mr. Ianella:

We are submitting herewith two (2) copies of the above-referenced report. Our office retains all the detailed quantity compilations and figures used in developing the cost estimates generalized in the report, and these will be submitted upon request.

If you or your staff have any questions regarding this submittal, please feel free to contact us at your convenience.

As the next stage of the drainage review of McCormick Ranch, we now propose to proceed in an investigation of the drainage deficiencies which have occurred in the existing construction.

Sincerely yours,
DASHNEY AND ASSOCIATES, INC.

Rolf Erikson

Rolf Erikson, P.E.

RE:is

2801 NORTH 24TH STREET/PHOENIX, ARIZONA 85008/PHONE (602) 956-2984

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SCOPE

The purpose of this report is to provide an independent review and recommend changes in the McCormick Ranch Drainage Plans for Phase II and the McCormick Ranch Center, as prepared by Toups Engineering, particularly in relation to the Shea Boulevard and Pima Road improvement plans (Project P-7809) which are presently being developed by the firm of Dibble & Associates, Inc. of Phoenix, Arizona.

LOCATION OF PROJECT AND DESCRIPTION OF AREA

The area is bounded by Via de Ventura on the south, Hayden Road (80th Street) and its southerly straight-line projection on the west, the Central Arizona Project Canal to the north, and 96th Street to the east, with portions of the upper watersheds extending easterly of the latter in a north-northeast direction to the origin at the Central Arizona Project Canal. Roughly centered in the study area on a north-south axis is Pima Road. The larger watersheds flow generally in a south-southwesterly direction at slopes averaging 0.8%. The terrain is typical Sonoran Desert of the Lower Colorado Subdivision, dominated by creosote bush, with some salt bush, desert thorn, and mesquite in the vicinity of the washes. The percentage of vegetative cover is generally around 10%, with thicker concentration in the vicinity of the washes and the poorly-drained areas. The watershed soil is composed of Calciorthids (high calcium content), with Haplargids (containing clay strata) in the upper region, all of which have a moderate to slow rate of permeability. The northern two-thirds of the area (i.e., that lying north of Shea Boulevard) is generally zoned R1-35 and now contains a scattering of single-family residences east of Pima Road - with many new subdivisions in the planning stage - while several single-family residential subdivisions already exist west of Pima Road. Southerly of Pima Road and south of Shea Boulevard, the McCormick Ranch Phase II is now under development, with a variety of single- and multi-family units with adjoining parks and recreation areas. East of Pima Road and south of Shea Boulevard, within the study area, there is to be a planned commercial development known as McCormick Ranch Center, which is to include offices, a finance center, and various shopping areas, with interspersed parks and some R1-35 residential development along its southerly edge.

INVESTIGATION AND RESULTS

The first drainage study relating to the area to be found in the City of Scottsdale files was dated in September, 1973, and was made by Water Resources Associates, Inc. This used the SCS method and considered roughly the upper 2 miles of the larger watersheds to be type "C" soil (i.e., having a slow infiltration rate). Further downstream, the soils were considered to be type "B" (i.e., having a moderate infiltration rate). On the basis of these two soil types, the Water Resources Associates report used SCS curve numbers of 81 and 85 and, to reach this conclusion, must have assumed the vegetative cover density to be 40%. For precipitation rates, the foregoing report used those given for Phoenix, Arizona on page 37 of "Estimated Return Periods for Short Duration Precipitation in Arizona" (Technical Memorandum WBTM WR-44, U.S. Department of Commerce, Environmental Services Administration, October, 1969). In an evaluation of the Water Resources report, only three possible discrepancies are apparent. The utilization of factors for "B" soil in the watersheds, while in accordance with the

City of Phoenix "Storm Drain Design Manual - Subdivision Drainage Design" (October, 1972), page 36, is not in agreement with the type "C" soils shown in the Arizona Highway Department's "Hydrologic Design for Highway Drainage in Arizona", Figure 2-1 (page 44a), which is now the standard accepted in the Scottsdale drainage ordinance. In addition, the assessment of 40% vegetative cover density is the absolute maximum allowable for desert brush (page 8 of the Arizona Highway Department manual). The assessment of using "C" soils with 10% vegetative cover results in SCS curve number 89, while considering type "C" soils in an ultimate development with about 30% impervious surface raises the SCS curve number to 91. Furthermore, while the Water Resources report did select higher SCS curve numbers south of Shea Boulevard to allow the addition of impervious areas in the ultimately-developed areas of the McCormick Ranch area, no such allowance was made for the off-site watersheds having their origins north of Shea Boulevard.

The major, and generally-accepted, drainage study of the area entitled "McCormick Ranch Phase II Master Storm Drainage Study and Report" was prepared by Toups Corporation and was completed in its final accepted form on February 28, 1978. Under the assumption that they accounted for future development, the off-site areas and curve numbers in the latter report were taken from the aforementioned drainage report prepared by Water Resources Associates, Inc., dated September, 1973 (with the exception that all soils were considered type "B"). However, the Toups study extended the off-site drainage areas used in the original Water Resources report to the old Verde Canal, which is roughly 2,000 feet northeasterly of the actual location of the Central Arizona Project Canal. (See Map "A", Appendix I.) This, in effect, added 0.52 square miles to the true off-site watersheds. The Toups study utilized the U.S. Department of Agriculture - Soil Conservation Service - TR20 Project Formulation - hydrology computer program for determining the runoff rates and adopted the original (and now outdated) Arizona Highway Department method for determining precipitation rates. The latter method, which was formulated in 1968 at the same time the SCS hydrologic procedure was adopted by the Highway Department, was later found to be inaccurate and was consequently amended in April, 1975. As an example, the use of the outdated Arizona Highway Department procedure resulted in the 100-year 1-hour rainfall being estimated at 2.20 inches, while the accepted value is 2.66 inches (i.e., from the previously cited "Estimated Return Periods for Short Duration Precipitation in Arizona"). The effect of using a rainfall rate of 2.20 inches with a SCS curve number of 81 is a runoff rate of 0.75 inch, while the now-accepted rainfall rate of 2.66 inches with an SCS curve number 91 results in a runoff rate of 1.75 inches. The net result of using the foregoing different values causes considerable variation in the computed actual discharge rates. For example, the area designated as "H" (352 acres) in the Toups study would develop a discharge rate of 351 cfs during the 100-year event (using a rainfall rate of 2.20" and an SCS curve number 81); while, using the now-accepted values (SCS curve number 91 and a rainfall rate of 2.66"), the rate would be 622 cfs. Map "B" in Appendix II of this report shows the runoff values at various key points, as determined by the Toups study.

The most recent study relating to the area is entitled "Hydrology and Hydraulic Report - Pima-Bell Road from Shea Boulevard to Scottsdale Road", which was prepared by Dibble and Associates, Consulting Engineers, and is dated February 9, 1979. A portion of this study concerned a drainage area on the easterly side of Pima Road to the north of Shea Boulevard, which is part of the off-site water-

sheds entering McCormick Ranch Phase II. The Dibble study and report, which was done in connection with 4.7 miles of roadway improvement for the City of Scottsdale (Project P-7809), rather than using the SCS method for determining storm discharge rates, utilized instead the traditional rational method. A runoff coefficient "C" factor of 0.5 was adopted in this study and is consistent with both the existing zoning and proposed development for the area, as delineated by the City of Scottsdale grading and drainage ordinance. For the determination of rainfall rates, the Dibble study utilized the Arizona Highway Department method, including the aforementioned amendments of April, 1975. As a result, the rainfall rates used were reasonably close to those on page 37 of "Estimated Return Periods for Short Duration Precipitation in Arizona". For example, the 1-hour, 100-year rate was found to be 2.51", while the accepted value is 2.66". The Dibble study (for the determination of drainage areas), besides using the conventional 1" = 2000' U.S.G.S. Quadrangle Maps of Paradise Valley and Sawick Mountain, also utilized field cross-sections augmented by information obtained from field inspections and areas planimetered from 1" = 400' aerial photographs. In this context, it is notable that the watersheds determined by the Dibble study are somewhat at variance with those given in the reports by both Water Resources Associates and Toups Corporation. (See Map "A", Appendix I.) The Dibble study found that some 433.23 acres (designated as Areas "2" to "7") easterly and immediately adjacent to Pima Road and north of Shea Boulevard formed the upper part of a watershed eventually draining into the McCormick Ranch Phase II - plus the equivalent of 45.68 acres from a larger, more northerly area which would be received as overflow due to inadequate capacity of natural channels. Examination of 1" = 400' scale aerial photos reveals that there is another 167.75 acres belonging to the same watershed westerly of Pima Road which also now drains across Shea Boulevard into McCormick Ranch Phase II - for an actual total off-site drainage area of 646.66 acres (1.01 square miles). This is substantially greater than the area of 0.66 square miles which was delineated for the same watershed by both the Water Resources report (which designated it as Area "5") and the Toups study (which referred to it as Area "E"). Examination of the 1" = 400' scale aerial photos indicates the determination of the drainage area reached by the Dibble study to be completely valid. The underestimated drainage area and the use of lower SCS curve numbers by both the Water Resources report and the Toups study, plus the use of a substandard 1-hour, 100-year rainfall rate, in the case of the Toups study, resulted in the discharge rate at Shea Boulevard's being estimated variously at 280 and 329 cfs (concentration point number 30 in the Toups study). This same discharge, using the true watershed areas and the more-accepted rainfall rates and SCS curve numbers, computes to be 882 cfs (873 cfs by the use of the rational method). Moreover, just downstream from the latter, across Arabian Trail, there has been constructed a 10' x 3' box culvert, which has a capacity of only 280 cfs. Even further downstream, the discharges computed through use of the corrected drainage areas and the revised rainfall rates and higher SCS curve numbers continue to remain substantially larger than the Toups study. At concentration point 42, the new values would be 1350 cfs, while previously, it had been computed at 760 cfs. Moreover, at the latter point, a structural plate arch culvert has been installed across Mountain View Road, and the grading plan for the Paradise Park Manor subdivision just upstream has been developed on the basis of the lower discharge figure - as computed by Toups Corporation. Further downstream, the difference in computed discharges continues, but due to a large inflow from the east, the percentage variation becomes less, and consequently, the effect on existing structures and drainage facilities is less. At concen-

tration point 50, the revised discharge is calculated at 2750 cfs, while the previous figure was 2281 cfs. At the latter point, a large multi-plate arch culvert has been constructed in the drainageway (known as Camelback Walk) below Via Linda (previously known as Double Tree Ranch Road) for use also as an equestrian underpass. While the Toups Corporation ran a backwater analysis (including also the structure) using a value of 2400 cfs, an additional 350 cfs will only marginally (0.25') raise the 100-year water surface elevations.

Other drainage being introduced into the McCormick Ranch Phase II directly across Shea Boulevard by the existing Dibble plans is generated by 89.48 acres (designated as Area No. 1) lying also just east of Pima Road. While the original Toups study did not consider any drainage being introduced into the McCormick Ranch project at this point, the roadway construction for Pima Road south of Shea Boulevard, as designed by the firm of Collar, Williams, & White, provided for this runoff, and a culvert crossing a spur for Mountain View Road just easterly of Pima Road was sized for some 328 cfs. This is more than adequate to meet the requirements of the existing Dibble plans, as the site (approximately concentration point 22 in the Toups study) would be subjected to about 262 cfs in the 100-year event.

Runoff computations using the revised runoff parameters and corrections to the drainage areas are given in Appendix II of this report, and Map "C" in Appendix I shows the results.

CONCLUSIONS

The present paving and drainage plans for Project P-7809, as they have now been prepared by Dibble & Associates, could create problems and the potential for flooding of both streets and homes in the McCormick Ranch Phase II. In particular, the two sites which have inadequate capacities to meet the anticipated flows are the easterly 10' x 3' box culvert in Arabian Trail and the drainageway through Paradise Park Manor, plus its crossing with Mountain View Road. Considering the above and other aspects of the drainage facilities now constructed in the McCormick Ranch Phase II, nine alternates appear possible for the proposed future construction of Pima Road north of Shea and also for the McCormick Ranch Center on the easterly side of Pima Road, as follows:

Alternate A

1. Proceed with present Dibble plans
2. Make no alterations in existing McCormick Ranch drainage
3. Leave in place inadequate culvert at Shea Boulevard Station 15+60 (Project P-7809)

Alternate B

1. Same as above
2. Same as above
3. Construct adequate culvert at Shea Boulevard Station 15+60 to provide for drainage area north of Shea Boulevard and west of Pima Road

Alternate C

1. Alter Dibble plans to convey drainage directly southerly across Shea

Boulevard, with ~~more~~ none being conveyed to the west, and provide minimal outlet channel to the existing ditch along east side of Pima Road
2. Make no alterations in existing McCormick Ranch drainage
3. Leave in place inadequate culvert at Shea Boulevard Station 15+60

Alternate D

1. Same as above
2. Same as above
3. Construct adequate culvert at Shea Boulevard Station 15+60

Alternate E

1. Same as above
2. Remove existing inadequate culvert beneath Mountain View Road spur and fully improve channel on east side of Pima from Mountain View Road to Shea Boulevard
3. Leave in place inadequate culvert at Shea Boulevard Station 15+60

Alternate F

1. Same as above
2. Same as above
3. Utilize pipe removed from Mountain View Road spur to construct an adequate drainage crossing at Pima Road Station 15+60

Alternate G

1. Same as above
2. Remove inadequate culvert beneath Mountain View Road spur on east side of Pima Road and improve channel on east side of Pima Road only to the minimal extent necessary to provide an outlet of the box culvert at Shea Boulevard
3. Same as above

Alternate H

1. Same as above
2. Fully improve channel on east side of Pima Road from Mountain View Road to Shea Boulevard and construct adequate culvert in Mountain View Road spur
3. Leave in place inadequate culvert at Shea Boulevard Station 15+60

Alternate I

1. Same as above
2. Same as above
3. Utilize pipe removed from Mountain View Road spur to construct an adequate drainage crossing at Pima Road Station 15+60

Alternates "A" and "B" essentially perpetuate the existing undesirable situation of inadequate culverts inside the presently-developed McCormick Ranch Phase II. Alternates "C" through "I" divert the anticipated runoff at the intersection of

of Pima Road and Shea Boulevard along the easterly side of Pima Road - an area yet to be developed. Alternates "D" through "I" actually are possible improvements over Alternate "C" - of which, Alternate "I" is the ideal scheme which should ultimately be achieved by the final construction.

An examination of the existing drainage facilities from Camelback Walk north along Pima Road to its intersection with Shea Boulevard was made to verify their adaptability to accepting an additional 478.91 acres of runoff, which were to be drained directly westerly into the northern part of McCormick Ranch Phase II. The bridge for Camelback Walk at Pima Road would be adequate for the increased discharge (estimated at 2160 cfs) and, according to backwater computations, the water surface at the inlet would only increase 0.45'. The channel along the northerly side of Pima Road to the temporary Mountain View Road spur would be adequate. However, the culverts below the spur would be inadequate for the higher discharge (estimated a 800 cfs), as well as the channel extending northerly to Shea Boulevard.

The diversion of some 478.91 acres of watershed to the easterly side of Pima Road would greatly lessen the danger of flooding inside the presently-developed areas of McCormick Ranch Phase II. The 10' x 3' box culvert (capacity 280 cfs) at the northeasterly extremity of Arabian Trail (roughly concentration point 30 in the Toups study) would be subjected to only 252 cfs in the 100-year event. The drainageway through Paradise Park Manor subdivision and the structural plate arch culvert at its crossing with Mountain View Road (roughly concentration point 42) would be subjected to 877 cfs, which is still somewhat over the design capacity of 760 cfs, but this should be acceptable, since 1-foot freeboard was provided in setting the adjacent building elevations. Included in Appendix III of this report, for various key points, are the hydrologic computations which allow for the proposed modifications in the Dibble plans, and the results are shown on Map "D" of Appendix I.

A general summary of the above alternates, with associated costs, is as follows:

Alternate	Compatible With Exist. McCormick Ranch Drainage	Adequate For Drainage Across Shea	Adequate For Exist. Drainage Along Pima	Adequate For Future Drainage Along Pima	Cost
A	No	No	Yes	Yes	151,000
B	No	Yes	Yes	Yes	194,200*
C	Yes	No	No	No	118,600
D	Yes	Yes	No	No	161,800*
E	Yes	No	Yes	No	145,210**
F	Yes	Yes	Yes	No	172,260***
G	Yes	Yes	No	No	151,860****
H	Yes	No	Yes	Yes	223,420*****
I	Yes	Yes	Yes	Yes	250,470******

*43,200 of these costs could be required of future developers
**26,610 of these costs could be required of future developers
(Net cost for City of Scottsdale essentially same as "C")

***53,660 of these costs could be required of future developers (essentially same as "C")
****33,260 of these costs could be required of future developers
*****104,820 of these costs could be required of future developers (essentially same as "C")
******131,870 of these costs could be required of future developers (essentially same as "C")

RECOMMENDATIONS

Inasmuch as Alternates "A" and "B" offer no solutions to the drainage deficiencies inside McCormick Ranch Phase II, neither can be recommended. In addition, Alternate "D" should not be considered, as another solution - Alternate "G" - can achieve the same results at a lesser cost. Also, Alternates "E" and "H" should not be adopted, as they offer no remedy to the inadequate culvert at Shea Boulevard Station 15+60. Alternate "C", on the basis of pure economics, less risk of possible flooding to residences, and adaptability to future improvements, is the most reasonable solution, although it entails (for the present) some risk of flooding along Pima Road. Improvements to the property to the east of Pima Road (including an adequate channel) and to Shea Boulevard west of Pima Road (including an adequate structure at Station 15+60) are represented by Alternates "F" and "G", which could be adopted as possible stage improvements to Alternate "C" - the additional cost possibly being borne by developers. Ultimately, in the last stage, Alternate "I" should be achieved, as this would solve all existing and future drainage problemes related to McCormick Ranch Phase II and McCormick Ranch Center.

In summation, for the present, the following changes should be made in the Dibble plans:

1. The present two drainage structures shown crossing Shea Boulevard at or near the intersection of Pima Road should be deleted.

2. A single drainage structure should be placed at approximately Shea Boulevard Station 21+10, with a capacity of approximately 795 cfs - possibly a 5-barrel 6' x 3' box culvert, or equivalent.

3. The outlet of the foregoing structure should be designed with a drop structure with about a 4' fall, since without it, the velocity in the ultimate outlet channel would achieve 9.22 fps, which is in excess of the allowable 6-8 fps in a grass-lined channel (i.e., with slopes less than 5%).

4. A temporary channel should be constructed from the outlet of the foregoing and graded to daylight in the existing channel on the east side of Pima Road.

In the future, upon developing the property to the east side of Pima Road from Mountain View Road to Shea Boulevard, the following should be required:

1. Remove and salvage the 4-barrel 42" x 150' RGRCP presently constructed

below the Mountain View Road spur.

2. Construct a culvert adequate for 800 cfs below Mountain View Road on the east side of Pima Road - possibly a 4-barrel 6' x 4' box culvert, or an equivalent.

3. Deepen and widen the ditch on the east side of Pima Road from Mountain View Road to Shea Boulevard to accommodate 795 cfs. This will require, on the east side of Pima Road, an estimated additional 20 feet of drainage easement, which should flare to 50 feet in the northerly 350 feet.

In addition, upon initiating roadway improvements on Shea Boulevard between Hayden and Pima Roads, the existing 2-barrel 36" x 22' Corrugated Metal Arch Pipe at Shea Boulevard Station 15+60 should be replaced by 4-barrel 42" RGRCP, which should have been removed and salvaged from the Mountain View Road spur adjacent to Pima Road. Before the final placement of these is specified in the construction plans, the elevation of the 24" water line southerly of Shea Boulevard should be verified through actual field excavation, as the elevation may make the installation of 42" RGRCP at this site impractical.

Hydraulic computations for all proposed new drainage structures are included in Appendix IV of this report.

As a miscellaneous item of interest, it is noted that the Pima Road plans, as developed by the firm of Collar, Williams, and White (and now constructed) did not allow for a 2-barrel 48" RGRCP crossing Pima Road just north of its intersection with Via Linda to provide for some 199 cfs (as given in the Toups study). Instead, only a single 18" RGRCP was constructed to provide only for roadway drainage. A notation in the Collar, Williams, and White Pima Road drainage report attributes this change to a decision by the developer that the parcels easterly of Pima Road and immediately northerly of Via Linda would have on-site retention. Therefore, the area that must utilize on-site retention in the future has been shown on Map "D" in Appendix I of this report.

APPENDIX I

APPENDIX II

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET

S C S METHOD: PART I

Concentration point C w/revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.085	square miles
Drainage Length	2900	feet
Elevation		
Top of Drainage Area	1376	feet
At Structure	1368	feet
Drainage Area Slope	0.38	%
Drainage Width	950	feet
Width factor W_f	1.10	
Vegetative Cover Type	Lawns + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Precipitation	P = 1 hour =	2.66	inches
Curve Number		94	
Runoff	Q =	2.05	inches
Time of Concentration	Tc	0.37	hours
Time of Peak	Tp = (Tc)(W_f)	0.41	hours

Peak Discharge $Qp = \frac{484\,AQ}{Tp} = \frac{484(0.085)(2.05)}{0.41}$

= 206 cfs

Computed by RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET

S C S METHOD: PART I

Concentration Point 9 w/revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.180	square miles
Drainage Length	3900	feet
Elevation		
Top of Drainage Area	1376	feet
At Structure	1360	feet
Drainage Area Slope	0.41	%
Drainage Width	1300	feet
Width factor W_f	1.00	
Vegetative Cover Type	Lawn + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Precipitation	P = 1 hour =	2.66	inches
Curve Number		93	
Runoff	Q =	1.95	inches
Time of Concentration	Tc	6.43	hours
Time of Peak	Tp = (Tc)(W_f)	0.43	hours

Peak Discharge $Qp = \frac{484\,AQ}{Tp} = \frac{484(.180)1.95}{0.43}$

= 395 cfs

Computed by RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

Concentration Point 17 w/revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	2.54	square miles
Drainage Length	17000	feet $\frac{17000}{4157} = 4.09$
Elevation		
Top of Drainage area	1506	feet
At Structure	1366	feet
Drainage Area Slope	0.82	%
Vegetative Cover Type	Desert Brush	
Vegetative Cover Density	10	%
Soil Group	"C"	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number	91	
Time of Concentration	1.50	hours
Peak Design Discharge		

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{1229.3CQ}{\frac{D}{2} + 0.9}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	1537
2 hour	2.82		2.82	1.95	1262
3 hour	2.97		2.97	2.10	1076
6 hour	3.35		3.35	2.40	757

Computed by: RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

Concentration Point 20 w/ Revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	2.654	square miles
Drainage Length	20000	feet
Elevation		
Top of Drainage area	1506	feet
At Structure	1360	feet
Drainage Area Slope	0.73	%
Vegetative Cover Type	Desert Brush + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number 91
Time of Concentration $1.5 + \frac{3000}{5 \times 3600} = 1.67$ hours
Peak Design Discharge

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{1284.54\,Q}{\frac{D}{2} + 1.00}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	1499 (use 1537)
2 hour	2.82		2.82	1.95	1252
3 hour	2.97		2.97	2.10	1079
6 hour	3.35		3.35	2.40	771

Computed by: RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
RATIONAL METHOD

Concentration point 22 w/ exist Dibble plans

LOCATION DATA

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA

Design Frequency		100	years
Drainage Area	A_1	154.00	acres
	A_2		acres
	A_3		acres
Drainage Length		8200	feet
Elevation			
Top of Drainage Area		1407	feet
At Structure		1347	feet
Drainage Area Slope		6.73	%
Precipitation			
P = 6-hour		3.35	inches
P = 24-hour		4.04	inches

DESIGN COMPUTATIONS

Precipitation P_1 = 1-hour		2.66	inches
Time of Concentration $\frac{34.5 + 2600}{6400}$	Tc	40.2	minutes
Rainfall Intensity	i	3.4	inches/hour
Runoff Coefficient	C_1		
	C_2		
	C_3		
Weighted Runoff Coefficient	C	0.50	
Peak Discharge Qp = CiA =		262	cfs

Computed by RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

Concentration point 26 w/ existing Dibble plans

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years	
Drainage Area	3.259	square miles	
Drainage Length	22.000	feet	
Elevation			
Top of Drainage area	1506	feet	1506
At Structure	1337	feet	1337
Drainage Area Slope	0.77	%	169
Vegetative Cover Type	Desert Brush + Paving		
Vegetative Cover Density	10	%	
Soil Group	C		
Precipitation			
P = 6 hour =	3.35	inches	
P = 24 hour =	4.04	inches	

DESIGN COMPUTATION:

Curve Number 91
Time of Concentration $1.67 + \frac{2000}{18000}$ 1.78 hours
Peak Design Discharge

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{1577.36\ Q}{\frac{D}{2} + 1.07}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	1758
2 hour	2.82		2.82	1.95	1486
3 hour	2.97		2.97	2.10	1289
6 hour	3.35		3.35	2.40	930

Computed by: RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET

S C S METHOD: PART I

Concentration POINT 28 w/ revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.035	square miles
Drainage Length	2000	feet
Elevation		
Top of Drainage Area	1361	feet
At Structure	1250	feet
Drainage Area Slope	0.55	%
Drainage Width	500	feet
Width factor W_f	1.24	
Vegetative Cover Type	Lawn + Parking	
Vegetative Cover Density	50	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Precipitation	P = 1 hour =	2.66	inches
Curve Number		91	
Runoff	Q =	1.75	inches
Time of Concentration	Tc	0.30	hours
Time of Peak	Tp = (Tc)(W_f)	0.37	hours

Peak Discharge $Qp = \frac{484\,AQ}{Tp} = \frac{484\,(0.035)\,1.75}{0.37}$

= 80 cfs

Computed by RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
RATIONAL METHOD

Concentration point 28 w/ revised parameters

LOCATION DATA

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA

Design Frequency		100	years
Drainage Area	A_1	22.4	acres
	A_2		acres
	A_3		acres
Drainage Length		2000	feet
Elevation			
Top of Drainage Area		1361	feet
At Structure		1350	feet
Drainage Area Slope		0.55	%
Precipitation			
P = 6-hour		3.35	inches
P = 24-hour		4.04	inches

DESIGN COMPUTATIONS

Precipitation P_1 = 1-hour		2.66	inches
Time of Concentration	Tc	18	minutes
Rainfall Intensity	i	5.6	inches/hour
Runoff Coefficient	C_1		
	C_2		
	C_3		
Weighted Runoff Coefficient	C	0.6	
Peak Discharge Qp = CiA =		75	cfs

Computed by RB Date June 1979

APPENDIX II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET

S C S METHOD: PART I

Downstream from Concentration Point 30 w/exist Dibble plans

LOCATION DATA:

Highway ARABIAN TRAIL County _____

Location _____

Project No. _____ Station _____

Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	1.01	square miles
Drainage Length	13 000	feet
Elevation		
Top of Drainage Area	1460	feet
At Structure	1363	feet
Drainage Area Slope	0.75	%
Drainage Width	2200	feet
Width factor W_f	1.00	
Vegetative Cover Type	Desert Brush + 30% Impervious	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Precipitation	P = 1 hour =	2.66	inches
Curve Number		91	
Runoff	Q =	1.75	inches
Time of Concentration	Tc	0.97	hours
Time of Peak	Tp = (Tc)(W_f)	0.97	hours

Peak Discharge $Qp = \frac{484\,AQ}{Tp} = \frac{484(1.01)1.75}{0.97}$

= 882 cfs

Computed by RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
RATIONAL METHOD

LOCATION DATA Concentration Point 30, with existing Dibble plans

Highway SHEA BLVD. County _____
Location _____
Project No. _____ Station 15+60
Name of Stream _____

DESIGN DATA

Design Frequency		100	years
Drainage Area	A_1	168	acres
	A_2		acres
	A_3		acres
Drainage Length		8000	feet
Elevation			
Top of Drainage Area		1420	feet
At Structure		1364	feet
Drainage Area Slope		0.7	%
Precipitation			
P = 6-hour		3.35	inches
P = 24-hour		4.04	inches

DESIGN COMPUTATIONS

Precipitation P_1 = 1-hour		2.66	inches
Time of Concentration	Tc	$\frac{8000}{25} + 13 = 51$ (use 50)	minutes
Rainfall Intensity	i	3.00	inches/hour
Runoff Coefficient	C_1		
	C_2		
	C_3		
Weighted Runoff Coefficient	C	0.5	
Peak Discharge Qp = CiA =		252	cfs

Computed by RB Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

LOCATION DATA: Concentration point 35 w/ revised parameters

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.577	square miles
Drainage Length	11000	feet
Elevation		
Top of Drainage area	1438	feet
At Structure	1352	feet
Drainage Area Slope	0.78	%
Vegetative Cover Type	Desert Brush + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number	91	
Time of Concentration	0.77	hours
Peak Design Discharge		

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{279.27Q}{\frac{D}{2} + 0.46}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	509
2 hour	2.82		2.82	1.95	373
3 hour					
6 hour					

Computed by: RE Date June 1979.

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

LOCATION DATA: Concentration Point 42 w/exist. Dibble plans

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	1.928	square miles
Drainage Length	18000	feet
Elevation		
Top of Drainage area	1460	feet
At Structure	1342	feet
Drainage Area Slope	6.66	%
Vegetative Cover Type	Desert Brush + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number 91
Time of Concentration $54.6 + \frac{5000}{6 \times 60} = 71.3 \text{ min} = 1.19$ hours
Peak Design Discharge

$$Q_p = \frac{484AQ}{\frac{D}{2} + .6T_c} = \frac{933.15\,Q}{\frac{D}{2} + 0.71}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	1350
2 hour	2.82		2.82	1.95	1064
3 hour					
6 hour					

Computed by: RE Date June 1979

Appendix II

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

LOCATION DATA: Concentration Point 50 with revised parameters

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	5.407	square miles
Drainage Length	24,800	feet
Elevation		
Top of Drainage area	1506	feet
At Structure	1326	feet
Drainage Area Slope	0.73	%
Vegetative Cover Type	Desert Brush + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number	91	
Time of Concentration $1.78 + \frac{2800}{18000}$	1.94	hours
Peak Design Discharge		

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{2616.99Q}{\frac{D}{2} + 1.164}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	2752
2 hour	2.82		2.82	1.95	2358
3 hour	2.97		2.97	2.10	2063
6 hour	3.35		3.35	2.40	1508

Computed by: RE Date June 1979.

APPENDIX III

APPENDIX III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
RATIONAL METHOD

@ Shea Boulevard with modified Dibble Plans

LOCATION DATA

Highway Shea Blvd. County Maricopa
Location
Project No. P-7809 Station 21+10
Name of Stream

DESIGN DATA

Design Frequency		100	years
Drainage Area	A_1	568.37	acres
	A_2		acres
	A_3		acres
Drainage Length		13000	feet
Elevation			
Top of Drainage Area		1460	feet
At Structure		1362	feet
Drainage Area Slope		0.75	%
Precipitation			
P = 6-hour		3.35	inches
P = 24-hour		4.04	inches

DESIGN COMPUTATIONS

Precipitation P_1 = 1-hour		2.66	inches
Time of Concentration	Tc	54.6	minutes
Rainfall Intensity	i	2.80	inches/hour
Runoff Coefficient	C_1		
	C_2		
	C_3		
Weighted Runoff Coefficient	C	0.50	
Peak Discharge Qp = CiA =		795	cfs

Computed by RE Date June, 1979

APPENDIX III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET

S C S METHOD: PART I

Concentration point C w/revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.085	square miles
Drainage Length	2900	feet
Elevation		
Top of Drainage Area	1376	feet
At Structure	1363	feet
Drainage Area Slope	0.38	%
Drainage Width	990	feet
Width factor W_f	1.10	
Vegetative Cover Type	Lawns + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Precipitation	P = 1 hour =	2.66	inches
Curve Number		94	
Runoff	Q =	2.05	inches
Time of Concentration	Tc	0.37	hours
Time of Peak	Tp = (Tc)(W_f)	0.41	hours

Peak Discharge $Qp = \frac{484\,AQ}{Tp} = \frac{484(0.085)(2.05)}{0.41}$

= 206 cfs

Computed by RE Date June 1979

Appendix III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET

S C S METHOD: PART I

Concentration Point 9 w/revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.180	square miles
Drainage Length	3500	feet
Elevation		
Top of Drainage Area	1376	feet
At Structure	1360	feet
Drainage Area Slope	0.41	%
Drainage Width	1300	feet
Width factor W_f	1.00	
Vegetative Cover Type	Lawn + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Precipitation	P = 1 hour =	2.66	inches
Curve Number		93	
Runoff	Q =	1.95	inches
Time of Concentration	Tc	0.43	hours
Time of Peak	Tp = (Tc)(W_f)	0.43	hours

Peak Discharge $Qp = \frac{484\,AQ}{Tp} = \frac{484(.180)1.95}{0.43}$

= 395 cfs

Computed by RE Date June 1979

Appendix III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

Concentration Point 17 w/revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	2.54	square miles
Drainage Length	17000	feet $\frac{17000}{4157} = 4.09$
Elevation		
Top of Drainage area	1506	feet
At Structure	1366	feet
Drainage Area Slope	0.82	%
Vegetative Cover Type	Desert Brush	
Vegetative Cover Density	10	%
Soil Group	"C"	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number	91	
Time of Concentration	1.50	hours
Peak Design Discharge		

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{1229.36\,Q}{\frac{D}{2} + 0.9}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	1537
2 hour	2.82		2.82	1.95	1262
3 hour	2.97		2.97	2.10	1076
6 hour	3.35		3.35	2.40	757

Computed by: RE Date June 1979

APPENDIX III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

Concentration Point 20 w/ Revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	2.654	square miles
Drainage Length	20000	feet
Elevation		
Top of Drainage area	1506	feet
At Structure	1360	feet
Drainage Area Slope	0.73	%
Vegetative Cover Type	Desert Brush + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number 91
Time of Concentration $1.5 + \frac{3,000}{5 \times 3600} = 1.67$ hours
Peak Design Discharge

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{1284.54\,Q}{\frac{D}{2} + 1.00}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	1499 (use 1537)
2 hour	2.82		2.82	1.95	1252
3 hour	2.97		2.97	2.10	1079
6 hour	3.35		3.35	2.40	771

Computed by: RE Date June 1975

APPENDIX III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

LOCATION DATA: Concentration point 22 w/modified Dibble plans

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.99	square miles
Drainage Length	15,600	feet
Elevation		
Top of Drainage area	1460	feet
At Structure	1347	feet
Drainage Area Slope	0.75	%
Vegetative Cover Type	Desert Brush + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number	91	
Time of Concentration	0.92	hours
Peak Design Discharge		

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{479.16\,Q}{\frac{D}{2} + 0.55}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	800
2 hour	2.82		2.82	1.95	603
3 hour					
6 hour					

Computed by: RE Date June 1978

APPENDIX III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

LOCATION DATA: Concentration point 26 w/ modified Dibble plans

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	4.01	square miles
Drainage Length	22,000	feet
Elevation		
Top of Drainage area	1506	feet
At Structure	1337	feet
Drainage Area Slope	0.77	%
Vegetative Cover Type	Desert Brush + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number	91	
Time of Concentration	1.78	hours
Peak Design Discharge		

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{1940.84\,Q}{\frac{D}{2} + 1.07}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	2163
2 hour	2.82		2.82	1.95	1828
3 hour	2.97		2.97	2.10	1580
6 hour	3.35		3.35	2.40	1144

Computed by: RE Date June 1979

APPENDIX III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET

S C S METHOD: PART I

Concentration POINT 28 w/ REVISED parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.035	square miles
Drainage Length	2000	feet
Elevation		
Top of Drainage Area	1361	feet
At Structure	1350	feet
Drainage Area Slope	0.55	%
Drainage Width	500	feet
Width factor W_f	1.24	
Vegetative Cover Type	Lawn + Parks	
Vegetative Cover Density	50	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Precipitation	P = 1 hour =	2.66	inches
Curve Number		91	
Runoff	Q =	1.75	inches
Time of Concentration	Tc	0.30	hours
Time of Peak	Tp = (Tc)(W_f)	0.37	hours
Peak Discharge	$Qp = \frac{484\,AQ}{Tp} =$	$\frac{484(0.035)1.75}{0.37}$	
	=	80	cfs

Computed by RE Date June 1979

Appendix III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
RATIONAL METHOD

Downstream From Concentration Point 30 w/modified Dibble plans

LOCATION DATA

Highway Arabian Trail County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA

Design Frequency		100	years
Drainage Area	A_1	168	acres
	A_2		acres
	A_3		acres
Drainage Length			feet
Elevation			
Top of Drainage Area			feet
At Structure			feet
Drainage Area Slope			%
Precipitation			
P = 6-hour			inches
P = 24-hour			inches

DESIGN COMPUTATIONS

Precipitation P_1 = 1-hour			inches
Time of Concentration	Tc	50	minutes
Rainfall Intensity	i	3.00	inches/hour
Runoff Coefficient	C_1		
	C_2		
	C_3		
Weighted Runoff Coefficient	C	0.5	
Peak Discharge Qp = CiA =		252	cfs

Computed by RE Date June 1979

APPENDIX III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
RATIONAL METHOD

LOCATION DATA Concentration Point 30, with existing Dibble plans

Highway SHEA BLVD. County _____
Location _____
Project No. _____ Station 15+60
Name of Stream _____

DESIGN DATA

Design Frequency		100	years
Drainage Area	A_1	168	acres
	A_2		acres
	A_3		acres
Drainage Length		8000	feet
Elevation			
Top of Drainage Area		1420	feet
At Structure		1364	feet
Drainage Area Slope		0.7	%
Precipitation			
P = 6-hour		3.35	inches
P = 24-hour		4.04	inches

DESIGN COMPUTATIONS

Precipitation P_1 = 1-hour		2.66	inches
Time of Concentration	Tc	$\frac{8000}{75} + 13 = 51$ (use 50)	minutes
Rainfall Intensity	i	3.00	inches/hour
Runoff Coefficient	C_1		
	C_2		
	C_3		
Weighted Runoff Coefficient	C	0.5	
Peak Discharge Qp = CiA =		252	cfs

Computed by _____ Date _____

APPENDIX III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

Concentration point 35 w/ revised parameters

LOCATION DATA:

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	0.577	square miles
Drainage Length	11000	feet
Elevation		
Top of Drainage area	1438	feet
At Structure	1352	feet
Drainage Area Slope	0.78	%
Vegetative Cover Type	DESERT BRUSH + PAVING	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number	91	
Time of Concentration	0.77	hours
Peak Design Discharge		

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{279.27Q}{\frac{D}{2} + 0.46}$$ _____ cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	509
2 hour	2.82		2.82	1.95	373
3 hour					
6 hour					

Computed by: RE Date June 1979.

Appendix III

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

LOCATION DATA: Concentration Point 50 with revised parameters

Highway _____ County _____
Location _____
Project No. _____ Station _____
Name of Stream _____

DESIGN DATA:

Design Frequency	100	years
Drainage Area	5.407	square miles
Drainage Length	24,800	feet
Elevation		
Top of Drainage area	1506	feet
At Structure	1326	feet
Drainage Area Slope	0.73	%
Vegetative Cover Type	Desert Brush + Paving	
Vegetative Cover Density	10	%
Soil Group	C	
Precipitation		
P = 6 hour =	3.35	inches
P = 24 hour =	4.04	inches

DESIGN COMPUTATION:

Curve Number	91	
Time of Concentration $1.78 + \frac{2800}{18000}$	1.94	hours
Peak Design Discharge		
$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} = \frac{2616.99Q}{\frac{D}{2} + 1.164}$		cfs

Storm Duration	Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge
1 hour	2.66		2.66	1.75	2752
2 hour	2.82		2.82	1.95	2358
3 hour	2.97		2.97	2.10	2063
6 hour	3.35		3.35	2.40	1508

Computed by: RE Date June 1979

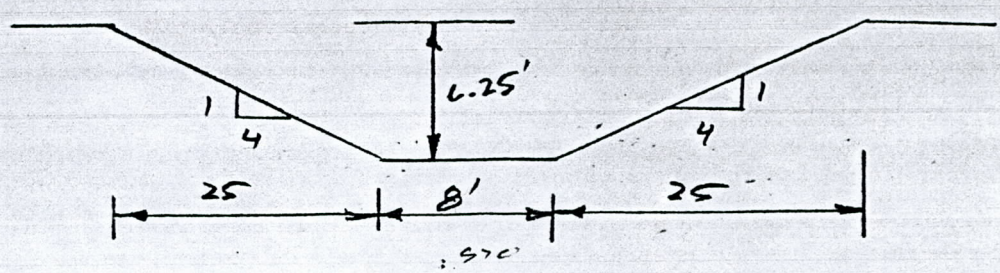
APPENDIX IV

Check Adequacy of exist channel from Camelback Walk to Mountain View Road

$Q = 800$ cfs

$n = 0.03$

$S = 0.003'/ft$



w/ $d = 5.11$ $\quad A = 145.33 \quad WP = 50.14 \quad R = 2.898$

$$V = \frac{1.486}{n} R^{2/3} S^{1/2} = \frac{1.486}{.03} \times \overset{2.0325}{2.898^{2/3}} \times \overset{0.0548}{0.003^{1/2}} = 5.52 \text{ FPS.}$$

$Q = 145.33 \times 5.52 = 802$ cfs $\simeq$ 800 CFS (OK)

since $d = 5.11' < 6.25'$ exist channel (OK)

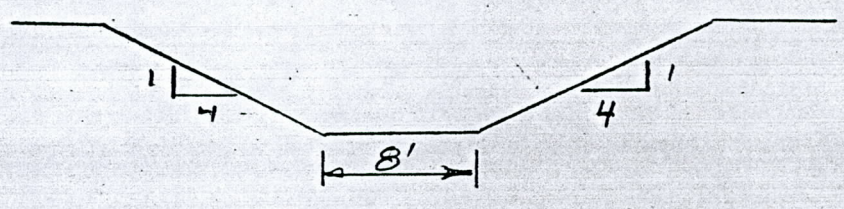
Channel Design From Mountain View Road to Shea Blvd

Sta. 84+30 (existing Sta) to 6+25 (Dibble Sta)

$Q = 795$ cfs

$n = 0.03$

$S = 0.0058$



w/ $d = 4.41$ $\quad A = 113.07 \quad WP = 44.37 \quad R = 2.548$

$$V = \frac{1.486}{n} R^{2/3} S^{1/2} = \frac{1.486}{.03} \times \overset{1.865}{2.548^{2/3}} \times \overset{.0762}{0.0058^{1/2}} = 7.03$$

$Q = 113.07 \times 7.03 = 795$ CFS (OK)

Sta. 6+25 to 10+20 (Dibble Sta)

$Q = 795$ cfs

$n = 0.03$ (same as above)

$S = 0.0120$

w/ d = 3.75 A = 86.25 WP = 38.93 R = 2.216

$$V = \frac{1.486}{n} \times R^{2/3} \times S^{1/2} = \frac{1.486}{.03} \times \overset{1.700}{2.216^{2/3}} \times \overset{0.110}{0.0120^{1/2}} = 9.22 \text{ F.P.S.}$$

Velocity exceeds allowable for 6" Bermuda Grass on 0%-5% slope (page 99, of "Design of Channels with Flexible Linings"). The channel should be designed in continuous grade from Mountain View Road to Shea Boulevard and Box Culvert at Shea Boulevard should be constructed with a drop at the outlet.

ARIZONA HIGHWAY DEPARTMENT — CULVERT COMPUTATION SHEET

PROJECT: Pima Road

STATION: 82+95 to 84+19

DESIGNER: BE

DATE: June 1979

HYDROLOGIC AND CHANNEL INFORMATION

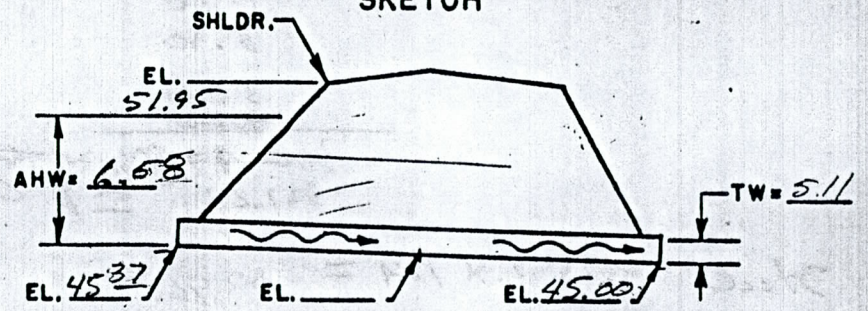
DRAINAGE AREA 634 ACRES

Q_1 = 800 TW_1 = 5.11

Q_2 = ____ TW_2 = ____

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

SKETCH



S_0 = 0.003 L = 124 L/100 S_0 = 0.37

MEAN STREAM VELOCITY = ____

CULVERT DESCRIPTION		Q	CAP. CHART HW	HEADWATER COMPUTATION										CONTROL HW	OUTLET VELOCITY	COST	DHW ELEV.	COMMENTS
				INLET CONT.		OUTLET CONTROL $HW = H + h_0 - LS_0$												
SIZE	ENTR. TYPE			HW/D	HW	K_e	H	d_c	$\frac{d_c + D}{2}$	TW	h_0	LS_0	HW					
2-10x4	Hdwl	800	800	1.64	6.58	0.4	2.4	3.70	3.85	5.11	5.11	0.37	7.39	7.39	10.0			INADEQUATE
3-8x4	Hdwl	800	960	1.37	5.48	0.4	1.80	3.30	3.65	5.11	5.11	0.37	6.54	6.54	8.3	78,506	51.99	OK
4-6x4	Hdwl	800	960	1.37	5.48	0.4	1.90	3.30	3.65	5.11	5.11	0.37	6.74	6.74	8.3	75,802	52.01	Say OK

SUMMARY & RECOMMENDATIONS

ARIZONA HIGHWAY DEPARTMENT

CULVERT COMPUTATION SHEET

PROJECT: Shea Boulevard

STATION: 21+10

DESIGNER: RE

DATE: June 1975

HYDROLOGIC AND CHANNEL INFORMATION

DRAINAGE AREA 522.71

Q_1 = 730

Q_2 =

TW_1 = 2.00 ⊕

TW_2 =

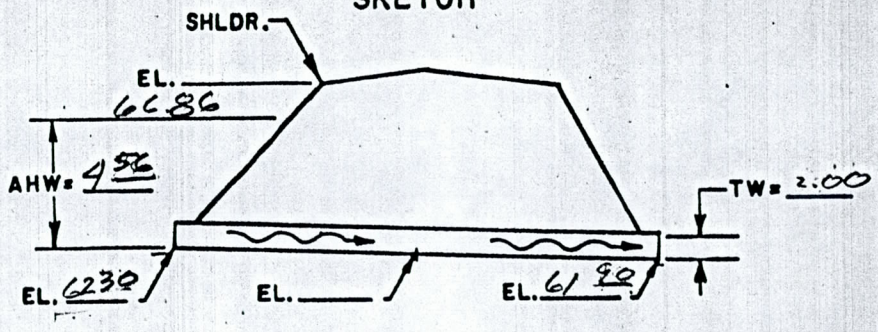
2.8

6/32

⊕ with 4' drop @ outlet

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

SKETCH



S_0 = 0.003'/ft L = 134 L/100 S_0 = 0.40

MEAN STREAM VELOCITY =

	CULVERT DESCRIPTION		Q	CAP. CHART HW	HEADWATER COMPUTATION										CONTROL HW	OUTLET VELOCITY	COST	DHW ELEV.	COMMENTS
					INLET CONT.		OUTLET CONTROL $HW = H + h_0 - LS_0$												
	SIZE	ENTR. TYPE			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c + D}{2}$	TW	h_0	LS_0	HW					
140	4-8' X3	Hdwl.	795	773	1.54	4.62	0.4	2.00	2.70	2.85	2.60	2.85	0.40	3.80	4.45	[illegible]	101,000		(OK) inlet velocity head = 1.08'
146	5-6' X3'	Hdwl.	795	725	1.50	4.95	0.4	2.10	2.79	2.90	2.60	2.90	0.40	4.60	4.95	7.88	94,000*		(OK) inlet velocity head = 1.21'
213	3-10' X3	Hdwl	795	725	1.50	4.95	0.4	2.20	2.79	2.90	2.60	2.90	0.40	4.70	4.95	[illegible]	165,500		(OK) inlet velocity head = 1.21'

SUMMARY & RECOMMENDATIONS

* $100,000 w/ drop structure

Shea Boulevard - Straight Drop Structure @
Outlet 5-6'x3' Box Culvert

$Q/bbl = \frac{795}{5} = 159$ $\quad y_c = 2.79$ $\quad TW = 4.41$

$y_3 = 2.15 \times 2.79 = 6.00$

Basin depression $= 6.00 - 4.41 = 1.59$

$h_0 = 4.00$ $\quad h_2 = 6.00 - 4.00 = +2.0$

$\frac{h_0}{y_c} = \frac{4.00}{2.79} = 1.43$ $\quad + \frac{h_2}{y_c} = \frac{2.00}{2.79} = 0.72$

From Figure IX-A-2 of "Hydraulic Design of Energy Dissipators For Culvert and Channels"

By extrapolation $\frac{L_1}{y_c} = 10$ $\quad \therefore L_1 = 27.9$

$L_2 + L_3 = 2.55 \times 2.79 = 7.11$ $\quad L_2 = 0.8 \times 2.79 = 2.23$ (use 2.25)
$L_3 = 1.75 \times 2.79 = 4.88$ (use 5.00)

$L_B = L_1 + L_2 + L_3 = 27.9 + 7.11 = 35.01'$ (use 35')

Floor Blocks:

height $= 0.8 y_c = 0.8 \times 2.79 = 2.23'$ $\quad w_0 = 6'$

width & spacing $= 0.55 y_c = 0.55 \times 2.79 = 1.53$ (use 1.5)

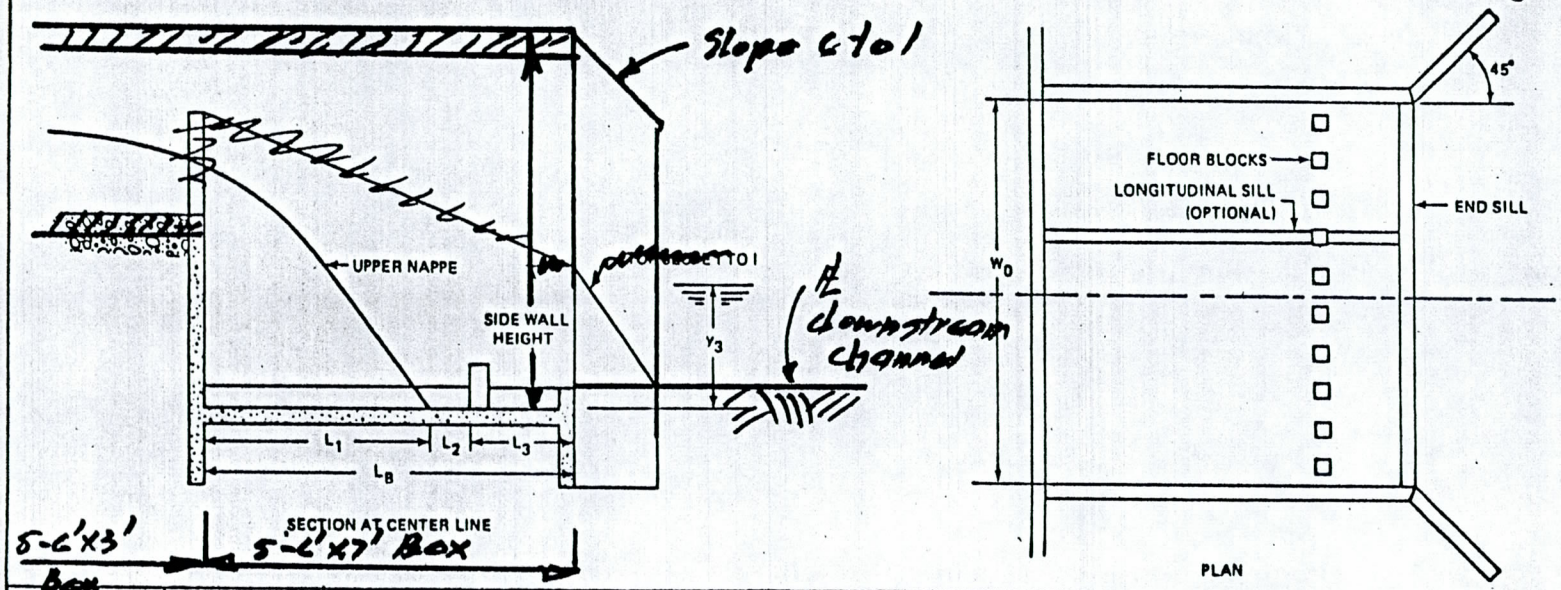
Use 2 Block with 1'-0" clear in each barrel

End Sill $= 0.4 y_c = 0.4 \times 2.79 = 1.14$ (use 1'-7")

Construct drop in outlet of 5-6'x3' Box Culvert w/ 35' section of 5-6'x7' Box.

STRAIGHT DROP STRUCTURE

9-A



	Natural S_o	New S_o	Normal Depth Upstream	Normal Depth Downstream	y_c	W_o
INITIAL DATA	0.012'/F	0.0058	2.98	4.41	2.79	32.67

	L_1	L_2	L_3	L_B	Floor Blocks Height	Floor Blocks Width	Spacing (1)	End Sill Height	Sidewall Height
DISSIPATOR DIMENSIONS	27.75	2.25	5.00	16.5	2.25	1.5	1.50	1.58	7.67

	y_3 min
	6.00

(1) Block should occupy 50 to 60 percent of Basin Width.

ARIZONA HIGHWAY DEPARTMENT

CULVERT COMPUTATION SHEET

PROJECT: Shea Blvd

STATION: 15+60

DESIGNER: RE

DATE: June 1979

HYDROLOGIC AND CHANNEL INFORMATION

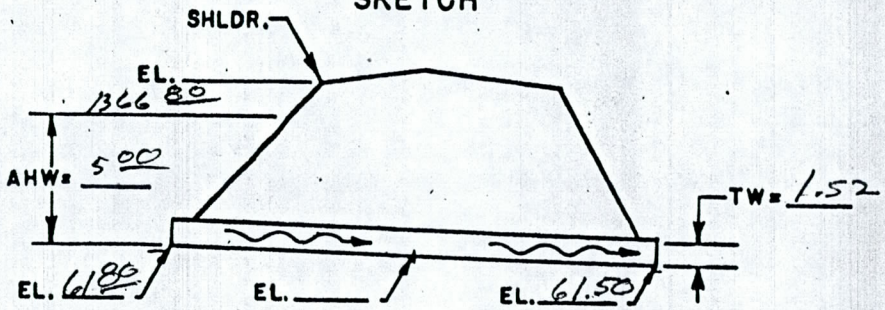
DRAINAGE AREA 160 Ac

Q_1 = 250 TW_1 = 1.52

Q_2 = ____ TW_2 = ____

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

SKETCH



S_0 = 0.0025'/FT L = 120 L/100 S_0 = 0.30

MEAN STREAM VELOCITY = ____

CULVERT DESCRIPTION		Q	CAP. CHART HW	HEADWATER COMPUTATION										CONTROL HW	OUTLET VELOCITY	COST	DHW ELEV.	COMMENTS
				INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$												
SIZE	ENTR. TYPE			HW/D	HW	K_e	H	d_c	$\frac{d_c + D}{2}$	TW	h_o	LS_o	HW					
10'x3'	Hdwl	250	279	1.55	4.65	0.4	1.90	2.70	2.85	1.52	2.85	0.30	4.45	4.65		$35,500		
2-6' x3'	Hdwl	250	287	1.32	3.96	0.4	1.60	2.50	2.75	1.52	2.75	0.30	4.05	4.05		$38,000		
3-42"	Hdwl	250	252	1.33	5.00	0.5	2.50	2.80	3.15	1.52	3.15	0.30	5.35	5.35				INADEQUATE
4-42"	Hdwl	250	332	1.08	3.78	0.5	1.40	2.50	3.00	1.52	3.00	0.30	4.10	4.10		$38,000	*	

SUMMARY & RECOMMENDATIONS

*. 21,200 IF constructed from Mountain View Road salvaged pipe.

PROJECT NO. _____

Line cos
6:1 0.992
4:1 0.970

WATER SURFACE PROFILE COMPUTATION SHEET

CHANNEL TYPE *Trapezoidal*

$n = 0.03$, $C^2 = (1.486/n)^2 = 2454$, $Q = 2730$ / 2100 / 2100 / 2100, $S_0 = 0.0033$ / 0.0033 / 0.0023 / 0.0023, $b = 120$ / 120 / 132, $d_c = 2.39$ / 2.02 / 2.02 / 1.95, $d_n = 3.30$ / 2.85 / 3.15 / 3.07 (6:1 / 4:1)

	Y	A	WP	R	$R^{4/3}$	V	$V^2/2g$	h_e	E	$\frac{V^2}{(C^2R^{4/3})}$	S_{fm}	$S_0 - S_{fm}$	$E_2 - (E_1 - h_e)$	ΔL	$\Sigma\Delta L$	S_0
280 ft upstream Toups 1450	3.30	483.12	173.23	2.789	(9629) 3.924	4.35	(18.89) 0.29		3.59	.0020						
Toups 1500	~~3.00~~	~~432.0~~	~~168.39~~	~~2.565~~	(8616) 3.511	4.861	(23.63) 0.37		~~3.37~~	~~.0027~~	~~.00235~~	~~+.00075~~	~~-0.22~~	~~232~~	~~≠ 480~~	~~.0033~~
ΔL=480' Toups 1500	2.86	408.64	166.13	2.460	(8146) 3.319	5.139	(26.41) 0.41		3.27	.0032	.0026	+.0007	+0.32	457	≅ 480	.0033
ΔL=760' CW&W -1.00	3.15	457.38	170.81	2.678	(9122) 3.717	4.591	(21.08) 0.33		3.48	.0023	.00275	-.00045	+0.21	470	achieves d_n	.0033
ΔL=100 CW&W 0.00	3.14	453.92	157.90	2.875	(10,027) 4.082	4.626	(21.40) 0.33		3.47	.00213	.0022	-.0001	-0.01	100	= 100	.0023
ΔL=100 CW&W 1.00	~~3.00~~	~~411.00~~	~~149.74~~	~~2.745~~	(9428) 3.842	5.111	(26.13) 0.41		~~3.41~~	~~.00277~~	~~.00245~~	~~-.00055~~	~~-0.06~~	~~109~~	~~≠ 100~~	.0030
CW&W 1.00	3.01	412.49	149.82	2.753	(9466) 3.858	5.09	(25.92) 0.40		3.41	.00273	.00243	-.00057	-0.06	105	≅ 100	.0030
CW&W 2.00	2.93	374.22	140.16	2.670	(9087) 3.703	5.61	(31.49) 0.49		3.42	.00347	.00310	-.0001	+0.01	100	= 100 (4)	.0030

COMPUTED BY _____ CHECKED BY .620 DATE _____

PROJECT NO. _____

2:1 cos .894

WATER SURFACE PROFILE COMPUTATION SHEET

CHANNEL TYPE Trapezoidal – Rectangular

$n = \frac{0.03}{0.02}$, $C^2 = (1.486/n)^2 = \frac{2454}{5520}$, $Q = 2100$, $S_0 = .0030$, $b =$ ____, $d_c =$ ____, $d_n =$ ____.

	Y	A	WP	R	$R^{4/3}$	V	$V^2/2g$	h_e	E	S_f $\frac{V^2}{(C^2R^{4/3})}$	S_{fm}	$S_0 - S_{fm}$	ΔE $E_2 - (E_1 - h_e)$	ΔL	$\Sigma\Delta L$	S_0	
CW&W 2.00	2.93	374.22	140.16	2.620	(9087) 3.703	5.61	(31.49) 0.49		3.42	.00347							
ΔL=100' CW&W 3.00	2.96	363.61	135.41	2.685	(9154) 3.731	5.775	(33.31) 0.52		3.48	.00364	.00356	-.00056	+.06	107 ≡ 100		.0030	
CW&W 4.00	3.00	354.00	130.74	2.708	(9258) 3.773	5.932	(35.19) 0.55		3.55	.00380	.00372	-.00072	+.07	97 ≡ 100		.0030	
CW&W 5.00	3.06	343.45	125.24	2.742	(9416) 3.837	6.114	(37.39) 0.58		3.69	.00397	.00388	-.00088	+.09	102 ≡ 100		.0030	
w = 58 CW&W 6.00	d_c = 3.31	273.89	112.87	2.838	(10,321) 4.206	9.818	(96.40) 1.49		4.80	.00934	.00666	-.00366	+1.16	316 ≠ 100		.0030	GOES SUPERCRITICAL
ΔL=30 d_c = 3.70 CW&W 6.30	3.70	198.69	61.98	3.206	(11,595) 4.725	10.569	(111.71) 1.74		5.44	.00963	.00949	-.00649	+0.64	95 ≠ 30		.0030	STILL SUPERCRITICAL
ΔL=37 CW&W 6.67	3.90	187.2	55.80	3.355	(12,320) 5.020	11.218	(125.84) 1.95		5.85	.01021	.00992	-.00692	+0.41	55 ≠ 37		.0030	STILL SUPERCRITICAL
ΔL=88 CW&W 7.55	4.70	235.2	57.80	4.067	(25,845) 6.493	8.929	(79.72) 1.24		6.19	.00222	.0062	-.0032	+0.29	91 ≡ 88 (OK)		.0030	

COMPUTED BY _____ CHECKED BY _____ DATE _____

3:1 948

WATER SURFACE PROFILE COMPUTATION SHEET

CHANNEL TYPE Rectangular → Trapezoidal

$n = 0.02$ (0.03), $C^2 = (1.486/n)^2 = 5520$ (2454), $Q = 2100$, $S_0 = .0030$, $b =$ _____, $d_c =$ _____, $d_n =$ _____

	Y	A	WP	R	$R^{4/3}$	V	$V^2/2g$	h_e	E	S_f $\frac{V^2}{(C^2R^{4/3})}$	S_{fm}	$S_0 - S_{fm}$	ΔE $E_2 - (E_1 - h_e)$	ΔL	$\Sigma\Delta L$
CW&W 6.67	3.90	187.2	55.80	3.555	(12,320) 5.020	11.218	(125.84) 1.95		5.85	.01021					
CW&W 7.55	4.89	234.72	57.78	4.062	(35,743) 6.479	8.947	(80.05) 1.24		6.13	.00224	.00622	.00322	+0.28	87 ≅	88
35' CW&W 7+90	5.44	320.31	75.87	4.222	(16,737) 6.820	6.556	(42.98) 0.67		6.11	.00257	.0024	+.0006	+0.02	33 ≅	35
16' CW&W 8+06	5.57	360.43	83.22	4.331	(17,314) 7.056	5.826	(33.947) 0.53		6.10	.00196	.00227	+.00073	+0.01	14 ≅	16
69' CW&W 8+75	5.50	354.75	82.77	4.286	(17,076) 6.959	5.920	(35.04) 0.54		6.04	.00205	.00201	+.00099	+0.07	71 ≅	69

COMPUTED BY_____ CHECKED BY_____ DATE_____

PROJECT NO. _____

WATER SURFACE PROFILE COMPUTATION SHEET

CHANNEL TYPE *Trapezoidal*

$n = 0.03$, $C^2 = (1.486/n)^2 = 2454$, $Q = 1600$, $S_0 = 0.0030$, $b =$ _____, $d_c =$ _____, $d_n =$ _____.

	Y	A	WP	R	$R^{4/3}$	V	$V^2/2g$	h_e	E	S_f: $\frac{V^2}{(C^2R^{4/3})}$	S_{fm}	$S_0 - S_{fm}$	ΔE: $E_2 - (E_1 - h_e)$	ΔL	$\Sigma\Delta L$
CW&W 8+75	5.50	354.75	82.77	4.286	(17,076) 6.959	4.510	(20.34) 0.32		5.82	.00119					
											.00098	+.00202	-.20	99 ≅	100
CW&W 9+75	5.42	442.71	104.70	4.228	(16,721) 6.839	3.614	(13.06) 0.20		5.62	.00078					
											~~.00088~~	~~+.00217~~	~~-.24~~	~~111 ≅~~	~~125~~
CW&W ~~11+00~~	~~5.15~~	~~415.09~~	~~102.17~~	~~4.051~~	~~(16,839) 6.959~~	~~3.855~~	~~(14.86) 0.23~~		~~5.38~~	~~.00088~~					
Sem 10.20 CW&W 11+00	5.12	412.06	102.23	4.031	(15,734) 6.912	3.883	(15.08) 0.23		5.35	.00096	.00087	+.00213	-.27	127 ≅	125

COMPUTED BY _____ CHECKED BY _____ DATE _____

PIMA RD BRIDGE OVER CAMELBACK WALK CHANNEL

SINGLE SPAN 48', CLEAR 8' - SEE BRIDGE PLANS FOR DETAILS.

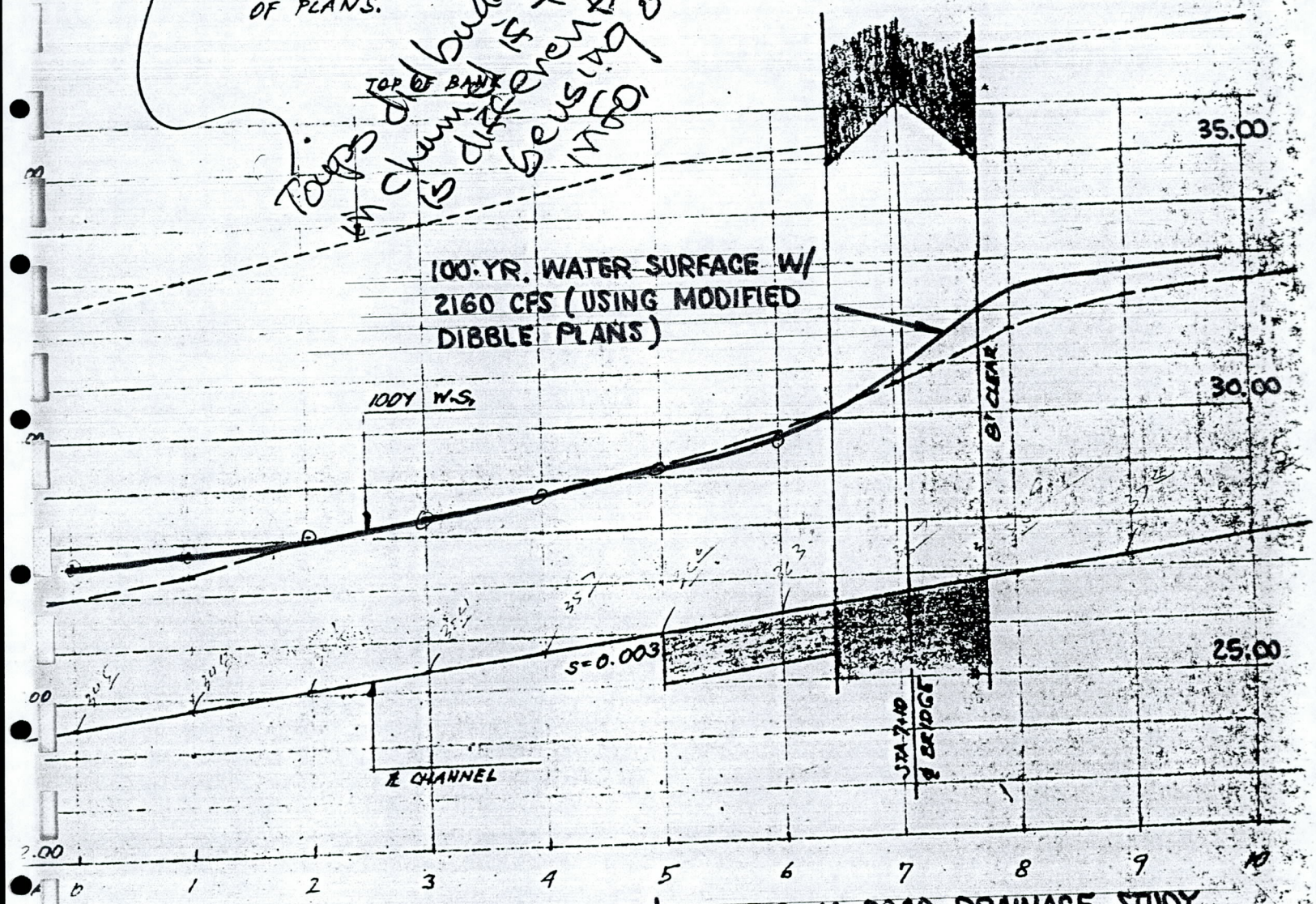
WATER SURFACE COMPUTATION BY BACKWATER METHOD - SEE ATTACHED COMP. PRINTS - SHEETS 11-15.

SECTION LOCATION MAP - SEE SHEET 12 - BRIDGE SITE PLAN.

Q100 FOR BRIDGE & CHANNEL FROM MASTER DRAIN. STUDY BY "TOUPS" STARTING WS ELEV. STA 0+00 - STA 1+00 (SEE SHEET 15 OF PLANS) FROM CHANNEL SECTION BY TOUPS USING MANNING.

FOR DETAILS OF CHANNEL BOTTOM AND BANKS PROTECTION SEE SHEET 15 OF PLANS.

Toups did hydraulics in channel & this would be different using other info.



FROM: COLLAR-WILLIAMS & WHITE PIMA ROAD DRAINAGE STUDY

CHANNEL PROFILE

(SEE PLAN SHEET 15 OF PLANS)

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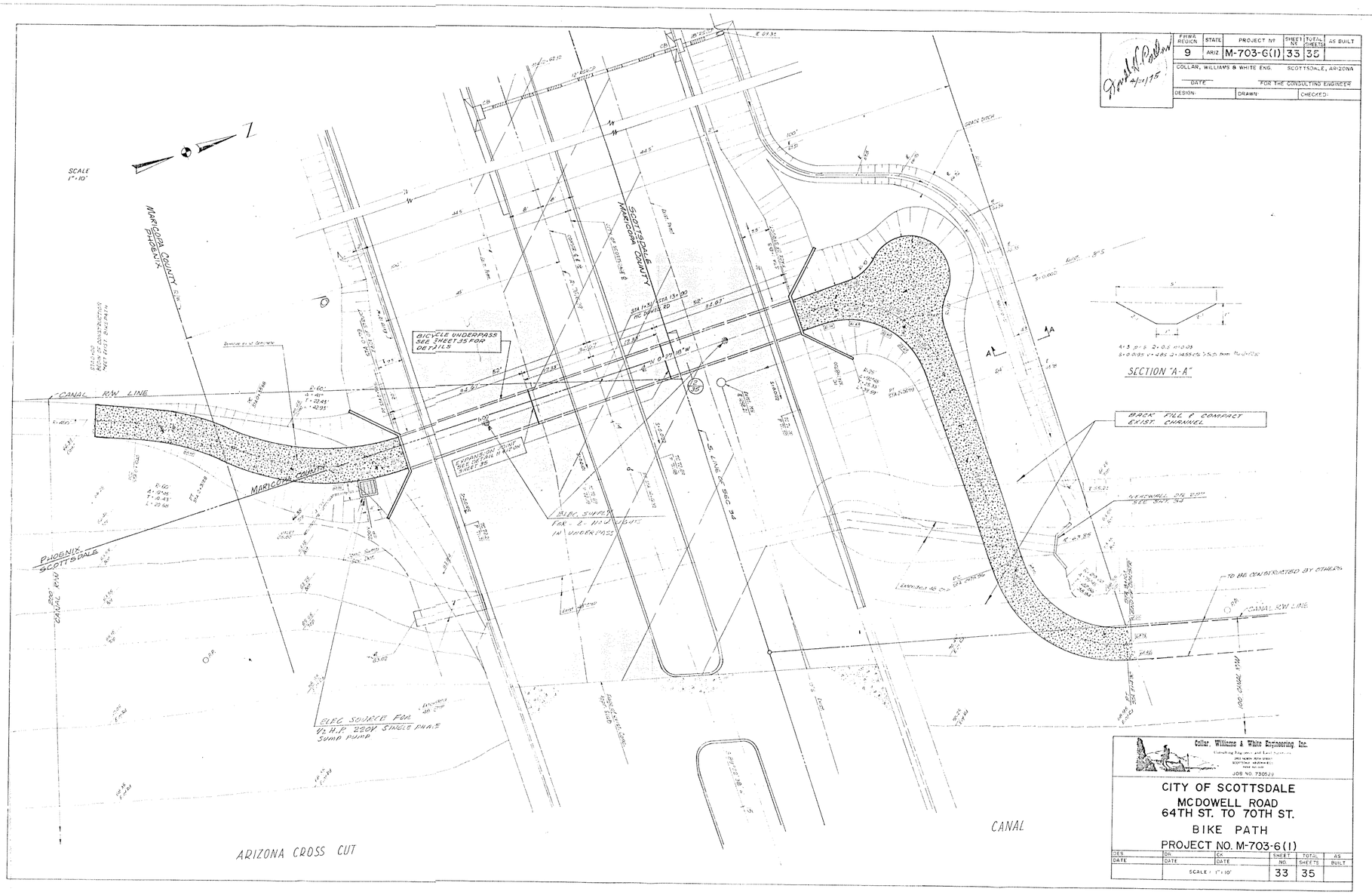
FHWA REGION	STATE	PROJECT Nº	SHEET Nº	TOTAL SHEETS	AS BUILT
9	ARIZ	M-703-6(1)	33	35	

COLLAR, WILLIAMS & WHITE ENG. SCOTTSDALE, ARIZONA

DATE FOR THE CONSULTING ENGINEER

DESIGN: DRAWN: CHECKED:



Collar, Williams & White Engineering, Inc.

JOB NO. 730529

CITY OF SCOTTSDALE
MCDOWELL ROAD
64TH ST. TO 70TH ST.
BIKE PATH
PROJECT NO. M-703-6(1)

DES	DN	CK	SHEET	TOTAL	AS
DATE	DATE	DATE	NO.	SHEETS	BUILT
	SCALE: 1"=10'		33	35	