RWCD FLOODWAY HYDROLOGY STUDIES SUMMARY

WATERSHED PARAMETERS

PRESENT CONDITIONS AS USED IN 1972 & 73 RUN

Colored Portions Shows Land as used in 1975 Present Land Use Run Aug 1975 RM Bartel

COLORED PORTION Shows 1975 Land Use For Area between Dams & RWCD

Yellow – 100 to 300 homes/sq mi

Green – 300 to 599 " "

– 600 to 120 " "

– 1200 to 1999 " "

BLUE – Over 2000 " "

BROWN – Irr. AGRI.

None Colored Land is Nat'l Desert.

Aug 75 RM Bartel

PROJECT TO YEAR 2000 BASED ON DATA

Year 2000 Land Use
Color Coded As Follows
Irr Agri SUPER
100-299
300-599
600-1200
1200-1999
2000+ over
Aug 74 R.H. Burtis

Note: All Lands Irr in 1975 are Assumed to either be Irr Land or Houses in 2000 — The area in Irr Land in Queen Creek has not been Colored on this map

1.) Alt # 3 used for Design Developed in Sept 1974 as Selected MCFCD for Design & Rules

2.) Dec. 1974 Reid OK from Washington to use Alt # 3 if Ordinance meeting this Req'd is passed by M C C. to Rpt'd 1" flow.

3.) April 1975, Request from FCD, to change Wording in Suggested Agreement

3a.) May 1975, Made Analysis of 100-yr, 2-hr Regulations

4.) June 6, 1975 Met with MCFCD to discuss effect of new Reg.

5.) June 12, 1975 Rec'd Wording to be used in Suggestion

6.) Oct 20, 1975 Rec'd Request again to change Wording in Suggestion.

1.) Alt # 3 used for Design Developed in Sept 1974 as Selected MCFCD for Design & RWCD

2.) Dec 1974 Recd OK from Washington to use Alt # 3 in Agreement meeting this Req'd is passed by MC Co. to Req'd 1" flow.

3.) April 1975, Request from FCD, to change Wording in Supplemental Agreement

3a.) May 1975, Made Analysis of 100-yr, 2-hr Regulations

4.) June 6, 1975 Met with MCFCD to discuss effect of new Req.

5.) June 12, 1975 Recd wording to be used in Supplement

6.) Oct 20, 1975 Recd Request again to change Wording in Supplement.

USDA - Soil Conservation Service
201 E. Indianola Ave., Suite 200
Phoenix, Arizona 85012

December 20, 1984

Dan E. Sagramoso
Chief Engineer & General Manager
Flood Control District of
Maricopa County
3335 W. Durango Street
Phoenix, Arizona 85009

Re: Eastern Maricopa County Master Drainage Study

Dear Dan:

In regards to your recent request for Powerline Floodway hydrology data we have made further search and have retrieved the study material for this structure. Robin McArthur and Harry Millsaps, hydraulic engineers on our staff, have subsequently met with Kebba Buckley, on December 13, and reviewed the material with her.

Recent studies have been made by Harry Millsaps to determine inlet design flow requirements along Reach 4 of the RWCD Floodway. He included the Powerline Floodway as part of his study. His work appears to satisfy our needs for designing the Powerline Floodway-RWCD Floodway junction structure.

Unless you foresee some changes that might impact upon the Powerline Floodway, we recommend that it and its associated drainage area be excluded from the Eastern Maricopa County Master Drainage study area.

If further discussion is needed please contact us.

Sincerely,

Verne H. Lathrist
State Conservationist

bcc: W. Wayne Killgore, ASTC (W), SCS, Phoenix, AZ
Ralph M. Arrington, SCE, SCS, Phoenix, AZ
Harry C. Millsaps, Hyd. Engr., SCS, Phoenix, AZ
Robin P. McArthur, Hyd. Engr., SCS, Phoenix, AZ

RPM:bjp
RPM

BUCKHORN-MESA WATERSHED
ARIZONA

FINAL

SUPPLEMENTAL WATERSHED WORK PLAN

AGREEMENT NO. 1

AND

SUPPLEMENTAL WATERSHED WORK PLAN NO. 1

JUNE 1976

ORIGINAL COPY

MANUALLY SIGNED

8. A paragraph Number 15 is added as follows:

The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964, as amended, and the regulations of the Secretary of Agriculture (7 CFR Sec. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity receiving federal financial assistance from the Department of Agriculture or any agency thereof.

9. A paragraph Number 16 is added as follows:

The Maricopa County Board of Supervisors recently approved changes to the subdivision regulations that require detention facilities be included in all new subdivision plats to detain a 100-year, two-hour storm. The Board of Supervisors will enforce these regulations in such a manner that the volume of storm water to be stored, for the area between the system of floodwater retarding structures and the Roosevelt Water Conservation District Floodway will equal or exceed one (1) inch over the newly developed area.

The sponsoring Local Organization and the Service further agree to all terms, conditions, and stipulations of said watershed work plan agreement, as supplemented, not modified herein.

Flood Control District of Maricopa County
Local Organization

3335 W. DURANGO
PHOENIX, ARIZONA 85009
Address Zip Code

By Henry S. Adams
Title Chairman
Date July 6, 1976

The signing of this agreement was authorized by a motion of the governing body of the Flood Control District of Maricopa County adopted at a meeting held on July 6, 1976.

Clerk Thea C. Woodall Date July 6, 1976

FLOOD CONTROL DISTRICT of Maricopa County

3325 West Durango Street • Phoenix, Arizona 85009 • Telephone (602) 262-3630/262-3639

October 20, 1975

Mr. George C. Marks, State Conservationist
U. S. Soil Conservation Service
6029 Federal Building
Phoenix, Arizona 85025

Dear Mr. Marks:

In response to your letter of September 3, 1975, we are submitting comments on the Draft Supplemental Work Plan and the Draft Environmental Impact Statement for the Buckhorn-Mesa Watershed Project.

SUPPLEMENTAL WATERSHED WORK PLAN

Paragraph 9 of the Draft Supplemental Watershed Work Plan Agreement No. 1, page IV has now been complied with by Maricopa County. Effective October 1,1975, the Board of Supervisors of Maricopa County approved changes to the subdivision regulations that require detention facilities be included in all subdivision plats to detain a 100-year two-hour storm. The exact wording of this change to the subdivision regulations has been reviewed by members of your staff and they have concurred that it meets the requirements stated in paragraph 9 (Page IV).

DRAFT ENVIRONMENTAL IMPACT STATEMENT

1. The first paragraph on page 4 and the third paragraph on page 41 should be modified as indicated in the comments above on the Supplemental Watershed Work Plan Agreement.

2. The proposed alignment of the floodways may be modified to reduce the impact on certain existing developments. We will discuss these matters with your staff in the near future.

3. The penultimate paragraph on page 11 states that sponsors will obtain the assistance of a qualified Mining Engineer in determining the extent and value of known mineral deposits. It is our understanding that known mineral deposits exist only in the Weekes Wash Dam site which is a responsibility of Pinal County.

4. In selecting a borrow for spoil-disposal areas close coordination should be effected with the Flood Control District in order that a minimum impact may be caused on proposed recreational facilities and developments.

Sincerely,

Herbert P. Donald

H. Millsaps

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

6029 Federal Building, 230 North First Avenue, Phoenix, Arizona 85025

SUBJECT: ENG - Design Peak Discharges - RWCD Floodway, Williams-Chandler, Apache Junction-Gilbert, and Buckhorn-Mesa Watersheds

DATE: August 27, 1975

TO:

Richard Mathews, Head
Design Unit, WTSC
Portland, Oregon

This memo is to confirm the telephone conversation between Harry Millsaps, Hydraulic Engineer, River Basin-Watershed Planning Staff, and Don Woodward, Hydrologist, E&WP Unit, concerning design peak discharges to be used for the design of the RWCD Floodway. The design discharges to be used are those transmitted to Mr. Paul Tilker by memo from me dated September 23, 1974. The ADP output data from which the design discharges can be obtained is referred to as Alternate No. 3 in the 1974 memo. Alternate No. 3 assumes 1-inch of on-site storage will be required on all new subdivision lands developed after 1975. This concept has been agreed to by the local sponsor(s) (Maricopa County Flood Control District) and the following wording is incorporated in the Supplemental Work Plan Agreement No. 1 for the Buckhorn-Mesa Watershed:

> "Construction of the RWCD Floodway will not commence until a regulation requiring storage of storm water on all subdivisions in the area between the system of floodwater retarding structures and the RWCD Floodway is in effect. The volume of storm water to be stored will equal or exceed one (1) inch over the newly developdd area."

If we can be of further assistance, please contact us.

Acting

George C. Marks
State Conservationist

cc:
Paul Tilker, Head, E&WP Unit
John W. Peterson, Asst. State Conserv.
Ronnie L. Clark, RBWP Staff Leader
Harry C. Millsaps, Hydraulic Engineer

FLOOD CONTROL DISTRICT of Maricopa County

3325 West Durango Street • Phoenix, Arizona 85009 • Telephone (602) 262-3630/262-3639

June 12, 1975

United States Department of Agriculture
Soil Conservation Service
230 North First Avenue
Phoenix, Arizona 85025

ATTENTION: Mr. George C. Marks

RE: Subdivision Detention Requirements

Dear Mr. Marks:

In a meeting held in our office on June 6, 1975, we met with members of your staff to discuss wording of paragraph 9, page vi of the SUPPLEMENTAL WATERSHED WORKPLAN AGREEMENT NO. 1 FOR BUCKHORN MESA. As a result of that meeting and subsequent telephone conversation with Mr. Arrington and Mr. Stone of your staff, we suggest that the wording in the above mentioned paragraph be changed to read as follows:

> Construction of the RWCD Floodway will not commence until a regulation requiring storage of storm water on all new subdivisions in the area between the system of floodwater retarding structures and the RWCD Floodway is in effect. The volume of storm water to be stored will equal or exceed one(1) inch over the newly developed area.

If we can be of further assistance, please contact us.

Sincerely,

HERBERT P. DONALD, P.E.
CHIEF ENGINEER AND GENERAL MANAGER

HPD/LAB/ly

R. Clark Re RB-WS
Harry File

MEMO TO FILES:

RE: ENC - HYDROLOGY - RWCD

HARRY MILLSAPS AND I ATTENDED A MEETING WITH HERB DONALD AND LES BOND ON THE HYDROLOGY OF RWCD ON JUNE ~~13~~ 16, 1975. THE RESULTS OF COMPUTER RUNS FOR THE PROPOSED FCDMC REGULATIONS WERE DISCUSSED IN DETAIL.

ALTERNATIVES DISCUSSED WERE AS FOLLOWS:

1. ACCEPT THE REVISED ROUTING WITH 5% - 12% INCREASE (APPROXIMATELY 500 CFS) REQUIRED FLOODWAY CAPACITY USING THE 100-YEAR 2-HOUR STORM RUNOFF AS BASIS, FOR REQ'D STORAGE.

2. REWORD PROPOSED REGULATION TO REQUIRE ON-SITE STORAGE IN ALL CASES.

3. BOARD OF SUPERVISORS TO ASSURE SCS BY LETTER THAT THE 1" STORAGE REQUIREMENT FOR FUTURE DEVELOPMENT WILL BE ENFORCED WITHIN THE RWCD WATERSHED.

4. BOARD OF SUPERVISORS TO ASSURE SCS BY LETTER THAT THEY WILL ENFORCE THE ON-SITE STORAGE OF 100-YEAR - 2-HOUR STORM RUNOFF FOR THE RWCD WATERSHED.

IT WAS DECIDED THAT THE FCDMC WILL PREPARE A WORDING FOR ALTERNATIVE NO. 3 ABOVE AND REQUEST SCS REVIEW.

WE FEEL THAT IF THE REGULATIONS ARE ENFORCED WITH THE INTERPRETATION OF STORAGE AND DETENTION SO AS PEAK DISCHARGES ARE NOT

ADDITIVE, THEN THIS WILL ADEQUATELY MEET THE ASSUMPTIONS FOR RUNOFF ROUTING MADE BY SCS IN PREVIOUSLY ACCEPTED HYDROLOGIC ANALYSIS, I.E. ONE-INCH STORAGE REQUIREMENT. THE FCDMC FEELS THEY WILL HAVE THIS POWER OF ENFORCEMENT WITH THE PRESENT WORDING OF THE REGULATION AND WILL SO TOO FOR THE RWCD WATERSHED.

CC: RON CLARKE, RB-WS

JOE KNISLEY, AC, TUCSON A.O.

River Basin-Watershed Planning Staff
Suite 326, Arizona Title Bldg., 111 W. Monroe, Phoenix, Arizona 85003

WS - RWCD Floodway Hydrologic Analysis May 21, 1975

Ralph Arrington
State Conservation Engineer

Attached is a copy of the printout showing the results of a recent TR-20 run for the RWCD Floodway. This run was made to determine the effect of new subdivision regulations on the design discharges presently being used by SCS for the design of the floodway. A comparison of the present design discharges and those from the revised analysis is shown in the following table.

COMPARISON OF PRESENT DESIGN PEAK DISCHARGES
FOR RWCD FLOODWAY AND THOSE DEVELOPED USING NEW SUBDIVISION REGULATIONS

Location on RWCD	Cross Section Number	Present Design Peaks Alt. #3	Revised Design Peaks Alt.#3(Rev.2)	Ratio: Alt.#3 / Alt.#3(Rev.2)
(at) Brown Rd.	1	1160	1300	1.12
(at) Apache Trail	4	1965	2160	1.10
(at) Broadway	7	2290	2550	1.11
(at) Southern	16	3440	3820	1.11
(at) Superstition Hwy.	34	4720	5250	1.11
(at) Baseline	37	4700	5230	1.11
(at) Guadalupe	56	4860	5400	1.11
(at) Elliot Rd.	68	5110	5640	1.10
	75	5285	5810	1.10
(above) Powerline (Ray Rd.)	100	5890	6410	1.09
(below) Powerline Channel	129	6470	6980	1.08
(at) So. Pacific R.R.	145	6880	7380	1.07
(at) Germann	152	6820	7310	1.07
(above) Queen Creek	155	6730	7200	1.07
Queen Creek (before Junction)	181	1910	1910	-
(below) Queen Creek Junction	182	8070	8540	1.06
(at) Reservation	185	8640	9100	1.05
(at) Place it turns west on Reservation	190	8690	9130	1.05

The present design discharges were developed assuming one inch of on-site storage on all new lands subdivided after 1975. The new run is based on the assumption (as interpreted from the proposed regulations) that sufficient storage will be required on all new subdivided lands to where the future peaks from the subdivided area for the 100-year, 2-hour storm will not exceed the predevelopment peaks for this storm.

It will be noted that the revised peaks are between 5 and 12 percent greater than those developed, assuming one inch of on-site storage.

Should you have any questions concerning the revised analysis, please let us know.

Ronnie L. Clark
RBWP Staff Leader

Attachment

cc: (w/o att.)
John W. Peterson
Harry C. Millsaps
Wendell A. Styner, WTSC, Portland, Ore.

HCMILLSAPS:jmr

Harry Millsaps

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE River Basin-Watershed Planning Staff
Suite 326, Arizona Title Bldg., 111 W. Monroe St., Phoenix, Arizona 85003

SUBJECT: WS - RWCD Floodway, Duration of Flood Flows DATE: May 15, 1975

TO: Wendell A. Styner, Hydrologist
West Technical Service Center
511 West Broadway, Room 209
Portland, Oregon 97209

As per telephone request, enclosed is a copy of the computer printout for ALT 3, TR-20 run on the RWCD Floodway. Discharge hydrographs have been printed out for selected locations along the floodway and can be used for estimating the duration of flow at these points. The computer hydrographs for the 100-year storm have been plotted for several of the locations, and these are enclosed for your use.

It will be noted on the plotting for cross section 34 (VS-34), ALT 3, that hydrographs for VS-82, ALT 1 & 4, have been superimposed. All these hydrographs are actually at the same location. The cross-section numbers were changed from one alternate to the next due to a problem with the TR-20 program.

As you know, we are presently making an additional run on the RWCD which could possibly modify the design hydrographs for the floodway. The run has been submitted to Fort Worth for processing, and we should receive a printout sometime next week. The run is being made to analyze the effect of new subdivision regulations which alter the amount of total storage required on new subdivided land from that assumed in the original analysis. We will keep you informed on this matter.

Harry C. Millsaps
Hydraulic Engineer

Encl.

cc: R. Clark
R. Arrington

Millsaps' Copy

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE River Basin-Watershed Planning Staff

Suite 326, Arizona Title Bldg., 111 W. Monroe, Phoenix, Arizona 85003

SUBJECT: WS - RWCD Flood Control Channel
Maricopa County FCD Meeting
April 23, 1975

DATE: April 30, 1975

TO:

Ronnie L. Clark
RBWP Staff Leader

Those in attendance at the meeting were as follows:

Herb Donald	Maricopa County FCD
Lee Ohsiek	Maricopa County FCD
Les Bond	Maricopa County FCD
Ralph Arrington	SCS
Ron Clark	SCS
Robin McArthur	SCS
Harry Millsaps	SCS

The purpose of the meeting was to discuss proposed changes in the Maricopa County's new subdivision regulations and their effect upon the peak discharges to be used in the design of the RWCD Floodway. It was explained that the design discharges for the floodway were developed assuming that all new lands subdivided after 1975 between the RWCD Floodway and floodwater retarding structures as installed or proposed to be installed in the Buckhorn-Mesa, Apache Junction-Gilbert, Williams-Chandler, and Lower Queen Creek Watersheds would require one inch of on-site storage.

The amount of storage actually used, however, was varied by the density of urbanization. This was calculated using the basic assumption that the maximum density of houses in any area would be about 2,000 houses per square mile, or each new housing unit would occupy about 0.33 acres. Insofar as computing required storage, the same size housing unit was used for all urban densities.

An analysis was then made assuming a retention type of storage, i.e., one inch of runoff was removed from the projected 100-year, 24-hour storm for the area occupied by each new housing unit within a subdivision. For example, if the density of development was 600 houses per square mile, the total amount of storage required would be 200 acre-inches (600x0.33x1=200) or 0.31 inches (200/640=0.31) per unit area. The required storage for other densities of urbanization was calculated in a similar manner. The total required storage for a subdivision was then removed from the local inflow hydrograph by a change (i.e., a reduction) in the runoff curve number as estimated for the subdivision without the consideration of on-site storage.

With regard to the new subdivision regulations, however, the amount of on-site storage is no longer fixed, but is related to "predevelopment" peak discharges for the 100-year, 2-hour storm. The new regulations as proposed to be written in the Buckhorn-Mesa Supplemental Work Plan Agreement states that: "In all new subdivisions, the runoff from the 100-year, 2-hour storm will be detained on-site and released at a rate not greater than the predevelopment peak discharge for the subdivided area."

With this criteria, it is first necessary to develop peak inflow hydrographs for the 100-year, 2-hour storm for "predevelopment" and "developed" conditions. Then, using shortcut procedures, the hydrograph for the "developed" conditions is routed through representative structures to determine the amount of storage required to limit the peak outflow from the structure to that "equal to" or "less than" the "predevelopment" peak discharge for the subdivided area. Once the required storage has been determined, the same procedures as used for one inch storage concept can be applied to determine the net effect of the proposed regulations. These procedures assume that if detention storage is used that the required storage will be released after the peak for the subdivided area has passed, or released in such a manner as to have only minor effect upon the peak outflow for the subdivided area. In other words, the detained storage is treated as retention storage and is not included in the computed hydrograph under "developed" conditions.

The County stated that these latter conditions are already in the subdivision regulations and could be written into the supplemental work plan agreement. The County also stated that although they had originally agreed to the one inch storage concept, that it is doubtful that a more stringent regulation than that presently proposed could be passed by the County Board of Supervisors. A letter from the County to SCS will be forwarded at a later date stating the County's position with respect to the new regulation.

It is not known at this time what the total effect of the change in storage concept will be, but preliminary analysis indicates that the net on-site storage as required by the new regulation will be less than the one inch used by SCS in their original analysis. This will result in increased runoff, and thus, in the peak discharges as presently approved by SCS for the design of the RWCD Floodway. The major change in storage appears to be in those areas of low density urbanization (i.e., 600 houses or less). With the procedures used by SCS and the one inch storage concept, approximately 0.31 inches of storage would be required per unit of area for this type of development. In using the new subdivision regulations, on the other hand, no storage would be required. This is due to the fact that there would be little or no change in the runoff characteristic between "predevelopment" and "developed" conditions, hence there would be little change in peak discharges for the two conditions. There are some areas,

however, where the new subdivision regulations may require more storage than the on inch used by SCS. It is, therefore, recommended that additional studies be made to determine the net effect of the new regulations on the design discharges for the RWCD Floodway.

Harry C. Millsaps
Hydraulic Engineer

cc:
Ralph Arrington
Wendall Styner

4/24/75

Summary of Steps in analysis
100-yr, 2-Hr Storm

(1) Take the 2Hr Rainfall Distribution

(2) Convert the 24Hr RCN to 2Hr RCN

(3) Develop runoff distribution for
   a. Present
   b. Future

(4) Derive Unit hydrographs using present and future Tc and Drainage Area

(5) Develop hydrograph by subarea for present and future

(6) Determine amount of storage for subarea by TR-55 to reduce future peak to predeveloped conditions

(7) Determine runoff curve number for future condition by subarea to account for storage on basis of 24Hr.
   24Hr RO − storage = Future 24Hr RO.

Check subareas for rainfall

Bob Clark
RD 45

FLOOD CONTROL DISTRICT of Maricopa County

3325 West Durango Street • Phoenix, Arizona 85009 • Telephone (602) 262-3630/262-3639

April 23, 1975

MARKS
PETERSON

COPIES FOR
R. Clark
R. Arrington
File

United States Department of Agriculture
Soil Conservation Service
230 North First Avenue
Phoenix, Arizona 85025

ATTENTION: Mr. Ralph Arrington

RE: Revision in Buckhorn Mesa Supplemental Watershed
Work Plan Agreement No. 1

Dear Mr. Arrington:

As discussed in our meeting this morning, we request that Paragraph 9, Page vi of the subject agreement be changed to read as follows:

> 9. A paragraph number 16 is added as follows: Construction of the Roosevelt Water Conservation District Floodway will not commence until the following regulation is in effect for the area between the system of floodwater retarding structures and the RWCD Floodway: In new subdivisions, the runoff from the 100-year, 2-hour storm will be detained on-site and released in a judicious manner so as not to coincide with the peak flow in the receiving ~~structure~~ WATERCOURSE.

We feel that this wording more closely reflects the wording and intent of the amendments currently proposed for the Maricopa County Subdivision Regulations. As discussed this morning, we feel that this meets or exceeds the conditions used for development of the hydrology under future conditions as computed by your office.

As a result of discussions with local engineers and other interested parties, we have every reason to believe that a change in the proposed detention requirement would cause an indefinite delay in adoption of any detention requirement for the unincorporated area of Maricopa County.

4/25

We appreciate the opportunity we had to discuss this matter with the Soil Conservation Service staff.

Sincerely,

HERBERT P. DONALD, P. E.
Chief Engineer and General Manager

HPD:LAB:dt

H. Millsaps

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE River Basin-Watershed Planning Staff

Suite 326, Arizona Title Bldg., 111 W. Monroe, Phoenix, Arizona 85003

SUBJECT: WS - Williams Chandler (RWCD Floodway) DATE: March 18, 1975

TO: District Engineer
U. S. Army Corps of Engineers
Attn: Mr. John Peterson
300 North Los Angeles Street
Los Angeles, California 90053

As per telephone request on March 17, 1975, enclosed is a line diagram showing the location of evaluation points for the 1974 analysis of the RWCD Floodway. We have also enclosed a plotting of the rainfall areal reduction curve used for this analysis. This curve was developed by Jim Malone (Former SCS hydrologist) in November of 1970. Computed hydrographs for selected locations along the RWCD have also been enclosed for your information.

If we can be of further assistance, please let us know.

Ronnie L. Clark
RBWP Staff Leader

Enclosures

cc: (w/o encl.)
R. S. Swenson
H. C. Millsaps

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE River Basin-Watershed Planning Staff

Suite 326, Arizona Title Bldg., 111 W. Monroe, Phoenix, Arizona 85003

FILED

SUBJECT: WS - RWCD Floodway, Buckhorn-Mesa Watershed
Hydrology, Hydraulics

DATE: January 23, 1975

TO: Kent Chen and John Pedersen
Floodplain Management Section
Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

In response to your telephone conversation with Harry Millsaps and Rexford Stone of our office concerning the RWCD Floodway, we are sending you the following information.

1. Description of several hydrologic alternatives studied.

2. Assumptions used in 1974 hydrologic analysis.

3. Work outline RWCD design hydrology.

4. Flow diagrams for hydrologic alternatives studied.

   a. Flow Diagram 1 gives sections numbers for Alternate 1 and 3.

   b. Flow Diagram 2 gives section numbers for Alternate 6, Revised Alternate 1, and Revised Alternate 2.

5. Summary tables showing peak flows into the Roosevelt Water Conservation District (RWCD) Floodway and adjacent to the floodway from Brown Road to Guadalupe Road.

6. Summary of cross section information used in Revised Alternate 1.

7. Computer printouts of the rating and routing of principal and emergency spillways for Site Nos. 1, 2, 3, 4, and 7 in the Buckhorn-Mesa Watershed.

8. Preliminary Table 3A showing channel data.

We could not obtain topographic maps with contour interval of 2 or 5 feet adjacent to the RWCD Floodway. However, aerial photography is available from which topo could be plotted. If you wish further information on this subject, please let us know.

A map showing the city of Mesa may be obtained from:

Mr. Howard W. Godfrey, Planning Director
City of Mesa
55 N. Center Street
Mesa, Arizona 85203

His telephone number is 602-834-2385.

Please let us know if we can be of any further help.

Ronnie L. Clark
RBWP Staff Leader

Enclosures

cc:
H. P. Donald, Maricopa County Flood Control District
C. A. Maguire, Asst. State Conservationist
R. M. Arrington, State Conservation Engineer

RKSTONE:jmr

Washington, D.C. 20250

DEC 24 1974

WS-PL-566 - Roosevelt Water Conservation District
Floodway - Buckhorn-Mesa, Apache Junction-Gilbert,
and Williams Chandler Watersheds

George C. Marks
State Conservationist, SCS
Phoenix, Arizona

Reference is made to your November 14, 1974, request concerning the hydraulic design for the Roosevelt Water Conservation District Floodway. We concur in your request to proceed with a supplemental watershed work plan agreement and hydraulic channel designs using Alternate No. 3 outlined in your memorandum.

We understand that Alternate No. 3 includes a minimum one inch on-site storage requirement. The Flood Control District of Maricopa County should be aware that an ordinance meeting this requirement should be in force prior to signing a project agreement for installation of the channel.

The Portland E&WP Unit has pointed out that the Corps of Engineers is preparing a Flood Plain Information Report for part of the damage area. If this is so, you should attempt to reconcile any differences that might exist between their draft report and our design hydrology.

Acting
NORMAN A. BERG

Kenneth E. Grant
Administrator

cc:
K. L. Williams, SCS, Portland, Oregon
P. O. Tilker, SCS, Portland, Oregon

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE River Basin-Watershed Planning Staff
Suite 326, Arizona Title Bldg., 111 W. Monroe, Phoenix, Arizona 85003

SUBJECT: WS - Williams-Chandler, Apache Junction-Gilbert, Buckhorn-Mesa (Design of RWCD Floodway)

DATE: September 27, 1974

TO: Wendell A. Styner, Hydrologist
West Technical Sercice Center
Portland, Oregon

The study of this watershed, based on revised land use, precipitation values, and reach routing coefficient, has been completed. A summary of the alternates 1 to 4 was prepared and discussed with the sponsors on September 6, 1974. The sponsors decided that we should proceed with preliminary design based on alternate 3 values. The attached sketch was given to the design unit to show the values to be used.

The assumptions used were discussed with Don Woodward when he was here in August. Attached to this letter is a copy of these general assumptions along with some of the specific calculations used to obtain RCN, T_c, Reach Routing Coeff., and Precipitation Values.

I understand that Ralph Arrington has sent up a report for Paul Tilker's review and thought you would probably like to have some of this background data for your files.

As I discussed with you in September, the cross-section numbers for alternates 5 and 6 are different than those used for alternates 1 to 4. This is because of the builtin limitation of the TR-20 program for numbers over 200. Why the first 4 alternates worked, I don't know; but cross checking of output data on the subwatersheds of alternate 3 and alternate 5 shows no difference between the two runs when the same values are inserted.

R. M. Bartels
Hydraulic Engineer

Attachments

cc:
R. Arrington (w/o attach.)

RBARTELS:mn

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE Room 6029 Federal Bldg., Phoenix, AZ 85025

SUBJECT: ENG - Hydrologic Data - RWCD Floodway
Williams Chandler, Arizona

DATE: September 23, 1974

TO: Paul Tilker, Head
E&WP Unit - WTSC

We are submitting for your review and information the revised hydrology for the RWCD Floodway. The computer data is compiled from previously agreed-to input data by Wendell A. Styner and Don Woodward. We request review for discrepancies which may have inadvertently occurred.

The project sponsors concur in the use of Alternate #3 for final design. We are submitting the ADP output for this alternative.

A summary table of peak discharges is attached. Please note cross-section numbers were changed to accommodate ADP loading. We have included the previous peak values (1973) for comparison.

We are making preliminary hydraulic designs in preparation for Lowell Kenedy's visit October 21, 1974.

Acting

George C. Marks
State Conservationist

Attachments

bcc: P. Monville

RMA:ks

ARIZONA RWCD

R.M. Bartels Sept. 6, 74

Assumptions used in 1974 analysis and reasons for redoing hydrology.

1) The original run was based on solid urban north of Guadalupe Road.

MAG Data for the years 1975 and 2000 do not indicate density anywhere near what was used in original (MAY 1973) analysis.

2) The 1974 analysis is based on MAG projections for 1975 and 2000.

3) A meeting with the Flood Control District suggested using some on site storage for all development between 1975 and 2000. It is expected that some type of zoning regulation will be passed by the County requiring storage on the subdivisions.

4) The 1974 analysis considered two storage possibilities. One half inch and one inch of storage.

5) A check of the rainfalls used in the MAY 1973 analysis indicates that they were for the area above the dams not for the area between the dams & the RWCD FLOODWAY.

6) The 1974 run was based on the precipitation shown on the Rev WB TP40 maps at a location half way between Mesa and Apache Junction.

ARIZONA RWCD

R. M. Bartels Sept 6, 1974

2 2

7) ~~A~~ meeting was held with Jim Malone, Hydrology Consultants Inc., on June ~~17~~ 12, 1974.

The pursose of the meeting was to consider the parameters used in the MAR 1973 run. Jim has been doing extensive consulting work in the area around Leisure World.

His recommendations included changing the velocity used in estimating time of concentration and the reach routing coeff.

This was discussed with the Regional Hydrologist and he agreed that 1.5 fps was a more representative velocity for natural conditions on alluvial fans than the 3 to 4 feet per second used in the MAR 1973 run.

Bob Bartels:mn
August 27, 1974

Sent to CofE 1/22/75

WORK OUTLINE

RWCD DESIGN HYDROLOGY

1. Use Jim Malone's method of placing storm on watershed; i.e., start at north end and reduce rainfall as we go south. Same general procedure as May 23, 1973 run.

2. Use data developed by Jim on 24-hour area reduction factor, and as calculated by Wendall Styner in his memo of July 19, 1974 to determine design precipitation. (See Attachment No. 1)

Drainage Area Total Sq. mi.	Drainage Area Intervening Sq. mi.	Intervening Rainfall (Percent of Point)	Average Rainfall For Total Watershed (Percent of Point)
1	1	100	100
5	4	96.2	97
25	20	91.9	93
55	30	87.6	90
95	40	82.8	87
150	55	78.8	84
220	70	77.6	82
300	80	74.5	80
385	85	71.0	78
500	115	69.3	76

3. Use the following precipitation values for design of RWCD. From WB Rev TP 40 maps, use point rainfall halfway between Mesa and Apache Junction as representative of uncontrolled area.

Map Rainfall	Factor	Plotted Value	*Design Point
1% = 3.6 inches	1.00	3.6	3.70
4% = 2.8 inches	1.00	2.8	2.80
10% = 2.25 inches	.99	2.23	2.20
20% = 1.85 inches	.96	1.78	1.80
50% = 1.35 inches	.88	1.19	1.20

* (See Attachment No. 2)

4. For Runoff Curve Number Determination use the following procedures:

A. From original data used in 1973 TR-20 Run and General Soil Maps, it has been determined that the soils for the uncontrolled area between the dams and the RWCD, except the San Tan Mountains, are B soils.

B. Use the procedures shown in Hydrology Design Manual to determine RCN for present natural conditions; i.e., use the curves in the handbook for the natural vegetation existing today to determine the short duration RCN.

C. Reduce the short duration RCN for duration; i.e., if short duration RCN is 80 then the 24-hour RCN will be 71. (Actual value used is a 24-hour RCN of 75 for desert conditions.)

D. The 24-hour RCN will be used on all desert lands in both present and future conditions.

E. The Runoff Curve Number for irrigated agricultural land is estimated to be 50 to show effect of built-in storage of leveled fields.

F. For urban lands, use the RCN shown in the Mohave County manual for urban areas. These RCN will not be reduced for duration. The percent of impervious surfaces will be estimated based on housing density from the MAG data. Use the following to determine the RCN of urban areas: (Attachment No. 3)

Density of Housing Units Number/Square Mile	RCN
0 to 100	Same as natural conditions
100 to 300	75
300 to 600	77
600 to 1200	79
1200 to 2000	80
2000 +	81

5. To estimate the effect of urbanization on T_c, use Figure 15-3 NEH-4, along with Figure ~~3-3~~ 3-5 of Urban Hydrology (~~Hydrology Tech. Note 1~~ TR-55 DATED 1/75 Lum) to determine the amount to reduce the T_c under natural conditions:

Increase in RCN From its Natural (Rangeland) Condition	Ratio of After Urbanization to Natural Conditions (T_c)
1	0.90
2	0.85
4	0.75
6	0.60

Example: If velocity is 1.5 fps in natural condition and then the area is completely urbanized, the velocity in the future condition is $\frac{1.5}{0.6} = 2.5$ fps

or if original T_c was 1.0 hour, the future T_c is 1.0 (0.6) = 0.6 hour.

6. When Don Woodward was down, it was agreed that the Chap. 15 method did not reduce the T_c enough. The procedures used in Urban Hydrology CTU Hydrol Tech. Note No. 1 were used to farther reduce the T_c. It was decided during Don's visit that the maximum reduction we would use was 0.60 of natural T_c. (Based on change in RCN from 75 to 81.)

7. Where new data is available on X-section shape and size - revise the T_c based on the channel characteristics. Use X-section data from Buckhorn-Mesa Areal Mapping. Use 4.0 fps for Buckhorn-Mesa area north of Apache Trail.

8. For areas of undefined channels (alluvial fans), use Figure 15.2 of NEH 4 to determine velocity for T_c and reach routing Coef.

For slopes of 1% to 2%, this figure shows a velocity of 1.0 fps to 1.4 fps for alluvial fan areas. Use a maximum velocity of 1.5 fps for reach routing or insert X-section data for routing purposes. The August 4 estimate of T_c is based on 1.5 fps for all alluvial fans (including desert and agricultural land). Don Woodward agreed with using 1.5 fps.

9. In areas of defined washes; foothills; mountains; I used a velocity of 6.0 fps, until I got to undefined channels, and I then used 1.5 fps. This primarily applies to San Tan Mountain areas.

10. Based on conversations with Paul Monville, we will use a "V" of 5 fps for RWCD channel. Do not use Resvoir Program.

11. To evaluate the effect of future urbanization on the watershed, a two-step approach will be needed:

A. First using MAG data for the year 2000, an ~~uncorrected~~ unadjusted for storage RCN for each subwatershed will be calculated, and a revised T_c based on this urbanization will be determined as explained in No. 5 item.

B. To determine the final RCN of the subwatershed, it will be necessary to reduce the ~~uncorrected~~ unadjusted RCN determined in (11. A) to show the effect of storage in the new subdivisions of one-half inch and one inch of runoff. The Figure A (next page) shows the estimate of how much to reduce the RCN based on the increase in housing units after 1975. (See Attachment No. 5 for derivation.)

12. Will need a total of three alternatives with three storms each analyzed. The storms to be analyzed are the 100-year, 25-year and 10-year storms. The alternates to be considered are Alt. 1 "Present Conditions", based on MAG 1975 data; "Future Conditions", based on MAG 2000 data; Alt. 2 using one-half inch of storage on new urban; and Alt. 3 would be with one inch of storage on new urban.

Copys given to Burns, + Maguire

Summary of

MCFCD MEETING 7/30/74

by R M Bartels

PARTICIPANTS
Herb Donald
Bob Wark
Lee Olesak
Ralph Arrington
Paul Manville
RON Clark
Harry Millsaps
B.L Bartels

DISCUSSION

I. PROJECTED URBANIZATION EFFECTED BY RWCD HYDROLOGY AND ECONOMIC BENEFITS

It was decided to use MAG Population Data for present conditions and year 2000 for benefits and design.

II. WITH A RE-EVALUATION OF RWCD HYDROLOGY FOR PEAK DISCHARGES, WHAT DEGREE OF ON-SITE STORAGE, IF ANY, SHOULD SCS INCLUDE WITHIN PROJECTED URBAN AREAS FOR REALISTIC ANALYSIS? WHAT TECHNIQUE SHOULD SCS USE TO EVALUATE THE EFFECT OF THIS STORAGE. – will use reduced Curve Number – RTSC Suggestion –

It was decided that two alternates with storage should be considered. The County will require some storage on future development but have not determined how much yet. For future urban conditions, year 2000, one alternate will be with 1/2 inch of storage & the other with 1 inch of storage on new developments.

III. WHERE ECONOMICS JUSTIFICATION OF THE 100-YEAR LEVEL OF PROTECTION IS NOT POSSIBLE, WILL MCFCD ACCEPT A LOWER LEVEL OF PROTECTION? IF SO, AT THE OPTIMUM LEVEL?

The County said they have no choice but to accept what we can justify. They agree that 100 year protection for Agri. Land is not needed. They did question the response of the Gila Indians to any thing less than 1% protection.

IV. SCS DESIRES TO REDUCE PHASE I CONSTRUCTION REACH. FOR SCHEDULE AND COST PURPOSES, WHERE SHOULD PHASE I END?

The possibility of dividing the first phase of the construction at the RR track was discussed. Because of the large outlay of funds required to build the section on the Indian land it is desirable to break into two reaches. This sounded reasonable to the FCD.

(over)

Another item brought up was the damages that occurred along Bowerbird Channel during June 2 the 4th. Apparently the long hot spell caused the concrete to buckle & spall. ~~Bob Ward had looked at~~ ~~the west~~ the reef & SOS should also look at it & help make recommendations on needed repair & maintenance. Paul Morrill will go with Ward next Mon on a inspection trip.

insert) ~~The FD~~ Bob Ward had looked at the entire channel last week & located 53 areas of damage.

D. Burns, Phoenix, Arizona

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE
~~West Technical Service Center, Portland, Oregon 97209~~ Attachment #1

ENG - Hydrology - RWCD Floodway Hydrology July 19, 1974

Ralph Arrington, State Conservation Engineer
SCS, Phoenix, Arizona 85025

In response to your request, I have reviewed the hydrology documentation to determine the hydrologic criteria for design of the subject floodway. The minutes of your June 12, 1974 meeting with Jim Malone were also reviewed, specifically regarding the assumptions made for the hydrologic analysis.

The main point of concern is large difference in discharge estimates and, therefore cost estimates, between the work plan and more recent studies. An apparent error in the original estimate and changing hydrology conditions and criteria have combined to contribute to the increased discharge estimates. Further, a few of the assumptions in the last, i.e., May 23, 1973, TR-20 output tend to be somewhat conservative.

The following suggestions are offered for your consideration in any additional study:

1. Rainfall

A. [redacted], as is the concept of using an areal distribution of rainfall. An [redacted] described on page 63 of the preliminary draft of "Probable Maximum Thunderstorm Precipitation Estimates-Southwest States," by Riedel and Hansen, NWS, [redacted]. The ellipses or pseudo isohyetals, have the major axis equal to twice the minor axis and an area of 0.125π (major axis)^2. Construction of isohyetals for specific areas can be done by drawing concentric ellipses on transparent material using:

$$\text{Length of major axis} = (8 \times \text{Area}/\pi)^{0.5}.$$

B. [redacted] The procedure is based on the premise that the average rainfall depth within a isohyetal is equal to the value from the area-reduction curve for the area within the isopyetal. For example, from Figure 27 of the NWS PMP report and a 100-year, 24-hour rainfall of 4.2 inches, the labeled isohyetals would be:

7/24

$$P = R\left[\frac{A_2F_2 - A_1F_1}{A_2 - A_1}\right]$$

Where: P is isohyetal label

R is point rainfall

A_2, A_1 are areas contained within the isohyetal to be labeled and the next inner isohyetal, respectively

F_2, F_1 are the area reduction factors corresponding to A_2, A_1 respectively.

Label	Area A	Areal Reduction Factor F		Precipitation
A	1	1.00	1.00	4.2
B	5	.97	.962	4.2 $\frac{(5)(.97) - (1)(1)}{5 - 1} = 4.04$
C	25	.93	.919	4.2 $\frac{(25)(.93) - (5)(.97)}{25 - 5} = 3.86$
D	55	.90	.876	3.68
E	95	.87	.8285	3.48
F	150	.84	.788	3.31
G	220	.82	.7762	3.26
H	300	.80	.7452	3.13
I	385	.78	.7095	2.98
J	500	.76 3.19	.6929	2.91

C. A isohyetal transparency is then overlain on a map of the watershed and the average precipitation estimated for each subwatershed. Orientation and location of the isohyetal pattern is made so that average precipitation over the entire basin is the same as the average precipitation from the area reduction curve, i.e., about 3.4 inches.

2. Urban Development

A. The degree and location of urban development must be established. Use of on-site storage to reduce runoff volumes is permissible but zoning ordinance require such storage. The sponsors must recognize that if allowance for storage is permitted in the hydrologic analysis, but is not then enforced, the level of protection will not be 100 years.

Use MAG DATA

Ke Ordinance suggests 1/2" to 1" storage

B. The T_c of urban areas will decrease about 25 to 50 percent or more, depending on the degree of urban development. The T_c for a composite of urban and rural areas could be estimated from the change in CN using Figure 15-3, NEH4. Increasing CN by 1 will decrease T_c about 11 percent.

will use Fig 15-3 to estimate effect

C. A check on the T_c for overland flow on alluvial fans, can be made using Figure 15.2 NEH4.

will use 1.5 fps for slopes less than 2%

3. Hydrograph Routings

A. Routing of hydrographs in the RWCD Floodway may be done by storage-indication routing if a significant portion of the flow is held in overbank storage. Storage-discharge relationships for each reach would have to be developed and the RESVOR standard control used with the TR-20 program.

B. If the discharge is essentially stream or channel flow then use the convex routing procedure with the REACH standard control. Routing reach lengths should be, closely, even multiples of the proper routing reach length described by Eq. 17-33, Chapter 17, NEH4.

All

Check reach length + allowable velocities

Comments on the proposed contract with Malone are:

1. Delete references to "IBM-360" or "IBM-1130." Refer instead to "Project Formulation Program - Hydrology - Technical Release 20 (TR-20)."

2. The latest version of the TR-20 program is February 14, 1974.

3. Division of Work, items 1a, b, c, and d, are discussed above.

Ralph Arrington

Item 1e, restate to stress that subwatersheds should have homogeneous hydrologic conditions. Problems have arisen in the TR-20 program where the subareas are too small. I would suggest [redacted] than farther division of the watershed.

4. The contract should definitely state who, the SCS or Malone's company, is to provide the computer services.

In conclusion, the E&WP Unit will furnish review of data, or provide hydrologic assistance as requested.

WAS

Wendell A. Styner
Hydraulic Engineer

cc:
D. Burns, Phoenix, Arizona

4 Note will use as originally defined subareas for 3 areas

Check with Don on Sub-Areas in Buckhorn Mesa Area

H C. Millsaps

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE River Basin-Watershed Planning Staff
Suite 326, Arizona Title Bldg., 111 W. Monroe, Phoenix, Arizona 85003

SUBJECT: MGT - Hydrology Assistance

DATE: July 16, 1974

TO: Don Woodward, Hydrologist
E&WP Unit, WTSC, SCS
Portland, Oregon

In response to your telephone call to Harry Millsaps on July 12, 1974, the following agenda is submitted for your information. This agenda outlines the schedule of activities planned for your trip to Arizona the week of August 5-8, 1974.

Monday, August 5, 1974 - Work with SCS, Watershed Planning Staff Hydrologist. Discuss procedures and analysis to be used in re-evaluating design discharges for RWCD Floodway. The following items will be discussed:

1. Location of urban areas
2. Effects of urbanization on:
   a. Time of concentration
   b. Runoff curve number
3. Method of calculating T_c
4. Method of determining routing coefficients
5. Rainfall
   a. Type of storm
   b. Amount (point)
   c. Areal size
   d. Areal distribution
   e. Time distribution
   f. Location of storm for critical design discharges should storm not cover total watershed
6. Selection of hydrologic areas — Keep as uniform as possible Tc 0.5hr or greater
7. Transmission losses — Reach Route attempt to keep exact length (or multiply as possible check)

Tuesday, August 6, 1974 - Work jointly and separately with SCS and Arizona Water Commission Planning Staff Hydrologists.

1. Continue discussion of RWCD Floodway hydrology.
2. Discuss revisions of Cottonwood Wash Watershed design and freeboard hydrograph storms (using thunderstorm PMP criteria) and their relation to the watershed evaluation storm peaks as presently used for economic evaluation.
3. Work with SCS and AWC hydrologists on procedures and criteria used for design and economic evaluation for Harquahala Valley Work Plan Supplement.

Wednesday, August 7, 1974 - Work with River Basin Staff Hydrologist

1. Review procedures used to estimate acres flooded by hydrologic evaluation units in Santa Cruz-San Pedro Type IV Study.

2. Discuss joint frequency flood plain analysis for tributary and main stem flood flows in Type IV Study.

3. Discuss procedures to be used in Type IV Study to determine percent chance flood by months.

4. Discuss procedures and guidelines to be used in revising the Type 15 Flood Insurance Study for the unincorporated areas of Santa Cruz County, Arizona.

Thursday, August 8, 1974 - Work with SCS River Basin and Watershed Planning Staff Hydrologists summarizing conclusions drawn from preceding days of discussion.

Should you have any questions concerning the proposed agenda, please feel free to call Harry Millsaps, River Basin Staff Hydrologist.

Acting
D. G. Burns
RB/P Staff Leader

cc:
G. C. Marks
J. E. Weaver
H. C. Millsaps
R. L. Clark
C. A. Maguire

Rob Bartels

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE RB-WS Planning Staff

Suite 326, Arizona Title Bldg., 111 W. Monroe, Phoenix, Arizona 85003

SUBJECT: WS - Williams-Chandler - Apache Junction, Gilbert - Buckhorn-Mesa WS, Minutes of RWCD Hydrology Meeting

DATE: June 17, 1974

TO: All Participants

A meeting was held June 12, 1974, in the RB-WP Conference Room to review development of design hydrology for the East Maricopa Watersheds and to discuss the need for additional analysis.

Participants of the meeting were as follows:

Ralph Arrington, State Engineer
Paul Monville, Design Engineer
Harry Millsaps, Hydraulic Engineer
Rexford Stone, Watershed Planning Party Civil Engineer
Robert Bartels, Watershed Planning Party Hydraulic Engineer
Jim Malone, Consultant Engineer, Hydrology Consultants, Inc.

Mr. Arrington opened the meeting and pointed out that so much work has been done on evaluating and re-evaluating the hydrology used to design the RWCD floodway, that he felt a meeting was needed to review the analyses that have been made; summarize these analyses; and determine if additional analyses were needed.

Since Mr. Malone, as a former employee of SCS, did the original TR-20 Program for the RWCD hydrology, he was requested to participate in the meeting.

The work plans prepared in the early 1960's showed the proposed RWCD Floodway ending at the Queen Creek Channel Junction. The sponsors were getting pressure from both the Roosevelt Water Conservation District and the Gila Indian Reservation that the formulation was not an adequate solution to the problem. Therefore, the SCS in the late 1960's decided to look into the possibility of supplementing the work plans to carry the flows from the three presently planned watersheds plus Queen Creek through the Gila Indian Reservation to the Gila River.

Since hydrologic procedures had changed from what had been used in the preparation of the three work plans, it was decided to use the TR-20 Program for the entire drainage area including Queen Creek. Cross sections, soils information, and vegetative cover information were obtained for the entire area. The first run considering the entire drainage area gave peak discharges of around 30,000 cfs for the section below Queen Creek Junction. Since this was much greater than the 5,500 cfs included in the work plans, it was decided that additional alternatives needed to be studied.

After several alternates were considered, the one which includes a large urban expansion in the area north of Guadalupe Road was used to provide the following design values for the RWCD Floodway.

At Apache Trail	3,700 cfs
At Powerline Channel (upstream)	18,700 cfs
Downstream of Powerline Channel	23,800 cfs
After Junction with Queen Creek	25,650 cfs

These values were based on the following assumptions:

1) Urban area from Guadalupe Road to base of Floodwater Retarding Structures prior to the year 2020.

2) The effects of urbanization were estimated by increasing present condition 24 hour curve numbers by 4 and by changing the Tc.

3) The time of concentration for any watershed urbanized was reduced to one-half of its original value.

4) An estimated RCN of 50 was used for irrigated agricultural areas to take into account the built-in storage of leveled fields.

5) The curve numbers for rangelands were reduced to show the effect of duration.

6) The velocity for estimating reach routing coefficients and Times of Concentration were based on channel cross sections taken at selected locations in the watershed.

7) The storm was located so that the largest rainfall fell over the urban areas. This will give the most critical condition for runoff volumes. It probably also gives the most critical condition for peak discharges because peaks are adding onto peaks in the present analysis. It definitely gives the most critical design peaks for the RWCD Floodway north of Powerline Channel.

8)a. An area Reduction Curve developed by Jim Malone was used to determine the areal storm precipitation values. The values on his curve are as follows:

DA (Sq. Mi.)	Areal Reduction Factor	DA (Sq. Mi.)	Areal Reduction Factor	DA (sq. Mi.)	Areal Reduction Factor
1.0	1.00	90.0	0.87	270.	(0.81)
10.0	0.95	110.0	0.86	320.	(0.80)
20.0	0.93	135.0	0.85	370.	(0.79)
40.0	0.90	160.0	0.84		
55.0	0.89	185.0	0.83		
75.0	0.88	220.0	0.82		

b. The following is a summary of the values used in the Present TR-20 Analysis:

The data was not specifically studied during the meeting but any changes in Areal Reduction Factors or location of storm will affect these values. Ran first analysis assuming Buckhorn-Mesa Dam built and Queen Creek uncontrolled.

Part of Study	(TR-20 Cross Section No.)	Drainage Area Sq. Mi.	Factor	Rainfall Inches
Upper Area	1 to 54	3.0 to 16.8	0.93	3.90
(Upstream of	55 to 125	16.8 to 38.5	0.90	3.78
Powerline	126 to 186	38.5 to 73	0.87	3.65
Channel)				
Lower Area	3 to 53	73 to 123	0.87	3.65
(From Power-	54 to 106	123 to 181	0.84	3.52
line Channel	107 to 173	181 to 370	0.81	3.40
to Gila River)				

Second analysis was done considering both Buckhorn-Mesa Dam and Queen Creek Dam built. This did not change any of the upper area values but did change the drainage area values for the lower area.

Lower Area	3 to 53	73 to 123	0.87	3.65
with Queen	54 to 106	123 to 134	0.84	3.52
Creek Dam Built	107 to 173	134 to 258	0.81	3.40

Jim Malone was then asked whether he felt that the analysis he had originally done was the best answer or whether additional analysis should be done.

The first point he mentioned was that he felt he had used too high of a reach routing coefficient. He apparently based it on in channel flows and neglected overland flow. He has done some work this past year that showed the effects of overland flow in reducing peaks.

He also felt he may have used too high of a velocity in estimating Tc. As he remembered they had used in channel velocity in all areas, and they may have had limited information on flows across fan areas. The question also came up as to how to calculate the time of concentration on the areas on alluvial fans. Jim's analysis apparently used only the in channel flow velocities and neglected what happens when these channels are full. For example: may have a channel 3 feet deep, 4 feet wide that will have a velocity of 7 ft./sec. and carry 80 cfs. However, the 100 year peak may be around 400 cfs with 300 cfs flowing overland at a depth of less than 1 foot. Average velocity here may be around 1 to 2 ft./sec.

Another point discussed was transmission losses. Everyone was sure that these occur but an agreement was not arrived at as how to estimate the effect on peak discharges.

Jim Malone mentioned that several of the developers in the area are including storage for runoff in the development. These have not been analyzed or included in the present runs. Disagree with statement by words used in memo dated June 3, 1974

The possibility of using excavated storage along the RWCD was discussed briefly. One area mentioned was just north of where Powerline Channel junctions with RWCD Floodway. The area presently is desert land and probably could be purchased. Since the present proposal calls for the excavation of over 13,000,000 cu. yds. to construct the channel, it may be cheaper and environmentally more favorable to excavate about half this volume in a storage reservoir and reduce the peak flow and thus the size of the channel.

Following the general discussion, major points of the meeting were summarized as to what things could be done to improve the present hydrologic values being used to design RWCD.

1) Rainfall - Area Reduction Curve could be applied in a different manner than was done. For example, the present run used 3.90 inches for the first 17 square miles. Based on the area reduction curve, the average for the area should be (0.93) (Point) = 0.93 (4.20) = 3.90 inches so this is the average rainfall. The next area shows that a factor of 0.90 (4.20) = 3.78 inches was applied on the area from 17 square miles to 38.5 square miles. The curve shows that the average rainfall that should be applied over the 38.5 square miles area is (0.90) (4.20) = 3.78 inches. However, we actually applied 3.90 inches over 17 square miles and 3.78 inches over 22 square miles. The average we used is about 3.83 inches instead of 3.78 inches.

2) The assumption in the original run on type of urbanization could be changed. There is no question that urbanization will occur but how dense, and with what kind of zoning regulations is up in the air. A computer run could be done that will use the conditions of June 1, 1974, and assume that all areas constructed after that will provide storage on their lots or subdivisions to store runoff from a selected design (Design storm frequency would have to be determined by the county). The present regulations of Mesa are requiring the storage of the 50-year storm, while Tempe has another frequency, and Phoenix yet another. For this alternative or assumption to be possible, it would require county zoning ordinance changes and a statement from the sponsors that this is the way they want us to design the Floodway.

3) Study and revise the time of concentrations based on additional cross section data. The TR-20 Program is very sensitive to the time of concentration. Some of the values used seem high; but without cross

section data, it would be just a judgment decision if changes are made. Where areas are presently zoned for a maximum of one house per two acres, assumptions used in original run on effect of urbanization on present Tc may be too drastic.

4. Based on cross section data, study and revise the reach routing coefficient used in all areas. Looking at the input data, the lowest coefficient used was 0.65 or about 3.5 fps. The consensus of opinion was that a 1.0 to 1.5 fps would be more reasonable on the alluvial fans under natural conditions. Ideally, we should input typical sections and let the program develop its own coefficient.

   Since the last run, additional work has been done on allowable velocities in the constructed floodway. These velocities should be used in any additional analysis.

5) Could check reasonableness of where the drainage subareas were broken for analysis. Should get away from long narrow watersheds. Instead break into two or three subareas based on slopes and development. Also, man has built across natural drainage in many locations, and these channels will affect the way the water will get into the RWCD. This could affect the sizing of the channel in the upper reaches. Jim is presently studying this for one of his clients.

6) Jim pointed out that the original run was done using a main time increment of 0.5 hours because of the limitations of the 1130 Computer. Since the TR-20 Program now is on the 360 and, this computer has additional capability, he suggested doing the run with a main time increment of 0.2 hours. On smaller watersheds, he stated this can have a drastic effect. He wasn't sure of the effect on the total watershed of 300 square miles.

7) We could do a detailed geomorphology study of the area and develop an estimate of transmission losses in each subwatershed. Once these losses were determined, it would be necessary to determine (a) how these losses affect the runoff hydrograph, and (b) how the runoff hydrographs combine together to affect the design of RWCD.

   The concensus of the meeting was that possibilities for improving the present hydrologic analysis for the RWCD exist. No conclusions were reached as to whether it will or will not be done. The matter is to be discussed with Wendell Styner when he is down next week.

   Jim Malone was asked as to what he recommended. He suggested working with summary points Nos. (1), (3), (4), and (6) with one alternate including point No. (2). If he used existing DA, RCN, and Point Precipitation Values, he felt his company could complete the resurvey work, re-evaluation of input data, and computer runs in about four weeks. Would probably need some additional time to write a report and work with final documentation.

Mr. Arrington asked Jim for a rough estimate of cost. The estimate given was $5,000 depending on how much data is needed and the alternatives to be studied.

R. M. Bartels

R. M. Bartels
Recorder

cc: Dennie Burns
Ronnie Clark
Cliffton Maguire
Wendell Styner

Dennie G. Burns, Phoenix, Arizona

West Technical Service Center, Portland, Oregon 97209

WS-PL-566 Williams-Chandler Watershed
RWCD Floodway, Arizona

June 3, 1974

Wendell A. Styner, Hydraulic Engineer
WTSC, SCS, Portland, Oregon

In May of 1973, Mr. Jim Malone sent to the E&WP Unit for our review and comment on the hydrologic documentation for the design of the RWCD floodway. The documentation indicated the one percent design flow for the floodway at the confluence with the Queen Creek was approximately 20,000 cfs as compared with original estimate of 5,500 cfs. This increase can be attributed to a procedural error in the original documentation and the assumption that the entire drainage area between the proposed floodwater retarding structures and the RWCD floodway would remain rangeland rather than become highly urbanized.

The TR-20 printout in the updated documentation indicated the peak flow from an upstream uncontrolled drainage area add directly to the peak flow of the next downstream drainage area. This addition of peak flows is a result of the configuration of the uncontrolled drainage areas. The work plan documentation assumed the peak flows were not directly additive. The TR-20 schematic diagram, runoff curve numbers, T_c values, etc., were reviewed with Jim in Portland during the week of May 21-25, 1973. The basic input data used and assumptions made were reasonable and reflected our current knowledge. Standard techniques were used and current hydrologic design policies were followed.

After a discussion with the design section on allowable velocities, it was noted that the assumed velocities in the floodway were high and a lower allowable velocity should be used.

Several recommendations for revisions in the TR-20 input data were made. They include:

1. Using a lower allowable design velocity

2. Reducing the rangeland runoff curve numbers for the effect of duration

3. Taking credit for the available storage in urban areas due to streets, etc.

4. Assume that transmission losses occur within the proposed floodway, and

5. Assume there was some storage (1-2 ins) available in the irrigated lands in the lower Queen Creek drainages.

6/5

The first three changes were incorporated in a revised TR-20 run which Arizona has. The revised TR-20 study would be dated June 1973. Any rerun since that date has not been formally reviewed. The entire documentation supporting enlarging and extending the RWCD floodway has not been formally reviewed by the E&WP Unit, according to my knowledge.

The TR-20 studies incorporating the suggested changes represents the best available estimates of the peak flows for various frequencies for the proposed RWCD floodway. The inclusion of the proposed Queen Creek and Buckhorn Mesa floodwater retarding structures will have a significant effect on the design discharge used.

Donald E. Woodward

Donald E. Woodward
Hydraulic Engineer

cc:
Dennie G. Burns, Phoenix, Ariz.

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE - River Basin-Watershed Planning Staff

Suite 326, Arizona Title Bldg., 111 W. Monroe St., Phoenix, Arizona 85003

SUBJECT: WS - Hydrology Computations, Roosevelt Water Conservation District Canal Floodway.

DATE: May 16, 1973

TO: David C. Ralston, Head
Design Section
SCS - WRTSC
Portland, Oregon

Please find enclosed a summary of the hydrology computations on the Roosevelt Water Conservation District Canal Floodway. Most of this hydrology was done by Jim Malone. We would like comments on the procedures and design valves being used. If you have any questions concerning the work Jim will try to answer them while in Portland the week of May 21-25. We are sending some maps and line diagrams for supporting this work under a separate cover.

D. G. Burns
Leader, RBWP Staff

Enclosure

cc:
C. A. Maguire
J. M. Malone

RWCD HYDROLOGY

INDEX TO SUPPORTING DATA

RWCD HYDROLOGY
SUMMARY

The RWCD Floodway is an existing channel paralleling the Roosevelt Water Conservation District Canal in Eastern Maricopa County. The canal is elevated above the ground level so that floodwater coming down the fan is intercepted by the canal banks. Since the canal was constructed there has been a difficult maintenance problem. Over the years the eastern bank of the canal has been built up and a floodway has been constructed down to the north boundary of the Gila River Reservation. The existing floodway has a capacity of about 2,500 cfs at the Reservation boundary.

Previous Studies

The floodway was first studied by SCS in preparation of the Buckhorn-Mesa, Apache Junction and Williams-Chandler P.L. 566 watersheds. The plans were completed in 1963 and approved for operations. The plans call for improving the floodway down to the Queen Creek channel and letting the floodway empty into the Queen Creek channel. The design capacity at the outlet was to be 5,500 cfs. The hydrology method used in preparation of the work plan was construction of triangular hydrographs and adding them together with travel time being accounted for by offsetting the beginning time of the hydrographs as they entered the channel.

In May 1971, additional hydrology work was done. A review of the criteria used in the 1963 work plans showed inadequacies in planning to stop the channel at the Queen Creek channel. The present dikes along the RWCD divert the Queen Creek low flows and the old Queen Creek channel has

been obliterated below the RWCD floodway. A review of the work plans by the Gila River Indian Tribes pointed out inadequacies in the plans to stop improvements of the RWCD floodway at the Reservation boundary. The Reservation has severe flooding problems from the existing floodway and would protest any improvement of the channel capacity unless plans are also made to improve the reach of the floodway that goes through the reservation. New criteria was established and the watershed was studied again to determine the required design capacities for constructing a floodway from Brown Road on the north to the Gila River on the south. The TR-20 hydrology program was used in the analysis and flood routing of hydrographs. The required design capacity at the outlet into the Gila River was 22,380 cfs for the one percent storm. A six-hour storm was used in the analysis. Alternate studies were made of 1) existing conditions of watershed cover and flood control structures, 2) existing conditions of watershed cover and Buckhorn-Mesa Dams constructed, 3) existing conditions of watershed cover and Buckhorn-Mesa dams constructed and Queen Creek dam constructed. Decisions were made to proceed with designing the floodway for a discharge of 22,000 cfs at the Reservation boundary.

In February 1972, additional interest was shown in the floodway as a possible outlet for a channel that would be constructed along the north side of the Superstition Freeway. It was decided to re-evaluate the hydrology of the upper portion of the RWCD floodway to see what effect the freeway channel would have on designing the RWCD. The computer program

TR-20 was used again. A type-2, 24 hr. storm was used in this analysis. Alternate conditions of 1) the Buckhorn-Mesa structures would not be constructed and 2) the Buckhorn-Mesa structures would be constructed. This analysis was written up in a report "A Floodwater Study." The report was sent to the RTSC in March 1972. This study did not analyze the effects of the freeway at any locations below the junction of the freeway and the RWCD.

In January 1973 the hydrology was again updated to analyze the effects of urbanization on designing the floodway. The TR-20 program was used with a Type-2, 24 hr. storm for various frequencies. The watershed was divided into an upper watershed and a lower watershed. The dividing line is the Powerline channel. The watershed areas above the existing dams were not included in the analysis.

Alternate studies were made of 1) Upper area, Without Buckhorn-Mesa dams, present conditions; 2) same as 1, future conditions of urbanizations; 3) future conditions of urbanization with Buckhorn-Mesa dams constructed.

The upper area hydrographs were input into the lower area studies and the following alternates were run: 1) Input from alternate 1 above, without Queen Creek dam constructed, present conditions of watershed cover; 2) input from alternate 2) above, without Queen Creek dam; 3) input from alt. #3 above, without Queen Creek dam; 4) input from

alt. #1 above with Queen Creek dam; 5) input from alt. #2 above, with Queen Creek dam; 6) input from alt. #3 above with Queen Creek dam.

DESIGN

The alternate of future conditions with the Buckhorn-Mesa dams and with the Queen Creek dam constructed was selected jointly by SCS and the sponsors of the projects for designing the RWCD Floodway. This resulted in a discharge of 33,000 cfs at the lower end of the floodway.

Burns-
RB-WS
Route
RB-WS

Room 6029 Federal Bldg., Phoenix, AZ 85025

ENG - Meeting with AHD on RWCD Floodway

September 12, 1972

George C. Marks
State Conservationist

Since the Arizona Highway Commission recently committed highway funds for the construction of two state bridges across the RWCD Floodway, we requested a meeting with AHD personnel to discuss consideration for design. We met September 11, 1972 in the office of Martin Toney, Assistant State Engineer, Structures, of the AHD. A copy of those in attendance is attached.

Discussion centered around two major topics for the project. They are: (1) hydrology and (2) the two state highway bridges across the floodway. Significant discussion items are as follows:

Hydrology

1. The proposed Superstition Freeway along the reach east of the RWCD Floodway to Apache Junction is still in the design consideration phase by the AHD. The proposal at present is to pass all waters (50-year frequency) through the highway alignment at the existing wash locations. If such washes have been, are or will be eradicated, the evaluation for design to pass floodwaters will be made at the time the design is prepared.

   This reach of the Superstition is not in the current 5-year construction schedule of the AHD.

2. The AHD has no projections for the urban development of the area affected by the RWCD Floodway.

3. The County Planning and Zoning Commission, upon the recommendation of the FCD of Maricopa County, is now requiring county urban developers to return all flood flows (up to 50-year frequency) back to the original courses to which they exited from the proposed development area.

Conclusion: Final design hydrology for the RWCD Floodway will be made on the basis that flood flows will enter into the floodway in existing washes as they are now located.

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State Bridges

1. AHD will make the soils evaluation for design of foundation conditions.

2. SCS will prepare a detailed topographic map of each site for design use. Grades, capacities, configuration and other design criteria for the floodway will also be furnished.

3. Due to the high skew ($\pm$ 45°) of the alignment at state bridge 87, George Watt will discuss the floodway alignment with the AHD after topographic maps are prepared to evaluate the potential for straightening the approach to the bridge.

4. Due to length of state highway bridge 87, a clear span of floodway cannot be made and proposed pier locations should be correlated with Southern Pacific Railroad for the railroad bridge to align piers due to the proximity of the two bridges.

5. AHD estimates six months design time for the bridges.

6. Construction schedules for the bridges and floodway will have to be coordinated to prevent construction problems and prevent undue hazards. Two proposals were suggested.

   a. SCS is to first construct floodway leaving dip sections at state highway crossings. Later the bridges will be constructed by an AHD contract.

      This proposal is unfavorable due to the liabilities for the flood hazard at the dip crossing. The SCS Administrator's approval will be required for this proposal.

   b. AHD is to excavate the floodway within their R-O-W and stockpile along the Indian Tribal R-O-W of the proposed floodway. They would then construct bridges by their contract. SCS will later construct the floodway, including disposal of excavated earth previously stockpiled.

      This proposal has to be cleared through the AHD for costs of excavation.

      Other proposals for the sequence of construction and under combinations of contracts may be considered at a later date.

A re-routing of traffic around the bridge locations will be necessary. Easements for the temporary route will be discussed with the Gila River Indian Community.

7. Mr. Toney will prepare a letter to the sponsors outlining the needs of the AHD in meeting the AHD committment for construction of the two highway bridges.

Ralph M. Arrington

Ralph M. Arrington
State Conservation Engineer

cc: Col. John C. Lowry, FCDMC
Martin Toney, AHD
Dennie Burns, WS-RB
Joe Hickerson, Chandler

MEETING

September 11, 1972

RWCD Channel

Name	Organization
R. C. Brechler	Bridge Engineer - Design, AHD
Jim Malone	Civil Engineer, SCS
George Watt	Design Engineer, SCS
L. E. Ohsiek	Ass't. Chief Engineer, FCD, Mar. Co.
M. C. Sheldon	AHD Hydraulics Branch
[illegible]n Weaver	Civil Engineer, SCS
Ron Slocum	SCS
James Glasgow	AHD Hydraulics Branch
Ralph Arrington	SCS
Eugene Jencsok	AHD Hydraulics Branch
Martin Toney	AHD Structures

Tc

Upper Portion (to Powerline Channel)

AUGUST 19, 1974 — Robert H. Bartels — 1974 Analysis of D.A. Uncontrolled after Peckham-Hess and Green Creek DAMS are Constructed

	DRAINAGE AREA Number	Size	① Travel Length	② Natural Velocity	③ Natural Tc	④ Increase in R(N) because of Urbanization	⑤ Revi. Factor for Tc	⑥ 1974 Tc Present (3)x(5)	⑦ RCN Present Cond	⑧ RCN (Unconstrained) Year 2000	⑨ Change in RCN (8)-(7)	⑩ Modification Factor for Tc	⑪ Tc Year 2000 (6)x(10)	⑫	
1	3		19000	4.0	1.30	—	—	1.30	66	78	12	0.60	0.80		1
2	8		19000	4.0	1.30	—	—	1.30	75	79	4	0.75	1.00		2
3	12		19500	4.0	1.40	3	0.80	1.10	78	79	1	0.90	1.00		3
4	17		14000	4.0	1.00	2	0.85	0.85	77	78	1	0.90	0.75		4
5	20		8000	1.5	1.50	—	—	1.50	69	80	11	0.60	0.90		5
6	~~23~~ (combined with 29)														6
7	29		11000	4.0	0.80	—	—	0.80	75	76	1	0.90	0.70		7
8	33		11500	1.5	2.10	—	—	2.10	65	79	14	0.60	1.25		8
9	39		9500	4.0	0.65	1	0.90	0.60	76	76	—	—	0.60		9
10	42		14000	1.5	2.60	—	—	2.60	69	79	10	0.60	1.55		10
11	48		8000	4.0	0.55	2	0.85	0.45	77	77	—	—	0.45		11
12	51		17000	1.5	3.20	—	—	3.20	69	79	10	0.60	1.90		12
13	57		12000	4.0	0.85	1	0.90	0.75	76	76	—	—	~~0.90~~	0.75 RMB	13
14	64		10000	4.0	0.7	1	0.90	0.65	76	76	—	—	~~0.90~~	0.65 RMB	14
15	68		13000	1.5	2.40	3	0.80	1.90	78	80	2	0.85	~~0.70~~	1.60 RMB	15
16	75		10000	4.0	0.70	2	0.85	0.60	77	77	—	—	~~0.85~~	0.60 RMB	16
17	80		19000	1.5	3.50	—	—	3.50	73	79	6	0.60	2.10		17
18	84		10000	1.5	~~0.7~~ 1.8	—	—	1.80 ~~0.70~~	63	78	15	0.60	~~0.40~~	1.10 RMB	18
19	89		12000	4.0	0.85	2	0.85	0.70	77	77	—	—	0.70		19
20	92		14000	4.0	1.0	1	0.90	0.90	76	76	—	—	0.90		20
21	95		21000	1.5	3.80	—	—	3.80	75	79	4	0.75	2.85		21
22	99		14000	4.0	1.00	1	0.90	0.90	76	76	—	—	0.90		22
23	107		20000	1.5	3.60	2	0.85	3.05	77	79	2	0.85	~~0.70~~	2.60 RMB	23
24	113		15000	1.5	2.80	—	—	2.80	74	76	2	0.85	2.40		24
25	116		11000	1.5	2.00	—	—	2.00	53	53	—	—	2.00		25
26	120		22000	1.5	4.00	—	—	4.00	65	68	3	0.80	3.20		26
27	122		10000	1.5	1.8	—	—	1.80	51	51	—	—	1.80		27
28	128		11000	4.0	0.8	—	—	0.80	75	76	1	0.90	0.70		28
29	133		10000	4.0	0.7	2	0.85	0.60	77	77	—	—	~~0.85~~	0.60 RMB	29
30	138		16000	1.5	3.0	1	0.90	2.70	76	78	2	0.85	~~0.75~~	2.30 RMB	30

Tc

Upper Portion
(To Powerline Channel)

AUGUST 19, 1974 — Robert M. Bartels — 1974 Analysis of D.A. Uncontrolled after Bartlett-Horseshoe and Queen Creek DAMS are Constructed

2/2

DRAINAGE AREA Number	Size	① Travel Length	② Natural Velocity	③ Natural Tc	④ Increase in RCN because of Urbanization	⑤ Rev. Factor for Tc	⑥ Tc Present (3)x(5)	⑦ RCN Present Cond	⑧ RCN (uncontrolled) Year 2000	⑨ Change in RCN (8)−(7)	⑩ Modification Factor for Tc	⑪ Tc Year 2000 (6)x(10)	⑫
143		37000	1.5	6.80	—	—	6.80	72	73	1	0.90	6.10	
147		13000	1.5	2.30	—	—	2.30	75	75	—	—	2.30	
150		20000	1.5	3.60	—	—	3.60	75	76	1	0.90	3.25	
152		21000	1.5	3.80	—	—	3.80	75	75	—	—	3.80	
156		11000	1.5	2.00	—	—	2.00	75	75	—	—	2.00	
159		24000	1.5	4.40	—	—	4.40	75	76	1	0.90	3.95	
160		12000	1.5	2.20	—	—	2.20	75	75	—	—	2.20	
163		11000	1.5	2.00	—	—	2.00	75	75	—	—	2.00	
165		19000	1.5	3.50	—	—	3.50	75	75	—	—	3.50	
168		11000	1.5	2.00	—	—	2.00	75	75	—	—	2.00	
170		11000	1.5	2.00	—	—	2.00	75	75	—	—	2.00	
171		20000	1.5	3.60	—	—	3.60	75	75	—	—	3.60	
174		10000	1.5	1.80	—	—	1.80	75	75	—	—	1.80	
178		8000	1.5	1.50	—	—	1.50	75	75	—	—	1.50	
180		18000	1.5	3.30	—	—	3.30	75	75	—	—	3.30	
183		5000	1.5	0.90	—	—	0.90	75	75	—	—	0.90	

Tc

LOWER PORTION (South of Powerline Channel)

AUGUST 19, 1974 Robert K. Bartels 1974 Analysis of D.A. Uncontrolled after Buckhorn-Mesa and Queen Creek DAMS are Constructed

1/2

	DRAINAGE AREA Number	Size	① Travel Length	② Natural Velocity	③ Natural Tc	④ Increase in RCN because of Urbanization	⑤ Rev. Factor for Tc	⑥ Tc Present (3)x(5)	⑦ RCN Present Cond	⑧ RCN Year 2000	⑨ Change in RCN	⑩ Modification Factor for Tc	⑪ Tc Year 2000 (6)x(10)	⑫	
1	3	Revised #13+300 303	12000	1.5	2.20	—	None	2.20	75	75	No Change	none	2.20		1
2	6	306	21000	1.5	3.80	—		3.80	68	68			3.80		2
3	7	307	29000	1.5	5.40	—		5.40	74	74			5.40		3
4	10	310	13000		2.50	—		2.50	75	75			2.50		4
5	13	313	24000		4.40	—		4.40	75	75			4.40		5
6	16	cct	16000		3.00	—		3.00	68	68			3.00		6
7	18	cct	17000		3.20	—		3.20	75	75			3.20		7
8	19	cct	27000		5.00	—		5.00	75	75			5.00		8
9	22		29000		5.40	—		5.40	75	75			5.40		9
10	27		7000		1.30	—		1.30	75	75			1.30		10
11	30		5000		0.90	—		0.90	75	75			0.90		11
12	33		5000		0.90	—		0.90	75	75			0.90		12
13	40		15000		2.80	—		2.80	68	68			2.80		13
14	42		30000		5.60	—		5.60	50	50			5.60		14
15	45		17000		3.20	—		3.20	53	53			3.20		15
16	47		30000		5.60	—		5.60	53	53			5.60		16
17	49		13000		2.40	—		2.40	55	55			2.40		17
18	53		18000		3.30	—		3.30	75	75			3.30		18
19	58		27000		5.00	—		5.00	50	50			5.00		19
20	59		10000		1.80	—		1.80	50	50			1.80		20
21	62		30000		5.60	—		5.60	51	51			5.60		21
22	66		14000	Use 7000'@1.5 1.3; 7000'@5.0 .4	1.70	—		1.70	68	68			1.70		22
23	117		30000	Use 15000@1.5 2.8; 15000@4.0 1.0	3.80	—		3.80	54	54			3.80		23
24	120		46000	Use 4.0 fps because of channel	3.20	—		3.20	53	53			3.20		24
25	139		30000	Use 10,000' of 4 fps 0.7; 20000 @ 1.5 3.6	4.30	—		4.30	58	58			4.30		25
26	141		30000	Use v = 6 fps for 20000 + 1.5 fps for 10000 0.9 1.8	2.70	—		2.70	73	73			2.70		26
27	146		30000	Use v = 4 fps - 15000 1.0; 1.5 fps 15000 2.8	3.80	—		3.80	65	65			3.80		27
28	150		26000	17000 @ 6 fps 0.8; 9000 @ 1.5 fps 1.7	2.50	—		2.50	67	67			2.50		28
29	153		22000	1.5	4.00	—		4.00	50	50			4.00		29
30															30

Lower PORTION (S of Powerline Channel) / AUGUST 19, 1974 Robert M. Bartels 1974 Analysis of D.A. Uncontrolled after Buckhorn and Queen Creek DAMS are Constructed 2/

	DRAINAGE AREA Number	Size	① Travel Length	② Natural velocity	③ Natural Tc	④ Increase in RCN because of Urbanization	⑤ Revi Factor for Tc	⑥ Tc Present (3)x(5)	⑦ RCN Present Cond	⑧ RCN Year 2000	⑨ Change in RCN	⑩ Modification Factor for Tc	⑪ Tc Year 2000 (6)x(10)	⑫
1	155	Rev No. 134300 455	28000	23000 @ 6.0 fps 5000 @ 1.5 fps	2.00	—	None	2.00	73	73	No Change	None	2.00	
2	158	458	21000	18000 @ 6.0 fps 3000 @ 1.5 fps	1.40	—	↓	1.40	79	79	↓	↓	1.40	
3	160	46	17000	1.5	3.20	—	↓	3.20	53	53	↓	↓	3.20	
4	165	[illegible]	22000	10000 @ 1.5 12000 @ 4.0	2.60	—	↓	2.60	54	54	↓	↓	2.60	
5	169	[illegible]	39000	29000 @ 6.0 10000 @ 1.5	3.10	—	↓	3.10	82	82	↓	↓	3.10	
6	172		13000	10000 @ 6.0 3000 @ 1.5	1.10	—	↓	1.10	81	81	↓	↓	1.10	

COMPUTATION SHEET — U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Attachment #4

STATE AR12. PROJECT RWCD
BY RMB DATE July 31, 1974 CHECKED BY DATE JOB NO.
SUBJECT Estimate Effect of Urbanization on T_c SHEET 1 OF 23

From Fig 15.3

To Est. effect of Changed RCN

				Portion of Present
Example 3000 ft Long		S = 1.5%		
1	Present RCN = 71	Lag = 0.8 hour		1.00
	73	Lag = 0.75 hour		.93
	75	Lag = 0.73 hours		.91
	77	Lag = 0.69		.86
	79	Lag = 0.65		.81
	81	Lag = 0.61		.75
○ Example #2	5000 ft	2.0%		
	Present RCN = 73	Lag = 1.00		
	Future 75	" 0.93		
	77	" 0.86		
	79	" 0.83		
	81	" 0.79		
	83	" 0.72		
× Example #3	2000 ft	S = 1%		
	Present RCN = 71	Lag = 0.71		1.00
	73	0.67		.94
	75	0.64		.90
	77	0.60		.85
	79	0.56		.79
	81	0.53		.75

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Attachment #4

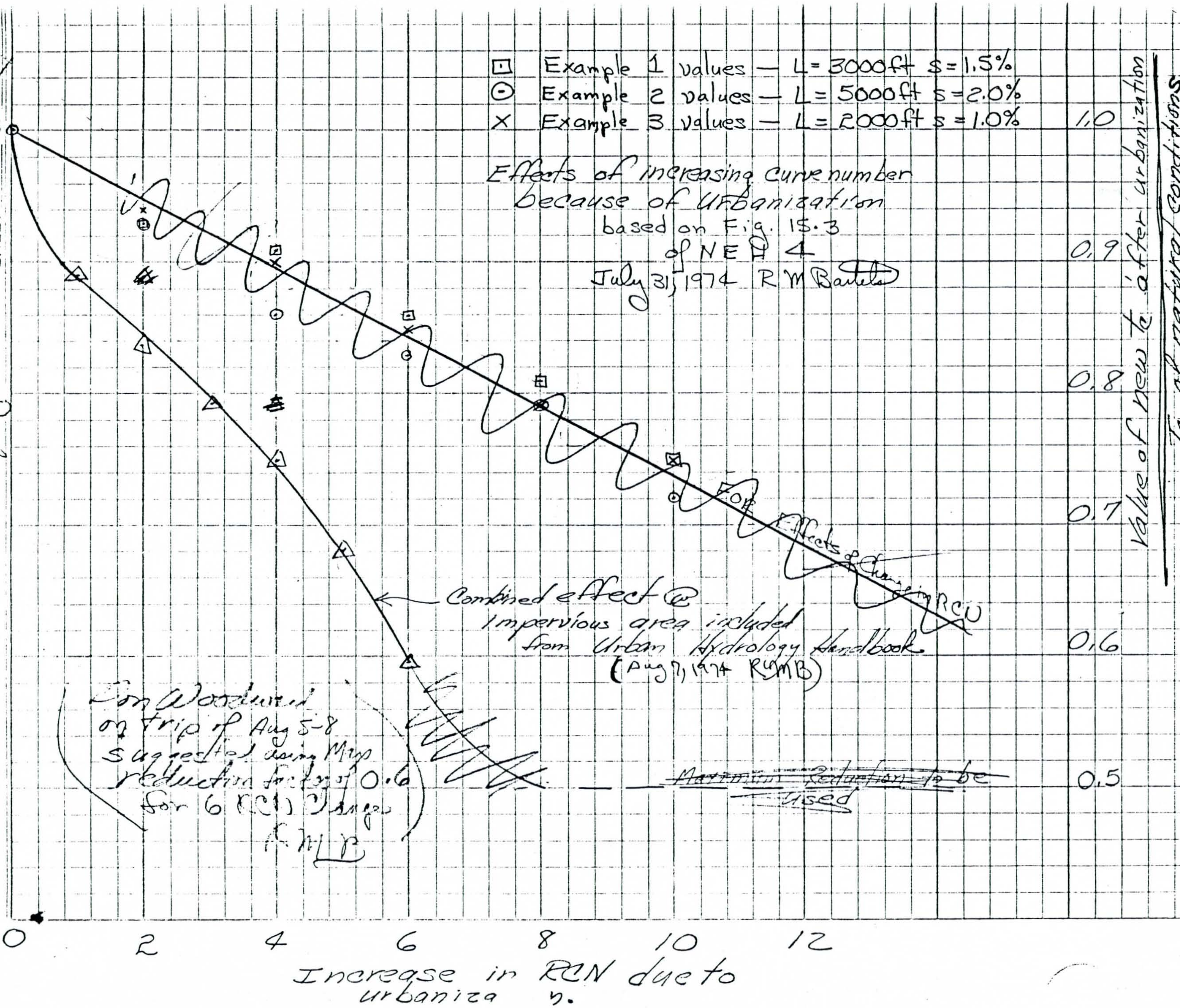
SHEET 2 OF 3

STATE Ariz

SUBJECT Values to be used in TR-20 program

DATE July 31 74

PROJECT RWCD



COMPUTATION SHEET

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE AR12 PROJECT RWCD Attachment #4

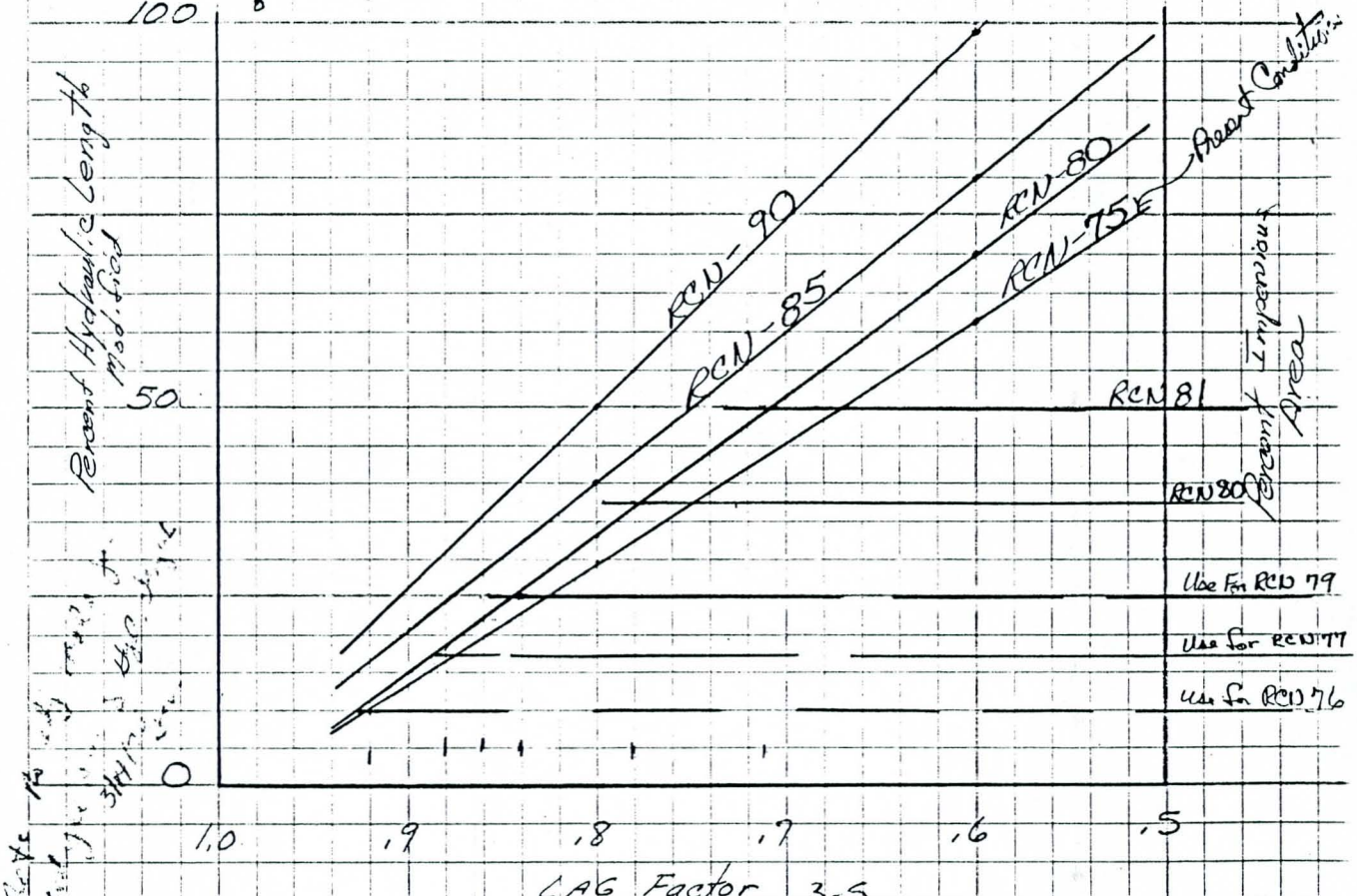
BY RMC DATE Aug 2 1974 CHECKED BY DATE JOB NO.

SUBJECT Effects of urbanization on T_c + Runoff SHEET 3 OF 3

To estimate the effect of urbanization use both Chapter 15 and Urban Hydrology Handbook.

See page 3-7 in Urban Hydrology Handbook

Will use Figure 3-3 to modify values developed by Chapter 15 to show effect of impervious area + channel modification.



Increase in RCN From Urbaniz.	Chapter 15 Values % of Natl T_c	Effect of Impervious Surface (Urban Hydro)	Combined Effect	Use
0	100	100	100	
1	97	92	89	.90
2	95	88	83.6	.85
3	92	86	79.1	.80
4	89	84	75.0	.75
5	87	78	67.8	.68
6	84	71	59.6	.60

DR12 RWCD

RMB Aug 7, 14

Tc vs Length for different Avg V 1 2

Calc T_c for various lengths based on variable velocitys.

1) For $v = 3.0$ fps for 10,000 ft $t_c = \frac{3333}{3600} = 0.925$

For $v = 3.0$ fps for 15,000 ft $t_c = \frac{5000}{3600}$ 1.39

For $v = 3.0$ fps for 5,000 ft $t_c = \frac{1670}{3600}$ 0.46

2) For $v = 2.0$ fps for 10,000 ft $t_c = \frac{5000}{3600} = 1.39$ hours

For $v = 2.0$ fps for 20,000 ft $t_c = \frac{10,000}{3600} = 2.77$ hours

For $v = 2.0$ fps for 5,000 ft $t_c = \frac{2500}{3600} = 0.70$ hours

3) For $v = 1.0$ fps for 3600 ft $t_c = 1.0$ hours

" 7200 ft $t_c = 2.0$ hours

10800 ft $t_c = 3.0$ hours

5000 ft t_c $1250/3600 = 0.35$ hrs

4) For $v = 4.0$ fps for 10,000 ft $t_c = 2500/3600 = 0.70$ hours

for 20,000 ft t_c $5000/3600 = 1.39$ hours

5) For $v = 5.0$ fps for 10,000 ft $t_c = 2000/3600 = 0.56$ hr

for 20,000 ft $t_c = 4000/3600$ 1.11 hr

6) For $v = 6.0$ fps for 12,000 ft $t_c = 2000/3600 = 0.56$ hr

24,000 ft $t_c = 4000/3600 = 1.11$ hr

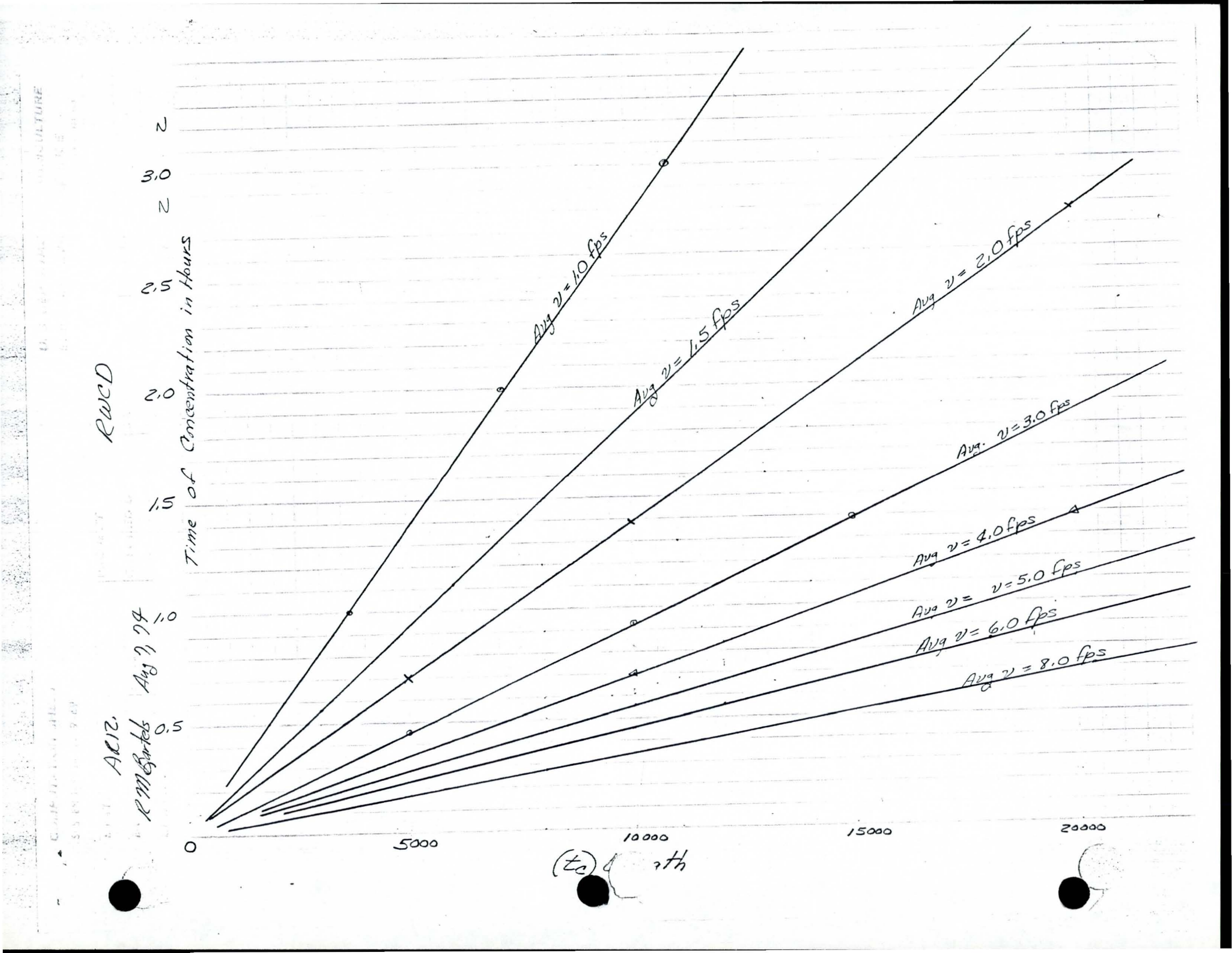
18,000 ft $t_c = 3000/3600 =$

7) For $v = 1.5$ fps for 6000 ft $t_c = 4000/3600 = 1.11$ hr

3000 ft $t_c = 2000/3600 = 0.56$ hr

8) For $v = 8.0$ fps for 16000 ft $t_c = 4000/3600 = 0.56$ hr

for 8000 ft $t_c = 1000/3600 = 0.28$ hrs


RWCD
Time of Concentration in Hours
3.0
2.5
2.0
1.5
1.0
0.5
0
5000
10000
15000
20000
(tc) 4th
Avg v = 1.0 fps
Avg v = 1.5 fps
Avg v = 2.0 fps
Avg v = 3.0 fps
Avg v = 4.0 fps
Avg v = v = 5.0 fps
Avg v = 6.0 fps
Avg v = 8.0 fps

CHANGE IN HOUSING
DENSITY 1975 - 2000

CHANGES IN DENSITY OF HOUSING 1975 - 2000
Aug 8, 1974 RMBartels

Legend of Change in Density Units/Square Mile	Color
0 - 99	None
100 - 399	
400 - 599	
600 - 899	
900 - 1299	
1300 - 1699	
Over 1700	

P.L. 566
FLOOD PREVENTION PROJECTS
WORK MAP
JULY 1974

Scale

COMPUTATION SHEET

SCS-ENG-523A Rev. 9-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Attachment #3

STATE	PROJECT		
AR12	RWCD		
BY RMB	DATE July 31, 74	CHECKED BY	DATE	JOB NO.

SUBJECT Estimate of % impervious surface SHEET 1 OF 7

Assume 200 homes/square mile

Avg number of paved roads would be ≈ 6 miles long 50' wide ≅ 40 Acres

Avg Home have 2500 sqft impervious Surface ≅ 12 Acres

Schools + Shopping Area 10 Acres

TOTAL impervious = 62 Acres

Approx % impervious = 10%

640 homes/square mile

Assume 12 miles of impervious roads ≅ 80 Acres

640 (2500) ≅ 240 Acres

Schools + Shopping Areas 20 Acres

140 Acres

Agree Table 2-2 Urban Hydrology (20.1%) → % impervious ≅ 140/640 = 21.9%

1200 homes/square mile

Urban Hydro shows 25% impervious for 1/8 lot

Assume 24 miles of Roads ≅ 120 Acres

1200 (2500)/43560 ≅ 70 Acres

Schools + Shopping Centers ≅ 20 Acres

210 Acres

% = 33% impervious

Urban Hydro shows 30% impervious for 1/8 lot

for 2000 homes/sq mi

30 mi Rds ≅ 140 Acres

2000 (2500)/43560 = 115 Acres

Schools + Shopping Ctrs = 30 Acres

285 Acres

= 45%

RWCD Attachment #3

Determine Urban RCN for 1975+2000 2 ~~2~~

The procedures in the Hydrology Design Manual page 10 show the following values for Urban RCN

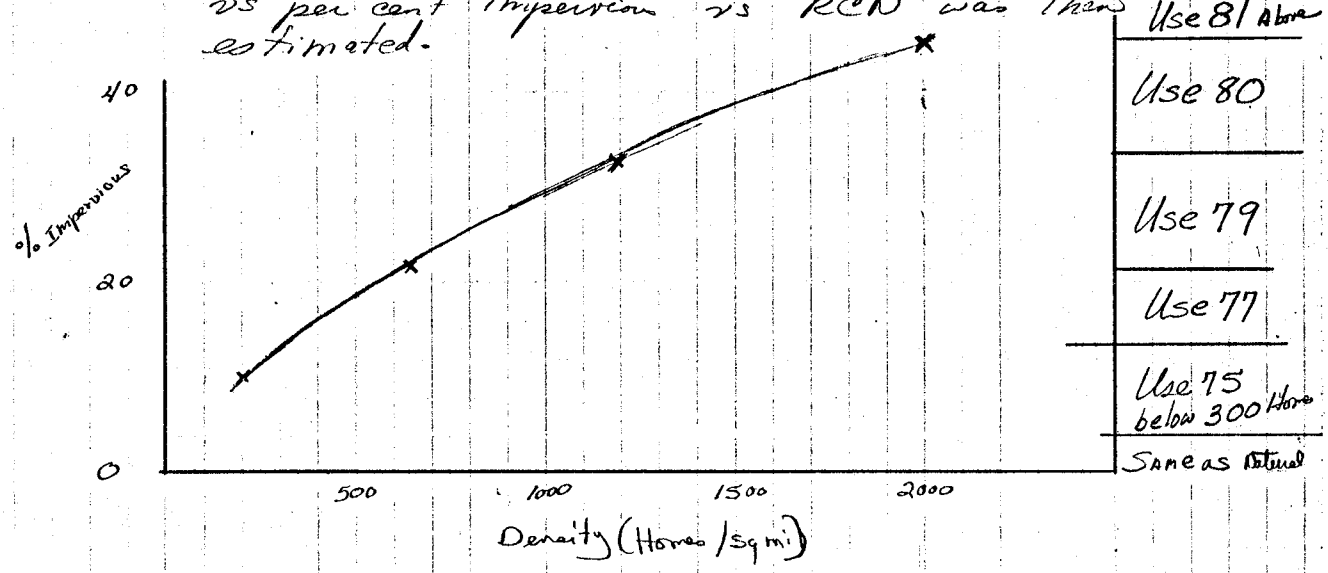
Low Density (15 to 18%)	77
Medium Density (21 to 27%)	79
High Density (50 to 75%)	81

To determine RCN, page 2 of this attachment (ATTACHMENT 3) was used to estimate the impervious areas for varying density of urban.

It shows the following:

200 homes/sq mi = 10% impervious
640 homes/sq mi = 22%
1200 homes/sq mi = 33%
2000 homes/sq mi = 45%

A range in values of Number of homes vs per cent impervious vs RCN was then estimated.



COMPUTATION SHEET

SCS-ENG-523A Rev. 9-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO 1969 O -364-109

STATE	PROJECT		Attachment #5
Ariz	RWCD		
BY R. M. Baeters	DATE Aug 5, 1974	CHECKED BY	DATE
SUBJECT To estimate the effects of a Storage Ordinance			JOB NO.

SHEET 1 OF 3

To determine the increase in urbanization it is proposed that MAG & PINAL County projections for 1975 (Present) and the year (2000) future be used.

This data is given in population and housing units per planning unit. The planning units vary from 1/2 Sq mile to 10 square mile in size.

For RCN Purposes it was decided to use a density / Sq mile of houses to estimate the % of impervious surfaces & thus the RCN.

For Storage purposes it is necessary to estimate the increase in developed land to estimate the area that will be partially controlled by storage.

To determine the effect lets assume that the maximum density is around 2000 homes/Sq mile or approximately 1/3 Acre / lot.

Therefore to est the effects of the ordinance we assume that 1/3 Acre will be partially controlled for each home increase between 1975 & 2000.

For Example: Check an increase from 100 homes to 500 homes.

Present RCN = 72 Amount of Sq mi affected by homes = 33 Acres

Future RCN = 77 (% storage) Amount of Sq mi affected by homes = .33 (500) = 165 Acres

increase in area urbanized = 132 Acres

Runoff 2% storage = (RCN) 77 (P_{100} = 3.7) = 1.57 inch = 640 (1.57) = 1005 Ac inch

Storage @ Ordinance for 1/2 inch on new development = 1/2 (132) 66 Ac inch

Net Runoff = 939 Ac inch

Effective RCN for 939/640 = 1.47 inch is 75 - Runoff = 1.44 inch

Storage @ Ordinance for 1 inch on new development = 132 Ac inches

Net Runoff = 873 Ac inch

Effective RCN for 873/640 = 1.36 inch = 73.5 Runoff = 1.35 inch

COMPUTATION SHEET

SCS-ENG-523A Rev. 9-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO 1969 O-364-109

STATE AR12	PROJECT RWCD	Attachment #5
BY RMB / DATE Aug 5 74	CHECKED BY / DATE	JOB NO.
SUBJECT Effects of Storage on RCN		SHEET 2 OF 3

For an increase in density from 200 homes to 1100 homes

Present developed Area @ RCN of 75 = 200 (.33) = 66 Acres

Future developed Area @ 1100 (.33) (RCN = 79) = 363 Acres

Net increase = 297 Acres

Effect of ½ inch of Storage would be

No Storage = RCN 94 (P = 3.7) = 1.72" Volume = (6½)(1.72) = 1100 Ac In
½ in storage = (297) ½ ≅ 150 Ac In
950 Ac In

Effective RCN for 950/640 or 1.48 inch runoff = 75.5 (runoff = 1.42 inch)

for 1" of Storage on new development

No Storage 1100 Ac In
Stored 1" (297) 297 Ac In
Net 803 Ac In

Effective RCN for 803/640 or 1.25 inches = 72 runoff = 1.26 inch

For An increase from 200 homes to 2000 homes

Present development Area @ RCN of 75 = 200 (.33) = 66 Acres
Future development Area @ RCN 80 = 2000 (.33) = 660 or 640 Acres

Increase in development = 594 Acres

Effect of ½" Storage would be:

No Storage RCN 80 (3.2 ind) = 1.80 (640) = 1152 Ac inch
½ inch Storage = (594)(½) 297

Net Runoff 855 Ac inch

Effective RCN for 855/640 or 1.34 inch = 73.0 (1.32 in runoff)

Effect of 1" storage would be

No Storage 1152 Ac inch
Storage 1" (594) 594 Ac inch
Net Runoff 558 Ac inch

Effective RCN for 558/640 or 0.87 inch Runoff = 65 (0.82 in runoff)

COMPUTATION SHEET

SCS-ENG-523A Rev. 9-69

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

GPO 1969 O—3[illegible]

#5

STATE	PROJECT		
ARIZONA	RWCD		
BY RMB	DATE Aug 5 74	CHECKED BY	DATE

JOB NO.

SUBJECT Summary of Effects of Storage on RCN (Future) SHEET 3 OF 3

Change in Density	Increase in # Houses per Square Mile	Future RCN w/o Storage	Future with Storage 1/2 inch	Future Diff. 1" of Storage on new develop	CN Change 1/2"	CN Change 1"
100 to 500	400	77	75.5	73.5	1.5	3.5
200 to 1100	900	79	75.5	72.0	3.5	7.0
900 to 2000	1800	80	73.0	65.0	7.0	15.0

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
GPO 1969 O-364-109

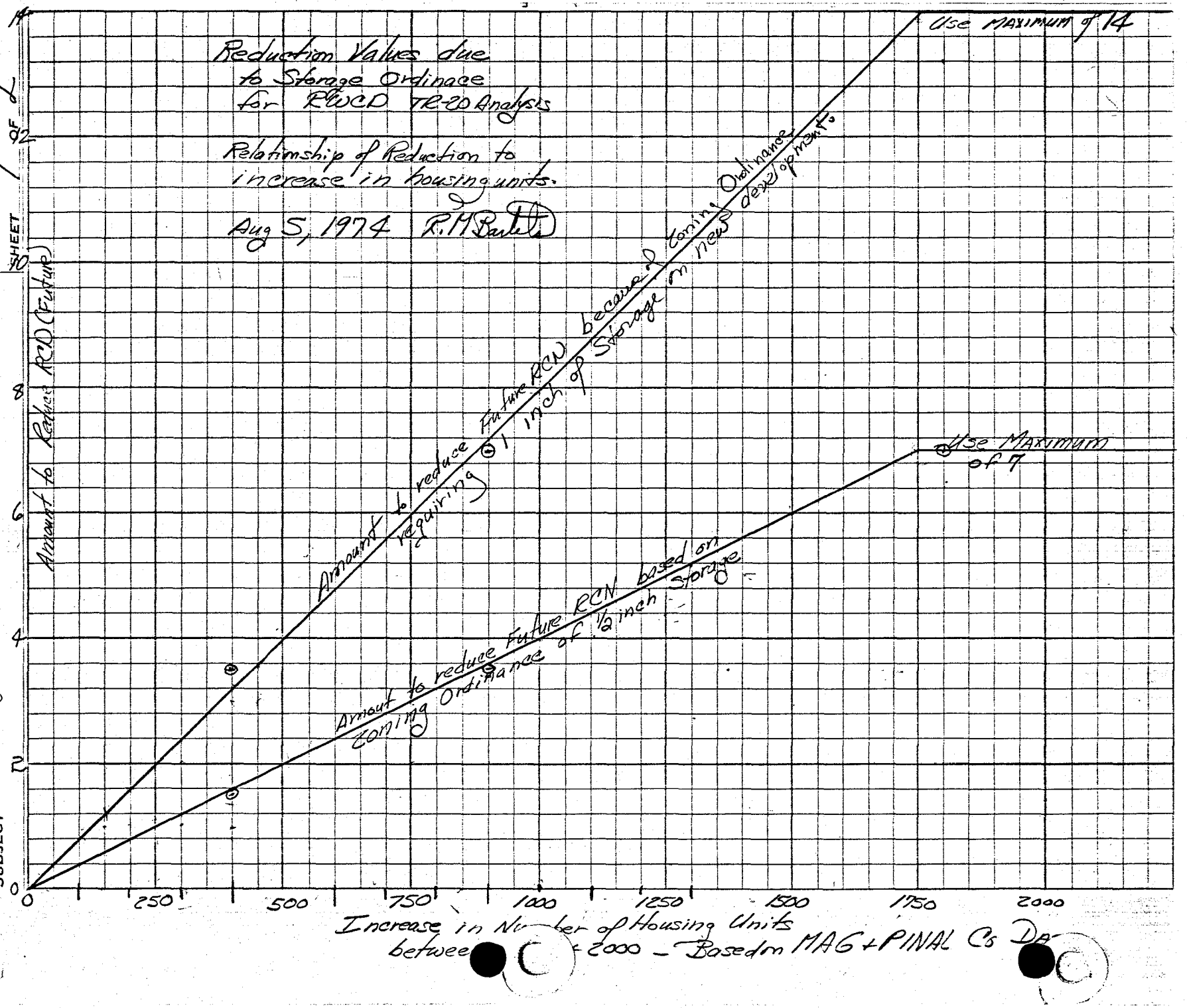
COMPUTATION SHEET
SCS-ENG-523A Rev. 9-69

STATE ARIZONA | PROJECT RWCD | JOB NO. FCMRE A
BY R.M. Bartels | DATE Aug 5, 1974 | CHECKED BY | DATE | SHEET 1 OF 2
SUBJECT

Reduction Values due to Storage Ordinace for RWCD TR-20 Analysis

Relationship of Reduction to increase in housing units.

Aug 5, 1974 R.M. Bartels



AR12.

RWCD

RM Butler Aug 8, 74

Figure A

2 2

For evaluation of Effect of Storage

For Estimating The effect of zoning with storage on new urbanization, we will need to develop a map summarizing the changes by MAG Planning Unit. Figure A shows the straight line reduction to be applied but for ease of showing on map we will break down into 6 areas. Show changes in density of housing.

				½ inch	1 inch
Area 1	100 to 399	dwelling	increase Reduce RCN	1	2
Area 2	400 to 599	"	" "	2	4
Area 3	600 to 899	"	" "	3	6
Area 4	900 to 1299	"	" "	4	9
Area 5	1300 to 1699	"	" "	6	12
Area 6	Over 1700	"	" "	7	14

ARIZONA RWCD

RMB Aug 20, 74

RC Number Calculations 1 2

The general writup, dealing with analysis of the watershed, states on page 2-4 the procedures used to determine rangeland, irr. land, and urban areas RCN.

This page gives the following values which will be used throughout the analysis.

Ⓐ Desert Rangeland (B-Soil) – use 24 hr RCN of 75
Ⓑ " " (D-Soil) " " " of 86

Ⓒ Irrigated Agriculture – use 24 Hr RCN of 50

Ⓓ 100 to 299 homes/sq mile – use 24 hr RCN of 75
Ⓔ 300 to 599 homes/sq mile – use " " of 77
Ⓕ 600 to 1199 homes/sq mile – use " " of 79
Ⓖ 1200 to 1999 " " – use " " of 80
Ⓗ 2000 + " " – use " " of 81

The RCN is determined for two conditions

Present (1975) and Future (2000)

The 1975 land use was determined by using MAG projection data for the urban areas + ortho quads + aerial photos for agriculture areas.

The area to be studied was colored to define the areas listed as Ⓒ through Ⓗ above. A MAP was then used to estimate the % of each of the land uses in each of the subwatersheds by coloring over the subareas the land use.

This method will then give the composite RCN for present conditions.

Ariz RWCD

RMB Aug 2074

RC Number Calculations 2 2

For Future Conditions a map was made up to show MAG + Pinal Co Land Use projections for the year 2000. It was estimated that the area under irr. in 1975 will be either irrigated or in houses in the year 2000. The map was first colored to show urban projections + then the Agri areas of 1975 were colored in.

For the area South of Powerline Channel no change in land use is projected between 1975 and 2000.

The Calc of the composite RCN was then done for the year 2000 same as was done for 1975.

This value is then modified to show the effect of storage required by zoning on all new construction after 1975.

Two conditions were considered ½ inch storage and 1 inch Storage. A relationship between old area developed + new area developed was estimated + a relationship was calculated for the amount of RCN reduction based on change in housing density. Figure A + its attached page of general writeup shows the result of these calculations

A map was ~~prepared~~ colored to show ranges of changes + this map is used to estimate the reduction to be used for Storage effect.

So the Future RCN will be based on both the year 2000 land use + the change in land use between 1975 and 2000.

RWCD Aug 19, 1974 R.M. BARTELS 1974 Analysis of Drainage Area uncontrolled after 1/2
Upper Watershed 1975 Land Use the construction of Queen Creek Dam and Buttern Mesa Dams

	DRAINAGE AREA		① Area A Desert RCN=75 "B Soil"	② Area B Desert RCN=86 "D Soil"	③ Area C Irrigated Agri. RCN=50	HOUSING DENSITY ④ Area D 100-299 homes RCN 75	⑤ AREA E 300-599 77	⑥ AREA F 600-1199 79	⑦ Area G 1200-1999 80	⑧ Area H over 2000 81	⑨ Composite RCN	⑩ USE	⑪	⑫	
1	Number	Size sq. miles													1
2	3	3.00	10%		35%	50%		5%			66.45	66			2
3	8	2.58	20%		10%	15%		50%	5%		74.75	75			3
4	12	1.58	40%					40%	20%		77.60	78			4
5	17	1.42	65%					5%	30%		76.70	77			5
6	20 (Wood)	1.32			35%			65%			68.85	69			6
7	29	1.33	100%								75.00	75			7
8	33	0.85			50%			50%			64.50	65			8
9	39	0.63	80%					20%			75.80	76			9
10	42	0.63			30%	30%		40%			69.10	69			10
11	48	1.13	60%					40%			76.60	77			11
12	51	0.81			30%	30%		40%			69.10	69			12
13	57	1.20	80%					20%			75.80	76			13
14	64	1.27	75%					25%			76.00	76			14
15	68	1.56				25%	5%	70%			77.90	78			15
16	75	1.48	60%					40%			76.60	77			16
17	80	3.12			10%	80%		10%			72.90	73			17
18	34	0.96			50%	50%					62.50	63			18
19	89	0.67	20%			40%		40%			76.60	77			19
20	92	1.57	80%					20%			75.80	76			20
21	95	1.28	10%		10%		40%	40%			74.90	75			21
22	99	1.06	80%					20%			75.80	76			22
23	107	1.63	5%			25%	50%	20%			76.80	77			23
24	113	1.63			5%	90%	5%				73.85	74			24
25	116	1.04			90%	10%					52.50	53			25
26	120	2.69	55%		40%		5%				65.10	65			26
27	122	0.97	5%		95%						51.25	51			27
28	128	1.05	30%			70%					75.00	75			28
29	133	1.71	20%			40%		40%			76.60	77			29
30	138	3.60				50%	30%	20%			76.40	76			30
31															31

RWCD Aug 19, 1974 R.M. BARTELS 1974 Analysis of Drainage Area uncontrolled after 2/2
Upper Watershed 1975 Land Use the construction of Queen Creek Dam and Buchorn Mesa DAMS

	DRAINAGE AREA		① Area A Desert RCN=75	② Area B Desert RCN=80	③ Area C Irrigated Agri.	HOUSING DENSITY ④ Area D 100-299 homes/sq mi	⑤ AREA E 300-599	AREA F 600-1199	⑦ Area G 1200-1999	⑧ Area H over 2000	⑨ Composite RCN	⑩ USE	⑪	⑫
1	Number	Size	"B Soil"	"D Soil"	~~RCN=50~~	RCN 75	~~77~~	~~79~~	~~80~~	~~81~~				
2	143	6.47	70%		15%		15%				71.55	72		
3	147	0.95	100%								75.00	75		
4	150	2.55	100%								75.00	75		
5	152	1.32	100%								75.00	75		
6	156	0.50	100%								75.00	75		
7	159	2.31	60%			40%					75.00	75		
8	160	1.11	100%								75.00	75		
9	163	1.06	100%								75.00	75		
10	165	2.54	100%								75.00	75		
11	168	0.57	100%								75.00	75		
12	170	1.28	100%								75.00	75		
13	171	2.12	100%								75.00	75		
14	174	1.66	100%								75.00	75		
15	178	0.64	100%								75.00	75		
16	180	1.71	100%								75.00	75		
17	183	0.52	100%								75.00	75		
18		20.84												
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														

Wt Av = $\frac{5201.91}{91.08} = 73.2$

AUGUST 20, 74 Robt. M. Bartels DAN Torpe 1974 Analysis of RWCD - Effects of Storage on Runoff Curve Numbers Future Conditions.

	DRAINAGE	① Increase 100-399 Reduce % RCN 1	② in Urbanization 400-599 Reduce % RCN 2	③ ~~600-799~~ Reduce % 3	④ 1975 to 2000 ~~800-1299~~ Reduce % 4.5	⑤ ~~1300-1999~~ Reduce % 6	⑥ 1700 ± Reduce % 7	⑦ No change 0	⑧ Amount to Reduce RCN for ½ inch Storage	⑨ Amount to Reduce RCN for 1 inch Storage	⑩ AMT. TO REDUCE RCN FOR ½ INCH STORAGE ELIMINATES STOR ON URBAN DRNS'S ≤ 600 HOU/MI²	⑪ AMT TO REDUCE RCN FOR 1-INCH OF STORAGE ELIMINATES STOR ON URBAN DRS ≤ 600 HOU/MI²	⑫
1													1
2	3	50%		30%		20%			2.60	5.20	2.1	4.2	2
3	8	35%	20%	30%		10%	5%		2.60	5.20	1.85	3.7	3
4	12	30%	30%	30%		5%		5%	2.10	4.20	1.2	2.4	4
5	17	10%	20%	30%				40%	1.40	2.80	.9	1.8	5
6	20			80%		20%			3.60	7.20	3.6	7.2	6
7	29	40%	30%					30%	1.00	2.00	—	—	7
8	33			100%					3.00	6.00	3.0	6.0	8
9	39	70%	10%	20%					1.50	3.00	.6	1.2	9
10	42			95%	5%				3.07	6.14	3.1	6.2	10
11	48	60%		40%					1.80	3.60	1.2	2.4	11
12	51			80%	20%				3.30	6.60	3.3	6.6	12
13	57	20%				~~20%~~		80%	~~1.20~~	~~2.40~~	~~0.2~~	~~0.4~~	13
14	64	30%				~~30%~~		70%	~~1.80~~	~~3.60~~	~~0.3~~	~~0.6~~	14
15	68		5%	65%	30%				3.40	6.80	3.3	6.6	15
16	75	~~30%~~ 20%		20%		~~20%~~		50%	~~1.90~~	~~3.80~~	.6 0.9	1.2 1.8	16
17	80			85%	15%				3.22	6.44	3.2	6.4	17
18	81			95%				5%	2.85	5.70	2.85	5.7	18
19	89	60%						40%	0.60	1.20	—	—	19
20	92	80% ~~70%~~				~~10%~~		20%	~~1.30~~ 0.8	~~2.60~~ 1.6	—	—	20
21	95		70%	30%					2.30	4.60	.9 0.5	1.8 1.0	21
22	99	50% ~~75%~~				~~20%~~ 10%		50%	~~1.75~~	~~3.50~~	Reduction —	Use 0.5 or 1.0 Reduction	22
23	107		50%	50%					2.50	5.00	1.5	3.0	23
24	113		5%	90%				5%	2.80	5.60	2.7	5.4	24
25	116			15%				85%	0.45	0.90	.45	.9	25
26	120		30%					70%	0.60	1.20	—	—	26
27	122							100%	0.00	0.00	—	—	27
28	128	60%						40%	0.60	1.20	—	—	28
29	133	40%						60%	0.40	0.80	—	—	29
30		* Values shown are reduction factors for ½ inch storage — 1 inch storage is 2 times as much reduction											30
31													31

Revised
AUG 27
RMB

	①	②	③	④	⑤	⑥	⑦	⑧ Reduce RCN 5 inch Storm	⑨ Reduce RCN 1 inch Storm	⑩ AMT. TO REDUCE RCN FOR 5-INCH STORM ELIMINATING STORAGE IN AREAS DENSITIES < 600 Units/MI	⑪ AMT TO REDUCE RCN FOR 1-INCH STORM, ELIMINATING STORAGE IN AREAS DENSITIES < 603 Units/MI	⑫
1		1	2	3	4,5	6	7	0	0.85	1.70			
2	138	40%	15%	5%			40	60%	0.40	0.80	45	.9	
3	143		25%					75%	0.50	1.00	—	—	
4	147							100%	0.00	0.00	—	—	
5	150	15%	25%					60%	0.65	1.30	—	—	
6	152							100%	0.00	0.00	—	—	
7	156							100%	0.00	0.00	—	—	
8	159	40%						60%	0.40	0.80	—	—	
9	160	10%						90%	0.10	0.20	—	—	
10	163							100%	0	0	—	—	
11													
12	no change for rest of Sub Watersheds												
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
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27													
28													
29													
30													
31													

Upper Watershed RWCD Aug 19, 1974 R.M. BARTELS 1974 Analysis of Drainage Area uncontrolled after 1/2
Land Use 2000 (Upper Area) the construction of Queen Creek Dam and Buckhorn Mesa Dams

	DRAINAGE AREA		① Area A Desert RCN=75	② Area B Desert RCN=82	③ Area C Irrigated Agri.	HOUSING DENSITY ④ Area D 100-299 homes/sq	⑤ AREA E 300-599	⑥ AREA F 600-1199	⑦ Area G 1200-1999	⑧ Area H Over 2000	⑨ Composite RCN (uncontrolled)	⑩ Reduction ½ inch Storage	⑪ Corrected RCN ½ inch 9+10	Reduction 1 inch Storage	⑫ Corrected RCN 1 inch 9-11	
1	Number	Size	"B Soil"	"D Soil"	~~RCN=86~~	RCN 75	~~RCN=77~~	~~RCN=79~~	80	~~RCN=84~~							1
2	3	3.00				30%	20%	30%	20%		77.60	2.60	75.00	5.20	72.40		2
3	8	2.58				15%		15%	65%	5%	79.15	2.60	76.55	5.20	73.95		3
4	12	1.58	5%			25%			40%	30%	78.80	2.10	76.70	4.20	74.60		4
5	17	1.42	40%			10%	10%		10%	30%	77.50	1.40	76.10	2.80	74.70		5
6	20	1.32						40%	30%	30%	79.90	3.60	76.30	7.20	72.70		6
7	29	1.33	30%			40%	30%				75.60	1.00	74.60	2.00	73.60		7
8	33	0.85						60%	40%		79.40	3.00	76.40	6.00	73.40		8
9	39	0.63				70%	10%		20%		76.20	1.50	74.70	3.00	73.20		9
10	42	0.63						70%	30%		79.30	3.05	76.25	6.15	73.15		10
11	48	1.13				60%			40%		77.00	1.80	75.20	3.60	73.40		11
12	51	0.81						80%	5%	15%	79.35	3.30	76.05	6.60	72.75		12
13	57	1.20				80%		20%			75.80	0.20	75.60	0.40	75.40		13
14	64	1.27				75%		25%			76.00	0.30	75.70	0.60	75.40		14
15	68	1.56						30%	40%	30%	80.00	3.40	76.60	6.80	73.20		15
16	75	1.48				60%		20%	20%		76.80	0.90	75.90	1.80	75.00		16
17	80	3.12						90%		10%	79.20	3.20	76.00	6.45	72.75		17
18	84	0.96			5%			95%			77.55	2.85	74.70	5.70	71.85		18
19	89	0.67				60%		40%			76.60	0.60	76.00	1.20	75.40		19
20	92	1.57	10%			70%		20%			75.80	0.80	75.00	1.60	74.20		20
21	95	1.28					20%	50%	30%		78.90	2.30	76.60	4.60	74.30		21
22	99	1.06				80%		20%			75.80	0.5	75.3	1.00	74.80		22
23	107	1.63					10%	70%	20%		79.00	2.50	76.50	5.00	74.00		23
24	113	1.63			10%			90%			76.10	2.80	73.30	5.60	70.50		24
25	116	104			90%			10%			52.90	0.45	52.45	0.90	52.00		25
26	120	2.69	50%		30%		15%	5%			68.00	0.60	67.40	1.20	66.80		26
27	122	0.97	5%		95%						51.25	0.00	51.25	0.00	51.25		27
28	128	1.05	20%			20%	60%				76.20	0.60	75.60	1.20	75.00		28
29	133	1.71	20%			40%		40%			76.60	0.40	76.20	0.80	75.80		29
30	138	3.60					60%	30%	10%		77.90	~~0.40~~	~~77.50~~	~~0.80~~	~~77.10~~		30
31												Revised 0.85	77.05	1.70	76.2		31

Upper Watershed RWCP Aug. 19, 1974 R.M. BARTELS 1974 Analysis of Drainage Area Uncontrolled after the construction of Queen Creek Dam and Buckhorn Mesa Dams 2/2

Land Use 2000 (Upper Area)

	DRAINAGE AREA		① Area A Desert RCN=75 "B Soil"	② Area B Desert RCN=86 "D Soil"	③ Area C Irrigated Agri.	HOUSING DENSITY ④ Area D 100-299 homes/sq mi	⑤ AREA E 300-599	⑥ AREA F 600-1199	⑦ Area G 1200-1999	⑧ Area H Over 2000	⑨ Composite RCN (uncorrected)	⑩ Reduction for 1 inch Storage	⑪ Corrected RCN for 1 inch Storage 9-10	Reduction for 1 inch Storage	⑫ Corrected RCN for 1 inch Storage 9-11	
1	Number	Size				RCN 75											1
2	143	6.47	60%		10%		20%	10%			73.30	0.50	72.80	1.00	72.30		2
3	147	0.95	100%								75.00	0.00	75.00	0.00	75.00		3
4	150	2.55	60%				40%				75.80	0.65	75.15	1.30	74.50		4
5	152	1.32	100%								75.00	0.00	75.00	0.00	75.00		5
6	156	0.50	100%								75.00	0.00	75.00	0.00	75.00		6
7	159	2.31	20%			20%	60%				76.20	0.40	75.80	0.80	75.40		7
8	160	1.11	90%				10%				75.20	0.10	75.10	0.20	75.00		8
9	163	1.06	100%								75.00	0.00	75.00	0.00	75.00		9
10	165	2.54	100%								75.00	0.00	75.00	0.00	75.00		10
11	168	0.57	100%								75.00	0.00	75.00	0.00	75.00		11
12	170	1.28	100%								75.00	0.00	75.00	0.00	75.00		12
13	171	2.12	100%								75.00	0.00	75.00	0.00	75.00		13
14	174	1.66	100%								75.00	0.00	75.00	0.00	75.00		14
15	178	0.64	100%								75.00	0.00	75.00	0.00	75.00		15
16	180	1.71	100%								75.00	0.00	75.00	0.00	75.00		16
17	183	0.52	100%								75.00	0.00	75.00	0.00	75.00		17
18																	18
19																	19
20																	20
21																	21
22																	22
23																	23
24																	24
25																	25
26																	26
27																	27
28																	28
29																	29
30																	30
31																	31

ARIZONA RWCD

RM Barnes Aug 21 74

Summary of RCN for Upper Portion 1 1

To Show effects of Storage on Year 2000 RCN

DRAINAGE AREA	ALT 4 Uncorrected RCN Calc	ALT 2 RCN @ ½" Storage Calc	ALT 2 RCN @ ½" Storage Use	ALT 3 RCN @ 1" Storage Calc	ALT 3 RCN @ 1" Storage Use
3	77.6	75.0	75.0	72.4	72
8	79.15	76.55	77.0	73.95	74
12	78.80	76.7	77.0	74.6	75
17	77.50	76.1	76	74.7	75
20	79.90	76.3	76	72.7	73
29	75.6	74.6	75	73.6	74
33	79.4	76.4	76	73.4	73
39	76.2	74.7	75	73.2	73
42	79.3	76.25	76	73.1	73
48	77.0	75.20	75	73.4	73
51	79.35	76.05	76	72.75	73
57	75.80	75.6	76	75.4	75
64	76.0	75.7	76	75.4	75
68	80.0	76.6	77	73.2	73
75	76.8	75.9	76	75.0	75
80	79.2	76.0	76	72.75	73
84	77.55	74.7	75	71.85	72
89	76.6	76.0	76	75.4	75
92	75.8	75.0	75	74.2	74
95	78.9	76.6	77	74.3	74
99	75.8	75.3	75	74.8	75
107	79.0	76.5	77	74.0	74
113	76.1	73.3	73	70.5	71
116	52.9	52.45	52	52.0	52
120	68.0	67.4	67	66.8	67
122	51.25	51.25	51	51.25	51
128	76.2	75.6	76	75.00	75
133	76.6	76.2	76	75.8	76
138	77.9	77.05	77	76.2	77 76
143	73.3	72.8	73	72.3	72
147	75.0	75.0	75	—	75
150	75.8	75.15	75	74.5	75
152	75.0		75		75
156	75.0		75		75
159	76.2	75.8	76	75.4	75
160	75.2	75.1	75	75.0	75
163	75.0		75		75
165					
168					
170					

Same to end of Upper Watersheds.

COMPUTATION SHEET

SCS-ENG-523A Rev. 9-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO : 1969 O—364-109

STATE	PROJECT		
ARIZONA	RWCD		
BY RM Bartels	DATE	CHECKED BY	DATE
JOB NO.			

SUBJECT Changes in Density of Housing

SHEET 1 OF 2

Planning Unit	1975 Density	2000 Density	Increase in Density	Color on Map
402	21	124	103	
403	3	22	19	
404A	6	135	129	
404B	19	37	18	
452	12	248	236	
453	5	5	—	
454	1000	1471	471	
906	121	913	792	
404C	24	246	222	
520	24	243	219	
521	140	394	254	
522	3	294	291	
909	121	767	646	
523A	15	228	213	
523B	10	45	35	
568	71	113	42	
565	11	1658	1647	
566	1085	1444	359	
910	635	1205	570	
567A	0	5	5	
567B	22	155	133	
912	20	4362	4342	
617	1830	2648	818	
914	1490	2068	578	
619A	30	438	408	
619B	960	1600	640	
616	586	2144	1558	
618	744	2054	1310	
915	780	1290	510	
620A	800	1374	574	
620B	1090	2100	1190	
621A	756	1586	830	
652	23	810	787	
653A	272	933	661	
621B	393	833	440	
682	15	690	675	
653B	140	800	660	
621C	1	535	534	
705	6	20	14	
720	0.2	4.2	4	

Legend

0-99	—
100-299	
400-599	
600-899	
900-1299	
1300-1699	
Over 1700	

COMPUTATION SHEET

SCS-ENG-523A Rev. 9-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO : 1969 O—364-109

STATE		PROJECT		
BY	DATE	CHECKED BY	DATE	JOB NO.
SUBJECT				SHEET 2 OF 2

Planning Unit

Pond No.	1975 Dam	2000	Diff	Color	~~Expect~~
~~Sec~~ 7 BM	1	150	149		
Sec 15 BM	110	277	167		
Sec 17 BM	150	240	90		
18 BM	90	200	110		
N½ 19 BM	860	1000	140		
N½ 20 DM	460	820	160		
N½ 21 DM	200	500	300		
22 DM	100	210	110		
S½ 19	220	1000	80		
S½ 20	240	400	160		
S½ 21	240	300	60		
29	87	350	263		
30	340	400	60		
31	8	350	342		

RWCD

ANALYSIS OF EFFECTS OF STORAGE ON RCN

5/2/25

BLUE FIGURES ARE STORAGE REQUIREMENTS & RCN BASED ON FIGURE 7-2 URBAN HYD. HANDBOOK TR-55 BLACK FIGURES ARE REPORTED FIG. 7-1, TR-55

* RED FIGURES ARE RCN CALCULATED ELIMINATING STORAGE ON URBAN DENSITIES OF < 600 HOUSES

USING BARTEL'S DATA FOR 1-INCH OF STORAGE

	SUB DRAINAGE		FUTURE W/O STORAGE				FUTURE W/ 1-INCH STORAGE				FUTURE W/ NEW SUBDIVISION REGULATIONS			
	NO.	D.A.	PRES. RCN	100-YR, 24-HR RAINFALL	FURTURE 24 HR RCN	Q (in)	WT. ACC. RCN	STORAGE Req'd	NET FUTURE 24-HR RUNOFF	Req'd 24-HR RCN	WT. ACC. RCN	STORAGE Req'd	NET FUTURE 24-HR RUNOFF	Req'd 24-HR RCN	WT. ACC. RCN
1															
2															
3															
4	(1) 3	3.00	66	3.60	78	1.57	78.6 @ 3	.38	1.19	72 73	72.0 @ 3	.45 .27	1.12 1.31	71 74	71 74 @ 3
5	(3) 8	2.58	75	3.60	79	1.64	78.5 @ 10	.34	1.30	74 75	72.9 @ 10	.25	1.39	75	72.9 @ 10
6	(6) 12	1.58	78	3.40	79	1.48	78.6 @ 14	.25	1.23	75 76				78	72.9
7	(8) 17	1.42	79	"	78	1.42		.19	1.23	75 75				77	
8	(10) 20	1.32	69	"	80	1.56		.45	1.11	73 73		.30	1.26	76	
9	(13) 29	1.33	75	"	76	1.29		.12	1.17	74 76		.59	0.99	75	74.1
10	(15) 33	0.85	65	"	79	1.49	78.4 @ 35	.36	1.11	73 73	73.6 @ 35	.54	1.15	74	75.4 @ 35
11	(18) 39	0.63	76	"	76	1.29		.18	1.11	73 75	avg 74 + 3.40 avg Runoff = 1.18	.34	1.08	76	avg 75.1 + 3.40 * Runoff = 1.29
12	(20) 42	0.63	69	"	79	1.49		.38	1.11	73 73			1.15	74	- 1.18
13	(21) 48	1.13	77	"	77	1.36		.25	1.11	73 75				77	
14	(23) 51	0.81	69	"	79	1.49		.38	1.11	73 73		.45 .56	1.04 1.13	73	.111 / 1.18 = 9%
15	(26) 57	1.20	76	"	76	1.29		.05	1.23	75 76				76	
16	(27) 64	1.27	76	"	76	1.29		.05	1.23	75 76				76	
17	(29) 68	1.56	78	"	80	1.56		.45	1.11	73 73		.23	1.33	77	
18	80	1.48	77	"	77	1.36		.13	1.23	75 76				77	
19	80	3.12	73	"	79	1.49	78.2 @ 82	.38	1.11	73 73	73.6 @ 82	.35 .27	1.13 1.25	73	74.6 75.3 @ 82
20	(34) 84	0.96	63	3.40	78	1.42	78.2 @ 86	.37	1.05	72 72	73.6 @ 86	.30	1.15	73	74.4 75.2 @ 86
21	(36) 89	0.67	77	3.20	77	1.21		.12	1.09	75 77				77	
22	(37) 92	1.57	76	"	76	1.15		.11	1.04	74 76				76	
23	(41) 95	1.28	75	"	78	1.27		.23	1.04	74 76		.24 .30	1.04 1.04	74	
24	(42) 99	1.06	76	"	76	1.15		.06	1.09	75 76				76	
25	(46) 107	1.63	77	"	79	1.34		.30	1.04	74 76		.24	1.08	75	
26	(47) 113	1.63	74	"	76	1.15		.27	0.88	71 71		.16 .23	0.92	72	
27	(49) 116	1.04	53	"	53	0.20		.03	0.17	52 52				53	
28	(55) 120	2.69	65	"	68	0.73		.04	0.69	67 68		.19	.54	69	
29	(56) 122	0.57	51	"	51	0.15	75.8 @ 124	—	0.15	51 51	71.9 @ 124			51	72.3 75.1 @ 124
30	(58) 128	1.05	75	"	76	1.15		.06	1.09	75 76	avg 72 + 3.40 * Runoff = 1.05			75	avg 73 + 3.40 * Runoff = 1.16
	(64) 133	1.71	77	"	77	1.15		—	1.15	76 76		.22	1.09	77	
	(65) 138	3.60	76	"	78	1.27		.12	1.15	76 77				77	

RWCD

ANALYSIS OF EFFECTS OF STORAGE ON RCN

1] FIG 7-1 & 7-2 REFERS TO FIGS. IN TR-55, URBAN HYDROLOGY HANDBOOK

	①		②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	
	SUB DRAINAGE		100-YR 24-HR	PRESENT	FUTURE	DIFF. OF PRES & FUT		FUTURE	DIFF OF PRES & FUT	DIFF OF FUT RCN		FUTURE	DIFF OF PRES & FUT	DIFF OF FUT RCN	
1	No.	D.A.	RAINFALL	RCN	RCN W/O STOR.	RCN W/O STORAGE		RCN W/ 1-INCH STOR	RCN W/ 1-INCH STOR	W/O STOR & W/ 1-INCH		RCN W/ NEW RESULT	RCN W/ NEW RESULT	W/ 1-INCH & W/ NEW RCN	
2															
3	USDA NO.										1]	FIG 7-1	FIG 7-2	FIG 7-1	FIG 7-2
4	(1) 3	3.00	3.60	66	78	+12		72	+6	−6		74	71	+8	+5
5	(3) 8	2.58 5.58	3.60	75	79	+4		74	−1	−5		75	75	—	—
6	(6) 12	1.58 7.16	3.40	78	79	+1		75	−3	−4		78	78	—	—
7	(8) 17	1.42	"	77	78	+1		75	−2	−3		77	77	—	—
8	(10) 20	1.32	"	69	80	+11		73	+4	−7		76	73	+7	+4
9	(13) 29	1.23	"	75	76	+1		74	−1	−2		75	75	—	—
10	(15) 33	0.85 12.01	"	65	79	+14		73	+7	−6		74	71	+9	+6
11	(18) 39	0.63	"	76	77	+1		73	−3	−4		76	76	—	—
12	(20) 42	0.63	"	69	79	+10		73	+4	−6		74	72	+5	+3
13	(21) 48	1.13	"	77	77	—		73	−4	−4		77	77	—	—
14	(23) 51	0.81	"	69	79	+10		73	+4	−6		73	72	+4	+3
15	(26) 57	1.20	"	76	76	—		75	−1	−1		76	76	—	—
16	(27) 64	1.27	"	76	76	—		75	−1	−1		76	76	—	—
17	(29) 68	1.56	"	78	80	+2		73	−5	−7		77	77	−1	−1
18	(31) 75	1.48	"	77	77	—		75	−2	−2		77	77	—	—
19	(33) 80	3.12 28.91	"	73	79	+6		73	—	−6		73	73	—	—
20	(36) (84)	0.96 25.87	3.40	63	78	+15		72	+9	−6		73	70	+10	+7
21	(38) 89	0.67 24.80	3.20	77	77	—		75	−2	−2		77	77	—	—
22	(39) 92	1.57	"	76	76	—		74	−2	−2		76	76	—	—
23	(41) 95	1.28	"	75	78	+3		74	−1	−4		74	74	−1	−1
24	(42) 99	1.06	"	76	76	—		75	−1	−1		76	76	—	—
25	(44) 107	1.63	"	77	79	+2		74	−3	−5		75	71	−2	−6
26	(47) 113	1.63	"	74	76	+2		71	−3	−5		76	73	+2	−1
27	(49) 116	1.04	"	53	53	—		52	−1	−1		53	53	—	—
28	(53) 120	2.69	"	65	68	+3		67	+2	−1		64	65	−1	—
29	(55) 122	0.97 29.41	"	51	51	—		51	—	—		51	51	—	—
30	(58) 128	1.05	"	75	76	+1		75	—	−1		75	75	—	—
31	(60) 133	1.71	"	77	74	−1 ?		76	−1	—		77	77	+1	+1
	(63) 138	3.00	"	76	78	+2		76	—	−2		74	75	+2	−1

R.W.C.D.

ANALYSIS OF EFFECTS FLOOD CONTROL DISTRICT SUBDIVISION REGULATION POLICY RELATED TO PEAK FLOW REDUCTION

R. McArthur 4/24/75

DRAINAGE AREA NUMBER	SIZE (MI²)	① 100 Yr-24 Hr Rainfall (In.)	② 100 Yr-2 Hr Rainfall (In.)	③ PRESENT RCN 24 HR	④ PRESENT RCN 2 HR	⑤ Tc PRESENT (Hrs.)	⑥ Tc FUTURE (Hrs.)	⑦ PRESENT RUNOFF 2 HR-100 YR (In.)	⑧ FUTURE No Storage RCN 24 HR	⑨ FUTURE No Storage RCN 2 HR	⑩ 100 YR-2 HR PRESENT PEAK q	PRESENT PEAK csm	⑪ FUTURE RUNOFF V_r	Peak Out / Peak In	V_s/V_r	⑫ Volume of Storage Required (V_s)
3	3.00	3.60	2.65	66	75	1.30	0.80	0.74	78	84	855	285	1.24	0.38	.368	.45 0.27
8	2.58	3.60	2.65	75	82	1.30	1.00	1.10	79	85	1136	440	1.30	0.73	0.192	0.25
20	1.58	3.40	2.55	69	77	1.50	0.90	0.77	80	86	451	285	1.29	0.41	0.340	.44 0.30
33	0.85	3.40	2.55	65	74	2.10	1.25	0.64	79	85	152	179	1.22	0.32	0.410	.50 0.34
42	0.63	3.40	2.55	69	77	2.60	1.55	0.77	79	85	115	183	1.22	0.41	0.340	.41 0.39
51	0.81	3.40	2.55	69	77	3.20	1.90	0.77	79	85	125	154	1.22	0.38	0.368	.45 0.36
68	1.56	3.40	2.55	78	84	1.90	1.60	1.16	80	86	556	356	1.29	0.80	0.178	0.23
80	3.12	3.40	2.55	73	80	3.50	2.10	0.92	79	85	538	172	1.22	0.47	0.298	.36 0.35
84	0.96	3.40	2.55	63	73	1.80	1.10	0.60	78	84	191	199	1.16	0.33	0.408	.47 0.30
95	1.28	3.20	2.40	75	82	3.80	2.85	0.92	79	85	205	160	1.10	0.63	0.222	.24 0.30
107	1.63	3.20	2.40	77	83	3.05	2.60	0.98	79	85	335	206	1.10	0.30	0.420	.46 0.26
113	1.63	3.20	2.40	74	81	2.80	2.40	0.87	76	82	327	200	0.92	0.84	0.170	.15 0.23
120	2.69	3.20	2.40	65	74	4.00	3.20	0.55	68	77	230	86	0.68	0.62	0.227	.15 0.19
138	3.60	3.20	2.40	76	82	2.70	2.30	0.92	78	84	805	224	1.04	0.81	0.175	.18 0.22

X. Sect

% Agri pres.	% Agri fut.	X. Sect	D.A	Pres. RCN	DIFF	Future RCN No Stor	Future RCN 1/2 Stor	Future RCN 1-in. Stor
15	10	143	6.47	72	1	73	73	72
		147		75		75	75	75
		150		75	1	76	75	75
		152		75		75	75	75
		156		75		75	75	75
		159		75	1	76	76	75
		160		75		75	75	75
		163		75	→	→	→	→
		165		75	→	→	→	→
		168		75	→	→	→	→
		170		75	→	→	→	→
		171		75	→	→	→	→
		174		75	→	→	→	→
		178		75	→	→	→	→
		180		75	→	→	→	→
		183		75	→	→	→	→

7.55 sq mi pres. 3.48 sq mi
Diff = 4.11 sq mi [illegible] g agric land converted to urban above between 143 on Elliot Road.

RWCD — Aug 19, 1974 — R.M. BARTELS — 1974 Analysis of Drainage Area uncontrolled after the construction of Queen Creek Dam and Buckhorn Mesa Dams — 1/2

Lower Watershed — 1975 Land Use — 2000 Land Use

Assume No Change

	DRAINAGE AREA		① Area A Desert RCN=75 "B Soil"	② Area B Desert RCN=82 "D Soil"	③ Area C Irrigated Agri. RCN=50	HOUSING DENSITY ④ Area D 100-299 homes/sq mi RCN 75	⑤ AREA E 300-599 77	⑥ AREA F 600-1199 ~~79~~	⑦ Area G 1200-1999 80	⑧ Area H over 2000 81	⑨ Composite RCN	⑩ USE	⑪ Tc	⑫
1	Number	Size												1
2	3	1.00	100%								75.00	75	2.20	2
3	6	2.97	70%		30%						67.50	68	3.8	3
4	7	9.48	95%		5%						73.75	74	5.4	4
5	10	0.99	100%								75.00	75	2.5	5
6	13	3.70	100%								75.00	75	4.4	6
7	16	2.90	70%		30%						67.50	68	3.0	7
8	18	1.25	100%								75.00	75	3.2	8
9	19	2.05	100%								75.00	75	5.0	9
10	22	3.20	100%								75.00	75	5.4	10
11	27	0.58	100%								75.00	75	1.3	11
12	30	0.41	100%								75.00	75	0.9	12
13	33	0.54	100%								75.00	75	0.9	13
14	40	1.56	70%		30%						67.50	68	2.8	14
15	42	6.11			100%						50.00	50	5.6	15
16	45	3.60	10%		90%						52.50	53	3.2	16
17	47	4.68	10%		90%						52.50	53	5.6	17
18	49	0.72	20%		80%						55.00	55	2.4	18
19	53	5.25	75%		5%			20%			74.55	75	3.3	19
20	58	3.07			100%						50.00	50	5.0	20
21	59	0.69			100%						50.00	50	1.8	21
22	62	5.93	5%		95%						51.25	51	5.6	22
23	66	1.03	70%		30%						67.50	68	1.7	23
24	117	15.90	15%		85%						53.75	54	3.8	24
25	120	4.70	10%		90%						52.50	53	3.2	25
26	139	7.90	30%		70%						57.50	58	4.3	26
27	141	9.00	20%	50%	30%						73.00	73	2.7	27
28	146	16.60	60%		40%						65.00	65	3.8	28
29	150	6.00	10%	40%	50%						66.90	67	2.5	29
30														30
31														31

RWCD — Aug 19, 1974 — R.M. BARTELS — 1974 Analysis of Drainage Area uncontrolled after the construction of Queen Creek Dam and Buckhorn Mesa Dams — 2/2

Lower Watershed — 1975 Land Use — 2000 Land Use

Assume No Change

	DRAINAGE AREA		① Area A Desert RCN=75 "B Soil"	② Area B Desert RCN=86 "D Soil"	③ Area C Irrigated Agri. RCN=50	HOUSING DENSITY ④ Area D 100-299 homes/Sec. RCN 75	⑤ AREA E 300-599	⑥ AREA F 600-1199	⑦ Area G 1200-1999	⑧ Area H over 2000	⑨ Composite RCN	⑩ USE	⑪ Tc	⑫
1	Number	Size												
2	153	3.90			100%						50.00	50	4.0	
3	155	13.90	20%	50%	30%						73.00	73	2.0	
4	158	8.30	30%	60%	10%						79.10	79	1.4	
5	160	2.60	10%		90%						52.50	53	3.2	
6	165	16.50	15%		85%						53.75	54	2.6	
7	169	13.80	40%	60%							81.60	82	3.1	
8	172	5.00	50%	50%							80.50	81	1.1	
9														
10														
11														
12														
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31														

RWCD

Ariz.
R.M. Bartels Aug 19, 1974

Steps to determine reach routing coefficient on TR-20 Program — Present + Future (2000) conditions

① Determine t_c Present Conditions and Future Conditions — include effects of urbanization

② Using graph relating T_c Vs Length for various velocitys estimate the avg velocity used in calculating the T_c of the watershed.

③ Using this average velocity go to the graph showing the "C" value versus v based on the equation $C = \frac{v}{v+1.7}$.

④ Use the C value determined by this basis for the reach routing Coeff through the watershed.

Note. For the RWCD Channel, we will use an average velocity of 5 fps. this was agreed to during Woodwards trip of Aug 5-8th with Monville.

Note: for the QUEEN CREEK CHANNEL we will use an estimated velocity of 4 fps because of the concentrated flows + existance of a channel at present time. This is an estimate based on judgement. AWSP II program has not been run on the channel.

ARIZONA

RM. BARTELS

RWCD

REACH ROUTING COEFF. ( ) 1 2

FOR Upper Area

Reach Iden. Number	Reach Length *	Sub. Watershed Num	Avg V from Te	C value from Curve
5	7000	Not applicable	RWCD Channel use 5.0 fps	0.75
11	2700	Not Applicable	RWCD Channel 5.0 fps	0.75
14	5000	Not Applicable	RWCD CHANNEL use 5.0 fps	0.75
19	7000	20		
23	3000	Not Applicable	RWCD channel Use 5.0 FPS	0.75
(B) 32	11500	33		
36	1000	Not Applicable	RWCD Channel Use 5.0 fps	0.75
(A) 41	14000	42		
45	500	Not Applicable	RWCD Channel Use 5.0 fps	0.75
50	16000	51		
54	1900	Not Applicable	RWCD Channel Use 5.0 fps	0.75
67	12000	68		
77	7500	68		
79	16000	80		
83	3000	Not Applicable	RWCD Channel use V = 5.0 fps	0.75
86	2800	"	"	0.75
(A) 94	21000	95		
(B) 101	20000	107		
110	4700	113		
115	8000	116		
119	4000	Not Applicable	RWCD Channel Use V = 5.0 fps	0.75
121	8500	122		
125	5000	Not Applicable	RWCD Channel Use V = 5.0 fps	0.75
130	7400	138		
135	5000	138		
137	8000	138		
140	8500	138		
142	31000	143		
146	4600	Not Applicable	RWCD Channel V = 5.0 fps	0.75
149	2800	"	"	0.75
(A) 151	21000	152		
155	600	Not Applicable	RWCD Channel V = 5.0 fps	0.75
158	2800	" "	" "	0.75
162	10000	163		
(A) 167	11000	168		
(A) 173	10000	174		
177	7500	178		
(A) 182	5000	183		

* Will use lengths used in MAY 1973 run unless otherwise noted.

(A) Use length used in Te calculations

(B) Combined watersheds here

AR12.

RWCD

RMB Aug 20, 74

REACH ROUTING COEFF.

	Reach ID No	Reach Length *	Sub Watershed No	Avg v from t_c	Value from Curve	2	2
Lower Portion	5	16000	Not Applicable	Powerline Channel Use 7.0 fps	0.81		
	9	2700	16				
	12	3000	16				
	15	16000	16				
	21	2700	22				
	24	2500	27				
	26	650	27				
	29	4000	30				
	32	2400	33				
	35	1800	33				
	37	9000	Not Applicable	Powerline Channel Use 7.0 fps	0.81		
	39	11000	"	RWCD Channel Use 5.0 fps	0.75		
	41	28400	42				
Ⓐ	44	17000	45				
	48	12700	49				
	52	2000	53				
	55	1800	53				
	57	7000	Not Applicable	RWCD Channel Use v = 5.0 fps	0.75		
	61	29350	62				
	65	20000	Not Applicable	RWCD Channel Use 5 = 5.0 fps	0.75		
Ⓐ	119	46000	All in channel so don't use 120 values	Queen Creek Use v = 4.0 fps	0.70		
	143	8800	Between watersheds	No channel Use v = 1.5 fps	0.47		
	149	5200	"	"	0.47		
	152	21000	153				
	157	16000	160				
	162	18300	165				
	164	7000	Not Applicable	QUEEN CREEK Use v = 4.0 fps	0.70		
	168	12000	" "	RWCD Channel Use v = 5.0 fps	0.75		
	171	22400	" "	" "	0.75		

* All values unless otherwise noted are ones used in May 1973 run

Ⓐ Use values used in t_c Calculations

ARIZONA RWCD

RM Bartels Aug 21 74

Avg Velocity for Selected Subwatersheds

For Upper Portion	Watershed No	T_c (1975)	Avg v 1975	T_c (2000)	Avg v (2000)	Length
	20	1.50	1.50	0.90	2.50	8000
	33	2.10	1.50	1.25	2.60	11500
	42	2.60	1.50	1.55	2.30	14000
	51	3.20	1.50	1.90	2.80	17000
	68	1.90	1.90	1.60	2.20	13000
	80	3.50	1.50	2.10	2.90	19000
	95	3.80	1.50	2.85	2.00	21000
	107	3.05	1.80	2.60	2.10	20000
	113	2.80	1.50	2.40	1.80	15000
	116	2.00	1.50	2.00	1.50	11000
	122	1.80	1.50	1.80	1.50	10000
	138	2.70	1.50	2.30	2.00	16000
	143	6.80	1.50	6.10	1.70	37000
	152	3.80	1.50	3.80	1.50	21000
	163	2.00	1.50	2.00	1.50	11000
	168	2.00	1.50	2.00	1.50	11000
	174	1.80	1.50	1.80	1.50	10000
	178	1.50	1.50	1.50	1.50	8000
	183	0.90	1.50	0.90	1.50	5000
Lower Portion						
	16	3.00	1.50	3.00	1.50	16000
	22	5.40	1.50	5.40	1.50	29000
	27	1.30	1.50	1.30	1.50	7000
	30	0.90	1.50	0.90	1.50	5000
	33	0.90	1.50	0.90	1.50	5000
	42	5.60	1.50	5.60	1.50	30000
	45	3.20	1.50	3.20	1.50	17000
	49	2.40	1.50	2.40	1.50	13000
	53	3.30	1.50	3.30	1.50	18000
	62	5.60	1.50	5.60	1.50	30000
	153	4.00	1.50	4.00	1.50	22000
	160	3.20	1.50	3.20	1.50	17000
	165	2.60	1.20	2.60	1.20	22000

PROJECT ARIZONA RWCD

RM BARTELS AUG 21, 74

SUBJECT REACH ROUTING COEFF (2000') SHEET 1 OF 2

FOR UPPER AREA	Ident Number	Length* (Ft)	Representative Sub Watershed Number	Avg v. from Te	C Value from Curve
	5	7000'	N/A	RWCD Channel use 5.0	0.75
	11	2700'	N/A	"	0.75
	14	5000'	N/A	"	0.75
	19	7000'	20	2.50	0.60
	23	3000'	N/A	RWCD channel use 5.0	0.75
	(A)(B) 32	11500'	33	2.60	0.61
Length of (old 36, 45+54)	(C) 36	3400'	N/A	use 5.0	0.75
	41	14000'	42	2.30	0.58
	50	16000'	51	2.80	0.62
	67	12000'	68	2.20	0.56
	77	7500'	68	2.20	0.56
	79	16000'	80	2.90	0.63
Length of (old 83+86)	(C) 83	5800'	N/A	use 5.0	0.75
	(A) 94	21000'	95	2.00	0.54
	(B) 101	20000'	107	2.10	0.55
	110	4700'	113	1.80	0.51
	115	8000'	116	1.50	0.47
	119	4000'	N/A	RWCD Channel	0.75
	121	8500'	122	1.50	0.47
	125	5000'	N/A	RWCD Channel	0.75
	130	7400'	138	2.00	0.54
	135	5000'	138	↓	0.54
	137	8000'	138	↓	0.54
	140	8500'	138	↓	0.54
	142	31000'	143	1.70	0.50
Length of (old 146+149)	(C) 146	7400'	N/A	RWCD Channel	0.75
	(A) 151	21000'	152	1.50	0.47
Length of (old 155, 158, +182)	(A) 158	4200'	N/A	RWCD Channel	0.75
	162	10000'	163	1.50	0.47
	(A) 167	11000'	168	↓	↓
	(A) 173	10000'	174		
	177	7500'	178		
	(A) 182	5000'	183		

* Use same lengths as MAY 1973 computer run unless otherwise noted

(A) = Length used in Te calculations

(B) Combined Watersheds

(C) Combined Reaches

STATE ARIZ. RWCD

BY RMB Aug 20, 74

SUBJECT

REACH ROUTING COEFF. (2000) 2 2

	Reach ID No	Reach Length *	Sub Watershed No	Avg v from t_c	Value from Curve
Lower Portion	305	16000	Not Applicable	Powerline Channel Use 7.0 fps	0.81
	309	2700	16	1.50	0.47
	312	3000	16	1.50	0.47
	315	16000	16	1.50	0.47
	321	2700	22	1.50	0.47
	324	2500	27	1.50	0.47
Comb ↓	~~326~~	~~650~~	~~27~~	~~1.50~~	~~0.47~~
	329	4800	30	1.50	0.47
	332	2400	33	1.50	0.47
	335	1800	33	1.50	0.47
	337	9000	Not Applicable	Powerline Channel Use 7.0 fps	0.81
	339	11000	"	RWCD Channel Use 5.0 fps	0.75
	341	28400	42	1.50	0.47
Ⓐ	344	17000	45	1.50	0.47
	348	12700	48	1.50	0.47
	352	2000	53	1.50	0.47
	355	1800	53	1.50	0.47
	357	7000	Not Applicable	RWCD Channel Use v = 5.0 fps	0.75
	361	29350	62	1.50	0.47
	365	20000	Not Applicable	RWCD Channel Use S = 5.0 fps	0.75
Ⓐ	419	46000	All in channel so don't use 128 values	Queen Creek Use v = 4.0 fps	0.70
	443	8800	Between watersheds	No channel Use v = 1.5 fps	0.47
	449	5200	"	"	0.47
	452	21000	153	1.50	0.47
	457	16000	160	1.50	0.47
	462	18300	165	2.20	0.57
	464	7000	Not Applicable	QUEEN CREEK Use V = 4.0 fps	0.70
	468	12000	" "	RWCD Channel Use v = 5.0 fps	0.75
	471	22400	" "	" "	0.75

* All values unless otherwise noted are ones used in May 1973 run

Ⓐ Use values used in t_c Calculations

ARIZONA RWCD

RM BARTELS AUG 21, 74

REACH ROUTING COEFF (1975) SHEET 1 OF 2

FOR		Ident Number	Length* (FT)	Representative Sub Watershed Number	Avg v. from te	C Value from Curve
UPPER AREA		5	7000'	N/A	RWCD Channel use 5.0	0.75
		11	2700'	N/A	"	0.75
		14	5000'	N/A	"	0.75
		19	7000'	20	1.50	0.47
		23	3000'	N/A	RWCD Channel use 5.0	0.75
	Ⓐ Ⓑ	32	11500'	33	1.50	0.47
Length of (old 36, 45, +54)	Ⓒ	36	3400'	N/A	use 5.0	0.75
		41	14000'	42	1.50	0.47
		50	16000'	51	1.50	0.47
		67	12000'	68	1.50	0.47
		77	7500'	68	1.90	0.53
		79	16000'	80	1.50	0.47
Length of (old 83+86)	Ⓒ	83	5800'	N/A	use 5.0	0.75
	Ⓐ	94	21000'	95	1.50	0.47
	Ⓑ	101	20000'	107	1.80	0.51
		110	4700'	113	1.50	0.47
		115	8000'	116	1.50	0.47
		119	4000'	N/A	RWCD Channel	0.75
		121	8500'	122	1.50	0.47
		125	5000'	N/A	RWCD Channel	0.75
		130	7400'	138	1.50	0.47
		135	5000'	138	↓	↓
		137	8000'	138		
		140	8500'	138		
		142	31000'	143		
Length of (old 146+149)	Ⓒ	146	7400'	N/A	RWCD Channel	0.75
	Ⓐ	151	21000'	152	1.50	0.47
Length of (old 155, 158, +182)	Ⓒ	158	4200'	N/A	RWCD Channel	0.75
		162	10000'	163	1.50	0.47
	Ⓐ	167	11000'	168	↓	↓
	Ⓐ	173	10000'	174		
		177	7500'	178		
	Ⓐ	182	5000'	183		

* Use same lengths as MAY 1973 computer run unless otherwise noted

Ⓐ Length used in Calculations
Ⓑ Combined Watersheds
Ⓒ Combined Reaches

STATE ARIZ. RWCD

BY RMB Aug 29, 74

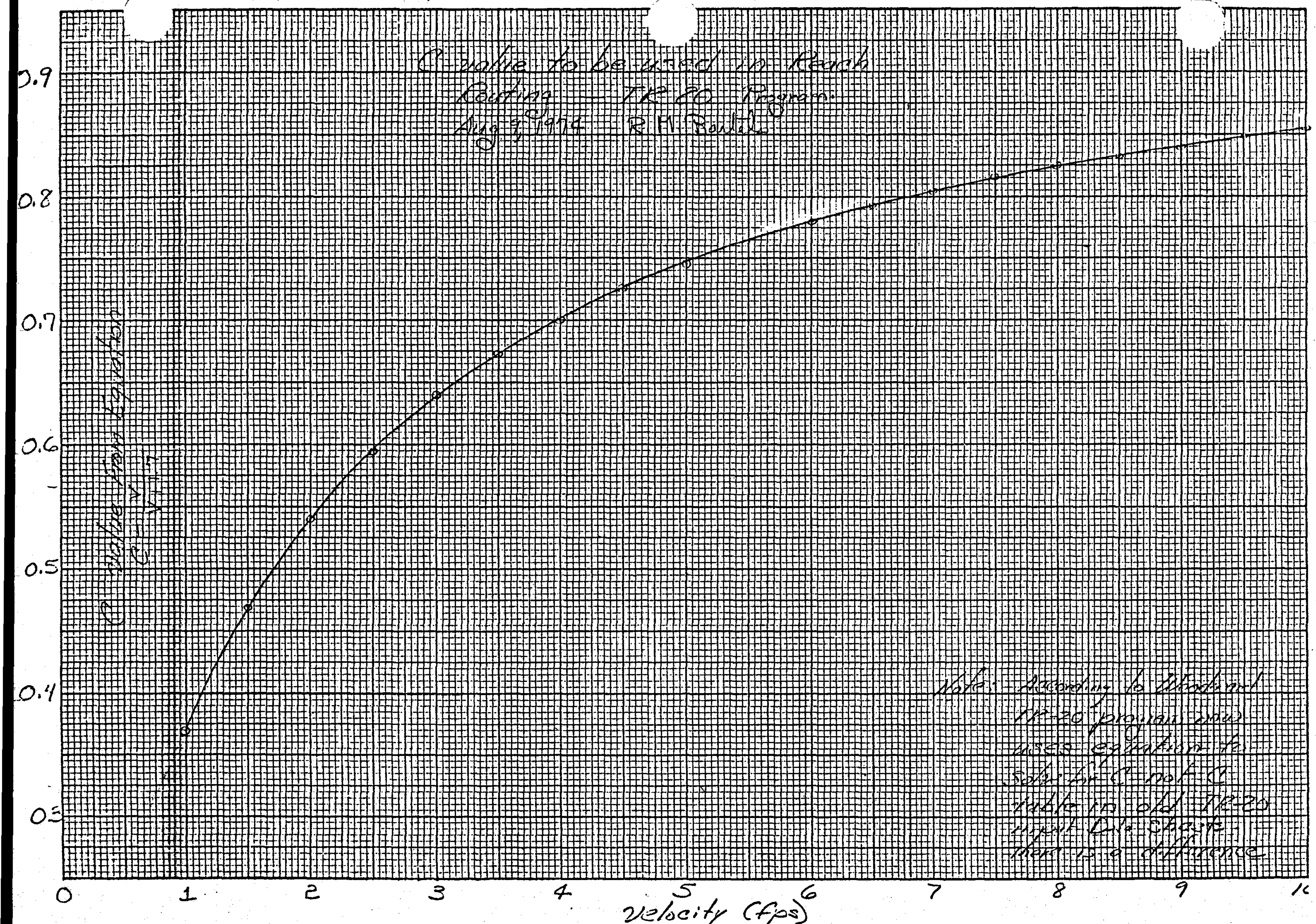
SUBJECT REACH ROUTING COEFF. (1975) 2 of 2

	Reach ID No	Reach Length *	Sub Watershed No	Avg v from t_c	Value from Curve
Lower Portion	305	16000	Not Applicable	Powerline Channel Use 7.0 fps	0.81
Revised No. are +300 (2 mis Aug 23), RA	309	2700	16	1.50	0.47
	312	3000	16	1.50	0.47
	315	16000	16	1.50	0.47
	321	2700	22	1.50	0.47
	324	2500	27	1.50	0.47
	26	~~650~~	~~27~~	~~1.50~~	~~0.47~~
Combine ↓ Now 4650 @329	329	~~4000~~	30	1.50	0.47
	332	2400	33	1.50	0.47
	335	1800	33	1.50	0.47
	337	9000	Not Applicable	Powerline channel Use 7.0 fps	0.81
	339	11000	"	RWCD Channel Use 5.0 fps	0.75
	341	28400	42	1.50	0.47
Ⓐ	344	17000	45	1.50	0.47
	348	12700	48	1.50	0.47
	352	2000	53	1.50	0.47
	355	1800	53	1.50	0.47
	357	7000	Not Applicable	RWCD Channel Use v = 5.0 fps	0.75
	361	29350	62	1.50	0.47
	365	20000	Not Applicable	RWCD Channel Use S = 5.0 fps	0.75
Ⓐ	419	46000	All in channel so don't use 128 values	Queen Creek Use v = 4.0 fps	0.70
	443	8800	Between watersheds	no channel Use v = 1.5 fps	0.47
	449	5200	"	"	0.47
	452	21000	153	1.50	0.47
	457	16000	160	1.50	0.47
	462	18300	165	2.20	0.57
	464	7000	Not Applicable	QUEEN CREEK Use V = 4.0 fps	0.70
	468	12000	" "	RWCD Channel Use v = 5.0 fps	0.75
	471	22400	" "	" "	0.75

* All values unless otherwise noted are ones used in May 1973 run

Ⓐ Use values used in t_c Calculations

Note 1973 x Sec No. are 300 less than used in This run


C value to be used in Reach
Routing — TR 20 Program.
Aug 9, 1974 R.H. Boulil
0.9
0.8
0.7
0.6
0.5
0.4
0.3
C value from Equation
Note: According to Woodward
TR-20 program now
uses equation to
solve for C not C
table in old TR-20
input Data Sheet
there is a difference
0
1
2
3
4
5
6
7
8
9
10
Velocity (fps)

ARIZONA RWCL

RM Bartek Aug 21, 74

Prec. For 1974 Analy. (Breakdown) 1 3

Will place precipitation starting in the upper portion of the watershed - X sec 3 and continue on through sub watershed 172 in the lower ~~area~~ portion of the watershed.

Try to place as close as possible to Jim Malones area reduction curve. However, will try to have Average Prec for total watershed at outlet equal % of point called for on Areal Reduction Curve.

From PAGE 1 of General discussion. Item 2

TOTAL Sq. Mile	Intervening Sq Mi	Intervening P (% of Point)	Avg Prec. for Total Watershed % of Pint
1	1	100	100
5	4	96.2	97
25	20	91.9	93
55	30	87.6	90
95	40	82.8	87
150	55	78.8	84
220	70	77.6	82
300	80	74.5	80
385	85	71.0	78

	WATERSHED No	Int D.A	Total DA	Int. P % of Point	TOTAL P % of Pint	
Upper Portion	3	3.00	3.00	Use 97	97	
	8	2.58	5.58	Use 97	97	541.26
	12	1.58	7.16	Use 92		
	17	1.42	8.58	Use 92		
	20	1.32	9.90	Use 92		
	29	1.33	11.23	Use 92		
	33	0.85	12.08	Use 92		
	39	0.63	12.71	Use 92		
	42	0.63	13.34	Use 92		
	48	1.13	14.47	Use 92		
	51	0.81	15.28	Use 92		
	57	1.20	16.48	Use 92		
	64	1.27	17.75	Use 92		
	68	1.56	19.31	Use 92		
	75	1.48	20.79	Use 92		
	80	3.12	23.91	Use 92	(1774.68)	
	84	0.96	24.87	Use 92	(19.29)(92)	93.8

AR12 RWCD

RM Bartel Aug 21, 1974

Prec for 1974 Analysis

2 3

	Watershed No	Int D.A Sq mi	TOTAL DA Sq mi.	Int P. % of Point	Avg P on Total Watershed % of Point
			24.87		
Upper Portion (Cont)	89	0.67	25.54	Use 87	
	92	1.57	27.11		
	95	1.28	28.39		
	99	1.06	29.45		
	107	1.63	31.08		
	113	1.63	32.71		
	116	1.04	33.75		
	120	2.69	36.44		
	122	0.97	37.41		
	128	1.05	38.46		
	133	1.71	40.17		
	138	3.60	43.77		
	143	6.47	50.24		
	147	0.95	51.19		
	150	2.55	53.74	(2626.53)	
	152	1.32	55.06	(30.19)(87)	90.3
	156	0.50	55.56	Use 82.5	
	159	2.31	57.87		
	160	1.11	58.98		
	163	1.06	60.04		
	165	2.54	62.58		
	168	0.57	63.15		
	170	1.28	64.43		
	171	2.12	66.55		
	174	1.66	68.21		
	178	0.64	68.85		
	180	1.71	70.56		
	182	0.52	71.08		
Lower Portion →	3	1.00	72.08		
	6	2.97	75.05		
	7	9.48	84.53		
	10	0.99	85.52		
	13	3.70	89.22		
	16	2.90	92.12		
	18	1.25	93.37		
	19	2.05	95.42		
	22	3.20	98.62		
	27	0.58	99.20		
	30	0.41	99.61		
	33	0.54	100.15	(44.59)(82.5) = 3678.6	86.1

Total 2621.07

RWCD

RMB 8/21/74

Rec for 1974 Analysis

3 3

	Watershed No	Int. D.A	Total DA	Int P % of Point	Avg P on Total Watershed % of Point
			100.15	(Total DA(P) 8621.07)	
Lower Portion (Cont.)	40	1.56	101.71	Use 79	
	42	6.11	107.82		
	45	3.60	111.42		
	47	4.68	116.10		
	49	0.72	116.82		
Queen Creek ADMS into EMF →	53	5.25	122.07		
	58	3.07	125.14		
	59	0.67	125.82		
	62	5.93	131.76		
	66	1.03	132.79		
	117	15.90	148.69		
	120	4.70	153.39	Total = 12,227.02 (53.24)(79) (4205.95)	83.6
	139	7.90	161.29	Use 77.5	
	141	9.00	170.29		
	146	16.60	186.89		
	150	6.00	192.89		
	153	3.90	196.79		
	155	13.90	210.69		
	158	8.30	218.99	Total = 17,911.02 (65.6)(77.5)	81.8
	160	2.60	221.59	Use 75.0 5084.0	
	165	16.50	238.09		
	169	13.80	251.89		
	172	5.00	256.89	~~Total~~ 37.9(75) 2842.5	80.8

Total = 20,753.5

ARIZONA RWCD

RMB Aug 21, 74

DESIGN STORMS For AH 1 to 3

POINT RAINFALLS (24 hour)

1%	3.70 inch
4%	2.80 inch
10%	2.20 inch

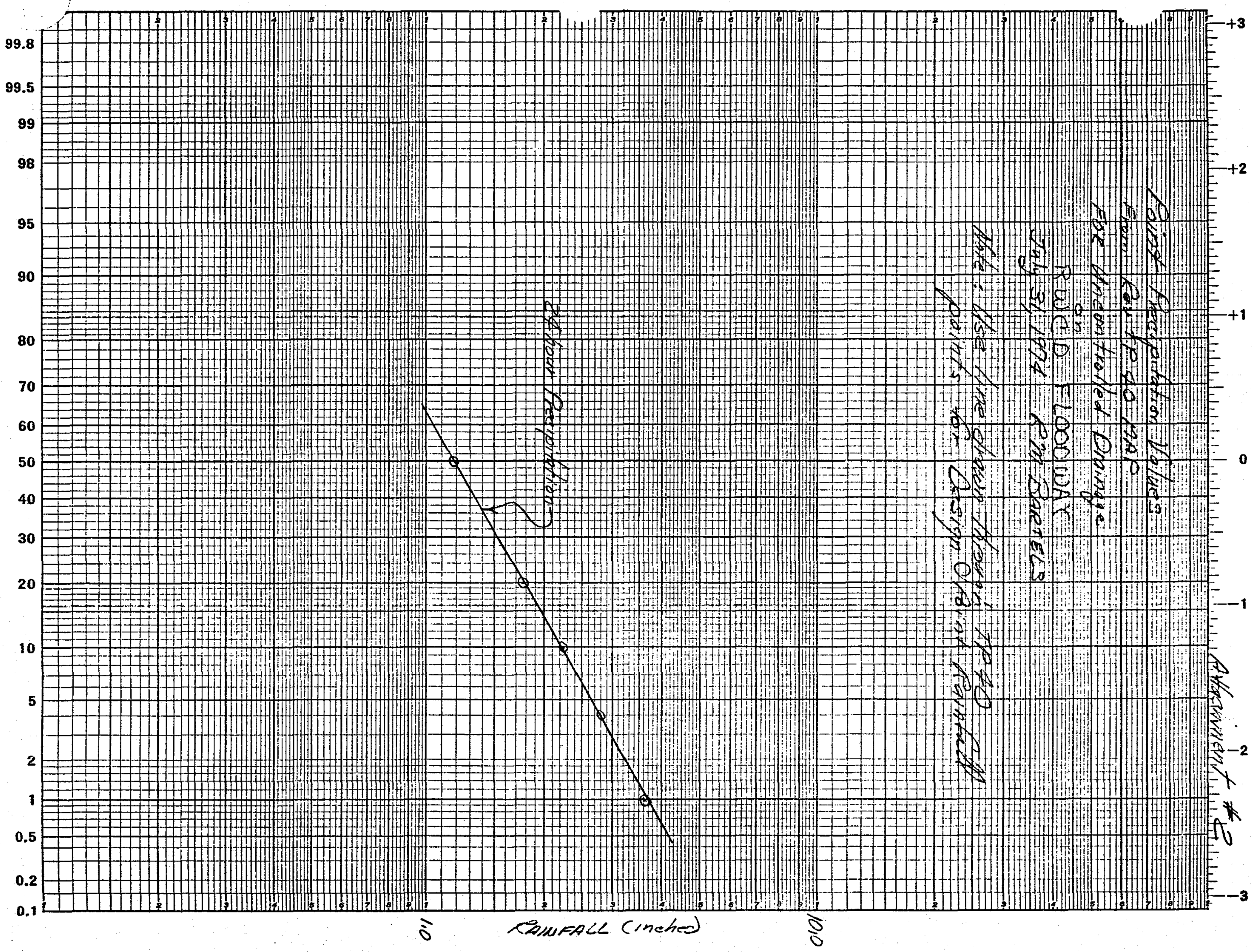
VALUES FOR EXECUTIVE CONTROL

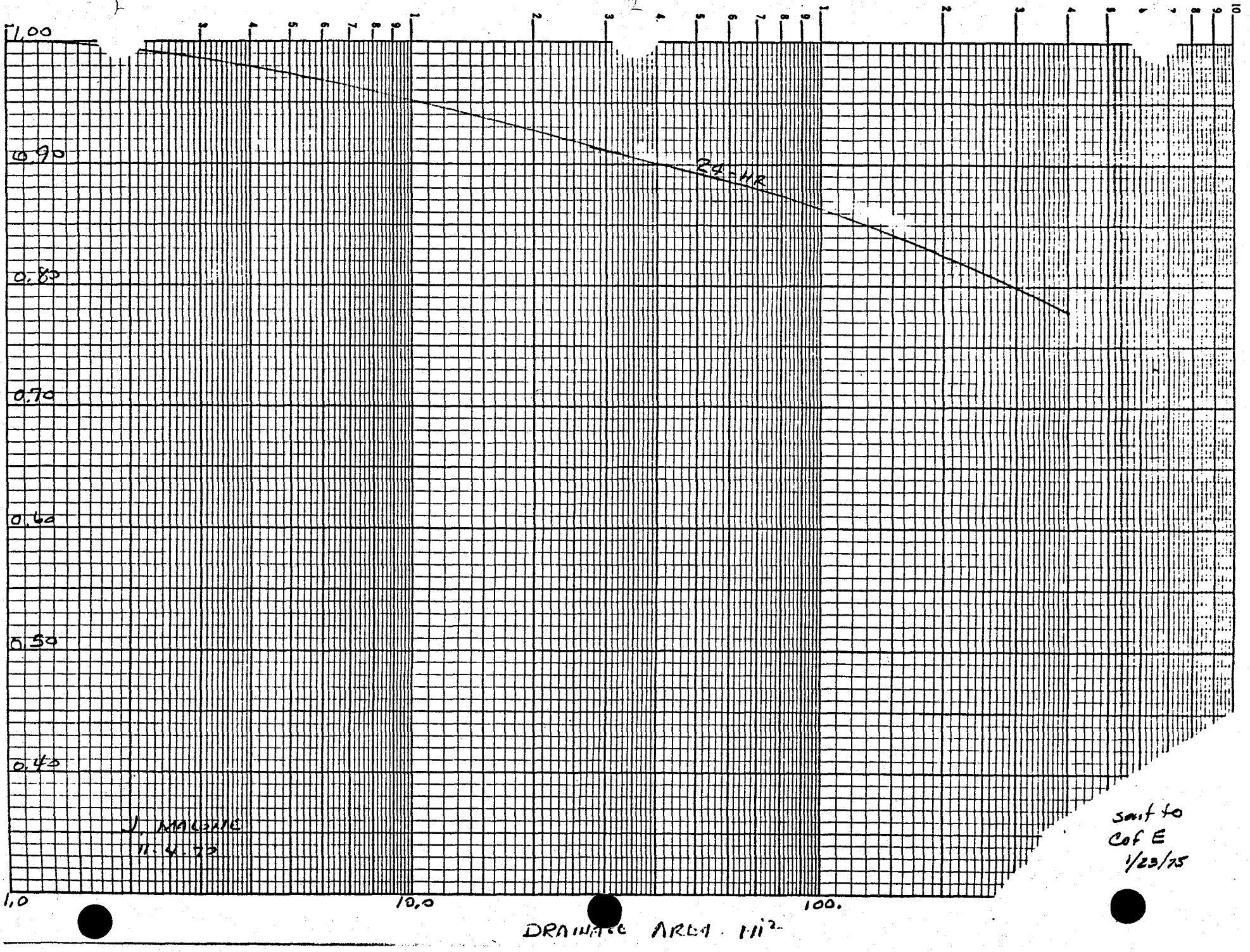
	X Section From	to	(1% Point)	(Mod Factor)	Design 1%	4% Point	(Factor)	4% Design
Upper Portion	003	011	3.70	(.97)	3.6	2.80	(.97)	2.70
	012	086	3.70	(.92)	3.4		(.92)	2.60
	089	155	3.70	(.87)	3.2		(.87)	2.45
	156	186	3.70	(.825)	3.05		(.825)	2.30
Lower Portion	003	039	3.70	(.825)	3.05		(.825)	2.30
	040	122	3.70	(.79)	2.90		(.79)	2.20
	139	159	3.70	(.775)	2.85		(.775)	2.15
	160	173	3.70	(.75)	2.80		(.75)	2.10

	From	To	10% Point	Factor	Design 10%
Upper	003	011	2.20	.97	2.15
	012	086		.92	2.00
	089	155		.87	1.90
	156	186		.825	1.80
Revised No by Add 300 to Xsec No — Lower	003	039		.825	1.80
	040	122		.79	1.75
	139	159		.775	1.70
	160	173		.75	1.65

303 to 339
340 to 422
439 to 459
460 to 473

3-3


99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
+3
+2
+1
0
−1
−2
−3
Point Precipitation Values
From Rev TP 40 MAP
For Uncontrolled Drainage
on
RUCD FLOOD DAY
July 31, 1974 R M BARTELS
Note: Use line drawn through TP 40
points for Design of Rainfall
24 hour Precipitation
Attachment #2
1.0
RAINFALL (inches)
10.0


SEMI-LOG. 3 CY. BY 10 DIV./ IN.
MADE IN USA
1.00
0.90
0.80
0.70
0.60
0.50
0.40
24-HR
1.0
10.0
100.
J. MALONE
11.4.72
Sent to
Cof E
1/23/75
DRAINAGE AREA 1.11 sq. mi.

AR12 RWCD (1974 Analysis)

ORMB Sept27, 74

Summary of Alternates Studied.

All Alternates except 6 are based on All proposed dams being Constructed in Both Buckhorn Mesa + Queen Creek Watersheds.

Alternate 1 – This alternate uses MAG projections for 1975 land use. The velocities for Tc + reach routing are based on natural conditions predominately. Used $v = 1.5$ fps for all fan areas south of Apache Trail. 100yr peak at End = 8350cfs

Alternate 2 – This Alternate uses MAG projections for 2000 land use. The velocities for natural areas stay the same as in Alternate 1 but the velocities in the urban areas are increased depending on the amount of urbanization. This Alternates RCN are based on the assumption of ½ inch storage being required on all new urban development following 1975.

Alternate 3 – This alternate is the same as Alternate 2 except the RCN of urban areas are modified to show effect of 1 inch of storage on new urban land.

Alternate 4 – This alternate uses the MAG 2000 data used for Alt 2 & 3 except the RCN are not modified for storage.

Alternate 5 – This alternate uses the same parameters as Alternate 3 except two side channel reservoirs are constructed along the RWCD. One is located above Powerline Channel and the second is located at the north boundary of the indian reservation.

Alternate 6 – This Alternate was run to determine what the Alt 3 peaks would have been if Buckhorn Mesa Dams were not built.

with Buckhorn-Mesa and Queen Creek DAMS Constructed for all except ALT 6.

ARIZONA R.M. Barnes Sept. 16, 74 RWCD Design Summary of Alternates

Location	1973 Analysis Assuming year 2020 Land use (Solid Urban above (Guadalupe)		1974 Analysis							
	X Sec No	100yr Peak	X-Section number for Alt 1 to 4	ALT 1 1975 land Use with MAG Projections 100yr Peak	ALT 2 2000 Land Use MAG Projections with ½ inch urban Storage 100yr Peak	ALT 3 2000 Land Use MAG Projections with 1" of urban storage 100yr Peak	ALT 4 2000 Land Use MAG Projection with No Storage 100yr Peak	X-Section number for ALT 5+6	ALT 5 2000 Land Use MAG Projections with 1 inch of Storage + 2 dams along RWCD 100yr. Peak	ALT 6 2000 Land Use MAG Projections with one inch of Storage without Buckhorn Mesa Dams Constructed No dams along RWCD 100yr Peak
RWCD @ Brown Road	3	2210	3	550	1380	1160 1.12 (1305)	1620	1	1160	1170
RWCD @ Apache Trail	10	2920	10	1290	2340	1965 1.10 (2155)	2675	4	1965	2050 ~~2020~~ (mark Low) (narrow Low)
RWCD @ Broadway	14	3035	14	1720	2690	2290 1.11 (2550)	3070	7	2290	2410 ~~2420~~
RWCD @ Southern	35	4980	35	2430	3955	3240 1.11 (3840)	4490	16	3440	~~4160~~ 3685
RWCD @ Superstition	82	10950	82	3090	5470	4720 1.11 (5240)	6240	34	4720	6725 ~~6350~~
RWCD @ Casa Blanca	86	10020	86	3110	5450	4700 1.11 (5220)	6260	37	4700	6740 ~~6370~~
RWCD @ GUADALUPE	124	13125	124	3420	5620	4860 1.11 (5390)	6420	56	4860	7350 ~~7140~~
RWCD @ Elliot	145	16370	145	3710	5850	5110 1.10 (5610)	6645	68	5110	7840 ~~7630~~
	155	15480	155	3940	6010	5285 1.10 (5810)	6800	75	5285	8130 ~~7950~~
RWCD above Maxerline (Kay Rd)	186	18600	186	4830	6605	5890 1.09 (6420)	7350	100	5890	8999 ~~8840~~
below DAM	B 01								4795	
RWCD Below Maxerline Channel	038	23800	338	6180	7175	6470 1.08 (6980)	7910	129	6140	~~9790~~ 9930
RWCD @ So. Pacific RR	056	23800	356	6400	7570	6880 1.07 (7370)	8300	145	6350	Rest of 10,190
RWCD at GERMANN	064	23800	364	6425	7500	6820 1.07 (7310)	8210	152	6385	Run did 10,200
RWCD above Queen Creek	67	23800	367	6425	7380	6730 1.07 (7210)	8060	155	6390	Not Work 10,180 End of ALT 6
Queen Creek below Junction	166		466	1910	1910	1910	1910	181	1910	
RWCD Below Queen Creek Junct	167	25600	467	7925	8705	8270 1.06 (8555)	9370	182	7900	inflow above Sec. 4 lost about 600 cfs due to error in input data so all values between 4 and 16 could be about 600 too.
RWCD At Reservation	170	25600	470	8270	9270	8610 1.05 (9038)	9940	185	7560	
RWCD at Place it turns West on Reservation	173	25600	473	8350	9300	8690 1.05 (9125)	9930	190	7600	
						Use for Design this Land Use + Storage			Possible ALT for Design	RMO Sept 16, 74

NOTE: RED FIGURES SHOW RESULTS OF TR-20 RUN FOR ALT 3 (REV-2) USING STORAGE REQUIRED TO RESTRICT FUTURE PEAK FLOWS FROM 100 yr. 24 hr STORM TO PRE-DEVELOPMENT PEAK (DISCHARGE)

Note 2nd DAM Built just up stream of this X-section

ARIZONA	RWCD		
R.M. Bracken Sept. 5, 74			

Summary of Alternates

①	②	③	④	⑤	⑥
1975 Land Use with BM Constructed And L.Q. Creek Constructed	2000 Land Use With ½ inch DAMS Constructed	2000 Land Use with 1 inch DAMS Constructed	2000 Land Use No on site Storage DAMS Constructed	2000 Land Use [redacted] inch of R. on site Storage with 2 dams along RWCD + BM + LQ Built	2000 Land Use with no Dams built on B. Mesa. and 1 inch of Storage on New Dams.

(100 Year Storm)

	ALT 1 to 4 X-Section Number	①	②	③	④	ALT 5 & 6 X-Section Number	⑤	⑥
RWCD @ Brown Road	3	350	1380	1160	1620	1	1160	1170
RWCD @ Apache Trail	10	1290	2340	1965	2675	4	1965	2050
RWCD @ Amadeus	14	1720	2690	2290	3070	7	2290	2410
RWCD @ Southern	35	2430	3955	3440	4490	16	3440	4060
RWCD @ Superstition	82	3090	5470	4720	6240	34	4720	6720
RWCD @ Baseline	86	3110	5450	4700	6260	37	4700	6740
RWCD @ Guadalupe	124	3420	5620	4860	6420	56	4860	7350
RWCD @ Elliot Rd	145	3710	5850	5110	6645	68	5110	7840
	155	3940	6010	5285	6800	75	5285	8130
RWCD above Powerline	186	4830	6605	5890	7350	100	5890	(4795 below dam)
RWCD Below Powerline	338	6180	7175	6470	7910	129	6140	9930
RWCD @ Southern Pacific	356	6400	7570	6880	8300	145	6350	10190
	364	6425	7500	6820	8210	152	6385	10200
RWCD above Queen Creek	367	6425	7380	6730	8060	155	6390	10180
Queen Creek	466	1910	1910	1910	1910	181	1910	
RWCD below Queen Creek	467	7925	8705	8070	9370	182	7900	
RWCD @ Reservation	470	8270	9270	8640	9940	185	7560	
RWCD where it turns to West on Reservation	473	8350	9300	8690	9930	190	7600	

Second Dam Built Just upstream of this x-section.

End of ALT 6 Analysis

Note: ALT 3 values < ALT 6 values are for same land use except Buckhorn-Mesa Dams are not built.

All evaluations are based on the assumption that the RWCD does not break regardless of Peak. RMB Sept 5, 1974

with Buckhorn-Mesa and Queen Creek Dam. Constructed for all except Alt 6.

ARIZONA R.W.D. Barnes Sept. 16, 74 RWCD Design

Summary of Alternates

Location	1973 Analysis Assuming year 2020 Land use (Solid Urban above (Guadalupe		1974 Analysis							
	X Sec No	100yr Peak	X-Section number for Alt 1 to 4	Alt 1 1975 Land Use with MAG Projections 100yr Peak	Alt 2 2000 Land Use MAG Projections with ½ inch urban Storage 100yr Peak	Alt 3 2000 Land Use MAG Projections with 1" of urban storage 100yr Peak	Alt 4 2000 Land Use MAG Projection with no Storage 100yr Peak	X-Section number for Alt 5+6	Alt 5 2000 Land Use MAG Projections with 1 inch of Storage +2 dams along RWCD 100yr. Peak	Alt 6 2000 Land Use MAG Projections with one inch of Storage without Buckhorn Mesa Dams Constructed No dams along RWCD 100yr Peak
RWCD @ Brown Road	3	2210	3	550	1380	1160	1620	1	1160	1170
RWCD @ Apache Trail	10	2920	10	1290	2340	1965	2675	4	1965	2020 (Maybe Low) (Maybe Low)
RWCD @ Broadway	14	3035	14	1720	2690	2290	3070	7	2290	2420
RWCD @ Southern	35	4980	35	2430	3955	3440	4490	16	3440	~~3685~~
RWCD @ Superstition	82	10950	82	3090	5470	4720	6240	34	4720	~~6350~~
RWCD @ Baseline	86	10020	86	3110	5450	4700	6260	37	4700	~~6390~~
RWCD @ GUADALUPE	124	13125	124	3420	5620	4860	6420	56	4860	~~7140~~
RWCD @ Elliot	145	16370	145	3710	5850	5110	6645	68	5110	~~7630~~
	155	15480	155	3940	6010	5285	6800	75	5285	7950
RWCD above Powerline (Bayrd)	186	18600	186	4830	6605	5890	7350	100	5890	~~8840~~
Below DAM	# 191								4795	
RWCD Below Powerline Channel	038	23800	338	6180	7175	6470	7910	129	6140	~~7780~~
RWCD @ So. Pacific RR	056	23800	356	6400	7570	6880	8300	145	6350	~~8230~~
RWCD at Germann	064	23800	364	6425	7500	6820	8210	152	6385	Runoff Not Work
RWCD above Queen Creek	67	23800	367	6425	7380	6730	8060	155	6390	
Queen Creek before Junction	166		466	1910	1910	1910	1910	181	1910	inflow above
RWCD Below Queen Creek Junct	167	25600	467	7925	8705	8070	9370	182	7900	Sec. 4 lost about 600 cfs
RWCD At Reservation	170	25600	470	8270	9270	8610	9940	185	7560	due to error
RWCD at Placeit turns West on Reservation	173	25600	473	8350	9300	8690	9930	190	7600	in input data. so all values between 4 and 16 could be about 600 low.
						Use for Design this Land Use + Storage			Poss. Use Alt for Design	RMO Sept 16, 74

Note 2nd Dam Built just up stream of this X-section

ARIZONA R.W.C.D. FLOODWAY

R.M. BARTELS Sept 11, 1974

The attached 2 sketch sheets show the results of the Alternate 3 TR-20 data.

This alternate is based on the year 2000 land use as projected by MAG & PINAL COUNTY Planning Dept.

It farther is based on the assumption that all new urbanization after 1975 will be required by zoning regulations to store 1 inch of runoff. - This was discussed with the Maricopa County Flood Control District on Sept. 6, 1974 and they agreed that this assumption was valid.

It also is based on the assumption that the BUCKHORN-MESA FLOODWATER RETARDING STRUCTURES are built and that the QUEEN CREEK DAM is Constructed.

The assumptions used in determining Runoff Curve No., Reach Routing Coeff., and Time of Concentration were discussed with Don Woodward during his AUGUST Trip to Phoenix.

On Sept. 6, 1974, the results of Alt 1 to 4 were discussed with Wendall Styner and he stated that as long as I had used the assumptions as agreed during Woodwards trip he would accept the TR-20 results.

They will need a summary report and to review the final hydrology used in the design of RWCD.

Robert M Bartels

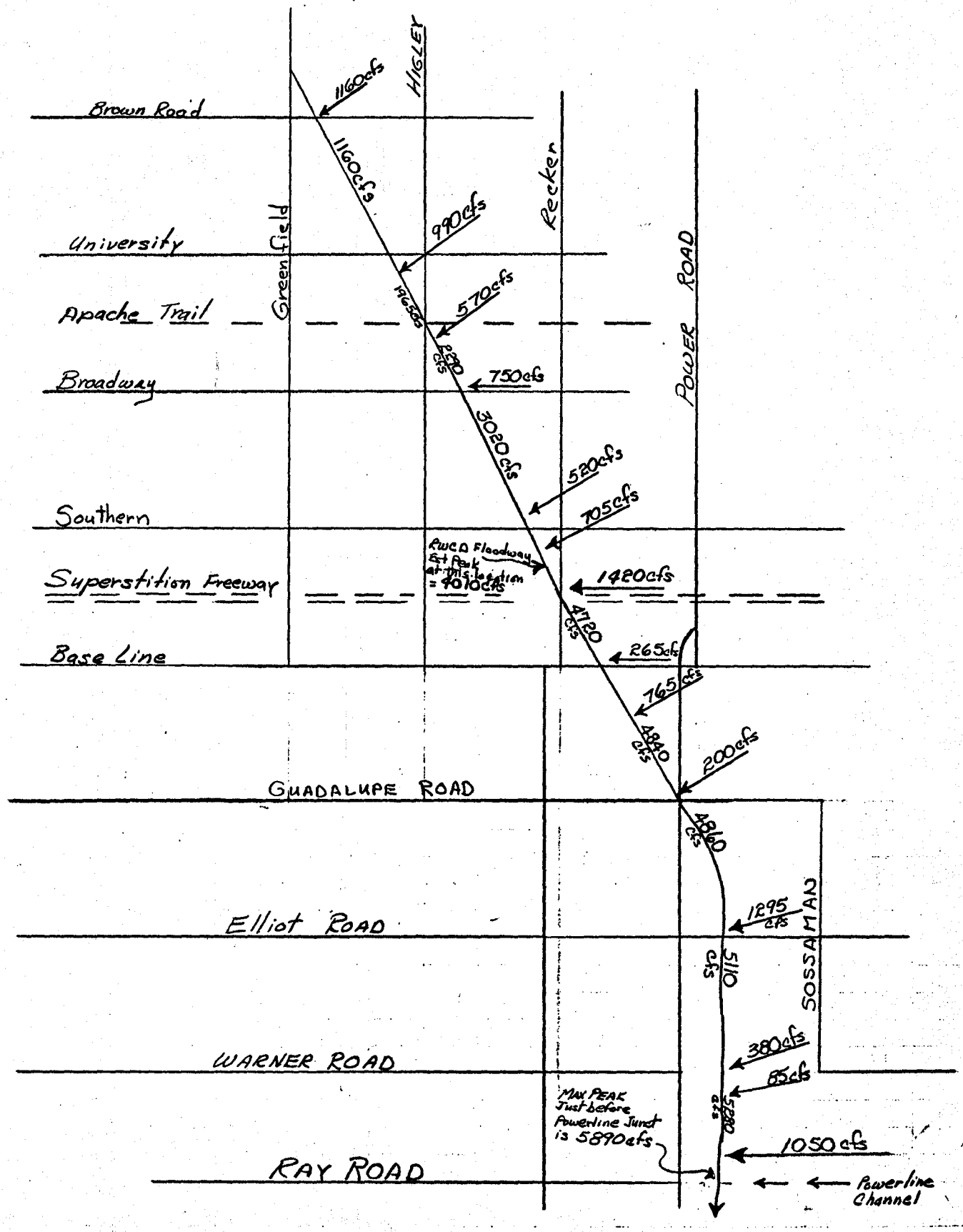
ARIZONA RWCD

R.M. BARTELS Sept 10, 74

Summary of Design Peaks (ALT 3)

100 year Storm

1 2

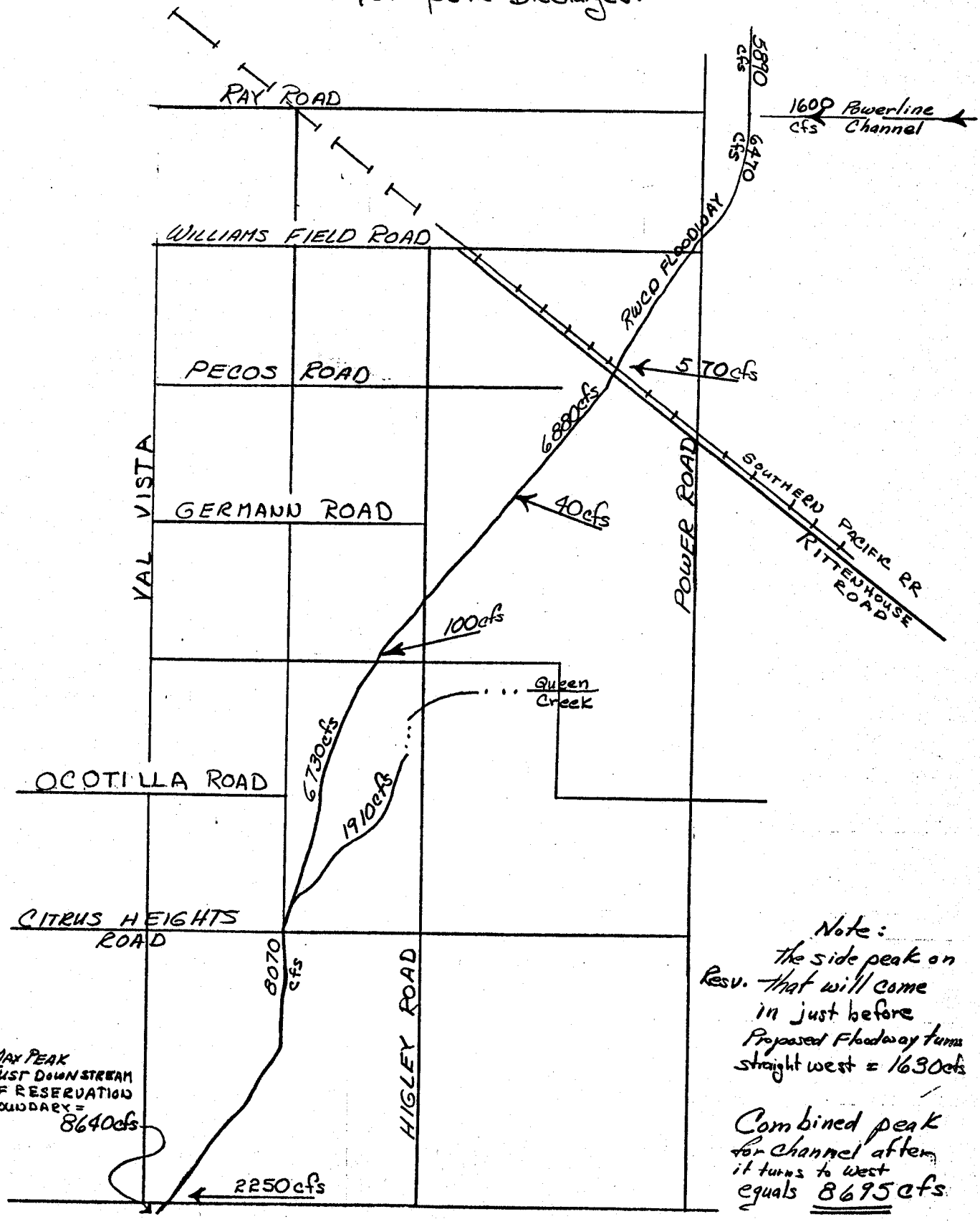


ARIZONA RWCD

RM BARTELS Sept 11, 74

Summary of Alternate 3

100 year peak Discharges.



Note: the side peak on Resv. that will come in just before Proposed Floodway turns straight west = 1630 cfs

Combined peak for channel after it turns to west equals 8695 cfs

ARIZONA RWCD DESIGN

RMB Sept 26, 74

Summary of Alternate 3 / /

This alternate was run in conjuction with Alternate 4+5. On Run of 5 an error occurred which caused the computer to stop. ~~However~~ This resulted in not getting an Summary table but all calc. for Alt 3 were completed.

Location	X-Sec No	100yr Peak	25yr Peak	10yr Peak
RWCD @ Brown Rd	3	1160	560	270
RWCD @ Apache Trail	10	1965	960	480
" @ Broadway	14	2290	1150	570
" @ Southern	35	3440	1760	850
" @ Superstition	82	4720	2410	1150
" " Baseline	86	4700	2410	1150
" At GUADALUPE	124	4860	2470	1170
" At Elliot	145	5110	2600	1230
" At Warner	155	5285	2700	1285
" Above Powerline	186	5890	3005	1440
" Below Powerline	338	6470	3280	1625
@ So. Pacific RR	356	6880	3470	1675
" Above Queen Creek	367	6730	3410	1675
" Below Queen Creek	467	8070	4000	1980
At Resv. Boundary	470	8640	4350	2170
At Place RWCD turns West	473	8690	4400	2210

ARIZONA RWCD

R. M Barth Sept 13, 74

Summary of Data from Alternate 3

Year 2000 Land Use @ no zoning change

Alt 3 X-Sec Number	100 year	25 year	10 year	Alternate 5 X-Sec Number
Above 186 same as for Alternate 5				
338	6470	3280	1625	129
356	6880	3470	1675	145
367	6730	3410	1675	155
467	8070	4000	1985	182
470	8640	4350	2175	185
473	8695	4400	2210	190

6/6/75

COMPARISION OF PEAK DISCHARGES FOR THE RWCD FLOODWAY

PRESENT CONDITIONS AND FUTURE CONDITIONS WITH B M & O. CR. STRS. INSTALLED AND VARYING DEGREES OF REQUIRED STORAGE ON NEW DEVELOPED LANDS

	① LOCATION ON RWCD	① X-SECT NO. OLD	① X-SECT NO. NEW	② PRESENT M7S LAND USE	③ FUTURE 1/2"-STOR.	④ FUTURE 1"-STOR	⑤ FUTURE NEW REGULAT	⑥ CORPS OF ENGINEERS	⑦	⑧ FUTURE NO STOR	⑨	⑩	⑪	⑫
1				ALT	ALT	ALT #3 (REV.)	ALT #3 (REV-2)							
2														
3	@ BROWN RD.	3	1	550	1380	1160	1300	900		1620				
4														
5	@ APPACHE TRAIL	10	4	1290	2340	1965	2160			2675				
6														
7	@ BROADWAY	14	7	1720	2690	2290	2550			3070				
8														
9	@ SOUTHERN	35	16	2430	3955	3440	3820	3300		4490				
10														
11	@ SUPERSTITION HWY	82	34	3090	5470	4720	5250			6240				
12														
13	@ BASELINE	86	37	3110	5450	4700	5230	5700		6260				
14														
15	@ GUADALUPE	124	56	3420	5620	4860	5400			6420				
16														
17	@ ELLIOT RD.	145	68	3710	5850	5110	5640	5600		6645				
18														
19	ABOVE POWERLINE	186	100	4830	6605	5890	6410	6700		7350				
20	(RAY ROAD)													
21	BELOW POWERLINE CH.	038	129	6180	7175	6470	6980	7600		7910				
22														
23	@ So. PACIFIC R.R.	056	145	6400	7570	6880	7380			8300				
24														
25	@ GERMANN	064	152	6425	7500	6820	7310			8210				
26														
27	ABOVE QUEEN CR. JT	166	181	6425	7380	6730	7200	7500		8060				
28	BELOW QUEEN CR JT	167	182	7925	8705	8070	8540	8000		9370				
29	@ RESERVATION BLD	170	185	8270	9270	8640	9100			9940				
30	@ LOCATION WHERE?													
31	RWCD TURNS WEST ON RESERVATION	173	190	8350	9300	8690	9130			9930				

COMPARISON OF RUNS

RM BARTELS AUG 29, 74

	X Section No	With B.M. Constructed & 2020 Land Use — VALUES IN 1973 (5-25) — RAINFALL	RUNOFF	Peak Disc	CSM	Freq of Storm	D. Area Total	With B.M. Constructed & 1975 Land Use — VALUES IN 1994 (AUG RUN) — Diff Area Total	RAINFALL	RUNOFF	PEAK Disc.	CSM	Freq of Storm	Present Conditions (As run in 1972) w/o Buckhorn Mesa Constructed — 1972 — D. Area	RAINFALL	RUNOFF	PEAK	CSM	Present Cond. (As Run in 1972) w/ Buckhorn Mesa Constructed — RAINFALL	RUNOFF	PEAK	CSM
1	3 RWCD @ Brown	3.90	2.02	2210	738	1	3.00	3.00	3.60	0.85	550	183	1	3.00	4.60	1.96	1700	566	3.40	1.14	705	300
2	10 RWCD @ Arroyo Trail	3.90	1.93	2920	522	1	5.58	5.58	3.60	1.09	1290	230		7.44	4.60	2.14	3520	470	3.40	1.24	1900	255
3	14 RWCD @ Broadway	3.90	1.90	3085	423	1	7.16	7.16	3.40	1.16	1720	240		9.03	4.60	2.16	3690	408	3.40	1.25	1960	216
4	35 RWCD @ Southern	3.84	1.91	4980	418	1	12.07	12.08	3.40	1.13	2430	200		18.97	4.18	2.06	6990	370	3.09	1.18	3695	194
5	82 RWCD @ Separation Freeway	3.78	1.90	10950	430		25.47	23.91	3.40	1.18	3090	129		43.30	4.04	1.99	10670	245	2.99	1.15	5670	130
6	86 RWCD @ Carillon	3.78	1.89	10020	378		26.48	24.87	3.40	1.16	3110	125		44.26	4.04	1.98	10300	232	2.99	1.15	5440	122
7	124 RWCD @ Guadalupe	3.78	1.86	13125	340		38.55	36.74	3.20	1.06	3420	93		58.45	4.04	1.93	12570	215	2.99	1.11	6780	116
8	145 RWCD @ Elliot	3.65	1.81	16870	316		51.80	50.24	3.20	1.06	3710	73		78.57	3.95	1.89	15250	194	2.92	1.09	8455	107
9	146 RWCD @ Warner	3.65	1.81	15480	316		51.80	50.24	3.20	1.06	3690	73		78.57	3.95	1.89	15070	191	2.92	1.09	8320	105
10	186 RWCD @ Ray Road	3.65	1.73	18600	256		72.64	71.08	3.05	1.04	4830	68		99.41	3.95	1.84	18250	187	2.92	1.05	9920	99
11																						
12																						
13																						
14	34 Side Drainage @ Southern	3.84	1.91	1350	618		2.18	2.18	3.40	1.02	360	166		5.96	4.18	1.90	2065	346				
15	69 Side Drainage @ Ellsworth	3.78	1.88	2350	583		4.03	4.03	3.40	1.34	820	202		11.94	4.04	2.08	920	77 ← Brazil Program				
16	78 Hawes Rd @ Southern	3.78	1.87	3330	605		5.51	5.51	3.40	1.35	1120	202		15.52	4.04	2.04	1820	117				
17	96 @ Ellsworth	3.78	1.81	1480	483		3.07	2.85	3.20	1.13	370	130		3.61	4.04	1.80	1060	293				
18	114 Side Drainage @ Southern	3.78	1.79	3150	426		7.39	7.17	3.20	1.13	770	107		9.48	4.04	1.82	2410	255				
19	141 @ Southern - Signal Butte Rd	3.65	1.80	3100	455		6.80	7.03	3.20	1.16	1150	163		13.65	3.95	1.83	4190	306				
20	144 Side Drainage @ Elliot	3.65	1.66	4080	307		13.27	13.50	3.20	1.05	1150	85		20.12	3.95	1.77	4150	206				
	184 Side Drainage @ Ray Rd	3.65	1.51	3850	248		15.51	15.52	3.05	0.99	1040	67		15.51	3.95	1.64	2700	174				
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