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Casandro Wash Dam

Final Design Report

for the

Flood Control District of Maricopa County

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CH2M HILL

February 1995

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List of Acronyms

AASHTO	American Association of State Highway Transportation Officials
ABC	Aggregate Base Course
ACI	American Concrete Institute
ADMS	Area Drainage Master Study
ADWR	Arizona Department of Water Resources
AISC	American Institute of Steel Construction
BUREC	U.S. Bureau of Reclamation
cfs	Cubic feet per second
COE	U.S. Army Corps of Engineers
CY	Cubic yards
FCDMC	Flood Control District of Maricopa County
MAG	Maricopa Association of Governments
MCE	Maximum credible earthquake
MUSLE	Modified Uniform Soil Loss Equation
OD	Outside diameter
PMF	Probable maximum flood
PMP	Probable maximum precipitation
PSIAC	Pacific Southwest InterAgency Committee
RCC	Roller compacted concrete
RCP	Reinforced concrete pipe
SCS	Soil Conservation Service
SPT	Standard penetration test
TP	Test pit
UBC	Uniform Building Code
USGS	U.S. Geological Survey
VE	Value engineering
WSEL	Water surface elevation

Executive Summary

In January 1994, the Flood Control District of Maricopa County (FCDMC) contracted with CH2M HILL to provide preliminary and final design services for the proposed Casandro Wash Dam project. Casandro Wash is an ephemeral stream draining approximately a 3-square-mile watershed west of the town of Wickenburg in Maricopa County, Arizona. Flooding has occurred in Casandro Wash on several occasions. Some of the more significant recent events occurred in 1976, 1983, and 1993. In each of these floods, residents reported property damage from inundation and sediment deposition.

The Casandro Wash Dam is classified by the Arizona Department of Water Resources (ADWR) as a small, high hazard dam. The 0.5 probable maximum flood is recommended for spillway design purposes by ADWR. Freeboard will be controlled by residual freeboard requirement of 3 feet above the maximum routed 0.5 PMF water surface elevation.

A sedimentation investigation was conducted to estimate potential sediment supply to the reservoir site. Sediment deposited in the Casandro Wash Dam reservoir area reduces the available storage volume for floodwater. For the purposes of sizing the reservoir, approximately 2 acre-feet should be allowed for sediment storage during the 100-year event. Monitoring of sediment accumulation should be included in the reservoir maintenance plan. According to the District staff, a regular maintenance interval of about 5 years may be expected if no large floods occur on Casandro Wash. If maintenance occurs every five years, an average of about 2 acre-feet of sediment will be removed.

Hydraulic structures associated with the Casandro Wash Dam include the low-flow outlet, spillway, spillway chute, energy dissipator at the end of the spillway chute, and a sedimentation reservoir within the reservoir. Outflow from the reservoir includes a low flow orifice, and the emergency spillway. As currently planned, the emergency spillway will consist of an elliptical crest, with the crest apex at elevation 2155.0 feet. The proposed spillway chute has a slope of 3:1, which is sufficient to maintain supercritical flow. The sedimentation reservoir, located near the reservoir inlet, will be designed according to guidelines presented in the FCDMC Hydraulic Design Manual, following approval of the site grading plan.

A geotechnical investigation was performed to obtain subsurface information at the proposed dam site and reservoir area for development of geotechnical recommendations for design and construction. The field exploration included 13 soil borings and 21 test pits. Laboratory tests were performed to characterize the onsite materials and determine their engineering properties. A CH2M HILL engineer specified test pit and boring locations, determined sampling intervals, and provided general oversight during all exploration operations. Laboratory testing included Atterberg limits, sieve analysis, specific gravity, bulk density, and moisture content to establish index properties and verify field classifications. The data for all laboratory results is included in the previously submitted *Geotechnical Data Report* (CH2M HILL, October, 1994).

Several dam alignments were evaluated during concept design. All proposed alignments extended off the same high point on the right abutment to varying points on the left abutment. The foundation soils are similar for all proposed alignments. The foundation material encountered consisted of recent alluvial deposits comprised of loose to medium dense sand overlying dense to very dense cemented sand. The depth to the partially cemented material varied greatly. The overlying loose soil in the reservoir should be removed and the dam founded on cemented or very dense sand. The abutment conditions were similar to the foundation except for an increase in the amount of fines present to approximately 12 percent. The right abutment is thin in cross section and should be buttressed with fill. Because geotechnical conditions are similar at the proposed alignments, the final alignment was determined based on other conditions such as spillway size and orientation, reservoir storage, and earthwork minimization.

The proposed dam will be a homogenous earthfill dam constructed of materials excavated from the reservoir. Field exploration and laboratory test results did not reveal a suitable low permeable material for use as a core for a zoned earth dam. Therefore, a homogenous dam with a chimney drain is preferred over importing clay soil for a core. The material in the reservoir may be suitable for use in the construction of a RCC dam, but cost and potentially compressible foundation conditions eliminated RCC from further consideration.

The top crest width of the dam will be 14 feet. Based on the investigations described in this report, a design peak rock acceleration of 0.1g is recommended for final design. (Details of the seismic investigation are included in the *Geotechnical Design Report*.)

Field surveys of the project area were performed from January through mid-April 1994. The only known utility within the project area is a 10-inch vitrified clay sewerline, which will be relocated. A 6-inch waterline, located north of the detention reservoir, serves the adjacent residential properties; it does not require relocation. Generally paralleling the wash alignment, the waterline is approximately 200 feet north of the wash centerline.

On the north side of the reservoir, sewer, water, and electrical services extend along private access drives. Service connections for the residential and commercial buildings along the south side of the reservoir extend to the south (toward U.S. 60), and away from the project area. Service connections do not appear to conflict with the dam/detention basin. However, the south access road alignment will likely be located over the sewer and water service connections to the Ryan property on the right abutment of the proposed dam. Also, the overhead power pole for service to residents is located within the dike prism and may need to be relocated.

The 10-inch sewerline has an easement of varying width through the project area. Partial relocation of the sewer will require an amendment to the easement description and resubmittal to the Town of Wickenburg for their approval.

The Grading Plan shown in the plan submittal depicts the property parcels in the project area. Consideration was given during development of the plan to minimize right-of-way needed for the facility. It is anticipated that in lieu of purchasing right-of-way, temporary construction easements could be obtained for certain areas that require grading.

Access easements will be required for the north and south maintenance roads.

Construction of the Casandro Wash Dam requires the acquisition of two permits: the Dam Safety Permit issued by Arizona Department of Water Resources Dam Safety Division; and the U.S. Army Corps of Engineers Section 404 Fill and Dredge permit. The District is primarily responsible for obtaining these permits, however, CH2M HILL is assisting in preparing applications and in coordinating the permitting efforts. Prior to construction, a U.S. EPA Stormwater NPDES permit for construction activities also will be required.

As part of the concept design analysis, two dam alignments were identified and staked in the field during the initial field and geotechnical investigations. They were based on the geotechnical setting (for instance, the location of abutments) as well as the storage capacity needed to impound the 100-year storm. The alternative analysis consisted of developing preliminary earthwork quantities and order-of-magnitude construction cost estimates to determine the preferred layout. The results of this analysis showed that one alignment (Alignment II) is more cost effective, shorter, requires less earthwork, and provides better hydraulics for the spillway than the alternative.

Two options were reviewed for the spillway construction: structural concrete and RCC. Structural reinforced concrete appears to be the most cost-effective option for constructing the spillway and energy dissipator.

The concept design plan and dam location were the two primary factors in determining the extent of sanitary sewer relocation. A profile of the existing sewer was prepared from as-built drawings. The digital terrain model, proposed grading plan, and dam alignment were superimposed on the profile to determine the extent of required sewer relocation. Two alignments were investigated for the relocated sewer. The second alignment consisted of routing the sewer under the dam, and it became the preferred alternative.

The dam can be accessed through portions of existing private drives off the public streets. Roads for maintenance access will spur off the private drives and extend to the top of the dam on both the north and south side of the spillway, as well as to the upstream and downstream toes.

The preliminary construction cost estimate for the detention basin and dam project is $1,164,584. Estimates were developed for the major elements in the concept design submittal. A 20 percent contingency was applied for minor items not specifically identified or shown.

The recommended design features are summarized below:

- Dam location: see plans submittal, Appendix A.
- Dam height: 32.5 feet to the top of the dam; 24 feet to the crest.
- Dam length : 350± feet. Dam top width: 14 feet.
- Embankment slopes: upstream 3:1; downstream 3:1.
- Dam configuration: homogenous earthfill with chimney drain.
- Spillway type: structural concrete, 80-foot width.
- Spillway configuration: elliptical crest.
- Impoundment area : 14 acres.
- 100-year water surface elevation: 2155.3 feet.
- Design capacity: 0.5_Probable Maximum Flood with 3 feet of freeboard.
- Low flow outlet: 36-inch RCP restricted to a 1.4 ft^2 orifice.

Section 1
Introduction

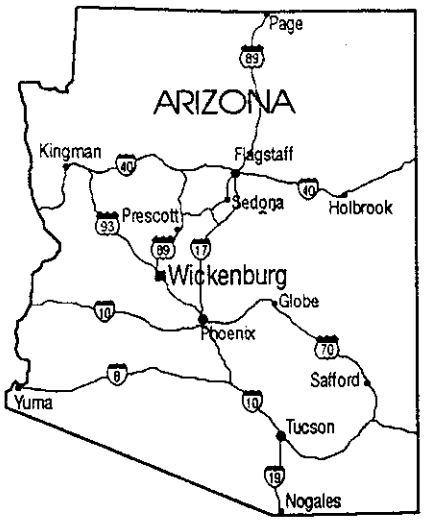
In January 1994, the Flood Control District of Maricopa County contracted with CH2M HILL to provide preliminary and final design services for the proposed Casandro Wash Dam project. This *Final Design Report* summarizes the data collected, and presents the results and recommendations of the preliminary analyses for the proposed dam. It documents the design considerations and the decisions made which led to the concept design plan submittal. The work described includes a review of the hydrologic analysis prepared in support of the area drainage master study (by others); an analysis of the maximum probable flood for the Casandro Wash watershed; a summary of the geotechnical investigations of the dam site, detention basin and borrow areas; and the proposed modifications to conflicting utilities.

Casandro Wash is an ephemeral stream draining approximately a 3-square-mile watershed west of the town of Wickenburg in Maricopa County, Arizona (see Figure 1-1). The watershed generates approximately 1,770 cfs in the 100-year storm event. The storm runoff in the watershed is conveyed through Wickenburg in generally a south to north direction, crossing U.S. Highway 60, where runoff is discharged into Sols Wash.

Downstream of the crossing at U.S. 60, Casandro Wash is characterized by a poorly defined alluvial channel within a broad, deep valley. The downstream reaches of Casandro Wash are conveyed primarily through undersized drainage channels and inverted crown roadway sections. Immediately upstream of the confluence with Sols Wash, a railroad drainage crossing structure limits the conveyance capacity of Casandro Wash into Sols Wash, resulting in localized flooding of the urban areas between Mariposa Drive and the Southern Pacific Transportation Company railroad crossing.

Flooding has occurred in Casandro Wash on several occasions. Some of the more significant recent events occurred in 1976, 1983, and 1993. In each of these floods, residents reported property damage from inundation and sediment deposition.

An Area Drainage Master Study (ADMS) prepared for the District in 1991 recommended the construction of a detention dam to reduce the effects of flooding from discharges in Casandro Wash. In addition, the plan recommended construction of an outfall stormdrain conveyance system downstream of the proposed dam location to the outfall at Sols Wash.



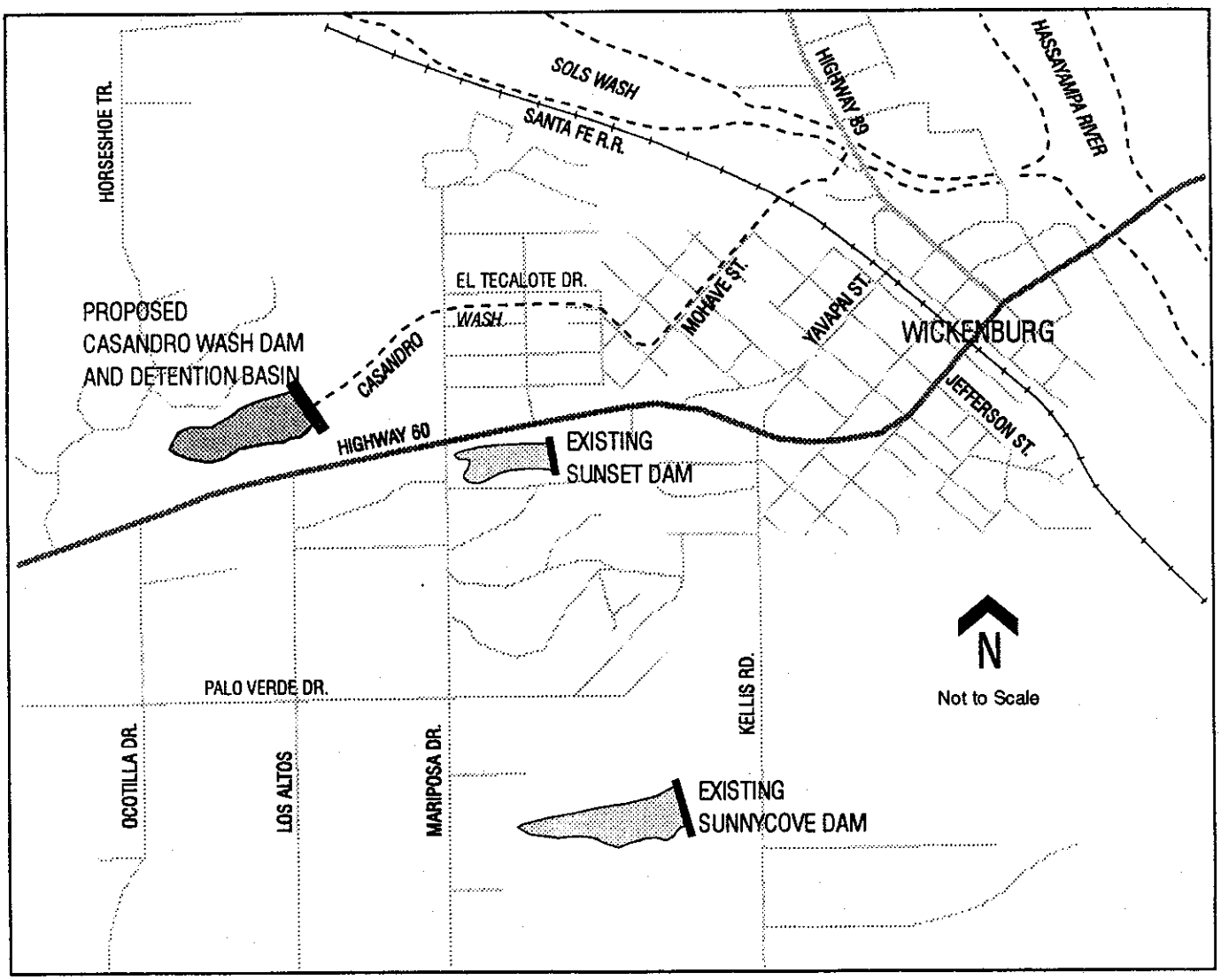


FIGURE 1-1

LOCATION AND VICINITY MAP

CASANDRO WASH DETENTION BASIN
WICKENBURG, AZ.

CH2M HILL

Objectives

The objectives of this report are to:

1. Describe the hydrologic, geologic, and geotechnical settings for the proposed dam.
2. Identify design- and permitting-related constraints for the structure.
3. Present the criteria for the final design.
4. Describe alternative dam locations, sizes, configurations, and construction materials, and the evaluation process used to select the preferred alternative.
5. Present the recommended design (including analysis and evaluation) for review and approval by the District.
6. Present budget-level opinions of probable cost for use in evaluating and budgeting the proposed project.

Information used in this design was derived from a number of sources and previous studies. Some of the sources included:

- Topographic mapping dated June 18, 1993, prepared for the District by Aerial Mapping Company, Inc.
- Design plans and analyses for the Sunset and Sunnycove Dam prepared by the Soil Conservation Service (SCS), June 1975.
- Hydrologic modeling prepared for the Wickenburg ADMS, 1990
- Utilities maps prepared by the Town of Wickenburg.
- Right-of-way maps and land ownership information provided by the District

Value Engineering Meeting

On April 12, 1994, a Value Engineering meeting was held at the fire station in Wickenburg. Hydrology, hydraulics, geotechnical, and unit cost data were presented. Several alternative dam alignments, configurations, construction methods, and outlet configurations were also presented and evaluated. A summary of those discussions along with the meeting's agenda, attendees list, handouts, and minutes are presented in Appendix E. As a result of the meeting, refinements were made to the concept plans which led to the current designs shown on the

construction drawings accompanying this report. Those refinements resulting in significant improvement to the initial concept plan are listed below:

- Review of the hydraulics resulted in raising the top of dam to an elevation of 2163.5, and modifying the spillway crest.

- The north (left) dam abutment was rotated eastward, which better aligned the dam with the natural drainage channel and shortened the length of the dam.

- With the revised dam location and higher dam, the spillway width was revised to 80 feet. This requires less structural concrete.

The concept design submittal presents the refinements to the detention basin and dam concept grading plan as well as major design elements including the spillway, energy dissipator, access roads, and relocated sewer.

Existing property and right-of-way information was provided by the Town of Wickenburg and modified with updated information provided by the District. The grading plan was reviewed to minimize the affect on adjacent properties and the purchase of unnecessary land. Existing property lines and proposed right-of-way are shown in the concept design submittal.

Acknowledgments

CH2M HILL would like to acknowledge the efforts and assistance of the staff of the Town of Wickenburg, specifically Mayor Dallas Gant, Town Manager Ben Navdelli, and Building Safety Inspector, Skip Blunt. We would also like to thank the Wickenburg Volunteer Fire Department for the generous use of their meeting room facilities.

Table 1-1 Casandro Wash Project Data	
Drainage basin area	**3.0 ± sq. mi.**
Dam crest elevation (nominal)	2163.5 ft
Spillway crest elevation	2155.0 ft
100-year flood - volume inflow	156 ac-ft
0.5_PMF - Inflow cfs volume	 5404 cfs 203 ac-ft
0.5 PMF Outflow	3,700 cfs
Reservoir storage available with 2 ac-ft for sediment below 2155.0	143 ac-ft
Height of dam above bed of wash	24.0 ft
Height of dam above foundation	32.5 ft
Type of dam	Homogenous with chimney drain
Upstream and downstream slopes	3H:1V
Sediment detention basin volume	2 ac-ft
Outlet pipe	36" RCP
Lip of outlet invert elevation	2135.0
Fix orifice type	Sharp edges
Fix orifice coefficient	0.60
Fix orifice arc	1.4 sq. ft.
Capacity of fixed orifice with water surface at 2155.0 ft	30 cfs
Gated outlet	24-inch square sluice gate
Capacity of downstream storm drain	339 cfs
Spillway type	Concrete chute over embankment
Spillway crest type	Elliptical
Spillway crest discharge coefficient	3.1 to 3.9
Crest length	80 ft
Chute width	80 ft
Stilling basin type	Type III (USBR)
Spillway peak discharges during 100-year flood	120 cfs
Combined discharges outlet and spillway during 100-year flood	150 cfs

Section 2
Hydrology and Hydraulics

This section describes hydrologic modeling, sedimentation engineering, and hydraulic design of outlet structures for the Casandro Wash Dam.

Hydrologic Analysis

Hydrologic modeling of Casandro Wash was performed using the USCOE Flood Hydrograph Package HEC-1, and the modeling guidelines adopted in the FCDMC *Hydrologic Design Manual* for the design of the proposed detention dam. The 100-year discharge was estimated using procedures outlined in the FCDMC publication *"Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology"* (1992). Preliminary design criteria for the detention dam require that the 100-year event be substantially detained below the spillway elevation and/or the maximum outflow be less than or equal to the hydraulic capacity of the proposed storm drain to be constructed downstream of the dam. Preliminary design of the storm drain is described in the FCDMC report *"Casandro Wash Outfall for Casandro Wash Dam"* (1993). Design of the storm drain is not part of this project. According to the FCDMC report, the capacity of the storm drain is 339 cfs.

Hydrology

Hydrologic data for the Casandro Wash watershed were directly obtained or were modified from the Wickenburg ADMS, except as described below. Future watershed conditions assume 100 percent build-out according to the existing zoning in the watershed to account for potential changes in runoff rates over the long design life of the detention dam. Recently, development in the Casandro Wash watershed has been rapid.

Rainfall. Rainfall was estimated for the 6-hour local storm (drainage areas less than 100 square miles). Rainfall depths were determined using the PREFRE program provided with the FCDMC *Hydrology Manual.* Rainfall depths were input into the HEC-1 model after adjustment for areal reduction using Table 2.2 (p. 2-20 of the FCDMC manual). A depth-area reduction factor of 0.985 was used. The adjusted 6-hour rainfall depths for Casandro Wash are:

- P_2 = 1.39 inch (2-year)
- P_{10} = 2.20 inches (10-year)
- P_{100} = 3.35 inches (100-year)

FCDMC design storm pattern number 1.5 was used as shown on Figure 2.17 and interpolated from Table 2.4 of the FCDMC *Manual.*

Rainfall Losses. Rainfall losses were determined using FCDMC *Manual* tables and Green-Ampt soil loss parameters. Surface retention was estimated at 0.10. This estimate was based on a theoretical maximum of 0.15 inch for the area's natural conditions, hill slopes, and desert, and a theoretical minimum for paved urban areas of 0.05 inch. Development of the area typically has been both residential and commercial, with residential development of up to four residences per acre. The surface retention or initial abstraction of 0.10 represents a future conditions detention basin average.

Green-Ampt parameters were based on soil characteristics described in the Aguila-Carefree SCS Soil Survey Report. Soil units in the watershed included clay loams, sandy clay loams, and sandy loams. Soil unit coverages were areally weighted using equations and methodologies described in the FCDMC *Manual*. Percent imperviousness for the watershed was estimated based on full build-out under existing zoning for the Town of Wickenburg. For areas within unincorporated Maricopa County without ordinanced zoning, the zoning for the Town of Wickenburg nearest the Maricopa County portion of the watershed was used. Future condition percent imperviousness averaged about 35 percent for the entire watershed.

Unit Hydrograph. Clark unit hydrograph procedures were used to develop runoff peaks and volumes. Time of concentration equation #5.5 (FCDMC *Manual*), for desert and mountain areas, was used. The detention basin area was planimetered on US Geological Survey (USGS) topographic mapping. Watershed length was similarly measured on USGS topographic mapping. The detention basin factor Kb for the time of concentration equation was determined by areally weighting between the categories of commercial, residential areas, Type A, and desert range lands Type B using Figure 5.5 of the FCDMC *Manual*. Measured watercourse slopes were adjusted, as required, using Figure 5.4 of the FCDMC *Manual*. Unit hydrograph parameters input into HEC-1 were determined using the software program MCUHP1 provided with the FCDMC *Manual*.

Channel Routing. Channel routing parameters were based on a typical average cross section from the dam to an upstream confluence of the two subwatersheds. Only one routing reach was needed for the watershed upstream of the proposed dam site. Modified Puls storage routing techniques were used, according to guidelines given in the FCDMC *Manual*. Due to the short length of the routing reach, minimal hydrograph attenuation occurs in the model output.

Detention Basin Routing. Detention basin routing was computed using elevation-storage information estimated by planimetering 2-foot contour interval mapping provided by the District, and the proposed grading plan and dam alignment provided by CH2M HILL. Detention basin outflow was estimated as described in the Hydraulic Structures Design section of this report (see p. 2-11), and included both the low flow orifice discharge and discharge over the spillway. The detention basin stage-elevation-area-volume relationship was adjusted to account for 2 acre-feet sediment storage during the 100-year event, as described later in this report.

Modeling Results. Peak discharge estimates for the flow into the Casandro Wash Dam project area are shown in Table 2-1. The 100-year design peak was estimated at 1,769 cfs with a total volume of 156 acre-feet. The 2-, 10-, and 50-year discharge estimates are 506 cfs, 1,028 cfs, and 1,544 cfs, respectively, with volumes of 43, 86, and 129 acre-feet. The calculation of synthetic skew for the 2-, 10-, and 100-year discharge using procedures outlined in Bulletin 17B of the Water Resource Council indicate the synthetic skew is -0.11, well within the regional skew of -0.1 computed by the Water Resource Council in Bulletin 17B. Computation sheets and sample output from HEC-1, 100-year modeling are provided in the appendix.

Table 2-1.
Casandro Wash
Hydrology

Recurrence Interval (years)	Peak (cfs)	Volume (acre-feet)
100	1,769	156
50	1,544	129
2	506	43

Probable Maximum Flood

The probable maximum flood and emergency spillway design criteria for the Casandro Wash Dam were determined as specified in ADWR's report *"Guidelines for the Determination of Spillway Capacity Requirements"* dated May 1991 (hereafter, "the ADWR Manual").

The half-probable maximum flood (0.5_PMF) and full PMF were estimated using procedures outlined in Hydrometerological Report 49 (HMR 49; *Probable Maximum Precipitation Estimates, Colorado River and Great Detention Basin Drainages*, U.S. Army Corps of Engineers, September 1977). The HEC-1 hydrologic model was used to estimate the PMF and 0.5_PMF. The 100-year HEC-1 model described in the previous section of this report was modified by substituting 0.5_PMF and full PMF rainfall distributions.

Probable maximum precipitation (PMP) for a "local" storm was determined from HMR 49, as documented in computation sheets provided in the appendix. The PMP analysis included the following:

- 1-hour PMP of 11.5 inches
- No elevation adjustment (site < 5,000 feet)
- 6-hour to 1-hour ratio of 1.32
- Areal reduction of 0.25-, 0.5-, 0.75-hour PMP values (area = 1.24)
- No areal reduction adjustment for 1-hour to 6-hour durations
- COE alternative incremental PMP distribution (EM#1110-2-1411)
- No areal distribution of the PMP storm

Application of the PMP depth and distribution to the HEC-1 watershed model for Casandro Wash resulted in a PMF estimate of 10,941 cfs (HEC-1 file "CASFPMFE.HC1"). The 0.5_PMF was determined by ratioing the full PMF hydrograph ordinates from the HEC-1 model using a JR record, resulting in a 0.5_PMF estimate of 5,398 cfs, volume of 203 acre-feet cfs (HEC-1 file "HPM.HC1"). Computation sheets for determination of PMF and 0.5_PMF are included in the appendix.

Dam and Detention Basin Criteria

In Arizona, spillway design criteria, as outlined in the ADWR Manual, are a function of the hazard classification of the dam. Hazard classification is based on factors such as the height of the dam; storage capacity; existing and probable future downstream development; uses of the detention basin; operational procedures; type of dam; type of spillway; site and foundation geology; the size, slope, material composition, and configuration of the downstream channel; and the distance of the dam from the nearest downstream development. The Casandro Wash Dam will have a spillway crest height of about 24 feet (total dam height of about 32.5 feet), a maximum storage capacity of about 145 acre-feet (below the spillway), will have increased future residential development downstream, will be used for flood control purposes only, will be uncontrolled, and will probably be earthen with an overflow emergency spillway.

The Casandro Wash Dam will be classified as a small, significant-to-high-hazard dam by ADWR due to the presence of more than a small number of habitable structures downstream and the potential for appreciable economic losses downstream, according to criteria outlined in the ADWR Manual. Table 1 of the ADWR Manual (see appendix) classifies these characteristics as "high hazard." The dam is classified as "high hazard" for urban development, and "significant hazard" for economic loss. Dam size is a function of its height and capacity. The proposed dam's height is less than 25 feet, and its proposed capacity is between 15 and 499 acre-feet. These characteristics give the proposed structure a cumulative rating factor of 0. According to Table 2 of the ADWR Manual, "small" dams have a cumulative rating between 0 and 2.

Spillway Design Criteria

The spillway design flood recommended in the ADWR Manual for the proposed Casandro Wash Dam configuration is the half-probable maximum flood (0.5_PMF), given the hazard and size classification. Small dams in the high hazard class are to have a spillway that passes the 0.5_PMF. By comparison, small dams in the significant hazard class are to have a spillway that passes the 100-year to 0.5_PMF, as indicated on Table 3 of the ADWR Manual.

Total freeboard, or the distance between the top of the dam and the spillway crest, is determined by the type of dam, the maximum water surface during discharge of the design flow (0.5_PMF), wave height and runup, and economic factors. The minimum permissible total freeboard for the spillway will be 4 feet, according to the ADWR Manual.

Residual freeboard, or the distance between the maximum water surface during passage of the inflow design flood and the top of the dam, must be a minimum of three feet, except when the inflow design flood is the 0.5_PMF or greater. For cases when the inflow design flood is 0.5_PMF or greater, the residual freeboard may be reduced. Freeboard will be applied to the routed 0.5_PMF maximum water surface elevation. Table 2-2 summarizes the spillway design criteria for the dam.

Table 2-2.
Casandro Wash
Spillway Design Criteria

Spillway Capacity	0.5_PMF
Freeboard	4 ft (spillway to top of dam) or 3 ft above 0.5_PMF WSEL
Routed 0.5_PMF	3,700 cfs

Dam Failure Analysis

A dam failure analysis was prepared using HEC-1 for review by the District and ADWR as an aid in developing emergency response plans for the area. This report was submitted for review under separate cover. In this evaluation, various failure scenarios were modeled. The scenario with the most significant effect was a rapid breach (15-minute) with a full reservoir. The model indicated that the 0.5_PMF water surface elevation between the dam and the railroad embankment would increase by a maximum of about 2 feet. The analysis is included in Appendix C.

Outlet Criteria

The outlet will be used to drain the reservoir by 2 methods: (1) a fixed, ungated orifice, and (2) a manually operated sluice gate. The outlet orifice must be sized to limit the flow through the dam until the peak flow of the unregulated drainage area between the dam and the controller's downstream culvert has passed. The capacity of the controlling culvert allows only 20 cfs to be discharged from Casandro Wash Dam while the peak unregulated flow occurs.

WILL RELEASE 30 cfs – CONFUSING

Summary

For the Casandro Wash Dam project, the routed 0.5_PMF of 3,700 cfs is recommended for spillway design purposes. Freeboard will be controlled by residual freeboard requirement of 3 feet above the maximum routed 0.5_PMF water surface elevation (WSEL).

Detention Basin Design

The Casandro Wash Detention Basin and Dam were sized to store the 100-year flood. HEC-1 detention basin routings were performed to estimate flood water storage requirements, maximum water surface ponding elevations, and to optimize spillway and low-flow outlet characteristics. Design of the spillway and outlet will be described later in this report.

Stage-Storage Capacity Curve. A detention basin grading plan was developed to meet site geotechnical and civil requirements (described elsewhere), as well as flood water storage needs. A 2-foot contour interval digital terrain model of the detention basin was developed using AutoCAD-based software. Level-pool surface areas were determined for each contour interval and were checked by planimetering plotted maps of the grading plan. Elevations and surface area were used by the HEC-1 model to estimate storage volume. Figure 2-1 shows storage capacity and area curves.

Stage-Discharge Rating Curve. Detention basin outflow will be through a low-flow orifice outlet until the reservoir fills to the spillway crest. Flows exceeding the Q100 will also discharge over the spillway. The spillway elevation and orifice opening were varied to achieve the maximum outflow without exceeding the 339 cfs capacity of the proposed FCDMC storm drain downstream. The capacity of the downstream storm drain was estimated from a HEC-1 model provided by the District. Both the timing and magnitude of detention basin outflow were compared to the District HEC-1 model to test if the capacity was exceeded. After optimization, a spillway elevation of 2,155 feet and an orifice opening of 1.4 ft^2 were selected. The spillway rating curve was developed using procedures described elsewhere in this report. Figure 2-1 shows the stage discharge curve.

or

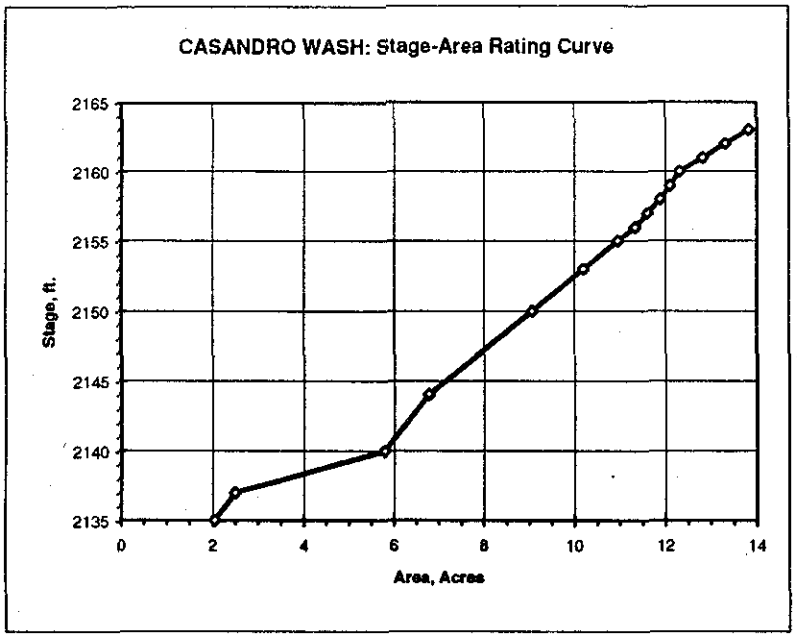
Drain Time. The estimated time to drain the detention basin is approximately 136 hours (5.7 days) through the fixed orifice and assuming no inflow into the reservoir during the draining period. This drain time applies to all flows in excess of the 100-year, including the full PMF, since flood volumes in excess of the 100-year flow exit through the spillway. Shorter drain times can be achieved by removing or enlarging the orifice, using a 24" x 24" sluice gate designed to be operated manually by FCDMC field personnel.

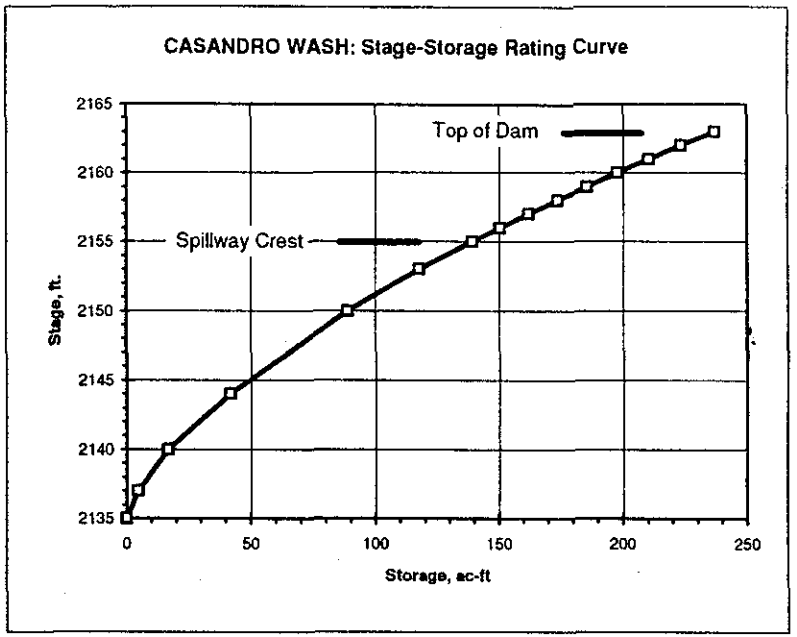
ACTUALLY ≈5'/DAY ≠ 40A

Maximum Ponding Elevation. The maximum ponding elevations after routing for various design events are summarized in Table 2-3 (not including freeboard requirements, if any). Maximum ponding elevations were estimated using HEC-1. The proposed top of dam elevation is 2163.5 feet.

Table 2-3.
Casandro Wash
Maximum Ponding Elevation

Flood Recurrence Interval	Elevation
Q100	2155.3
0.5 PMF	2160.2





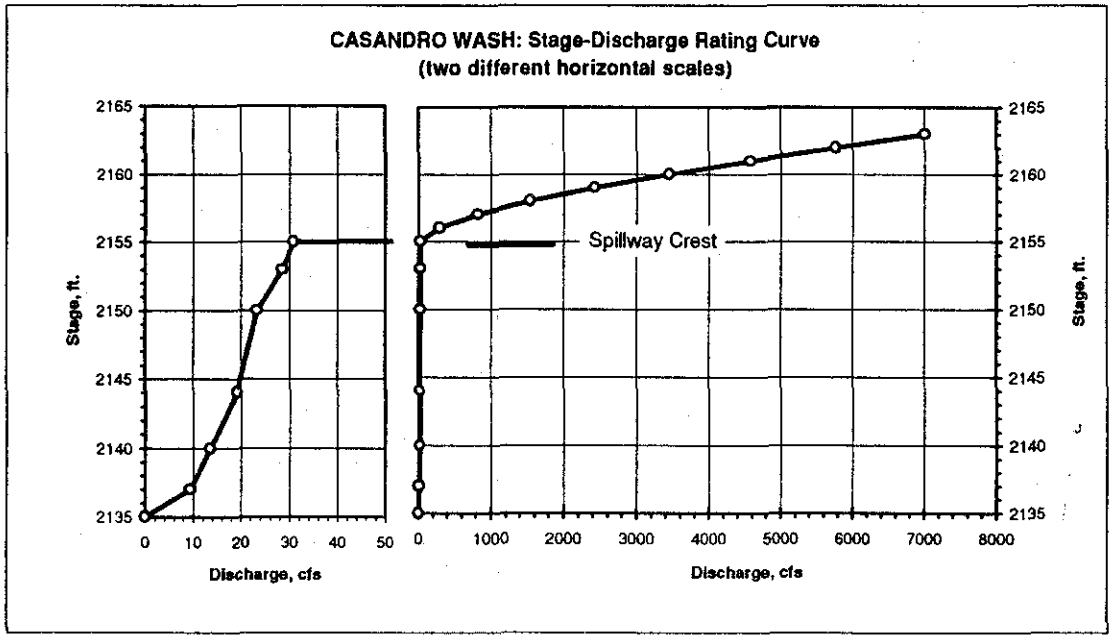


Figure 2-1: Storage capacity and area curves.

SWW35441\HY\PLOT.XLS

Sedimentation Engineering

A sedimentation investigation was conducted to estimate potential sediment supply to the detention basin. Sediment yield estimates will be used to predict sediment maintenance requirements and estimate sediment storage requirements during the design storm. Criteria for design of sedimentation reservoir within the detention basin will be addressed separately.

Sediment Supply

Sediment deposited in the Casandro Dam detention basin area reduces the available storage volume for floodwater. The estimate of sediment supply will be used to evaluate the additional storage volume needed to meet the requirements for floodwater storage and conveyance through the dam.

Data Requirements. Technical data required for estimating sediment supply were obtained from existing studies, regional geologic, land use and watershed mapping, HEC-1 hydrologic modeling of the watershed prepared for this project, and a sieve analysis of Casandro Wash bed sediments.

Methodology. Sediment supply was estimated using the following methodologies:

- PSIAC Method (Pacific Southwest InterAgency Committee). This procedure was developed for planning-level analyses of sedimentation in the southwestern United States, and uses generalized watershed characteristics to predict sedimentation rates. The methodology is described in "*Design Manual for Engineering Analysis of Fluvial Systems,*" Arizona Department of Water Resources, 1985.

- MUSLE (Modified Uniform Soil Loss Equation). MUSLE was developed by the SCS to predict rates of soil erosion, and is also commonly used to predict sediment yield in the arid southwest. MUSLE can be used to estimate sediment supplied from individual design storms, as well as average annual sediment production. MUSLE is described in "*Design Manual for Engineering Analysis of Fluvial Systems,*" Arizona Department of Water Resources, 1985, with supplemental information available in "*Predicting Rainfall Erosion Loss - A Guide to Conservation Planning,*" USDA Agricultural Handbook 537, 1978.

- C.T. Yang's Bedload Sediment Transport Function. C.T. Yang developed a sediment transport function which is commonly used to predict sediment movement rates in sand/gravel-bedded streams. Casandro Wash sediment load is mostly sand and gravel as indicated by sieve analysis of channel bed sediments from the project site. Yang's sediment equation is described in "*Unit Stream Power Equation for Gravel,*" ASCE Journal of Hydraulic Engineering, Vol. 110, No. 12, December, 1984.

- SCS Modeling for Sunset and Sunnycove Dams. The SCS prepared a sedimentation investigation for two dams on watersheds similar to Casandro Wash, that are located within one mile of Casandro Wash. SCS estimates are based on sediment survey data and the "Range Method." SCS estimates are described in "*Watershed Work Plan: Wickenburg Watershed, Maricopa and Yavapai Counties, Arizona,*" Soil Conservation Service, December 1974.

- FCDMC Sediment Maintenance Data. The District periodically removes sediment from Sunset and Sunnycove Dams in Wickenburg. Although no systematic sediment removal data is maintained, anecdotal information was used to roughly estimate potential sedimentation at Casandro Wash Dam.

Results. Estimates of average annual sediment supply at Casandro Wash detention basin from the sedimentation investigation are shown in Table 2-4. Estimates of sediment supply for specific recurrence interval design floods are shown in Table 2-5. It was assumed that the reservoir trapping efficiency was 100 percent due to the high percentage of bed load transport, orifice-type outlet design, and relatively long drain time relative to the design storm duration.

Table 2-4.
Casandro Wash
Sediment Supply Estimates

Methodology	Average Annual Supply (AF/yr)
PSIAC	0.3
MUSLE	0.6
SCS Studies	0.3
Yang Equation	0.4
FCDMC Maintenance	0.1 - 11.9

Table 2-5
Casandro Wash
Sediment Supply for Design Storms

Recurrence Interval	MUSLE (AF/yr)	Yang Equation (AF/yr)
Q2	0.5	0.3
Q5	0.8	0.6
Q10	1.1	0.8
Q25	1.5	1.1
Q50	1.7	1.4
Q100	2.0	1.6

Discussion. Sediment supply estimates are relatively consistent between all methodologies used. Estimates based on anecdotal sediment maintenance information supplied by the District exceed the upper limit of sediment yields expected at the Casandro Wash site, but illustrate the variability of sediment supply in an arid environment. It is likely the upper limit of sediment yield shown in Table 5 is skewed upward as a result of several large events occurring upstream of Sunset Dam during recent years; the long-term average is likely to be lower. It is also noted that the estimated sediment supply does not increase dramatically with the return period. This is probably due to the relatively short duration of the design flood, as well as the relatively intense design rainfall and steep channels which produce high velocity turbulent flow even for more frequent flood events.

Given the results reported above, sediment supply rates to be used for design of the detention basin are based on the average of the methods reported, and are summarized in Table 2-6. For the purposes of sizing the detention basin, approximately 2 acre-feet should be allowed for sediment storage during the 100-year event.

Table 2-6
Casandro Wash
Design Sediment Volumes

Recurrence Interval	Sediment Volume
Average Annual	0.4 AF/yr
Q100	1.8 AF

Sediment Maintenance

Sediment maintenance requirements for the Casandro Wash detention basin are directly related to the sediment supply rates. The average annual sediment yield of 0.4 AF/year can be used to predict annual sediment maintenance needs. However, since annual sedimentation may be highly variable, as indicated by anecdotal information obtained for the nearby Sunset and Sunnycove Dams, actual sediment removal requirements may vary significantly in any given year. Therefore, monitoring of sediment accumulation should be included in the detention basin maintenance plan. According to the District staff, a regular maintenance schedule of about 5 years may be expected if no large floods occur on Casandro Wash. If maintenance occurs every five years, about 2 acre-feet of sediment will be removed on average (5 x 0.4 AF/yr.).

Downstream Impacts

Construction of the detention basin will interrupt the natural sediment supply from the upper watershed to the portion of the watershed downstream of the dam. In addition, water flowing over the spillway and through the low-flow orifice will probably experience higher velocities

than naturally occur in Casandro Wash under existing conditions. These factors will tend to increase channel bank and bed erosion in the reach of the wash between the dam and the downstream storm drain. Erosion will be expressed as reduced sediment clogging of culvert inlets at road crossings, and accelerated scour on the downstream side of road crossings. Scour downstream of road crossings occurs under existing conditions. Design of structures to mitigate erosion in the downstream channel is not part of this study, but would likely include grade control structures to maintain a stable slope in the channel reach.

Bank erosion is also undercutting channel banks at several locations immediately upstream of the detention basin site. Property owners should be notified of this existing condition. It is not anticipated that operation of the detention basin will affect existing bank erosion upstream of the inundation area.

Hydraulic Structures Design

Hydraulic structures associated with the Casandro Wash Dam include the low-flow outlet, spillway, spillway chute, energy dissipator at the end of the spillway chute, and a sedimentation reservoir within the detention basin.

Detention Basin Outlet

Orifice. Outflow from the detention basin includes a low flow orifice, and the emergency spillway. The low flow outlet is a 36-inch reinforced concrete pipe (RCP) with a 1.4 ft^2 orifice plate. The orifice is sized to discharge approximately 20 cfs at the time of the downstream watershed hydrograph peak at the storm drain inlet and approximately 30 cfs during the 100-year flood event. Maximum downstream discharge at the storm drain inlet occurs at 4:05 hours, according to the District HEC-1 model. The difference between the downstream peak discharge (6-hour storm) and the 339 cfs capacity of the storm drain is 20 cfs. The orifice rating curve was developed by the HEC-1 model assuming an orifice coefficient of 0.6 and an inlet elevation of 2,135 feet. A gated outlet will also be provided as a backup for the orifice to facilitate maintenance, and to allow opening of the orifice in the event of debris clogging. The inlet to the orifice will be placed in a grated concrete box to reduce the potential for debris and sediment clogging.

Spillway. As currently planned, the emergency spillway will consist of an elliptical crest, with the crest apex at elevation 2155.0 feet. The spillway length will be 80 feet, and the design head will be 5.5 feet for the 0.5_PMF event. The total spillway height will be 8.5 feet. The spillway chute and energy dissipator was sized for the routed 0.5_PMF. A spillway rating curve for the elliptical crest was developed using the procedures outlined in the *"Design of Small Dams"* by the U.S. Bureau of Reclamation (1987) and *"Hydraulic Design of Spillways,"* by the U.S. Army Corps of Engineers (1990).

Energy Dissipator. The proposed spillway chute has slope of 3:1, which is sufficient to maintain supercritical flow. A BUREC Type III energy dissipator is proposed to force a

hydraulic jump before flow exits to the natural channel downstream of the dam. The detention basin will be placed approximately 6 feet below natural grade to ensure that the computed jump height will match the tailwater elevation of the downstream channel. Dumped riprap (D_{50}=2 feet) will be placed downstream of the dissipator to mitigate impacts on the dam backslope during the spillway design event, and during lesser flows exiting the dissipator.

Sedimentation Detention Basin. The sedimentation detention basin will be designed according to guidelines presented in the FCDMC *Hydraulic Design Manual*. The required sediment storage volume is 2 acre-feet, both for the 100-year event and for the average annual yield during a 5-year period of no maintenance. The sedimentation detention basin will be located near the detention basin inlet to concentrate deposition of coarser sediment material. Finer sediments will mostly accumulate wherever ponding occurs, particularly near the low-flow outlet. Permanent sedimentation markers will be used to allow the District staff to assess the amount of deposition within the detention basin.

Section 3
Geotechnical Investigation

The purpose of the geotechnical investigation was to obtain subsurface information at the proposed damsite and detention basin area for development of geotechnical recommendations for design and construction. The field exploration included 13 soil borings and 21 test pits. Laboratory tests were performed to characterize the onsite materials and determine their engineering properties.

Field Investigations

Previous Site Geotechnical Work

No evidence of previous geotechnical work was found for the Casandro Wash project site. However, geologic investigation reports for two previously constructed floodwater-retarding structures in the Wickenburg watershed are available. The Sunnycove and the Sunset Floodwater Retarding Structures are located within the town limits of Wickenburg, and are within about one mile of the Casandro Wash project site to the south and southeast, respectively.

The Sunnycove and Sunset damsites contain alluvial deposits overlying dense, carbonate-cemented sand and gravel, generally similar to the subsurface conditions found at Casandro Wash. Both dams have cutoff trenches excavated into the cemented material and the embankments are constructed with material excavated within the detention basins.

Field Exploration

Between January 18 and 28, 1994, CH2M HILL conducted a field exploration of the project site. The exploration consisted of excavating 21 test pits, drilling 13 soil borings, and performing 9 infiltration tests. The infiltration tests were performed in both boreholes and test pits. A CH2M HILL engineer specified test pit and boring locations, determined sampling intervals, and provided general oversight during all exploration operations. Locations of the test pits and soil borings are shown in Figure 3-1. A summary of the field exploration program are presented below. Detailed information is included in the Geotechnical Report, Volume 1, Field and Laboratory Data.

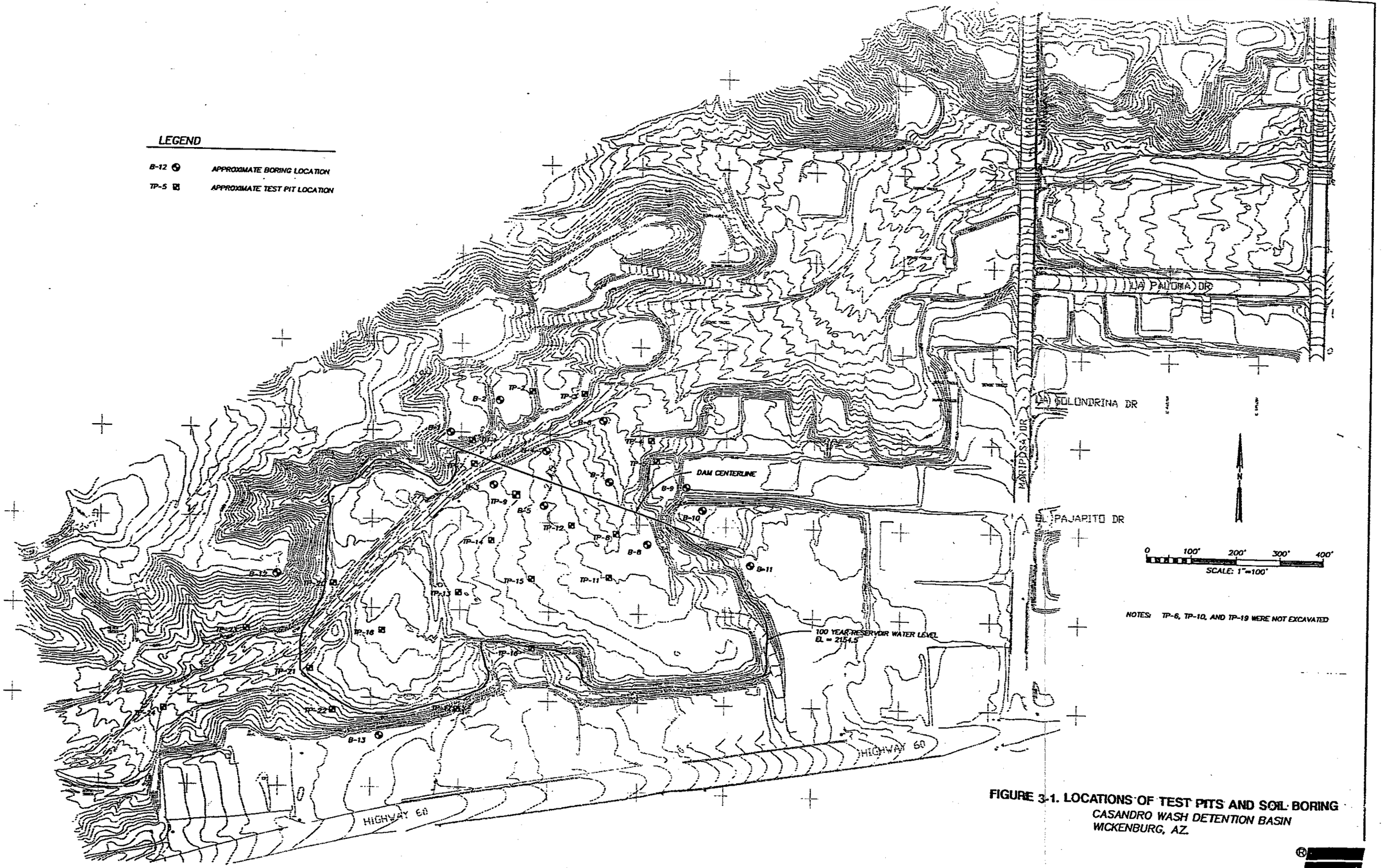


FIGURE 3-1. LOCATIONS OF TEST PITS AND SOIL BORING
CASANDRO WASH DETENTION BASIN
WICKENBURG, AZ.

CH2M HILL

Test Pits

Riggs Enterprises of Wickenburg, Arizona, was subcontracted to excavate all of the test pits for this exploration. Depths of the test pits ranged from 5 to 18 feet. As indicated in Figure 3-1, the test pits were located near the proposed dam alignment and throughout the detention basin and banks of Casandro Wash. All of the test pits were completed with a Caterpillar EL 200B trackhoe.

Disturbed soil samples were obtained from each of the major soil layers encountered in the test pits. Each soil sample was composed of a bulk sample portion, weighing approximately 40 pounds, and a moisture sample portion. Bulk samples were enclosed in doubled, plastic bulk soil sample bags, and in doubled, gallon-size plastic bags with zip-lock enclosures. A CH2M HILL engineer visually classified all soil samples following the Unified Soil Classification System, in general accordance with ASTM D 2488.

Soil encountered in the test pits was classified in the field as gravelly sand with varying amounts of silt or clay. Two major soil layers were commonly identified, consisting of a loose-to-medium-dense sand overlying dense-to-very-dense cemented sand. Samples taken from the cemented zone were typically highly reactive to hydrochloric acid, indicating a carbonate cementing agent in the soil. Depth to the cemented layer varied from near ground surface to about 16 feet below ground surface below ground surface. In some of the test pits the cemented layer was not encountered, even after reaching a maximum pit depth of 20 feet bgs.

After sampling and logging the soil profile, all test pits were backfilled with the excavated soil. The trackhoe operator used the bucket and tracks of the trackhoe to compact the fill as much as possible while backfilling the test pits.

Soil Borings

From January 24 through January 28, 1994, Enviro-Drill, Inc., from Phoenix, Arizona, drilled 13 soil borings using a CME 75 drill rig. All soil borings were advanced using 8-inch-outside-diameter (OD), hollow-stem augers. Soil Borings B-1, B-2, B-9, and B-10 were drilled to a final depth of 100 feet bgs. The remaining borings along the proposed dam alignment and on the banks of Casandro Wash were drilled to a final depth of 50 feet. Locations of the soil borings are shown in Figure 3-1.

Disturbed soil samples were obtained in each of the soil borings using a 2-inch-OD split-spoon sampler. Sampling was performed on 2.5-foot intervals between zero and 20 feet. After 20 feet, sampling continued on 5-foot intervals until the maximum depth of the boring was reached. In some soil borings the sampling interval was extended to 10-foot intervals after drilling 20 feet into the cemented zone. In these cases, the 10-foot sample interval was continued to the total depth of the boring.

Standard Penetration Tests (SPTs) were performed in accordance with ASTM D1586. The SPT uses a 140-pound hammer, dropped 30 inches, to drive the sampler 18 inches into the soil. The number of hammer blows for each 6-inch interval of sampler penetration is counted and recorded. The sum of the blows during the last two 6-inch penetration intervals determines the "N" value expressed as blows per foot (blowcounts) for the sample. The SPT hammer used for this project was an automatic, fully enclosed hammer fastened to the drill rig. No rope, cable, or cathead was used.

In-place density samples were obtained typically between ground surface and 10 feet below ground surface. A 3-inch-OD, 12-inch-long split barrel sampler, equipped with two 6-inch brass-sleeve liners, was used to obtain density samples. This sampler was driven in the same manner as the standard split-spoon sampler described above in general accordance with ASTM D 3550.

Where fine-grain soil was encountered, or SPT blow counts were comparatively low, 3-inch-OD Shelby tube samplers were used to obtain relatively undisturbed soil samples. The thin-walled Shelby tubes were advanced in general accordance with procedures described in ASTM D 1587.

A CH2M HILL engineer visually classified soils recovered during the drilling program following the Unified Soil Classification System, and in general accordance with ASTM D 2488. Soil samples obtained from the SPTs were placed in plastic bags with zip-lock-type enclosures. In-place density samples collected in the 6-inch brass sleeves, as well as Shelby tube samples, were sealed with plastic end caps and black plastic tape. Sample descriptions, blowcounts recorded during the SPTs, and related information were recorded on the soil boring logs. Upon completion of the soil borings, all boreholes were grouted to ground surface with a sand/cement grout poured from the ground surface. No borehole caving was observed.

Soil encountered in the borings was consistent with soil found in the test pits. At various depths in all of the borings the cemented layer was encountered. As indicated by the blowcounts, visual classification, and reaction to hydrochloric acid, once this layer was identified, it continued through to the final depth of the soil boring. Therefore, total thickness of the cemented layer was not observed.

Infiltration Testing

In Test Pits TP-8 and TP-9 and in Soil Borings B-1, B-2, B-3, B-5, B-8, B-9, and B-10 infiltration testing was performed. The borehole infiltration tests were performed on selected boreholes. After drilling to the predetermined depth for the test, the augers were pulled up approximately 3 feet off the bottom of the borehole. Approximately 500 gallons of water were pumped down the auger. Water was generally observed to flow up near or at the borehole collar in the annular space outside the augers. An electric water level sounder was used to determine the water level inside the hollow stem auger as it declined. Water level measurements were generally recorded every 30 seconds for a 10-minute period.

Infiltration tests were performed in selected test pits by driving a stake calibrated with 0.1-foot increments into the bottom of the test pit. Water was added to the test pit, and the depth of water was recorded periodically over a 10-minute period.

A summary of the results from the infiltration test is presented in Table 3-1, below. Data from the infiltration tests are included in the Geotechnical Data Report, Volume 1.

Table 3-1
Casandro Wash
Field Permeability Test Results

Infiltration Test Location	Estimated Permeability (cm/sec)
B-1	1.1 (10^{-4})
B-2	6.1 (10^{-5}) 10^{-4}
B-3	1.7 (10^{-4})
B-5	1.4 (10^{-4})
B-8	7.0 (10^{-5}) 10^{-4}
B-9	2.3 (10^{-5}) ARTI-LES
B-10	2.9 (10^{-5}) CHED ??
TP-8	7.5 (10^{-3})
TP-9	4.2 (10^{-4})

THICKNESS: ALLUVIUM/GILA

10^{-3} cm/sec

AVG ≈ 1×10^{-4}

Laboratory Testing

Laboratory testing included Atterberg limits, sieve analysis, specific gravity, bulk density, and moisture content to establish index properties and verify field classifications. Standard Proctor compaction tests, direct shear, unconsolidated-undrained triaxial shear, and consolidated-undrained triaxial shear with pore pressure measurements on remolded samples were performed to assess strength characteristics for embankment design. Laboratory triaxial permeability testing of remolded samples was performed to aid in assessing seepage potential and slope stability. The data for all laboratory results is included in the Geotechnical Data Report. A summary of the soil classification and index property testing is shown in Table 3-2.

Concept Design Criteria

The geotechnical design criteria for the dam are based on the results of field exploration, laboratory testing, and engineering analysis. They provide the basis for the project's design and for final geotechnical and construction recommendations.

Dam Alignment

Several dam alignments were evaluated during concept design. All proposed alignments extended off the same high point on the right abutment (Ryan's property) to varying points on the left abutment. The foundation soils are similar for all proposed alignments. The foundation material encountered consisted of recent alluvial deposits comprised of loose-to-medium-dense sand overlying dense-to-very-dense cemented sand. The depth to the partially cemented material varied greatly. The overlying loose soil in the detention basin should be removed and the dam founded on the cemented or very dense sand. The abutment conditions were similar to the foundation except for an increase in the amount of fines present to approximately 12 percent. The right abutment is thin in cross section and should be buttressed with fill.

Because geotechnical conditions are similar at the proposed alignments, the final alignment was determined on the basis of other design constraints such as spillway size and orientation, detention basin storage, and minimizing earthwork.

Dam Type

The proposed dam will be a homogenous earthfill dam constructed of materials excavated from the detention basin. Field exploration and laboratory test results did not reveal suitable low permeable material for use as a core for a zoned earth dam. Therefore, a homogenous dam with a chimney drain is preferred over importing clay soil for a core. The material in the detention basin may be suitable for use in construction of a RCC dam, but cost and potentially compressible foundation conditions eliminated RCC from further consideration.

Dam Construction

The proposed dam cross section will have 3:1 (horizontal to vertical) slopes upstream and downstream. Engineering analysis indicates 3:1 slopes have an adequate factor of safety for slope stability under steady state seepage, seismic, and rapid drawdown conditions. Slopes steeper than 3:1 are easily eroded, more costly to maintain, and would not meet stability requirements. Detention basin sideslopes below the high water line should also be graded to a 3:1 slope and be well vegetated to prevent failures and rapid erosion.

Table 3-2
Summary of Laboratory Analyses
Casandro Wash Detention Basin

Test Pit/ Boring #	Depth (ft)	Sample I.D.	Classification	Field Soil Properties		Particle Size Distribution % Passing by Weight (a)		Atterberg Limits		Moisture Density Relationship		Specific Gravity	Shear Strength (b)		Triaxial Shear (c)		Permeability (f)
				Dry Density (pcf)	Moisture Content (%)	#4	#200	LL	PI	Max Dry Density (pcf)	Optimum Moisture Content (%)		C (ksf)	0 (Deg)	C (ksf)	0 (Deg)	K (cm/sec)
TP-1	5	TP-1, B-1	SW-SM		2.5	65.0	9.3										
TP-1	9	TP-1, B-2	SW									2.62					1.1E-03
TP-2	3	TP-2, B-1	SW		3.8								0.4	39			
TP-3	5	TP-3, B-1	SP		3.9	86.0	3.5										
TP-3	17	TP-3, B-2	SW-SC			67.0	11.7										
TP-4	3	TP-4, B-1	SW-SM		4.0												
TP-4	14	TP-4, B-2	SW-SM			52.0	6.0						0	45			
TP-5	7	TP-5, B-1	SM		5.6												
TP-5	16	TP-5, B-2	SW-SM			67.0	9.3										6.0E-04
TP-7	4	TP-7, B-1	SW-SM		3.9												7.6E-04
TP-7	15	TP-7, B-2	SW-SM			90.0	9.8										
TP-8	4	TP-8, B-1	SM		7.4										2.88	0	
TP-8	15	TP-8, B-2	SW-SM			71.0	7.6						0.5	40			1.2E-04
TP-9	2	TP-9, B-1	SW-SM		6.8	64.0	8.3										
TP-11	2	TP-11, B-1	SP		6.1	88.0	3.4										
TP-11	5	TP-11, B-2	SC		7.6	74.0	12.1			113.0	14.2						
TP-11	14	TP-11, B-3	SM										0	45			
TP-12	4	TP-12, B-1	SM		5.0					118.0	11.5		1.55	27			
TP-12	9	TP-12, B-2	GW-GM			37.0	6.3										1.1E-04
TP-13	4	TP-13, B-1	SP-SM										0	45			
TP-15	5	TP-15, B-1	SM		6.2	75.0	25.6	27.0	6.0						0.72	22.0	
TP-15	10	TP-15, B-2	SP														1.6E-03
TP-15	13	TP-15, B-3	SW-SM			51.0	6.3										4.2E-04
TP-16	2	TP-16, B-1	SM		4.3												
TP-16	8	TP-16, B-2	SW-SM		9.1	81.0	7.3										
TP-18	3	TP-18, B-1	SW-SM		6.9	51.0	5.4			114.0	12.9						8.3E-05
TP-18	9	TP-18, B-2	SW-SM			61.0	5.1										

Table 3-2
Summary of Laboratory Analyses
Casandro Wash Detention Basin

Test Pit/ Boring #	Depth (ft)	Sample I.D.	Classification	Field Soil Properties		Particle Size Distribution % Passing by Weight (a)		Atterberg Limits		Moisture Density Relationship		Specific Gravity	Shear Strength (b)		Triaxial Shear (c)		Permeability (f)
				Dry Density (pcf)	Moisture Content (%)	#4	#200	LL	PI	Max Dry Density (pcf)	Optimum Moisture Content (%)		C (ksf)	0 (Deg)	C (ksf)	0 (Deg)	K (cm/sec)
TP-20	3	TP-20, B-1	SW-SM		5.0	63.0	10.3			118.0	11.8	2.57					2.1E-06
TP-20	8	TP-20, B-2	SW-SM	124 (d)		69.0	11.8										
TP-21	3	TP-21, B-1	SW		5.2	74.0	4.3										
TP-21	5	TP-21, B-2	SM		5.7												
TP-22	3	TP-22, B-1	SM		4.8	88.0	18.7			120.0	11.0						1.1E-04
TP-23	5	TP-23, B-1	SW		4.6	66.0	2.7										
TP-24	2	TP-24, B-1	SW		7.9	85.0	5.9			109.0	14.6						
TP-24	2	TP-24, B-2	SW-SM		7.5	63.0	5.9										
B-1	17.5	B-1, SS-8	CL					33.0	12.0								
B-6	10	B-6, ST-5	SW	106.0	5.6												
B-10	4	B-10, ST-3	SM	98.0	9.9												
B-10	20	B-10, SC-9	SW-SM	92.0	9.6												
Sediment (e)	0		SW			90.0	3.0										

Notes:

(a) 100% of every sample passed 2-inch sieve

(b) Direct shear test with normal stresses of 1, 2, and 3 ksf

(c) Triaxial shear test with confining pressures of 10, 20, and 30 psi

(d) Sample was cemented. Density determined by paraffin coating method. (ASTM D1188)

(e) Surface sample collected near TP-21

(f) Permeability determined in laboratory on sample compacted to 95% of ASTM 698 at optimum moisture.

During final design, slope stability of the dam and detention basin were analyzed under the following conditions:

- Short and long duration seepage
- Rapid drawdown of detention basin
- Earthquake shaking

Table 3-3 presents the results of the slope stability analysis. Detailed discussion and the stability analysis calculations are included in the Geotechnical Report, Volume 2, Analysis and Recommendations.

The minimum top width of the dam is required to be 14 feet to meet SCS requirements.

Engineering analysis indicates that under seepage conditions of several weeks, water could flow through most of the dam. To protect the dam from seepage erosion at the downstream toe, a chimney drain should be constructed in the dam. The drain should extend from just below the crest of the dam to below the bottom keyway. Pipes should be installed to provide positive drainage from the chimney drain to the downstream face. A keyway should be installed into the cemented foundation soil to reduce seepage along the foundation/embankment interface. The keyway should extend a minimum of 4 feet into the cemented material for the length of the dam. Detailed seepage analysis and drainage recommendations are included in the Geotechnical Report, Volume 2.

Table 3-3
Summary of Slope Stability Analysis
Casandro Wash Dam Embankment
Wickenburg, Arizona

Case	Factor of Safety[a]	
	Target[b]	Estimated
Upstream slope, 3:1, static, PMF water level	1.5	2.7
Upstream slope, 3:1, seismic acceleration, PMF water level[a]	1.1	1.5
Upstream slope, 3:1, rapid drawdown from PMF water level	1.2	1.2
Downstream slope, 3:1, steady state seepage at PMF water level	1.5	2.7
Downstream slope, 3:1 slope, steady state seepage, seismic acceleration	1.1	1.9

Notes:

[a] All factor of safety values reported for PMF water level.

[b] Target factors of safety based on Soil Conservation Service specified values (SCS, 1985).

Seismicity

An investigation of the existing seismic information was performed for the region around the dam. This investigation included:

- Data search of the USGS National Information Earthquake Center records for seismic activity within 150 km of the site.
- Review of seismotectonic data for the New Waddell Dam site approximately 45 km east of Wickenburg.
- Review of seismic zoning maps from the Uniform Building Code, Soil Conservation Service, Applied Technology Council, and Federal Emergency Management Agency.
- Evaluation of the known active faults, the maximum credible earthquake (MCE) from these faults, and the peak acceleration at the site from the MCE of each fault.

Based on the above investigation, a design peak rock acceleration of 0.1g is recommended for final design. This is the same value recommended in the SCS design manual. Details of the seismic investigation are included in Volume 2 of the Geotechnical Report.

Water for Construction

Water will be required during construction for both dust control and embankment moisture control. To achieve near optimum moisture conditions in the embankment soil the contractor should prewet the borrow area in phases. Alternatively the borrow area could be wetted as it is developed. Based on prewetting continuously for 2 week, the irrigation rate is expected to be 50 to 100 gpm. If the contractor chooses not to prewet the estimated water requirement is 75 to 125 gpm. The Town of Wickenburg has indicated that a short term rate of 500 gpm at 60 psi is available at the hydrant near the wash on a continuous basis.

Control of Water During Construction

The construction period is anticipated to be about 4-6 months. During this time the contractor will reroute a section of the existing sewer pipe pipeline and remove a portion of the existing sewer beneath the damsite, excavate the foundation for the damsite, construct the outlet works, place the embankment and chimney drain, construct the spillway and stilling basin, and complete the reservoir grading, roadways, and seed all disturbed areas. Should rainfall occur during this period portions of the completed work could be adversely affected. This conceptual plan identifies the areas of work that may be affected and presents possible control alternatives. The construction contractor will be responsible for submitting a plan prior to construction that will demonstrate the methods that will be employed to deal with water during construction.

Potential Surface Water Impacts and Mitigation

For small amounts of precipitation that do not produce surface water in the detention basin project site the damage to the project work should be minimal provided the exposed work is protected. There may be some erosion of cut or fill slopes. This damage can usually be easily repaired. The contractor should construct some berms or other barriers at strategic locations prior to rainfall occurring to reduce surface erosion.

Should ponding occur anywhere in the detention basin project area the contractor will be required to pump out the water and restore the work to the specified condition before the completed work will be accepted and new construction started. Borrow areas will have to be dried out as will any embankments, pipe trenches, foundation areas, roadways, or any other location where ponding occurs. It will be the contractors responsibility to remove the ponded water as soon as practical and restore the wetted surfaces to their prior condition.

A temporary detention basin can be constructed within the upstream areas of the project site to reduce the potential for flooding of completed work. Water that ponds can be used for roadway dust control and in the dam embankment provided it does not contain any harmful substances. Once the new sewer pipeline is installed through the damsite it could be used to route excess surface water through the damsite area prior to being put into service as the sewerline. Prior to putting the new sewerline in service it would have to be cleaned and repaired if damaged.

The area within the foundation for the dam will have to be excavated to expose acceptable foundation soil. This will result in a continuous area from one abutment to the other that will be depressed below the original ground surface. Upon approval of the foundation the contractor will place fill uniformly and horizontally across the entire dam footprint area up to the original ground surface. It is normal practice for the contractor to pump small quantities of surface water across the dam footprint until the outlet works is completed. For quantities in excess of what can be pumped or stored in a temporary detention basin the damsite will be flooded. The contractor will not be allowed to bring the dam embankment up as a tilted surface to route water around one end.

Should the damsite have ponded water the contractor will be required to pump out the damsite and borrow areas as soon as is practical. All wetted soil will have to be removed that does not comply with the specifications or that will compromise the quality of the project. This type of work can be quite extensive depending on the preventative measures taken by the contractor before the rainfall. Water discharged from the damsite will enter the natural drainage course of Casandro Wash. The contractor will be required to cooperate with any remedial work that is occurring downstream.

Once the dam embankment is higher than the detention basin bottom the contractor can use the outlet works through the dam for transport of excess water. The outlet pipe may have to

be extended beyond the stilling basin to prevent damage to this area of the project. Any damage from any cause will have to be repaired by the contractor.

If the runoff is sufficiently great the dam may be overtopped even with the outlet operating. There is no inexpensive way to prevent erosion of part of the dam. Following the flooding the contractor will have to pump the water over the dam or let it go through the outlet. The contractor will not be allowed to breach the dam to allow water to pass through the damsite.

The dam is vulnerable to overtopping until the spillway and stilling basin are operational. Should overtopping occur when concrete work is not completed or the backfill behind the walls is not placed, there could be damage to the work. All damage will have to be repaired before proceeding with additional work. Should overtopping of the dam occur there will likely be significant amounts of soil carried downstream.

Specifications will be prepared requiring the contractor to develop a diversion and control of water plan that he intends to implement. During construction the onsite Owners representative will document that the plan is being implemented. As damage caused by flooding is frequently a basis for a construction claim for extra money it is important that the work the contractor does and does not do to protect the project site be well documented with text and pictures.

Section 4
Site Civil

This section describes the field surveys, existing utilities, and right-of-way information obtained for the Casandro Wash Dam project.

Field Surveys

Field surveys of the project area were performed from mid-January through mid-April 1994. The surveys established the project control points using state plane coordinates. Section corner monumentation along Mariposa Drive was used as the basis of bearing. A preliminary survey line (P-line) was established by placing 4 control points (½-inch rebar) along the bottom of the wash for locating test pits and borings. Two centerline alignments were initially set for the dam, which consisted of end control points and staking along the centerline at 25-foot intervals, indicating the proposed dam elevations. The 100-year water surface elevation (initially 5,954 feet) was also staked around the detention basin area to provide a visual perspective of the size of the basin.

Bluestake was contacted to identify existing utilities within the project area. Additional utility information was collected from the Town of Wickenburg for the sewer, water, and right-of-way. The information is collectively shown in the preliminary plans submittal provided in Appendix A.

Existing Utilities

The only known utility within the detention basin is a 10-inch vitrified clay sewerline. The sewer was designed by Yost & Gardner Engineers, Phoenix, for the Town of Wickenburg. It was constructed in 1987, and serves the residential and commercial properties along U.S. 60, west of the site. The sewer alignment generally extends through the project area from southwest to northeast. The depth of cover through this reach ranges from 11 feet near the west end, to 5 feet at the east end, with an average depth of approximately 9 feet under the proposed detention basin area. There are three manholes located within the detention basin area, and four manholes located downstream between the dam and Mariposa Drive. Existing manhole frames and covers are generally at grade and are standard items per Maricopa Association of Governments (MAG) Detail No.424.

The slope of the sewer varies from 10.37% as it enters the detention basin area just north of US 60, to 0.80% west of Mariposa Drive. Although its design capacity is not known (data are not available from the engineer of record), only a small depth of flow was observed during the field survey. However, calculations show that the capacity of the line at full depth and a slope of 0.80% could handle a flow of 1.7 cfs.

A 6-inch waterline is located north of the detention basin which serves the adjacent residential properties. It generally parallels the wash alignment and is approximately 200 feet north of the wash centerline. There are three fire hydrants located on the waterline west of Mariposa Drive. Wickenburg's Public Works Director was contacted on June 20, 1994, regarding the use of water during construction. In summary, the existing waterline is a 6-inch line that is looped within the Town's water system. There is approximately 90 psi pressure in the main system, so there should be no problem delivering roughly 500 gpm at 60 psi to the hydrant. The Town will install a temporary meter with a standard 2½-inch hose connection for the contractor's use during construction. A deposit of $450 is required by the Town for the meter installation, and the cost of water is $1.25 per 1000 gallon.

Other existing public utilities were identified, but are outside the immediate project area. These utilities should not be affected by the dam and basin construction. The utilities provide service to the residents and commercial buildings along U.S. 60., and consist of the following:

- Overhead power serving the residences to the north
- Waterline along the north side of U.S. 60
- Overhead power along the north side of U.S. 60
- Gas line along the north side of U.S. 60

Residents on the north side of the detention basin have sewer, water, and electrical services that extend along their private access drives. The service connections for the residents and commercial buildings along the south side of the detention basin extend to the south (toward U.S. 60), and away from the project area. Service connections do not appear to conflict with the dam or detention basin. However, the south access road alignment will likely be located over the sewer and water service connections to the Ryan property on the right abutment of the proposed dam. Also, the overhead power pole for residential service is located within the dike prism and may need to be relocated.

Right-of-Way and Easements

Existing right-of-way maps for the project area were obtained from the Town of Wickenburg. Property lines are depicted in the Preliminary Plans. These property delineations will require verification by the District as part of their effort in acquiring right-of-way for the detention basin, dam, and access roads. Updated information provided by the District will be incorporated into the plans.

The 10-inch sewerline has an easement of varying width through the project area. The easement is shown on the as-built drawings prepared by Yost & Gardner. Partial relocation of the sewer will require an amendment to the easement description and resubmittal to the Town of Wickenburg for its approval.

The Grading Plan shown in the plan submittal depicts the property parcels in the project area. Consideration was given during development of the plan to minimize right-of-way needed for

the facility. It is anticipated that in lieu of purchasing right-of-way, fill slope easements could be obtained for certain areas that require grading.

Access easements will be required for the north and south maintenance roads. The maintenance road on the north side extends from the top of dam to a nearby residential access drive. The south maintenance road extends from the dam and wraps around the north and east sides of the residential property, using the entrance from U.S. 60 as a common entrance drive. A separate access permit to U.S. 60 will not be required. Both maintenance roads will require a minimum 24-foot-wide easement. The north maintenance road is approximately 300 feet long, and the south road is approximately 750 feet long. Exact lengths and widths of these easements will be determined during plan review.

Section 5
Permits

Construction of the Casandro Wash Dam requires the acquisition of two permits: the Dam Safety Permit issued by the ADWR Dam Safety Division, and the COE Section 404 Fill and Dredge permit. The District is primarily responsible for obtaining these permits, however, CH2M HILL is assisting in preparing applications and in coordinating the permitting efforts. Prior to construction, a U.S. EPA Stormwater NPDES permit for construction activities will also be required.

ADWR Dam Safety Permit

The objective of ADWR's Dam Safety Permit is to ensure that the dam is designed in accordance with state standards and regulations. Under ADWR criteria, the dam will be classified as a "small, high hazard" dam. This designation places certain design criteria on the spillway capacity and freeboard requirements.

CH2M HILL has coordinated with ADWR during the concept design analyses. The hydrologic analyses have been submitted to ADWR for review. This Design Report and 90% design submittal will be provided to ADWR following review by the District. The District has submitted a permit application and dam failure analysis to ADWR.

U.S. COE Section 404 Permit

Section 404 of the federal Clean Water Act regulates the "discharge of fill material into 'Waters of the U.S.'." This permit, administered by the COE, requires that various resource agencies and interested parties be given the opportunity to review and comment on the project. To streamline the process for certain types of projects, a number of Nationwide Permits have been granted. This project appears to meet the requirements of Nationwide Permit 26, which covers certain projects affecting less than 10 acres.

A pre-application meeting was held with the COE by the District on June 13, 1994. Based on the results of that meeting, the permit application was prepared by the District and submitted to the COE for review.

Section 6
Concept Design Recommendations

Dam and Spillway

As part of the concept design analysis, two dam alignments were identified and staked in the field during the initial field and geotechnical investigations. They were based on the geotechnical setting (for instance, the location of abutments) as well as the storage capacity needed to impound the 100-year storm. Both alignments are consistent with the concept location first presented by the District. Figures 6-1 and 6-2 show the alignments with respect to the existing topography.

A number of assumptions were initially made regarding the basic earth dam and spillway geometry. Concepts were developed and discussed in a Value Engineering workshop. As a result, some of the initial assumptions were revisited. The initial design assumptions are listed below; subsequent revisions to the assumptions are shown in brackets.

- The soils excavated from the detention basin would be used to construct the earth dam.
- The dam would be homogeneous with a 4-foot-wide granular chimney drain to control seepage.
- Overexcavation for the foundation would be required to approximately 6 feet deep.
- Top width of the dam would be 20 feet for accessibility and dam stability. [The width was later changed by the owner to a 14-foot top width.]
- Side slope on both faces would be 3:1, based on an initial geotechnical evaluation and maintenance requirements.
- Spillway crest width would be 200 feet, and crest elevation 2154.5 (initial hydraulic analysis). [Revised basin/spillway design changed the crest width to 80 feet, and the elevation to 2155.0.]
- Top of dam elevation would be 2160.5 feet based on hydrologic study. [Revised analysis changed the top of dam elevation to 2163.5.]
- The spillway would be an Ogee-type configuration, and taper to an 80-foot-wide stilling detention basin with energy dissipators. [This assumption was reviewed and changed to an elliptical crest spillway with a 3:1 slope to the chute. No taper is required to the spillway, simplifying the construction.]

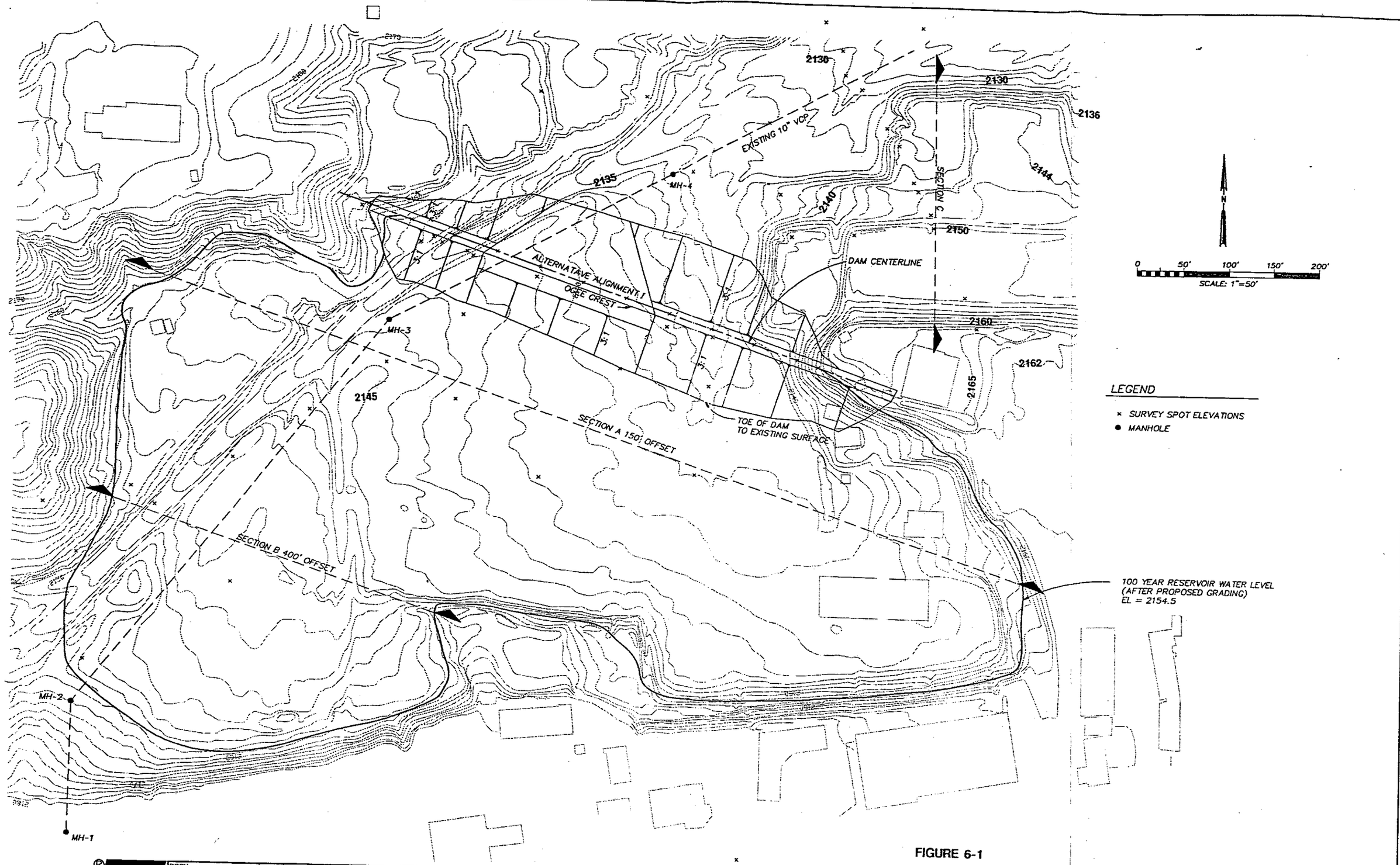


FIGURE 6-1

CH2M HILL

DSGN					
DR SWK35441\3441C005					
CHK					
APVD	NO.	DATE	REVISION	BY	APVD

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VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

ALTERNATIVE DAM ALIGNMENT I

CASANDRO WASH DETENTION BASIN
WICKENBURG, AZ.

SHEET 1
DWG NO.
DATE
PROJ NO.

PRELIMINARY

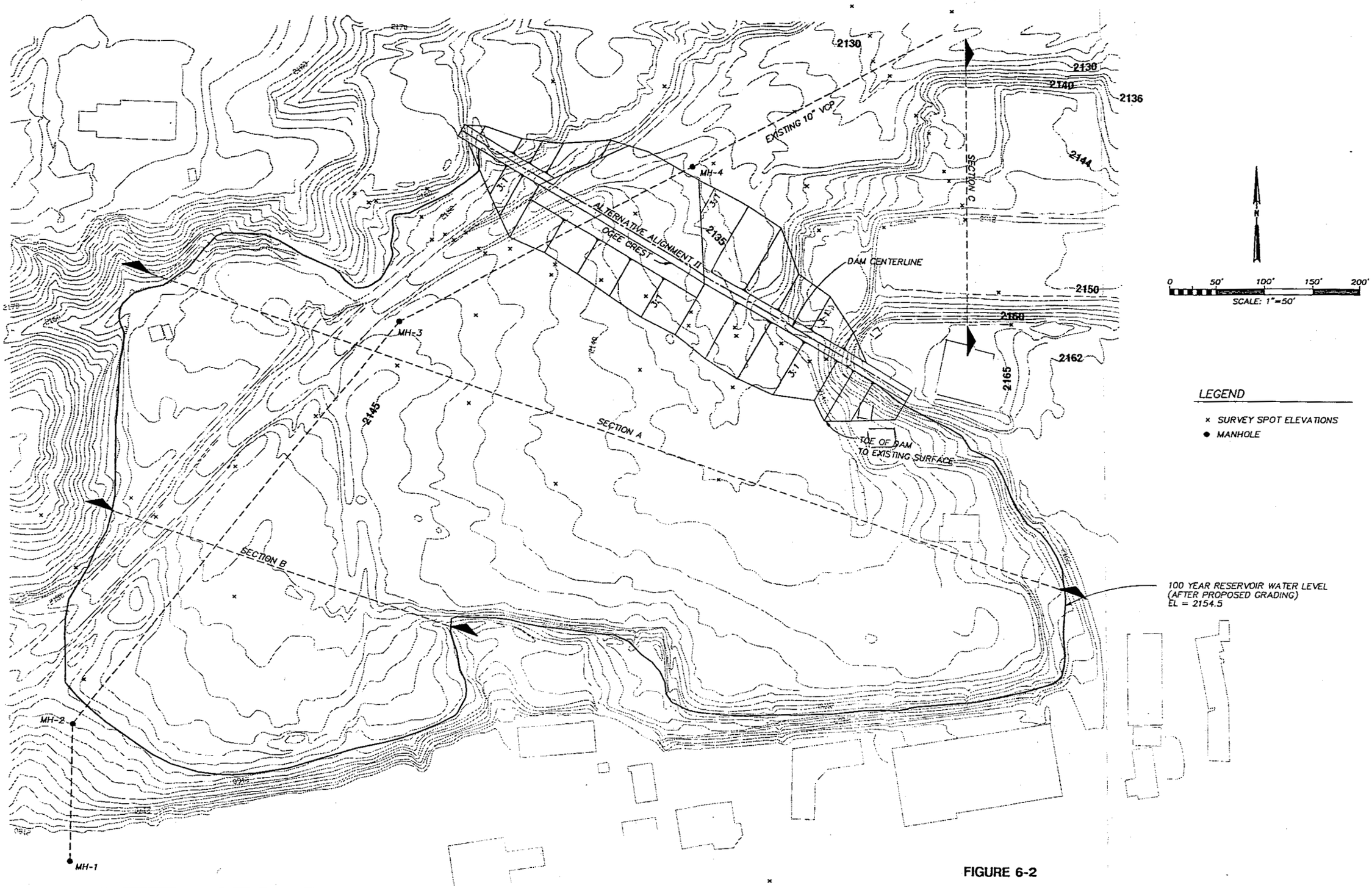

FIGURE 6-2

CH2M HILL	DSGN					
	DR SINGS441\S441C003					
	CHK					
	APVD	NO.	DATE	REVISION	BY	APVD

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ALTERNATIVE DAM ALIGNMENT II

CASANDRO WASH DETENTION BASIN
WICKENBURG, AZ.

SHEET	2
DWG NO.	
DATE	
PROJ NO.	

PRELIMINARY

- The detention basin outlet works would consist of a 36-inch-diameter pipe with a 20-inch diameter orifice plate.

The concept design alternative analysis consisted of developing preliminary earthwork quantities and order-of-magnitude construction cost estimates to determine the preferred layout. The results of this analysis showed that the Alignment II alternative was more cost effective than Alignment I. Alignment II is shorter, requires less earthwork, and provides better hydraulics for the spillway.

Using the Alignment II alternative, a digital terrain model was prepared to verify the detention basin's storage capacity, check the earthwork calculations, and prepare typical sections through the detention basin. The model and manual calculations checked within less than two percent of each other.

A concept design grading plan was prepared consistent with the storage capacity needs for the detention basin. The grading plan used adjacent land east of the dam as a disposal site for the excess soil. The prospective disposal area is presently graded in a tiered fashion and is within the 100-year floodplain delineation. It was thought that by filling this site with the overexcavated material from the detention basin, the site could be regraded and become developable property. Consideration has already been given (by others) to develop this land as a park.

As a result of the Value Engineering and concept design review, earthwork for the dam and detention basin are balanced. Thus, a disposal area for waste material will not be a major concern.

Two options were reviewed for the spillway construction: structural concrete and RCC. Several construction contractors with experience with RCC placement were contacted to discuss constructibility and costs. The cost of setting up and operating a pug mill to produce approximately 1,500 CY of the RCC mix made that option more costly than structural concrete. Thus, structural reinforced concrete appears to be the most cost-effective option for constructing the spillway and energy dissipator.

Sewer Relocation

The dam location and detention basin grading were the primary factors in determining the extent of sanitary sewer relocation. A profile of the existing sewer was prepared from as-built drawings. The digital terrain model, proposed grading plan, and dam alignment were superimposed on the profile to determine the extent of required sewer relocation. Approximately 950 lineal feet of existing sewerline and three manholes either will be removed or abandoned in place. Three alignments were investigated for the relocated sewer. The first alignment routed the sewerline around the north side of the dam. This alignment requires trench excavation and manhole depths over 35 feet. It was dismissed as impractical to construct. The second alignment consisted of routing the sewer under the dam. This

alignment, which became the preferred alternative, was submitted in the concept design. It consisted of replacing only a portion of the existing sewer (from MH #19 to MH #17), or about 875 feet. The alignment was later modified as a result of the design submittal, and extends from MH #20 to MH #16, or about 1,450 feet. This alignment was preferred by the District because of the depth of the existing sewer within the detention basin area.

Relocation under the dam and detention basin requires lowering the sewer by flattening its slope. This was accomplished with a constant slope on the pipe and relocating the sewer alignment as shown in the plan submittal. The full flow capacity of the proposed sewer pipe is approximately 4.2 cfs, more than twice the existing pipe through the same reach. Since the detention basin will likely impound water several times per year, watertight frames and covers will also be required within the detention basin. Under the dam. the pipe will have to be encased in concrete.

The Town of Wickenburg's Public Works Department and consulting engineer were contacted to discuss the limiting criteria for the sewer relocation. These criteria are summarized in Section 6, Concept Design Recommendations.

Design recommendations for the sewer relocation are:

- Sewer and manhole details should be in accordance with MAG standards.
- Relocated sewer pipe should be 12-inch RCP; ASTM C-76 (During the design review process, the sewerline was changed to Ductile Iron Pipe, Class 51. DIP is typically used by MAG communities for sewer construction.)
- D-Load = 18,000 lbs/ft.
- Trench condition should be Class B (Compacted granular bedding), except for within 20 feet of toe of dam where trench should be concrete encased to 0.7D above pipe invert (pipe zone modified to full concrete encasement).
- Minimum slope should be 0.01 percent.
- Maximum length of sewer line between manholes should be 500 feet.
- Maximum depth of manholes should be 20 feet.
- Manholes within the detention basin and downstream manholes subjected to flood conditions should be retrofitted with watertight frames and covers.

Other Utilities

If required, adjustments to service connections will be designed in accordance with UBC and MAG standards.

Maintenance Roads

Maintenance roads are not for general public use. Therefore, the recommendations for roadway design stated in the AASHTO Policy on Geometric Design of Highways and Streets may not be fully applicable. Access to the dam will use portions of existing private drives off the public streets. Roads for maintenance access will spur off the private drives and extend to the top of the dam on both the north and south side of the spillway, as well as to the upstream and downstream toes. The maintenance road design must accommodate county maintenance and emergency vehicles. Two access ramps (north and south side of basin) will be provided for occasional nonvehicle recreational use and maintenance. Therefore, the maintenance roads will be based on less than a 20-mph design speed. The following criteria are recommended based on the types of maintenance vehicles anticipated:

- Turning radius based on SU-30 vehicles.
- Maximum grade of 10 percent, with 80-foot vertical curves.
- Roadway width will be 14 feet (20 feet for the entrance drive south of the dam).
- Minimum structural section of maintenance roads will be 4-inch granular base course.

Outlet Pipe through Dam

The following criteria are recommended for the outlet pipe through the dam.

- The outlet pipe shall be 36-inch Reinforced Concrete Pipe, ASTM C-76.
- D-Load = 18,000 lbs/ft.
- Trench shall be encased in concrete to 6 inches above spring line.

Structural Elements

It is recommended that structural elements be designed in accordance with AISC and ACI requirements.

Landscaping

The landscaping plan and recommendations are presented in Appendix B.

Preliminary Construction Costs and Schedule

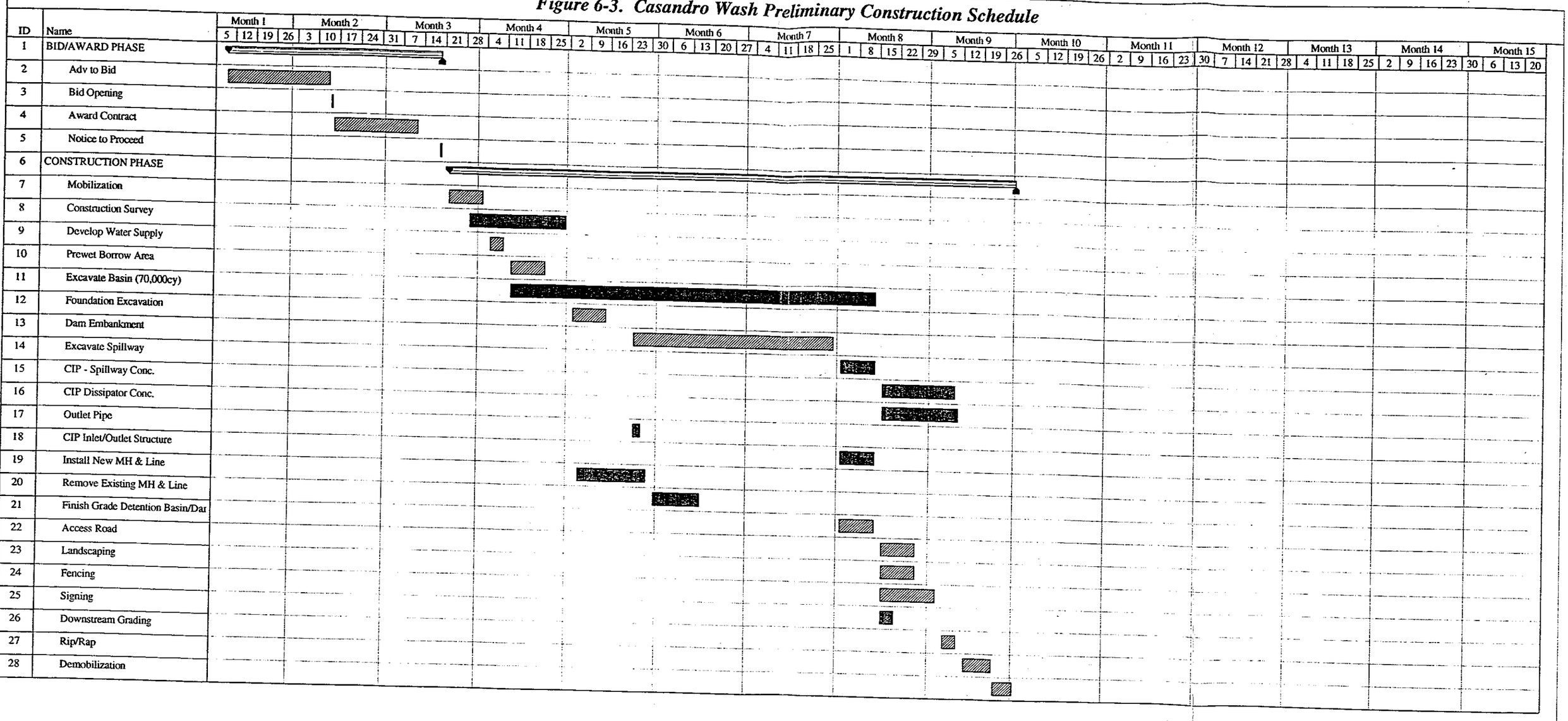
The preliminary construction cost opinion for the detention basin and dam project is summarized in Table 6-1. The detailed estimate is presented in Appendix D. Estimates were developed for the major elements shown in the 90% design submittal. No contingency was applied.

Table 6-1
Opinion of Probable Cost
Casandro Wash Dam

Description	TOTAL
A. Detention Basin Construction	$142,000
B. Dam Construction	392,000
C. Structures	296,000
D. Sewer Realignment	82,000
E. Site Development	163,584
Subtotal Construction Cost	**1,075,584**
Construction Testing and Administration	89,000
Total Construction Cost	**$1,164,584**

Figure 6-3 presents the preliminary construction schedule showing the bid, award, and construction phases, as well as the major items of work within each phase. The purpose of the schedule is to obtain an understanding of the overall project sequencing, to verify the project's constructibility, and to determine an approximate duration of construction.

Figure 6-3. Casandro Wash Preliminary Construction Schedule



Project:
Date: 6/9/94

Critical Noncritical Progress Milestone Summary Rolled Up

Appendixes

Appendix A.

Plan Sheets

Plan Sheets

Submitted Under Separate Cover

Appendix B.

Landscaping

CASANDRO WASH DAM PROJECT
(Town of Wickenburg)

LANDSCAPE CONCEPT SUBMITTAL

Prepared For

Maricopa County Flood Control District
2801 West Durango Street
Phoenix, Az. 85012-3393

Prepared By:

Boyd C. Winfrey
Landscape Architect
1420 Oak Lane
Prescott, Arizona 86301

June 6, 1994

LANDSCAPE CONCEPT SUBMITTAL OUTLINE

1.0 INTRODUCTION

- 1.1 LIMITS OF SUBMITTAL
- 1.2 SITE DESCRIPTION
  1. LOCATION
  2. GENERAL CHARACTER
  3. EXISTING PLANTS
  4. GENERAL SOILS DESCRIPTION
- 1.3 WICKENBURG PARK PLANS
- 1.4 DESERT TORTOISES

2.0 LANDSCAPE CONCEPT

- 2.1 RETAIN EXISTING VEGETATION
- 2.2 PLANTING APPROACH
- 2.3 PROPOSED SEED LIST
- 2.4 NATIVE PLANT SALVAGE
  1. ARIZONA STATE NATIVE PLANT LAW

3.0 SOILS TEST

- 3.1 TEST RESULTS
- 3.2 COMMENTS

4.0 IRRIGATION RECOMMENDATIONS

- 4.1 SEEDED AREAS
- 4.2 MESQUITE TRANSPLANTS

CASANDRO WASH DAM PROJECT
(Town of Wickenburg)

LANDSCAPE CONCEPT SUBMITTAL

1.0 INTRODUCTION

1.1 The landscape concept submittal is limited to the proposed seed and plant list and the feasibility of using a temporary watering system. To arrive at these recommendations it is important to review the following related information.

1.2 Casandro Wash project site is located in the Town of Wickenburg approximately 1500 feet upstream of Mariposa Drive in what is predominately a residential neighborhood. The site varies in elevation with typical arroyo carved bluffs and canyons bordering the wash on the north and south.

The site is vegetated with typical Sonoran desert vegetation. The Casandro Wash Vegetation Survey list the following plants within the project site:

Mesquite	Prosopis juliflora
Desert Broom	Baccharis sarathroides
Catclaw	Acacia greggii
Creosote	Larrea tridentata
Wolfberry	Lycium andersonii
Grey Thorn	Zizyphus obtusifolia
Burro Bush	Hymenoclea salsola
Turpentine Broom	Thamnosma montana
Triangle Leaf Bursage	Ambrosia deltoidea
Desert Mallow	Sphaeralcea ambigua
Desert Marigold	Baileya multiradiata

Native grasses and Palo Verde are not listed as a part of this survey.

The soils are typical desert wash sandy gravely soils with a high pH and low plasticity index. This soil would be considered poor for agricultural purposes but for reintroducing native plants it is acceptable.

1.3 In the early stages of this project the Town of Wickenburg had requested the detention basin be graded to allow for a future park. This is no longer the case and the Town of Wickenburg will not be establishing a park.

1.4 The Arizona Game & Fish Department's Heritage Data Management System does not indicate the presence of any special status species of wildlife in the project vicinity. However, it is possible that Sonoran desert tortoise could be encountered

during construction. This species is a Category 2 Candidate for listing under the Endangered Species Act and if encountered should be handled in accordance with established guidelines.

2.0 LANDSCAPE CONCEPTS

2.1 It is recommended that native vegetation be retained in the project area by selective grading. These pockets of vegetation will provide wildlife habitat and at the same time provide a seed source for natures revegetation process.

2.2 It is recommended that revegetation of the Casandro Wash Dam Project be accomplished in two approaches, seeding and salvage of existing mesquite. The seed mix for the dam should not contain mesquite or desert broom but they should be included in the mix for slopes and the floor of the basin.

Salvage, holding and replanting native mesquite is recommended for this project providing it can be accommodated within the project budget. The cost for transplanting native trees has typically been running $55 to $60 per caliper inch trunk. Further inventory and tagging of existing mesquite would be necessary to determine the number of potential transplant candidates. This effort is not currently in our scope of work. Further comments and recommendations on this issue are requested.

2.3 The following preliminary seed list is included for review and comment:

Filaree	Erodium circutarium
Indian Wheat	Plantago insularis
Purple heliotrope	Phacelia tenacetifolia
Annual brome	Bromus rubens
Big galleta	Hilaria rigida
Desert needlegrass	Stripa speciosa
Sand dropseed	Sporobolus cryptandeus
Plains bristlegrass	Setaria macrostachya
Meaquite	Prosopis juliflora
Desert Broom	Baccharis sarathroides
Catclaw	Acacia greggii
White Thorn	Acacia constricta
Creosote Bush	Larrea tridentata
Triangle Leaf Bursage	Ambrosia deltoidea
Desert Marigold	Baileya multiradiata

2.4 The Arizona Native Plant Law applies to this project. State agencies clearing land exceeding one-fourth acre are required to submit a written notice of intent to clear land 60 days prior to beginning work. Salvaged plant material retained on the project site do not require a non fee permit by the state agency performing the salvage.

3.0 SOILS TEST

3.1 The horticultural soils test results are as follows:

TEST	STANDARD	TEST RESULTS	COMMENT
pH	6.0 to 8.3	Average 8.6	High
Soluble salts	2000 PPM Max	Average 362	Acceptable
P.I.	5 to 20	Average 2.2	Low
Gradation			
2 Inch	100%	100%	Acceptable
1/2 Inch	85% to 100%	91.5%	Acceptable
No. 40 sieve	35% to 100%	26.8%	Low

3.2 Generally speaking the soils of this region are alluvial deposits which consist of gravel, sand, silt, and clay. This soil, as mentioned earlier, is of poor agricultural quality but quite suitable for the natural selection of native plants. Natural selection implies that, when a broad variety of native seed is broadcast over a wide are, only seed which is in a ideal location receiving the appropriate amounts of sun and water will germinate.

The high pH is indicative of Arizona desert region and would be a problem if a large amount of container grown plants were introduced into the project. Ideally it would be better if the pH did not exceed 8.3. To lower the pH, soil sulfur or sulfuric acid can be applied to planted areas which in turn will result in increased soluble salts. The tested soluble salts for Casandro Wash are very low consequently any increase should not be a problem. Having taken all this into consideration We do not recommend a soil pH modification. The natural selection process for seeded native plants should overcome the high pH.

The plasticity index is notably low. This will not negatively affect plant growth but it does point out the need for erosion protection in the form of native grasses. A quick establishment of native grasses will not only help prevent erosion but will enhance the growth of seeded shrubs and trees.

4.0 IRRIGATION RECOMMENDATIONS

4.1 Seeded areas within the project do not require and should not have supplemental irrigation. However the ideal time of year for seeding large areas is in the late fall.

4.2 If it is deemed feasible to salvage, hold and replant native mesquite, for this project, a temporary drip irrigation system is recommended for approximately the first year after transplant. Temporary water will also be needed for the mesquite holding area.

Water can be accessed from a 2 inch water main located in the roadway at Sunset Terrace just North of the project site.

Appendix C.

Computations

Hydrology

MEMORANDUM CH2M HILL

TO: Michael Lopez/FCDMC

COPIES: Steve Walker/PHX
Sandy Story/FCDMC
Peter Binney/DEN
Roger Lindquist/CVO
John Livingston/RDD
Henry Allen/PHX

FROM: Jon Fuller/PHX

DATE: January 26, 1994

SUBJECT: Casandro Wash Hydrology

PROJECT: SWW35441

Introduction

This memorandum describes HEC-1 hydrologic modeling of Cassandro Wash performed for the design of a proposed detention dam on Cassandro Wash near Wickenburg, Arizona. The 100-year discharge was estimated using procedures outlined in the Flood Control District of Maricopa County (FCDMC) Manual *"Drainage Design Manual for Maricopa County, Arizona, Volume I Hydrology"* (1992). Preliminary design criteria for the detention basin require that the 100-year event be detained below the spillway elevation and that maximum outflow be less than or equal to the capacity of the proposed storm drain to be constructed downstream of the dam. Preliminary design of the storm drain is described in the FCDMC Report *"Casandro Wash Outfall for Casandro Wash Dam"* (1993). Design of the storm drain is not part of this project, and is not discussed further in this memorandum.

Hydrology

Hydrologic modeling was completed using the HEC-1 computer model. Hydrologic data for the Casandro Wash watershed was directly obtained or was modified from the Wickenberg Area Drainage Master Study (ADMS), except as described below. Future watershed conditions, at 100 percent build-out of existing zoning, was assumed given the long design life of the detention dam and recent, rapid development in the Wickenberg area.

Rainfall. Rainfall was estimated for the 6-hour local storm (drainage areas less than 100 square miles). Rainfall depths were determined using the PREFRE program provided with the FCDMC Hydrology Manual. Rainfall depths were input into the HEC-1 model after adjustment for aerial reduction using Table 2.2 (p. 220 of the FCDMC Manual). A depth

area reduction factor of 0.985 was used. The adjusted rainfall six hour rainfall depths for Cassandro Wash are:

- P_2 = 1.39 inch,
- P_{10} = 2.20 inches.
- P_{100} = 3.35 inches.

FCDMC design storm pattern number 1.5 was used as shown on Figure 2.17 and interpolated from Table 2.3 of the FCDMC manual.

Rainfall Losses. Rainfall losses were determined using FCDMC Manual Tables and Green-Ampt soil loss parameters. Surface retention was estimated at 0.10. This estimate was based on a theoretical maximum for the area for natural conditions, hill slopes and desert of 0.15 inch and a theoretical minimum for paved urban areas of 0.05 inch. Development of the area typically has been residential and commercial with residential development of up to four residents per acre. The surface retention or initial abstraction of 0.10 represents a future conditions basin average.

Green-Ampt parameters were based on soil characteristics described in the Aguila-Carefree Soil Conservation Service (SCS) Soil Survey Report. Soil units in the watershed included clay loams, sandy clay loams and sandy loams. Soil unit coverages were aerially-weighted using equations and methodologies described in the FCDMC manual. Percent imperviousness for the watershed was estimated based on full build out under existing zoning for the Town of Wickenberg. For areas within unincorporated Maricopa County without ordinanced zoning, the zoning for the City of Wickenberg nearest the Maricopa County portion of the watershed was used. Future condition percent imperviousness averaged about 35% for the entire watershed.

Unit Hydrograph. Clark unit hydrograph procedures were used to develop runoff peaks and volumes. Time of concentration equation #5.5, for desert and mountain areas, in the FCDMC manual was used. Basin area was planimetered on USGS topographic mapping. Watershed length was similarly measured on USGS topographic mapping. The basin factor Kb for the time of concentration equation was determined by aerially weighting between the categories of commercial, residential areas, Type A and desert range lands, type B using Figure 5.5 of the FCDMC manual. Measured watercourse slopes were adjusted, as required, using Figure 5.4 of the FCDMC manual. Unit hydrograph parameters input into HEC1 were determined using the software program MCUHP1 provided with the FCDMC Manual.

Channel Routing. Channel routing parameters were based on typical average cross section from the dam to an upstream confluence of the two subwatersheds. Only one routing reach was needed for the watershed, upstream of the proposed dam site. Modified

Puls storage routing techniques were used, according to guidelines given in the FCDMC Manual.

Reservoir Routing. Preliminary reservoir routing was computed using elevation-storage information estimated by planimetering 2-foot contour interval mapping provided by the FCDMC and the preliminary dam alignment provided by CH2M HILL. Reservoir outflow was assumed to be zero to determine maximum storage requirements upstream of the dam. Storage requirements for sedimentation, volume adjustments for slope stabilization, basin and site grading, as well as final dam alignments will be modeled later in the design process. The objective of preliminary reservoir routing was to estimate total storm volumes.

Modeling Results

Peak discharge estimates for the Casandro Wash detention dam project are shown in Table 1. The 100-year design peaks was estimated at 1,769 cfs with a total volume of 156 acre feet. The two, ten and fifty year discharge estimates are 506 cfs, 1,028 cfs, and 1,544 cfs, respectively, with volumes of 43, 86 and 129 acre feet. The calculation of synthetic skew for the two, ten and one-hundred using procedures outlined in bulletin 17B of the Water Resource Council indicate the synthetic skew is -0.11, well within the regional skew of -0.1 computed by the Water Resource Council in Bulletin 17B. Computation sheets and sample output from HEC-1 100-year modeling is attached.

Table 1.
Casandro Wash Detention Dam, Hydrology.

Recurrence Interval	Peak (cfs)	Volume (Acre-feet)
100	1,769	156
50	1,544	129
2	506	43

SUBJECT CASANDIZO WASH

BY JEF DATE 1/16

SHEET NO. 1 OF

PROJECT NO. SWW35441.HY.10

Objective:

To estimate design peak & volume for detention basin and spillway design. (Q_{100})

Methodology

Use procedures outlined in "FCDMC, 1992 "Drainage Design Manual for Maricopa County, Arizona Volume I: Hydrology"

Procedures

A. RAINFALL

(1) DESIGN STORM - Table 2.1, p. 2-3

USE 6-HR LOCAL STORM (D.A 0-100 mi²)

(2) RAINFALL DEPTH - 6HR

$P_2 = 1.41$

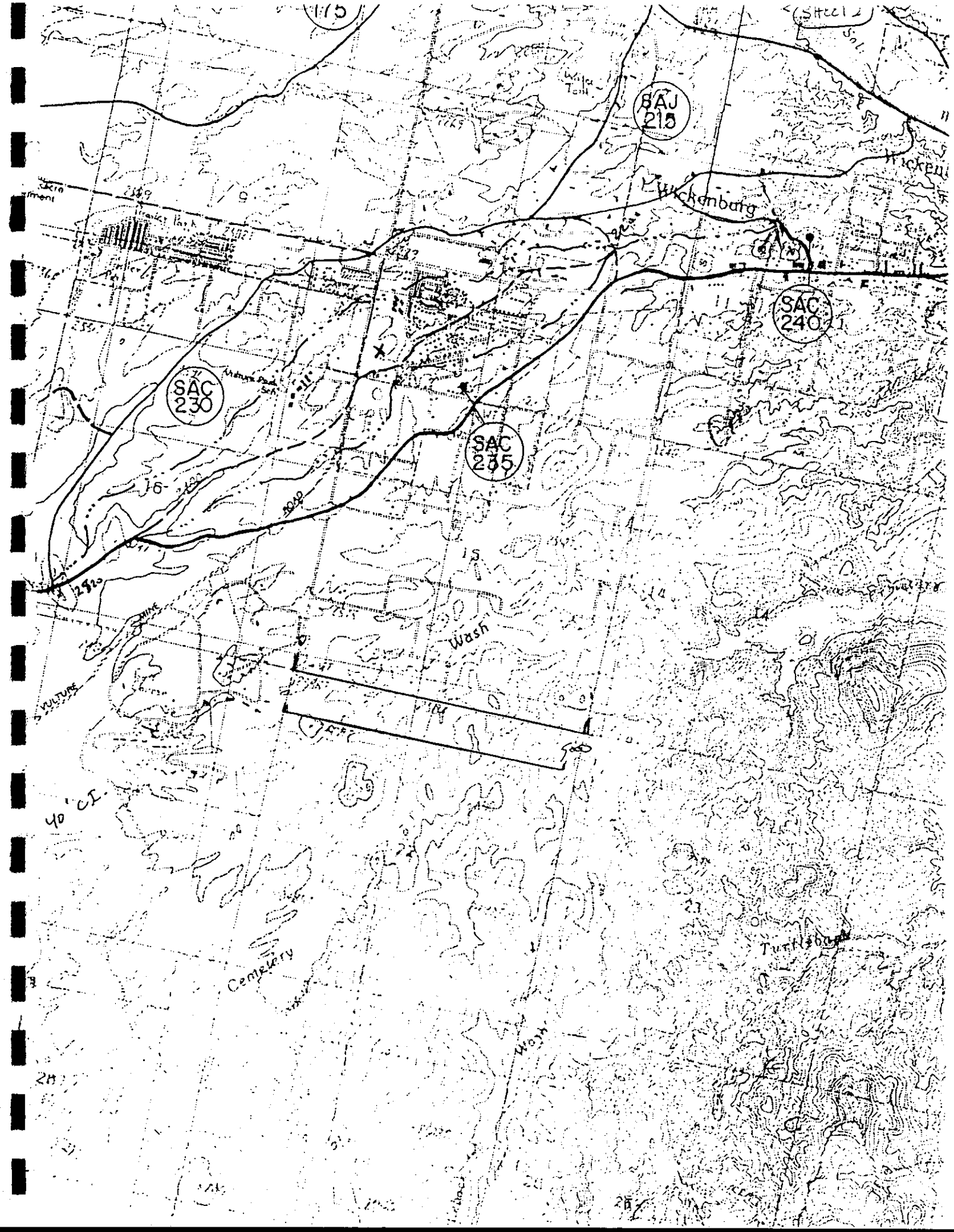
$P_{10} = 2.23$

$P_{100} = 3.40$

} CORRECTED

R.I	6HR		24-HR
2	1.41	RRAD FROM MAP	1.65
5	1.87		2.28
10	2.22		2.69
25	2.67		3.33
50	3.05		3.77
100	3.36		4.18

FORM 38


SAJ 215
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SAC 240
SAC 230
SAC 235
Wash
Cemetery
Wash
Turtleback

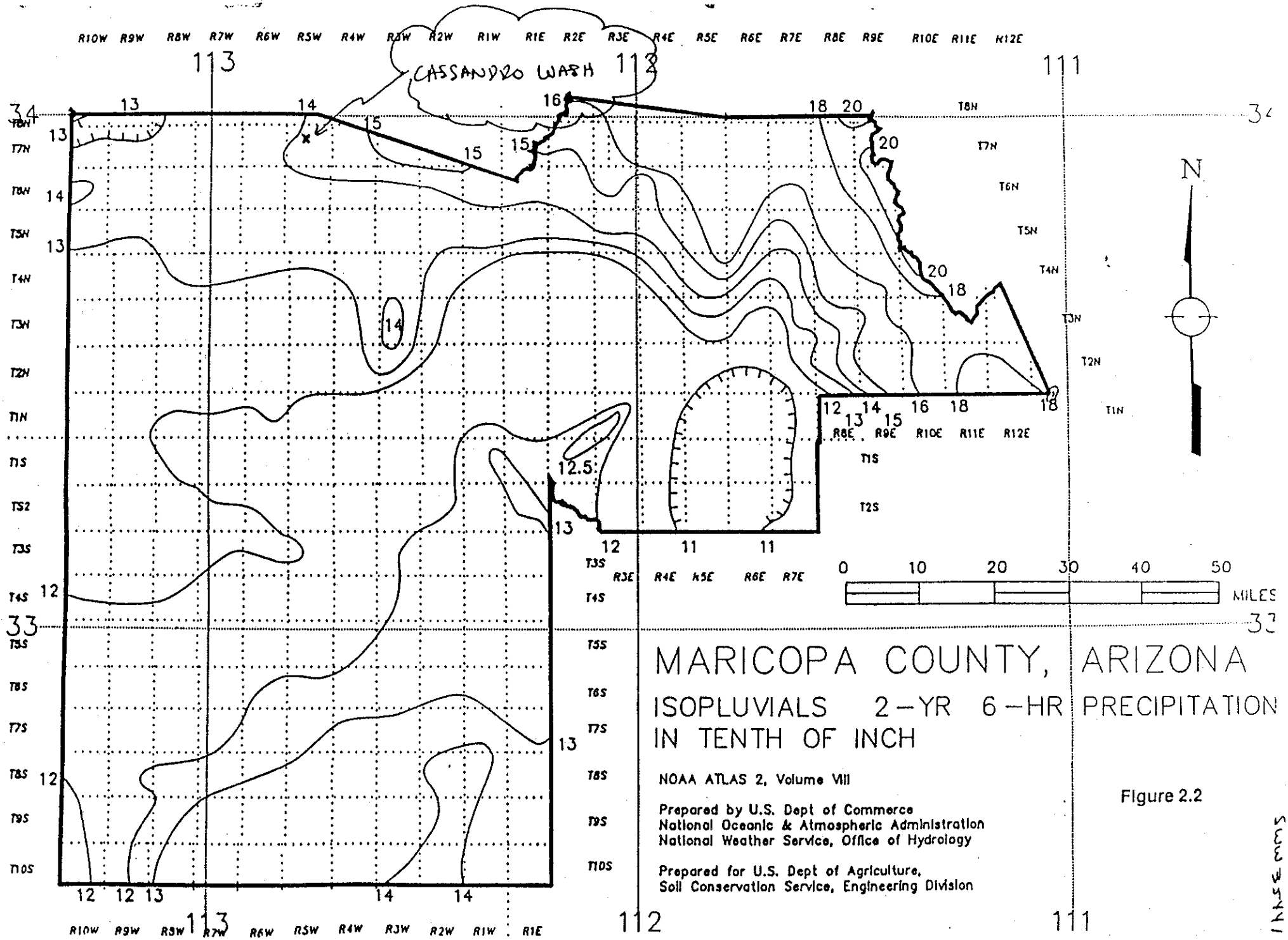
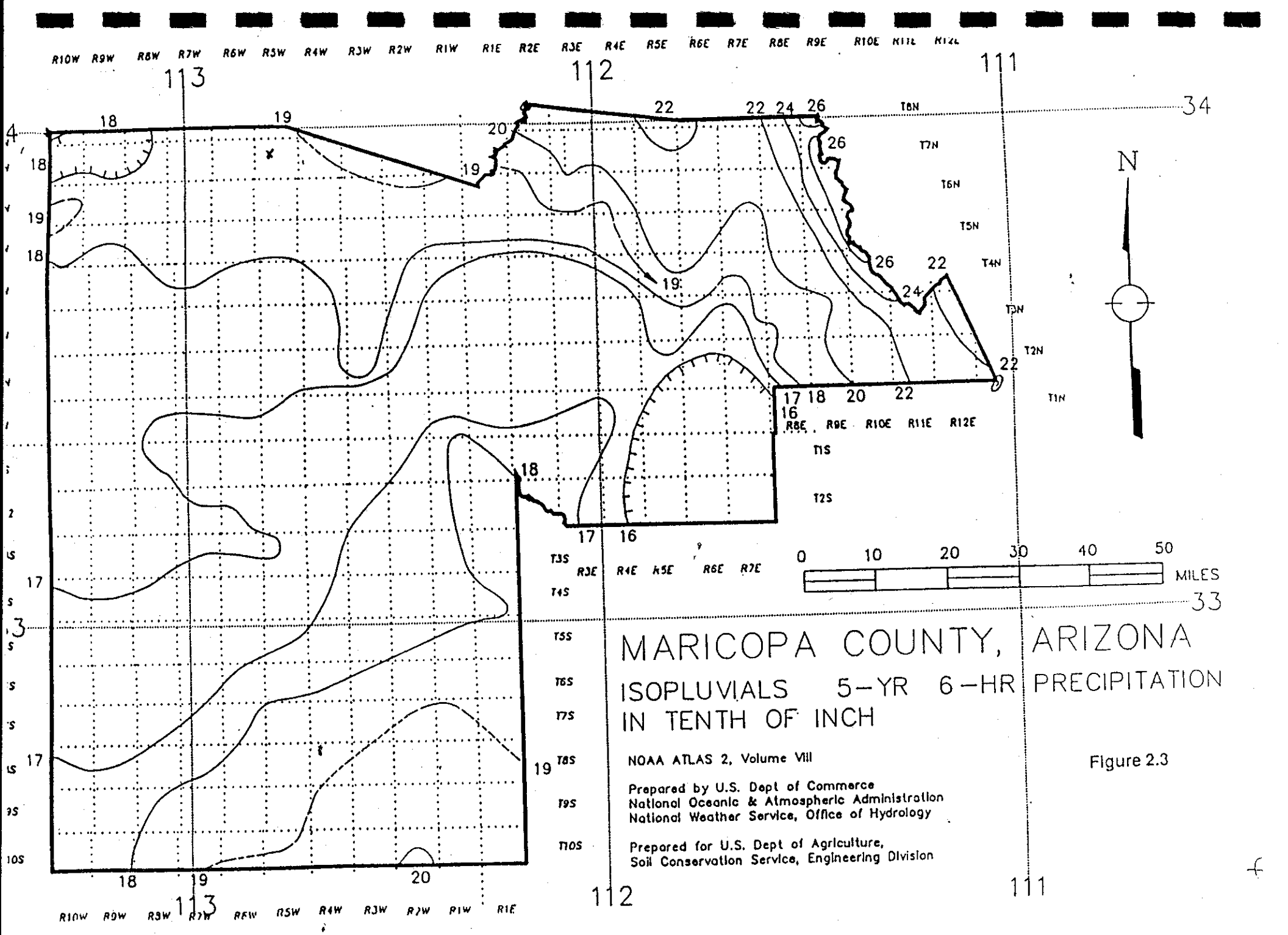


Figure 2.2

SHEET 3 - SUMMARY


MARICOPA COUNTY, ARIZONA
ISOPLUVIALS 5-YR 6-HR PRECIPITATION
IN TENTH OF INCH
NOAA ATLAS 2, Volume VIII
Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division
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T8N T7N T6N T5N T4N T3N T2N T1N T1S T2S T3S T4S T5S T6S T7S T8S T9S T10S
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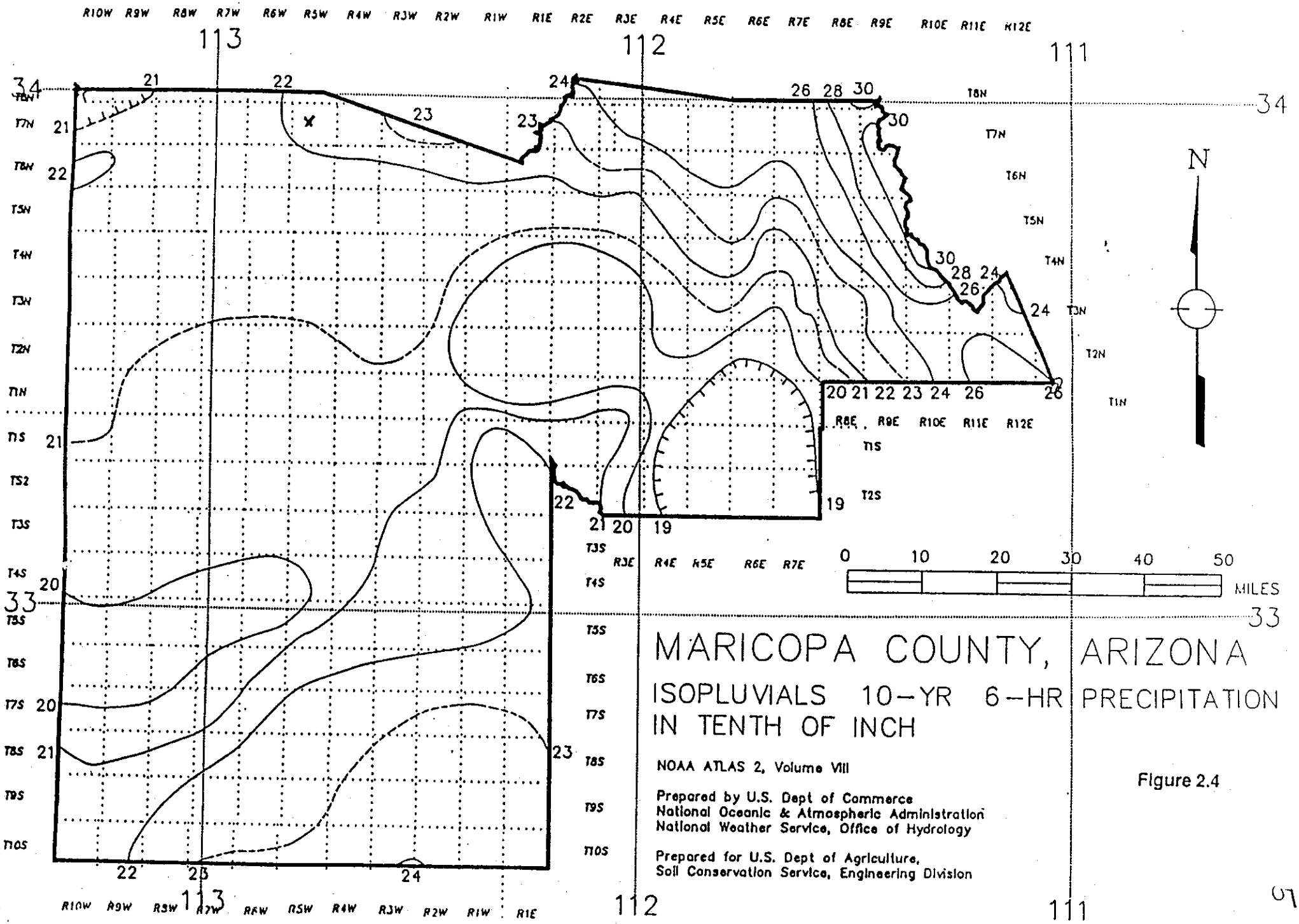
Figure 2.3



MARICOPA COUNTY, ARIZONA

ISOPLUVIALS 10-YR 6-HR PRECIPITATION IN TENTH OF INCH

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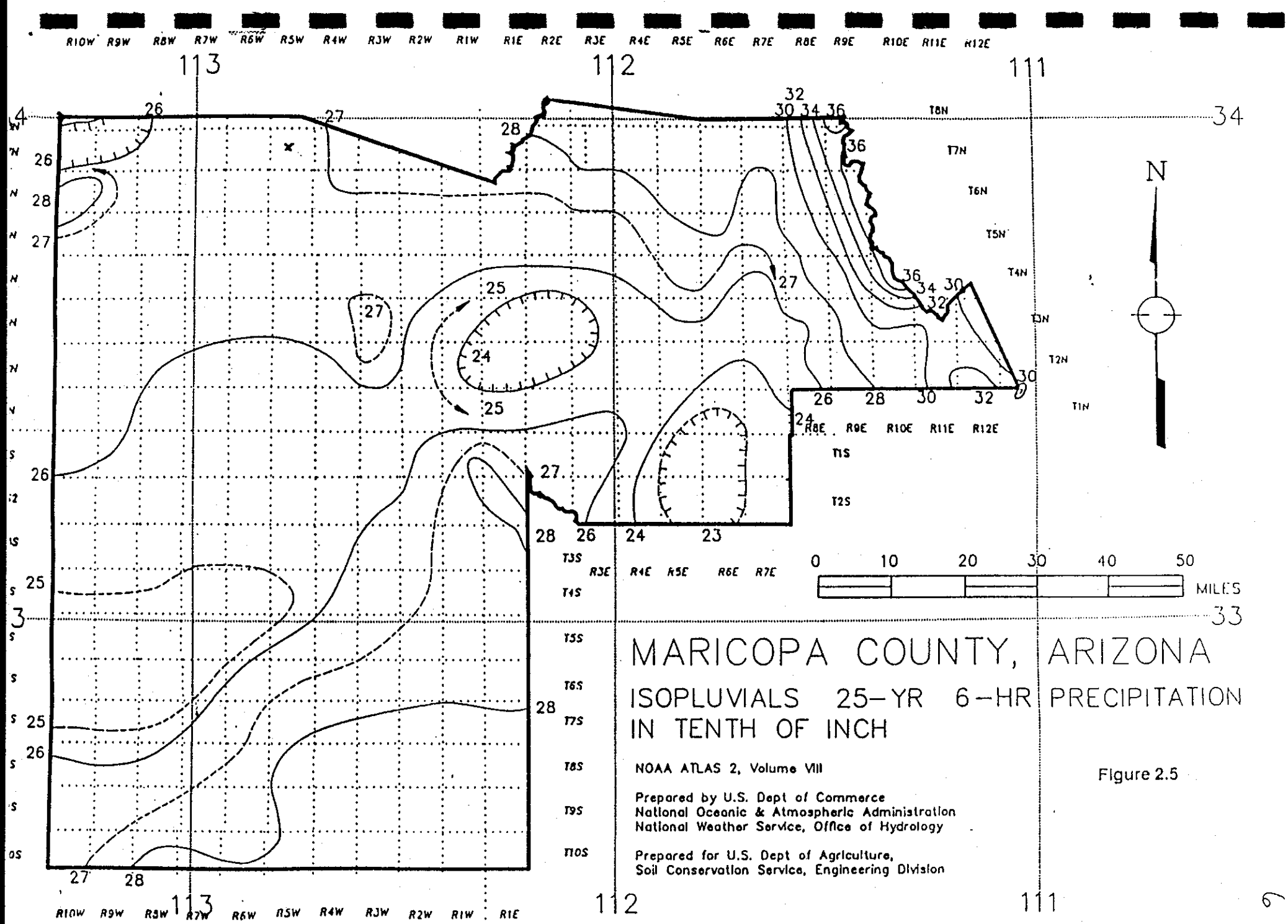
Figure 2.4



MARICOPA COUNTY, ARIZONA

ISOPLUVIALS 25-YR 6-HR PRECIPITATION IN TENTH OF INCH

NOAA ATLAS 2, Volume VIII

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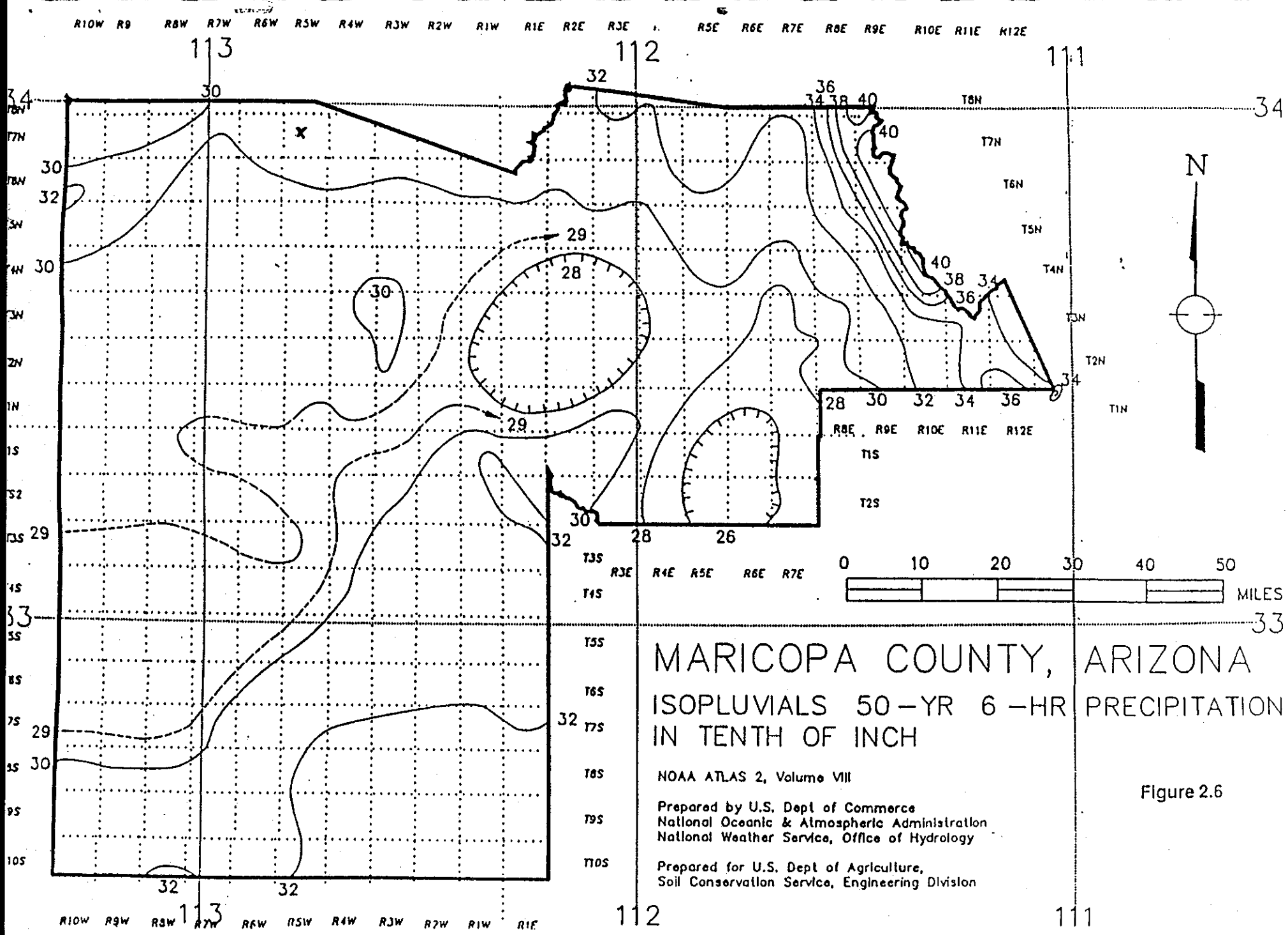
Figure 2.5


MARICOPA COUNTY, ARIZONA
ISOPLUVIALS 50-YR 6-HR PRECIPITATION
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R3E R4E R5E R6E R7E
T8N T7N T6N T5N T4N T3N T2N T1N
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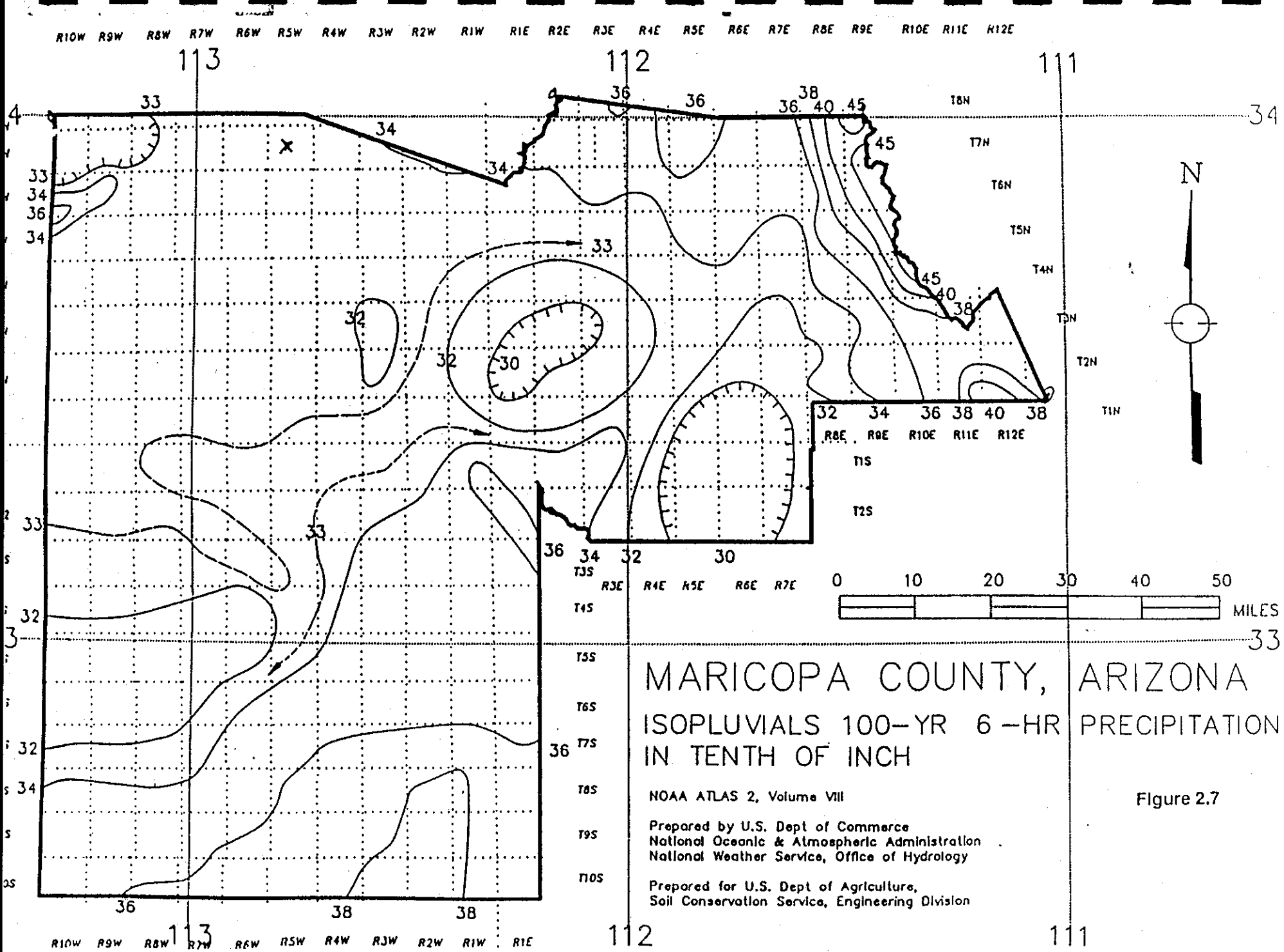
Figure 2.6



MARICOPA COUNTY, ARIZONA

ISOPLUVIALS 100-YR 6-HR PRECIPITATION IN TENTH OF INCH

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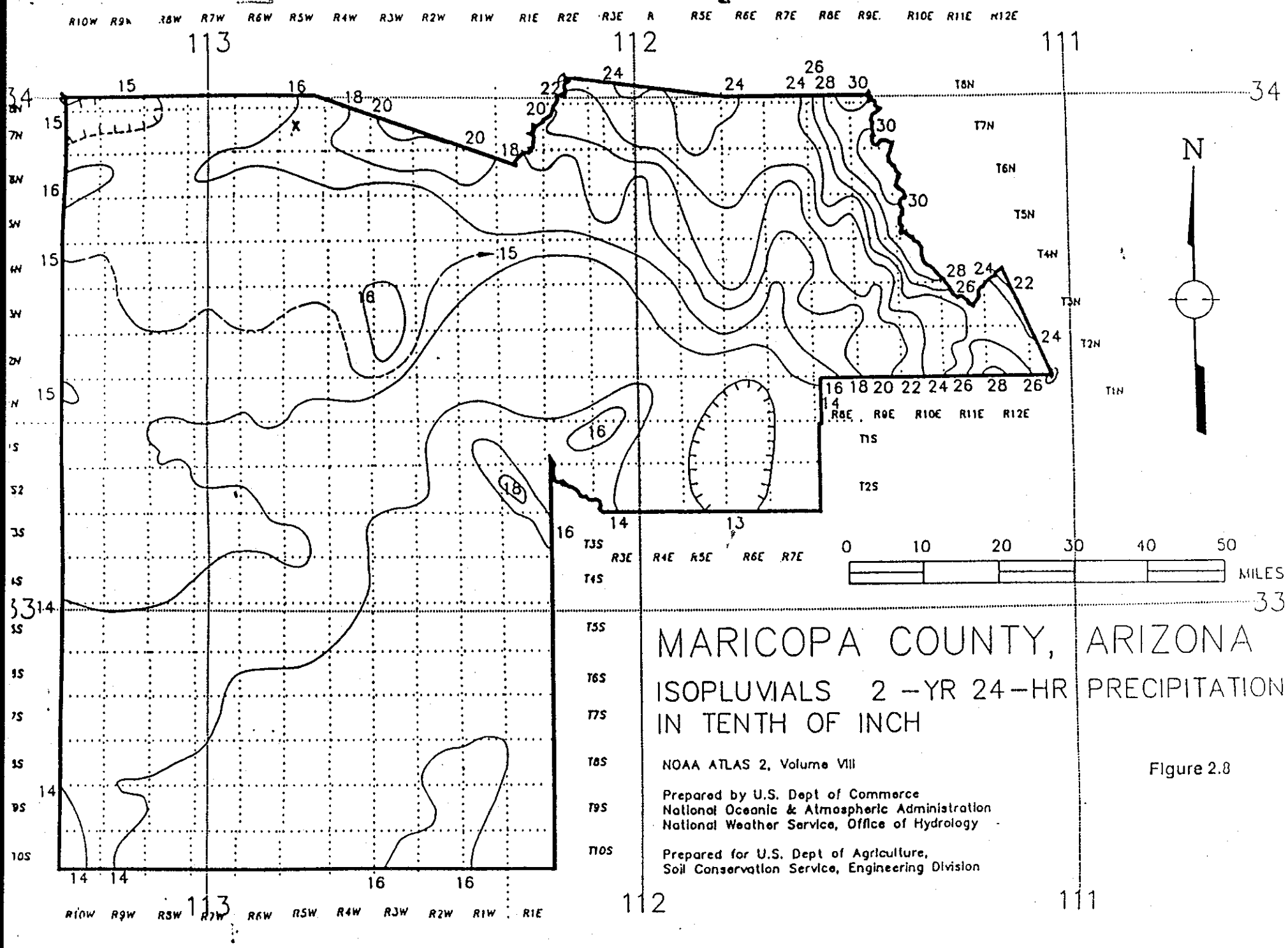
Figure 2.7


MARICOPA COUNTY, ARIZONA
ISOPLUVIALS 2 -YR 24-HR PRECIPITATION
IN TENTH OF INCH
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Prepared for U.S. Dept of Agriculture,
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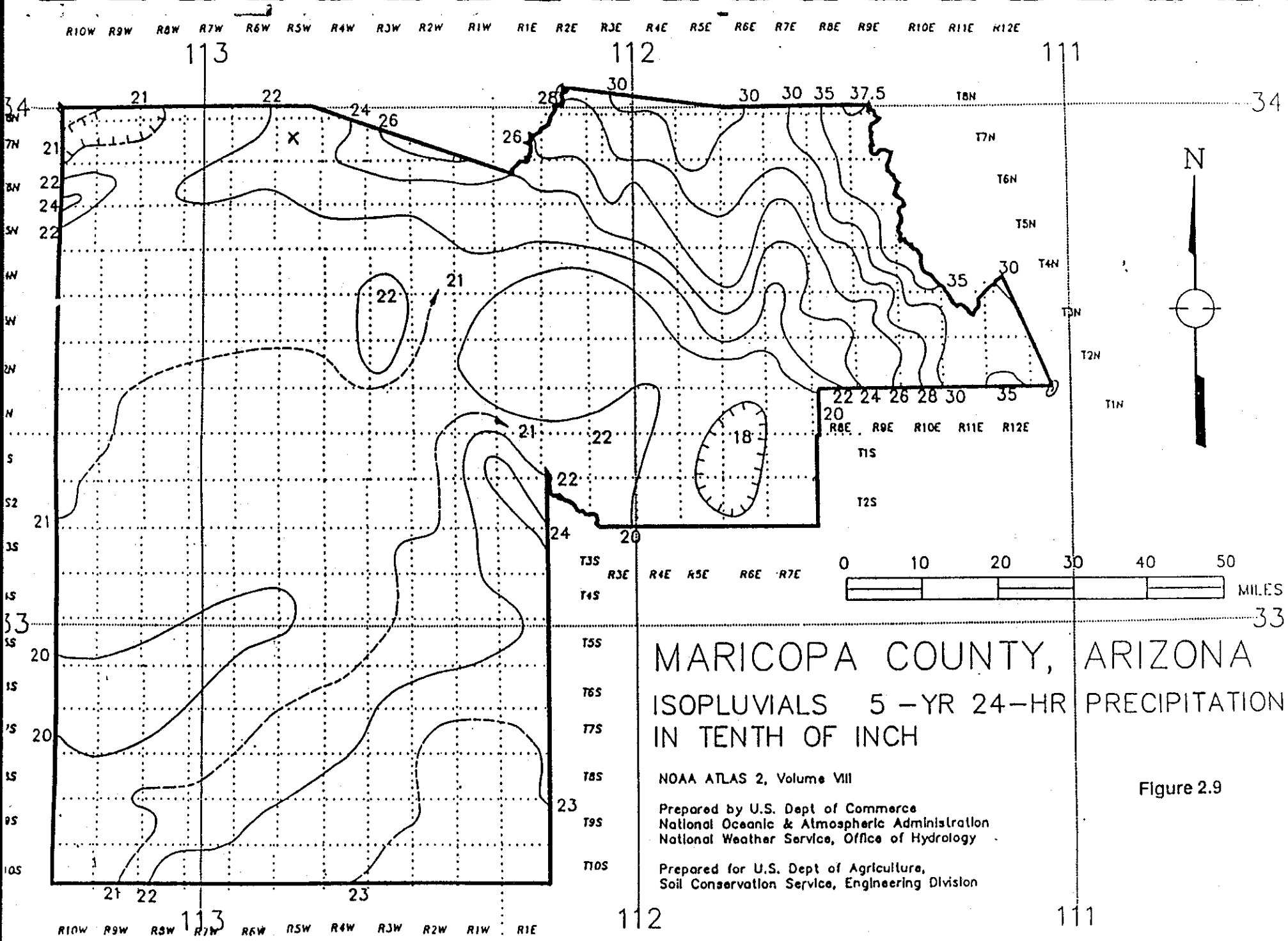
Figure 2.8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ISOPLUVIALS 5 -YR 24-HR PRECIPITATION
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Figure 2.9

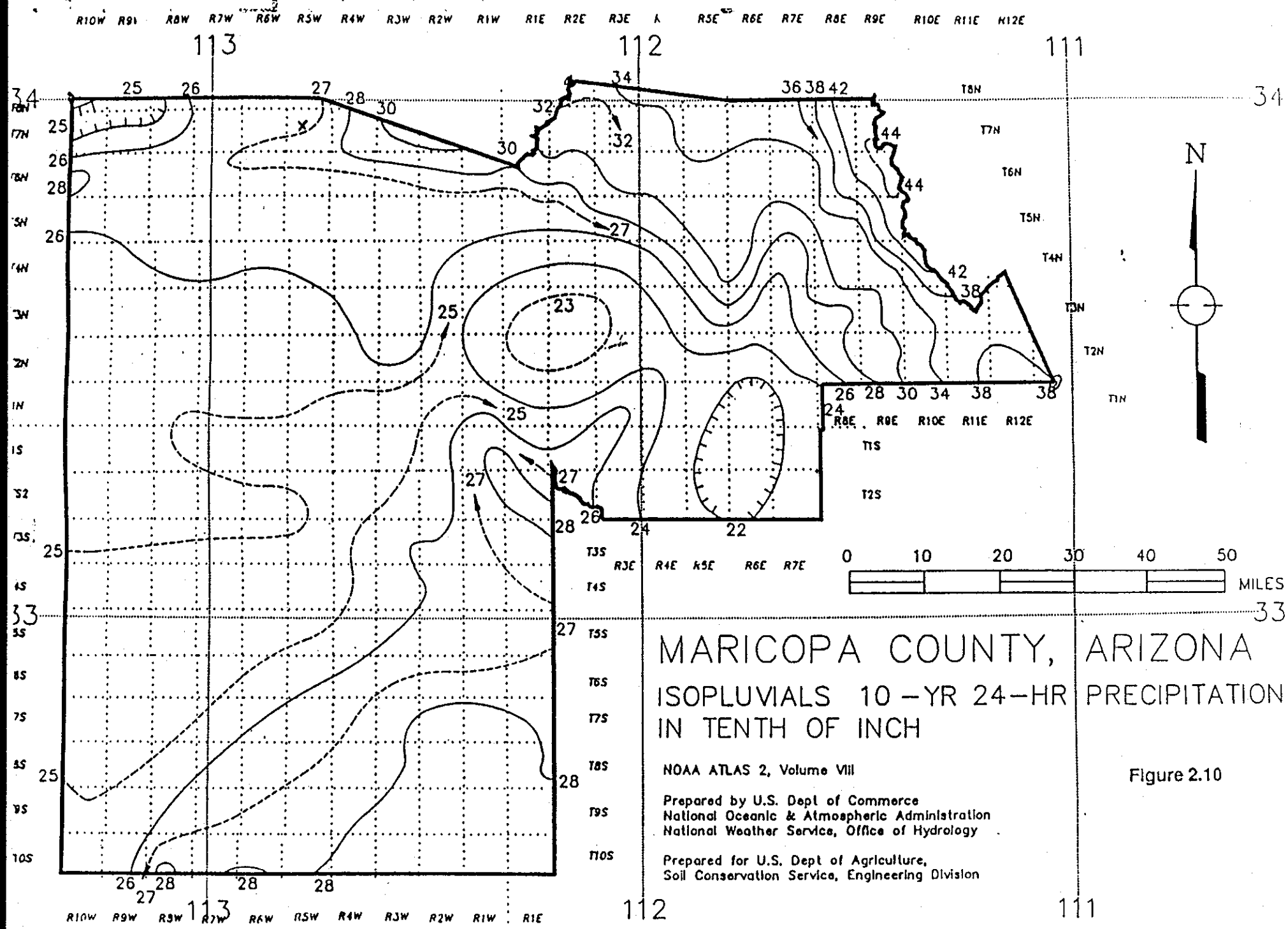
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Figure 2.10

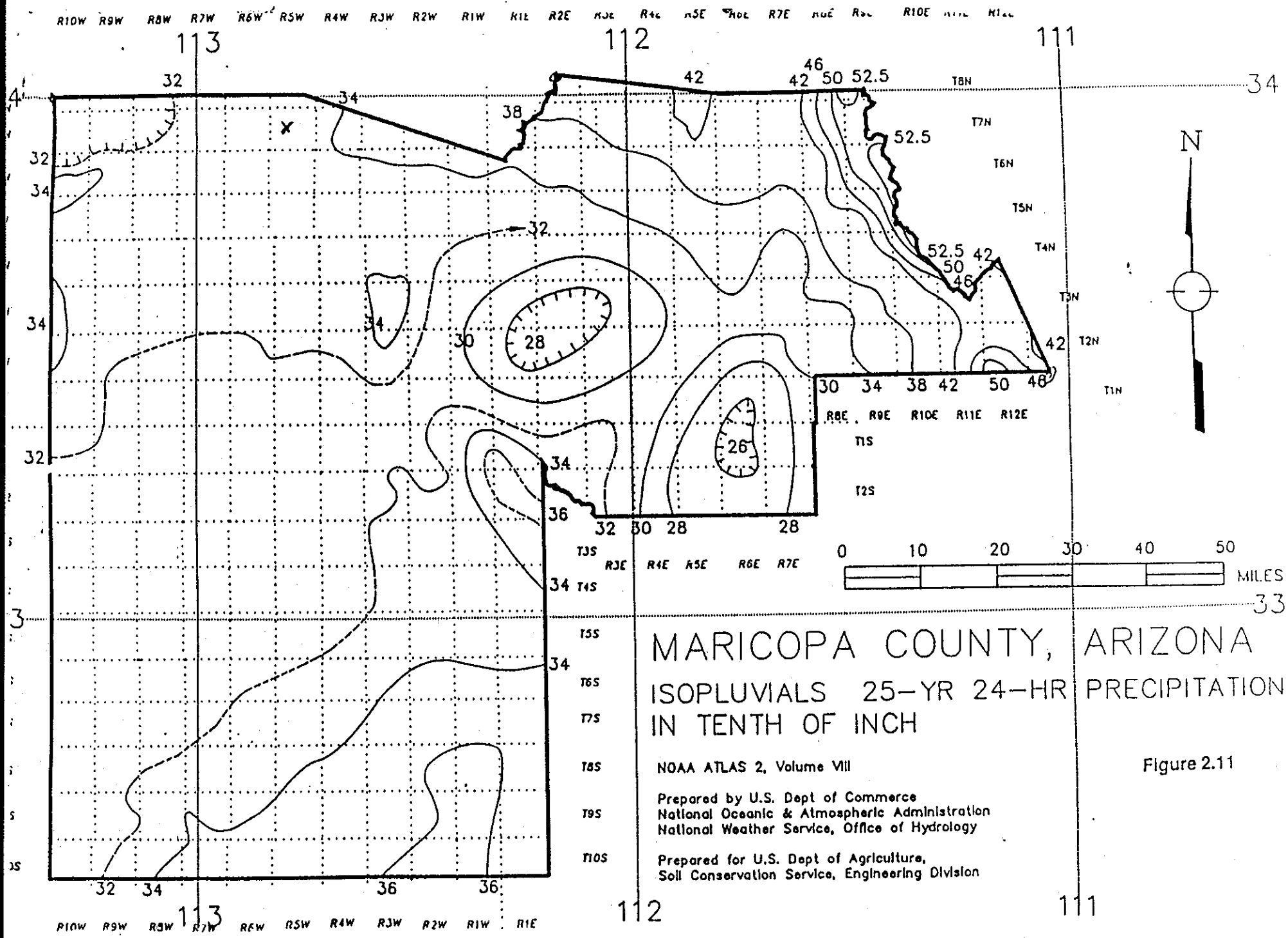
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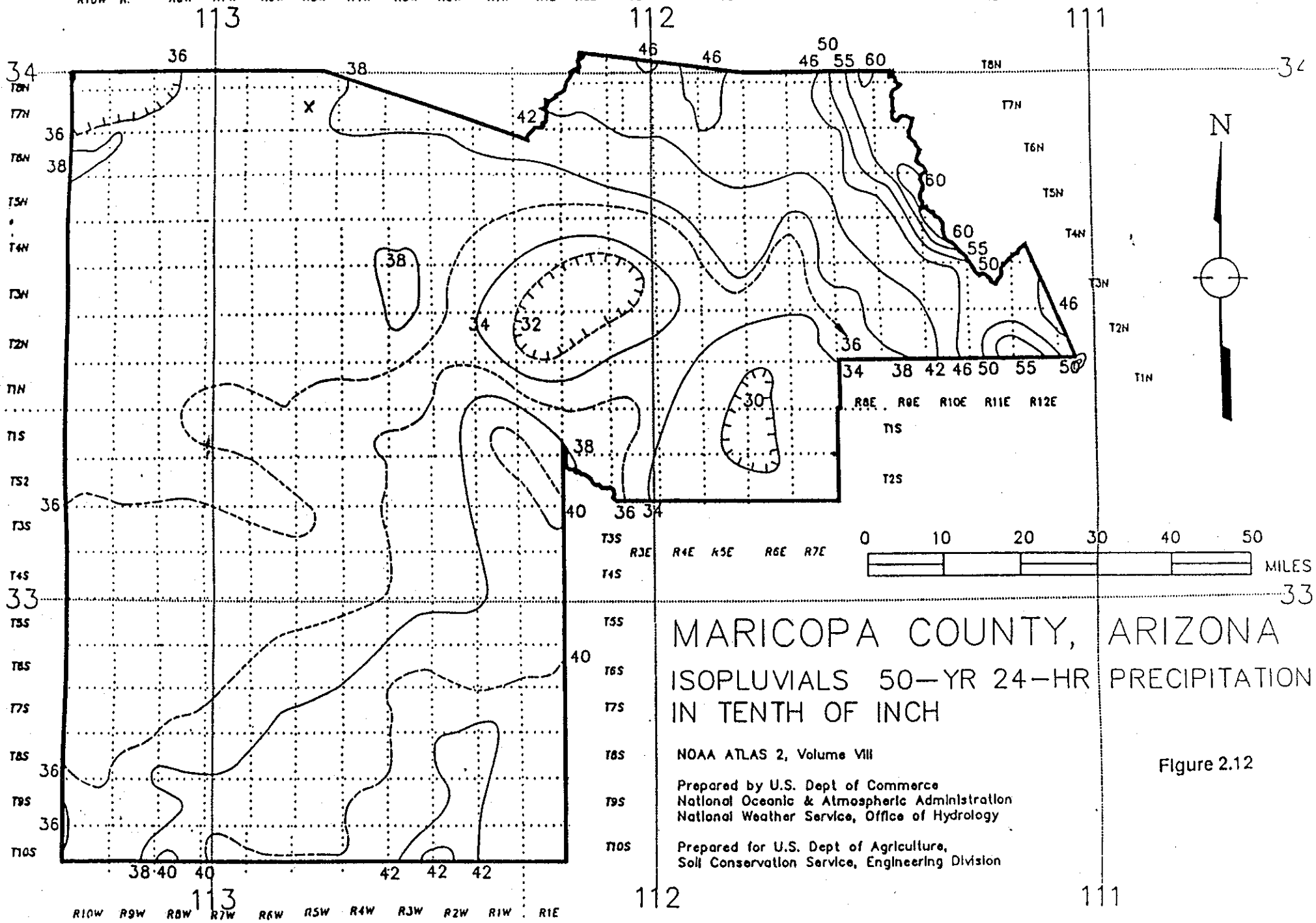
Figure 2.11


MARICOPA COUNTY, ARIZONA
ISOPLUVIALS 50—YR 24—HR PRECIPITATION
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Soil Conservation Service, Engineering Division
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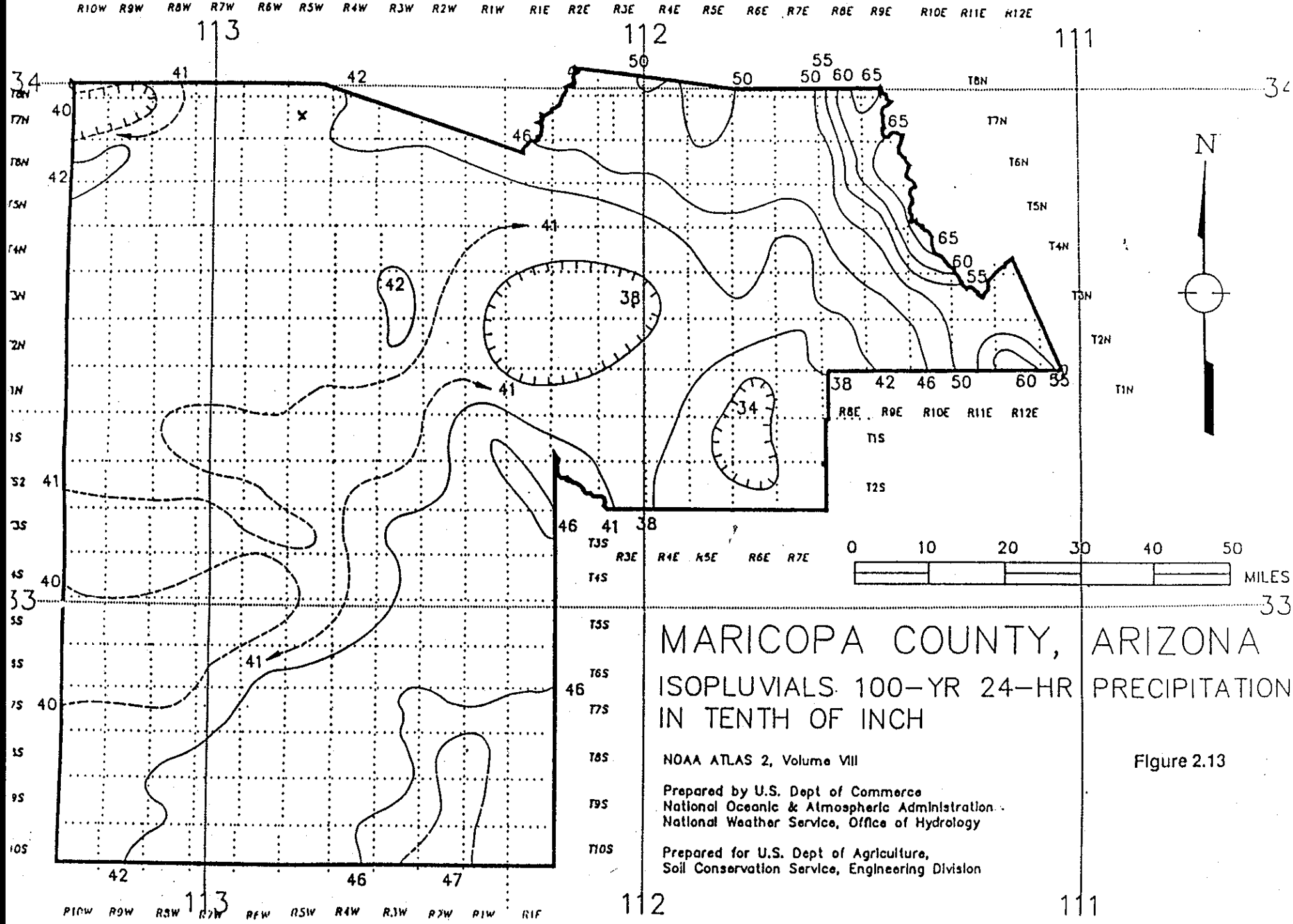
Figure 2.12



MARICOPA COUNTY, ARIZONA

ISOPLUVIALS 100-YR 24-HR PRECIPITATION IN TENTH OF INCH

NOAA ATLAS 2, Volume VIII

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Prepared for U.S. Dept of Agriculture,
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Figure 2.13

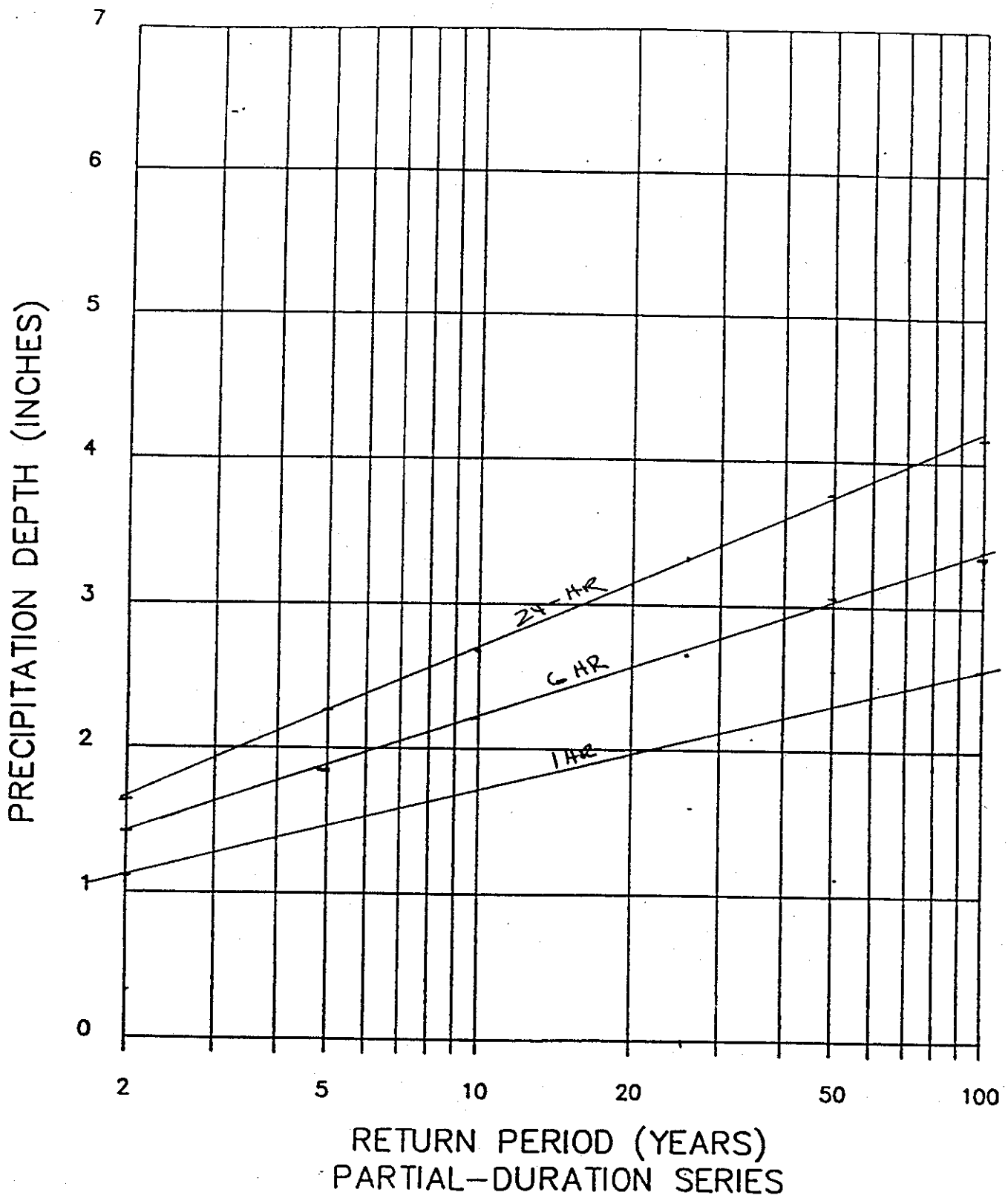


Figure 2.14
Precipitation Depth versus Return Period for Partial-Duration Series

(3) DEPTH-AREA REDUCTION - Table 2.2 p. 2-20

D.A. = 1.24

→ DARF = .985 — SEE MCUHP1 OUTPUT

ADJUSTED RAINFALL DEPTHS - CAR

P_2 = 1.39

P_{10} = 2.20

P_{100} = 3.35

(4) DESIGN STORM

PATTERN 1.53 ⇝ 1.5

Use: Figure 2.17 p 2.26

Table 2.3 p 2.25

CHECKED CALCULATIONS USING DISTRICTS' PEEFRE.EXE PROGRAM

Sheet 17

Table 2.2
Depth-Area Reduction Factors
for 6-Hour Duration Rainfall

Area, Square Miles	Ratio to Point of Rainfall
0	1.0
1	0.987
5	0.96
10	0.94
20	0.91
30	0.89
40	0.87
50	0.86
100	0.80
200	0.72
300	0.66
400	0.61
500	0.57

Use the depth-area reduction values from Figure 2.14 or Table 2.2 to correct the 6-hour point rainfall depth from the isopluvial maps (Figures 2.2 through 2.7) for all flood studies in which the 6-hour local storm is the design rainfall criteria (see Table 2.1).

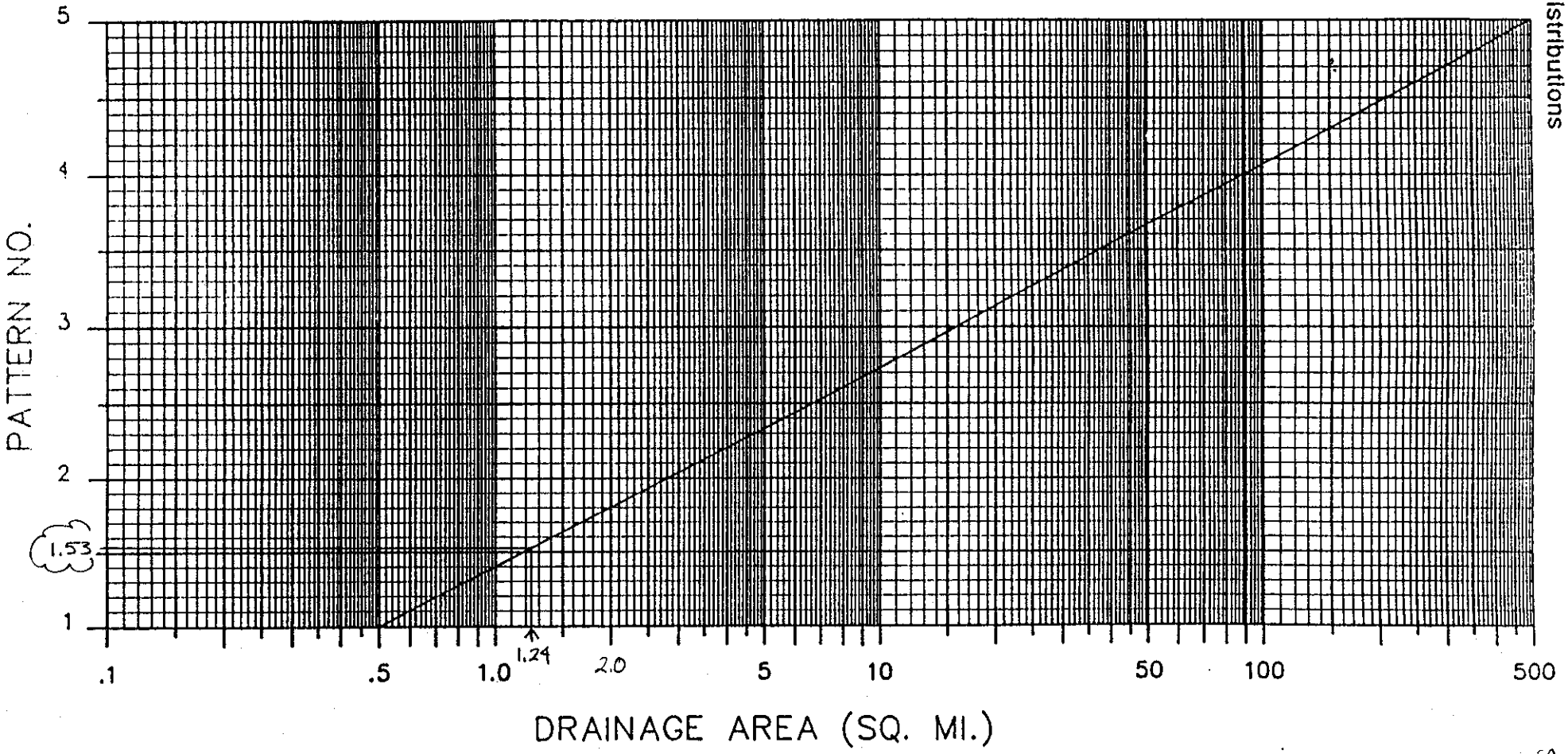
If the flood study is for the design of a retention/detention facility for a small drainage area and the design rainfall criteria is the 100-year, 2-hour storm, then the point rainfall depths from Figure 2.1 are not to be reduced for area. This is because local retention/detention basins will be provided only for very small drainage areas and the point rainfall from Figure 2.1 is representative of the equivalent uniform depth of rainfall over the entire contributing area.

If a general storm is the accepted design rainfall criteria (as opposed to the 6-hour local storm as defined in this manual), then the appropriate depth-area reduction curve will need to be defined to correspond with the rainfall duration and the temporal distribution of the general storm. This will need to be performed on a case-by-case basis depending on the purpose of the study, location of the watershed, and other meteorological and hydrological factors.

2.3.1 Procedure for Depth-Area Adjustment

The following procedure is to be used with the 6-hour local storm rainfall depths (Figures 2.2 through 2.7):

1. Determine the size of the drainage area.



use 1.5

Sheet 18

Figure 2.17
Area Versus Pattern Number for Maricopa County

Sheet 19

interpolated values

(round to 1 decimal place)

Table 2.4
6-Hour Distributions*

Time (hrs)	Pattern 1	Pattern 2		Pattern 3	Pattern 4	Pattern 5
0:00	0.0	0.0	0.0	0.0	0.0	0.0
0:15	0.8	0.9	0.9	1.5	2.1	2.4
0:30	1.6	1.6	1.6	2.0	3.5	4.3
0:45	2.5	2.5	2.5	3.0	5.1	5.9
1:00	3.3	3.4	3.4	4.8	7.1	7.8
1:15	4.1	4.2	4.2	6.3	8.7	9.8
1:30	5.0	5.1	5.1	7.6	10.5	11.9
1:45	5.8	5.9	5.9	9.0	12.5	14.1
2:00	6.6	6.7	6.7	10.5	14.3	16.2
2:15	7.4	7.5	7.6	11.9	16.0	18.6
2:30	8.7	8.7	8.7	13.5	17.9	21.2
2:45	9.9	10.0	10.0	15.2	20.1	23.9
3:00	11.8	11.9	12.0	17.5	23.2	27.1
3:15	13.8	15.1	16.3	22.2	28.1	32.1
3:30	21.6	23.5	25.2	30.4	36.4	40.8
3:45	37.7	41.6	45.1	47.2	50.0	51.5
4:00	83.4	76.0	69.4	67.0	65.8	62.7
4:15	91.1	87.2	83.7	79.6	77.3	73.5
4:30	93.1	91.5	90.0	86.8	84.1	81.4
4:45	95.0	94.4	93.8	91.2	88.8	86.4
5:00	96.2	95.6	95.0	94.6	92.7	90.7
5:15	97.2	96.7	96.3	96.0	94.5	93.0
5:30	98.3	97.9	97.5	97.3	96.4	95.4
5:45	99.1	98.9	98.8	98.7	98.2	97.7
6:00	100.0	100.0	100.0	100.0	100.0	100.0

*Pattern represents percent Rainfall Depth.

8. RAINFALL LOSSES

1. SURFACE RETENTION

Table 4.1 p 4-5

DESERT LANDSCAPE = 0.10

NATURAL CONDITIONS – Hillslope, Sonoran desert = 0.15" ← theoretical maximum

Development has been residential & commercial
↳ up to 4 RAC ↳ on corridors

Landscaping is mixture of desert, lawn/turf, and pavement
Pavement is theoretical minimum value = 0.05"

Assume IA = 0.10 as future average

2. GREEN-AMPT PARAMETERS

USE AGUILA-CARRERE SCS SOILS SURVEY RPT

a) Soil Units in Watershed

38 - Clay loam
73 - Sandy Clay loam
94 - Sandy loam

} See Regional Map

b) Subbasin distribution

D.A.	38 %	73 %	94 %	TOTAL	
SAC 230	163.2 (36)	28.5 (6)	260.5 (58)	452.2	0.71 mi²
SAC 235	159.4 (63)	56.0 (22)	36.5 (14)	251.9	0.39 mi²
SAC 240	89.6 (100)			89.6	0.14 mi

c) Areal Average of Green-Ampt Parameters

$$\overline{XKSAT} = \text{anti log}\left(\frac{\sum A_i \log XKSAT_i}{A_T}\right)$$

→ Appendix A

UNIT	Log ~~XKSAT~~	XKSAT	Log XKSAT
38	~~-1.398~~	0.13	-0.8861
73	~~-1.222~~	0.09	-1.0458
94	~~-0.398~~	.33	-0.4815
		0 ~~.04~~	~~-1.3979~~

↳ value wrong in FCD manual

O.A.	$\overline{XKSAT}$	PSIF	DTHETA (normal)
SAC 230	~~0.067~~ ~~0.15~~ .218	~~5.6~~ 5.2	.25
SAC 235	~~0.101~~ ~~0.06~~ .139	~~8.6~~ 6.2	~~.15~~ .23
CAS 240	~~0.04~~ .130	~~9.6~~ 6.4	~~.15~~ .21

(fig. 4-3, p 4-11

d) Vegetative Adjustment to $\overline{XKSAT}$ (fig 4-4, p 4-14)

% cover = 20%

SAC 230	~~0.17~~ .242	$\overline{XK} \times 1.11$
SAC 235	~~0.07~~ .154	
CAS 240	~~0.04~~ .144	

$$C_k = \frac{V_c - 10}{90} + 1.0 = 1.11$$

e) Impervious Area Estimate

Future Conditions = 35%

PCFCD Manual for 3 RAC (average)

Sheet 22

4.2 Surface Retention Loss

Surface retention loss, as used herein, is the summation of all rainfall losses other than infiltration. The major component of surface retention loss is depression storage; relatively minor components of surface retention loss are due to interception and evaporation, as previously discussed. Depression storage is considered to occur in two forms. First, in-place depression storage occurs at, and in the near vicinity of, the raindrop impact. The mechanism for this depression storage is the microrelief of the soil and soil cover. The second form of depression storage is the retention of surface runoff that occurs away from the point of raindrop impact in surface depressions such as puddles, roadway gutters and swales, roofs, irrigation bordered fields and lawns, and so forth.

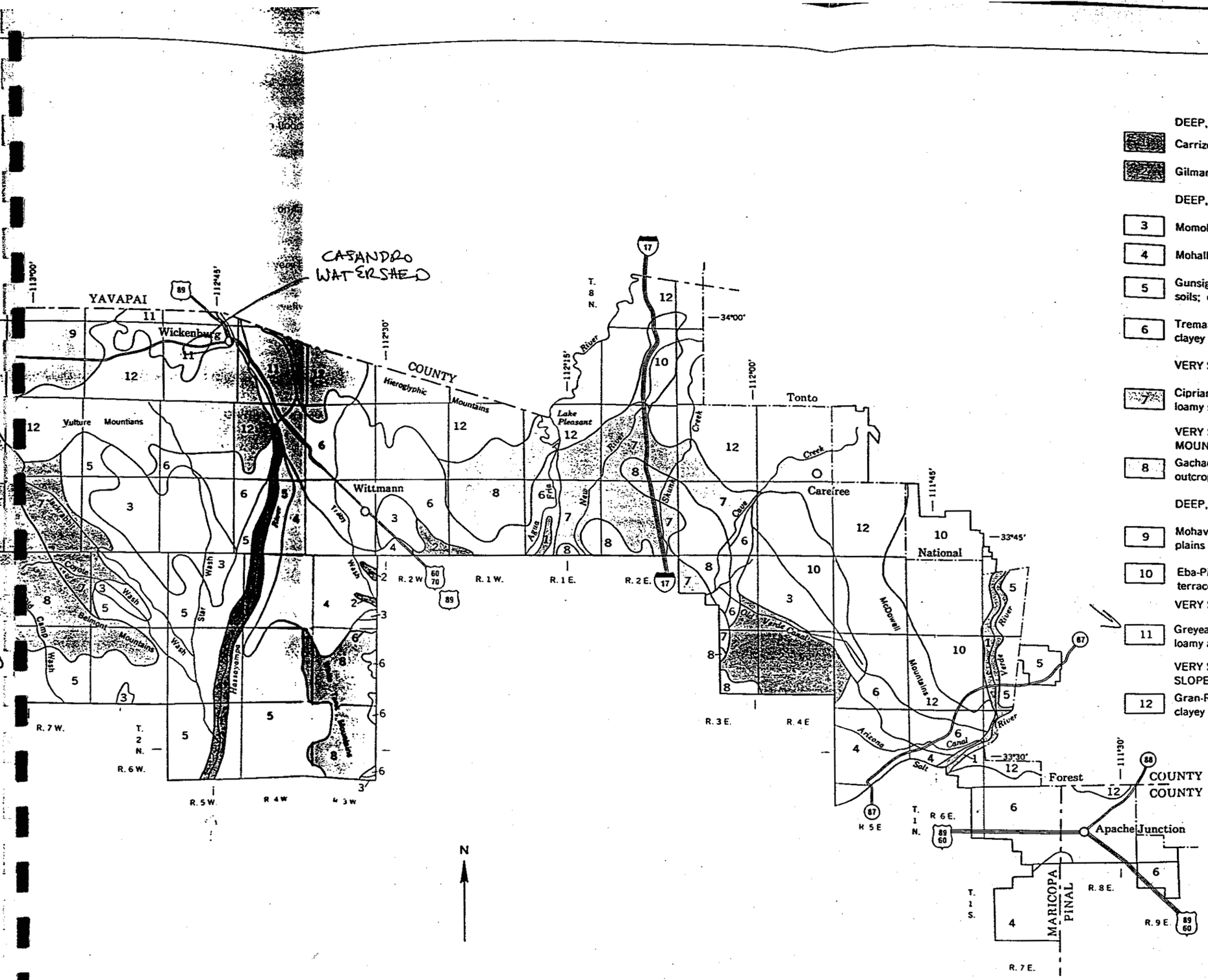
A relatively minor contribution by interception is also considered as a part of the total surface retention loss. Estimates of surface retention loss are difficult to obtain and are a function of the physiography and land-use of the area.

The surface retention loss on impervious surfaces has been estimated to be in the range 0.0625 inch to 0.125 inch by Tholin and Keefer (1960), 0.11 inch for 1 percent slope to 0.06 inch for 2.5 percent slopes by Viessman (1967), and 0.04 inch based on rainfall-runoff data for an urban watershed in Albuquerque by Sabol (1983). Hicks (1944) provides estimates of surface retention losses during intense storms as 0.20 inch for sand, 0.15 inch for loam, and 0.10 inch for clay. Tholin and Keefer (1960) estimated the surface retention loss for turf to be between 0.25 to 0.50 inch. Based on rainfall simulator studies on undeveloped alluvial plains in the Albuquerque area, the surface retention loss was estimated as 0.1 to 0.2 inch (Sabol and others, 1982a). Rainfall simulator studies in New Mexico result in estimates of 0.39 inch for eastern plains rangelands and 0.09 inch for pinon-juniper hillslopes (Sabol and others, 1982b). Surface retention losses for various land-uses and surface cover conditions in Maricopa County have been extrapolated from these reported estimates and these are shown in Table 4.1.

Table 4.1
Surface Retention Loss for Various Land Surfaces in Maricopa County

Land-use and/or Surface Cover (1)	Surface Retention Loss IA, inches (2)	
Natural		
Desert and rangeland, flat slope	0.35	
Hillslopes, Sonoran Desert	0.15	← Theor. max.
Mountain, with vegetated surface	0.25	
Developed (Residential and Commercial)		
Lawn and turf	0.20	
Desert landscape	0.10	← Future
Pavement	0.05	← Theor. min.
Agricultural		
Tilled fields and irrigated pasture	0.50	

SHEET 23



Compiled 1983

LEGEND

DEEP, VERY WARM SOILS; ON FLOOD PLAINS AND ALLUVIAL FANS

Carrizo: Nearly level and gently sloping, occasionally flooded, very gravelly, sandy soils; on flood p

Gilman: Nearly level, rarely flooded, loamy soils; on flood plains and alluvial fans

DEEP, VERY WARM SOILS; ON FAN TERRACES

3 Momoli-Carrizo-Denure: Nearly level, nongravelly to very gravelly, loamy and sandy soils; on fan

4 Mohall-Contine: Nearly level and gently sloping, loamy and clayey soils; on fan terraces

5 Gunsight-Rillito-Chuckawalla: Dominantly gently sloping to moderately steep, gravelly and very gra soils; on fan terraces

6 Tremant-Ebon-Pinamt: Dominantly gently sloping to moderately steep, gravelly and very gravelly, l clayey soils; on fan terraces

VERY SHALLOW, SHALLOW, AND DEEP, VERY WARM SOILS; ON FAN TERRACES

Cipriano-Suncity-Carefree: Nearly level and gently sloping, cobbly and nongravelly to very gravelly, loamy soils; on fan terraces

VERY SHALLOW AND SHALLOW, VERY WARM SOILS, AND ROCK OUTCROP; ON HILL SLOPES MOUNTAIN SLOPES

8 Gachado-Rock outcrop-Quilotosa: Dominantly strongly sloping to steep, very gravelly, loamy soils, a outcrop; on hill slopes and mountain slopes

DEEP, WARM SOILS; ON FAN TERRACES AND FLOOD PLAINS

9 Mohave-Continental-Guest: Nearly level and gently sloping, clayey and loamy soils; on fan terraces plains

10 Eba-Pinaleno: Dominantly gently sloping to moderately steep, very gravelly, clayey and loamy soils; terraces

VERY SHALLOW, SHALLOW, AND DEEP, WARM SOILS; ON FAN TERRACES

11 Greyeagle-Continental-Nickel: Dominantly gently sloping to moderately steep, nongravelly and very loamy and clayey soils; on fan terraces

VERY SHALLOW AND SHALLOW, WARM SOILS, AND ROCK OUTCROP; ON HILL SLOPES AND M SLOPES

12 Gran-Rock outcrop-Lehmans: Dominantly moderately steep and steep, nongravelly and very gravell clayey soils, and Rock outcrop; on hill slopes and mountain slopes

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

U.S. DEPARTMENT OF INTERIOR
BUREAU OF INDIAN AFFAIRS
BUREAU OF LAND MANAGEMENT

ARIZONA AGRICULTURAL EXPERIMENT STATION

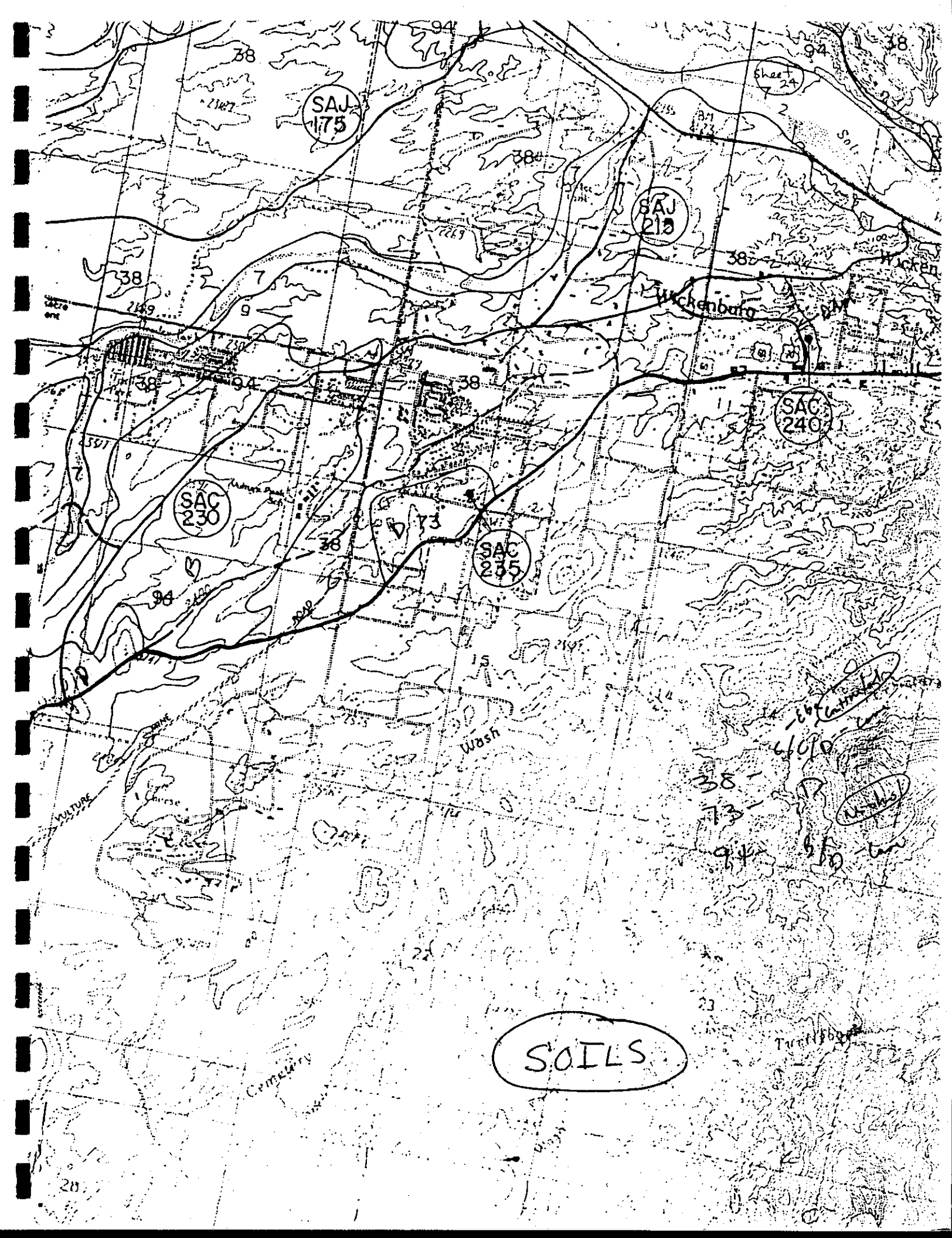
GENERAL SOIL MAP

AGUILA-CAREFREE AREA
PARTS OF MARICOPA AND PINAL COUNTIES
ARIZONA

Scale 1:506,880

2 0 2 4 6 8 Miles

2 0 4 8 12 16 Km


SAJ 175
SAJ 215
SAC 240
SAC 230
SAC 255
Wickenburg
Wash
Cemetery
SOILS

Sheet 25

Aguila-Carefree Soil Survey

Map Unit No.	Soil Name	USDA Soil Texture	% of Map Unit	Control Horizon Depth, Inches	Table 4.2 Textural Class	XKSAT, Inch/hour
29, 30	Denure	Fine Sandy Loam	40	0-2	Loam	0.34
	Momoli	Gravelly Sandy Loam	30	0-10	Sandy Loam	
	Carrizo	Gravelly Sandy Loam	20	0-10	Sandy Loam	
	Gilman		3.33		Loam	
	Maripo		3.33		Sandy Loam	
	Carrizo		3.33		Loamy Sand	
31, 32	Dixaleta	Extremely Cobbly Sandy Loam	85	1-8	Sandy Loam	0.33
	Rock Outcrop		35		—	
	Ohaco		2.5		Clay Loam	
	Nickel		2.5		Sandy Loam	
	Cave		2.5		Loam	
	Eba		2.5		Sandy Loam	
	Gran		2.5		Clay Loam	
	Lehmans		2.5		Clay Loam	
33, 34, 35	Eba	Very Gravelly Loam	80	0-3	Sandy Loam	0.23
	Pinalena		10		Sandy Clay Loam	
	Continental		10		Clay	
36	Eba	Very Gravelly Loam	45	(0-3)	Sandy Loam	0.07
	Continental	Clay	35	(1-60)	Clay	
	Ohaco		5		Clay Loam	
	Pinaleno		5		Sandy Clay Loam	
	Sun City		5		Sandy Clay Loam	
	Tres Hermanos		5		Clay Loam	
37, 38	Eba	Very Gravelly Loam	40	(0-3)	Sandy Loam	0.13
	Continental	Clay	25	(1-60)	Clay	ok
	Cave	Loam	20	(1-14)	Loam	
	Anthony		2.5		Sandy Loam	
	Arizo		2.5		Loamy Sand	
	Greyeagle		2.5		Sandy Loam	
	Ohaco		2.5		Clay Loam	
	Nickel		2.5		Sandy Loam	
	Pinaleno		2.5		Sandy Clay Loam	
39	Eba	Very Gravelly Loam	30	0-3	Sandy Loam	0.29
	Nickel	Gravelly Loam	25	1-10	Sandy Loam	
	Cave	Loam	25	1-14	Loam	
	Arizo		4		Loamy Sand	
	Pinaleno		4		Sandy Clay Loam	
	Sun City		4		Sandy Clay Loam	
	Greyeagle		4		Sandy Loam	
	Ohaco		4		Clay Loam	

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Map Unit No.	Soil Name	USDA Soil Texture	% of Map Unit	Control Horizon Depth, Inches	Table 4.2 Textural Class	XKSAT, Inch/ hour
70, 71	Gunsight	Very Gravelly Loam	40	0-11	Sandy Loam	0.36
	Rillito	Gravelly Loam	40	0-12	Sandy Loam	
	Carrizo		2.22		Loamy Sand	
	Chuckawalla		2.22		Silt	
	Ebon		2.22		Clay Loam	
	Mohall		2.22		Loam	
	Pinamt		2.22		Silt	
	Tremant		2.22		Sandy Loam	
	Cipriano		2.22		Sandy Loam	
	Antho		2.22		Sandy Loam	
	Gilman		2.22		Loam	
72, 73	Lehmans	Clay Loam	64	0-2	Clay Loam	0.09
	Rock Outcrop		30		—	
	Arizo		7.2		Loamy Sand	
	Eba		7.2		Sandy Loam	
	Pinaleno		7.2		Sandy Clay Loam	
	Greyeagle		7.2		Sandy Loam	
	Nickel		7.2		Sandy Loam	
74	Luke	Very Gravelly Clay	45	1-28	Silty Clay	0.08
	Cipriano	Very Gravelly Loam	35	0-6	Sandy Loam	
	Beardsley		2.857		Clay	
	Contine		2.857		Clay Loam	
	Ebon		2.857		Silty Clay Loam	
	Pinamt		2.857		Silt	
	Sun City		2.857		Sandy Clay Loam	
	Gunsight		2.857		Loamy Sand	
	Carrizo		2.857		Loamy Sand	
75	Mohall	Loam	80	0-7	Loam	0.23
	Gilman		5		Loam	
	Glenbar		5		Loam	
	Contine		5		Clay Loam	
	Tremont		5		Sandy Loam	
76	Mohall	Loam	80	0-7	Loam	0.23
	Contine		3.33		Clay Loam	
	Mohall		3.33		Clay Loam	
	Tremant		3.33		Sandy Loam	
	Antho		3.33		Sandy Loam	
	Estrella		3.33		Loam	
	Valencia		3.33		Sandy Loam	

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Map Unit No.	Soil Name	USDA Soil Texture	% of Map Unit	Control Horizon Depth, Inches	Table 4.2 Textural Class	XKSAT, inch/hour
86	Mohave	Clay Loam	85	2-15	Clay Loam	0.05
	Anthony		3		Sandy Loam	
	Gila		3		Loam	
	Tres Hermanos		3		Clay Loam	
	Mohave		3		Loam	
	Continental		3		Clay	
87	Mohave	Clay Loam	45	2-11	Clay Loam	0.04
	Mohave	Clay Loam	40	2-5	Clay Loam	
	Mohave		15		Clay Loam	
88	Mohave	Clay Loam	45	2-11	Clay Loam	0.02
	Guest	Clay	40	2-60	Clay	
	Mohave		7.5		Loam	
	Continental		7.5		Clay	
89	Mohave	Clay Loam	50	2-11	Clay Loam	0.06
	Tres Hermanos	Gravelly Clay Loam	30	2-20	Sandy Clay Loam	
	Arizo		5		Loamy Sand	
	Anthony		5		Sandy Loam	
	Continental		5		Clay	
	Pinaleno		5		Sandy Clay Loam	
90	Momoli	Gravelly Sandy Loam	70	0-3	Sandy Loam	0.39
	Carrizo		7.5		Loamy Sand	
	Maripo		7.5		Sandy Loam	
	Pinamt		7.5		Silt	
	Denure		7.5		Sandy Loam	
91, 92	Momoli	Very Gravelly Sandy Loam	45	1-60	Loamy Sand	0.93
	Carrizo	Very Gravelly Sandy Loam	35	0-11	Loamy Sand	
	Mohall		2.5		Loam	
	Tremant		2.5		Sandy Loam	
	Gunsight		2.5		Loamy Sand	
	Chuckawalla		2.5		Silt	
	Denure		2.5		Sandy Loam	
	Gilman		2.5		Loam	
	Maripo		2.5		Sandy Loam	
	Carrizo		2.5		Sandy Loam	
93, 94	Nickel	Gravelly Loam	50	1-10	Sandy Loam	~~0.04~~
	Cave	Loam	35	1-14	Loam	.33
	Arizo		3.75		Loamy Sand	
	Anthony		3.75		Sandy Loam	
	Pinaleno		3.75		Sandy Clay Loam	
	Greyeagle		3.75		Sandy Loam	

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The three infiltration parameters are functions of soil characteristics, ground surface characteristics, and land management practices. The soil characteristics of interest are particle size distribution (soil texture), organic matter, and bulk density. The primary soil surface characteristics are vegetation canopy cover, ground cover, and soil crusting. The land management practices are identified as various tillages as they result in changes to soil porosity.

Values of Green and Ampt equation parameters as a function of soil characteristics alone (bare ground condition) have been obtained from published reports (Rawls and others, 1983; Rawls and Brakensiek, 1983), and average values of XKSAT and PSIF for each of the soil texture classes are shown in Columns (2) and (3) of Table 4.2. The values of XKSAT and PSIF from Table 4.2 or Figure 4.3 should be used if general soil texture classification of the drainage area is available. References used to create Table 4.2 can be found in the Documentation Manual.

In Table 4.2, loamy sand and sand are combined. The parameter values that are shown in the table are for loamy sand. The hydraulic conductivity (XKSAT) for sand is often used as 4.6 inches/hour, and the capillary suction (PSIF) is often used as 1.9 inches. Using those parameter values for drainage areas can result in the generation of no rainfall excess—which may or may not be correct. Incorrect results could cause serious consequences for flood control planning and design. Therefore, it is recommended that—for watersheds consisting of relatively small subareas of sand—the Green and Ampt parameter values for loamy sand be used for the sand portion of the watershed. If the area contains a large portion of sand, then either the Green and

Table 4.2
Green and Ampt Loss Rate Parameter Values for Bare Ground

Soil Texture Classification (1)	XKSAT Inches/hour (2)	PSIF Inches (3)	DTHETA[1]		
			Dry (4)	Normal (5)	Saturated (6)
loamy sand & sand	1.2	2.4	0.35	0.30	0
sandy loam	0.40	4.3	0.35	0.25	0
loam	0.25	3.5	0.35	0.25	0
silty loam	0.15	6.6	0.40	0.25	0
silt	0.10	7.5	0.35	0.15	0
sandy clay loam	0.06	8.6	0.25	0.15	0
clay loam	0.04	8.2	0.25	0.15	0
silty clay loam	0.04	10.8	0.30	0.15	0
sandy clay	0.02	9.4	0.20	0.10	0
silty clay	0.02	11.5	0.20	0.10	0
clay	0.01	12.4	0.15	0.05	0

[1] Selection of DTHETA:
Dry = Nonirrigated lands, such as desert and rangeland;
Normal = Irrigated lawn, turf, and permanent pasture;
Saturated = Irrigated agricultural land.

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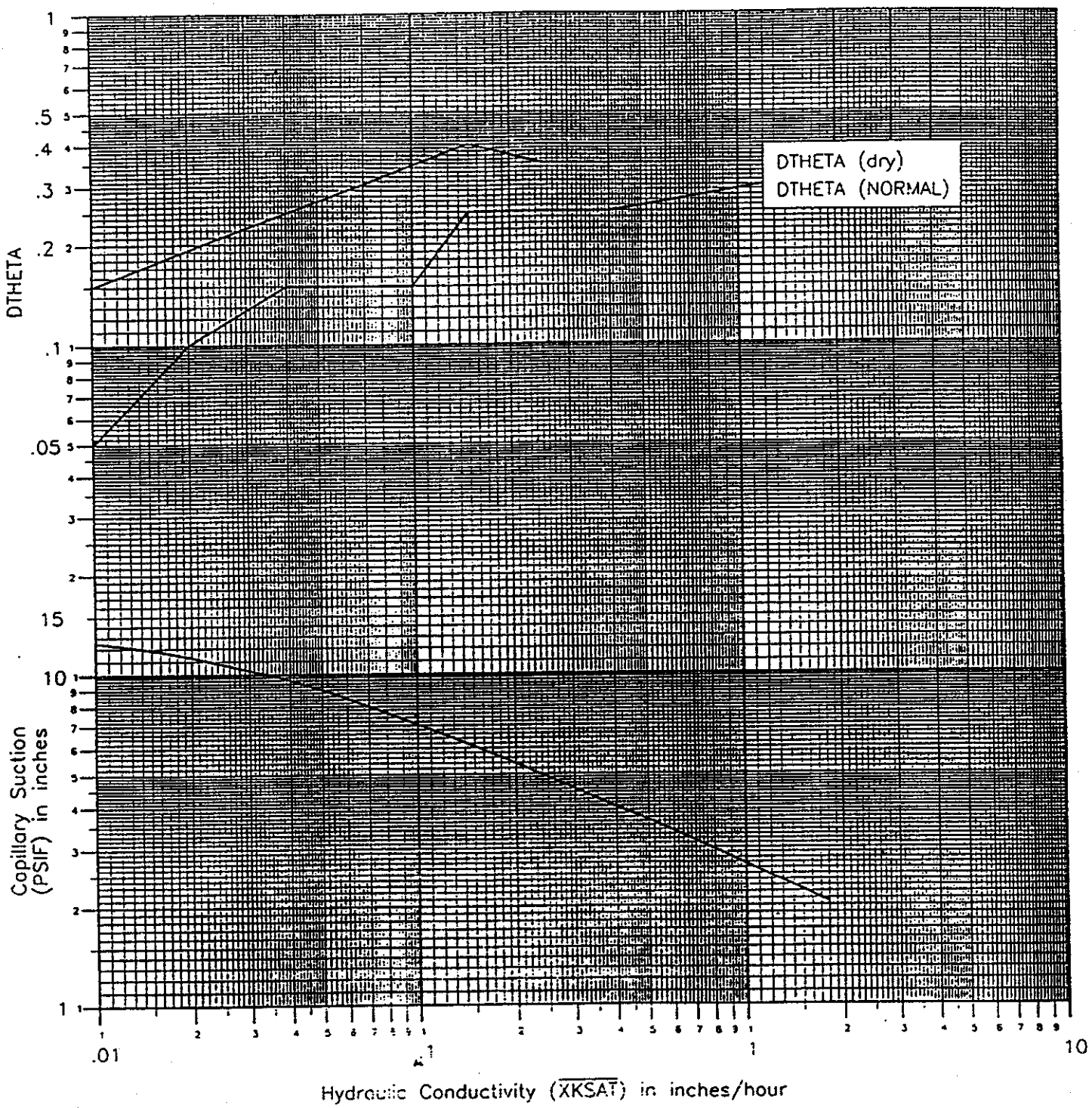

Figure 4.3
Composite Values of PSIF and DTHETA as a function of XKSAT
(To be used for area-weighted averaging of Green and Ampt parameters.)

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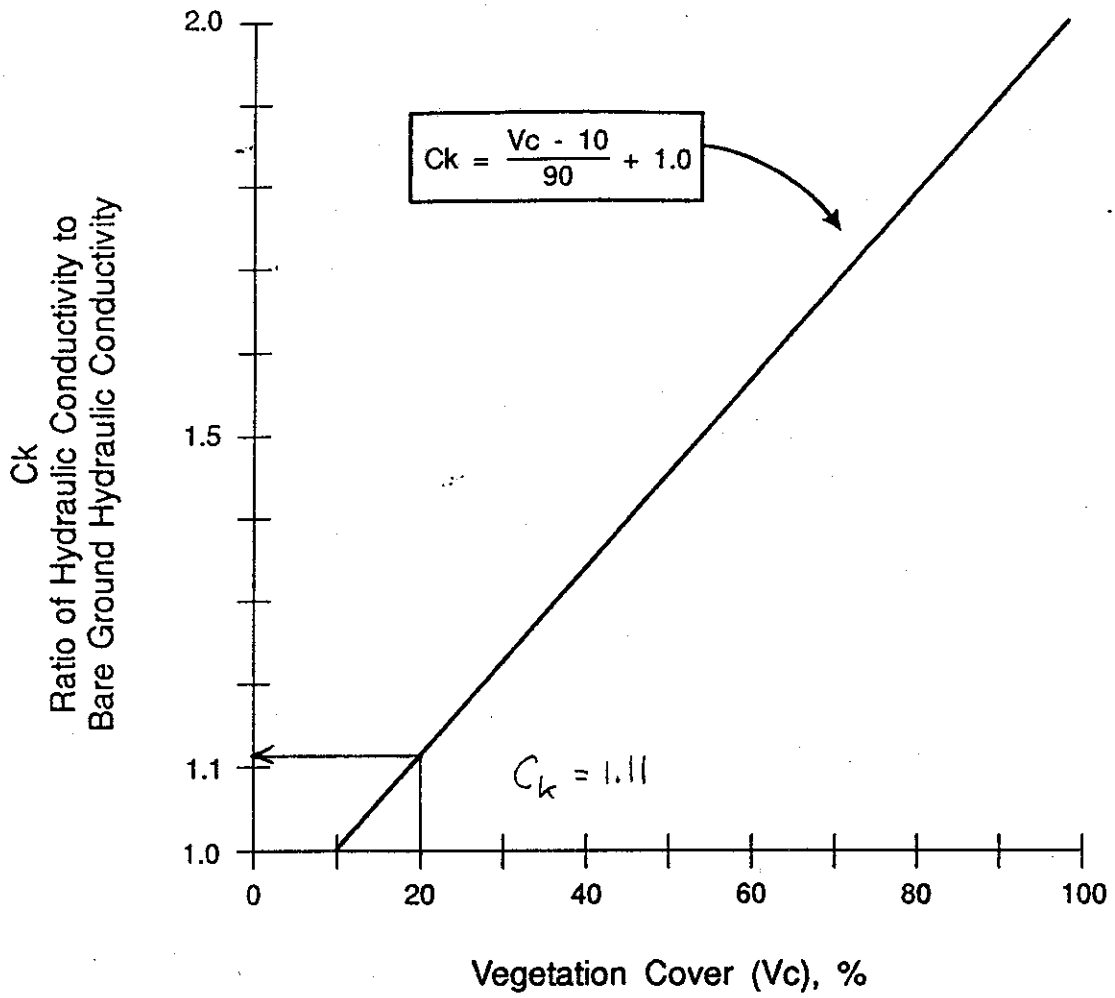
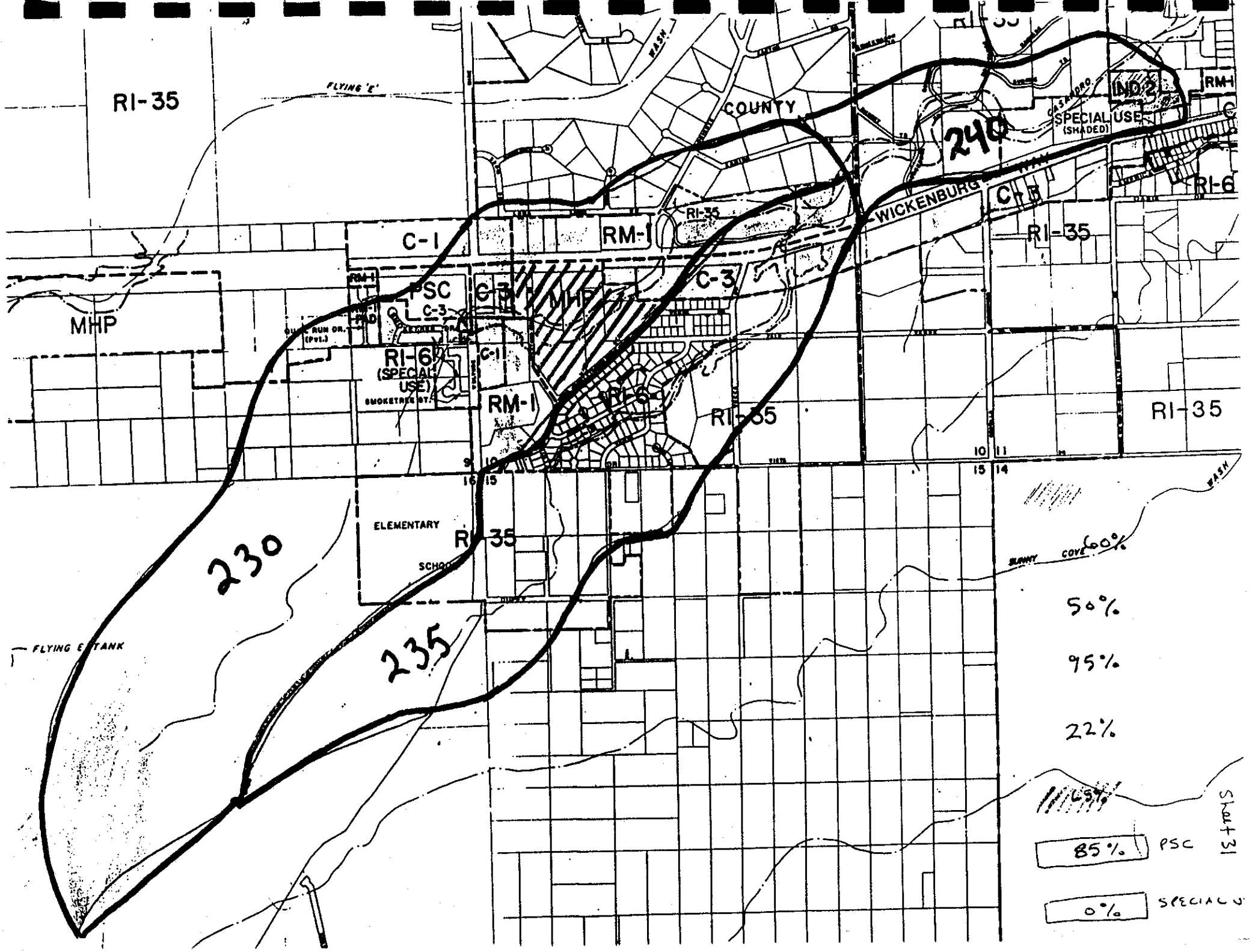


Figure 4.4
Effect of Vegetation Cover on Hydraulic Conductivity
For Hydraulic Soil Groups B, C, and D, and for all Soil Textures
***other than* Sand and Loamy Sand**

on canopy cover for trees and shrubs. Note that this correction can be applied only to soils other than sand and loamy sand.

The influence of tillage results in a change in total porosity and therefore a need to modify the three Green and Ampt equation infiltration parameters. The effect of tillage systems on soil porosity and the corresponding changes to hydraulic conductivity, wetting front capillary suction, and water retention is available (Rawls and Brakensiek, 1983). Although this information is available, it is not presented in this manual, nor is it recommended that these adjustments be made to the infiltration parameters for design purpose use in Maricopa County; because for most flood estimation purposes it cannot be assumed that the soil will be in any particular state of tillage at the time of storm occurrence and therefore the base condition infiltration parameters, as presented, should be used for flood estimation purposes. However,


RI-35
FLYING 'E'
COUNTY
WASH
CASSADORO
SPECIAL USE (SHADED)
IND 2
RM-1
RI-6
240
WICKENBURG
C-3
C-1
RM-1
RI-35
MHP
PSC
C-3
RI-6 (SPECIAL USE)
SMOKETREE DR.
RUM DR. (PVT.)
ELEMENTARY
SCHOOL
230
235
FLYING E TANK
SLANTY COVE
60%
50%
95%
22%
65%
85% PSC
0% SPECIAL U
Sheet 31

Sheet 32

Table 4.1 Classification of Zoning Types for Estimation of Imperviousness

Gilbert-Chandler ADMS Land Use Category	Imperviousness Area (percent)	Gilbert Zoning Unit	Gilbert Description	Chandler Zoning Unit	Chandler Description	Mesa Zoning Unit	Mesa Description	Tempe Zoning Unit	Tempe Description	County Zoning Unit	County Description	Phoenix Zoning Unit	Phoenix Description	Cave Creek EIS % Imp. Area (including R.O.W.)
Agriculture	0	AG	Agriculture	AG-1	Agriculture	AG	Agriculture	AG	Agriculture					
Very Low Density Residential	15					R1-90	Single Residence			RURAL-190	190,000 sq. ft./dwelling unit	S-1	Ranch or Farm Residential, > 1 acre	15
						SR	Suburban Ranch			RURAL-70	70,000 sq. ft./dwelling unit	S-2	Ranch or Farm Commercial	18
		R1-43	Rural							RURAL-43	one acre/dwelling unit	RE-43	Single Family, 1 acre minimum	20
Low Density Residential	25	R1-35	Rural Residential	SF-33	Single Family	R1-35	Single Residence			R1-35	Single Family Residential, 35,000 sq. ft./dwelling unit	RE-35	SF, 35,000 sq.ft min.	22
												RE-24	SF, 24,000 sq.ft min.	25
		R1-20	SF, Residential	SF-18	Single Family					R1-18	SFR, 18,000 sq. ft./unit	R1-18	SF, 18,000 sq.ft min.	25
		R1-15	" "			R1-15	Single Residence	R1-15	One Family Residential			R1-14	SF, 14,000 sq.ft min.	30
Medium Density Residential	45	R1-10	" "	SF-10	Single Family	R1-9	Single Residence	R1-10	One Family Residential	R1-10	SFR, 10,000 sq. ft./unit	R1-10	SF, 10,000 sq.ft min.	38
		R1-8	" "					R1-8	One Family Residential	R1-8	SFR, 8,000 sq. ft./unit	R1-8	SF, 8,000 sq.ft min.	45
		R1-7	" "	SF-7	Single Family	R1-7	Single Residence	R1-7	One Family Residential					
						R1-6	Single Residence	R1-6	One Family Residential	R1-6	SFR, 6,000 sq. ft./unit	R1-6	SF, 6,000 sq.ft min.	50
						TCR-1	Town Center, Single Family	RO	Residence/Office			R-O	Res. Office	50
Multiple Family Residential	65	R-2	Duplex	MF-1	Medium Density	R-2	Restricted Multiple Resid.	R-2	Multi-Family Residential	R-2	2 Family Residence	R-2	MF, 4,000 sq.ft./unit	60
		R-3	Multi-Family, Apartments	MF-2	Multi-Family	R-3	Limited Multiple Resid.	R-3R	Multi-Family Restricted	R-3	Multiple Family, Residential	R-3	MF, 3,000 sq.ft./unit	65
		R-4	Multi-Family, General	MF-3	High Density	R-4	General Multiple Resid.	R-3	Multi-Family Limited	R-4	Multiple Family, Residential	R-4	MF, 1,500 sq.ft./unit	65
		R-5	Townhouse Residential					R-4	Multi-Family General	R-5	Multiple Family, Residential	R-4A	MF, 1,000 sq.ft./unit	70
								R-Th	Townhouse			R-5	MF, 1,000 sq.ft./unit	70
		MH	Mobile Home	MH-1	Mobile Homes	TCR-2	TC, Restricted Multi-Res.	RMH	Mobile Home Residence	MHR	Manufactured Housing, Resid.	CP/BP	Business Park	65
		CTP	Commercial Trailer Park			TCR-3	TC, General Res.	MHS	Manufactured Housing Subd.			R-H	Resort District	65
								TP	Trailer Park					
Industrial	75	I-1	Garden Type Industrial			M-1	Limited Industrial	I-1	Light Industrial			IND PARK	Industrial Park	75
		I-2	Light Industrial	I-1	Light Industrial			I-2	General Industrial	I-2	Light Industrial	A-1	Light Industrial	75
		I-3	General Industrial	I-2	General Industrial	M-2	General Industrial	I-3	Heavy Industrial	I-3	Heavy Industrial	A-2	Heavy Industrial	75
Commercial	90	C-1	Light Commercial	C-1	Neighborhood Commercial	C-1	Neighborhood Comm.	CCR	Convenience Commercial	C-1	Neighborhood Commercial	C-1	Neighborhood Commercial	95
		C-2	General Commercial	C-2	Community Commercial	C-2	Limited Comm.	C-1	Neighborhood Commercial	C-2	Intermediate Commercial	C-2	Intermediate Commercial	95
		C-3	Central Commercial	C-3	Regional Comercial	C-3	General Comm.	C-2	General Commercial	C-3	General Commercial	C-3	General Commercial	95
		RS	Residential Services			OS	Office-Services	CCD	Central Comm. District	C-O	Commercial Office	C-O	Commercial Office	75
		RCC	Residential Conveniences			TCC	TC, High Intensity Mixed Use					HR	High Rise District	85
						TCB-1	TC, Limited Comm./General Manufacturing							
						TCB-2	TC, General Comm./Light Manufacturing							
		MISCELLANEOUS CATEGORIES: These map units should be evaluated on a case by case basis.												
		PAD	Planned Area Development	PAD	Planned Area Development			S	Private School	PD	Planned Development Overlay	PAD	Planned Area Development	85
		PSC-1	Planned Neighborhood Shopping											
		PSC-2	Planned Shopping Center							CS	Planned Shopping Center	PSC	Planned Shopping Center	85
		IB	Industrial Buffer											
				PCO	Planned C Offices	PEP	Planned Employment Park							
						PF	Public Facilities			SU	Special Uses			
										SC	Senior Citizen Overlay	PCD	Planned Community Development	60
										NUP	Neighborhood Plan of Development			
										RUP	Residential Plan of Development			
										IUP	Industrial Plan of Development			
												R.O.W.	Right of Way	VARIABLE
												P-1	Parking, Open	VARIABLE
												P-2	Parking, Structures	VARIABLE
												D.G	Dwelling Group	85
Mixed Use Area	55	Town of Gilbert ONLY – added for future conditions land uses for an area east of the Eastern Canal south of the SPRR												

Casandro Wash
Percent Impervious Area Measurements by Drainage Sub-Basin

(Tables from Calculations by K. Bradford, 1/21/94, following)

	Acres for Percent Impervious								
Drainage Sub-Basin	**0%**	**22%**	**30%**	**50%**	**60%**	**65%**	**75%**	**85%**	**95%**
#230	0	339	0	16.4	47.0	30.7	0	7.69	23.9
#235	0	151	0	54.8	16.7	0	0	0	17.9
#240	19.1	60.5	3.71	0	0	0	5.29	0	0

Note: Took average of 3 planimeter measurements

	Percent of Total for Each Impervious Area									
Drainage Sub-Basin	**Total * Acreage**	**0%**	**22%**	**30%**	**50%**	**60%**	**65%**	**75%**	**85%**	**95%**
#230	465	0	73	0	3	10	7	0	2	5
#235	240	0	63	0	23	7	0	0	0	7
#240	89	22	68	4	0	0	0	6	0	0

* Based on planimeter measurements (average of 3)

Weighted	Percent	Impervious
230	.346	~ 35%
235	.362	~ 36%
240	.207	~ 21%

CH2M HILL

SUBJECT [illegible]
% IMPERVIOUS AREA PARAMETER
[illegible]

BY [illegible] DATE [illegible]
SHEET NO. 1 OF
PROJECT NO. [illegible]

Sheet 07

	[illegible]								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
#230	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]
#235	[illegible]	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
#240	19.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0

Note:
[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0

[illegible]

WEIGHTED PERCENT IMPERVIOUSNESS

230	.346	≈	35%
235	.362	=	36%
240	.207	=	21%

FORM 3B

SUBJECT CAMINO - HYDROL

BY JBF DATE 1/17

SHEET NO. ~~29~~ 35 OF

PROJECT NO. SWW3541

C. UNIT HYDROGRAPH - USE CLARK UHG

LIMITATIONS

1. D.A. < 5 mi² OK

(1) TIME OF CONCENTRATION (eq. 5.5, p. ~~64~~ 5-10)

$$T_c = 11.4\, L^{0.50}\, k_b^{0.52}\, S^{-0.31}\, i^{-0.38}$$

T_c = hours

L = length flow path (miles)

k_b = resistance coef.

S = ft/mile slope

i = excess intensity in/hr

D.A.	L	k_b	S	i
SAC 230	2.4	.040	137.5	—
SAC 235	2.0	.035	137.0	—
[CAS 240]	0.9	.035	139.9	—

REPORTED BY FLOMIC HYDROLOGY (S-GRAPH)

	SAC 230	SAC 235	~~SAC~~ CAS 240
L (mi) :	2.32	1.95	0.57
k_b see following sheets :	~~0.15~~ ~~0.057~~ 0.023	0.025 ~~0.15~~	0.028 ~~0.15~~

↳ ~~Hillslopes/Alluvial Fans, D.A. 5 mi² (Sheet 31)~~ Table 5.1, Residential Areas

$k_b = m \log(D.A) + b$ m = -0.00625 b = 0.04

S, max elev:	2520	2441	~~2200~~ 2250
min elev:	2200	2200	2134
S:	138	124	204
Adjusted S: (Fig 5.4)	~~150~~	~~120~~	200

- Sheet ~~30~~ 39

FORM 3B

Sheet 36

Table 5.1
Equation for Estimating K_b in the Tc Equation

$K_b = m \log A + b$ Where A is drainage area, in acres				
Type	Description	Typical Applications	Equation Parameters	
			m	b
A	Minimal roughness: Relatively smooth and/or well graded and uniform land surfaces. Surface runoff is sheet flow.	Commercial/ industrial areas Residential area Parks and golf courses	–0.00625	0.04
B	Moderately low roughness: Land surfaces have irregularly spaced roughness elements that protrude from the surface but the overall character of the surface is relatively uniform. Surface runoff is predominately sheet flow around the roughness elements.	Agricultural fields Pastures Desert rangelands Undeveloped urban lands	–0.01375	0.08
C	Moderately high roughness: Land surfaces that have significant large- to medium-sized roughness elements and/or poorly graded land surfaces that cause the flow to be diverted around the roughness elements. Surface runoff is sheet flow for short distances draining into meandering drainage paths.	Hillslopes Brushy alluvial fans Hilly rangeland Disturbed land, mining, etc. Forests with underbrush	–0.025	0.15
D	Maximum roughness: Rough land surfaces with torturous flow paths. Surface runoff is concentrated in numerous short flow paths that are often oblique to the main flow direction.	Mountains Some wetlands	–0.030	0.20

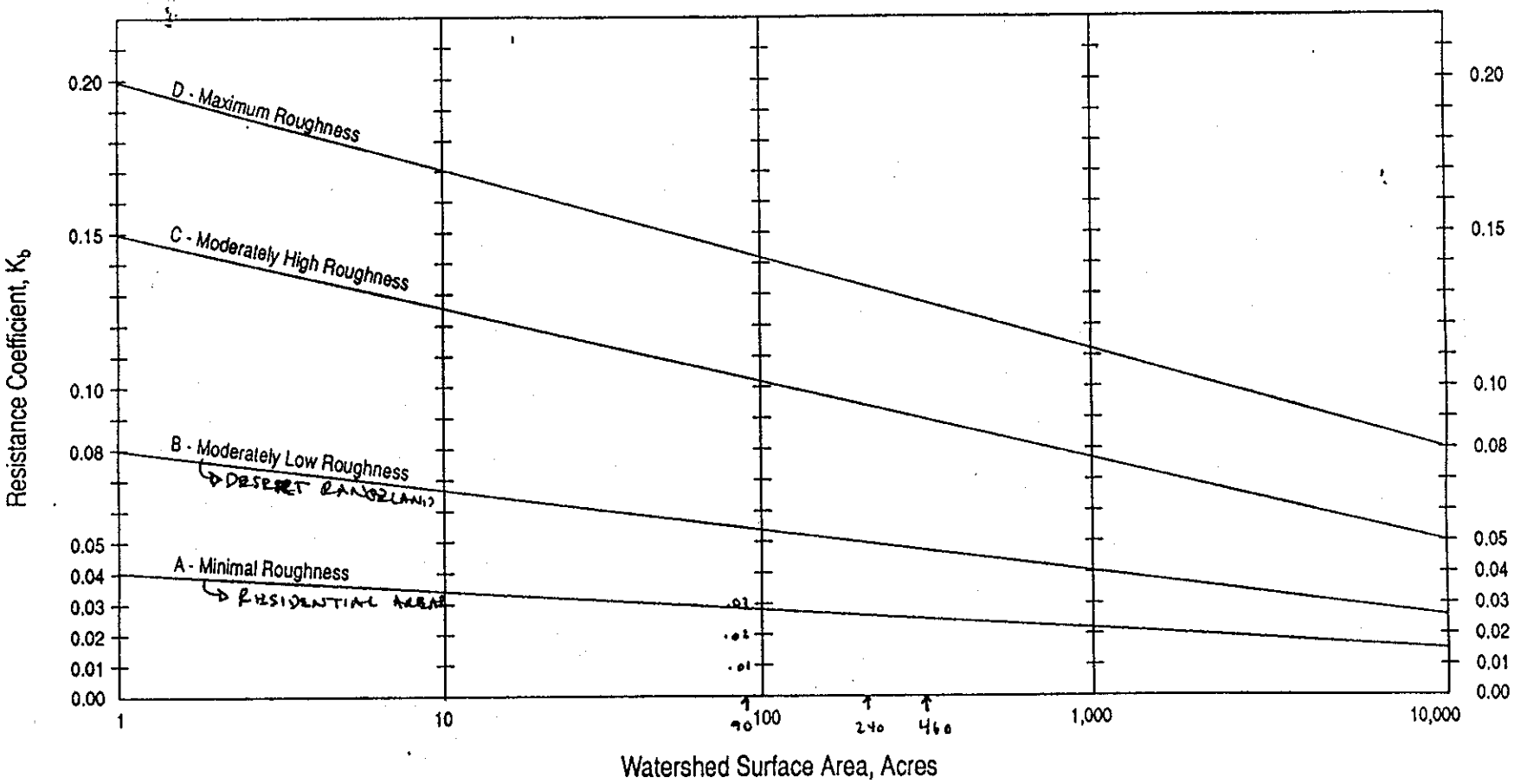


Figure 5.5

Resistance Coefficient "K_b" as a Function of Watershed Size and Surface Roughness Characteristics

Sheet 37

SUBJECT CASANDRO WASH

BY JRF DATE 1/21

SHEET NO. 38 OF

PROJECT NO.

K_b factor weighting

Use Wickenburg Zoning map & FCDMC % Impervious Classification

a) for ≥60% impervious - curve A

b) for <60% impervious - curve B

BASIN A	≥60%	<60%	D.A.
230	24%	76%	461
235	14%	86%	243
240	6%	94%	90
	↑	↑	
	Curve A	Curve B	

$K_b = m \log A + b$

	Curve A	Curve B	
m	-.00625	-.01375 ~~-.04~~	
b	~~-.01375~~ .04	~~-.04~~ .08	
	K_b	K_b	Wt'd Kb
230	.023	.043	.038
235	.025	.047	.044
240	.027	.053	.051

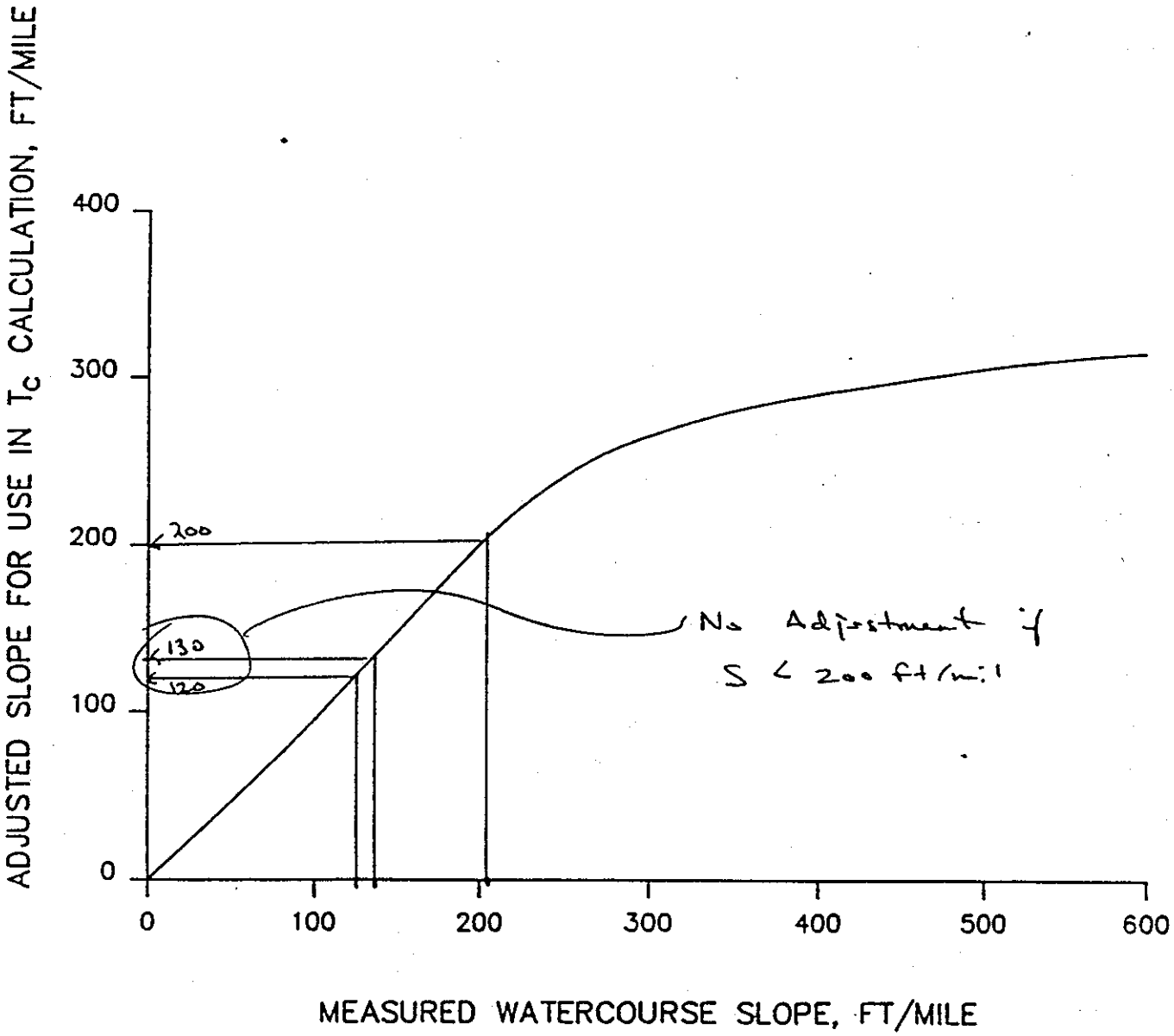


Figure 5.4
Slope Adjustment for Steep Watercourses in Natural Watersheds
(Source: *Drainage Criteria Manual*, Urban Drainage and Flood Control District, Colorado, May 1984.)

SUBJECT CASANDRA – HYDROL

BY DEF DATE 1/18

SHEET NO. 40 OF

PROJECT NO.

C. UNIT HYDROGRAPH – CLARK UHG

USE MCUHP1 PROGRAM

	D.A. (mi²)	L (mi)	K_b	S (ft/mi)	IA	DTHETA	PSIF	KSAT	RTIMP
SAC 230	0.72	2.4	.038 ~~0.075~~	138	0.10	.25	5.2 ~~6.0~~	0.24 ~~0.19~~	35
SAC 235	0.38	2.0	.044 ~~0.025~~	124	0.10	.23 ~~.15~~	6.2 ~~8.6~~	0.15 ~~0.07~~	36 ~~36~~
CAS 240	0.14	0.9	.051 ~~0.028~~	200*	0.10	.21 ~~.15~~	6.4 ~~9.6~~	0.14 ~~0.07~~	21 ~~35~~

↑ Adjusted (>200 ft/mi)

$P_{6HR,100YR}$ = 3.40 (NOT AERIALLY REDUCED)

URBAN BASIN (incl. residential)

OUTPUT FILE P:/SWW35441/HY/CAS100G.OUT (in HCI format)

	DA mi²	(Ac)
230	.72	461
235	.38	243
240	.14	90

Sheet 41

Table 5.2
Values of the Synthetic Dimensionless Time-Area Relations for the Clark Unit Hydrograph

Time, as a percent of Time of Concentration (1)	Contributing Area, as a Percent of Total Area		
	Urban Watersheds (2)	Natural Watersheds (3)	HEC-1 Default (4)
0	0	0	0.0
10	5	3	4.5
20	16	5	12.6
30	30	8	23.2
40	65	12	35.8
50	77	20	50.0
60	84	43	64.2
70	90	75	76.8
80	94	90	87.4
90	97	96	95.5
100	100	100	100.0

USE

NATURAL defined as "Undeveloped"

5.6 S-Graphs

An S-graph is a dimensionless form of a unit hydrograph and it can be used in the place of a unit hydrograph in performing flood hydrology studies. The concept of the S-graph dates back to the development of the unit hydrograph itself, although the application of S-graphs has not been as widely practiced as that of the unit hydrograph. The use of S-graphs has been practiced mainly by the U.S. Army Corps of Engineers, Los Angeles District, and the U.S. Bureau of Reclamation (USBR).

An example of an S-graph from Design of Small Dams (USBR, 1987) is shown in Figure 5.8. The discharge scale is expressed as percent of ultimate discharge (Qult), and the time scale is expressed as percent lag. Lag is defined as the elapsed time, usually in hours, from the beginning of an assumed continuous series of unit rainfall excess increments over the entire watershed to the instant when the rate of resulting runoff equals 50 percent of the ultimate discharge. The intensity of rainfall excess is 1 inch per duration of computation interval (Δt). An equivalent definition of lag is the time for 50 percent of the total volume of runoff of a unit hydrograph to occur. It is to be noted that there are numerous definitions for lag in hydrology and the S-graph lag should not be calculated by methods that are not consistent with this definition.

Ultimate discharge is the maximum discharge that would be achieved from a particular watershed when subjected to a continuous intensity of rainfall excess of

SUBJECT CASANORO - HYDROL. ROUTING

BY JCF DATE 1/18

SHEET NO. 42 OF

PROJECT NO.

D. CHANNEL ROUTING

- USE FCDMC ROUTING UNIT, SHORTEN REACH LENGTH TO REFLECT NEW DAM LOCATION

REACH LENGTH = 4200 FT (-200)

E. DIAGRAM WATERSHED

SAC230 → ADD → CONTR → ADD → END

SAC235 → ADD

CAS240

F. RUN MODEL

		FCD - DAMBG100.HC1
Q_{100} =	~~2108~~ 1769 CFS	1418
Vol_{100} =	~~152~~ 149 AF	112 AF

G. ADD DAM - PLANIMETER 2-FT CONTOURS & ENTER ON SA, SE, SV RECORDS

MAX STORAGE ELEVATION - 2160.3 - NO OUTFLOW

2159.7 - APPROX OUTFLOW = 30 CFS

SUBJECT Casandra
Sediment Storage

BY H. Allen (40) DATE 1/31/95
SHEET NO. 1 OF 1
PROJECT NO. SWW3544L.PS

Calculate volume of sediment storage in basin using average end-areas
- using most recent grading plan

1) Small basin where wash enters detention area

El, ft	ΔEl.	Area(ac.)	Ave. Area	Volume
2144		0		
	1'		0.15	0.15 ac-ft
2145		0.3		

2) basin at dam, volume below culvert invert (El. 2135)

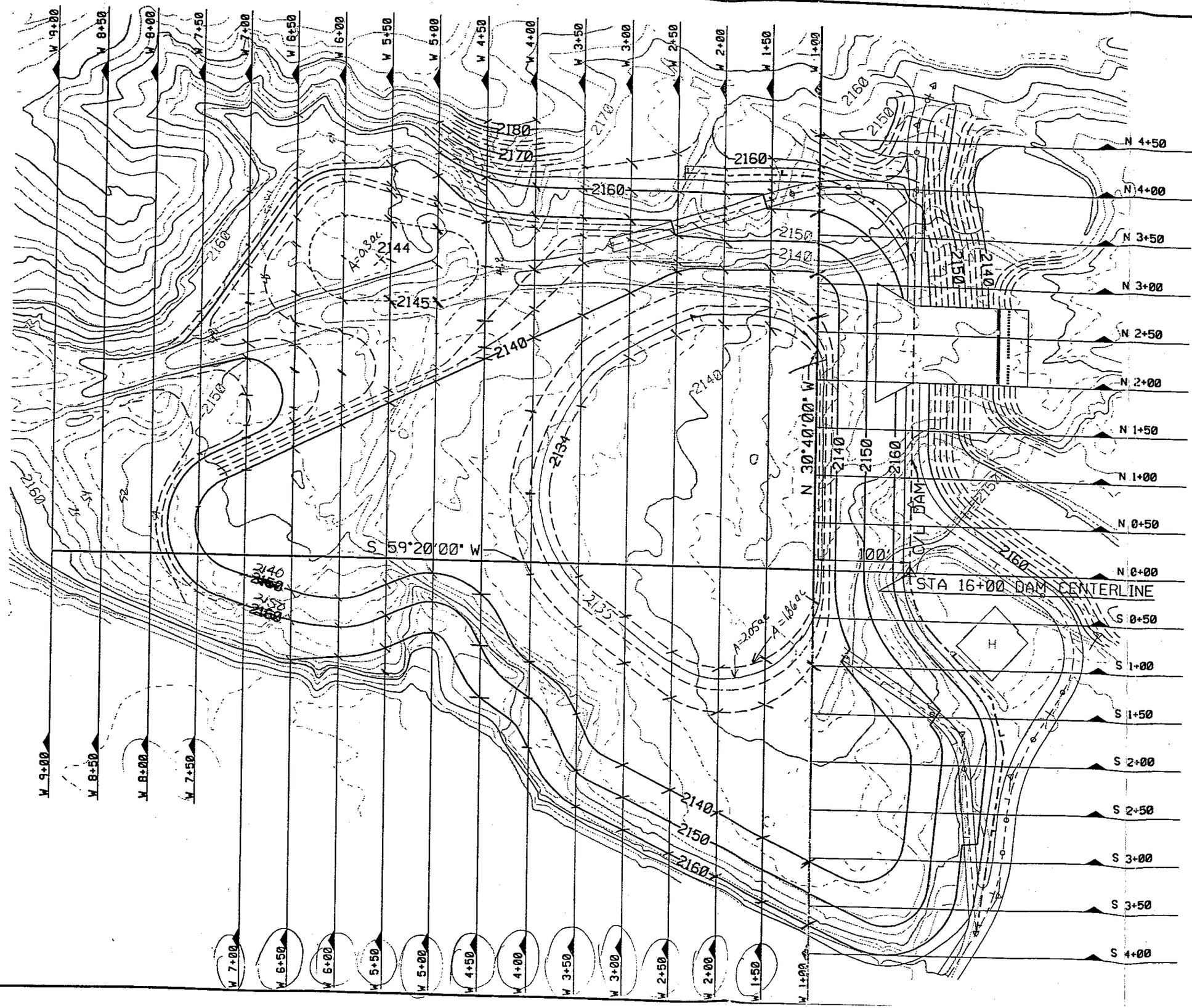
El, ft	ΔEl	Area (ac.)	Ave. Area	Volume
2134		1.86 ac.		
	1'		1.96	1.96 ac-ft
2135		2.05 ac.		

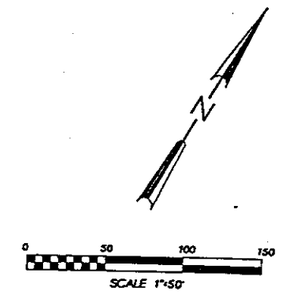
3) Total volume = 0.15 + 1.96 = 2.11 ac-ft.

2137 = 2.49 ac.

FORM 3B

01-25-95 SWW3541-5441XSLO.DGN





NOTES:
1. SEE SHEET 3 FOR SURVEY CONTROL DATA

LEGEND

N/S 0+50	.....DAM CROSS-SECTION
W 2+50	.....DETENTION BASIN CROSS-SECTION
—2140—	.....NEW CONTOUR
—2140—	.....EXISTING CONTOUR
H	.....EXISTING HOUSE

NO	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

CROSS-SECTION INDEX SHEET

	BY	DATE
DESIGNED	TJ WOLF	2/01/95
DRAWN	MD COEN	2/01/95
CHECKED	JE LIVINGSTON	2/1/95

CH2M HILL

CASANDRO WASH

SHEET OF

HEC1 S/N: 0134301122 HMVersion: 6.33 Data File: Q100.hc1

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*              MAY   1991              *
*           VERSION 4.0.1E             *
*                                      *
*  RUN DATE  02/02/1995  TIME  14:11:15 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

```
::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::
:::                                    :::
:::  Full Microcomputer Implementation :::
:::                 by                 :::
:::        Haestad Methods, Inc.       :::
:::                                    :::
::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              * filename = Q100.HC1
              *
              *
              *DIAGRAM
              *
    1         ID   Casandro Wash Detention Dam  CH2M Hill    April, 1994
    2         ID   HEC-1 for Q100, revised dam location alternative #3
              *
    3         IT       5                    900
    4         IO       3
              *

    5         KK  SAC230
    6         KM   SUB-BASIN SAC230
    7         KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
    8         KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
    9         KM   BASIN FROM WICKENBERG ADMS
   10         BA    .720
   11         IN      15
   12         KM   RAINFALL DEPTH OF 3.40 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
              * 10 year = 2.202,  100 year = 3.350
   13         PB   3.350
   14         KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.53
   15         PC    .000    .009    .016    .025    .034    .042    .051    .059    .067    .075
   16         PC    .087    .100    .119    .151    .235    .416    .760    .872    .915    .944
   17         PC    .956    .967    .979    .989   1.000
   18         LG    .100    .250   5.200    .240  35.000
   19         UC    .446    .367
   20         UA       0       5      16      30      65      77      84      90      94      97
   21         UA     100
              *

   22         KK  SAC235
   23         KM   SUB-BASIN sac235
   24         KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
   25         KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
   26         KM   BASIN FROM WICKENBERG ADMS
   27         BA    .380
   28         LG    .100    .230   6.200    .150  36.000
   29         UC    .450    .461
   30         UA       0       5      16      30      65      77      84      90      94      97
   31         UA     100
              *

   32         KK     ADD
   33         KM   ADD SAC230 & SAC235
   34         HC       2
              *

   35         KK   ROUTE
   36         KM   ROUTE COMBINED HYDROGRAPH TO DAM LOCATION
   37         RS       1    FLOW      -1
   38         RC    .045     .03    .045    4200   .0175
   39         RX   463.5   467.5   477.5   487.5   512.5   522.5   532.5   536.5
   40         RY    16.5    12.5    12.5    10.0    10.0    12.5    12.5    16.5
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  41          KK  CAS240
  42          KM   SUB-BASIN cas240
  43          KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
  44          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
  45          KM   BASIN MODIFIED FROM WICKENBERG ADMS TO REFLECT DAM LOCATION
  46          BA    .140
  47          LG    .100    .210   6.400    .140  21.000
  48          UC    .258    .232
  49          UA       0       5      16      30      65      77      84      90      94      97
  50          UA     100
              *

  51          KK   DAMIN
  52          KO       1
  53          KM   ADD ROUTED HYDROGRAPH TO CAS240
  54          HC       2
              *

  55          KK  DAMOUT
  56          KM    Route Hydrograph Through Dam.
  57          KM
  58          RS       1    STOR       2
  59          KO       1
              *
  60          SA    2.05    2.49    5.80    6.77    9.06   10.20   10.96   11.34   11.61   11.88
  61          SA   12.09   12.31   12.81   13.31   13.81
  62          SE    2135    2137    2140    2144    2150    2153    2155    2156    2157    2158
  63          SE    2159    2160    2161    2162    2163
  64          SQ       0     9.5    13.5    19.1    23.3    28.6    30.9     295     823    1539
  65          SQ    2423    3450    4577    5773    7015
              *
  66          ZZ
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    5      SAC230
                .
                .
   22           .      SAC235
                .           .
                .           .
   32         ADD............
                V
                V
   35       ROUTE
                .
                .
   41           .      CAS240
                .           .
                .           .
   51       DAMIN............
                V
                V
   55      DAMOUT
(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

K/L14PRINT

```
****************************************                    ****************************************
*                                      *                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *    U.S. ARMY CORPS OF ENGINEERS      *
*              MAY   1991              *                    *    HYDROLOGIC ENGINEERING CENTER     *
*           VERSION 4.0.1E             *                    *          609 SECOND STREET           *
*                                      *                    *       DAVIS, CALIFORNIA 95616        *
*  RUN DATE  02/02/1995  TIME  14:11:15 *                    *          (916) 756-1104              *
*                                      *                    *                                      *
****************************************                    ****************************************
```

Casandro Wash Detention Dam CH2M Hill April, 1994
HEC-1 for Q100, revised dam location alternative #3

```
  4 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           3  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         900  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      4    0  ENDING DATE
                     NDTIME        0255  ENDING TIME
                      ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL    0.08 HOURS
                      TOTAL TIME BASE   74.92 HOURS

        ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


          **************
          *            *
  5 KK    *    SAC230  *
          *            *
          **************
```

SUB-BASIN SAC230
6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
BASIN FROM WICKENBERG ADMS
RAINFALL DEPTH OF 3.40 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.53

```
 11 IN          TIME DATA FOR INPUT TIME SERIES
                      JXMIN          15  TIME INTERVAL IN MINUTES
                     JXDATE      1    0  STARTING DATE
```

```
                JXTIME          0  STARTING TIME

            SUBBASIN RUNOFF DATA

 10 BA        SUBBASIN CHARACTERISTICS
                TAREA        0.72  SUBBASIN AREA

              PRECIPITATION DATA

 14 PB          STORM        3.35  BASIN TOTAL PRECIPITATION

 14 PI        INCREMENTAL PRECIPITATION PATTERN
                0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                0.00      0.00      0.00      0.01      0.01      0.01      0.01      0.01      0.01      0.03
                0.03      0.03      0.06      0.06      0.06      0.11      0.11      0.11      0.04      0.04
                0.04      0.01      0.01      0.01      0.01      0.01      0.01      0.00      0.00      0.00
                0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                0.00      0.00

 18 LG        GREEN AND AMPT LOSS RATE
                STRTL        0.10  STARTING LOSS
                  DTH        0.25  MOISTURE DEFICIT
                 PSIF        5.20  WETTING FRONT SUCTION
                XKSAT        0.24  HYDRAULIC CONDUCTIVITY
                RTIMP       35.00  PERCENT IMPERVIOUS AREA

 19 UC        CLARK UNITGRAPH
                   TC        0.45  TIME OF CONCENTRATION
                    R        0.37  STORAGE COEFFICIENT

 20 UA        ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
              100.0

                                                  ***

                                          UNIT HYDROGRAPH PARAMETERS
                                   CLARK   TC=  0.45 HR,       R=  0.37 HR
                                  SNYDER   TP=  0.29 HR,      CP=  0.48

                                             UNIT HYDROGRAPH
                                         26 END-OF-PERIOD ORDINATES
            83.      383.      684.      750.      692.      597.      487.      387.      308.      246.
           195.      156.      124.       99.       79.       62.       50.       40.       32.       25.
            20.       16.       13.       10.        8.        6.

   ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   SAC230

  TOTAL RAINFALL =    3.35, TOTAL LOSS =    1.03, TOTAL EXCESS =    2.32

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                 6-HR       24-HR       72-HR     74.92-HR
  1078.       4.17       (CFS)     178.         45.         15.         14.
                       (INCHES)   2.293       2.306       2.306       2.306
                        (AC-FT)    88.         89.         89.         89.

                    CUMULATIVE AREA =    0.72 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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          *            *
22 KK     *   SAC235   *
          *            *
          **************
                         SUB-BASIN sac235
                         6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
                         THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
                         BASIN FROM WICKENBERG ADMS

             SUBBASIN RUNOFF DATA

27 BA          SUBBASIN CHARACTERISTICS
                     TAREA        0.38  SUBBASIN AREA

               PRECIPITATION DATA

14 PB                STORM        3.35  BASIN TOTAL PRECIPITATION

14 PI            INCREMENTAL PRECIPITATION PATTERN
                   0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                   0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                   0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                   0.00      0.00      0.00      0.01      0.01      0.01      0.01      0.01      0.01      0.03
                   0.03      0.03      0.06      0.06      0.06      0.11      0.11      0.11      0.04      0.04
                   0.04      0.01      0.01      0.01      0.01      0.01      0.01      0.00      0.00      0.00
                   0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                   0.00      0.00

28 LG          GREEN AND AMPT LOSS RATE
                     STRTL        0.10  STARTING LOSS
                       DTH        0.23  MOISTURE DEFICIT
                      PSIF        6.20  WETTING FRONT SUCTION
                     XKSAT        0.15  HYDRAULIC CONDUCTIVITY
                     RTIMP       36.00  PERCENT IMPERVIOUS AREA

29 UC          CLARK UNITGRAPH
                        TC        0.45  TIME OF CONCENTRATION
                         R        0.46  STORAGE COEFFICIENT

30 UA          ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                     0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
                   100.0

                                                   ***

                                              UNIT HYDROGRAPH PARAMETERS
                                       CLARK   TC=  0.45 HR,       R=  0.46 HR
                                      SNYDER   TP=  0.31 HR,      CP=  0.44

                                                UNIT HYDROGRAPH
                                           32 END-OF-PERIOD ORDINATES
             35.      162.      298.      339.      324.      290.      248.      207.      172.      144.
            120.      100.       84.       70.       58.       48.       40.       34.       28.       23.
             20.       16.       14.       11.        9.        8.        7.        6.        5.        4.
              3.        3.

   ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION   SAC235

  TOTAL RAINFALL =    3.35, TOTAL LOSS =    0.87, TOTAL EXCESS =    2.48

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
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  (CFS)      (HR)                 6-HR       24-HR       72-HR     74.92-HR
   532.      4.25       (CFS)     100.        25.          8.          8.
                      (INCHES)   2.450       2.467       2.467       2.467
                       (AC-FT)     50.         50.         50.         50.

                      CUMULATIVE AREA =    0.38 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 32 KK      *      ADD   *
            *            *
            **************
                        ADD SAC230 & SAC235

 34 HC          HYDROGRAPH COMBINATION
                      ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

    ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION      ADD

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                 6-HR       24-HR       72-HR     74.92-HR
   1608.      4.17       (CFS)     278.        70.         23.         22.
                      (INCHES)   2.347       2.361       2.361       2.361
                       (AC-FT)    138.        139.        139.        139.

                      CUMULATIVE AREA =    1.10 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 35 KK      *     ROUTE  *
            *            *
            **************
                        ROUTE COMBINED HYDROGRAPH TO DAM LOCATION

            HYDROGRAPH ROUTING DATA

 37 RS          STORAGE ROUTING
                      NSTPS          1  NUMBER OF SUBREACHES
                       ITYP       FLOW  TYPE OF INITIAL CONDITION
                     RSVRIC      -1.00  INITIAL CONDITION
                          X       0.00 WORKING R AND D COEFFICIENT

 38 RC          NORMAL DEPTH CHANNEL
                        ANL      0.045  LEFT OVERBANK N-VALUE
                       ANCH      0.030  MAIN CHANNEL N-VALUE
                        ANR      0.045  RIGHT OVERBANK N-VALUE
                      RLNTH      4200.  REACH LENGTH
                        SEL     0.0175  ENERGY SLOPE
                      ELMAX        0.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION
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                                    CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 40 RY       ELEVATION     16.50     12.50     12.50     10.00     10.00     12.50     12.50     16.50
 39 RX       DISTANCE     463.50    467.50    477.50    487.50    512.50    522.50    532.50    536.50

                                                  ***

                                  COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE       0.00      0.87      1.83      2.88      4.02      5.25      6.57      7.98      9.93     12.10
          OUTFLOW       0.00     27.97     90.60    181.95    300.62    446.32    619.30    820.07   1082.86   1405.42
        ELEVATION      10.00     10.34     10.68     11.03     11.37     11.71     12.05     12.39     12.74     13.08

          STORAGE      14.29     16.51     18.75     21.01     23.29     25.60     27.93     30.28     32.65     35.05
          OUTFLOW    1769.68   2172.41   2611.51   3085.39   3592.83   4132.80   4704.46   5307.08   5940.05   6602.82
        ELEVATION      13.42     13.76     14.11     14.45     14.79     15.13     15.47     15.82     16.16     16.50


    ***           ***           ***           ***           ***

                      HYDROGRAPH AT STATION    ROUTE

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                   6-HR      24-HR      72-HR     74.92-HR
   1552.       4.25          (CFS)    277.       70.        23.        22.
                           (INCHES)   2.341     2.361      2.361      2.361
                           (AC-FT)    137.      139.       139.       139.

PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
  (AC-FT)      (HR)                   6-HR      24-HR      72-HR     74.92-HR
     13.       4.25                    3.         1.         0.         0.

 PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
   (FEET)      (HR)                   6-HR      24-HR      72-HR     74.92-HR
   13.22       4.25                  10.97      10.25      10.08      10.08

                        CUMULATIVE AREA =    1.10 SQ MI


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            **************
            *            *
 41 KK      *    CAS240  *
            *            *
            **************
                          SUB-BASIN cas240
                          6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
                          THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
                          BASIN MODIFIED FROM WICKENBERG ADMS TO REFLECT DAM LOCATION

              SUBBASIN RUNOFF DATA

 46 BA          SUBBASIN CHARACTERISTICS
                      TAREA        0.14  SUBBASIN AREA

                PRECIPITATION DATA

 14 PB                STORM        3.35  BASIN TOTAL PRECIPITATION

 14 PI            INCREMENTAL PRECIPITATION PATTERN
                    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
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                0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                0.00      0.00      0.00      0.01      0.01      0.01      0.01      0.01      0.01      0.03
                0.03      0.03      0.06      0.06      0.06      0.11      0.11      0.11      0.04      0.04
                0.04      0.01      0.01      0.01      0.01      0.01      0.01      0.00      0.00      0.00
                0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                0.00      0.00

 47 LG        GREEN AND AMPT LOSS RATE
                    STRTL        0.10  STARTING LOSS
                      DTH        0.21  MOISTURE DEFICIT
                     PSIF        6.40  WETTING FRONT SUCTION
                    XKSAT        0.14  HYDRAULIC CONDUCTIVITY
                    RTIMP       21.00  PERCENT IMPERVIOUS AREA

 48 UC        CLARK UNITGRAPH
                       TC        0.26  TIME OF CONCENTRATION
                        R        0.23  STORAGE COEFFICIENT

 49 UA        ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                  0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
                100.0

                                                  ***

                                              UNIT HYDROGRAPH PARAMETERS
                                        CLARK   TC=  0.26 HR,       R=  0.23 HR
                                       SNYDER   TP=  0.19 HR,      CP=  0.52

                                                UNIT HYDROGRAPH
                                            16 END-OF-PERIOD ORDINATES
            63.      187.      231.      182.      128.       89.       62.       43.       30.       21.
            15.       10.        7.        5.        3.        2.

    ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   CAS240

   TOTAL RAINFALL =    3.35, TOTAL LOSS =    1.03, TOTAL EXCESS =    2.32

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                  6-HR       24-HR       72-HR     74.92-HR
    275.       4.08        (CFS)      35.         9.          3.          3.
                         (INCHES)   2.300       2.305       2.305       2.305
                          (AC-FT)     17.         17.         17.         17.

                       CUMULATIVE AREA =    0.14 SQ MI


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           **************
           *            *
 51 KK     *     DAMIN  *
           *            *
           **************

 52 KO        OUTPUT CONTROL VARIABLES
                    IPRNT           1  PRINT CONTROL
                    IPLOT           0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE
                        ADD ROUTED HYDROGRAPH TO CAS240

 54 HC        HYDROGRAPH COMBINATION
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ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

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HYDROGRAPH AT STATION DAMIN
SUM OF 2 HYDROGRAPHS

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	1		1845	226	0.	2		1330	451	0.	3		0815	676	0.
1		0005	2	0.	1		1850	227	0.	2		1335	452	0.	3		0820	677	0.
1		0010	3	1.	1		1855	228	0.	2		1340	453	0.	3		0825	678	0.
1		0015	4	2.	1		1900	229	0.	2		1345	454	0.	3		0830	679	0.
1		0020	5	4.	1		1905	230	0.	2		1350	455	0.	3		0835	680	0.
1		0025	6	6.	1		1910	231	0.	2		1355	456	0.	3		0840	681	0.
1		0030	7	8.	1		1915	232	0.	2		1400	457	0.	3		0845	682	0.
1		0035	8	10.	1		1920	233	0.	2		1405	458	0.	3		0850	683	0.
1		0040	9	12.	1		1925	234	0.	2		1410	459	0.	3		0855	684	0.
1		0045	10	14.	1		1930	235	0.	2		1415	460	0.	3		0900	685	0.
1		0050	11	16.	1		1935	236	0.	2		1420	461	0.	3		0905	686	0.
1		0055	12	18.	1		1940	237	0.	2		1425	462	0.	3		0910	687	0.
1		0100	13	20.	1		1945	238	0.	2		1430	463	0.	3		0915	688	0.
1		0105	14	21.	1		1950	239	0.	2		1435	464	0.	3		0920	689	0.
1		0110	15	23.	1		1955	240	0.	2		1440	465	0.	3		0925	690	0.
1		0115	16	24.	1		2000	241	0.	2		1445	466	0.	3		0930	691	0.
1		0120	17	25.	1		2005	242	0.	2		1450	467	0.	3		0935	692	0.
1		0125	18	26.	1		2010	243	0.	2		1455	468	0.	3		0940	693	0.
1		0130	19	26.	1		2015	244	0.	2		1500	469	0.	3		0945	694	0.
1		0135	20	27.	1		2020	245	0.	2		1505	470	0.	3		0950	695	0.
1		0140	21	28.	1		2025	246	0.	2		1510	471	0.	3		0955	696	0.
1		0145	22	28.	1		2030	247	0.	2		1515	472	0.	3		1000	697	0.
1		0150	23	29.	1		2035	248	0.	2		1520	473	0.	3		1005	698	0.
1		0155	24	29.	1		2040	249	0.	2		1525	474	0.	3		1010	699	0.
1		0200	25	29.	1		2045	250	0.	2		1530	475	0.	3		1015	700	0.
1		0205	26	29.	1		2050	251	0.	2		1535	476	0.	3		1020	701	0.
1		0210	27	29.	1		2055	252	0.	2		1540	477	0.	3		1025	702	0.
1		0215	28	29.	1		2100	253	0.	2		1545	478	0.	3		1030	703	0.
1		0220	29	29.	1		2105	254	0.	2		1550	479	0.	3		1035	704	0.
1		0225	30	30.	1		2110	255	0.	2		1555	480	0.	3		1040	705	0.
1		0230	31	30.	1		2115	256	0.	2		1600	481	0.	3		1045	706	0.
1		0235	32	31.	1		2120	257	0.	2		1605	482	0.	3		1050	707	0.
1		0240	33	33.	1		2125	258	0.	2		1610	483	0.	3		1055	708	0.
1		0245	34	34.	1		2130	259	0.	2		1615	484	0.	3		1100	709	0.
1		0250	35	36.	1		2135	260	0.	2		1620	485	0.	3		1105	710	0.
1		0255	36	38.	1		2140	261	0.	2		1625	486	0.	3		1110	711	0.
1		0300	37	41.	1		2145	262	0.	2		1630	487	0.	3		1115	712	0.
1		0305	38	44.	1		2150	263	0.	2		1635	488	0.	3		1120	713	0.
1		0310	39	49.	1		2155	264	0.	2		1640	489	0.	3		1125	714	0.
1		0315	40	54.	1		2200	265	0.	2		1645	490	0.	3		1130	715	0.
1		0320	41	65.	1		2205	266	0.	2		1650	491	0.	3		1135	716	0.
1		0325	42	86.	1		2210	267	0.	2		1655	492	0.	3		1140	717	0.
1		0330	43	118.	1		2215	268	0.	2		1700	493	0.	3		1145	718	0.
1		0335	44	174.	1		2220	269	0.	2		1705	494	0.	3		1150	719	0.
1		0340	45	265.	1		2225	270	0.	2		1710	495	0.	3		1155	720	0.
1		0345	46	402.	1		2230	271	0.	2		1715	496	0.	3		1200	721	0.
1		0350	47	590.	1		2235	272	0.	2		1720	497	0.	3		1205	722	0.
1		0355	48	845.	1		2240	273	0.	2		1725	498	0.	3		1210	723	0.
1		0400	49	1157.	1		2245	274	0.	2		1730	499	0.	3		1215	724	0.
1		0405	50	1463.	1		2250	275	0.	2		1735	500	0.	3		1220	725	0.
1		0410	51	1685.	1		2255	276	0.	2		1740	501	0.	3		1225	726	0.
1		0415	52	1769.	1		2300	277	0.	2		1745	502	0.	3		1230	727	0.
1		0420	53	1723.	1		2305	278	0.	2		1750	503	0.	3		1235	728	0.

1	0425	54	1594.	*	1	2310	279	0.	*	2	1755	504	0.	*	3	1240	729	0.
1	0430	55	1425.	*	1	2315	280	0.	*	2	1800	505	0.	*	3	1245	730	0.
1	0435	56	1241.	*	1	2320	281	0.	*	2	1805	506	0.	*	3	1250	731	0.
1	0440	57	1066.	*	1	2325	282	0.	*	2	1810	507	0.	*	3	1255	732	0.
1	0445	58	907.	*	1	2330	283	0.	*	2	1815	508	0.	*	3	1300	733	0.
1	0450	59	762.	*	1	2335	284	0.	*	2	1820	509	0.	*	3	1305	734	0.
1	0455	60	637.	*	1	2340	285	0.	*	2	1825	510	0.	*	3	1310	735	0.
1	0500	61	536.	*	1	2345	286	0.	*	2	1830	511	0.	*	3	1315	736	0.
1	0505	62	449.	*	1	2350	287	0.	*	2	1835	512	0.	*	3	1320	737	0.
1	0510	63	378.	*	1	2355	288	0.	*	2	1840	513	0.	*	3	1325	738	0.
1	0515	64	317.	*	2	0000	289	0.	*	2	1845	514	0.	*	3	1330	739	0.
1	0520	65	269.	*	2	0005	290	0.	*	2	1850	515	0.	*	3	1335	740	0.
1	0525	66	229.	*	2	0010	291	0.	*	2	1855	516	0.	*	3	1340	741	0.
1	0530	67	195.	*	2	0015	292	0.	*	2	1900	517	0.	*	3	1345	742	0.
1	0535	68	169.	*	2	0020	293	0.	*	2	1905	518	0.	*	3	1350	743	0.
1	0540	69	148.	*	2	0025	294	0.	*	2	1910	519	0.	*	3	1355	744	0.
1	0545	70	129.	*	2	0030	295	0.	*	2	1915	520	0.	*	3	1400	745	0.
1	0550	71	112.	*	2	0035	296	0.	*	2	1920	521	0.	*	3	1405	746	0.
1	0555	72	98.	*	2	0040	297	0.	*	2	1925	522	0.	*	3	1410	747	0.
1	0600	73	88.	*	2	0045	298	0.	*	2	1930	523	0.	*	3	1415	748	0.
1	0605	74	79.	*	2	0050	299	0.	*	2	1935	524	0.	*	3	1420	749	0.
1	0610	75	70.	*	2	0055	300	0.	*	2	1940	525	0.	*	3	1425	750	0.
1	0615	76	62.	*	2	0100	301	0.	*	2	1945	526	0.	*	3	1430	751	0.
1	0620	77	53.	*	2	0105	302	0.	*	2	1950	527	0.	*	3	1435	752	0.
1	0625	78	45.	*	2	0110	303	0.	*	2	1955	528	0.	*	3	1440	753	0.
1	0630	79	37.	*	2	0115	304	0.	*	2	2000	529	0.	*	3	1445	754	0.
1	0635	80	31.	*	2	0120	305	0.	*	2	2005	530	0.	*	3	1450	755	0.
1	0640	81	26.	*	2	0125	306	0.	*	2	2010	531	0.	*	3	1455	756	0.
1	0645	82	23.	*	2	0130	307	0.	*	2	2015	532	0.	*	3	1500	757	0.
1	0650	83	20.	*	2	0135	308	0.	*	2	2020	533	0.	*	3	1505	758	0.
1	0655	84	18.	*	2	0140	309	0.	*	2	2025	534	0.	*	3	1510	759	0.
1	0700	85	15.	*	2	0145	310	0.	*	2	2030	535	0.	*	3	1515	760	0.
1	0705	86	13.	*	2	0150	311	0.	*	2	2035	536	0.	*	3	1520	761	0.
1	0710	87	11.	*	2	0155	312	0.	*	2	2040	537	0.	*	3	1525	762	0.
1	0715	88	10.	*	2	0200	313	0.	*	2	2045	538	0.	*	3	1530	763	0.
1	0720	89	8.	*	2	0205	314	0.	*	2	2050	539	0.	*	3	1535	764	0.
1	0725	90	7.	*	2	0210	315	0.	*	2	2055	540	0.	*	3	1540	765	0.
1	0730	91	6.	*	2	0215	316	0.	*	2	2100	541	0.	*	3	1545	766	0.
1	0735	92	5.	*	2	0220	317	0.	*	2	2105	542	0.	*	3	1550	767	0.
1	0740	93	4.	*	2	0225	318	0.	*	2	2110	543	0.	*	3	1555	768	0.
1	0745	94	3.	*	2	0230	319	0.	*	2	2115	544	0.	*	3	1600	769	0.
1	0750	95	3.	*	2	0235	320	0.	*	2	2120	545	0.	*	3	1605	770	0.
1	0755	96	2.	*	2	0240	321	0.	*	2	2125	546	0.	*	3	1610	771	0.
1	0800	97	2.	*	2	0245	322	0.	*	2	2130	547	0.	*	3	1615	772	0.
1	0805	98	2.	*	2	0250	323	0.	*	2	2135	548	0.	*	3	1620	773	0.
1	0810	99	1.	*	2	0255	324	0.	*	2	2140	549	0.	*	3	1625	774	0.
1	0815	100	1.	*	2	0300	325	0.	*	2	2145	550	0.	*	3	1630	775	0.
1	0820	101	1.	*	2	0305	326	0.	*	2	2150	551	0.	*	3	1635	776	0.
1	0825	102	1.	*	2	0310	327	0.	*	2	2155	552	0.	*	3	1640	777	0.
1	0830	103	1.	*	2	0315	328	0.	*	2	2200	553	0.	*	3	1645	778	0.
1	0835	104	0.	*	2	0320	329	0.	*	2	2205	554	0.	*	3	1650	779	0.
1	0840	105	0.	*	2	0325	330	0.	*	2	2210	555	0.	*	3	1655	780	0.
1	0845	106	0.	*	2	0330	331	0.	*	2	2215	556	0.	*	3	1700	781	0.
1	0850	107	0.	*	2	0335	332	0.	*	2	2220	557	0.	*	3	1705	782	0.
1	0855	108	0.	*	2	0340	333	0.	*	2	2225	558	0.	*	3	1710	783	0.
1	0900	109	0.	*	2	0345	334	0.	*	2	2230	559	0.	*	3	1715	784	0.
1	0905	110	0.	*	2	0350	335	0.	*	2	2235	560	0.	*	3	1720	785	0.
1	0910	111	0.	*	2	0355	336	0.	*	2	2240	561	0.	*	3	1725	786	0.
1	0915	112	0.	*	2	0400	337	0.	*	2	2245	562	0.	*	3	1730	787	0.
1	0920	113	0.	*	2	0405	338	0.	*	2	2250	563	0.	*	3	1735	788	0.
1	0925	114	0.	*	2	0410	339	0.	*	2	2255	564	0.	*	3	1740	789	0.
1	0930	115	0.	*	2	0415	340	0.	*	2	2300	565	0.	*	3	1745	790	0.
1	0935	116	0.	*	2	0420	341	0.	*	2	2305	566	0.	*	3	1750	791	0.
1	0940	117	0.	*	2	0425	342	0.	*	2	2310	567	0.	*	3	1755	792	0.
1	0945	118	0.	*	2	0430	343	0.	*	2	2315	568	0.	*	3	1800	793	0.
1	0950	119	0.	*	2	0435	344	0.	*	2	2320	569	0.	*	3	1805	794	0.

1	0955	120	0.	*	2	0440	345	0.	*	2	2325	570	0.	*	3	1810	795	0.
1	1000	121	0.	*	2	0445	346	0.	*	2	2330	571	0.	*	3	1815	796	0.
1	1005	122	0.	*	2	0450	347	0.	*	2	2335	572	0.	*	3	1820	797	0.
1	1010	123	0.	*	2	0455	348	0.	*	2	2340	573	0.	*	3	1825	798	0.
1	1015	124	0.	*	2	0500	349	0.	*	2	2345	574	0.	*	3	1830	799	0.
1	1020	125	0.	*	2	0505	350	0.	*	2	2350	575	0.	*	3	1835	800	0.
1	1025	126	0.	*	2	0510	351	0.	*	2	2355	576	0.	*	3	1840	801	0.
1	1030	127	0.	*	2	0515	352	0.	*	3	0000	577	0.	*	3	1845	802	0.
1	1035	128	0.	*	2	0520	353	0.	*	3	0005	578	0.	*	3	1850	803	0.
1	1040	129	0.	*	2	0525	354	0.	*	3	0010	579	0.	*	3	1855	804	0.
1	1045	130	0.	*	2	0530	355	0.	*	3	0015	580	0.	*	3	1900	805	0.
1	1050	131	0.	*	2	0535	356	0.	*	3	0020	581	0.	*	3	1905	806	0.
1	1055	132	0.	*	2	0540	357	0.	*	3	0025	582	0.	*	3	1910	807	0.
1	1100	133	0.	*	2	0545	358	0.	*	3	0030	583	0.	*	3	1915	808	0.
1	1105	134	0.	*	2	0550	359	0.	*	3	0035	584	0.	*	3	1920	809	0.
1	1110	135	0.	*	2	0555	360	0.	*	3	0040	585	0.	*	3	1925	810	0.
1	1115	136	0.	*	2	0600	361	0.	*	3	0045	586	0.	*	3	1930	811	0.
1	1120	137	0.	*	2	0605	362	0.	*	3	0050	587	0.	*	3	1935	812	0.
1	1125	138	0.	*	2	0610	363	0.	*	3	0055	588	0.	*	3	1940	813	0.
1	1130	139	0.	*	2	0615	364	0.	*	3	0100	589	0.	*	3	1945	814	0.
1	1135	140	0.	*	2	0620	365	0.	*	3	0105	590	0.	*	3	1950	815	0.
1	1140	141	0.	*	2	0625	366	0.	*	3	0110	591	0.	*	3	1955	816	0.
1	1145	142	0.	*	2	0630	367	0.	*	3	0115	592	0.	*	3	2000	817	0.
1	1150	143	0.	*	2	0635	368	0.	*	3	0120	593	0.	*	3	2005	818	0.
1	1155	144	0.	*	2	0640	369	0.	*	3	0125	594	0.	*	3	2010	819	0.
1	1200	145	0.	*	2	0645	370	0.	*	3	0130	595	0.	*	3	2015	820	0.
1	1205	146	0.	*	2	0650	371	0.	*	3	0135	596	0.	*	3	2020	821	0.
1	1210	147	0.	*	2	0655	372	0.	*	3	0140	597	0.	*	3	2025	822	0.
1	1215	148	0.	*	2	0700	373	0.	*	3	0145	598	0.	*	3	2030	823	0.
1	1220	149	0.	*	2	0705	374	0.	*	3	0150	599	0.	*	3	2035	824	0.
1	1225	150	0.	*	2	0710	375	0.	*	3	0155	600	0.	*	3	2040	825	0.
1	1230	151	0.	*	2	0715	376	0.	*	3	0200	601	0.	*	3	2045	826	0.
1	1235	152	0.	*	2	0720	377	0.	*	3	0205	602	0.	*	3	2050	827	0.
1	1240	153	0.	*	2	0725	378	0.	*	3	0210	603	0.	*	3	2055	828	0.
1	1245	154	0.	*	2	0730	379	0.	*	3	0215	604	0.	*	3	2100	829	0.
1	1250	155	0.	*	2	0735	380	0.	*	3	0220	605	0.	*	3	2105	830	0.
1	1255	156	0.	*	2	0740	381	0.	*	3	0225	606	0.	*	3	2110	831	0.
1	1300	157	0.	*	2	0745	382	0.	*	3	0230	607	0.	*	3	2115	832	0.
1	1305	158	0.	*	2	0750	383	0.	*	3	0235	608	0.	*	3	2120	833	0.
1	1310	159	0.	*	2	0755	384	0.	*	3	0240	609	0.	*	3	2125	834	0.
1	1315	160	0.	*	2	0800	385	0.	*	3	0245	610	0.	*	3	2130	835	0.
1	1320	161	0.	*	2	0805	386	0.	*	3	0250	611	0.	*	3	2135	836	0.
1	1325	162	0.	*	2	0810	387	0.	*	3	0255	612	0.	*	3	2140	837	0.
1	1330	163	0.	*	2	0815	388	0.	*	3	0300	613	0.	*	3	2145	838	0.
1	1335	164	0.	*	2	0820	389	0.	*	3	0305	614	0.	*	3	2150	839	0.
1	1340	165	0.	*	2	0825	390	0.	*	3	0310	615	0.	*	3	2155	840	0.
1	1345	166	0.	*	2	0830	391	0.	*	3	0315	616	0.	*	3	2200	841	0.
1	1350	167	0.	*	2	0835	392	0.	*	3	0320	617	0.	*	3	2205	842	0.
1	1355	168	0.	*	2	0840	393	0.	*	3	0325	618	0.	*	3	2210	843	0.
1	1400	169	0.	*	2	0845	394	0.	*	3	0330	619	0.	*	3	2215	844	0.
1	1405	170	0.	*	2	0850	395	0.	*	3	0335	620	0.	*	3	2220	845	0.
1	1410	171	0.	*	2	0855	396	0.	*	3	0340	621	0.	*	3	2225	846	0.
1	1415	172	0.	*	2	0900	397	0.	*	3	0345	622	0.	*	3	2230	847	0.
1	1420	173	0.	*	2	0905	398	0.	*	3	0350	623	0.	*	3	2235	848	0.
1	1425	174	0.	*	2	0910	399	0.	*	3	0355	624	0.	*	3	2240	849	0.
1	1430	175	0.	*	2	0915	400	0.	*	3	0400	625	0.	*	3	2245	850	0.
1	1435	176	0.	*	2	0920	401	0.	*	3	0405	626	0.	*	3	2250	851	0.
1	1440	177	0.	*	2	0925	402	0.	*	3	0410	627	0.	*	3	2255	852	0.
1	1445	178	0.	*	2	0930	403	0.	*	3	0415	628	0.	*	3	2300	853	0.
1	1450	179	0.	*	2	0935	404	0.	*	3	0420	629	0.	*	3	2305	854	0.
1	1455	180	0.	*	2	0940	405	0.	*	3	0425	630	0.	*	3	2310	855	0.
1	1500	181	0.	*	2	0945	406	0.	*	3	0430	631	0.	*	3	2315	856	0.
1	1505	182	0.	*	2	0950	407	0.	*	3	0435	632	0.	*	3	2320	857	0.
1	1510	183	0.	*	2	0955	408	0.	*	3	0440	633	0.	*	3	2325	858	0.
1	1515	184	0.	*	2	1000	409	0.	*	3	0445	634	0.	*	3	2330	859	0.
1	1520	185	0.	*	2	1005	410	0.	*	3	0450	635	0.	*	3	2335	860	0.

1	1525	186	0.	*	2	1010	411	0.	*	3	0455	636	0.	*	3	2340	861	0.
1	1530	187	0.	*	2	1015	412	0.	*	3	0500	637	0.	*	3	2345	862	0.
1	1535	188	0.	*	2	1020	413	0.	*	3	0505	638	0.	*	3	2350	863	0.
1	1540	189	0.	*	2	1025	414	0.	*	3	0510	639	0.	*	3	2355	864	0.
1	1545	190	0.	*	2	1030	415	0.	*	3	0515	640	0.	*	4	0000	865	0.
1	1550	191	0.	*	2	1035	416	0.	*	3	0520	641	0.	*	4	0005	866	0.
1	1555	192	0.	*	2	1040	417	0.	*	3	0525	642	0.	*	4	0010	867	0.
1	1600	193	0.	*	2	1045	418	0.	*	3	0530	643	0.	*	4	0015	868	0.
1	1605	194	0.	*	2	1050	419	0.	*	3	0535	644	0.	*	4	0020	869	0.
1	1610	195	0.	*	2	1055	420	0.	*	3	0540	645	0.	*	4	0025	870	0.
1	1615	196	0.	*	2	1100	421	0.	*	3	0545	646	0.	*	4	0030	871	0.
1	1620	197	0.	*	2	1105	422	0.	*	3	0550	647	0.	*	4	0035	872	0.
1	1625	198	0.	*	2	1110	423	0.	*	3	0555	648	0.	*	4	0040	873	0.
1	1630	199	0.	*	2	1115	424	0.	*	3	0600	649	0.	*	4	0045	874	0.
1	1635	200	0.	*	2	1120	425	0.	*	3	0605	650	0.	*	4	0050	875	0.
1	1640	201	0.	*	2	1125	426	0.	*	3	0610	651	0.	*	4	0055	876	0.
1	1645	202	0.	*	2	1130	427	0.	*	3	0615	652	0.	*	4	0100	877	0.
1	1650	203	0.	*	2	1135	428	0.	*	3	0620	653	0.	*	4	0105	878	0.
1	1655	204	0.	*	2	1140	429	0.	*	3	0625	654	0.	*	4	0110	879	0.
1	1700	205	0.	*	2	1145	430	0.	*	3	0630	655	0.	*	4	0115	880	0.
1	1705	206	0.	*	2	1150	431	0.	*	3	0635	656	0.	*	4	0120	881	0.
1	1710	207	0.	*	2	1155	432	0.	*	3	0640	657	0.	*	4	0125	882	0.
1	1715	208	0.	*	2	1200	433	0.	*	3	0645	658	0.	*	4	0130	883	0.
1	1720	209	0.	*	2	1205	434	0.	*	3	0650	659	0.	*	4	0135	884	0.
1	1725	210	0.	*	2	1210	435	0.	*	3	0655	660	0.	*	4	0140	885	0.
1	1730	211	0.	*	2	1215	436	0.	*	3	0700	661	0.	*	4	0145	886	0.
1	1735	212	0.	*	2	1220	437	0.	*	3	0705	662	0.	*	4	0150	887	0.
1	1740	213	0.	*	2	1225	438	0.	*	3	0710	663	0.	*	4	0155	888	0.
1	1745	214	0.	*	2	1230	439	0.	*	3	0715	664	0.	*	4	0200	889	0.
1	1750	215	0.	*	2	1235	440	0.	*	3	0720	665	0.	*	4	0205	890	0.
1	1755	216	0.	*	2	1240	441	0.	*	3	0725	666	0.	*	4	0210	891	0.
1	1800	217	0.	*	2	1245	442	0.	*	3	0730	667	0.	*	4	0215	892	0.
1	1805	218	0.	*	2	1250	443	0.	*	3	0735	668	0.	*	4	0220	893	0.
1	1810	219	0.	*	2	1255	444	0.	*	3	0740	669	0.	*	4	0225	894	0.
1	1815	220	0.	*	2	1300	445	0.	*	3	0745	670	0.	*	4	0230	895	0.
1	1820	221	0.	*	2	1305	446	0.	*	3	0750	671	0.	*	4	0235	896	0.
1	1825	222	0.	*	2	1310	447	0.	*	3	0755	672	0.	*	4	0240	897	0.
1	1830	223	0.	*	2	1315	448	0.	*	3	0800	673	0.	*	4	0245	898	0.
1	1835	224	0.	*	2	1320	449	0.	*	3	0805	674	0.	*	4	0250	899	0.
1	1840	225	0.	*	2	1325	450	0.	*	3	0810	675	0.	*	4	0255	900	0.
				*					*					*				

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PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	74.92-HR
1769.	4.25	(CFS)	312.	79.	26.	25.
		(INCHES)	2.336	2.355	2.355	2.355
		(AC-FT)	154.	156.	156.	156.

CUMULATIVE AREA = 1.24 SQ MI

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            **************
            *            *
 55 KK      *   DAMOUT   *
            *            *
            **************
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Route Hydrograph Through Dam.

59 KO OUTPUT CONTROL VARIABLES

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                    IPRNT          1  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

            HYDROGRAPH ROUTING DATA

 58 RS        STORAGE ROUTING
                    NSTPS          1  NUMBER OF SUBREACHES
                     ITYP       STOR  TYPE OF INITIAL CONDITION
                   RSVRIC       2.00  INITIAL CONDITION
                        X       0.00 WORKING R AND D COEFFICIENT

 60 SA            AREA        2.0       2.5       5.8       6.8       9.1      10.2      11.0      11.3      11.6      11.9
                             12.1      12.3      12.8      13.3      13.8

 62 SE        ELEVATION     2135.00   2137.00   2140.00   2144.00   2150.00   2153.00   2155.00   2156.00   2157.00   2158.00
                            2159.00   2160.00   2161.00   2162.00   2163.00

 64 SQ        DISCHARGE        0.        10.       14.       19.       23.       29.       31.      295.      823.     1539.
                             2423.     3450.     4577.     5773.     7015.
                                                          ***

                                          COMPUTED STORAGE-ELEVATION DATA

          STORAGE       0.00      4.53     16.62     41.74     89.06    117.93    139.09    150.24    161.71    173.46
        ELEVATION    2135.00   2137.00   2140.00   2144.00   2150.00   2153.00   2155.00   2156.00   2157.00   2158.00

          STORAGE     185.44    197.64    210.20    223.26    236.82
        ELEVATION    2159.00   2160.00   2161.00   2162.00   2163.00
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                                          HYDROGRAPH AT STATION   DAMOUT

*****************************************************************************************************************************
                                        *                                 *                                 *
 DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                        *                                 *
  1     0000   1      4.      2.0  2135.9 *  2     0100 301      25.     98.1  2150.9 *  3     0200 601      20.     52.4  2145.4
  1     0005   2      4.      2.0  2135.9 *  2     0105 302      25.     97.9  2150.9 *  3     0205 602      20.     52.3  2145.3
  1     0010   3      4.      1.9  2135.9 *  2     0110 303      25.     97.7  2150.9 *  3     0210 603      20.     52.2  2145.3
  1     0015   4      4.      1.9  2135.9 *  2     0115 304      25.     97.6  2150.9 *  3     0215 604      20.     52.0  2145.3
  1     0020   5      4.      1.9  2135.8 *  2     0120 305      25.     97.4  2150.9 *  3     0220 605      20.     51.9  2145.3
  1     0025   6      4.      1.9  2135.8 *  2     0125 306      25.     97.2  2150.8 *  3     0225 606      20.     51.8  2145.3
  1     0030   7      4.      1.9  2135.9 *  2     0130 307      25.     97.0  2150.8 *  3     0230 607      20.     51.6  2145.3
  1     0035   8      4.      2.0  2135.9 *  2     0135 308      25.     96.9  2150.8 *  3     0235 608      20.     51.5  2145.2
  1     0040   9      4.      2.0  2135.9 *  2     0140 309      25.     96.7  2150.8 *  3     0240 609      20.     51.3  2145.2
  1     0045  10      4.      2.1  2135.9 *  2     0145 310      25.     96.5  2150.8 *  3     0245 610      20.     51.2  2145.2
  1     0050  11      5.      2.2  2136.0 *  2     0150 311      25.     96.4  2150.8 *  3     0250 611      20.     51.1  2145.2
  1     0055  12      5.      2.2  2136.0 *  2     0155 312      25.     96.2  2150.7 *  3     0255 612      20.     50.9  2145.2
  1     0100  13      5.      2.3  2136.0 *  2     0200 313      25.     96.0  2150.7 *  3     0300 613      20.     50.8  2145.1
  1     0105  14      5.      2.4  2136.1 *  2     0205 314      25.     95.9  2150.7 *  3     0305 614      20.     50.7  2145.1
  1     0110  15      5.      2.6  2136.1 *  2     0210 315      25.     95.7  2150.7 *  3     0310 615      20.     50.5  2145.1
  1     0115  16      6.      2.7  2136.2 *  2     0215 316      24.     95.5  2150.7 *  3     0315 616      20.     50.4  2145.1
  1     0120  17      6.      2.8  2136.2 *  2     0220 317      24.     95.3  2150.7 *  3     0320 617      20.     50.2  2145.1
  1     0125  18      6.      2.9  2136.3 *  2     0225 318      24.     95.2  2150.6 *  3     0325 618      20.     50.1  2145.1
  1     0130  19      6.      3.1  2136.4 *  2     0230 319      24.     95.0  2150.6 *  3     0330 619      20.     50.0  2145.0
  1     0135  20      7.      3.2  2136.4 *  2     0235 320      24.     94.8  2150.6 *  3     0335 620      20.     49.8  2145.0
  1     0140  21      7.      3.4  2136.5 *  2     0240 321      24.     94.7  2150.6 *  3     0340 621      20.     49.7  2145.0
  1     0145  22      7.      3.5  2136.5 *  2     0245 322      24.     94.5  2150.6 *  3     0345 622      20.     49.6  2145.0
  1     0150  23      8.      3.6  2136.6 *  2     0250 323      24.     94.3  2150.5 *  3     0350 623      20.     49.4  2145.0
  1     0155  24      8.      3.8  2136.7 *  2     0255 324      24.     94.2  2150.5 *  3     0355 624      20.     49.3  2145.0
  1     0200  25      8.      3.9  2136.7 *  2     0300 325      24.     94.0  2150.5 *  3     0400 625      20.     49.2  2144.9
  1     0205  26      9.      4.1  2136.8 *  2     0305 326      24.     93.8  2150.5 *  3     0405 626      20.     49.0  2144.9
  1     0210  27      9.      4.2  2136.9 *  2     0310 327      24.     93.7  2150.5 *  3     0410 627      20.     48.9  2144.9
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1	0215	28	9.	4.3	2136.9	*	2	0315	328	24.	93.5	2150.5	*	3	0415	628	20.	48.7	2144.9
1	0220	29	9.	4.5	2137.0	*	2	0320	329	24.	93.3	2150.4	*	3	0420	629	20.	48.6	2144.9
1	0225	30	10.	4.6	2137.0	*	2	0325	330	24.	93.2	2150.4	*	3	0425	630	20.	48.5	2144.9
1	0230	31	10.	4.8	2137.1	*	2	0330	331	24.	93.0	2150.4	*	3	0430	631	20.	48.3	2144.8
1	0235	32	10.	4.9	2137.1	*	2	0335	332	24.	92.8	2150.4	*	3	0435	632	20.	48.2	2144.8
1	0240	33	10.	5.1	2137.1	*	2	0340	333	24.	92.7	2150.4	*	3	0440	633	20.	48.1	2144.8
1	0245	34	10.	5.2	2137.2	*	2	0345	334	24.	92.5	2150.4	*	3	0445	634	20.	47.9	2144.8
1	0250	35	10.	5.4	2137.2	*	2	0350	335	24.	92.3	2150.3	*	3	0450	635	20.	47.8	2144.8
1	0255	36	10.	5.6	2137.3	*	2	0355	336	24.	92.2	2150.3	*	3	0455	636	20.	47.7	2144.8
1	0300	37	10.	5.8	2137.3	*	2	0400	337	24.	92.0	2150.3	*	3	0500	637	20.	47.5	2144.7
1	0305	38	10.	6.0	2137.4	*	2	0405	338	24.	91.9	2150.3	*	3	0505	638	20.	47.4	2144.7
1	0310	39	10.	6.3	2137.4	*	2	0410	339	24.	91.7	2150.3	*	3	0510	639	20.	47.3	2144.7
1	0315	40	10.	6.6	2137.5	*	2	0415	340	24.	91.5	2150.3	*	3	0515	640	20.	47.1	2144.7
1	0320	41	10.	6.9	2137.6	*	2	0420	341	24.	91.4	2150.2	*	3	0520	641	20.	47.0	2144.7
1	0325	42	10.	7.3	2137.7	*	2	0425	342	24.	91.2	2150.2	*	3	0525	642	20.	46.8	2144.6
1	0330	43	11.	8.0	2137.9	*	2	0430	343	24.	91.0	2150.2	*	3	0530	643	20.	46.7	2144.6
1	0335	44	11.	8.9	2138.1	*	2	0435	344	24.	90.9	2150.2	*	3	0535	644	20.	46.6	2144.6
1	0340	45	11.	10.3	2138.4	*	2	0440	345	24.	90.7	2150.2	*	3	0540	645	20.	46.4	2144.6
1	0345	46	12.	12.5	2139.0	*	2	0445	346	24.	90.5	2150.2	*	3	0545	646	20.	46.3	2144.6
1	0350	47	13.	15.9	2139.8	*	2	0450	347	24.	90.4	2150.1	*	3	0550	647	19.	46.2	2144.6
1	0355	48	14.	20.7	2140.7	*	2	0455	348	24.	90.2	2150.1	*	3	0555	648	19.	46.0	2144.5
1	0400	49	16.	27.5	2141.7	*	2	0500	349	23.	90.1	2150.1	*	3	0600	649	19.	45.9	2144.5
1	0405	50	18.	36.4	2143.2	*	2	0505	350	23.	89.9	2150.1	*	3	0605	650	19.	45.8	2144.5
1	0410	51	20.	47.1	2144.7	*	2	0510	351	23.	89.7	2150.1	*	3	0610	651	19.	45.6	2144.5
1	0415	52	21.	58.9	2146.2	*	2	0515	352	23.	89.6	2150.1	*	3	0615	652	19.	45.5	2144.5
1	0420	53	22.	70.8	2147.7	*	2	0520	353	23.	89.4	2150.0	*	3	0620	653	19.	45.4	2144.5
1	0425	54	23.	82.0	2149.1	*	2	0525	354	23.	89.3	2150.0	*	3	0625	654	19.	45.2	2144.4
1	0430	55	24.	92.3	2150.3	*	2	0530	355	23.	89.1	2150.0	*	3	0630	655	19.	45.1	2144.4
1	0435	56	26.	101.3	2151.3	*	2	0535	356	23.	88.9	2150.0	*	3	0635	656	19.	45.0	2144.4
1	0440	57	27.	109.1	2152.1	*	2	0540	357	23.	88.8	2150.0	*	3	0640	657	19.	44.8	2144.4
1	0445	58	28.	115.7	2152.8	*	2	0545	358	23.	88.6	2149.9	*	3	0645	658	19.	44.7	2144.4
1	0450	59	29.	121.2	2153.3	*	2	0550	359	23.	88.5	2149.9	*	3	0650	659	19.	44.6	2144.4
1	0455	60	29.	125.8	2153.7	*	2	0555	360	23.	88.3	2149.9	*	3	0655	660	19.	44.4	2144.3
1	0500	61	30.	129.7	2154.1	*	2	0600	361	23.	88.1	2149.9	*	3	0700	661	19.	44.3	2144.3
1	0505	62	30.	132.8	2154.4	*	2	0605	362	23.	88.0	2149.9	*	3	0705	662	19.	44.2	2144.3
1	0510	63	31.	135.5	2154.7	*	2	0610	363	23.	87.8	2149.8	*	3	0710	663	19.	44.0	2144.3
1	0515	64	31.	137.7	2154.9	*	2	0615	364	23.	87.7	2149.8	*	3	0715	664	19.	43.9	2144.3
1	0520	65	39.	139.4	2155.0	*	2	0620	365	23.	87.5	2149.8	*	3	0720	665	19.	43.8	2144.3
1	0525	66	71.	140.8	2155.2	*	2	0625	366	23.	87.3	2149.8	*	3	0725	666	19.	43.6	2144.2
1	0530	67	92.	141.7	2155.2	*	2	0630	367	23.	87.2	2149.8	*	3	0730	667	19.	43.5	2144.2
1	0535	68	106.	142.3	2155.3	*	2	0635	368	23.	87.0	2149.7	*	3	0735	668	19.	43.4	2144.2
1	0540	69	114.	142.6	2155.3	*	2	0640	369	23.	86.9	2149.7	*	3	0740	669	19.	43.2	2144.2
1	0545	70	117.	142.7	2155.3	*	2	0645	370	23.	86.7	2149.7	*	3	0745	670	19.	43.1	2144.2
1	0550	71	118.	142.8	2155.3	*	2	0650	371	23.	86.5	2149.7	*	3	0750	671	19.	43.0	2144.2
1	0555	72	116.	142.7	2155.3	*	2	0655	372	23.	86.4	2149.7	*	3	0755	672	19.	42.8	2144.1
1	0600	73	113.	142.5	2155.3	*	2	0700	373	23.	86.2	2149.6	*	3	0800	673	19.	42.7	2144.1
1	0605	74	108.	142.4	2155.3	*	2	0705	374	23.	86.1	2149.6	*	3	0805	674	19.	42.6	2144.1
1	0610	75	103.	142.1	2155.3	*	2	0710	375	23.	85.9	2149.6	*	3	0810	675	19.	42.5	2144.1
1	0615	76	98.	141.9	2155.3	*	2	0715	376	23.	85.7	2149.6	*	3	0815	676	19.	42.3	2144.1
1	0620	77	91.	141.6	2155.2	*	2	0720	377	23.	85.6	2149.6	*	3	0820	677	19.	42.2	2144.1
1	0625	78	85.	141.4	2155.2	*	2	0725	378	23.	85.4	2149.5	*	3	0825	678	19.	42.1	2144.0
1	0630	79	78.	141.1	2155.2	*	2	0730	379	23.	85.3	2149.5	*	3	0830	679	19.	41.9	2144.0
1	0635	80	72.	140.8	2155.2	*	2	0735	380	23.	85.1	2149.5	*	3	0835	680	19.	41.8	2144.0
1	0640	81	65.	140.5	2155.1	*	2	0740	381	23.	85.0	2149.5	*	3	0840	681	19.	41.7	2144.0
1	0645	82	59.	140.3	2155.1	*	2	0745	382	23.	84.8	2149.5	*	3	0845	682	19.	41.5	2144.0
1	0650	83	54.	140.0	2155.1	*	2	0750	383	23.	84.6	2149.4	*	3	0850	683	19.	41.4	2143.9
1	0655	84	48.	139.8	2155.1	*	2	0755	384	23.	84.5	2149.4	*	3	0855	684	19.	41.3	2143.9
1	0700	85	44.	139.6	2155.0	*	2	0800	385	23.	84.3	2149.4	*	3	0900	685	19.	41.1	2143.9
1	0705	86	39.	139.4	2155.0	*	2	0805	386	23.	84.2	2149.4	*	3	0905	686	19.	41.0	2143.9
1	0710	87	35.	139.3	2155.0	*	2	0810	387	23.	84.0	2149.4	*	3	0910	687	19.	40.9	2143.9
1	0715	88	31.	139.1	2155.0	*	2	0815	388	23.	83.9	2149.3	*	3	0915	688	19.	40.7	2143.8
1	0720	89	31.	139.0	2155.0	*	2	0820	389	23.	83.7	2149.3	*	3	0920	689	19.	40.6	2143.8
1	0725	90	31.	138.8	2155.0	*	2	0825	390	23.	83.5	2149.3	*	3	0925	690	19.	40.5	2143.8
1	0730	91	31.	138.6	2155.0	*	2	0830	391	23.	83.4	2149.3	*	3	0930	691	19.	40.4	2143.8
1	0735	92	31.	138.4	2154.9	*	2	0835	392	23.	83.2	2149.3	*	3	0935	692	19.	40.2	2143.8
1	0740	93	31.	138.3	2154.9	*	2	0840	393	23.	83.1	2149.2	*	3	0940	693	19.	40.1	2143.7

1	0745	94	31.	138.1	2154.9	*	2	0845	394	23.	82.9	2149.2	*	3	0945	694	19.	40.0	2143.7
1	0750	95	31.	137.9	2154.9	*	2	0850	395	23.	82.8	2149.2	*	3	0950	695	19.	39.8	2143.7
1	0755	96	31.	137.7	2154.9	*	2	0855	396	23.	82.6	2149.2	*	3	0955	696	19.	39.7	2143.7
1	0800	97	31.	137.5	2154.8	*	2	0900	397	23.	82.4	2149.2	*	3	1000	697	19.	39.6	2143.7
1	0805	98	31.	137.3	2154.8	*	2	0905	398	23.	82.3	2149.1	*	3	1005	698	19.	39.5	2143.6
1	0810	99	31.	137.1	2154.8	*	2	0910	399	23.	82.1	2149.1	*	3	1010	699	19.	39.3	2143.6
1	0815	100	31.	136.9	2154.8	*	2	0915	400	23.	82.0	2149.1	*	3	1015	700	19.	39.2	2143.6
1	0820	101	31.	136.7	2154.8	*	2	0920	401	23.	81.8	2149.1	*	3	1020	701	19.	39.1	2143.6
1	0825	102	31.	136.5	2154.8	*	2	0925	402	23.	81.7	2149.1	*	3	1025	702	18.	38.9	2143.6
1	0830	103	31.	136.3	2154.7	*	2	0930	403	23.	81.5	2149.0	*	3	1030	703	18.	38.8	2143.5
1	0835	104	31.	136.1	2154.7	*	2	0935	404	23.	81.3	2149.0	*	3	1035	704	18.	38.7	2143.5
1	0840	105	31.	135.9	2154.7	*	2	0940	405	23.	81.2	2149.0	*	3	1040	705	18.	38.6	2143.5
1	0845	106	31.	135.7	2154.7	*	2	0945	406	23.	81.0	2149.0	*	3	1045	706	18.	38.4	2143.5
1	0850	107	31.	135.4	2154.7	*	2	0950	407	23.	80.9	2149.0	*	3	1050	707	18.	38.3	2143.5
1	0855	108	30.	135.2	2154.6	*	2	0955	408	23.	80.7	2148.9	*	3	1055	708	18.	38.2	2143.4
1	0900	109	30.	135.0	2154.6	*	2	1000	409	23.	80.6	2148.9	*	3	1100	709	18.	38.1	2143.4
1	0905	110	30.	134.8	2154.6	*	2	1005	410	23.	80.4	2148.9	*	3	1105	710	18.	37.9	2143.4
1	0910	111	30.	134.6	2154.6	*	2	1010	411	23.	80.3	2148.9	*	3	1110	711	18.	37.8	2143.4
1	0915	112	30.	134.4	2154.6	*	2	1015	412	23.	80.1	2148.9	*	3	1115	712	18.	37.7	2143.4
1	0920	113	30.	134.2	2154.5	*	2	1020	413	22.	80.0	2148.8	*	3	1120	713	18.	37.6	2143.3
1	0925	114	30.	134.0	2154.5	*	2	1025	414	22.	79.8	2148.8	*	3	1125	714	18.	37.4	2143.3
1	0930	115	30.	133.8	2154.5	*	2	1030	415	22.	79.6	2148.8	*	3	1130	715	18.	37.3	2143.3
1	0935	116	30.	133.6	2154.5	*	2	1035	416	22.	79.5	2148.8	*	3	1135	716	18.	37.2	2143.3
1	0940	117	30.	133.4	2154.5	*	2	1040	417	22.	79.3	2148.8	*	3	1140	717	18.	37.1	2143.3
1	0945	118	30.	133.1	2154.4	*	2	1045	418	22.	79.2	2148.7	*	3	1145	718	18.	36.9	2143.2
1	0950	119	30.	132.9	2154.4	*	2	1050	419	22.	79.0	2148.7	*	3	1150	719	18.	36.8	2143.2
1	0955	120	30.	132.7	2154.4	*	2	1055	420	22.	78.9	2148.7	*	3	1155	720	18.	36.7	2143.2
1	1000	121	30.	132.5	2154.4	*	2	1100	421	22.	78.7	2148.7	*	3	1200	721	18.	36.6	2143.2
1	1005	122	30.	132.3	2154.4	*	2	1105	422	22.	78.6	2148.7	*	3	1205	722	18.	36.4	2143.2
1	1010	123	30.	132.1	2154.3	*	2	1110	423	22.	78.4	2148.6	*	3	1210	723	18.	36.3	2143.1
1	1015	124	30.	131.9	2154.3	*	2	1115	424	22.	78.3	2148.6	*	3	1215	724	18.	36.2	2143.1
1	1020	125	30.	131.7	2154.3	*	2	1120	425	22.	78.1	2148.6	*	3	1220	725	18.	36.1	2143.1
1	1025	126	30.	131.5	2154.3	*	2	1125	426	22.	77.9	2148.6	*	3	1225	726	18.	35.9	2143.1
1	1030	127	30.	131.3	2154.3	*	2	1130	427	22.	77.8	2148.6	*	3	1230	727	18.	35.8	2143.1
1	1035	128	30.	131.1	2154.2	*	2	1135	428	22.	77.6	2148.6	*	3	1235	728	18.	35.7	2143.0
1	1040	129	30.	130.9	2154.2	*	2	1140	429	22.	77.5	2148.5	*	3	1240	729	18.	35.6	2143.0
1	1045	130	30.	130.7	2154.2	*	2	1145	430	22.	77.3	2148.5	*	3	1245	730	18.	35.5	2143.0
1	1050	131	30.	130.5	2154.2	*	2	1150	431	22.	77.2	2148.5	*	3	1250	731	18.	35.3	2143.0
1	1055	132	30.	130.2	2154.2	*	2	1155	432	22.	77.0	2148.5	*	3	1255	732	18.	35.2	2143.0
1	1100	133	30.	130.0	2154.1	*	2	1200	433	22.	76.9	2148.5	*	3	1300	733	18.	35.1	2142.9
1	1105	134	30.	129.8	2154.1	*	2	1205	434	22.	76.7	2148.4	*	3	1305	734	18.	35.0	2142.9
1	1110	135	30.	129.6	2154.1	*	2	1210	435	22.	76.6	2148.4	*	3	1310	735	18.	34.8	2142.9
1	1115	136	30.	129.4	2154.1	*	2	1215	436	22.	76.4	2148.4	*	3	1315	736	18.	34.7	2142.9
1	1120	137	30.	129.2	2154.1	*	2	1220	437	22.	76.3	2148.4	*	3	1320	737	18.	34.6	2142.9
1	1125	138	30.	129.0	2154.0	*	2	1225	438	22.	76.1	2148.4	*	3	1325	738	17.	34.5	2142.8
1	1130	139	30.	128.8	2154.0	*	2	1230	439	22.	76.0	2148.3	*	3	1330	739	17.	34.4	2142.8
1	1135	140	30.	128.6	2154.0	*	2	1235	440	22.	75.8	2148.3	*	3	1335	740	17.	34.2	2142.8
1	1140	141	30.	128.4	2154.0	*	2	1240	441	22.	75.7	2148.3	*	3	1340	741	17.	34.1	2142.8
1	1145	142	30.	128.2	2154.0	*	2	1245	442	22.	75.5	2148.3	*	3	1345	742	17.	34.0	2142.8
1	1150	143	30.	128.0	2154.0	*	2	1250	443	22.	75.3	2148.3	*	3	1350	743	17.	33.9	2142.7
1	1155	144	30.	127.8	2153.9	*	2	1255	444	22.	75.2	2148.2	*	3	1355	744	17.	33.8	2142.7
1	1200	145	30.	127.6	2153.9	*	2	1300	445	22.	75.0	2148.2	*	3	1400	745	17.	33.6	2142.7
1	1205	146	30.	127.4	2153.9	*	2	1305	446	22.	74.9	2148.2	*	3	1405	746	17.	33.5	2142.7
1	1210	147	30.	127.2	2153.9	*	2	1310	447	22.	74.7	2148.2	*	3	1410	747	17.	33.4	2142.7
1	1215	148	30.	127.0	2153.9	*	2	1315	448	22.	74.6	2148.2	*	3	1415	748	17.	33.3	2142.7
1	1220	149	30.	126.8	2153.8	*	2	1320	449	22.	74.4	2148.1	*	3	1420	749	17.	33.2	2142.6
1	1225	150	30.	126.6	2153.8	*	2	1325	450	22.	74.3	2148.1	*	3	1425	750	17.	33.1	2142.6
1	1230	151	30.	126.4	2153.8	*	2	1330	451	22.	74.1	2148.1	*	3	1430	751	17.	32.9	2142.6
1	1235	152	29.	126.2	2153.8	*	2	1335	452	22.	74.0	2148.1	*	3	1435	752	17.	32.8	2142.6
1	1240	153	29.	126.0	2153.8	*	2	1340	453	22.	73.8	2148.1	*	3	1440	753	17.	32.7	2142.6
1	1245	154	29.	125.7	2153.7	*	2	1345	454	22.	73.7	2148.0	*	3	1445	754	17.	32.6	2142.5
1	1250	155	29.	125.5	2153.7	*	2	1350	455	22.	73.5	2148.0	*	3	1450	755	17.	32.5	2142.5
1	1255	156	29.	125.3	2153.7	*	2	1355	456	22.	73.4	2148.0	*	3	1455	756	17.	32.3	2142.5
1	1300	157	29.	125.1	2153.7	*	2	1400	457	22.	73.2	2148.0	*	3	1500	757	17.	32.2	2142.5
1	1305	158	29.	124.9	2153.7	*	2	1405	458	22.	73.1	2148.0	*	3	1505	758	17.	32.1	2142.5
1	1310	159	29.	124.7	2153.6	*	2	1410	459	22.	72.9	2148.0	*	3	1510	759	17.	32.0	2142.4

1	1315	160	29.	124.5	2153.6	*	2	1415	460	22.	72.8	2147.9	*	3	1515	760	17.	31.9	2142.4
1	1320	161	29.	124.3	2153.6	*	2	1420	461	22.	72.6	2147.9	*	3	1520	761	17.	31.8	2142.4
1	1325	162	29.	124.1	2153.6	*	2	1425	462	22.	72.5	2147.9	*	3	1525	762	17.	31.7	2142.4
1	1330	163	29.	123.9	2153.6	*	2	1430	463	22.	72.3	2147.9	*	3	1530	763	17.	31.5	2142.4
1	1335	164	29.	123.7	2153.5	*	2	1435	464	22.	72.2	2147.9	*	3	1535	764	17.	31.4	2142.4
1	1340	165	29.	123.5	2153.5	*	2	1440	465	22.	72.0	2147.8	*	3	1540	765	17.	31.3	2142.3
1	1345	166	29.	123.3	2153.5	*	2	1445	466	22.	71.9	2147.8	*	3	1545	766	17.	31.2	2142.3
1	1350	167	29.	123.1	2153.5	*	2	1450	467	22.	71.7	2147.8	*	3	1550	767	17.	31.1	2142.3
1	1355	168	29.	122.9	2153.5	*	2	1455	468	22.	71.6	2147.8	*	3	1555	768	17.	31.0	2142.3
1	1400	169	29.	122.7	2153.5	*	2	1500	469	22.	71.4	2147.8	*	3	1600	769	17.	30.8	2142.3
1	1405	170	29.	122.5	2153.4	*	2	1505	470	22.	71.3	2147.7	*	3	1605	770	17.	30.7	2142.2
1	1410	171	29.	122.3	2153.4	*	2	1510	471	22.	71.1	2147.7	*	3	1610	771	17.	30.6	2142.2
1	1415	172	29.	122.1	2153.4	*	2	1515	472	22.	71.0	2147.7	*	3	1615	772	17.	30.5	2142.2
1	1420	173	29.	121.9	2153.4	*	2	1520	473	22.	70.8	2147.7	*	3	1620	773	17.	30.4	2142.2
1	1425	174	29.	121.7	2153.4	*	2	1525	474	22.	70.7	2147.7	*	3	1625	774	17.	30.3	2142.2
1	1430	175	29.	121.5	2153.3	*	2	1530	475	22.	70.5	2147.7	*	3	1630	775	17.	30.2	2142.2
1	1435	176	29.	121.3	2153.3	*	2	1535	476	22.	70.4	2147.6	*	3	1635	776	16.	30.0	2142.1
1	1440	177	29.	121.1	2153.3	*	2	1540	477	22.	70.2	2147.6	*	3	1640	777	16.	29.9	2142.1
1	1445	178	29.	120.9	2153.3	*	2	1545	478	22.	70.1	2147.6	*	3	1645	778	16.	29.8	2142.1
1	1450	179	29.	120.7	2153.3	*	2	1550	479	22.	69.9	2147.6	*	3	1650	779	16.	29.7	2142.1
1	1455	180	29.	120.5	2153.2	*	2	1555	480	22.	69.8	2147.6	*	3	1655	780	16.	29.6	2142.1
1	1500	181	29.	120.3	2153.2	*	2	1600	481	22.	69.6	2147.5	*	3	1700	781	16.	29.5	2142.0
1	1505	182	29.	120.1	2153.2	*	2	1605	482	22.	69.5	2147.5	*	3	1705	782	16.	29.4	2142.0
1	1510	183	29.	119.9	2153.2	*	2	1610	483	22.	69.3	2147.5	*	3	1710	783	16.	29.3	2142.0
1	1515	184	29.	119.7	2153.2	*	2	1615	484	22.	69.2	2147.5	*	3	1715	784	16.	29.1	2142.0
1	1520	185	29.	119.5	2153.2	*	2	1620	485	22.	69.0	2147.5	*	3	1720	785	16.	29.0	2142.0
1	1525	186	29.	119.3	2153.1	*	2	1625	486	22.	68.9	2147.4	*	3	1725	786	16.	28.9	2142.0
1	1530	187	29.	119.1	2153.1	*	2	1630	487	21.	68.7	2147.4	*	3	1730	787	16.	28.8	2141.9
1	1535	188	29.	118.9	2153.1	*	2	1635	488	21.	68.6	2147.4	*	3	1735	788	16.	28.7	2141.9
1	1540	189	29.	118.7	2153.1	*	2	1640	489	21.	68.4	2147.4	*	3	1740	789	16.	28.6	2141.9
1	1545	190	29.	118.5	2153.1	*	2	1645	490	21.	68.3	2147.4	*	3	1745	790	16.	28.5	2141.9
1	1550	191	29.	118.3	2153.0	*	2	1650	491	21.	68.2	2147.3	*	3	1750	791	16.	28.4	2141.9
1	1555	192	29.	118.2	2153.0	*	2	1655	492	21.	68.0	2147.3	*	3	1755	792	16.	28.2	2141.9
1	1600	193	29.	118.0	2153.0	*	2	1700	493	21.	67.9	2147.3	*	3	1800	793	16.	28.1	2141.8
1	1605	194	29.	117.8	2153.0	*	2	1705	494	21.	67.7	2147.3	*	3	1805	794	16.	28.0	2141.8
1	1610	195	29.	117.6	2153.0	*	2	1710	495	21.	67.6	2147.3	*	3	1810	795	16.	27.9	2141.8
1	1615	196	28.	117.4	2152.9	*	2	1715	496	21.	67.4	2147.3	*	3	1815	796	16.	27.8	2141.8
1	1620	197	28.	117.2	2152.9	*	2	1720	497	21.	67.3	2147.2	*	3	1820	797	16.	27.7	2141.8
1	1625	198	28.	117.0	2152.9	*	2	1725	498	21.	67.1	2147.2	*	3	1825	798	16.	27.6	2141.7
1	1630	199	28.	116.8	2152.9	*	2	1730	499	21.	67.0	2147.2	*	3	1830	799	16.	27.5	2141.7
1	1635	200	28.	116.6	2152.9	*	2	1735	500	21.	66.8	2147.2	*	3	1835	800	16.	27.4	2141.7
1	1640	201	28.	116.4	2152.8	*	2	1740	501	21.	66.7	2147.2	*	3	1840	801	16.	27.3	2141.7
1	1645	202	28.	116.2	2152.8	*	2	1745	502	21.	66.5	2147.1	*	3	1845	802	16.	27.1	2141.7
1	1650	203	28.	116.0	2152.8	*	2	1750	503	21.	66.4	2147.1	*	3	1850	803	16.	27.0	2141.7
1	1655	204	28.	115.8	2152.8	*	2	1755	504	21.	66.2	2147.1	*	3	1855	804	16.	26.9	2141.6
1	1700	205	28.	115.6	2152.8	*	2	1800	505	21.	66.1	2147.1	*	3	1900	805	16.	26.8	2141.6
1	1705	206	28.	115.4	2152.7	*	2	1805	506	21.	65.9	2147.1	*	3	1905	806	16.	26.7	2141.6
1	1710	207	28.	115.2	2152.7	*	2	1810	507	21.	65.8	2147.1	*	3	1910	807	16.	26.6	2141.6
1	1715	208	28.	115.0	2152.7	*	2	1815	508	21.	65.7	2147.0	*	3	1915	808	16.	26.5	2141.6
1	1720	209	28.	114.8	2152.7	*	2	1820	509	21.	65.5	2147.0	*	3	1920	809	16.	26.4	2141.6
1	1725	210	28.	114.6	2152.7	*	2	1825	510	21.	65.4	2147.0	*	3	1925	810	16.	26.3	2141.5
1	1730	211	28.	114.4	2152.6	*	2	1830	511	21.	65.2	2147.0	*	3	1930	811	16.	26.2	2141.5
1	1735	212	28.	114.3	2152.6	*	2	1835	512	21.	65.1	2147.0	*	3	1935	812	16.	26.1	2141.5
1	1740	213	28.	114.1	2152.6	*	2	1840	513	21.	64.9	2146.9	*	3	1940	813	16.	26.0	2141.5
1	1745	214	28.	113.9	2152.6	*	2	1845	514	21.	64.8	2146.9	*	3	1945	814	16.	25.9	2141.5
1	1750	215	28.	113.7	2152.6	*	2	1850	515	21.	64.6	2146.9	*	3	1950	815	16.	25.7	2141.5
1	1755	216	28.	113.5	2152.5	*	2	1855	516	21.	64.5	2146.9	*	3	1955	816	16.	25.6	2141.4
1	1800	217	28.	113.3	2152.5	*	2	1900	517	21.	64.3	2146.9	*	3	2000	817	15.	25.5	2141.4
1	1805	218	28.	113.1	2152.5	*	2	1905	518	21.	64.2	2146.8	*	3	2005	818	15.	25.4	2141.4
1	1810	219	28.	112.9	2152.5	*	2	1910	519	21.	64.1	2146.8	*	3	2010	819	15.	25.3	2141.4
1	1815	220	28.	112.7	2152.5	*	2	1915	520	21.	63.9	2146.8	*	3	2015	820	15.	25.2	2141.4
1	1820	221	28.	112.5	2152.4	*	2	1920	521	21.	63.8	2146.8	*	3	2020	821	15.	25.1	2141.4
1	1825	222	28.	112.3	2152.4	*	2	1925	522	21.	63.6	2146.8	*	3	2025	822	15.	25.0	2141.3
1	1830	223	28.	112.2	2152.4	*	2	1930	523	21.	63.5	2146.8	*	3	2030	823	15.	24.9	2141.3
1	1835	224	28.	112.0	2152.4	*	2	1935	524	21.	63.3	2146.7	*	3	2035	824	15.	24.8	2141.3
1	1840	225	27.	111.8	2152.4	*	2	1940	525	21.	63.2	2146.7	*	3	2040	825	15.	24.7	2141.3

1	1845	226	27.	111.6	2152.3	*	2	1945	526	21.	63.0	2146.7	*	3	2045	826	15.	24.6	2141.3
1	1850	227	27.	111.4	2152.3	*	2	1950	527	21.	62.9	2146.7	*	3	2050	827	15.	24.5	2141.3
1	1855	228	27.	111.2	2152.3	*	2	1955	528	21.	62.7	2146.7	*	3	2055	828	15.	24.4	2141.2
1	1900	229	27.	111.0	2152.3	*	2	2000	529	21.	62.6	2146.6	*	3	2100	829	15.	24.3	2141.2
1	1905	230	27.	110.8	2152.3	*	2	2005	530	21.	62.5	2146.6	*	3	2105	830	15.	24.2	2141.2
1	1910	231	27.	110.6	2152.2	*	2	2010	531	21.	62.3	2146.6	*	3	2110	831	15.	24.1	2141.2
1	1915	232	27.	110.5	2152.2	*	2	2015	532	21.	62.2	2146.6	*	3	2115	832	15.	23.9	2141.2
1	1920	233	27.	110.3	2152.2	*	2	2020	533	21.	62.0	2146.6	*	3	2120	833	15.	23.8	2141.2
1	1925	234	27.	110.1	2152.2	*	2	2025	534	21.	61.9	2146.6	*	3	2125	834	15.	23.7	2141.1
1	1930	235	27.	109.9	2152.2	*	2	2030	535	21.	61.7	2146.5	*	3	2130	835	15.	23.6	2141.1
1	1935	236	27.	109.7	2152.1	*	2	2035	536	21.	61.6	2146.5	*	3	2135	836	15.	23.5	2141.1
1	1940	237	27.	109.5	2152.1	*	2	2040	537	21.	61.5	2146.5	*	3	2140	837	15.	23.4	2141.1
1	1945	238	27.	109.3	2152.1	*	2	2045	538	21.	61.3	2146.5	*	3	2145	838	15.	23.3	2141.1
1	1950	239	27.	109.2	2152.1	*	2	2050	539	21.	61.2	2146.5	*	3	2150	839	15.	23.2	2141.1
1	1955	240	27.	109.0	2152.1	*	2	2055	540	21.	61.0	2146.4	*	3	2155	840	15.	23.1	2141.0
1	2000	241	27.	108.8	2152.0	*	2	2100	541	21.	60.9	2146.4	*	3	2200	841	15.	23.0	2141.0
1	2005	242	27.	108.6	2152.0	*	2	2105	542	21.	60.7	2146.4	*	3	2205	842	15.	22.9	2141.0
1	2010	243	27.	108.4	2152.0	*	2	2110	543	21.	60.6	2146.4	*	3	2210	843	15.	22.8	2141.0
1	2015	244	27.	108.2	2152.0	*	2	2115	544	21.	60.5	2146.4	*	3	2215	844	15.	22.7	2141.0
1	2020	245	27.	108.0	2152.0	*	2	2120	545	21.	60.3	2146.4	*	3	2220	845	15.	22.6	2141.0
1	2025	246	27.	107.9	2152.0	*	2	2125	546	21.	60.2	2146.3	*	3	2225	846	15.	22.5	2140.9
1	2030	247	27.	107.7	2151.9	*	2	2130	547	21.	60.0	2146.3	*	3	2230	847	15.	22.4	2140.9
1	2035	248	27.	107.5	2151.9	*	2	2135	548	21.	59.9	2146.3	*	3	2235	848	15.	22.3	2140.9
1	2040	249	27.	107.3	2151.9	*	2	2140	549	21.	59.7	2146.3	*	3	2240	849	15.	22.2	2140.9
1	2045	250	27.	107.1	2151.9	*	2	2145	550	21.	59.6	2146.3	*	3	2245	850	15.	22.1	2140.9
1	2050	251	27.	106.9	2151.9	*	2	2150	551	21.	59.5	2146.2	*	3	2250	851	15.	22.0	2140.9
1	2055	252	27.	106.8	2151.8	*	2	2155	552	21.	59.3	2146.2	*	3	2255	852	15.	21.9	2140.8
1	2100	253	27.	106.6	2151.8	*	2	2200	553	21.	59.2	2146.2	*	3	2300	853	15.	21.8	2140.8
1	2105	254	26.	106.4	2151.8	*	2	2205	554	21.	59.0	2146.2	*	3	2305	854	15.	21.7	2140.8
1	2110	255	26.	106.2	2151.8	*	2	2210	555	21.	58.9	2146.2	*	3	2310	855	15.	21.6	2140.8
1	2115	256	26.	106.0	2151.8	*	2	2215	556	21.	58.7	2146.2	*	3	2315	856	15.	21.5	2140.8
1	2120	257	26.	105.8	2151.7	*	2	2220	557	21.	58.6	2146.1	*	3	2320	857	15.	21.4	2140.8
1	2125	258	26.	105.7	2151.7	*	2	2225	558	21.	58.5	2146.1	*	3	2325	858	15.	21.3	2140.7
1	2130	259	26.	105.5	2151.7	*	2	2230	559	21.	58.3	2146.1	*	3	2330	859	15.	21.2	2140.7
1	2135	260	26.	105.3	2151.7	*	2	2235	560	21.	58.2	2146.1	*	3	2335	860	14.	21.1	2140.7
1	2140	261	26.	105.1	2151.7	*	2	2240	561	21.	58.0	2146.1	*	3	2340	861	14.	21.0	2140.7
1	2145	262	26.	104.9	2151.6	*	2	2245	562	21.	57.9	2146.0	*	3	2345	862	14.	20.9	2140.7
1	2150	263	26.	104.8	2151.6	*	2	2250	563	21.	57.7	2146.0	*	3	2350	863	14.	20.8	2140.7
1	2155	264	26.	104.6	2151.6	*	2	2255	564	21.	57.6	2146.0	*	3	2355	864	14.	20.7	2140.6
1	2200	265	26.	104.4	2151.6	*	2	2300	565	20.	57.5	2146.0	*	4	0000	865	14.	20.6	2140.6
1	2205	266	26.	104.2	2151.6	*	2	2305	566	20.	57.3	2146.0	*	4	0005	866	14.	20.5	2140.6
1	2210	267	26.	104.0	2151.6	*	2	2310	567	20.	57.2	2146.0	*	4	0010	867	14.	20.4	2140.6
1	2215	268	26.	103.9	2151.5	*	2	2315	568	20.	57.0	2145.9	*	4	0015	868	14.	20.3	2140.6
1	2220	269	26.	103.7	2151.5	*	2	2320	569	20.	56.9	2145.9	*	4	0020	869	14.	20.2	2140.6
1	2225	270	26.	103.5	2151.5	*	2	2325	570	20.	56.8	2145.9	*	4	0025	870	14.	20.1	2140.6
1	2230	271	26.	103.3	2151.5	*	2	2330	571	20.	56.6	2145.9	*	4	0030	871	14.	20.0	2140.5
1	2235	272	26.	103.1	2151.5	*	2	2335	572	20.	56.5	2145.9	*	4	0035	872	14.	19.9	2140.5
1	2240	273	26.	103.0	2151.4	*	2	2340	573	20.	56.3	2145.9	*	4	0040	873	14.	19.8	2140.5
1	2245	274	26.	102.8	2151.4	*	2	2345	574	20.	56.2	2145.8	*	4	0045	874	14.	19.7	2140.5
1	2250	275	26.	102.6	2151.4	*	2	2350	575	20.	56.1	2145.8	*	4	0050	875	14.	19.6	2140.5
1	2255	276	26.	102.4	2151.4	*	2	2355	576	20.	55.9	2145.8	*	4	0055	876	14.	19.5	2140.5
1	2300	277	26.	102.3	2151.4	*	3	0000	577	20.	55.8	2145.8	*	4	0100	877	14.	19.4	2140.4
1	2305	278	26.	102.1	2151.4	*	3	0005	578	20.	55.6	2145.8	*	4	0105	878	14.	19.3	2140.4
1	2310	279	26.	101.9	2151.3	*	3	0010	579	20.	55.5	2145.7	*	4	0110	879	14.	19.2	2140.4
1	2315	280	26.	101.7	2151.3	*	3	0015	580	20.	55.4	2145.7	*	4	0115	880	14.	19.1	2140.4
1	2320	281	26.	101.5	2151.3	*	3	0020	581	20.	55.2	2145.7	*	4	0120	881	14.	19.0	2140.4
1	2325	282	26.	101.4	2151.3	*	3	0025	582	20.	55.1	2145.7	*	4	0125	882	14.	18.9	2140.4
1	2330	283	26.	101.2	2151.3	*	3	0030	583	20.	54.9	2145.7	*	4	0130	883	14.	18.8	2140.4
1	2335	284	25.	101.0	2151.2	*	3	0035	584	20.	54.8	2145.7	*	4	0135	884	14.	18.7	2140.3
1	2340	285	25.	100.8	2151.2	*	3	0040	585	20.	54.7	2145.6	*	4	0140	885	14.	18.6	2140.3
1	2345	286	25.	100.7	2151.2	*	3	0045	586	20.	54.5	2145.6	*	4	0145	886	14.	18.5	2140.3
1	2350	287	25.	100.5	2151.2	*	3	0050	587	20.	54.4	2145.6	*	4	0150	887	14.	18.5	2140.3
1	2355	288	25.	100.3	2151.2	*	3	0055	588	20.	54.2	2145.6	*	4	0155	888	14.	18.4	2140.3
2	0000	289	25.	100.1	2151.2	*	3	0100	589	20.	54.1	2145.6	*	4	0200	889	14.	18.3	2140.3
2	0005	290	25.	100.0	2151.1	*	3	0105	590	20.	54.0	2145.6	*	4	0205	890	14.	18.2	2140.2
2	0010	291	25.	99.8	2151.1	*	3	0110	591	20.	53.8	2145.5	*	4	0210	891	14.	18.1	2140.2

2	0015	292	25.	99.6	2151.1	*	3	0115	592	20.	53.7	2145.5	*	4	0215	892	14.	18.0	2140.2
2	0020	293	25.	99.4	2151.1	*	3	0120	593	20.	53.5	2145.5	*	4	0220	893	14.	17.9	2140.2
2	0025	294	25.	99.3	2151.1	*	3	0125	594	20.	53.4	2145.5	*	4	0225	894	14.	17.8	2140.2
2	0030	295	25.	99.1	2151.0	*	3	0130	595	20.	53.3	2145.5	*	4	0230	895	14.	17.7	2140.2
2	0035	296	25.	98.9	2151.0	*	3	0135	596	20.	53.1	2145.4	*	4	0235	896	14.	17.6	2140.2
2	0040	297	25.	98.8	2151.0	*	3	0140	597	20.	53.0	2145.4	*	4	0240	897	14.	17.5	2140.1
2	0045	298	25.	98.6	2151.0	*	3	0145	598	20.	52.9	2145.4	*	4	0245	898	14.	17.4	2140.1
2	0050	299	25.	98.4	2151.0	*	3	0150	599	20.	52.7	2145.4	*	4	0250	899	14.	17.3	2140.1
2	0055	300	25.	98.2	2151.0	*	3	0155	600	20.	52.6	2145.4	*	4	0255	900	14.	17.2	2140.1
						*							*						

****

PEAK FLOW (CFS)	TIME (HR)		6-HR	MAXIMUM AVERAGE FLOW 24-HR	72-HR	74.92-HR
118.	5.83	(CFS)	47.	32.	23.	23.
		(INCHES)	0.350	0.957	2.101	2.125
		(AC-FT)	23.	63.	139.	141.

PEAK STORAGE (AC-FT)	TIME (HR)	6-HR	MAXIMUM AVERAGE STORAGE 24-HR	72-HR	74.92-HR
143.	5.83	137.	117.	72.	70.

PEAK STAGE (FEET)	TIME (HR)	6-HR	MAXIMUM AVERAGE STAGE 24-HR	72-HR	74.92-HR
2155.33	5.83	2154.78	2152.80	2147.52	2147.09

CUMULATIVE AREA = 1.24 SQ MI

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SAC230	1078.	4.17	178.	45.	15.	0.72		
HYDROGRAPH AT	SAC235	532.	4.25	100.	25.	8.	0.38		
2 COMBINED AT	ADD	1608.	4.17	278.	70.	23.	1.10		
ROUTED TO	ROUTE	1552.	4.25	277.	70.	23.	1.10	13.22	4.25
HYDROGRAPH AT	CAS240	275.	4.08	35.	9.	3.	0.14		
2 COMBINED AT	DAMIN	1769.	4.25	312.	79.	26.	1.24		
ROUTED TO	DAMOUT	118.	5.83	47.	32.	23.	1.24	2155.33	5.83

*** NORMAL END OF HEC-1 ***

Probable Maximum Flood

MEMORANDUM

CH2M HILL

TO: Steve Walker/PHX

COPIES: Michael Lopez/FCDMC
Sandy Story/FCDMC
Peter Binney/DEN
Roger Lindquist/CVO
John Livingston/RDD

FROM: Jon Fuller/PHX

DATE: January 26, 1994

SUBJECT: Casandro Wash Probable Maximum Flood Determination

PROJECT: SWW35441.HY.10

Introduction

This memorandum summarizes emergency spillway design criteria for the Casandro Wash Detention Dam, as specified in Arizona Department of Water Resources (ADWR) report *"Guidelines for the Determination of Spillway Capacity Requirements"* dated May, 1991 (hereafter, "the ADWR Manual"). The memorandum also summarizes the procedures used and the modeling results for the probable maximum flood (PMF) at the proposed dam site.

Hazard Classification

In Arizona, spillway design criteria, as outlined in the ADWR Manual, are a function of the hazard classification of the dam. Hazard classification is based on factors such as the height of the dam, storage capacity, existing and probable future downstream development, uses of the reservoir, operational procedures, the type of dam, the type of spillway, the site and foundation geology, the size, slope and material composition and configuration of the downstream channel and the distance of the dam from the nearest downstream development. The Casandro Wash Dam will have a spillway crest height of about 25 feet (total dam height of about 30 feet), a maximum storage capacity of about 150 acre feet (below the spillway), will have increased future residential development downstream, will be used for flood control purposes only, will be uncontrolled, and will probably be earthen with an overflow emergency spillway.

The Casandro Wash Dam will be classified as a small, significant to high hazard dam by ADWR due to more than a small number of habitable structures downstream and the potential for appreciable economic losses downstream. Table 1 of the ADWR Manual

(attached) classifies these characteristics as high hazard. The dam is classified as high hazard for urban development, and significant hazard for economic loss. Dam size is a function of its height and capacity. The proposed dam's height is between 25 and 39 feet, and its proposed capacity is between 15 and 499 acre feet. These characteristics give the proposed structure a cumulative rating factor of 1. According to Table 2 of the ADWR Manual, "small" dams have a cumulative rating between 0 and 2.

Spillway Design Criteria

The spillway design flood recommended by ADWR for the proposed Casandro Wash Dam is the half probable maximum flood (0.5_PMF), given the hazard and size classification. Small dams in the high hazard class are to have a spillway that passes the 0.5_PMF; small dams in the significant hazard class are to have a spillway that passes the 100-year to 0.5_PMF, as indicated on Table 3 of the ADWR Manual (attached).

Total freeboard, or the distance between the top of the dam and the spillway crest, is determined by the type of dam, the maximum water surface during discharge of the design flow (0.5_PMF), wave height and runup, and economic factors. The minimum permissible total freeboard for the spillway will be 4 feet according to the ADWR Manual.

Residual freeboard, or the distance between the maximum water surface during passage of the inflow design flood and the top of the dam, must be a minimum of three feet, except when the inflow design flood is the 0.5_PMF or greater. For cases when the inflow design flood is 0.5_PMF or greater, the residual freeboard may be reduced.

Probable Maximum Flood Estimate

The 0.5_PMF and full PMF (PMF) were estimated using procedures outlined in Hydrometerological Report 49 (HMR 49; *Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages*, US Army Corps of Engineers, September 1997). The HEC-1 hydrologic model used to estimate the PMF and 0.5_PMF was developed by the FCDMC for the Casandro Wash as part of the Wickenburg Area Drainage Master Study (ADMS) and updated by CH2M HILL for this project. The HEC-1 model is described in detail elsewhere (See memorandum to Michael Lopez/FCDMC from Jon Fuller/CH2M HILL dated January 26, 1994).

Probable maximum precipitation (PMP) for a "local" storm was determined from HMR 49, as documented in computation sheets attached to this memorandum. The PMP

analysis featured the following:

- 1-hour PMP of 11.5 inches
- No elevation adjustment (site < 5,000 feet)
- 6-hour to 1-hour ratio of 1.32
- Aerial reduction of 0.25-, 0.5-, 0.75-hour PMP values (area = 1.24)
- No aerial reduction adjustment for 1-hour to 6-hour durations
- Alternative incremental PMP distribution developed by USACOE (EM#1110-2-1411)
- No aerial distribution of the PMP storm

Application of the PMP depth and distribution to the HEC1 watershed model for Casandro Wash resulted in a PMF estimate of 10,941 cfs (HEC-1 file "CASFPMFE.HC1"). The 0.5_PMF was determined by ratioing the full PMF hydrograph ordinates from the HEC1 model using a JR record, resulting in a 0.5_PMF estimate of 5,404 cfs (HEC-1 file "CASHPMFE.HC1"). Computation sheets for determination of PMF and 0.5_PMF are attached to this memorandum.

Summary

For the Casandro Wash project, the 0.5_PMF of 5,404 is recommended for design purposes. Freeboard is likely to be controlled by residual freeboard requirement of 3 feet above the maximum 0.5_PMF water surface elevation (WSEL). The Casandro Wash Dam is a high hazard, small dam.

Table 1.
Casandro Wash Spillway Design Criteria

Spillway Capacity	0.5_PMF
Freeboard	4 ft (spillway to top of dam) or 3 ft above 0.5_PMF WSEL
0.5_PMF	5,404 cfs

Jon Fuller

STATE OF ARIZONA

DEPARTMENT OF WATER RESOURCES

ENGINEERING DIVISION/SAFETY OF DAMS SECTION

DRAFT

GUIDELINES FOR THE DETERMINATION OF SPILLWAY CAPACITY REQUIREMENTS

DRAFT

PREPARED BY

DAN ROGER LAWRENCE, CHIEF

ENGINEERING DIVISION/SAFETY OF DAMS SECTION

MAY 1991

2

TABLE 1. DOWNSTREAM HAZARD POTENTIAL CLASSIFICATION

CATEGORY	URBAN DEVELOPMENT	ECONOMIC LOSS
Low	No permanent structure for human habitation.	Minimal (undeveloped to occasional structures or agriculture).
Significant	No urban development and no more than a small number of habitable structures.*	Appreciable (notable agriculture, industry or other structures).
High	Urban development with more than a small number of habitable structures.*	Excessive (extensive community, industry, agriculture).

* Because this definition does not cite a specific number of lives that could be lost, some difficulty has been experienced in determining whether dams should be categorized as having "significant" or "high" downstream hazard potential. The issue is clarified by emphasizing that the downstream hazard potential classification should be based on the density of downstream development containing habitable structures. For example, dams located upstream of isolated farmhouses would be classified as having significant downstream hazard potential, and those located upstream of several houses or a residential development would be classified as having a high downstream hazard potential.

SIZE CLASSIFICATION

Dams are classified into small, medium and large sizes. A numerical rating procedure, based on the descriptive characteristics of height and reservoir capacity has been developed to determine the dam size classification.

Height is measured from the lowest elevation of the outside limit of the dam (usually the downstream toe) to the spillway crest, or top of spillway gates if so equipped. For dams with no spillway, the height is measured to the crest of the dam.

Reservoir capacity, in acre-feet, is measured to the spillway crest, or top of the spillway gates if so equipped. For dams with no spillway, capacity is measured to the dam crest.

The categories and corresponding rating factors are shown in Table 2.

TABLE 2. SIZE CLASSIFICATION RATING CATEGORIES

Height (feet)	Rating Factor	Capacity (acre-feet)	Rating Factor
6-24	0	15-499	0
25-39	1	500-999	1
40-59	2	1,000-2,999	2
60-79	3	3,000-9,999	3
80-99	4	10,000-24,999	4
100+	5	25,000+	5

A numerical rating is computed for each dam by adding the corresponding rating factors for each of the two categories. For example, a dam that is 65 feet in height and has a reservoir capacity of 22,000 acre-feet would have a rating of (3+4=7). Small dams have a rating in the range 0-2, medium dams in the range of 3-7 and large dams, 8 or greater.

EQUIRED HYDROLOGIC CRITERIA

An evaluation of the performance and capacity of an existing spillway or a hydrologic design study for a spillway at a proposed dam is required to determine the ability of the structure to safely pass a flood whose magnitude is established on the basis of the size and downstream hazard potential classifications assigned to the dam.

The Inflow Design Flood (IDF) for a specific spillway is determined by the runoff hydrograph selected primarily on the basis of the size and hazard classifications assigned to the dam. As there are many factors to consider in the selection of the magnitude of this flood, it is not the purpose of these guidelines to require a specific flood frequency, volume or rainfall depth for each classification. However, Table 3 does provide ranges of flood magnitudes from which the Inflow Design Flood may be selected on the basis of the designated hazard potential and size classifications. These ranges of flood magnitudes generally define the limits acceptable to the Department of Water Resources for use as the basis for sizing the spillway.

TABLE 3. RECOMMENDED SPILLWAY DESIGN FLOODS

HAZARD CLASS	SIZE CLASSIFICATION	INFLOW DESIGN FLOOD MAGNITUDE
Low	Small	100-year
	Medium	100-year to 0.5 PMF
	Large	0.5 PMF
Significant	Small	100-year to 0.5 PMF
	Medium	0.5 PMF
	Large	0.5 PMF to PMF
High	Small	0.5 PMF
	Medium	0.5 PMF to PMF
	Large	PMF

OK

RECOMMENDED

The flood magnitudes shown in Table 3 are derived from rainfall depths for various durations and severities of storms. Both general frontal and thunderstorm type storms should be studied with due consideration given tropical storm potential and orographic influences that may greatly increase rainfall amounts.

Recorded rainfall and flood flows in Arizona are rather sparse, and the period of record is usually short. Consequently, rainfall data are usually obtained from data published by the National Weather Service as listed in the References. Synthetic flood hydrographs are then developed by modeling the watershed's rainfall/runoff response and employing the unit hydrograph approach.

The peak inflow rate usually has a greater influence than the runoff volume on the spillway capacity requirement for a dam with a small reservoir storage that is subject to storm inflow from a large watershed. In this case, the Inflow Design Flood (IDF) peak flow is essentially equal to the peak outflow rate. Conversely, a reservoir that is relatively large compared to contributing watershed will usually attenuate the IDF peak; in this case, the spillway peak discharge may be considerably less than the IDF peak.

A spillway capacity less than outlined above will be acceptable for: (1) all new dams, (2) existing dams which are being enlarged or improved, and (3) dams being reevaluated for safety, where the owner (or the owner's engineer) can demonstrate to the Department that the incremental damages due to failure of the dam are insignificant and will not cause loss of life. The analysis shall be based upon the dam failure caused by a flood which just exceeds the routing capacity of the reservoir. The result shall be compared to the pre-failure conditions such as the spillway discharge and any reasonable rainfall runoff occurring between the dam site and the point(s) of interest below the dam. The burden of proof rests with the owner.

RESERVOIR ROUTING REQUIREMENTS

The adequacy of the spillway for an existing dam is normally determined by routing the Inflow Design Flood through the reservoir and spillway. Flood routings for spillway capacity determinations will normally be required to commence with the reservoir storage level at the spillway crest elevation. Infrequent exception would be: (1) normal conservation storage level is below the spillway crest of a reservoir without a flood storage pool, (2) the normal upper surface of the conservation pool is limited to a level that is coincident with the bottom level of the flood control pool allocation or (3) the reservoir is used exclusively for flood control and would normally be empty. Deviations from the normal starting level of routing at the spillway crest elevation must be considered on the basis of risk and reservoir operating procedure.

FREEBOARD REQUIREMENTS

Total freeboard (the distance between the top of the dam and the spillway crest) is determined by the type of dam, the maximum water surface during discharge of the Inflow Design Flood, maximum anticipated wave ~~height and runup, and by economic factors.~~ The minimum permissible total freeboard shall be four feet.

Residual freeboard (the distance between the maximum water surface and the top of the dam) depends on dam type, wave height and runup, the slope and finish of the upper part of the upstream face, and the Inflow Design Flood. Generally, the minimum permissible residual freeboard for an earthfill or rockfill dam shall be the greater of either the sum of wave height and runup or three feet. This requirement may be reduced in those cases where the Inflow Design Flood is the 0.5 PMF or greater.

The minimum residual freeboard for a concrete dam of any type without either a parapet wall or protection against overpour shall be the same as that of an earthfill or rockfill dam. Concrete dams provided with parapet walls exceeding the minimum residual freeboard height, or concrete dams provided with adequate splash impact protection at the toe need no other residual freeboard requirements except those which the owner may wish to provide.

DEFINITIONS

The following definitions may be helpful to those concerned with the design of an emergency spillway. The terminology is largely based on data published by Federal agencies.

100-Year Flood - The flood runoff whose magnitude is expected to be equaled or exceeded, on the average, once in 100 years. Stated another way, it is a flood that has a one percent chance of being equaled or exceeded in any one year.

Concrete Dam - Any dam constructed of concrete. Some examples are: arch, gravity, arch-gravity, slab and buttress, multiple arch. A dam having only a concrete facing should not be referred to as a concrete dam.

Drainage Area - The area that drains naturally to a particular point on a river or stream.

Earth Dam (Earthfill Dam) - An embankment dam in which more than 50% of the total volume is formed of compacted fine-grained material obtained from a borrow area.

Embankment Dam (Fill Dam) - Any dam constructed of excavated materials.

Fetch - The straight line distance between a dam and the farthest reservoir shore. The fetch is one of the factors used in calculating wave heights in a reservoir.

Flood - The runoff from rainfall or snowmelt of significant magnitude and often related to a theoretical frequency of occurrence. Flood is inflow to the water control structure.

Flood Routing - The determination of the attenuating effects of storage on a flood passing through a valley, channel, or reservoir.

Hydrograph - A graphical representation of discharge, stage, or other hydraulic property with respect to time for a particular point on a stream. (At times the term is applied to the phenomenon the graphical representation describes: hence a flood hydrograph is the passage of flood discharge past the observation point).

Inflow Design Flood (IDF) - The reservoir flood inflow whose magnitude has been selected for design requirements based on the size and assigned hazard classification of the dam. The magnitude of the IDF may range from the 100-year flood to the PMF.

Masonry Dam - Any dam constructed mainly of stone, brick, or concrete blocks that may or may not be joined with mortar. A dam having only a masonry facing should not be referred to as a masonry dam.

CH2M HILL

CASCANDRA PMP

SHEET NO. ___ OF ___

PROJECT NO. SWW35441.HY

LOCAL STORM ESTIMATE

- USE HMR 49 (COE, 1979) - Chap 6, p 148 PROCEDURES

① FIND 1-HR PMP - Figure 4.5 (p 115)

LAT. 33° 58'

LONG. 112° 46'

1-HR PMP = 11.5"

② ELEVATION ≤ 5000' - NO ADJUSTMENT FOR ELEVATION

③ 6/1 HR RATIO = 1.32" ~> 1.3" Fig 4.7 (p 118)

1.30 3

1.40 14.5 $\frac{3}{14.5} = \frac{x}{0.1}$ x = 0.021 (+ 1.30)

④ PERCENT DURATIONAL VARIATION - Table 4.4 (p 120)

DURATION = 6 HR ~> 130 %

⑤ PMP 1 HR = 11.5" (Table 4.4)

1/4	1/2	3/4	1	2	3	4	5	6
8.5	10.2	10.9	11.5	13.1	13.9	14.4	14.7	15.0

⑥ AREA REDUCTION Fig 4.9 (p 123)

.98	.99	.99	1	1	1	1	1	1
8.4	10.1	10.8	11.5	13.1	13.9	14.4	14.7	15.0

⑦ AREA REDUCTION

FORM 38

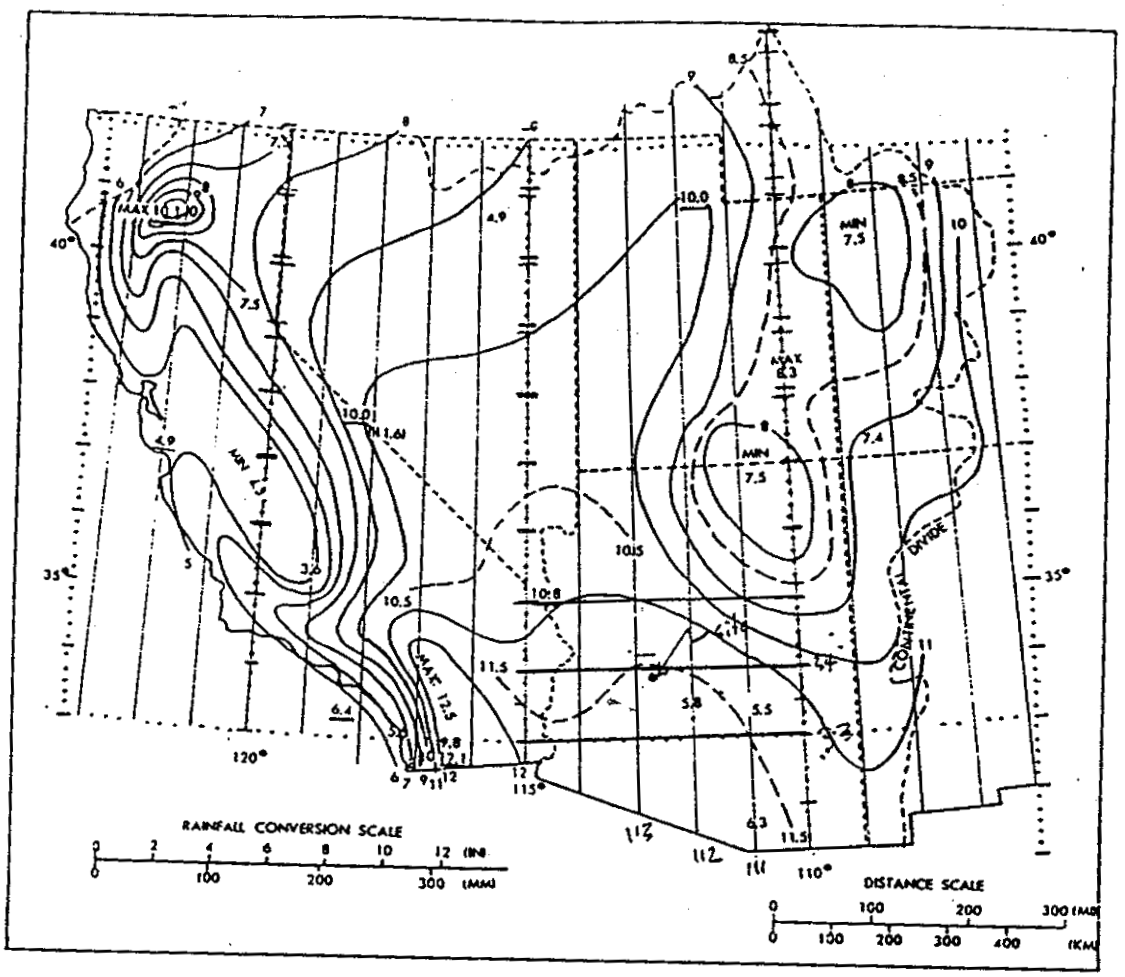


Figure 4.5--Local-storm PMP for 1 mi^2 (2.6 km^2) 1 hr. Directly applicable for locations between sea level and 5000 ft (1524 m). Elevation adjustment must be applied for locations above 5000 ft.

events. In contrast to figure 4.4, figure 4.5 maintains a maximum between these two locations. There is no known meteorological basis for a different solution. The analysis suggests that in the northern portion of the region maximum PMP occurs between the Sierra Nevada on the west and the Wasatch range on the east.

A discrete maximum (> 10 inches, 254 mm) occurs at the north end of the Sacramento Valley in northern California because the northward-flowing moist air is increasingly channeled and forced upslope. Support for this PMP center comes from the Newton, Kennett, and Red Bluff storms (fig. 4.1). Although the analysis in this region appears to be an extension of the broad maximum through the center of the Southwestern Region, it does not indicate the direction of moist inflow. The pattern has evolved primarily as a result of attempts to tie plotted maxima into a reasonable picture while considering inflow directions, terrain effects, and moisture potential.

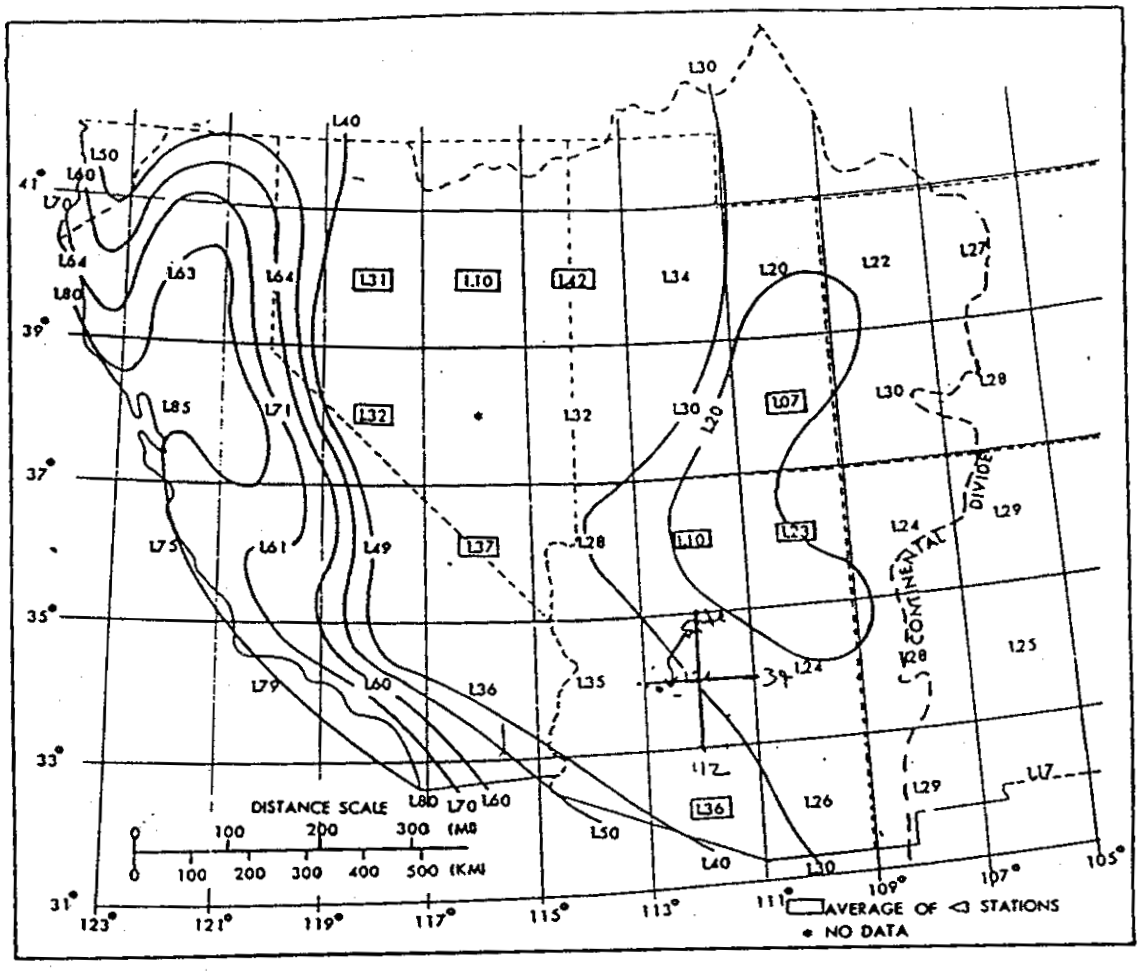


Figure 4.7.--Analysis of 6/1-hr ratios of averaged maximum station data (plotted at midpoints of a 2° latitude-longitude grid).

establish the basic depth-duration curve, then structure a variable set of depth-duration curves to cover the range of 6/1-hr ratios that are needed.

Three sets of data were considered for obtaining a base relation (see table 4.3 for depth-duration data):

a. An average of depth-duration relations from each of 17 greatest 3-hr rains from summer storms (1940-49) in Utah (U. S. Weather Bureau 1951b) and in unpublished tabulations for Nevada and Arizona (1940-63). The 3-hr amounts ranged from 1 to 3 inches (25 to 76 mm) in these events.

b. An average depth-duration relation from 14 of the most extreme short-duration storms listed in Storm Rainfall (U. S. Army, Corps of Engineers 1945-). These storms come from Eastern and Central States and have 3-hr amounts of 5 to 22 inches (127 to 559 mm).

8

SHEET 4

ratios than storms with high 3/1-hr ratios. The geographical distribution of 15-min to 1-hr ratios also were inversely correlated with magnitudes of the 6/1-hr ratios of figure 4.7. For example, Los Angeles and San Diego (high 6/1-hr ratios) have low 15-min to 1-hr ratios (approximately 0.60) whereas the 15-min to 1-hr ratios in Arizona and Utah (low 6/1-hr ratios) were generally higher (approximately 0.75).

Depth-duration relations for durations less than 1 hour were then smoothed to provide a family of curves consistent with the relations determined for 1 to 6 hours, as shown in figure 4.3. Adjustment was necessary to some of the curves to provide smoother relations through the common point at 1 hour.

We believe we were justified in reducing the number of the curves shown in figure 4.3 for durations less than 1 hour, letting one curve apply to a range of 6/1-hr ratios. The corresponding curves have been indicated by letter designators, A-D, on figure 4.3. As an example, for any 6-hr amount between 115% and 135% of 1-hr, 1-mi^2 (2.6-km^2) PMP, the associated values for durations less than 1 hour are obtained from the curve designated as "B".

Table 4.4 lists durational variations in percent of 1-hr PMP for selected 6/1-hr rain ratios. These values were interpolated from figure 4.3.

To determine 6-hr PMP for a basin, use figure 4.3 (or table 4.4) and the geographical distribution of 6/1-hr ratios given in figure 4.7.

Table 4.4.--Durational variation of 1-mi^2 (2.6-km^2) local-storm PMP in percent of 1-hr PMP (see figure 4.3)

6/1-hr ratio	Duration (hr) 1/4	1/2	3/4	1	2	3	4	5	6
1.1	86	93	97	100	107	109	110	110	110
~~1.2~~	~~74~~	~~89~~	~~95~~	~~100~~	~~110~~	~~115~~	~~118~~	~~119~~	~~120~~
CASSANDRA → 1.3	74	89	95	100	114	121	125	128	130
~~1.4~~	~~63~~	~~83~~	~~93~~	~~100~~	~~118~~	~~126~~	~~132~~	~~137~~	~~140~~
1.5	63	83	93	100	121	132	140	145	150
1.6	43	70	87	100	124	138	147	154	160
1.8	43	70	87	100	130	149	161	171	180
2.0	43	70	87	100	137	161	175	188	200

4.5 Depth-Area Relation

We have thus far developed local-storm PMP for an area of 1 mi^2 (2.6 km^2). To apply PMP to a basin, we need to determine how 1-mi^2 (2.6-km^2) PMP should decrease with increasing area. We have adopted depth-area relations based on rainfalls in the Southwest and from consideration of a model thunderstorm.

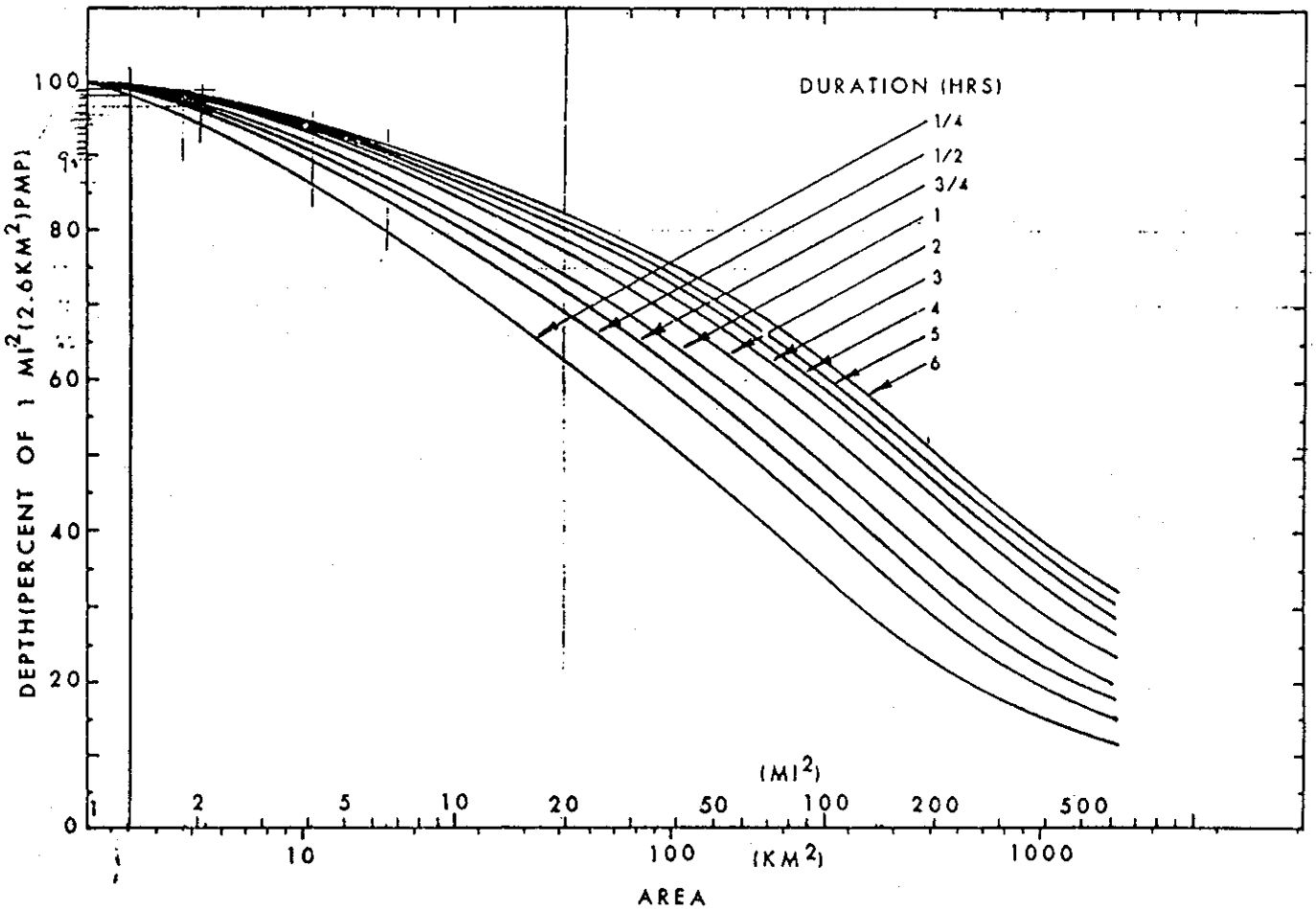


Figure 4.9.--Adopted depth-area relations for local-storm PMP.

CH2M HILL

SUBJECT: CACANDRO - PMP (LOCAL)

BY: JEF DATE: 1/24

SHEET NO. 6 OF

PROJECT NO. SNW25441.HY

(8) INCREMENTAL PMP

1/4	1/2	3/4	1	2	3	4	5	6
8.4	1.7	0.7	0.7					
			11.5	1.6	0.8	0.5	0.3	0.3

(9) PMP DISTRIBUTION - Table 4.7 p.126

↳ 6 HR STORM

	HMR #5	EM 1110-2-1411
1	0.3	0.3
2	0.8	0.5
3	11.5	1.6
4	1.6	11.5
5	0.5	0.5
6	0.3	0.3

(10) ~~ARE~~ DISTRIBUTE STORM W/IN BASIN

D.A. = 1.24 " 81% WITHIN 1 mi ∴ USE MAXIMUM PMP (NO REDUCTION) - CONSERVATIVE ASSUMPTION

(11) Q_{PMF} = 8097 / 8435 cfs — CASFPMF.HC1

8164 → W/ 15-MIN INCREMENTS = ~~7325~~ 11093 — CASFPMFE.HC1

(12) ½ PMF - Ratio hydrograph ordinates using JR record w/ JR.2 = 0.5 (÷ flow ordinates by 2)

CASHPMFE.HC1

Q½PMF = 4073

15 MIN INCREMENTS → 5481

USE FOR DESIGN

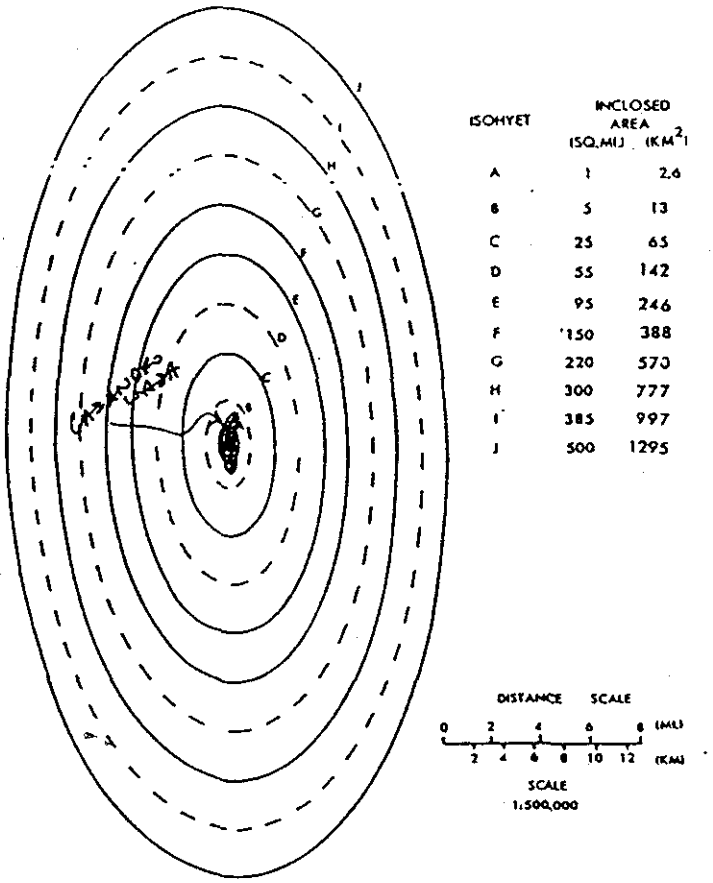


Figure 4.10.--Idealized local-storm isohyetal pattern.

storm period. The sequence of hourly incremental PMP for the Southwest 6-hr thunderstorm in accord with this study is presented in column 2 of table 4.7. A small variation from this sequence is given in Engineering Manual 1110-2-1411 (U. S. Army, Corps of Engineers 1965). The latter, listed in column 3 of table 4.7, places greater incremental amounts somewhat more toward the end of the 6-hr storm period. In application, the choice of either of these distributions is left to the user since one may prove to be more critical in a specific case than the other.

Table 4.7.--Time sequence for hourly incremental PMP in 6-hr storm

Increment	HMR No. 5[1]	EM1110-2-1411[2]
	Sequence Position	
Largest hourly amount	Third	Fourth
2nd largest	Fourth	Third
3rd largest	Second	Fifth
4th largest	Fifth	Second
5th largest	First	Last
least	Last	First

[1]U. S. Weather Bureau 1947.
[2]U. S. Corps of Engineers 1952.

12

7

Watershed Reduced
to 1:500,000

SUBJECT CASANDRA - PMP BY JEF DATE 2/1
SHEET ___ OF ___
PROJECT NO. SWW3544.HV

CODING OF HEC 1 PI RECORDS

STORM IN 1-HR INCREMENTS

HR	1 HR INC.	15-MIN INC.
1	0.3	.075 .075 .075 .075
2	0.5	.125 .125 .125 .125
3	1.6	.4 .4 .4 .4
4	11.5	8.4 1.7 0.7 0.7
5	0.8	.2 .2 .2 .2
6	0.3	.075 .075 .075 .075

USE 15-MIN INCREMENT FOR 1-HR PMP PER TABLE

Split hours 1-3, 5, 6 into even increments for PI Record per FCDMC Instructions

Spillway

CH2M HILL

SUBJECT: CASANORO DAM
SPILLWAY DESIGN

BY: JDT / RCV 8-15-94
SHEET NO. 1 of ____ DATE 5-11-94
PROJECT NO. SWW35441.CV.

(1)

PROCEDURES:

(1) USE BUREC, 1987 "DESIGN OF SMALL DAMS"

(a) CREST PROCEDURES p 365 - 373

- GEOMETRY
- RATING
- APPROACH

(b) SPILLWAY CHUTE (O/S CREST) p 383 - 386

(ALSO VEN TE CHOW, 1959 CHAPTER 14)
"HYDRAULIC DESIGN OF SPILLWAYS" USACOE 1990
EM 1110-2-1603 1/90

(c) ENERGY DISSIPATOR ("HYDRAULIC DESIGN OF STILLING BASINS & ENERGY DISSIPATORS" BUREC ENGIN MONO GRAPH #25 1974)

(2) USE USACOE, 1990 "HYDRAULIC DESIGN OF SPILLWAYS"
EM 1110-2-1603 SEPT / 90

↳ ELLIPTICAL CREST PROFILES

(3) DESIGN FLOOD = ½ PMF PER DIRECTION OF MICHAEL LOPEZ / FCOMC - VERBAL + 25% COMMENT LETTER

REV 9/93 FORM

DESIGN CRITERIA

Routed ½ PMF (3700 cfs) 2/21/95

1) PASS ~~½ PMF (5400 CFS)~~ WITH 3 FT FREEBOARD INCLUDING ROUTING AFFECTS

~~2) PASS FULL PMF (10910 CFS) WITH MINIMUM (0 FT) FREEBOARD, INCLUDING ROUTING AFFECTS~~

3) SPILLWAY CREST AT 2163.5 - (½ PMF + 3') ELEVATION ≈ 2155 FT

4) DAM TOP @ 2163.5 ELEVATION

5) MINIMIZE SPILLWAY LENGTH (80 FT)

6) STORE Q100 + SEDIMENT YIELD OF 2 AF - ORIFICE FLOW WITHOUT SPILLING IN EXCESS OF D/S STORM DRAIN CAPACITY OF 339 CFS

7) DESIGN SPILLWAY FOR MAXIMUM EFFICIENCY (MINIMUM INLET LOSSES)

8) MINIMIZE COST

CONSIDER ROUTING OF HYDROGRAPH?

① ALLOWABLE TO ROUTE ½ PMF SINCE RESERVOIR NORMALLY EMPTY

② FROM VE MTG -- SENIOR LEADING TOWARD NOT ROUTING ½ PMF, ROUTE FULL PMF

SUMMARY

(1) SIZE SPILLWAY FOR ROUTED ½ PMF + 3' FREEBOARD

(2) ½ PMF = 5400 CFS (SEE "FINAL HSM HCI")

(3) ROUTED ½ PMF = ~~3900~~ 3700 2/21/95 CFS

ROUTED ½ PMF = 3950 CFS WITH FIRST GRADING PLAN WHICH ASSUMED Q100 OVER SPILLWAY. REVISED SPILLWAY PER FCD COMMENTS WILL STORE ENTIRE Q100 VOLUME THEREFORE SPILLWAY DESIGN = 3950 CFS. USE ~~[illegible]~~

BELOW FROM THE

SUBJECT: CHANGRO SPILLWAY REVISIONS

BY: JBF

SHEET NO. 1 of ____ DATE 6/23

PROJECT NO. SWW3544.1. CV

(3)

FULL PMF = 10940 CFS (9700 ROUTED)

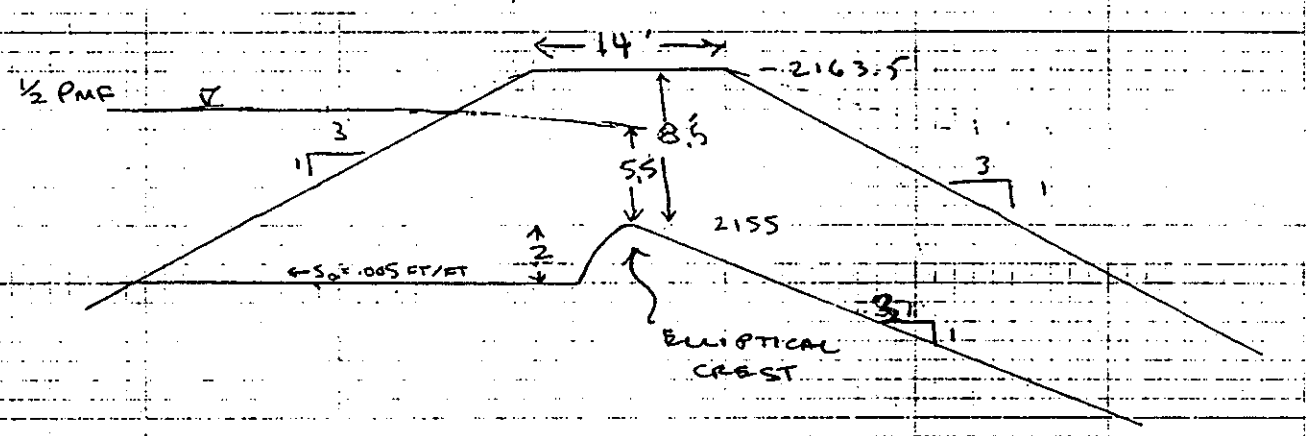
DESIGN OF SPILLWAY CREST

½ PMF = 5400 CFS (~~4000~~ 3700 2/2/95, ROUTED)

USE ROUTED Q'S

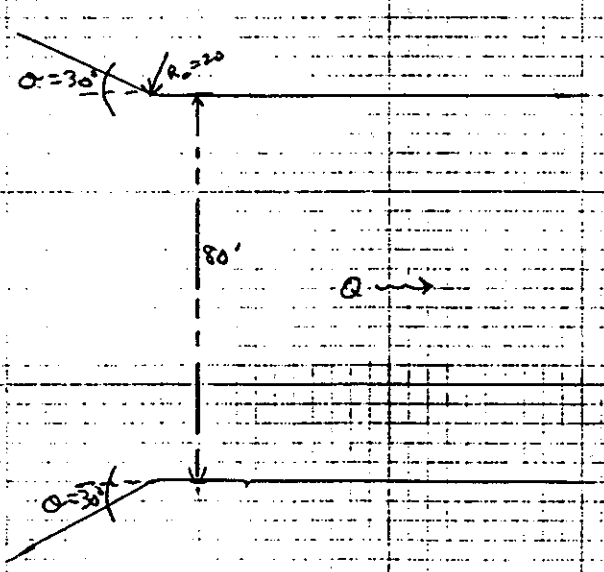
GIVEN:

1. ELLIPTICAL PROFILE (USACOE EM 1110-2-1603, JAN. '90)
2. LENGTH = 80 FT
3. ELEVATION CREST ≅ 2155 (VERIFY W/ CALC)
4. TOP OF DAM = 2163.5
5. TARGET HEAD, H_0 ≈ 5.5 FT
6. APPROACH CHANNEL DEPTH, P = 2 FT
7. ROUTED ½ PMF ≈ ~~3900~~ 3700 2/2/95 CFS



CREST PROFILE

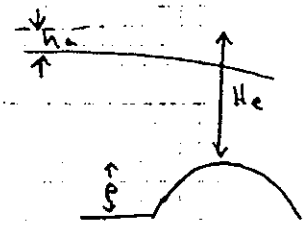
CONCEPTUAL SKETCHES



CREST PLAN VIEW

DESIGN PROCEDURE

STEP ONE: ESTIMATE H_o



$H_e = 5.5$ FT

$$\left[\begin{array}{l} Q = CLH^{3/2} \\ \left(\frac{39.0}{3.9(10)}\right)^{.67} = H \\ H = 5.4 \end{array}\right] \text{OK}$$

(5.2 for 3700 cfs)

ESTIMATE APPROACH VELOCITY

ASSUME $C = 3.9$ (USACOE, 1990 PLATE 3-3)
↳ SEE SHEET 5, ATTACHED)

$q = C H_e^{1.5}$

$q = 50.3 \frac{cfs}{FT}$ (UNIT WEIR Q)

(46.3 cfs/ft for 3700 cfs)

VELOCITY, $V_a = \frac{q}{(H_e + P)} = \frac{50.3}{8.5} = 5.92$ FT/s

$\left(V_a = \frac{46.3}{(5.5+2)} = 6.2 \text{ ft/s}\right)$

APPROACH VELOCITY HEAD, V_h

$h_a = \frac{V^2}{2g} = \frac{(5.92)^2}{64.4} = 0.54$ FT

$[(6.2)^2/64.4 = 0.60 \text{ ft}]$

ENTRANCE LOSS COEFFICIENT, K_a

$K_a = 0$ SINCE $r_c > 0.5 H_e$ & $\theta < 45°$
> 5 ($r_c = 20$ FT)

(SEE BUREC, p 369)

ENTRANCE LOSS, $h_a = K_a \cdot H_v = 0$

FRICTION SLOPE, S_f

$$S_f = \left(\frac{V_a \, n}{1.486 \, r^{2/3}}\right)^2$$

$n = 0.018$, Mannings concrete

$r = \frac{A}{P}$, Hydr. Radius

$= \frac{5.5(80)}{80 + 2(5.5)}$

$= 4.84$

$S_f = 0.00063$

($S_f = 0.00069$ for 3700 cfs)

FRICTION LOSS, h_f

$h_f = S_f (l)$

$l = 50$ FT, length approach channel

$h_f = 0.031$ FT

($h_f = 0.034'$ for 3700 cfs)

TOTAL APPROACH LOSS, h_t

$= h_f + h_a = 0.031$ FT

EFFECTIVE HEAD $H_o = 5.5 \text{ FT} - 0.031 = 5.47$ FT

($H_o = 5.5 - 0.034 = 5.47$ ft)

EFFECTIVE HEAD DIAGRAM (EXPLANATION OF TERMS)

$Q = CLH_e^{3/2}$

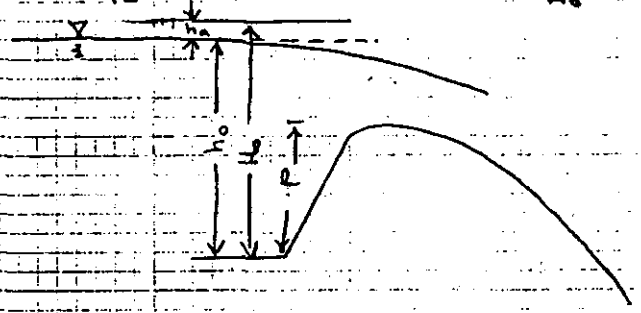
H_e = ACTUAL HEAD ON CREST, INCLUDING APPROACH VELOCITY HEAD (h_a)

= DOES NOT INCLUDE
1. APPROACH CHANNEL FRICTION LOSS
2. INLET ENTRANCE LOSS
3. TRANSITION LOSS
4. CURVATURE LOSS - UPSTREAM CHANNEL

(MUST BE ADDED TO H_e TO DETERMINE RESERVOIR ELEVATION (PONDING SURFACE))

H_o = DESIGN HEAD (H_e @ Q_{DESIGN})

IDEAL NAPPE WHEN $H_e/H_o = 1$ ($H_e = H_o$)



H_o, EFFECTIVE HEAD = H_e - APPROACH LOSS, (p. 373 BUREC

WHEN $\frac{H_e}{H_o} > 1$ (UP TO 1.33) NEGATIVE PRESSURE OCCURS WHICH INCREASES C & INCREASE WEIR Q

(USACOE, 1990, SECTION 3)

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              * FINAL 1/2 PMF RUN  HPM.HC1
              *
              *DIAGRAM
              *
    1         ID   Casandro Wash Detention Dam     CH2M Hill     August, 1994
    2         ID   Copy of HEC-1 for Q100, changed precipitation
    3         ID   Revised dam location and basin grading
              * 1/2 PMF Run - routed
              *
    4         IT       5                    900
    5         IO       3
              *
    6         JR    FLOW      .5
              *

    7         KK  SAC230
    8         KM   SUB-BASIN SAC230
    9         KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
   10         KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
   11         KM   BASIN FROM WICKENBERG ADMS
   12         BA    .720
   13         IN      15
   14         PB      15
   15         KM   THE FOLLOWING PI RECORD USES A 6-HOUR STORM -  HMR#5 DISTRIBUTION
   16         PI   0.075   0.075   0.075   0.075   0.125   0.125   0.125   0.125     0.4     0.4
   17         PI     0.4     0.4     8.4     1.7     0.7     0.7     0.2     0.2     0.2     0.2
   18         PI   0.075   0.075   0.075   0.075
   19         LG    .100    .250   5.200    .240  35.000
   20         UC    .446    .367
   21         UA       0       5      16      30      65      77      84      90      94      97
   22         UA     100
              *

   23         KK  SAC235
   24         KM   SUB-BASIN sac235
   25         KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
   26         KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
   27         KM   BASIN FROM WICKENBERG ADMS
   28         BA    .380
   29         LG    .100    .230   6.200    .150  36.000
   30         UC    .450    .461
   31         UA       0       5      16      30      65      77      84      90      94      97
   32         UA     100
              *

   33         KK     ADD
   34         KM   ADD SAC230 & SAC235
   35         HC       2
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  36          KK   ROUTE
  37          KM   ROUTE COMBINED HYDROGRAPH TO DAM LOCATION
  38          RS       1    FLOW      -1
  39          RC    .045     .03    .045    4200   .0175
  40          RX   463.5   467.5   477.5   487.5   512.5   522.5   532.5   536.5
  41          RY    16.5    12.5    12.5    10.0    10.0    12.5    12.5    16.5
              *

  42          KK  CAS240
  43          KM   SUB-BASIN cas240
  44          KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
  45          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
  46          KM   BASIN MODIFIED FROM WICKENBERG ADMS TO REFLECT DAM LOCATION
  47          BA    .140
  48          LG    .100    .210   6.400    .140  21.000
  49          UC    .258    .232
  50          UA       0       5      16      30      65      77      84      90      94      97
  51          UA     100
              *

  52          KK   DAMIN
  53          KM   ADD ROUTED HYDROGRAPH TO CAS240
  54          KO       1
  55          HC       2
              *

  56          KK  DAMOUT
  57          KM    Route Hydrograph Through Dam.
  58          KM
  59          RS       1    STOR       2
  60          KO       1
              *
  61          SA    2.05    2.49    5.80    6.77    9.06   10.20   10.96   11.34   11.61   11.88
  62          SA   12.09   12.31   12.81   13.31   13.81
  63          SE    2135    2137    2140    2144    2150    2153    2155    2156    2157    2158
  64          SE    2159    2160    2161    2162    2163
  65          SQ       0     9.5    13.5    19.1    23.3    28.6    30.9     295     823    1539
  66          SQ    2423    3450    4577    5773    7015
              *
  67          ZZ
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7      SAC230
                .
                .
   23           .      SAC235
                .           .
                .           .
   33        ADD............
                V
                V
   36       ROUTE
                .
                .
   42           .      CAS240
                .           .
                .           .
   52       DAMIN............
                V
                V
   56      DAMOUT
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
****************************************                                    ****************************************
*                                      *                                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY  1991               *                                    *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.0.1E             *                                    *         609 SECOND STREET            *
*                                      *                                    *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE  02/02/1995  TIME  14:12:34 *                                    *          (916) 756-1104              *
*                                      *                                    *                                      *
****************************************                                    ****************************************


                        Casandro Wash Detention Dam     CH2M Hill     August, 1994
                        Copy of HEC-1 for Q100, changed precipitation
                        Revised dam location and basin grading

  5 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           3  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         900  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      4    0  ENDING DATE
                     NDTIME        0255  ENDING TIME
                      ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL    0.08 HOURS
                      TOTAL TIME BASE   74.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

    JP          MULTI-PLAN OPTION
                      NPLAN           1  NUMBER OF PLANS

    JR          MULTI-RATIO OPTION
                    RATIOS OF RUNOFF
                   0.50


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  7 KK      *   SAC230   *
            *            *
            **************
                        SUB-BASIN SAC230
                        6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
```

```
                    THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
                    BASIN FROM WICKENBERG ADMS
                    THE FOLLOWING PI RECORD USES A 6-HOUR STORM -  HMR#5 DISTRIBUTION

13 IN        TIME DATA FOR INPUT TIME SERIES
                 JXMIN          15  TIME INTERVAL IN MINUTES
                JXDATE      1    0  STARTING DATE
                JXTIME           0  STARTING TIME

           SUBBASIN RUNOFF DATA

12 BA        SUBBASIN CHARACTERISTICS
                 TAREA        0.72  SUBBASIN AREA

             PRECIPITATION DATA

15 PB            STORM       15.00  BASIN TOTAL PRECIPITATION

15 PI          INCREMENTAL PRECIPITATION PATTERN
                 0.03      0.03      0.02      0.03      0.03      0.02      0.03      0.03      0.02      0.02
                 0.03      0.03      0.04      0.04      0.04      0.04      0.04      0.04      0.04      0.04
                 0.04      0.04      0.04      0.04      0.13      0.13      0.13      0.13      0.13      0.13
                 0.13      0.13      0.13      0.13      0.13      0.13      2.80      2.80      2.80      0.57
                 0.57      0.57      0.23      0.23      0.23      0.23      0.23      0.23      0.07      0.07
                 0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07
                 0.02      0.03      0.02      0.02      0.03      0.02      0.02      0.03      0.02      0.02
                 0.03      0.02

19 LG        GREEN AND AMPT LOSS RATE
                 STRTL        0.10  STARTING LOSS
                   DTH        0.25  MOISTURE DEFICIT
                  PSIF        5.20  WETTING FRONT SUCTION
                 XKSAT        0.24  HYDRAULIC CONDUCTIVITY
                 RTIMP       35.00  PERCENT IMPERVIOUS AREA

20 UC        CLARK UNITGRAPH
                    TC        0.45  TIME OF CONCENTRATION
                     R        0.37  STORAGE COEFFICIENT

21 UA        ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                 0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
               100.0

                                                  ***

                                          UNIT HYDROGRAPH PARAMETERS
                                   CLARK   TC=  0.45 HR,       R=  0.37 HR
                                  SNYDER   TP=  0.29 HR,      CP=  0.48

                                          UNIT HYDROGRAPH
                                     26 END-OF-PERIOD ORDINATES
            83.      383.      684.      750.      692.      597.      487.      387.      308.      246.
           195.      156.      124.       99.       79.       62.       50.       40.       32.       25.
            20.       16.       13.       10.        8.        6.

   ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   SAC230
                      FOR PLAN 1, RATIO = 0.50

  TOTAL RAINFALL =   15.00, TOTAL LOSS =    1.64, TOTAL EXCESS =   13.36

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
 (CFS)        (HR)                   6-HR       24-HR       72-HR     74.92-HR
  6516.       3.50        (CFS)      1028.        258.         86.         83.
                        (INCHES)    13.275      13.305      13.305      13.305
```

```
                    (AC-FT)      510.       511.       511.       511.

                    CUMULATIVE AREA =    0.72 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   SAC230
                       FOR PLAN 1, RATIO = 0.50

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)        (HR)                  6-HR      24-HR      72-HR     74.92-HR
   3258.       3.50        (CFS)     514.       129.        43.         41.
                         (INCHES)   6.637      6.652      6.652       6.652
                          (AC-FT)    255.       255.       255.        255.

                    CUMULATIVE AREA =    0.72 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


          **************
          *            *
 23 KK    *    SAC235  *
          *            *
          **************
                     SUB-BASIN sac235
                     6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
                     THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
                     BASIN FROM WICKENBERG ADMS

             SUBBASIN RUNOFF DATA

 28 BA         SUBBASIN CHARACTERISTICS
                    TAREA        0.38  SUBBASIN AREA

               PRECIPITATION DATA

 15 PB              STORM       15.00  BASIN TOTAL PRECIPITATION

 15 PI           INCREMENTAL PRECIPITATION PATTERN
                   0.03      0.03      0.02      0.03      0.03      0.02      0.03      0.03      0.02      0.02
                   0.03      0.03      0.04      0.04      0.04      0.04      0.04      0.04      0.04      0.04
                   0.04      0.04      0.04      0.04      0.13      0.13      0.13      0.13      0.13      0.13
                   0.13      0.13      0.13      0.13      0.13      0.13      2.80      2.80      2.80      0.57
                   0.57      0.57      0.23      0.23      0.23      0.23      0.23      0.23      0.07      0.07
                   0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07
                   0.02      0.03      0.02      0.02      0.03      0.02      0.02      0.03      0.02      0.02
                   0.03      0.02

 29 LG         GREEN AND AMPT LOSS RATE
                    STRTL        0.10  STARTING LOSS
                      DTH        0.23  MOISTURE DEFICIT
                     PSIF        6.20  WETTING FRONT SUCTION
                    XKSAT        0.15  HYDRAULIC CONDUCTIVITY
                    RTIMP       36.00  PERCENT IMPERVIOUS AREA

 30 UC         CLARK UNITGRAPH
                       TC        0.45  TIME OF CONCENTRATION
                        R        0.46  STORAGE COEFFICIENT

 31 UA         ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                    0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
```

```
                    100.0
                                                                    ***
                                                          UNIT HYDROGRAPH PARAMETERS
                                                   CLARK   TC=  0.45 HR,       R=  0.46 HR
                                                  SNYDER   TP=  0.31 HR,      CP=  0.44

                                                          UNIT HYDROGRAPH
                                                     32 END-OF-PERIOD ORDINATES
                35.      162.      298.      339.      324.      290.      248.      207.      172.      144.
               120.      100.       84.       70.       58.       48.       40.       34.       28.       23.
                20.       16.       14.       11.        9.        8.        7.        6.        5.        4.
                 3.        3.

     ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION   SAC235
                          FOR PLAN 1, RATIO = 0.50

   TOTAL RAINFALL =   15.00, TOTAL LOSS =    1.32, TOTAL EXCESS =   13.68

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                   6-HR       24-HR       72-HR     74.92-HR
   3076.       3.50        (CFS)      555.        139.         46.         45.
                         (INCHES)   13.570      13.617      13.617      13.617
                          (AC-FT)     275.        276.        276.        276.

                         CUMULATIVE AREA =    0.38 SQ MI

     ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION   SAC235
                          FOR PLAN 1, RATIO = 0.50

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                   6-HR       24-HR       72-HR     74.92-HR
   1538.       3.50        (CFS)      277.         70.         23.         22.
                         (INCHES)    6.785       6.808       6.808       6.808
                          (AC-FT)     138.        138.        138.        138.

                         CUMULATIVE AREA =    0.38 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  33 KK     *      ADD   *
            *            *
            **************
                          ADD SAC230 & SAC235

  35 HC          HYDROGRAPH COMBINATION
                      ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                    ***

     ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      ADD
                          FOR PLAN 1, RATIO = 0.50
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PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR       24-HR       72-HR     74.92-HR
   4796.      3.50        (CFS)     791.        198.         66.          64.
                        (INCHES)   6.688       6.706       6.706        6.706
                         (AC-FT)    392.        393.        393.         393.

                       CUMULATIVE AREA =    1.10 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


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           *            *
 36 KK     *     ROUTE  *
           *            *
           **************
                         ROUTE COMBINED HYDROGRAPH TO DAM LOCATION

              HYDROGRAPH ROUTING DATA

 38 RS          STORAGE ROUTING
                      NSTPS          1  NUMBER OF SUBREACHES
                       ITYP       FLOW  TYPE OF INITIAL CONDITION
                      RSVRIC      -1.00  INITIAL CONDITION
                           X       0.00 WORKING R AND D COEFFICIENT

 39 RC          NORMAL DEPTH CHANNEL
                        ANL      0.045  LEFT OVERBANK N-VALUE
                       ANCH      0.030  MAIN CHANNEL N-VALUE
                        ANR      0.045  RIGHT OVERBANK N-VALUE
                      RLNTH      4200.  REACH LENGTH
                        SEL     0.0175  ENERGY SLOPE
                      ELMAX        0.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                      CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 41 RY        ELEVATION     16.50     12.50     12.50     10.00     10.00     12.50     12.50     16.50
 40 RX        DISTANCE     463.50    467.50    477.50    487.50    512.50    522.50    532.50    536.50

                                                          ***

                                      COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE      0.00      0.87      1.83      2.88      4.02      5.25      6.57      7.98      9.93     12.10
          OUTFLOW      0.00     27.97     90.60    181.95    300.62    446.32    619.30    820.07   1082.86   1405.42
        ELEVATION     10.00     10.34     10.68     11.03     11.37     11.71     12.05     12.39     12.74     13.08

          STORAGE     14.29     16.51     18.75     21.01     23.29     25.60     27.93     30.28     32.65     35.05
          OUTFLOW   1769.68   2172.41   2611.51   3085.39   3592.83   4132.80   4704.46   5307.08   5940.05   6602.82
        ELEVATION     13.42     13.76     14.11     14.45     14.79     15.13     15.47     15.82     16.16     16.50


    ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION    ROUTE
                       FOR PLAN 1, RATIO = 0.50

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR       24-HR       72-HR     74.92-HR
   4700.      3.50        (CFS)     791.        198.         66.          64.
                        (INCHES)   6.682       6.706       6.706        6.706
                         (AC-FT)    392.        393.        393.         393.
```

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PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
  (AC-FT)      (HR)                 6-HR       24-HR       72-HR      74.92-HR
     28.       3.50                  6.          2.          1.          1.

 PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
   (FEET)      (HR)                 6-HR       24-HR       72-HR      74.92-HR
    15.47      3.50                11.66       10.42       10.14       10.14

                      CUMULATIVE AREA =    1.10 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


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          *            *
  42 KK   *   CAS240   *
          *            *
          **************
                         SUB-BASIN cas240
                         6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
                         THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
                         BASIN MODIFIED FROM WICKENBERG ADMS TO REFLECT DAM LOCATION

              SUBBASIN RUNOFF DATA

  47 BA         SUBBASIN CHARACTERISTICS
                      TAREA        0.14  SUBBASIN AREA

                PRECIPITATION DATA

  15 PB               STORM       15.00  BASIN TOTAL PRECIPITATION

  15 PI           INCREMENTAL PRECIPITATION PATTERN
                    0.03      0.03      0.02      0.03      0.03      0.02      0.03      0.03      0.02      0.02
                    0.03      0.03      0.04      0.04      0.04      0.04      0.04      0.04      0.04      0.04
                    0.04      0.04      0.04      0.04      0.13      0.13      0.13      0.13      0.13      0.13
                    0.13      0.13      0.13      0.13      0.13      0.13      2.80      2.80      2.80      0.57
                    0.57      0.57      0.23      0.23      0.23      0.23      0.23      0.23      0.07      0.07
                    0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07
                    0.02      0.03      0.02      0.02      0.03      0.02      0.02      0.03      0.02      0.02
                    0.03      0.02

  48 LG         GREEN AND AMPT LOSS RATE
                      STRTL        0.10  STARTING LOSS
                        DTH        0.21  MOISTURE DEFICIT
                       PSIF        6.40  WETTING FRONT SUCTION
                      XKSAT        0.14  HYDRAULIC CONDUCTIVITY
                      RTIMP       21.00  PERCENT IMPERVIOUS AREA

  49 UC         CLARK UNITGRAPH
                         TC        0.26  TIME OF CONCENTRATION
                          R        0.23  STORAGE COEFFICIENT

  50 UA         ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                      0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
                    100.0

                                                   ***

                                          UNIT HYDROGRAPH PARAMETERS
                                   CLARK   TC=  0.26 HR,       R=  0.23 HR
                                  SNYDER   TP=  0.19 HR,      CP=  0.52
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                                                UNIT HYDROGRAPH
                                            16 END-OF-PERIOD ORDINATES
            63.      187.      231.      182.      128.      89.       62.       43.       30.       21.
            15.       10.        7.        5.        3.       2.

    ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   CAS240
                       FOR PLAN 1, RATIO = 0.50

   TOTAL RAINFALL =   15.00, TOTAL LOSS =    1.55, TOTAL EXCESS =   13.45

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                  6-HR       24-HR       72-HR      74.92-HR
   1748.       3.33        (CFS)     201.        50.         17.          16.
                         (INCHES)   13.372     13.387      13.387       13.387
                          (AC-FT)    100.       100.        100.         100.

                         CUMULATIVE AREA =    0.14 SQ MI

    ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   CAS240
                       FOR PLAN 1, RATIO = 0.50

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                  6-HR       24-HR       72-HR      74.92-HR
    874.       3.33        (CFS)     101.        25.          8.           8.
                         (INCHES)    6.686      6.693       6.693        6.693
                          (AC-FT)     50.        50.         50.          50.

                         CUMULATIVE AREA =    0.14 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


          **************
          *            *
 52 KK    *     DAMIN  *
          *            *
          **************
                       ADD ROUTED HYDROGRAPH TO CAS240

 54 KO          OUTPUT CONTROL VARIABLES
                      IPRNT          1  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

 55 HC          HYDROGRAPH COMBINATION
                      ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                          ***
*****************************************************************************************************************************

                                              HYDROGRAPH AT STATION    DAMIN
                                                  SUM OF  2 HYDROGRAPHS
                                                PLAN 1,   RATIO =  0.50

*****************************************************************************************************************************
                                 *                                 *                                 *
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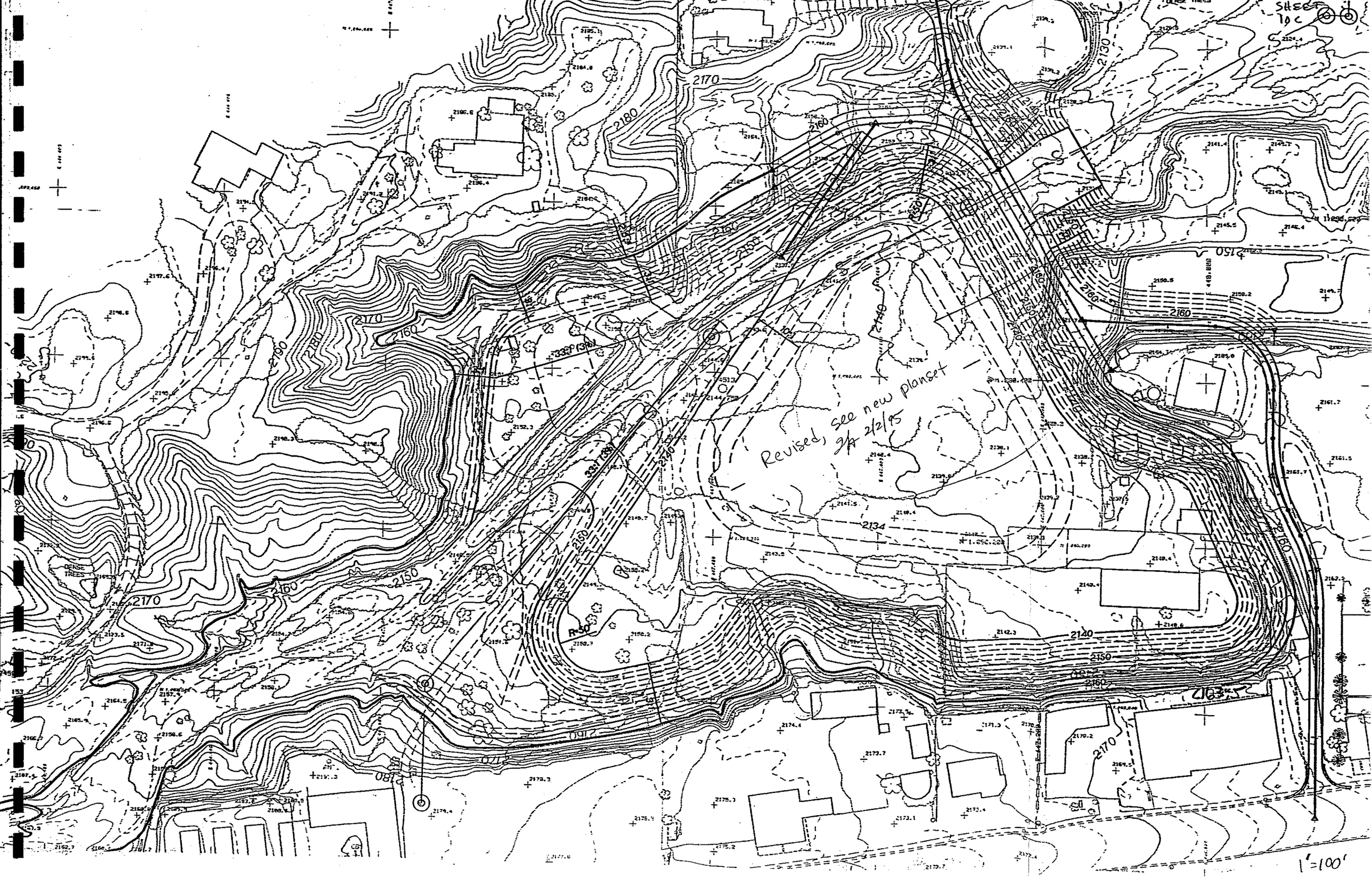
K/74 4PRINT

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
					*						*						*					
1		0000	1	0.	*	1		1845	226	0.	*	2		1330	451	0.	*	3		0815	676	0.
1		0005	2	0.	*	1		1850	227	0.	*	2		1335	452	0.	*	3		0820	677	0.
1		0010	3	1.	*	1		1855	228	0.	*	2		1340	453	0.	*	3		0825	678	0.
1		0015	4	3.	*	1		1900	229	0.	*	2		1345	454	0.	*	3		0830	679	0.
1		0020	5	5.	*	1		1905	230	0.	*	2		1350	455	0.	*	3		0835	680	0.
1		0025	6	7.	*	1		1910	231	0.	*	2		1355	456	0.	*	3		0840	681	0.
1		0030	7	10.	*	1		1915	232	0.	*	2		1400	457	0.	*	3		0845	682	0.
1		0035	8	13.	*	1		1920	233	0.	*	2		1405	458	0.	*	3		0850	683	0.
1		0040	9	16.	*	1		1925	234	0.	*	2		1410	459	0.	*	3		0855	684	0.
1		0045	10	19.	*	1		1930	235	0.	*	2		1415	460	0.	*	3		0900	685	0.
1		0050	11	22.	*	1		1935	236	0.	*	2		1420	461	0.	*	3		0905	686	0.
1		0055	12	24.	*	1		1940	237	0.	*	2		1425	462	0.	*	3		0910	687	0.
1		0100	13	26.	*	1		1945	238	0.	*	2		1430	463	0.	*	3		0915	688	0.
1		0105	14	28.	*	1		1950	239	0.	*	2		1435	464	0.	*	3		0920	689	0.
1		0110	15	31.	*	1		1955	240	0.	*	2		1440	465	0.	*	3		0925	690	0.
1		0115	16	34.	*	1		2000	241	0.	*	2		1445	466	0.	*	3		0930	691	0.
1		0120	17	39.	*	1		2005	242	0.	*	2		1450	467	0.	*	3		0935	692	0.
1		0125	18	43.	*	1		2010	243	0.	*	2		1455	468	0.	*	3		0940	693	0.
1		0130	19	47.	*	1		2015	244	0.	*	2		1500	469	0.	*	3		0945	694	0.
1		0135	20	50.	*	1		2020	245	0.	*	2		1505	470	0.	*	3		0950	695	0.
1		0140	21	53.	*	1		2025	246	0.	*	2		1510	471	0.	*	3		0955	696	0.
1		0145	22	55.	*	1		2030	247	0.	*	2		1515	472	0.	*	3		1000	697	0.
1		0150	23	58.	*	1		2035	248	0.	*	2		1520	473	0.	*	3		1005	698	0.
1		0155	24	60.	*	1		2040	249	0.	*	2		1525	474	0.	*	3		1010	699	0.
1		0200	25	62.	*	1		2045	250	0.	*	2		1530	475	0.	*	3		1015	700	0.
1		0205	26	67.	*	1		2050	251	0.	*	2		1535	476	0.	*	3		1020	701	0.
1		0210	27	83.	*	1		2055	252	0.	*	2		1540	477	0.	*	3		1025	702	0.
1		0215	28	111.	*	1		2100	253	0.	*	2		1545	478	0.	*	3		1030	703	0.
1		0220	29	152.	*	1		2105	254	0.	*	2		1550	479	0.	*	3		1035	704	0.
1		0225	30	200.	*	1		2110	255	0.	*	2		1555	480	0.	*	3		1040	705	0.
1		0230	31	249.	*	1		2115	256	0.	*	2		1600	481	0.	*	3		1045	706	0.
1		0235	32	296.	*	1		2120	257	0.	*	2		1605	482	0.	*	3		1050	707	0.
1		0240	33	336.	*	1		2125	258	0.	*	2		1610	483	0.	*	3		1055	708	0.
1		0245	34	371.	*	1		2130	259	0.	*	2		1615	484	0.	*	3		1100	709	0.
1		0250	35	400.	*	1		2135	260	0.	*	2		1620	485	0.	*	3		1105	710	0.
1		0255	36	423.	*	1		2140	261	0.	*	2		1625	486	0.	*	3		1110	711	0.
1		0300	37	442.	*	1		2145	262	0.	*	2		1630	487	0.	*	3		1115	712	0.
1		0305	38	586.	*	1		2150	263	0.	*	2		1635	488	0.	*	3		1120	713	0.
1		0310	39	1152.	*	1		2155	264	0.	*	2		1640	489	0.	*	3		1125	714	0.
1		0315	40	2270.	*	1		2200	265	0.	*	2		1645	490	0.	*	3		1130	715	0.
1		0320	41	3801.	*	1		2205	266	0.	*	2		1650	491	0.	*	3		1135	716	0.
1		0325	42	4989.	*	1		2210	267	0.	*	2		1655	492	0.	*	3		1140	717	0.
1		0330	43	5398.	*	1		2215	268	0.	*	2		1700	493	0.	*	3		1145	718	0.
1		0335	44	5240.	*	1		2220	269	0.	*	2		1705	494	0.	*	3		1150	719	0.
1		0340	45	4808.	*	1		2225	270	0.	*	2		1710	495	0.	*	3		1155	720	0.
1		0345	46	4259.	*	1		2230	271	0.	*	2		1715	496	0.	*	3		1200	721	0.
1		0350	47	3708.	*	1		2235	272	0.	*	2		1720	497	0.	*	3		1205	722	0.
1		0355	48	3221.	*	1		2240	273	0.	*	2		1725	498	0.	*	3		1210	723	0.
1		0400	49	2812.	*	1		2245	274	0.	*	2		1730	499	0.	*	3		1215	724	0.
1		0405	50	2470.	*	1		2250	275	0.	*	2		1735	500	0.	*	3		1220	725	0.
1		0410	51	2159.	*	1		2255	276	0.	*	2		1740	501	0.	*	3		1225	726	0.
1		0415	52	1864.	*	1		2300	277	0.	*	2		1745	502	0.	*	3		1230	727	0.
1		0420	53	1600.	*	1		2305	278	0.	*	2		1750	503	0.	*	3		1235	728	0.
1		0425	54	1364.	*	1		2310	279	0.	*	2		1755	504	0.	*	3		1240	729	0.
1		0430	55	1162.	*	1		2315	280	0.	*	2		1800	505	0.	*	3		1245	730	0.
1		0435	56	995.	*	1		2320	281	0.	*	2		1805	506	0.	*	3		1250	731	0.
1		0440	57	855.	*	1		2325	282	0.	*	2		1810	507	0.	*	3		1255	732	0.
1		0445	58	734.	*	1		2330	283	0.	*	2		1815	508	0.	*	3		1300	733	0.
1		0450	59	638.	*	1		2335	284	0.	*	2		1820	509	0.	*	3		1305	734	0.
1		0455	60	564.	*	1		2340	285	0.	*	2		1825	510	0.	*	3		1310	735	0.
1		0500	61	502.	*	1		2345	286	0.	*	2		1830	511	0.	*	3		1315	736	0.
1		0505	62	451.	*	1		2350	287	0.	*	2		1835	512	0.	*	3		1320	737	0.
1		0510	63	403.	*	1		2355	288	0.	*	2		1840	513	0.	*	3		1325	738	0.
1		0515	64	353.	*	2		0000	289	0.	*	2		1845	514	0.	*	3		1330	739	0.

1C/4PRINT

1	0520	65	303.	*	2	0005	290	0.	*	2	1850	515	0.	*	3	1335	740	0.
1	0525	66	258.	*	2	0010	291	0.	*	2	1855	516	0.	*	3	1340	741	0.
1	0530	67	218.	*	2	0015	292	0.	*	2	1900	517	0.	*	3	1345	742	0.
1	0535	68	185.	*	2	0020	293	0.	*	2	1905	518	0.	*	3	1350	743	0.
1	0540	69	161.	*	2	0025	294	0.	*	2	1910	519	0.	*	3	1355	744	0.
1	0545	70	139.	*	2	0030	295	0.	*	2	1915	520	0.	*	3	1400	745	0.
1	0550	71	120.	*	2	0035	296	0.	*	2	1920	521	0.	*	3	1405	746	0.
1	0555	72	104.	*	2	0040	297	0.	*	2	1925	522	0.	*	3	1410	747	0.
1	0600	73	92.	*	2	0045	298	0.	*	2	1930	523	0.	*	3	1415	748	0.
1	0605	74	83.	*	2	0050	299	0.	*	2	1935	524	0.	*	3	1420	749	0.
1	0610	75	74.	*	2	0055	300	0.	*	2	1940	525	0.	*	3	1425	750	0.
1	0615	76	65.	*	2	0100	301	0.	*	2	1945	526	0.	*	3	1430	751	0.
1	0620	77	56.	*	2	0105	302	0.	*	2	1950	527	0.	*	3	1435	752	0.
1	0625	78	48.	*	2	0110	303	0.	*	2	1955	528	0.	*	3	1440	753	0.
1	0630	79	41.	*	2	0115	304	0.	*	2	2000	529	0.	*	3	1445	754	0.
1	0635	80	34.	*	2	0120	305	0.	*	2	2005	530	0.	*	3	1450	755	0.
1	0640	81	28.	*	2	0125	306	0.	*	2	2010	531	0.	*	3	1455	756	0.
1	0645	82	25.	*	2	0130	307	0.	*	2	2015	532	0.	*	3	1500	757	0.
1	0650	83	22.	*	2	0135	308	0.	*	2	2020	533	0.	*	3	1505	758	0.
1	0655	84	20.	*	2	0140	309	0.	*	2	2025	534	0.	*	3	1510	759	0.
1	0700	85	17.	*	2	0145	310	0.	*	2	2030	535	0.	*	3	1515	760	0.
1	0705	86	15.	*	2	0150	311	0.	*	2	2035	536	0.	*	3	1520	761	0.
1	0710	87	13.	*	2	0155	312	0.	*	2	2040	537	0.	*	3	1525	762	0.
1	0715	88	11.	*	2	0200	313	0.	*	2	2045	538	0.	*	3	1530	763	0.
1	0720	89	9.	*	2	0205	314	0.	*	2	2050	539	0.	*	3	1535	764	0.
1	0725	90	8.	*	2	0210	315	0.	*	2	2055	540	0.	*	3	1540	765	0.
1	0730	91	7.	*	2	0215	316	0.	*	2	2100	541	0.	*	3	1545	766	0.
1	0735	92	6.	*	2	0220	317	0.	*	2	2105	542	0.	*	3	1550	767	0.
1	0740	93	5.	*	2	0225	318	0.	*	2	2110	543	0.	*	3	1555	768	0.
1	0745	94	4.	*	2	0230	319	0.	*	2	2115	544	0.	*	3	1600	769	0.
1	0750	95	3.	*	2	0235	320	0.	*	2	2120	545	0.	*	3	1605	770	0.
1	0755	96	3.	*	2	0240	321	0.	*	2	2125	546	0.	*	3	1610	771	0.
1	0800	97	2.	*	2	0245	322	0.	*	2	2130	547	0.	*	3	1615	772	0.
1	0805	98	2.	*	2	0250	323	0.	*	2	2135	548	0.	*	3	1620	773	0.
1	0810	99	2.	*	2	0255	324	0.	*	2	2140	549	0.	*	3	1625	774	0.
1	0815	100	1.	*	2	0300	325	0.	*	2	2145	550	0.	*	3	1630	775	0.
1	0820	101	1.	*	2	0305	326	0.	*	2	2150	551	0.	*	3	1635	776	0.
1	0825	102	1.	*	2	0310	327	0.	*	2	2155	552	0.	*	3	1640	777	0.
1	0830	103	1.	*	2	0315	328	0.	*	2	2200	553	0.	*	3	1645	778	0.
1	0835	104	1.	*	2	0320	329	0.	*	2	2205	554	0.	*	3	1650	779	0.
1	0840	105	0.	*	2	0325	330	0.	*	2	2210	555	0.	*	3	1655	780	0.
1	0845	106	0.	*	2	0330	331	0.	*	2	2215	556	0.	*	3	1700	781	0.
1	0850	107	0.	*	2	0335	332	0.	*	2	2220	557	0.	*	3	1705	782	0.
1	0855	108	0.	*	2	0340	333	0.	*	2	2225	558	0.	*	3	1710	783	0.
1	0900	109	0.	*	2	0345	334	0.	*	2	2230	559	0.	*	3	1715	784	0.
1	0905	110	0.	*	2	0350	335	0.	*	2	2235	560	0.	*	3	1720	785	0.
1	0910	111	0.	*	2	0355	336	0.	*	2	2240	561	0.	*	3	1725	786	0.
1	0915	112	0.	*	2	0400	337	0.	*	2	2245	562	0.	*	3	1730	787	0.
1	0920	113	0.	*	2	0405	338	0.	*	2	2250	563	0.	*	3	1735	788	0.
1	0925	114	0.	*	2	0410	339	0.	*	2	2255	564	0.	*	3	1740	789	0.
1	0930	115	0.	*	2	0415	340	0.	*	2	2300	565	0.	*	3	1745	790	0.
1	0935	116	0.	*	2	0420	341	0.	*	2	2305	566	0.	*	3	1750	791	0.
1	0940	117	0.	*	2	0425	342	0.	*	2	2310	567	0.	*	3	1755	792	0.
1	0945	118	0.	*	2	0430	343	0.	*	2	2315	568	0.	*	3	1800	793	0.
1	0950	119	0.	*	2	0435	344	0.	*	2	2320	569	0.	*	3	1805	794	0.
1	0955	120	0.	*	2	0440	345	0.	*	2	2325	570	0.	*	3	1810	795	0.
1	1000	121	0.	*	2	0445	346	0.	*	2	2330	571	0.	*	3	1815	796	0.
1	1005	122	0.	*	2	0450	347	0.	*	2	2335	572	0.	*	3	1820	797	0.
1	1010	123	0.	*	2	0455	348	0.	*	2	2340	573	0.	*	3	1825	798	0.
1	1015	124	0.	*	2	0500	349	0.	*	2	2345	574	0.	*	3	1830	799	0.
1	1020	125	0.	*	2	0505	350	0.	*	2	2350	575	0.	*	3	1835	800	0.
1	1025	126	0.	*	2	0510	351	0.	*	2	2355	576	0.	*	3	1840	801	0.
1	1030	127	0.	*	2	0515	352	0.	*	3	0000	577	0.	*	3	1845	802	0.
1	1035	128	0.	*	2	0520	353	0.	*	3	0005	578	0.	*	3	1850	803	0.
1	1040	129	0.	*	2	0525	354	0.	*	3	0010	579	0.	*	3	1855	804	0.
1	1045	130	0.	*	2	0530	355	0.	*	3	0015	580	0.	*	3	1900	805	0.


SHEET 10c
Revised, see new planset
2/2/95
2170
2180
2160
2150
2140
2134
2130
R-50
DENSE TREES
1'=100'

HEC1 S/N: 0134301122 HMVersion: 6.33 Data File: hpm.hc1

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE (HEC-1)   *
*              MAY  1991               *
*            VERSION 4.0.1E            *
*                                      *
*  RUN DATE 02/02/1995  TIME  14:12:34 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

```
::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::
:::                                  :::
:::  Full Microcomputer Implementation :::
:::              by                  :::
:::       Haestad Methods, Inc.      :::
:::                                  :::
::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              * FINAL 1/2 PMF RUN  HPM.HC1
              *
              *DIAGRAM
              *
    1         ID   Casandro Wash Detention Dam     CH2M Hill     August, 1994
    2         ID   Copy of HEC-1 for Q100, changed precipitation
    3         ID   Revised dam location and basin grading
              * 1/2 PMF Run - routed
              *
    4         IT       5                    900
    5         IO       3
              *
    6         JR    FLOW      .5
              *

    7         KK  SAC230
    8         KM   SUB-BASIN SAC230
    9         KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
   10         KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
   11         KM   BASIN FROM WICKENBERG ADMS
   12         BA    .720
   13         IN      15
   14         PB      15
   15         KM   THE FOLLOWING PI RECORD USES A 6-HOUR STORM -  HMR#5 DISTRIBUTION
   16         PI   0.075   0.075   0.075   0.075   0.125   0.125   0.125   0.125     0.4     0.4
   17         PI     0.4     0.4     8.4     1.7     0.7     0.7     0.2     0.2     0.2     0.2
   18         PI   0.075   0.075   0.075   0.075
   19         LG    .100    .250   5.200    .240  35.000
   20         UC    .446    .367
   21         UA       0       5      16      30      65      77      84      90      94      97
   22         UA     100
              *

   23         KK  SAC235
   24         KM   SUB-BASIN sac235
   25         KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
   26         KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
   27         KM   BASIN FROM WICKENBERG ADMS
   28         BA    .380
   29         LG    .100    .230   6.200    .150  36.000
   30         UC    .450    .461
   31         UA       0       5      16      30      65      77      84      90      94      97
   32         UA     100
              *

   33         KK     ADD
   34         KM   ADD SAC230 & SAC235
   35         HC       2
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  36          KK   ROUTE
  37          KM   ROUTE COMBINED HYDROGRAPH TO DAM LOCATION
  38          RS       1    FLOW      -1
  39          RC    .045     .03    .045    4200   .0175
  40          RX   463.5   467.5   477.5   487.5   512.5   522.5   532.5   536.5
  41          RY    16.5    12.5    12.5    10.0    10.0    12.5    12.5    16.5
              *

  42          KK  CAS240
  43          KM   SUB-BASIN cas240
  44          KM   6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
  45          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
  46          KM   BASIN MODIFIED FROM WICKENBERG ADMS TO REFLECT DAM LOCATION
  47          BA    .140
  48          LG    .100    .210   6.400    .140  21.000
  49          UC    .258    .232
  50          UA       0       5      16      30      65      77      84      90      94      97
  51          UA     100
              *

  52          KK   DAMIN
  53          KM   ADD ROUTED HYDROGRAPH TO CAS240
  54          KO       1
  55          HC       2
              *

  56          KK  DAMOUT
  57          KM    Route Hydrograph Through Dam.
  58          KM
  59          RS       1    STOR       2
  60          KO       1
              *
  61          SA    2.05    2.49    5.80    6.77    9.06   10.20   10.96   11.34   11.61   11.88
  62          SA   12.09   12.31   12.81   13.31   13.81
  63          SE    2135    2137    2140    2144    2150    2153    2155    2156    2157    2158
  64          SE    2159    2160    2161    2162    2163
  65          SQ       0     9.5    13.5    19.1    23.3    28.6    30.9     295     823    1539
  66          SQ    2423    3450    4577    5773    7015
              *
  67          ZZ
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7      SAC230
                .
                .
   23           .      SAC235
                .           .
                .           .
   33         ADD............
                V
                V
   36       ROUTE
                .
                .
   42           .      CAS240
                .           .
                .           .
   52       DAMIN............
                V
                V
   56     DAMOUT
(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
****************************************                    ****************************************
*                                      *                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *    U.S. ARMY CORPS OF ENGINEERS      *
*             MAY   1991               *                    *    HYDROLOGIC ENGINEERING CENTER     *
*           VERSION 4.0.1E             *                    *          609 SECOND STREET           *
*                                      *                    *       DAVIS, CALIFORNIA 95616        *
*  RUN DATE  02/02/1995  TIME  14:12:34 *                    *           (916) 756-1104             *
*                                      *                    *                                      *
****************************************                    ****************************************
```

Casandro Wash Detention Dam CH2M Hill August, 1994
Copy of HEC-1 for Q100, changed precipitation
Revised dam location and basin grading

```
  5 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1   0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        900  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      4   0  ENDING DATE
                     NDTIME       0255  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL    0.08 HOURS
                      TOTAL TIME BASE   74.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

    JP          MULTI-PLAN OPTION
                      NPLAN          1  NUMBER OF PLANS

    JR          MULTI-RATIO OPTION
                    RATIOS OF RUNOFF
                   0.50


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


           **************
           *            *
  7 KK     *    SAC230  *
           *            *
           **************
                      SUB-BASIN SAC230
                      6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
```

```
                    THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
                    BASIN FROM WICKENBERG ADMS
                    THE FOLLOWING PI RECORD USES A 6-HOUR STORM -  HMR#5 DISTRIBUTION

 13 IN        TIME DATA FOR INPUT TIME SERIES
                   JXMIN          15  TIME INTERVAL IN MINUTES
                 JXDATE      1    0  STARTING DATE
                 JXTIME           0  STARTING TIME

            SUBBASIN RUNOFF DATA

 12 BA        SUBBASIN CHARACTERISTICS
                   TAREA        0.72  SUBBASIN AREA

              PRECIPITATION DATA

 15 PB             STORM       15.00  BASIN TOTAL PRECIPITATION

 15 PI          INCREMENTAL PRECIPITATION PATTERN
                  0.03      0.03      0.02      0.03      0.03      0.02      0.03      0.03      0.02      0.02
                  0.03      0.03      0.04      0.04      0.04      0.04      0.04      0.04      0.04      0.04
                  0.04      0.04      0.04      0.04      0.13      0.13      0.13      0.13      0.13      0.13
                  0.13      0.13      0.13      0.13      0.13      0.13      2.80      2.80      2.80      0.57
                  0.57      0.57      0.23      0.23      0.23      0.23      0.23      0.23      0.07      0.07
                  0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07
                  0.02      0.03      0.02      0.02      0.03      0.02      0.02      0.03      0.02      0.02
                  0.03      0.02

 19 LG        GREEN AND AMPT LOSS RATE
                  STRTL        0.10  STARTING LOSS
                    DTH        0.25  MOISTURE DEFICIT
                   PSIF        5.20  WETTING FRONT SUCTION
                  XKSAT        0.24  HYDRAULIC CONDUCTIVITY
                  RTIMP       35.00  PERCENT IMPERVIOUS AREA

 20 UC        CLARK UNITGRAPH
                     TC        0.45  TIME OF CONCENTRATION
                      R        0.37  STORAGE COEFFICIENT

 21 UA        ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                  0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
                100.0

                                                  ***

                                          UNIT HYDROGRAPH PARAMETERS
                                     CLARK   TC=  0.45 HR,       R=  0.37 HR
                                    SNYDER   TP=  0.29 HR,      CP=  0.48

                                            UNIT HYDROGRAPH
                                        26 END-OF-PERIOD ORDINATES
            83.      383.      684.      750.      692.      597.      487.      387.      308.      246.
           195.      156.      124.       99.       79.       62.       50.       40.       32.       25.
            20.       16.       13.       10.        8.        6.

    ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   SAC230
                      FOR PLAN 1, RATIO = 0.50

   TOTAL RAINFALL =   15.00, TOTAL LOSS =    1.64, TOTAL EXCESS =   13.36

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                 6-HR       24-HR       72-HR     74.92-HR
   6516.       3.50       (CFS)     1028.       258.        86.         83.
                        (INCHES)   13.275      13.305      13.305      13.305
```

```
                    (AC-FT)      510.        511.        511.        511.

                    CUMULATIVE AREA =    0.72 SQ MI


    ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   SAC230
                       FOR PLAN 1, RATIO = 0.50

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                 6-HR       24-HR       72-HR     74.92-HR
   3258.      3.50        (CFS)    514.        129.         43.         41.
                        (INCHES)  6.637       6.652       6.652       6.652
                         (AC-FT)   255.        255.        255.        255.

                    CUMULATIVE AREA =    0.72 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


          **************
          *            *
 23 KK    *   SAC235   *
          *            *
          **************
                         SUB-BASIN sac235
                         6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
                         THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
                         BASIN FROM WICKENBERG ADMS

            SUBBASIN RUNOFF DATA

 28 BA        SUBBASIN CHARACTERISTICS
                    TAREA        0.38  SUBBASIN AREA

              PRECIPITATION DATA

 15 PB              STORM       15.00  BASIN TOTAL PRECIPITATION

 15 PI          INCREMENTAL PRECIPITATION PATTERN
                   0.03      0.03      0.02      0.03      0.03      0.02      0.03      0.03      0.02      0.02
                   0.03      0.03      0.04      0.04      0.04      0.04      0.04      0.04      0.04      0.04
                   0.04      0.04      0.04      0.04      0.13      0.13      0.13      0.13      0.13      0.13
                   0.13      0.13      0.13      0.13      0.13      0.13      2.80      2.80      2.80      0.57
                   0.57      0.57      0.23      0.23      0.23      0.23      0.23      0.23      0.07      0.07
                   0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07
                   0.02      0.03      0.02      0.02      0.03      0.02      0.02      0.03      0.02      0.02
                   0.03      0.02

 29 LG        GREEN AND AMPT LOSS RATE
                    STRTL        0.10  STARTING LOSS
                      DTH        0.23  MOISTURE DEFICIT
                     PSIF        6.20  WETTING FRONT SUCTION
                    XKSAT        0.15  HYDRAULIC CONDUCTIVITY
                    RTIMP       36.00  PERCENT IMPERVIOUS AREA

 30 UC        CLARK UNITGRAPH
                       TC        0.45  TIME OF CONCENTRATION
                        R        0.46  STORAGE COEFFICIENT

 31 UA        ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                    0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
```

```
                    100.0
                                                        ***

                                                UNIT HYDROGRAPH PARAMETERS
                                          CLARK   TC=  0.45 HR,       R=  0.46 HR
                                         SNYDER   TP=  0.31 HR,      CP=  0.44

                                                    UNIT HYDROGRAPH
                                              32 END-OF-PERIOD ORDINATES
              35.      162.      298.      339.      324.      290.      248.      207.      172.      144.
             120.      100.       84.       70.       58.       48.       40.       34.       28.       23.
              20.       16.       14.       11.        9.        8.        7.        6.        5.        4.
               3.        3.

     ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION   SAC235
                         FOR PLAN 1, RATIO = 0.50

   TOTAL RAINFALL =   15.00, TOTAL LOSS =    1.32, TOTAL EXCESS =   13.68

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                   6-HR       24-HR       72-HR     74.92-HR
   3076.       3.50        (CFS)      555.        139.         46.         45.
                         (INCHES)   13.570      13.617      13.617      13.617
                          (AC-FT)     275.        276.        276.        276.

                         CUMULATIVE AREA =    0.38 SQ MI


     ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION   SAC235
                         FOR PLAN 1, RATIO = 0.50

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                   6-HR       24-HR       72-HR     74.92-HR
   1538.       3.50        (CFS)      277.         70.         23.         22.
                         (INCHES)    6.785       6.808       6.808       6.808
                          (AC-FT)     138.        138.        138.        138.

                         CUMULATIVE AREA =    0.38 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  33 KK     *       ADD  *
            *            *
            **************
                          ADD SAC230 & SAC235

  35 HC          HYDROGRAPH COMBINATION
                       ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                        ***

     ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION      ADD
                         FOR PLAN 1, RATIO = 0.50
```

```
PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR       24-HR       72-HR     74.92-HR
   4796.      3.50        (CFS)     791.        198.         66.         64.
                        (INCHES)   6.688       6.706       6.706       6.706
                         (AC-FT)    392.        393.        393.        393.

                       CUMULATIVE AREA =    1.10 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***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            *            *
 36 KK      *     ROUTE  *
            *            *
            **************
                        ROUTE COMBINED HYDROGRAPH TO DAM LOCATION

               HYDROGRAPH ROUTING DATA

 38 RS           STORAGE ROUTING
                      NSTPS          1  NUMBER OF SUBREACHES
                       ITYP       FLOW  TYPE OF INITIAL CONDITION
                      RSVRIC     -1.00  INITIAL CONDITION
                           X      0.00 WORKING R AND D COEFFICIENT

 39 RC           NORMAL DEPTH CHANNEL
                        ANL      0.045  LEFT OVERBANK N-VALUE
                       ANCH      0.030  MAIN CHANNEL N-VALUE
                        ANR      0.045  RIGHT OVERBANK N-VALUE
                      RLNTH      4200.  REACH LENGTH
                        SEL     0.0175  ENERGY SLOPE
                      ELMAX        0.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                     CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 41 RY        ELEVATION    16.50     12.50     12.50     10.00     10.00     12.50     12.50     16.50
 40 RX        DISTANCE    463.50    467.50    477.50    487.50    512.50    522.50    532.50    536.50
                                                          ***

                                     COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE      0.00      0.87      1.83      2.88      4.02      5.25      6.57      7.98      9.93     12.10
          OUTFLOW      0.00     27.97     90.60    181.95    300.62    446.32    619.30    820.07   1082.86   1405.42
        ELEVATION     10.00     10.34     10.68     11.03     11.37     11.71     12.05     12.39     12.74     13.08

          STORAGE     14.29     16.51     18.75     21.01     23.29     25.60     27.93     30.28     32.65     35.05
          OUTFLOW   1769.68   2172.41   2611.51   3085.39   3592.83   4132.80   4704.46   5307.08   5940.05   6602.82
        ELEVATION     13.42     13.76     14.11     14.45     14.79     15.13     15.47     15.82     16.16     16.50


    ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION    ROUTE
                         FOR PLAN 1, RATIO = 0.50

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR       24-HR       72-HR     74.92-HR
   4700.      3.50        (CFS)     791.        198.         66.         64.
                        (INCHES)   6.682       6.706       6.706       6.706
                         (AC-FT)    392.        393.        393.        393.
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PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
  (AC-FT)      (HR)                 6-HR       24-HR       72-HR     74.92-HR
     28.       3.50                  6.          2.          1.          1.

 PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
   (FEET)      (HR)                 6-HR       24-HR       72-HR     74.92-HR
    15.47      3.50                11.66       10.42       10.14       10.14

                      CUMULATIVE AREA =    1.10 SQ MI


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          *            *
  42 KK   *    CAS240  *
          *            *
          **************
                    SUB-BASIN cas240
                    6-HOUR RAINFALL, PATTERN NO. 1.53 WAS USED TO FIND TC & R FOR THIS BASIN
                    THIS BASIN USED RAINFALL REDUCTION FACTOR OF .985
                    BASIN MODIFIED FROM WICKENBERG ADMS TO REFLECT DAM LOCATION

             SUBBASIN RUNOFF DATA

  47 BA        SUBBASIN CHARACTERISTICS
                    TAREA        0.14  SUBBASIN AREA

               PRECIPITATION DATA

  15 PB             STORM       15.00  BASIN TOTAL PRECIPITATION

  15 PI          INCREMENTAL PRECIPITATION PATTERN
                   0.03      0.03      0.02      0.03      0.03      0.02      0.03      0.03      0.02      0.02
                   0.03      0.03      0.04      0.04      0.04      0.04      0.04      0.04      0.04      0.04
                   0.04      0.04      0.04      0.04      0.13      0.13      0.13      0.13      0.13      0.13
                   0.13      0.13      0.13      0.13      0.13      0.13      2.80      2.80      2.80      0.57
                   0.57      0.57      0.23      0.23      0.23      0.23      0.23      0.23      0.07      0.07
                   0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07      0.07
                   0.02      0.03      0.02      0.02      0.03      0.02      0.02      0.03      0.02      0.02
                   0.03      0.02

  48 LG        GREEN AND AMPT LOSS RATE
                    STRTL        0.10  STARTING LOSS
                      DTH        0.21  MOISTURE DEFICIT
                     PSIF        6.40  WETTING FRONT SUCTION
                    XKSAT        0.14  HYDRAULIC CONDUCTIVITY
                    RTIMP       21.00  PERCENT IMPERVIOUS AREA

  49 UC        CLARK UNITGRAPH
                       TC        0.26  TIME OF CONCENTRATION
                        R        0.23  STORAGE COEFFICIENT

  50 UA        ACCUMULATED-AREA VS. TIME,  11 ORDINATES
                   0.0       5.0      16.0      30.0      65.0      77.0      84.0      90.0      94.0      97.0
                 100.0

                                                  ***

                                          UNIT HYDROGRAPH PARAMETERS
                                     CLARK   TC=  0.26 HR,       R=  0.23 HR
                                    SNYDER   TP=  0.19 HR,      CP=  0.52
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                                                UNIT HYDROGRAPH
                                            16 END-OF-PERIOD ORDINATES
          63.      187.      231.      182.      128.      89.      62.      43.      30.      21.
          15.       10.        7.        5.        3.       2.

   ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   CAS240
                      FOR PLAN 1, RATIO = 0.50

  TOTAL RAINFALL =   15.00, TOTAL LOSS =    1.55, TOTAL EXCESS =   13.45

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR       24-HR       72-HR      74.92-HR
  1748.       3.33        (CFS)     201.        50.         17.          16.
                        (INCHES)   13.372     13.387      13.387       13.387
                         (AC-FT)    100.       100.        100.         100.

                       CUMULATIVE AREA =    0.14 SQ MI


   ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   CAS240
                      FOR PLAN 1, RATIO = 0.50

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR       24-HR       72-HR      74.92-HR
   874.       3.33        (CFS)     101.        25.          8.           8.
                        (INCHES)    6.686      6.693       6.693        6.693
                         (AC-FT)     50.        50.         50.          50.

                       CUMULATIVE AREA =    0.14 SQ MI


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          *            *
 52 KK    *     DAMIN  *
          *            *
          **************
                    ADD ROUTED HYDROGRAPH TO CAS240

 54 KO          OUTPUT CONTROL VARIABLES
                      IPRNT          1  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

 55 HC          HYDROGRAPH COMBINATION
                      ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                        ***
*****************************************************************************************************************************

                                              HYDROGRAPH AT STATION    DAMIN
                                                  SUM OF  2 HYDROGRAPHS
                                                PLAN 1,   RATIO =  0.50

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DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
					*						*						*					
1		0000	1	0.	*	1		1845	226	0.	*	2		1330	451	0.	*	3		0815	676	0.
1		0005	2	0.	*	1		1850	227	0.	*	2		1335	452	0.	*	3		0820	677	0.
1		0010	3	1.	*	1		1855	228	0.	*	2		1340	453	0.	*	3		0825	678	0.
1		0015	4	3.	*	1		1900	229	0.	*	2		1345	454	0.	*	3		0830	679	0.
1		0020	5	5.	*	1		1905	230	0.	*	2		1350	455	0.	*	3		0835	680	0.
1		0025	6	7.	*	1		1910	231	0.	*	2		1355	456	0.	*	3		0840	681	0.
1		0030	7	10.	*	1		1915	232	0.	*	2		1400	457	0.	*	3		0845	682	0.
1		0035	8	13.	*	1		1920	233	0.	*	2		1405	458	0.	*	3		0850	683	0.
1		0040	9	16.	*	1		1925	234	0.	*	2		1410	459	0.	*	3		0855	684	0.
1		0045	10	19.	*	1		1930	235	0.	*	2		1415	460	0.	*	3		0900	685	0.
1		0050	11	22.	*	1		1935	236	0.	*	2		1420	461	0.	*	3		0905	686	0.
1		0055	12	24.	*	1		1940	237	0.	*	2		1425	462	0.	*	3		0910	687	0.
1		0100	13	26.	*	1		1945	238	0.	*	2		1430	463	0.	*	3		0915	688	0.
1		0105	14	28.	*	1		1950	239	0.	*	2		1435	464	0.	*	3		0920	689	0.
1		0110	15	31.	*	1		1955	240	0.	*	2		1440	465	0.	*	3		0925	690	0.
1		0115	16	34.	*	1		2000	241	0.	*	2		1445	466	0.	*	3		0930	691	0.
1		0120	17	39.	*	1		2005	242	0.	*	2		1450	467	0.	*	3		0935	692	0.
1		0125	18	43.	*	1		2010	243	0.	*	2		1455	468	0.	*	3		0940	693	0.
1		0130	19	47.	*	1		2015	244	0.	*	2		1500	469	0.	*	3		0945	694	0.
1		0135	20	50.	*	1		2020	245	0.	*	2		1505	470	0.	*	3		0950	695	0.
1		0140	21	53.	*	1		2025	246	0.	*	2		1510	471	0.	*	3		0955	696	0.
1		0145	22	55.	*	1		2030	247	0.	*	2		1515	472	0.	*	3		1000	697	0.
1		0150	23	58.	*	1		2035	248	0.	*	2		1520	473	0.	*	3		1005	698	0.
1		0155	24	60.	*	1		2040	249	0.	*	2		1525	474	0.	*	3		1010	699	0.
1		0200	25	62.	*	1		2045	250	0.	*	2		1530	475	0.	*	3		1015	700	0.
1		0205	26	67.	*	1		2050	251	0.	*	2		1535	476	0.	*	3		1020	701	0.
1		0210	27	83.	*	1		2055	252	0.	*	2		1540	477	0.	*	3		1025	702	0.
1		0215	28	111.	*	1		2100	253	0.	*	2		1545	478	0.	*	3		1030	703	0.
1		0220	29	152.	*	1		2105	254	0.	*	2		1550	479	0.	*	3		1035	704	0.
1		0225	30	200.	*	1		2110	255	0.	*	2		1555	480	0.	*	3		1040	705	0.
1		0230	31	249.	*	1		2115	256	0.	*	2		1600	481	0.	*	3		1045	706	0.
1		0235	32	296.	*	1		2120	257	0.	*	2		1605	482	0.	*	3		1050	707	0.
1		0240	33	336.	*	1		2125	258	0.	*	2		1610	483	0.	*	3		1055	708	0.
1		0245	34	371.	*	1		2130	259	0.	*	2		1615	484	0.	*	3		1100	709	0.
1		0250	35	400.	*	1		2135	260	0.	*	2		1620	485	0.	*	3		1105	710	0.
1		0255	36	423.	*	1		2140	261	0.	*	2		1625	486	0.	*	3		1110	711	0.
1		0300	37	442.	*	1		2145	262	0.	*	2		1630	487	0.	*	3		1115	712	0.
1		0305	38	586.	*	1		2150	263	0.	*	2		1635	488	0.	*	3		1120	713	0.
1		0310	39	1152.	*	1		2155	264	0.	*	2		1640	489	0.	*	3		1125	714	0.
1		0315	40	2270.	*	1		2200	265	0.	*	2		1645	490	0.	*	3		1130	715	0.
1		0320	41	3801.	*	1		2205	266	0.	*	2		1650	491	0.	*	3		1135	716	0.
1		0325	42	4989.	*	1		2210	267	0.	*	2		1655	492	0.	*	3		1140	717	0.
1		0330	43	5398.	*	1		2215	268	0.	*	2		1700	493	0.	*	3		1145	718	0.
1		0335	44	5240.	*	1		2220	269	0.	*	2		1705	494	0.	*	3		1150	719	0.
1		0340	45	4808.	*	1		2225	270	0.	*	2		1710	495	0.	*	3		1155	720	0.
1		0345	46	4259.	*	1		2230	271	0.	*	2		1715	496	0.	*	3		1200	721	0.
1		0350	47	3708.	*	1		2235	272	0.	*	2		1720	497	0.	*	3		1205	722	0.
1		0355	48	3221.	*	1		2240	273	0.	*	2		1725	498	0.	*	3		1210	723	0.
1		0400	49	2812.	*	1		2245	274	0.	*	2		1730	499	0.	*	3		1215	724	0.
1		0405	50	2470.	*	1		2250	275	0.	*	2		1735	500	0.	*	3		1220	725	0.
1		0410	51	2159.	*	1		2255	276	0.	*	2		1740	501	0.	*	3		1225	726	0.
1		0415	52	1864.	*	1		2300	277	0.	*	2		1745	502	0.	*	3		1230	727	0.
1		0420	53	1600.	*	1		2305	278	0.	*	2		1750	503	0.	*	3		1235	728	0.
1		0425	54	1364.	*	1		2310	279	0.	*	2		1755	504	0.	*	3		1240	729	0.
1		0430	55	1162.	*	1		2315	280	0.	*	2		1800	505	0.	*	3		1245	730	0.
1		0435	56	995.	*	1		2320	281	0.	*	2		1805	506	0.	*	3		1250	731	0.
1		0440	57	855.	*	1		2325	282	0.	*	2		1810	507	0.	*	3		1255	732	0.
1		0445	58	734.	*	1		2330	283	0.	*	2		1815	508	0.	*	3		1300	733	0.
1		0450	59	638.	*	1		2335	284	0.	*	2		1820	509	0.	*	3		1305	734	0.
1		0455	60	564.	*	1		2340	285	0.	*	2		1825	510	0.	*	3		1310	735	0.
1		0500	61	502.	*	1		2345	286	0.	*	2		1830	511	0.	*	3		1315	736	0.
1		0505	62	451.	*	1		2350	287	0.	*	2		1835	512	0.	*	3		1320	737	0.
1		0510	63	403.	*	1		2355	288	0.	*	2		1840	513	0.	*	3		1325	738	0.
1		0515	64	353.	*	2		0000	289	0.	*	2		1845	514	0.	*	3		1330	739	0.

1	0520	65	303.	*	2	0005	290	0.	*	2	1850	515	0.	*	3	1335	740	0.
1	0525	66	258.	*	2	0010	291	0.	*	2	1855	516	0.	*	3	1340	741	0.
1	0530	67	218.	*	2	0015	292	0.	*	2	1900	517	0.	*	3	1345	742	0.
1	0535	68	185.	*	2	0020	293	0.	*	2	1905	518	0.	*	3	1350	743	0.
1	0540	69	161.	*	2	0025	294	0.	*	2	1910	519	0.	*	3	1355	744	0.
1	0545	70	139.	*	2	0030	295	0.	*	2	1915	520	0.	*	3	1400	745	0.
1	0550	71	120.	*	2	0035	296	0.	*	2	1920	521	0.	*	3	1405	746	0.
1	0555	72	104.	*	2	0040	297	0.	*	2	1925	522	0.	*	3	1410	747	0.
1	0600	73	92.	*	2	0045	298	0.	*	2	1930	523	0.	*	3	1415	748	0.
1	0605	74	83.	*	2	0050	299	0.	*	2	1935	524	0.	*	3	1420	749	0.
1	0610	75	74.	*	2	0055	300	0.	*	2	1940	525	0.	*	3	1425	750	0.
1	0615	76	65.	*	2	0100	301	0.	*	2	1945	526	0.	*	3	1430	751	0.
1	0620	77	56.	*	2	0105	302	0.	*	2	1950	527	0.	*	3	1435	752	0.
1	0625	78	48.	*	2	0110	303	0.	*	2	1955	528	0.	*	3	1440	753	0.
1	0630	79	41.	*	2	0115	304	0.	*	2	2000	529	0.	*	3	1445	754	0.
1	0635	80	34.	*	2	0120	305	0.	*	2	2005	530	0.	*	3	1450	755	0.
1	0640	81	28.	*	2	0125	306	0.	*	2	2010	531	0.	*	3	1455	756	0.
1	0645	82	25.	*	2	0130	307	0.	*	2	2015	532	0.	*	3	1500	757	0.
1	0650	83	22.	*	2	0135	308	0.	*	2	2020	533	0.	*	3	1505	758	0.
1	0655	84	20.	*	2	0140	309	0.	*	2	2025	534	0.	*	3	1510	759	0.
1	0700	85	17.	*	2	0145	310	0.	*	2	2030	535	0.	*	3	1515	760	0.
1	0705	86	15.	*	2	0150	311	0.	*	2	2035	536	0.	*	3	1520	761	0.
1	0710	87	13.	*	2	0155	312	0.	*	2	2040	537	0.	*	3	1525	762	0.
1	0715	88	11.	*	2	0200	313	0.	*	2	2045	538	0.	*	3	1530	763	0.
1	0720	89	9.	*	2	0205	314	0.	*	2	2050	539	0.	*	3	1535	764	0.
1	0725	90	8.	*	2	0210	315	0.	*	2	2055	540	0.	*	3	1540	765	0.
1	0730	91	7.	*	2	0215	316	0.	*	2	2100	541	0.	*	3	1545	766	0.
1	0735	92	6.	*	2	0220	317	0.	*	2	2105	542	0.	*	3	1550	767	0.
1	0740	93	5.	*	2	0225	318	0.	*	2	2110	543	0.	*	3	1555	768	0.
1	0745	94	4.	*	2	0230	319	0.	*	2	2115	544	0.	*	3	1600	769	0.
1	0750	95	3.	*	2	0235	320	0.	*	2	2120	545	0.	*	3	1605	770	0.
1	0755	96	3.	*	2	0240	321	0.	*	2	2125	546	0.	*	3	1610	771	0.
1	0800	97	2.	*	2	0245	322	0.	*	2	2130	547	0.	*	3	1615	772	0.
1	0805	98	2.	*	2	0250	323	0.	*	2	2135	548	0.	*	3	1620	773	0.
1	0810	99	2.	*	2	0255	324	0.	*	2	2140	549	0.	*	3	1625	774	0.
1	0815	100	1.	*	2	0300	325	0.	*	2	2145	550	0.	*	3	1630	775	0.
1	0820	101	1.	*	2	0305	326	0.	*	2	2150	551	0.	*	3	1635	776	0.
1	0825	102	1.	*	2	0310	327	0.	*	2	2155	552	0.	*	3	1640	777	0.
1	0830	103	1.	*	2	0315	328	0.	*	2	2200	553	0.	*	3	1645	778	0.
1	0835	104	1.	*	2	0320	329	0.	*	2	2205	554	0.	*	3	1650	779	0.
1	0840	105	0.	*	2	0325	330	0.	*	2	2210	555	0.	*	3	1655	780	0.
1	0845	106	0.	*	2	0330	331	0.	*	2	2215	556	0.	*	3	1700	781	0.
1	0850	107	0.	*	2	0335	332	0.	*	2	2220	557	0.	*	3	1705	782	0.
1	0855	108	0.	*	2	0340	333	0.	*	2	2225	558	0.	*	3	1710	783	0.
1	0900	109	0.	*	2	0345	334	0.	*	2	2230	559	0.	*	3	1715	784	0.
1	0905	110	0.	*	2	0350	335	0.	*	2	2235	560	0.	*	3	1720	785	0.
1	0910	111	0.	*	2	0355	336	0.	*	2	2240	561	0.	*	3	1725	786	0.
1	0915	112	0.	*	2	0400	337	0.	*	2	2245	562	0.	*	3	1730	787	0.
1	0920	113	0.	*	2	0405	338	0.	*	2	2250	563	0.	*	3	1735	788	0.
1	0925	114	0.	*	2	0410	339	0.	*	2	2255	564	0.	*	3	1740	789	0.
1	0930	115	0.	*	2	0415	340	0.	*	2	2300	565	0.	*	3	1745	790	0.
1	0935	116	0.	*	2	0420	341	0.	*	2	2305	566	0.	*	3	1750	791	0.
1	0940	117	0.	*	2	0425	342	0.	*	2	2310	567	0.	*	3	1755	792	0.
1	0945	118	0.	*	2	0430	343	0.	*	2	2315	568	0.	*	3	1800	793	0.
1	0950	119	0.	*	2	0435	344	0.	*	2	2320	569	0.	*	3	1805	794	0.
1	0955	120	0.	*	2	0440	345	0.	*	2	2325	570	0.	*	3	1810	795	0.
1	1000	121	0.	*	2	0445	346	0.	*	2	2330	571	0.	*	3	1815	796	0.
1	1005	122	0.	*	2	0450	347	0.	*	2	2335	572	0.	*	3	1820	797	0.
1	1010	123	0.	*	2	0455	348	0.	*	2	2340	573	0.	*	3	1825	798	0.
1	1015	124	0.	*	2	0500	349	0.	*	2	2345	574	0.	*	3	1830	799	0.
1	1020	125	0.	*	2	0505	350	0.	*	2	2350	575	0.	*	3	1835	800	0.
1	1025	126	0.	*	2	0510	351	0.	*	2	2355	576	0.	*	3	1840	801	0.
1	1030	127	0.	*	2	0515	352	0.	*	3	0000	577	0.	*	3	1845	802	0.
1	1035	128	0.	*	2	0520	353	0.	*	3	0005	578	0.	*	3	1850	803	0.
1	1040	129	0.	*	2	0525	354	0.	*	3	0010	579	0.	*	3	1855	804	0.
1	1045	130	0.	*	2	0530	355	0.	*	3	0015	580	0.	*	3	1900	805	0.

1	1050	131	0.	*	2	0535	356	0.	*	3	0020	581	0.	*	3	1905	806	0.
1	1055	132	0.	*	2	0540	357	0.	*	3	0025	582	0.	*	3	1910	807	0.
1	1100	133	0.	*	2	0545	358	0.	*	3	0030	583	0.	*	3	1915	808	0.
1	1105	134	0.	*	2	0550	359	0.	*	3	0035	584	0.	*	3	1920	809	0.
1	1110	135	0.	*	2	0555	360	0.	*	3	0040	585	0.	*	3	1925	810	0.
1	1115	136	0.	*	2	0600	361	0.	*	3	0045	586	0.	*	3	1930	811	0.
1	1120	137	0.	*	2	0605	362	0.	*	3	0050	587	0.	*	3	1935	812	0.
1	1125	138	0.	*	2	0610	363	0.	*	3	0055	588	0.	*	3	1940	813	0.
1	1130	139	0.	*	2	0615	364	0.	*	3	0100	589	0.	*	3	1945	814	0.
1	1135	140	0.	*	2	0620	365	0.	*	3	0105	590	0.	*	3	1950	815	0.
1	1140	141	0.	*	2	0625	366	0.	*	3	0110	591	0.	*	3	1955	816	0.
1	1145	142	0.	*	2	0630	367	0.	*	3	0115	592	0.	*	3	2000	817	0.
1	1150	143	0.	*	2	0635	368	0.	*	3	0120	593	0.	*	3	2005	818	0.
1	1155	144	0.	*	2	0640	369	0.	*	3	0125	594	0.	*	3	2010	819	0.
1	1200	145	0.	*	2	0645	370	0.	*	3	0130	595	0.	*	3	2015	820	0.
1	1205	146	0.	*	2	0650	371	0.	*	3	0135	596	0.	*	3	2020	821	0.
1	1210	147	0.	*	2	0655	372	0.	*	3	0140	597	0.	*	3	2025	822	0.
1	1215	148	0.	*	2	0700	373	0.	*	3	0145	598	0.	*	3	2030	823	0.
1	1220	149	0.	*	2	0705	374	0.	*	3	0150	599	0.	*	3	2035	824	0.
1	1225	150	0.	*	2	0710	375	0.	*	3	0155	600	0.	*	3	2040	825	0.
1	1230	151	0.	*	2	0715	376	0.	*	3	0200	601	0.	*	3	2045	826	0.
1	1235	152	0.	*	2	0720	377	0.	*	3	0205	602	0.	*	3	2050	827	0.
1	1240	153	0.	*	2	0725	378	0.	*	3	0210	603	0.	*	3	2055	828	0.
1	1245	154	0.	*	2	0730	379	0.	*	3	0215	604	0.	*	3	2100	829	0.
1	1250	155	0.	*	2	0735	380	0.	*	3	0220	605	0.	*	3	2105	830	0.
1	1255	156	0.	*	2	0740	381	0.	*	3	0225	606	0.	*	3	2110	831	0.
1	1300	157	0.	*	2	0745	382	0.	*	3	0230	607	0.	*	3	2115	832	0.
1	1305	158	0.	*	2	0750	383	0.	*	3	0235	608	0.	*	3	2120	833	0.
1	1310	159	0.	*	2	0755	384	0.	*	3	0240	609	0.	*	3	2125	834	0.
1	1315	160	0.	*	2	0800	385	0.	*	3	0245	610	0.	*	3	2130	835	0.
1	1320	161	0.	*	2	0805	386	0.	*	3	0250	611	0.	*	3	2135	836	0.
1	1325	162	0.	*	2	0810	387	0.	*	3	0255	612	0.	*	3	2140	837	0.
1	1330	163	0.	*	2	0815	388	0.	*	3	0300	613	0.	*	3	2145	838	0.
1	1335	164	0.	*	2	0820	389	0.	*	3	0305	614	0.	*	3	2150	839	0.
1	1340	165	0.	*	2	0825	390	0.	*	3	0310	615	0.	*	3	2155	840	0.
1	1345	166	0.	*	2	0830	391	0.	*	3	0315	616	0.	*	3	2200	841	0.
1	1350	167	0.	*	2	0835	392	0.	*	3	0320	617	0.	*	3	2205	842	0.
1	1355	168	0.	*	2	0840	393	0.	*	3	0325	618	0.	*	3	2210	843	0.
1	1400	169	0.	*	2	0845	394	0.	*	3	0330	619	0.	*	3	2215	844	0.
1	1405	170	0.	*	2	0850	395	0.	*	3	0335	620	0.	*	3	2220	845	0.
1	1410	171	0.	*	2	0855	396	0.	*	3	0340	621	0.	*	3	2225	846	0.
1	1415	172	0.	*	2	0900	397	0.	*	3	0345	622	0.	*	3	2230	847	0.
1	1420	173	0.	*	2	0905	398	0.	*	3	0350	623	0.	*	3	2235	848	0.
1	1425	174	0.	*	2	0910	399	0.	*	3	0355	624	0.	*	3	2240	849	0.
1	1430	175	0.	*	2	0915	400	0.	*	3	0400	625	0.	*	3	2245	850	0.
1	1435	176	0.	*	2	0920	401	0.	*	3	0405	626	0.	*	3	2250	851	0.
1	1440	177	0.	*	2	0925	402	0.	*	3	0410	627	0.	*	3	2255	852	0.
1	1445	178	0.	*	2	0930	403	0.	*	3	0415	628	0.	*	3	2300	853	0.
1	1450	179	0.	*	2	0935	404	0.	*	3	0420	629	0.	*	3	2305	854	0.
1	1455	180	0.	*	2	0940	405	0.	*	3	0425	630	0.	*	3	2310	855	0.
1	1500	181	0.	*	2	0945	406	0.	*	3	0430	631	0.	*	3	2315	856	0.
1	1505	182	0.	*	2	0950	407	0.	*	3	0435	632	0.	*	3	2320	857	0.
1	1510	183	0.	*	2	0955	408	0.	*	3	0440	633	0.	*	3	2325	858	0.
1	1515	184	0.	*	2	1000	409	0.	*	3	0445	634	0.	*	3	2330	859	0.
1	1520	185	0.	*	2	1005	410	0.	*	3	0450	635	0.	*	3	2335	860	0.
1	1525	186	0.	*	2	1010	411	0.	*	3	0455	636	0.	*	3	2340	861	0.
1	1530	187	0.	*	2	1015	412	0.	*	3	0500	637	0.	*	3	2345	862	0.
1	1535	188	0.	*	2	1020	413	0.	*	3	0505	638	0.	*	3	2350	863	0.
1	1540	189	0.	*	2	1025	414	0.	*	3	0510	639	0.	*	3	2355	864	0.
1	1545	190	0.	*	2	1030	415	0.	*	3	0515	640	0.	*	4	0000	865	0.
1	1550	191	0.	*	2	1035	416	0.	*	3	0520	641	0.	*	4	0005	866	0.
1	1555	192	0.	*	2	1040	417	0.	*	3	0525	642	0.	*	4	0010	867	0.
1	1600	193	0.	*	2	1045	418	0.	*	3	0530	643	0.	*	4	0015	868	0.
1	1605	194	0.	*	2	1050	419	0.	*	3	0535	644	0.	*	4	0020	869	0.
1	1610	195	0.	*	2	1055	420	0.	*	3	0540	645	0.	*	4	0025	870	0.
1	1615	196	0.	*	2	1100	421	0.	*	3	0545	646	0.	*	4	0030	871	0.

1-C/1 4-PRINT

1	1620	197	0.	*	2	1105	422	0.	*	3	0550	647	0.	*	4	0035	872	0.
1	1625	198	0.	*	2	1110	423	0.	*	3	0555	648	0.	*	4	0040	873	0.
1	1630	199	0.	*	2	1115	424	0.	*	3	0600	649	0.	*	4	0045	874	0.
1	1635	200	0.	*	2	1120	425	0.	*	3	0605	650	0.	*	4	0050	875	0.
1	1640	201	0.	*	2	1125	426	0.	*	3	0610	651	0.	*	4	0055	876	0.
1	1645	202	0.	*	2	1130	427	0.	*	3	0615	652	0.	*	4	0100	877	0.
1	1650	203	0.	*	2	1135	428	0.	*	3	0620	653	0.	*	4	0105	878	0.
1	1655	204	0.	*	2	1140	429	0.	*	3	0625	654	0.	*	4	0110	879	0.
1	1700	205	0.	*	2	1145	430	0.	*	3	0630	655	0.	*	4	0115	880	0.
1	1705	206	0.	*	2	1150	431	0.	*	3	0635	656	0.	*	4	0120	881	0.
1	1710	207	0.	*	2	1155	432	0.	*	3	0640	657	0.	*	4	0125	882	0.
1	1715	208	0.	*	2	1200	433	0.	*	3	0645	658	0.	*	4	0130	883	0.
1	1720	209	0.	*	2	1205	434	0.	*	3	0650	659	0.	*	4	0135	884	0.
1	1725	210	0.	*	2	1210	435	0.	*	3	0655	660	0.	*	4	0140	885	0.
1	1730	211	0.	*	2	1215	436	0.	*	3	0700	661	0.	*	4	0145	886	0.
1	1735	212	0.	*	2	1220	437	0.	*	3	0705	662	0.	*	4	0150	887	0.
1	1740	213	0.	*	2	1225	438	0.	*	3	0710	663	0.	*	4	0155	888	0.
1	1745	214	0.	*	2	1230	439	0.	*	3	0715	664	0.	*	4	0200	889	0.
1	1750	215	0.	*	2	1235	440	0.	*	3	0720	665	0.	*	4	0205	890	0.
1	1755	216	0.	*	2	1240	441	0.	*	3	0725	666	0.	*	4	0210	891	0.
1	1800	217	0.	*	2	1245	442	0.	*	3	0730	667	0.	*	4	0215	892	0.
1	1805	218	0.	*	2	1250	443	0.	*	3	0735	668	0.	*	4	0220	893	0.
1	1810	219	0.	*	2	1255	444	0.	*	3	0740	669	0.	*	4	0225	894	0.
1	1815	220	0.	*	2	1300	445	0.	*	3	0745	670	0.	*	4	0230	895	0.
1	1820	221	0.	*	2	1305	446	0.	*	3	0750	671	0.	*	4	0235	896	0.
1	1825	222	0.	*	2	1310	447	0.	*	3	0755	672	0.	*	4	0240	897	0.
1	1830	223	0.	*	2	1315	448	0.	*	3	0800	673	0.	*	4	0245	898	0.
1	1835	224	0.	*	2	1320	449	0.	*	3	0805	674	0.	*	4	0250	899	0.
1	1840	225	0.	*	2	1325	450	0.	*	3	0810	675	0.	*	4	0255	900	0.
				*					*					*				

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PEAK FLOW (CFS)	TIME (HR)		6-HR	MAXIMUM AVERAGE FLOW 24-HR	72-HR	74.92-HR
5398.	3.50	(CFS)	891.	224.	75.	72.
		(INCHES)	6.681	6.705	6.705	6.705
		(AC-FT)	442.	443.	443.	443.

CUMULATIVE AREA = 1.24 SQ MI

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          **************
          *            *
 56 KK    *   DAMOUT   *
          *            *
          **************
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Route Hydrograph Through Dam.

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 60 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          1  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

            HYDROGRAPH ROUTING DATA

 59 RS        STORAGE ROUTING
                    NSTPS          1  NUMBER OF SUBREACHES
                     ITYP       STOR  TYPE OF INITIAL CONDITION
                   RSVRIC       2.00  INITIAL CONDITION
                        X       0.00 WORKING R AND D COEFFICIENT
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61 SA	AREA	2.0	2.5	5.8	6.8	9.1	10.2	11.0	11.3	11.6	11.9
		12.1	12.3	12.8	13.3	13.8					
63 SE	ELEVATION	2135.00	2137.00	2140.00	2144.00	2150.00	2153.00	2155.00	2156.00	2157.00	2158.00
		2159.00	2160.00	2161.00	2162.00	2163.00					
65 SQ	DISCHARGE	0.	10.	14.	19.	23.	29.	31.	295.	823.	1539.
		2423.	3450.	4577.	5773.	7015.					

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COMPUTED STORAGE-ELEVATION DATA

STORAGE	0.00	4.53	16.62	41.74	89.06	117.93	139.09	150.24	161.71	173.46
ELEVATION	2135.00	2137.00	2140.00	2144.00	2150.00	2153.00	2155.00	2156.00	2157.00	2158.00
STORAGE	185.44	197.64	210.20	223.26	236.82					
ELEVATION	2159.00	2160.00	2161.00	2162.00	2163.00					

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HYDROGRAPH AT STATION DAMOUT
PLAN 1, RATIO = 0.50

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DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1		0000	1	4.	2.0	2135.9	2		0100	301	25.	98.4	2151.0	3		0200	601	20.	52.7	2145.4
1		0005	2	4.	2.0	2135.9	2		0105	302	25.	98.2	2151.0	3		0205	602	20.	52.6	2145.4
1		0010	3	4.	1.9	2135.9	2		0110	303	25.	98.0	2150.9	3		0210	603	20.	52.4	2145.4
1		0015	4	4.	1.9	2135.9	2		0115	304	25.	97.9	2150.9	3		0215	604	20.	52.3	2145.3
1		0020	5	4.	1.9	2135.9	2		0120	305	25.	97.7	2150.9	3		0220	605	20.	52.2	2145.3
1		0025	6	4.	1.9	2135.9	2		0125	306	25.	97.5	2150.9	3		0225	606	20.	52.0	2145.3
1		0030	7	4.	2.0	2135.9	2		0130	307	25.	97.4	2150.9	3		0230	607	20.	51.9	2145.3
1		0035	8	4.	2.0	2135.9	2		0135	308	25.	97.2	2150.8	3		0235	608	20.	51.7	2145.3
1		0040	9	4.	2.1	2135.9	2		0140	309	25.	97.0	2150.8	3		0240	609	20.	51.6	2145.3
1		0045	10	5.	2.2	2136.0	2		0145	310	25.	96.9	2150.8	3		0245	610	20.	51.5	2145.2
1		0050	11	5.	2.3	2136.0	2		0150	311	25.	96.7	2150.8	3		0250	611	20.	51.3	2145.2
1		0055	12	5.	2.4	2136.1	2		0155	312	25.	96.5	2150.8	3		0255	612	20.	51.2	2145.2
1		0100	13	5.	2.6	2136.1	2		0200	313	25.	96.3	2150.8	3		0300	613	20.	51.1	2145.2
1		0105	14	6.	2.7	2136.2	2		0205	314	25.	96.2	2150.7	3		0305	614	20.	50.9	2145.2
1		0110	15	6.	2.9	2136.3	2		0210	315	25.	96.0	2150.7	3		0310	615	20.	50.8	2145.1
1		0115	16	6.	3.1	2136.3	2		0215	316	25.	95.8	2150.7	3		0315	616	20.	50.6	2145.1
1		0120	17	7.	3.3	2136.4	2		0220	317	25.	95.7	2150.7	3		0320	617	20.	50.5	2145.1
1		0125	18	7.	3.5	2136.5	2		0225	318	24.	95.5	2150.7	3		0325	618	20.	50.4	2145.1
1		0130	19	8.	3.7	2136.7	2		0230	319	24.	95.3	2150.7	3		0330	619	20.	50.2	2145.1
1		0135	20	8.	4.0	2136.8	2		0235	320	24.	95.2	2150.6	3		0335	620	20.	50.1	2145.1
1		0140	21	9.	4.3	2136.9	2		0240	321	24.	95.0	2150.6	3		0340	621	20.	50.0	2145.0
1		0145	22	10.	4.6	2137.0	2		0245	322	24.	94.8	2150.6	3		0345	622	20.	49.8	2145.0
1		0150	23	10.	4.9	2137.1	2		0250	323	24.	94.7	2150.6	3		0350	623	20.	49.7	2145.0
1		0155	24	10.	5.3	2137.2	2		0255	324	24.	94.5	2150.6	3		0355	624	20.	49.5	2145.0
1		0200	25	10.	5.6	2137.3	2		0300	325	24.	94.3	2150.5	3		0400	625	20.	49.4	2145.0
1		0205	26	10.	6.0	2137.4	2		0305	326	24.	94.2	2150.5	3		0405	626	20.	49.3	2145.0
1		0210	27	10.	6.5	2137.5	2		0310	327	24.	94.0	2150.5	3		0410	627	20.	49.1	2144.9
1		0215	28	10.	7.1	2137.6	2		0315	328	24.	93.8	2150.5	3		0415	628	20.	49.0	2144.9
1		0220	29	11.	7.9	2137.8	2		0320	329	24.	93.7	2150.5	3		0420	629	20.	48.9	2144.9
1		0225	30	11.	9.0	2138.1	2		0325	330	24.	93.5	2150.5	3		0425	630	20.	48.7	2144.9
1		0230	31	11.	10.5	2138.5	2		0330	331	24.	93.3	2150.4	3		0430	631	20.	48.6	2144.9
1		0235	32	12.	12.3	2138.9	2		0335	332	24.	93.2	2150.4	3		0435	632	20.	48.5	2144.9
1		0240	33	13.	14.4	2139.4	2		0340	333	24.	93.0	2150.4	3		0440	633	20.	48.3	2144.8
1		0245	34	14.	16.7	2140.0	2		0345	334	24.	92.8	2150.4	3		0445	634	20.	48.2	2144.8
1		0250	35	14.	19.3	2140.4	2		0350	335	24.	92.7	2150.4	3		0450	635	20.	48.1	2144.8
1		0255	36	15.	22.0	2140.9	2		0355	336	24.	92.5	2150.4	3		0455	636	20.	47.9	2144.8
1		0300	37	15.	24.9	2141.3	2		0400	337	24.	92.3	2150.3	3		0500	637	20.	47.8	2144.8

1	0305	38	16.	28.3	2141.9	*	2	0405	338	24.	92.2	2150.3	*	3	0505	638	20.	47.6	2144.7
1	0310	39	17.	34.2	2142.8	*	2	0410	339	24.	92.0	2150.3	*	3	0510	639	20.	47.5	2144.7
1	0315	40	19.	45.9	2144.5	*	2	0415	340	24.	91.8	2150.3	*	3	0515	640	20.	47.4	2144.7
1	0320	41	21.	66.6	2147.2	*	2	0420	341	24.	91.7	2150.3	*	3	0520	641	20.	47.2	2144.7
1	0325	42	25.	96.7	2150.8	*	2	0425	342	24.	91.5	2150.3	*	3	0525	642	20.	47.1	2144.7
1	0330	43	30.	132.3	2154.4	*	2	0430	343	24.	91.3	2150.2	*	3	0530	643	20.	47.0	2144.7
1	0335	44	1040.	165.3	2157.3	*	2	0435	344	24.	91.2	2150.2	*	3	0535	644	20.	46.8	2144.6
1	0340	45	2586.	187.4	2159.2	*	2	0440	345	24.	91.0	2150.2	*	3	0540	645	20.	46.7	2144.6
1	0345	46	3462.	197.8	2160.0	*	2	0445	346	24.	90.9	2150.2	*	3	0545	646	20.	46.6	2144.6
1	0350	47	3708.	200.5	2160.2	*	2	0450	347	24.	90.7	2150.2	*	3	0550	647	20.	46.4	2144.6
1	0355	48	3593.	199.2	2160.1	*	2	0455	348	24.	90.5	2150.2	*	3	0555	648	20.	46.3	2144.6
1	0400	49	3327.	196.2	2159.9	*	2	0500	349	24.	90.4	2150.1	*	3	0600	649	19.	46.2	2144.6
1	0405	50	3019.	192.5	2159.6	*	2	0505	350	24.	90.2	2150.1	*	3	0605	650	19.	46.0	2144.5
1	0410	51	2702.	188.8	2159.3	*	2	0510	351	23.	90.0	2150.1	*	3	0610	651	19.	45.9	2144.5
1	0415	52	2395.	185.1	2159.0	*	2	0515	352	23.	89.9	2150.1	*	3	0615	652	19.	45.8	2144.5
1	0420	53	2126.	181.4	2158.7	*	2	0520	353	23.	89.7	2150.1	*	3	0620	653	19.	45.6	2144.5
1	0425	54	1865.	177.9	2158.4	*	2	0525	354	23.	89.6	2150.1	*	3	0625	654	19.	45.5	2144.5
1	0430	55	1621.	174.6	2158.1	*	2	0530	355	23.	89.4	2150.0	*	3	0630	655	19.	45.4	2144.5
1	0435	56	1421.	171.5	2157.8	*	2	0535	356	23.	89.2	2150.0	*	3	0635	656	19.	45.2	2144.4
1	0440	57	1249.	168.7	2157.6	*	2	0540	357	23.	89.1	2150.0	*	3	0640	657	19.	45.1	2144.4
1	0445	58	1091.	166.1	2157.4	*	2	0545	358	23.	88.9	2150.0	*	3	0645	658	19.	45.0	2144.4
1	0450	59	951.	163.8	2157.2	*	2	0550	359	23.	88.8	2150.0	*	3	0650	659	19.	44.8	2144.4
1	0455	60	829.	161.8	2157.0	*	2	0555	360	23.	88.6	2149.9	*	3	0655	660	19.	44.7	2144.4
1	0500	61	747.	160.1	2156.9	*	2	0600	361	23.	88.4	2149.9	*	3	0700	661	19.	44.6	2144.4
1	0505	62	673.	158.5	2156.7	*	2	0605	362	23.	88.3	2149.9	*	3	0705	662	19.	44.4	2144.3
1	0510	63	606.	157.0	2156.6	*	2	0610	363	23.	88.1	2149.9	*	3	0710	663	19.	44.3	2144.3
1	0515	64	544.	155.6	2156.5	*	2	0615	364	23.	88.0	2149.9	*	3	0715	664	19.	44.2	2144.3
1	0520	65	485.	154.4	2156.4	*	2	0620	365	23.	87.8	2149.8	*	3	0720	665	19.	44.0	2144.3
1	0525	66	429.	153.1	2156.3	*	2	0625	366	23.	87.6	2149.8	*	3	0725	666	19.	43.9	2144.3
1	0530	67	376.	152.0	2156.2	*	2	0630	367	23.	87.5	2149.8	*	3	0730	667	19.	43.8	2144.3
1	0535	68	329.	151.0	2156.1	*	2	0635	368	23.	87.3	2149.8	*	3	0735	668	19.	43.6	2144.2
1	0540	69	290.	150.0	2156.0	*	2	0640	369	23.	87.2	2149.8	*	3	0740	669	19.	43.5	2144.2
1	0545	70	269.	149.1	2155.9	*	2	0645	370	23.	87.0	2149.7	*	3	0745	670	19.	43.4	2144.2
1	0550	71	248.	148.3	2155.8	*	2	0650	371	23.	86.8	2149.7	*	3	0750	671	19.	43.2	2144.2
1	0555	72	228.	147.4	2155.7	*	2	0655	372	23.	86.7	2149.7	*	3	0755	672	19.	43.1	2144.2
1	0600	73	208.	146.6	2155.7	*	2	0700	373	23.	86.5	2149.7	*	3	0800	673	19.	43.0	2144.2
1	0605	74	190.	145.8	2155.6	*	2	0705	374	23.	86.4	2149.7	*	3	0805	674	19.	42.8	2144.1
1	0610	75	173.	145.1	2155.5	*	2	0710	375	23.	86.2	2149.6	*	3	0810	675	19.	42.7	2144.1
1	0615	76	157.	144.4	2155.5	*	2	0715	376	23.	86.0	2149.6	*	3	0815	676	19.	42.6	2144.1
1	0620	77	143.	143.8	2155.4	*	2	0720	377	23.	85.9	2149.6	*	3	0820	677	19.	42.4	2144.1
1	0625	78	129.	143.2	2155.4	*	2	0725	378	23.	85.7	2149.6	*	3	0825	678	19.	42.3	2144.1
1	0630	79	116.	142.7	2155.3	*	2	0730	379	23.	85.6	2149.6	*	3	0830	679	19.	42.2	2144.1
1	0635	80	104.	142.2	2155.3	*	2	0735	380	23.	85.4	2149.5	*	3	0835	680	19.	42.0	2144.0
1	0640	81	93.	141.7	2155.2	*	2	0740	381	23.	85.3	2149.5	*	3	0840	681	19.	41.9	2144.0
1	0645	82	83.	141.3	2155.2	*	2	0745	382	23.	85.1	2149.5	*	3	0845	682	19.	41.8	2144.0
1	0650	83	74.	140.9	2155.2	*	2	0750	383	23.	84.9	2149.5	*	3	0850	683	19.	41.6	2144.0
1	0655	84	66.	140.6	2155.1	*	2	0755	384	23.	84.8	2149.5	*	3	0855	684	19.	41.5	2144.0
1	0700	85	59.	140.3	2155.1	*	2	0800	385	23.	84.6	2149.4	*	3	0900	685	19.	41.4	2143.9
1	0705	86	53.	140.0	2155.1	*	2	0805	386	23.	84.5	2149.4	*	3	0905	686	19.	41.3	2143.9
1	0710	87	47.	139.8	2155.1	*	2	0810	387	23.	84.3	2149.4	*	3	0910	687	19.	41.1	2143.9
1	0715	88	41.	139.5	2155.0	*	2	0815	388	23.	84.2	2149.4	*	3	0915	688	19.	41.0	2143.9
1	0720	89	37.	139.3	2155.0	*	2	0820	389	23.	84.0	2149.4	*	3	0920	689	19.	40.9	2143.9
1	0725	90	33.	139.2	2155.0	*	2	0825	390	23.	83.8	2149.3	*	3	0925	690	19.	40.7	2143.8
1	0730	91	31.	139.0	2155.0	*	2	0830	391	23.	83.7	2149.3	*	3	0930	691	19.	40.6	2143.8
1	0735	92	31.	138.8	2155.0	*	2	0835	392	23.	83.5	2149.3	*	3	0935	692	19.	40.5	2143.8
1	0740	93	31.	138.6	2155.0	*	2	0840	393	23.	83.4	2149.3	*	3	0940	693	19.	40.3	2143.8
1	0745	94	31.	138.5	2154.9	*	2	0845	394	23.	83.2	2149.3	*	3	0945	694	19.	40.2	2143.8
1	0750	95	31.	138.3	2154.9	*	2	0850	395	23.	83.1	2149.2	*	3	0950	695	19.	40.1	2143.7
1	0755	96	31.	138.1	2154.9	*	2	0855	396	23.	82.9	2149.2	*	3	0955	696	19.	40.0	2143.7
1	0800	97	31.	137.9	2154.9	*	2	0900	397	23.	82.7	2149.2	*	3	1000	697	19.	39.8	2143.7
1	0805	98	31.	137.7	2154.9	*	2	0905	398	23.	82.6	2149.2	*	3	1005	698	19.	39.7	2143.7
1	0810	99	31.	137.5	2154.8	*	2	0910	399	23.	82.4	2149.2	*	3	1010	699	19.	39.6	2143.7
1	0815	100	31.	137.3	2154.8	*	2	0915	400	23.	82.3	2149.1	*	3	1015	700	19.	39.4	2143.6
1	0820	101	31.	137.1	2154.8	*	2	0920	401	23.	82.1	2149.1	*	3	1020	701	19.	39.3	2143.6
1	0825	102	31.	136.9	2154.8	*	2	0925	402	23.	82.0	2149.1	*	3	1025	702	19.	39.2	2143.6
1	0830	103	31.	136.7	2154.8	*	2	0930	403	23.	81.8	2149.1	*	3	1030	703	19.	39.1	2143.6

1	0835	104	31.	136.5	2154.8	*	2	0935	404	23.	81.6	2149.1	*	3	1035	704	18.	38.9	2143.6
1	0840	105	31.	136.3	2154.7	*	2	0940	405	23.	81.5	2149.0	*	3	1040	705	18.	38.8	2143.5
1	0845	106	31.	136.1	2154.7	*	2	0945	406	23.	81.3	2149.0	*	3	1045	706	18.	38.7	2143.5
1	0850	107	31.	135.8	2154.7	*	2	0950	407	23.	81.2	2149.0	*	3	1050	707	18.	38.6	2143.5
1	0855	108	31.	135.6	2154.7	*	2	0955	408	23.	81.0	2149.0	*	3	1055	708	18.	38.4	2143.5
1	0900	109	31.	135.4	2154.7	*	2	1000	409	23.	80.9	2149.0	*	3	1100	709	18.	38.3	2143.5
1	0905	110	30.	135.2	2154.6	*	2	1005	410	23.	80.7	2148.9	*	3	1105	710	18.	38.2	2143.4
1	0910	111	30.	135.0	2154.6	*	2	1010	411	23.	80.6	2148.9	*	3	1110	711	18.	38.0	2143.4
1	0915	112	30.	134.8	2154.6	*	2	1015	412	23.	80.4	2148.9	*	3	1115	712	18.	37.9	2143.4
1	0920	113	30.	134.6	2154.6	*	2	1020	413	23.	80.2	2148.9	*	3	1120	713	18.	37.8	2143.4
1	0925	114	30.	134.4	2154.6	*	2	1025	414	23.	80.1	2148.9	*	3	1125	714	18.	37.7	2143.4
1	0930	115	30.	134.2	2154.5	*	2	1030	415	22.	79.9	2148.8	*	3	1130	715	18.	37.5	2143.3
1	0935	116	30.	134.0	2154.5	*	2	1035	416	22.	79.8	2148.8	*	3	1135	716	18.	37.4	2143.3
1	0940	117	30.	133.8	2154.5	*	2	1040	417	22.	79.6	2148.8	*	3	1140	717	18.	37.3	2143.3
1	0945	118	30.	133.5	2154.5	*	2	1045	418	22.	79.5	2148.8	*	3	1145	718	18.	37.2	2143.3
1	0950	119	30.	133.3	2154.5	*	2	1050	419	22.	79.3	2148.8	*	3	1150	719	18.	37.0	2143.3
1	0955	120	30.	133.1	2154.4	*	2	1055	420	22.	79.2	2148.7	*	3	1155	720	18.	36.9	2143.2
1	1000	121	30.	132.9	2154.4	*	2	1100	421	22.	79.0	2148.7	*	3	1200	721	18.	36.8	2143.2
1	1005	122	30.	132.7	2154.4	*	2	1105	422	22.	78.9	2148.7	*	3	1205	722	18.	36.7	2143.2
1	1010	123	30.	132.5	2154.4	*	2	1110	423	22.	78.7	2148.7	*	3	1210	723	18.	36.5	2143.2
1	1015	124	30.	132.3	2154.4	*	2	1115	424	22.	78.5	2148.7	*	3	1215	724	18.	36.4	2143.2
1	1020	125	30.	132.1	2154.3	*	2	1120	425	22.	78.4	2148.6	*	3	1220	725	18.	36.3	2143.1
1	1025	126	30.	131.9	2154.3	*	2	1125	426	22.	78.2	2148.6	*	3	1225	726	18.	36.2	2143.1
1	1030	127	30.	131.7	2154.3	*	2	1130	427	22.	78.1	2148.6	*	3	1230	727	18.	36.1	2143.1
1	1035	128	30.	131.5	2154.3	*	2	1135	428	22.	77.9	2148.6	*	3	1235	728	18.	35.9	2143.1
1	1040	129	30.	131.3	2154.3	*	2	1140	429	22.	77.8	2148.6	*	3	1240	729	18.	35.8	2143.1
1	1045	130	30.	131.1	2154.2	*	2	1145	430	22.	77.6	2148.5	*	3	1245	730	18.	35.7	2143.0
1	1050	131	30.	130.8	2154.2	*	2	1150	431	22.	77.5	2148.5	*	3	1250	731	18.	35.6	2143.0
1	1055	132	30.	130.6	2154.2	*	2	1155	432	22.	77.3	2148.5	*	3	1255	732	18.	35.4	2143.0
1	1100	133	30.	130.4	2154.2	*	2	1200	433	22.	77.2	2148.5	*	3	1300	733	18.	35.3	2143.0
1	1105	134	30.	130.2	2154.2	*	2	1205	434	22.	77.0	2148.5	*	3	1305	734	18.	35.2	2143.0
1	1110	135	30.	130.0	2154.1	*	2	1210	435	22.	76.9	2148.5	*	3	1310	735	18.	35.1	2142.9
1	1115	136	30.	129.8	2154.1	*	2	1215	436	22.	76.7	2148.4	*	3	1315	736	18.	35.0	2142.9
1	1120	137	30.	129.6	2154.1	*	2	1220	437	22.	76.6	2148.4	*	3	1320	737	18.	34.8	2142.9
1	1125	138	30.	129.4	2154.1	*	2	1225	438	22.	76.4	2148.4	*	3	1325	738	18.	34.7	2142.9
1	1130	139	30.	129.2	2154.1	*	2	1230	439	22.	76.2	2148.4	*	3	1330	739	18.	34.6	2142.9
1	1135	140	30.	129.0	2154.0	*	2	1235	440	22.	76.1	2148.4	*	3	1335	740	17.	34.5	2142.8
1	1140	141	30.	128.8	2154.0	*	2	1240	441	22.	75.9	2148.3	*	3	1340	741	17.	34.4	2142.8
1	1145	142	30.	128.6	2154.0	*	2	1245	442	22.	75.8	2148.3	*	3	1345	742	17.	34.2	2142.8
1	1150	143	30.	128.4	2154.0	*	2	1250	443	22.	75.6	2148.3	*	3	1350	743	17.	34.1	2142.8
1	1155	144	30.	128.2	2154.0	*	2	1255	444	22.	75.5	2148.3	*	3	1355	744	17.	34.0	2142.8
1	1200	145	30.	128.0	2153.9	*	2	1300	445	22.	75.3	2148.3	*	3	1400	745	17.	33.9	2142.7
1	1205	146	30.	127.8	2153.9	*	2	1305	446	22.	75.2	2148.2	*	3	1405	746	17.	33.8	2142.7
1	1210	147	30.	127.6	2153.9	*	2	1310	447	22.	75.0	2148.2	*	3	1410	747	17.	33.6	2142.7
1	1215	148	30.	127.4	2153.9	*	2	1315	448	22.	74.9	2148.2	*	3	1415	748	17.	33.5	2142.7
1	1220	149	30.	127.2	2153.9	*	2	1320	449	22.	74.7	2148.2	*	3	1420	749	17.	33.4	2142.7
1	1225	150	30.	126.9	2153.9	*	2	1325	450	22.	74.6	2148.2	*	3	1425	750	17.	33.3	2142.7
1	1230	151	30.	126.7	2153.8	*	2	1330	451	22.	74.4	2148.1	*	3	1430	751	17.	33.2	2142.6
1	1235	152	30.	126.5	2153.8	*	2	1335	452	22.	74.3	2148.1	*	3	1435	752	17.	33.0	2142.6
1	1240	153	30.	126.3	2153.8	*	2	1340	453	22.	74.1	2148.1	*	3	1440	753	17.	32.9	2142.6
1	1245	154	29.	126.1	2153.8	*	2	1345	454	22.	74.0	2148.1	*	3	1445	754	17.	32.8	2142.6
1	1250	155	29.	125.9	2153.8	*	2	1350	455	22.	73.8	2148.1	*	3	1450	755	17.	32.7	2142.6
1	1255	156	29.	125.7	2153.7	*	2	1355	456	22.	73.7	2148.0	*	3	1455	756	17.	32.6	2142.5
1	1300	157	29.	125.5	2153.7	*	2	1400	457	22.	73.5	2148.0	*	3	1500	757	17.	32.5	2142.5
1	1305	158	29.	125.3	2153.7	*	2	1405	458	22.	73.4	2148.0	*	3	1505	758	17.	32.3	2142.5
1	1310	159	29.	125.1	2153.7	*	2	1410	459	22.	73.2	2148.0	*	3	1510	759	17.	32.2	2142.5
1	1315	160	29.	124.9	2153.7	*	2	1415	460	22.	73.1	2148.0	*	3	1515	760	17.	32.1	2142.5
1	1320	161	29.	124.7	2153.6	*	2	1420	461	22.	72.9	2148.0	*	3	1520	761	17.	32.0	2142.4
1	1325	162	29.	124.5	2153.6	*	2	1425	462	22.	72.8	2147.9	*	3	1525	762	17.	31.9	2142.4
1	1330	163	29.	124.3	2153.6	*	2	1430	463	22.	72.6	2147.9	*	3	1530	763	17.	31.8	2142.4
1	1335	164	29.	124.1	2153.6	*	2	1435	464	22.	72.5	2147.9	*	3	1535	764	17.	31.6	2142.4
1	1340	165	29.	123.9	2153.6	*	2	1440	465	22.	72.3	2147.9	*	3	1540	765	17.	31.5	2142.4
1	1345	166	29.	123.7	2153.5	*	2	1445	466	22.	72.2	2147.9	*	3	1545	766	17.	31.4	2142.4
1	1350	167	29.	123.5	2153.5	*	2	1450	467	22.	72.0	2147.8	*	3	1550	767	17.	31.3	2142.3
1	1355	168	29.	123.3	2153.5	*	2	1455	468	22.	71.9	2147.8	*	3	1555	768	17.	31.2	2142.3
1	1400	169	29.	123.1	2153.5	*	2	1500	469	22.	71.7	2147.8	*	3	1600	769	17.	31.1	2142.3

1	1405	170	29.	122.9	2153.5	*	2	1505	470	22.	71.6	2147.8	*	3	1605	770	17.	30.9	2142.3
1	1410	171	29.	122.7	2153.5	*	2	1510	471	22.	71.4	2147.8	*	3	1610	771	17.	30.8	2142.3
1	1415	172	29.	122.5	2153.4	*	2	1515	472	22.	71.3	2147.7	*	3	1615	772	17.	30.7	2142.2
1	1420	173	29.	122.3	2153.4	*	2	1520	473	22.	71.1	2147.7	*	3	1620	773	17.	30.6	2142.2
1	1425	174	29.	122.1	2153.4	*	2	1525	474	22.	71.0	2147.7	*	3	1625	774	17.	30.5	2142.2
1	1430	175	29.	121.9	2153.4	*	2	1530	475	22.	70.8	2147.7	*	3	1630	775	17.	30.4	2142.2
1	1435	176	29.	121.7	2153.4	*	2	1535	476	22.	70.7	2147.7	*	3	1635	776	17.	30.3	2142.2
1	1440	177	29.	121.5	2153.3	*	2	1540	477	22.	70.5	2147.6	*	3	1640	777	17.	30.1	2142.2
1	1445	178	29.	121.3	2153.3	*	2	1545	478	22.	70.4	2147.6	*	3	1645	778	16.	30.0	2142.1
1	1450	179	29.	121.1	2153.3	*	2	1550	479	22.	70.2	2147.6	*	3	1650	779	16.	29.9	2142.1
1	1455	180	29.	120.9	2153.3	*	2	1555	480	22.	70.1	2147.6	*	3	1655	780	16.	29.8	2142.1
1	1500	181	29.	120.7	2153.3	*	2	1600	481	22.	69.9	2147.6	*	3	1700	781	16.	29.7	2142.1
1	1505	182	29.	120.5	2153.2	*	2	1605	482	22.	69.8	2147.6	*	3	1705	782	16.	29.6	2142.1
1	1510	183	29.	120.3	2153.2	*	2	1610	483	22.	69.6	2147.5	*	3	1710	783	16.	29.5	2142.0
1	1515	184	29.	120.1	2153.2	*	2	1615	484	22.	69.5	2147.5	*	3	1715	784	16.	29.4	2142.0
1	1520	185	29.	119.9	2153.2	*	2	1620	485	22.	69.3	2147.5	*	3	1720	785	16.	29.2	2142.0
1	1525	186	29.	119.7	2153.2	*	2	1625	486	22.	69.2	2147.5	*	3	1725	786	16.	29.1	2142.0
1	1530	187	29.	119.5	2153.1	*	2	1630	487	22.	69.0	2147.5	*	3	1730	787	16.	29.0	2142.0
1	1535	188	29.	119.3	2153.1	*	2	1635	488	22.	68.9	2147.4	*	3	1735	788	16.	28.9	2142.0
1	1540	189	29.	119.1	2153.1	*	2	1640	489	21.	68.7	2147.4	*	3	1740	789	16.	28.8	2141.9
1	1545	190	29.	118.9	2153.1	*	2	1645	490	21.	68.6	2147.4	*	3	1745	790	16.	28.7	2141.9
1	1550	191	29.	118.7	2153.1	*	2	1650	491	21.	68.4	2147.4	*	3	1750	791	16.	28.6	2141.9
1	1555	192	29.	118.5	2153.1	*	2	1655	492	21.	68.3	2147.4	*	3	1755	792	16.	28.5	2141.9
1	1600	193	29.	118.3	2153.0	*	2	1700	493	21.	68.1	2147.3	*	3	1800	793	16.	28.3	2141.9
1	1605	194	29.	118.1	2153.0	*	2	1705	494	21.	68.0	2147.3	*	3	1805	794	16.	28.2	2141.8
1	1610	195	29.	117.9	2153.0	*	2	1710	495	21.	67.8	2147.3	*	3	1810	795	16.	28.1	2141.8
1	1615	196	29.	117.7	2153.0	*	2	1715	496	21.	67.7	2147.3	*	3	1815	796	16.	28.0	2141.8
1	1620	197	29.	117.5	2153.0	*	2	1720	497	21.	67.5	2147.3	*	3	1820	797	16.	27.9	2141.8
1	1625	198	28.	117.3	2152.9	*	2	1725	498	21.	67.4	2147.3	*	3	1825	798	16.	27.8	2141.8
1	1630	199	28.	117.1	2152.9	*	2	1730	499	21.	67.3	2147.2	*	3	1830	799	16.	27.7	2141.8
1	1635	200	28.	117.0	2152.9	*	2	1735	500	21.	67.1	2147.2	*	3	1835	800	16.	27.6	2141.7
1	1640	201	28.	116.8	2152.9	*	2	1740	501	21.	67.0	2147.2	*	3	1840	801	16.	27.5	2141.7
1	1645	202	28.	116.6	2152.9	*	2	1745	502	21.	66.8	2147.2	*	3	1845	802	16.	27.4	2141.7
1	1650	203	28.	116.4	2152.8	*	2	1750	503	21.	66.7	2147.2	*	3	1850	803	16.	27.2	2141.7
1	1655	204	28.	116.2	2152.8	*	2	1755	504	21.	66.5	2147.1	*	3	1855	804	16.	27.1	2141.7
1	1700	205	28.	116.0	2152.8	*	2	1800	505	21.	66.4	2147.1	*	3	1900	805	16.	27.0	2141.7
1	1705	206	28.	115.8	2152.8	*	2	1805	506	21.	66.2	2147.1	*	3	1905	806	16.	26.9	2141.6
1	1710	207	28.	115.6	2152.8	*	2	1810	507	21.	66.1	2147.1	*	3	1910	807	16.	26.8	2141.6
1	1715	208	28.	115.4	2152.7	*	2	1815	508	21.	65.9	2147.1	*	3	1915	808	16.	26.7	2141.6
1	1720	209	28.	115.2	2152.7	*	2	1820	509	21.	65.8	2147.0	*	3	1920	809	16.	26.6	2141.6
1	1725	210	28.	115.0	2152.7	*	2	1825	510	21.	65.6	2147.0	*	3	1925	810	16.	26.5	2141.6
1	1730	211	28.	114.8	2152.7	*	2	1830	511	21.	65.5	2147.0	*	3	1930	811	16.	26.4	2141.6
1	1735	212	28.	114.6	2152.7	*	2	1835	512	21.	65.3	2147.0	*	3	1935	812	16.	26.3	2141.5
1	1740	213	28.	114.4	2152.6	*	2	1840	513	21.	65.2	2147.0	*	3	1940	813	16.	26.2	2141.5
1	1745	214	28.	114.2	2152.6	*	2	1845	514	21.	65.1	2147.0	*	3	1945	814	16.	26.1	2141.5
1	1750	215	28.	114.0	2152.6	*	2	1850	515	21.	64.9	2146.9	*	3	1950	815	16.	25.9	2141.5
1	1755	216	28.	113.9	2152.6	*	2	1855	516	21.	64.8	2146.9	*	3	1955	816	16.	25.8	2141.5
1	1800	217	28.	113.7	2152.6	*	2	1900	517	21.	64.6	2146.9	*	3	2000	817	16.	25.7	2141.5
1	1805	218	28.	113.5	2152.5	*	2	1905	518	21.	64.5	2146.9	*	3	2005	818	16.	25.6	2141.4
1	1810	219	28.	113.3	2152.5	*	2	1910	519	21.	64.3	2146.9	*	3	2010	819	15.	25.5	2141.4
1	1815	220	28.	113.1	2152.5	*	2	1915	520	21.	64.2	2146.8	*	3	2015	820	15.	25.4	2141.4
1	1820	221	28.	112.9	2152.5	*	2	1920	521	21.	64.0	2146.8	*	3	2020	821	15.	25.3	2141.4
1	1825	222	28.	112.7	2152.5	*	2	1925	522	21.	63.9	2146.8	*	3	2025	822	15.	25.2	2141.4
1	1830	223	28.	112.5	2152.4	*	2	1930	523	21.	63.7	2146.8	*	3	2030	823	15.	25.1	2141.3
1	1835	224	28.	112.3	2152.4	*	2	1935	524	21.	63.6	2146.8	*	3	2035	824	15.	25.0	2141.3
1	1840	225	28.	112.1	2152.4	*	2	1940	525	21.	63.5	2146.8	*	3	2040	825	15.	24.9	2141.3
1	1845	226	28.	111.9	2152.4	*	2	1945	526	21.	63.3	2146.7	*	3	2045	826	15.	24.8	2141.3
1	1850	227	27.	111.8	2152.4	*	2	1950	527	21.	63.2	2146.7	*	3	2050	827	15.	24.7	2141.3
1	1855	228	27.	111.6	2152.3	*	2	1955	528	21.	63.0	2146.7	*	3	2055	828	15.	24.6	2141.3
1	1900	229	27.	111.4	2152.3	*	2	2000	529	21.	62.9	2146.7	*	3	2100	829	15.	24.5	2141.2
1	1905	230	27.	111.2	2152.3	*	2	2005	530	21.	62.7	2146.7	*	3	2105	830	15.	24.4	2141.2
1	1910	231	27.	111.0	2152.3	*	2	2010	531	21.	62.6	2146.6	*	3	2110	831	15.	24.3	2141.2
1	1915	232	27.	110.8	2152.3	*	2	2015	532	21.	62.4	2146.6	*	3	2115	832	15.	24.1	2141.2
1	1920	233	27.	110.6	2152.2	*	2	2020	533	21.	62.3	2146.6	*	3	2120	833	15.	24.0	2141.2
1	1925	234	27.	110.4	2152.2	*	2	2025	534	21.	62.2	2146.6	*	3	2125	834	15.	23.9	2141.2
1	1930	235	27.	110.3	2152.2	*	2	2030	535	21.	62.0	2146.6	*	3	2130	835	15.	23.8	2141.1

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1	1935	236	27.	110.1	2152.2	*	2	2035	536	21.	61.9	2146.6	*	3	2135	836	15.	23.7	2141.1
1	1940	237	27.	109.9	2152.2	*	2	2040	537	21.	61.7	2146.5	*	3	2140	837	15.	23.6	2141.1
1	1945	238	27.	109.7	2152.1	*	2	2045	538	21.	61.6	2146.5	*	3	2145	838	15.	23.5	2141.1
1	1950	239	27.	109.5	2152.1	*	2	2050	539	21.	61.4	2146.5	*	3	2150	839	15.	23.4	2141.1
1	1955	240	27.	109.3	2152.1	*	2	2055	540	21.	61.3	2146.5	*	3	2155	840	15.	23.3	2141.1
1	2000	241	27.	109.1	2152.1	*	2	2100	541	21.	61.2	2146.5	*	3	2200	841	15.	23.2	2141.0
1	2005	242	27.	108.9	2152.1	*	2	2105	542	21.	61.0	2146.4	*	3	2205	842	15.	23.1	2141.0
1	2010	243	27.	108.8	2152.0	*	2	2110	543	21.	60.9	2146.4	*	3	2210	843	15.	23.0	2141.0
1	2015	244	27.	108.6	2152.0	*	2	2115	544	21.	60.7	2146.4	*	3	2215	844	15.	22.9	2141.0
1	2020	245	27.	108.4	2152.0	*	2	2120	545	21.	60.6	2146.4	*	3	2220	845	15.	22.8	2141.0
1	2025	246	27.	108.2	2152.0	*	2	2125	546	21.	60.4	2146.4	*	3	2225	846	15.	22.7	2141.0
1	2030	247	27.	108.0	2152.0	*	2	2130	547	21.	60.3	2146.4	*	3	2230	847	15.	22.6	2141.0
1	2035	248	27.	107.8	2152.0	*	2	2135	548	21.	60.1	2146.3	*	3	2235	848	15.	22.5	2140.9
1	2040	249	27.	107.7	2151.9	*	2	2140	549	21.	60.0	2146.3	*	3	2240	849	15.	22.4	2140.9
1	2045	250	27.	107.5	2151.9	*	2	2145	550	21.	59.9	2146.3	*	3	2245	850	15.	22.3	2140.9
1	2050	251	27.	107.3	2151.9	*	2	2150	551	21.	59.7	2146.3	*	3	2250	851	15.	22.2	2140.9
1	2055	252	27.	107.1	2151.9	*	2	2155	552	21.	59.6	2146.3	*	3	2255	852	15.	22.1	2140.9
1	2100	253	27.	106.9	2151.9	*	2	2200	553	21.	59.4	2146.2	*	3	2300	853	15.	22.0	2140.9
1	2105	254	27.	106.7	2151.8	*	2	2205	554	21.	59.3	2146.2	*	3	2305	854	15.	21.9	2140.8
1	2110	255	27.	106.6	2151.8	*	2	2210	555	21.	59.2	2146.2	*	3	2310	855	15.	21.8	2140.8
1	2115	256	26.	106.4	2151.8	*	2	2215	556	21.	59.0	2146.2	*	3	2315	856	15.	21.7	2140.8
1	2120	257	26.	106.2	2151.8	*	2	2220	557	21.	58.9	2146.2	*	3	2320	857	15.	21.6	2140.8
1	2125	258	26.	106.0	2151.8	*	2	2225	558	21.	58.7	2146.2	*	3	2325	858	15.	21.5	2140.8
1	2130	259	26.	105.8	2151.7	*	2	2230	559	21.	58.6	2146.1	*	3	2330	859	15.	21.4	2140.8
1	2135	260	26.	105.6	2151.7	*	2	2235	560	21.	58.4	2146.1	*	3	2335	860	15.	21.3	2140.7
1	2140	261	26.	105.5	2151.7	*	2	2240	561	21.	58.3	2146.1	*	3	2340	861	15.	21.2	2140.7
1	2145	262	26.	105.3	2151.7	*	2	2245	562	21.	58.2	2146.1	*	3	2345	862	14.	21.1	2140.7
1	2150	263	26.	105.1	2151.7	*	2	2250	563	21.	58.0	2146.1	*	3	2350	863	14.	21.0	2140.7
1	2155	264	26.	104.9	2151.6	*	2	2255	564	21.	57.9	2146.0	*	3	2355	864	14.	20.9	2140.7
1	2200	265	26.	104.7	2151.6	*	2	2300	565	21.	57.7	2146.0	*	4	0000	865	14.	20.8	2140.7
1	2205	266	26.	104.6	2151.6	*	2	2305	566	21.	57.6	2146.0	*	4	0005	866	14.	20.7	2140.6
1	2210	267	26.	104.4	2151.6	*	2	2310	567	20.	57.5	2146.0	*	4	0010	867	14.	20.6	2140.6
1	2215	268	26.	104.2	2151.6	*	2	2315	568	20.	57.3	2146.0	*	4	0015	868	14.	20.5	2140.6
1	2220	269	26.	104.0	2151.6	*	2	2320	569	20.	57.2	2146.0	*	4	0020	869	14.	20.4	2140.6
1	2225	270	26.	103.8	2151.5	*	2	2325	570	20.	57.0	2145.9	*	4	0025	870	14.	20.3	2140.6
1	2230	271	26.	103.7	2151.5	*	2	2330	571	20.	56.9	2145.9	*	4	0030	871	14.	20.2	2140.6
1	2235	272	26.	103.5	2151.5	*	2	2335	572	20.	56.7	2145.9	*	4	0035	872	14.	20.1	2140.6
1	2240	273	26.	103.3	2151.5	*	2	2340	573	20.	56.6	2145.9	*	4	0040	873	14.	20.0	2140.5
1	2245	274	26.	103.1	2151.5	*	2	2345	574	20.	56.5	2145.9	*	4	0045	874	14.	19.9	2140.5
1	2250	275	26.	102.9	2151.4	*	2	2350	575	20.	56.3	2145.8	*	4	0050	875	14.	19.8	2140.5
1	2255	276	26.	102.8	2151.4	*	2	2355	576	20.	56.2	2145.8	*	4	0055	876	14.	19.7	2140.5
1	2300	277	26.	102.6	2151.4	*	3	0000	577	20.	56.0	2145.8	*	4	0100	877	14.	19.6	2140.5
1	2305	278	26.	102.4	2151.4	*	3	0005	578	20.	55.9	2145.8	*	4	0105	878	14.	19.5	2140.5
1	2310	279	26.	102.2	2151.4	*	3	0010	579	20.	55.8	2145.8	*	4	0110	879	14.	19.4	2140.4
1	2315	280	26.	102.1	2151.4	*	3	0015	580	20.	55.6	2145.8	*	4	0115	880	14.	19.3	2140.4
1	2320	281	26.	101.9	2151.3	*	3	0020	581	20.	55.5	2145.7	*	4	0120	881	14.	19.2	2140.4
1	2325	282	26.	101.7	2151.3	*	3	0025	582	20.	55.3	2145.7	*	4	0125	882	14.	19.1	2140.4
1	2330	283	26.	101.5	2151.3	*	3	0030	583	20.	55.2	2145.7	*	4	0130	883	14.	19.0	2140.4
1	2335	284	26.	101.4	2151.3	*	3	0035	584	20.	55.1	2145.7	*	4	0135	884	14.	18.9	2140.4
1	2340	285	26.	101.2	2151.3	*	3	0040	585	20.	54.9	2145.7	*	4	0140	885	14.	18.8	2140.4
1	2345	286	25.	101.0	2151.2	*	3	0045	586	20.	54.8	2145.7	*	4	0145	886	14.	18.7	2140.3
1	2350	287	25.	100.8	2151.2	*	3	0050	587	20.	54.6	2145.6	*	4	0150	887	14.	18.6	2140.3
1	2355	288	25.	100.7	2151.2	*	3	0055	588	20.	54.5	2145.6	*	4	0155	888	14.	18.5	2140.3
2	0000	289	25.	100.5	2151.2	*	3	0100	589	20.	54.4	2145.6	*	4	0200	889	14.	18.4	2140.3
2	0005	290	25.	100.3	2151.2	*	3	0105	590	20.	54.2	2145.6	*	4	0205	890	14.	18.3	2140.3
2	0010	291	25.	100.1	2151.1	*	3	0110	591	20.	54.1	2145.6	*	4	0210	891	14.	18.2	2140.3
2	0015	292	25.	100.0	2151.1	*	3	0115	592	20.	54.0	2145.5	*	4	0215	892	14.	18.2	2140.2
2	0020	293	25.	99.8	2151.1	*	3	0120	593	20.	53.8	2145.5	*	4	0220	893	14.	18.1	2140.2
2	0025	294	25.	99.6	2151.1	*	3	0125	594	20.	53.7	2145.5	*	4	0225	894	14.	18.0	2140.2
2	0030	295	25.	99.4	2151.1	*	3	0130	595	20.	53.5	2145.5	*	4	0230	895	14.	17.9	2140.2
2	0035	296	25.	99.3	2151.1	*	3	0135	596	20.	53.4	2145.5	*	4	0235	896	14.	17.8	2140.2
2	0040	297	25.	99.1	2151.0	*	3	0140	597	20.	53.3	2145.5	*	4	0240	897	14.	17.7	2140.2
2	0045	298	25.	98.9	2151.0	*	3	0145	598	20.	53.1	2145.4	*	4	0245	898	14.	17.6	2140.2
2	0050	299	25.	98.7	2151.0	*	3	0150	599	20.	53.0	2145.4	*	4	0250	899	14.	17.5	2140.1
2	0055	300	25.	98.6	2151.0	*	3	0155	600	20.	52.8	2145.4	*	4	0255	900	14.	17.4	2140.1
						*							*						

****

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	74.92-HR
3708.	3.83	(CFS)	622.	176.	72.	69.
		(INCHES)	4.663	5.281	6.444	6.472
		(AC-FT)	308.	349.	426.	428.

PEAK STORAGE (AC-FT)	TIME (HR)	MAXIMUM AVERAGE STORAGE 6-HR	24-HR	72-HR	74.92-HR
201.	3.83	151.	123.	76.	73.

PEAK STAGE (FEET)	TIME (HR)	MAXIMUM AVERAGE STAGE 6-HR	24-HR	72-HR	74.92-HR
2160.23	3.83	2156.05	2153.36	2147.89	2147.47

CUMULATIVE AREA = 1.24 SQ MI

K/L4PRINT

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN		RATIO 1 0.50
HYDROGRAPH AT	SAC230	0.72	1	FLOW	3258.
				TIME	3.50
HYDROGRAPH AT	SAC235	0.38	1	FLOW	1538.
				TIME	3.50
2 COMBINED AT	ADD	1.10	1	FLOW	4796.
				TIME	3.50
ROUTED TO	ROUTE	1.10	1	FLOW	4700.
				TIME	3.50
			** PEAK STAGES IN FEET **		
			1	STAGE	15.47
				TIME	3.50
HYDROGRAPH AT	CAS240	0.14	1	FLOW	874.
				TIME	3.33
2 COMBINED AT	DAMIN	1.24	1	FLOW	5398.
				TIME	3.50
ROUTED TO	DAMOUT	1.24	1	FLOW	3708.
				TIME	3.83
			** PEAK STAGES IN FEET **		
			1	STAGE	2160.23
				TIME	3.83

*** NORMAL END OF HEC-1 ***

K/7 4PRINT

CH2M HILL

CASANDRA

SHEET NO. ____ of ____ DATE 6/28

PROJECT NO. SWN35441.CN

SPILLWAY CHUTE

① SEE HEC-2 "SPILLWAY.HC2"

FOR DEPTH & VELOCITY

② FREEBOARD

TOTAL DEPTH

AT CREST = $y = 5$ FT FREEBOARD = 3' 18'

AT DISSIPATOR $y = 1.1$ FT

VEL = 41.3 FT/s

FREEBOARD = $2.0 + 0.025\, V\sqrt[3]{y}$ (Sverdrup 22 p. 305)

= 3.1

TOTAL DEPTH CHL = 4.2 FT

USE 10 FT, CONSTRUCT EQUAL FORMS

SEE HC2 RUN - MAX FREEBOARD + DEPTH = 6.5 FT

③ TEST FOR POTENTIAL CONVERGENCE OF CHUTE

HYDRAULIC DESIGN OF SPILLWAYS EM 1110-2-1603 1/90 USACOE

① INCREASE F THRU CONVERGENCE

② PARALLEL WALLS AFTER F > 3.25

③ NEED HORIZONTAL CURVE AFTER F = 1.5

④ MAX CONVERGENCE = 5:1

CALCULATIONS

IF F = 1 AT CREST & F = 5 AT DISSIPATOR (+90 FT)

F = 3.25 AT + 51 FT $\frac{2.25}{4}$ $\frac{x}{90}$

MAX CONVERGENCE = 5:1

$\therefore \frac{51}{5} = 10$ FT EACH SIDE MAXIMUM

ASSUME 50% OF MAXIMUM POSSIBLE

DISSIPATOR TO 70 FT WIDE

WOULD INCREASE HEIGHT OF DISSIPATOR WALLS

CONCLUSION: PROBABLY MINIMAL SAVINGS

REV 9/93 FORM 18B

:2 S/N: 1916530021 HMVersion: 6.50 Data File: spilleps.hc2

```
****************************************
HEC-2 WATER SURFACE PROFILES            *
                                        *
Version  4.6.2;  May 1991               *
                                        *
RUN DATE    11AUG94    TIME   17:08:44  *
****************************************
```

```
****************************************
*  U.S. ARMY CORPS OF ENGINEERS        *
*  HYDROLOGIC ENGINEERING CENTER       *
*  609 SECOND STREET, SUITE D          *
*  DAVIS, CALIFORNIA 95616-4687        *
*          (916) 756-1104              *
****************************************
```

```
X     X  XXXXXXX   XXXXX            XXXXX
X     X  X        X     X          X     X
X     X  X        X                      X
XXXXXXX  XXXX     X         XXXXX   XXXXX
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX           XXXXXXX
```

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::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION  :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
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============================
H A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS RUN EXECUTED 11AUG94 17:08:44

****
HEC-2 WATER SURFACE PROFILES

ersion 4.6.2; May 1991
****

2 CHUTE PROFILE - CH2M HILL 6/94
REVISED ELLIPTICAL SPILLWAY

	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		2		1	-1				2158	

	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1		-1							

	1	3700								
C	.014	.014	.014	.1	.3					
	1	4	0	80	10	10	10			
	2163.5	0	2155	0	2155	80	2163.5	80		
1	2				10	10	10			-3.3
	3				10	10	10			-3.3
	4				10	10	10			-3.3
1	5				10	10	10			-3.3
	6				10	10	10			-3.3
1	7				10	10	10			-3.3
	8				10	10	10			-3.3
	9				10	10	10			-3.3
1	10				10	10	10			-3.3

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

ROF 1

CCHV= 0.100 CEHV= 0.300

*SECNO 1.000

20 CRITICAL DEPTH ASSUMED

CALC FREEBOARD

1.000	4.04	2159.04	2159.04	2158.00	2161.08	2.04	0.00	0.00	2163.50		
3700.0	0.0	3700.0	0.0	0.0	322.8	0.0	0.0	0.0	2163.50		
0.00	0.00	11.46	0.00	0.000	0.014	0.000	0.000	2155.00	0.00	2.5	6.5
0.002063	0.	0.	0.	0	10	0	0.00	80.00	80.00		

ECNO 2.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.60

2.000	2.24	2153.94	2155.74	0.00	2160.57	6.63	0.04	0.46	2160.20		
3700.0	0.0	3700.0	0.0	0.0	179.0	0.0	0.1	0.0	2160.20		
0.00	0.00	20.67	0.00	0.000	0.014	0.000	0.000	2151.70	0.00	2.7	4.9
0.013933	10.	10.	10.	7	5	0	0.00	80.00	80.00		

ECNO 3.000

3301 HV CHANGED MORE THAN HVINS

3.000	1.83	2150.23	2152.44	0.00	2160.07	9.83	0.19	0.32	2156.90		
3700.0	0.0	3700.0	0.0	0.0	147.0	0.0	0.1	0.0	2156.90		
0.00	0.00	25.16	0.00	0.000	0.014	0.000	0.000	2148.40	0.00	2.8	4.6
0.026508	10.	10.	10.	14	14	0	0.00	80.00	80.00		

ECNO 4.000

3301 HV CHANGED MORE THAN HVINS

4.000	1.61	2146.71	2149.13	0.00	2159.45	12.74	0.32	0.29	2153.60		
3700.0	0.0	3700.0	0.0	0.0	129.2	0.0	0.1	0.1	2153.60		
0.00	0.00	28.64	0.00	0.000	0.014	0.000	0.000	2145.10	0.00	2.8	4.4
0.040520	10.	10.	10.	16	17	0	0.00	80.00	80.00		

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

ECNO 5.000

01 HV CHANGED MORE THAN HVINS

5.000	1.47	2143.27	2145.84	0.00	2158.71	15.44	0.47	0.27	2150.30
3700.0	0.0	3700.0	0.0	0.0	117.3	0.0	0.2	0.1	2150.30
0.00	0.00	31.54	0.00	0.000	0.014	0.000	0.000	2141.80	0.00
0.055585	10.	10.	10.	17	17	0	0.00	80.00	80.00

ECNO 6.000

01 HV CHANGED MORE THAN HVINS

6.000	1.36	2139.86	2142.55	0.00	2157.83	17.97	0.63	0.25	2147.00
3700.0	0.0	3700.0	0.0	0.0	108.8	0.0	0.2	0.1	2147.00
0.00	0.00	34.02	0.00	0.000	0.014	0.000	0.000	2138.50	0.00
0.071296	10.	10.	10.	15	17	0	0.00	80.00	80.00

ECNO 7.000

01 HV CHANGED MORE THAN HVINS

7.000	1.28	2136.48	2139.24	0.00	2156.81	20.33	0.79	0.24	2143.70
3700.0	0.0	3700.0	0.0	0.0	102.3	0.0	0.2	0.1	2143.70
0.00	0.00	36.18	0.00	0.000	0.014	0.000	0.000	2135.20	0.00
0.087334	10.	10.	10.	16	20	0	0.00	80.00	80.00

ECNO 8.000

01 HV CHANGED MORE THAN HVINS

8.000	1.21	2133.11	2135.93	0.00	2155.64	22.52	0.95	0.22	2140.40
3700.0	0.0	3700.0	0.0	0.0	97.1	0.0	0.2	0.1	2140.40
0.00	0.00	38.09	0.00	0.000	0.014	0.000	0.000	2131.90	0.00
0.103419	10.	10.	10.	17	20	0	0.00	80.00	80.00

ECNO 9.000

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3301 HV CHANGED MORE THAN HVINS

9.000	1.16	2129.76	2132.64	0.00	2154.32	24.56	1.11	0.20	2137.10
3700.0	0.0	3700.0	0.0	0.0	93.0	0.0	0.2	0.1	2137.10
0.00	0.00	39.77	0.00	0.000	0.014	0.000	0.000	2128.60	0.00
0.119297	10.	10.	10.	17	20	0	0.00	80.00	80.00

ECNO 10.000

3301 HV CHANGED MORE THAN HVINS

10.000	1.12	2126.42	2129.34	0.00	2152.87	26.45	1.27	0.19	2133.80
3700.0	0.0	3700.0	0.0	0.0	89.6	0.0	0.3	0.2	2133.80
0.00	0.00	41.27	0.00	0.000	0.014	0.000	0.000	2125.30	0.00
0.134771	10.	10.	10.	17	20	0	0.00	80.00	80.00

THIS RUN EXECUTED 11AUG94 17:08:44

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EC-2 WATER SURFACE PROFILES

ersion 4.6.2; May 1991

****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

VISED ELLIPTICAL SPILL

MMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
1.000	0.00	0.00	0.00	2155.00	3700.00	2159.04	2159.04	2161.08	20.63	11.46	322.81	814.59
2.000	10.00	0.00	0.00	2151.70	3700.00	2153.94	2155.74	2160.57	139.33	20.67	179.00	313.46
3.000	10.00	0.00	0.00	2148.40	3700.00	2150.23	2152.44	2160.07	265.08	25.16	147.03	227.26
4.000	10.00	0.00	0.00	2145.10	3700.00	2146.71	2149.13	2159.45	405.20	28.64	129.18	183.81
5.000	10.00	0.00	0.00	2141.80	3700.00	2143.27	2145.84	2158.71	555.85	31.54	117.32	156.94
6.000	10.00	0.00	0.00	2138.50	3700.00	2139.86	2142.55	2157.83	712.96	34.02	108.77	138.57
7.000	10.00	0.00	0.00	2135.20	3700.00	2136.48	2139.24	2156.81	873.34	36.18	102.27	125.20
8.000	10.00	0.00	0.00	2131.90	3700.00	2133.11	2135.93	2155.64	1034.19	38.09	97.15	115.05
9.000	10.00	0.00	0.00	2128.60	3700.00	2129.76	2132.64	2154.32	1192.97	39.77	93.03	107.12
10.000	10.00	0.00	0.00	2125.30	3700.00	2126.42	2129.34	2152.87	1347.71	41.27	89.65	100.79

..VISED ELLIPTICAL SPILL

MMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
1.000	3700.00	2159.04	0.00	0.00	1.04	80.00	0.00
2.000	3700.00	2153.94	0.00	-5.10	0.00	80.00	10.00
3.000	3700.00	2150.23	0.00	-3.71	0.00	80.00	10.00
4.000	3700.00	2146.71	0.00	-3.52	0.00	80.00	10.00
5.000	3700.00	2143.27	0.00	-3.45	0.00	80.00	10.00
6.000	3700.00	2139.86	0.00	-3.40	0.00	80.00	10.00
7.000	3700.00	2136.48	0.00	-3.38	0.00	80.00	10.00
8.000	3700.00	2133.11	0.00	-3.37	0.00	80.00	10.00
9.000	3700.00	2129.76	0.00	-3.35	0.00	80.00	10.00
10.000	3700.00	2126.42	0.00	-3.34	0.00	80.00	10.00

UMMARY OF ERRORS AND SPECIAL NOTES

UTION SECNO= 1.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

RNING SECNO= 2.000 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CH2M HILL

SUBJECT: CASANDRO - DISSIPATOR

BY: [illegible]

SHEET NO. ____ of ____ DATE ~~6/27~~ 8/11/94

PROJECT NO. SWUU35441.CV

USE BURRE 1974 [illegible]

BASIC APPROACH

1. ASSUME D_2 = TW DEPTH SINCE [illegible]

   A) DOWNSTREAM CHANNEL SLOPE IS SUBCRITICAL

   B) DOWNSTREAM CHANNEL IS ERODIBLE AT PMF/½PMF

   THEREFORE:

   CRITICAL DEPTH AT DISSIPATOR OUTLET LIE CONTROLS

2. SELECT DISSIPATOR TYPE GIVEN INFLOW FROUDE NUMBER

3. COMPARE ½PMF & ~~PMF BASIN SIZES~~

   ~~& OPTIMIZE SELECTION OF BASIN GEOMETRY~~

   8/11/94 DELETE FULL PMF PER FCDMC INSTRUCTIONS

4. USE ~~Q_{PMF}~~ & $Q_{½PMF}$ AFTER HEC-1 ROUTING THRU BASIN SINCE BASIN NORMALLY DRY, PER ADWR REG'S

CH2M HILL

SUBJECT: CASANORO

BY: NEF

SHEET NO. ____ of ____ DATE 8/11

PROJECT NO. SWW35441.P3

DISSIPATOR

① TAILWATER DEPTH

A. HEC-2 RATING OF D/S CHANNEL DEFAULTS TO CRITICAL DEPTH, PROB DUE TO STEEP SLOPE (>2%)

∴ USE CRITICAL DEPTH ON DISSIPATOR LIP AS CONTROLLING TAILWATER

$Q_{1/2\,PMF} \approx 3700$ CFS (ROUTED, HPM, HCI, ALLOW FOR GRADING REVISIONS BY INCREASING ROUTED 1/2 PMP FROM 3428 CFS TO 3700 CFS)

$q = 46.25 \frac{CFS}{FT}$ (80 WIDTH)

CRIT. DEPTH, $d_c = \sqrt[3]{\frac{q^2}{g}} = 4.04$ FT

$V_c = \frac{Q}{L \cdot D_c} = 11.45$ FT/S

② VELOCITY ENTERING BASIN THRU SPILLWAY CHUTE

$V_T = \sqrt{2g\left(z - \frac{h}{2}\right)}$ BUREC MONOGRAPH #25, 1974 p. 31

h = max head on crest = 5.0'

z = total head to point of concern on chute = 2160 − 2125 = 35

$= \sqrt{2(32.2)\left(35 - \frac{5}{2}\right)}$

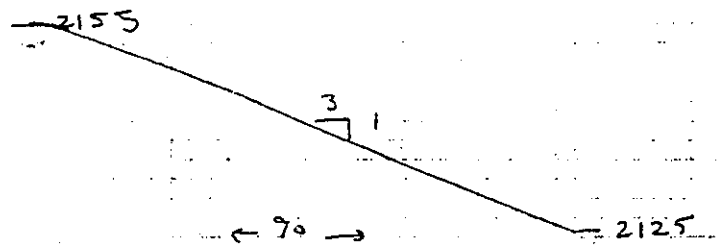
$V_T = 45.7$

ASSUME DISSIPATOR FLOOR @ 2125 FT

D_T, DEPTH @ $V_T = \frac{Q}{V_T \cdot L} = 1.01$ FT

F_1, ENTERING BASIN $= \frac{V}{\sqrt{gd}} = 8.01$

③ CHECK VELOCITY ESTIMATE USING HEC-2



? OK 2700 cfs

DEPTH @ BASIN = 1.1 FT
VELOCITY = 41.27
F = 6.87

USE FOR DESIGN

④ SELECT BASIN TYPE FOR FROUDE NUMBER & VELOCITY
(USBR BUREC, 1974; MONOGRAPH #25)

F > 4.5 ; VELOCITY < 50-60 FT/S

→ TYPE III BASIN

⑤ ESTIMATE TYPE III BASIN CHARACTERISTICS -

TAILWATER ELEVATION = CRITICAL DEPTH ON LIP

$$D_c = \sqrt[3]{\frac{q^2}{g}} = 4.04$$

USE TW TO ESTABLISH DEPTH OF BASIN

DEPTH ELEV'N OF D_c - D_2 FROM HYDRAULIC JUMP (ACHIEVE D_2 BY SINKING BASIN)

PLATE X, BUREC (ATTACHED)

$TW = D_2$ $TW/D_2 = 1.0$

$F = 6.9$

$\frac{TW}{D_1} = 9.4 \Rightarrow TW = 10.3$

DEPTH OF BASIN = ~~6.3~~ See next sheet

CH2M HILL

SUBJECT: CASANDRO

BY: [illegible]

SHEET NO. ____ of ____ DATE 8/11/94

PROJECT NO. SWW3544I.PS

BASIN CHARACTERISTICS

SEE BUREC, 1974 PLATE X $F = 6.9$, $D_2 = 10.3$

$\frac{L}{D_2} = 2.5$ $L = 25.8$ FT

$\frac{h_3}{D_1} = 1.75$ $h_3 = 1.9$ FT

$\frac{h_4}{D_1} = 14$ $h_4 = 1.5$ FT

FREEBOARD

BUREC, 1987 p 398 #25

$FREE = 0.1(v + d_2)$ $v = 41.3$

$= 5.2$ FT $d_2 = 10.3$

See following calcs. 8/11/23

RIP RAP SCOUR PROTECTION D/S OF LIP

$V_{exit} = \frac{Q}{D_c \cdot 80} = V_c = 11.4$ FT/S

USE FHWA '89 "DESIGN OF RIPRAP REVETMENT"

p. 30 Eq'n 6

$D_{50} = \frac{0.001 V_a^3}{d_{avg}^{1/2} K_1^{1.5}}$ $K_1 = 1$ (NO BANK SLOPE)

$D_{50} = \frac{.001 (11.4)^3}{4.04^{1/2}}$

$D_{50} = 0.7$ FT S.F. = 2.0 RAPIDLY VARIED FLOW (JUMP)

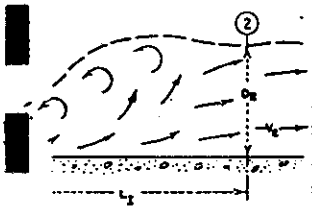
$D_{50} = 1.4$ FT

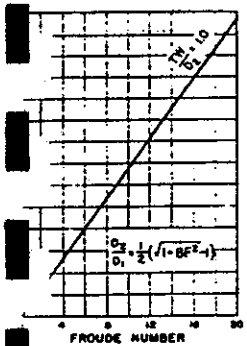
SEE GRADATION SPEC ATTACHED

REV 9/93 FORM 188

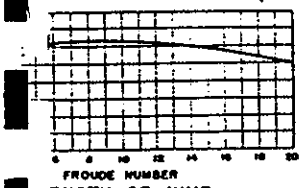
SECTION 1
INVESTIGATION OF THE JUMP ON HORIZONTAL APRONS (BASIN I)

... flat floor with no chute blocks, or end sill in basin. Usually not a basin because of excessive length. Characteristics of jumps for the range of Froude numbers is valid designers in selecting more basins II, III, IV, V, and VI.

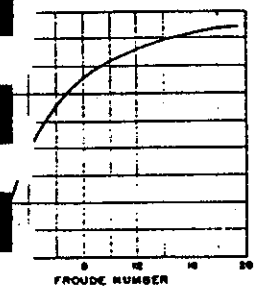




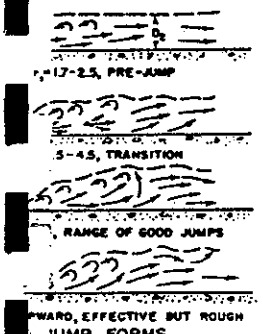
OF TW DEPTH TO D_1



LENGTH OF JUMP



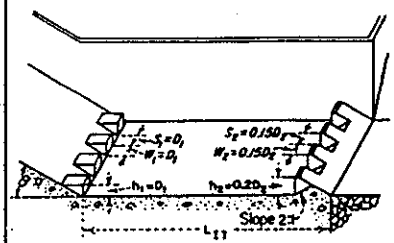
S OF ENERGY IN JUMP

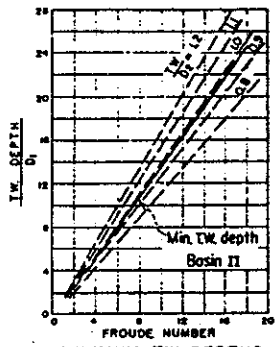


JUMP FORMS

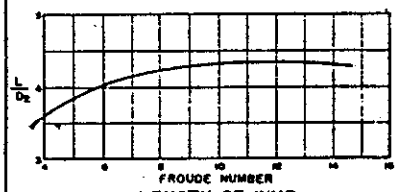
SECTION 2
STILLING BASIN FOR HIGH DAM AND EARTH DAM SPILLWAYS AND LARGE CANAL STRUCTURES (BASIN II)

Jump and basin length reduced about 33 percent with chute blocks and dentated end sill.
For use on high spillways, large canal structures, etc. for Froude numbers above 4.5.

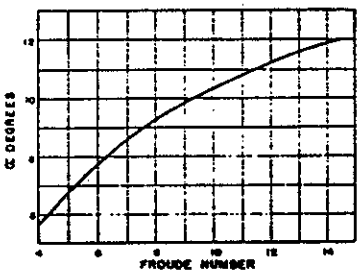


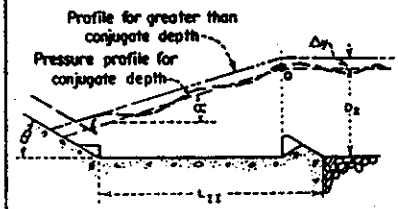


MINIMUM TW DEPTHS (SWEEPOUT)



LENGTH OF JUMP

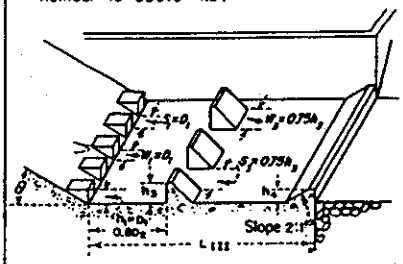


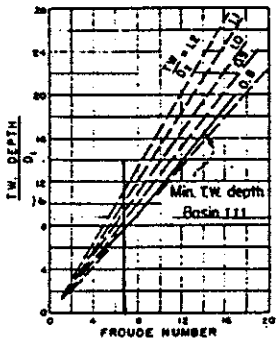


WATER SURFACE AND PRESSURE PROFILES

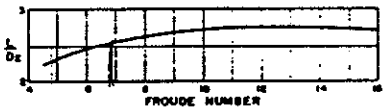
SECTION 3
SHORT STILLING BASINS FOR CANAL STRUCTURES, SMALL OUTLET WORKS AND SMALL SPILLWAYS (BASIN III)

Jump and basin length reduced about 60 percent with chute blocks, baffle piers, and solid end sill.
For use on small spillways, outlet works, small canal structures where V_1 does not exceed 50-60 feet per second and Froude number is above 4.5.

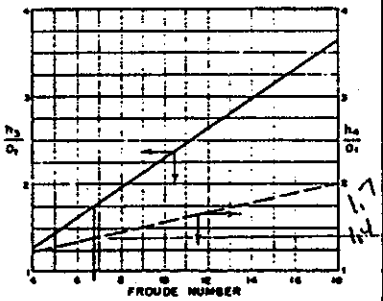




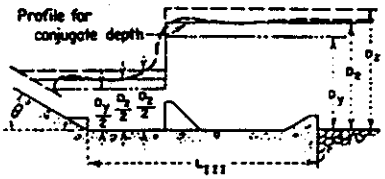
MINIMUM TW DEPTHS (SWEEPOUT)



LENGTH OF JUMP



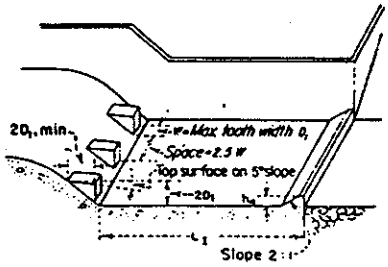
HEIGHT OF BAFFLE BLOCKS AND END SILLS

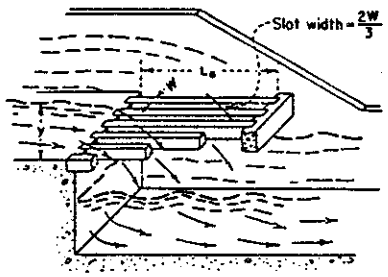


WATER SURFACE AND PRESSURE PROFILES

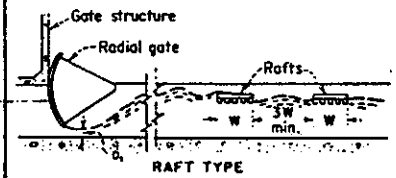
SECTION 4
STILLING BASIN DESIGN AND WAVE SUPRESSORS FOR CANAL STRUCTURES, OUTLET WORKS, AND DIVERSION DAMS (BASIN IV)

For use with jumps of Froude number 2.5 to 4.5 which usually occur on canal structures and diversion dams. This basin reduces excessive waves created in imperfect jumps.
May also use alternate design and/or wave suppressors shown below, or Basin VI

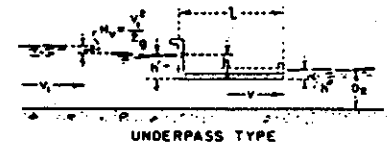




ALTERNATIVE DESIGN



RAFT TYPE



UNDERPASS TYPE
WAVE SUPPRESSORS

SUMMARY OF STILLING BASIN CHARACTERISTICS
SECTIONS 1 THROUGH 4

PLATE X

See following calcs
1/23

Table 3. Riprap gradation classes.

Riprap Class	Rock Size[1] (ft.)	Rock Size[2] (lbs)	Percent of Riprap Smaller Than
Facing	1.30	200	100
	0.95	75	50
	0.40	5	10
Light	1.80	500	100
	1.30	200	50
	0.40	5	10
1/4 ton	2.25	1000	100
	1.80	500	50
	0.95	75	10
1/2 ton	2.85	2000	100
	2.25	1000	50
	1.80	500	5
1 ton	3.60	4000	100
	2.85	2000	50
	2.25	1000	5
2 ton	4.50	8000	100
	3.60	4000	50
	2.85	2000	5

1 Assuming a specific gravity of 2.65.
2 Based on AASHTO gradations.

Gradation of the riprap being placed is controlled by visual inspection. To aid the inspector's judgment, two or more samples of riprap of the specified gradation should be prepared by sorting, weighing, and remixing in proper proportions. Each sample should weigh about 5 to 10 tons. One sample should be placed at the quarry and one sample at the construction site. The sample at the construction site could be part of the finished riprap blanket. These samples should be used as a frequent reference for judging the gradation of the riprap supplied.

An alternate gradation inspection procedure is to collect field samples of this riprap. Field samples should be collected at regular intervals; each sample should be evaluated to determine in place gradation.

4.3 LAYER THICKNESS

All stones should be contained reasonably well within the riprap layer thickness to provide maximum resistance against erosion. Oversize stones, even in isolated spots, may cause riprap failure by precluding mutual support between individual stones, providing large voids that expose filter and bedding materials, and creating excessive

CH2M HILL

SUBJECT Casandra Wash
Riprap downstream of stilling basin

BY H. Allen DATE 1/23/95
SHEET NO. 1 OF 1
PROJECT NO. SWW35441

Goal: Size rip-rap for stilling basin outlet

Given: flow depth = 4 ft.
flow velocity = 11.45 ft/s.
safety factor = 1.1
Procedure from COE publication "Hydraulic Design Criteria, Sheet 712-1, Stone Stability: Velocity vs Stone Diameter". (attached)
$\gamma_s = 165$ lbs/ft^3

Procedure:

- Using chart in back, for high turbulence flow and $V = 11.5$ ft/s, $D'_{50} = 1.7'$
- applying safety factor, $D_{50} = 1.1 D'_{50} = (1.1)(1.7) \cong 1.9'$, say 2.0'

$\rightarrow D_{50} = 2.0'$

$$W_{50} = \frac{\pi D_{50}^3 \gamma_s}{6} = \frac{\pi}{6}(2.0)^3(165) = 691 \text{ lbs}$$

$$W_{100} = 2 W_{50} = 1382 \text{ lbs}$$

$$\rightarrow D_{100} = \left(\frac{6W}{\pi \gamma_s}\right)^{1/3} = \left(\frac{6 \cdot 1382}{\pi \cdot 165}\right)^{1/3} = 2.5'$$

$$W_{15} = \frac{1}{16} W_{100} = 1382/16 = 86 \text{ lbs}$$

$$\rightarrow D_{15} = \left(\frac{6 \cdot 86}{\pi \cdot 165}\right)^{1/3} = 1.0'$$

- Mat Thickness is greater of:
  a) $2 D_{50} = 4'$
  b) $1.5 D_{100} = (1.5)(2.5) = 3.75$
  use 4.0'

DISSIPATOR

① TAILWATER DEPTH

A. HEC-2 RATING OF D/S CHANNEL DEFAULTS TO CRITICAL DEPTH, PROB DUE TO STEEP SLOPE (>2%)

∴ USE CRITICAL DEPTH ON DISSIPATOR LIP AS CONTROLLING TAILWATER

$Q_{1/2\,PMF} \approx 3700$ CFS (ROUTED, HPM.HC1, ALLOW FOR GRADING REVISIONS BY INCREASING ROUTED 1/2 PMF FROM 3428 CFS TO 3700 CFS)

$q = 46.25 \frac{CFS}{FT}$ (80 WIDTH)

CRIT. DEPTH, $d_c = \sqrt[3]{\frac{q^2}{g}} = 4.04$ FT

$V_c = \frac{Q}{L \cdot D_c} = 11.45$ FT/S

② VELOCITY ENTERING BASIN THRU SPILLWAY CHUTE

$V_T = \sqrt{2g\left(z - \frac{h}{2}\right)}$

BUREC MONOGRAPH #25, 1974 p.31
h = max head on crest = 5.0'
z = total head to point of concern on chute
2160 - 2125 = 35

$= \sqrt{2(32.2)\left(35 - \frac{5}{2}\right)}$

$V_T = 45.7$

ASSUME DISSIPATOR FLOOR @ 2125 FT

D_T, DEPTH @ $V_T = \frac{Q}{V_T \cdot L} = 1.01$ FT

$\mathbb{F}$, ENTERING BASIN $\doteq \frac{V}{\sqrt{gd}} = 8.01$

HYDRAULIC DESIGN CRITERIA

SHEET 712-1

STONE STABILITY

VELOCITY VS STONE DIAMETER

1. Purpose. Hydraulic Design Chart 712-1 can be used as a guide for the selection of rock sizes for riprap for channel bottom and side slopes downstream from stilling basins and for rock sizes for river closures. Recommended stone gradation for stilling basin riprap is given in paragraph 6.

2. Background. In 1885 Wilfred Airy[1] showed that the capacity of a stream to move material along its bed by sliding is a function of the sixth power of the velocity of the water.[1] Henry Law applied this concept to the overturning of a cube,[2] and in 1896 Hooker[2] illustrated its application to spheres. In 1932 and 1936 Isbash published coefficients for the stability of rounded stones dropped in flowing water.[3,4] The design curves given in Chart 712-1 have been computed using Airy's law and the experimental coefficients for rounded stones published by Isbash.

3. Theory. According to Isbash the basic equation for the movement of stone in flowing water can be written as:

$$V = C\left[2g\left(\frac{\gamma_s - \gamma_w}{\gamma_w}\right)\right]^{1/2}(D)^{1/2} \qquad (1)$$

where

V = velocity, fps

C = a coefficient

g = acceleration of gravity, ft/sec^2

γ_s = specific weight of stone, lb/ft^3

γ_w = specific weight of water, lb/ft^3

D = stone diameter, ft

The diameter of a spherical stone in terms of its weight W is

$$D = \left(\frac{6W}{\pi\gamma_s}\right)^{1/3} \qquad (2)$$

Substituting for D in equation 1 results in

$$V = C\left[2g\left(\frac{\gamma_s - \gamma_w}{\gamma_w}\right)\right]^{1/2}\left(\frac{6W}{\pi\gamma_s}\right)^{1/6} \qquad (3)$$

which describes Airy's law stated in paragraph 2.

4. Experimental Results. Experimental data on stone movement in flowing water from the early (1786) work of DuBuat[5] to the more recent Bonneville Hydraulic Laboratory tests[6] have been shown to confirm Airy's law and Isbash's stability coefficients.[7] The published experimental data are generally defined in terms of bottom velocities. However, some are in terms of average flow velocities and some are not specified. The Isbash coefficients are from tests with essentially no boundary layer development and the average flow velocities are representative of the velocity against stone. When the stone movement resulted by sliding, a coefficient of 0.86 was obtained. When movement was effected by rolling or overturning, a coefficient of 1.20 resulted. Extensive U. S. Army Engineer Waterways Experiment Station laboratory testing for the design of riprap below stilling basins indicates that the coefficient of 0.86 should be used with the average flow velocity over the end sill for sizing stilling basin riprap because of the excessively high turbulence level in the flow. For impact-type stilling basins, the Bureau of Reclamation[8] has adopted a riprap design curve based on field and laboratory experience and on a study by Mavis and Laushey.[9] The Bureau curve specifies rock weighing 165 lb/ft^3 and is very close to the Isbash curve for similar rock using a stability coefficient of 0.86.

5. Application. The curves given in Chart 712-1 are applicable to specific stone weights of 135 to 205 lb/ft^3. The use of the average flow velocity is desirable for conservative design. The solid-line curves are recommended for stilling basin riprap design and other high-level turbulence conditions. The dashed line curves are recommended for river closures and similar low-level turbulence conditions. Riprap bank and bed protection in natural and artificial flood-control channels should be designed in accordance with reference 10.

6. Stilling Basin Riprap.

a. Size. The W_{50} stone weight and the D_{50} stone diameter for establishing riprap size for stilling basins can be obtained using Chart 712-1 in the manner indicated by the heavy arrows thereon. The effect of specific weight of the rock on the required size is indicated by the vertical spread of the solid line curves.

b. Gradation. The following size criteria should serve as guidelines for stilling basin riprap gradation.

(1) The lower limit of W_{50} stone should not be less than the weight of stone determined using the appropriate "Stilling Basins" curve in Chart 712-1.

(2) The upper limit of W_{50} stone should not exceed the weight that can be obtained economically from the quarry or the size that will satisfy layer thickness requirements as specified in paragraph 6c.

(3) The lower limit of W_{100} stone should not be less than two times the lower limit of W_{50} stone.

(4) The upper limit of W_{100} stone should not be more than five times the lower limit of W_{50} stone, nor exceed the size that can be obtained economically from the quarry, nor exceed the size that will satisfy layer thickness requirements as specified in paragraph 6c.

(5) The lower limit of W_{15} stone should not be less than one-sixteenth the upper limit of W_{100} stone.

(6) The upper limit of W_{15} stone should be less than the upper limit of W_{50} stone as required to satisfy criteria for graded stone filters specified in EM 1110-2-1901.

(7) The bulk volume of stone lighter than the W_{15} stone should not exceed the volume of voids in the revetment without this lighter stone.

(8) W_0 to W_{25} stone may be used instead of W_{15} stone in criteria (5), (6), and (7) if desirable to better utilize available stone sizes.

c. Thickness. The thickness of the riprap protection should be $2D_{50\ max}$ or $1.5D_{100\ max}$, whichever results in the greater thickness.

d. Extent. Riprap protection should extend downstream to where nonerosive channel velocities are established and should be placed sufficiently high on the adjacent bank to provide protection from wave wash during maximum discharge. The required riprap thickness is determined by substituting values for these relations in equation 2.

7. References.

(1) Shelford, W., "On rivers flowing into tideless seas, illustrated by the river Tiber." Proceedings, Institute of Civil Engineers, vol 82 (1885).

(2) Hooker, E. H., "The suspension of solids in flowing water." Transactions, American Society of Civil Engineers, vol 36 (1896), pp 239-340.

(3) Isbash, S. V., Construction of Dams by Dumping Stones in Flowing

Water, Leningrad, 1932. Translated by A. Dorijikov, U. S. Army Engineer District, Eastport, CE, Maine, 1935.

(4) _____, "Construction of dams by depositing rock in running water." Transactions, Second Congress on Large Dams, vol 5 (1936), pp 123-136.

(5) DuBuat, P. L. G., Traite d'Hydraulique. Paris, France, 1786.

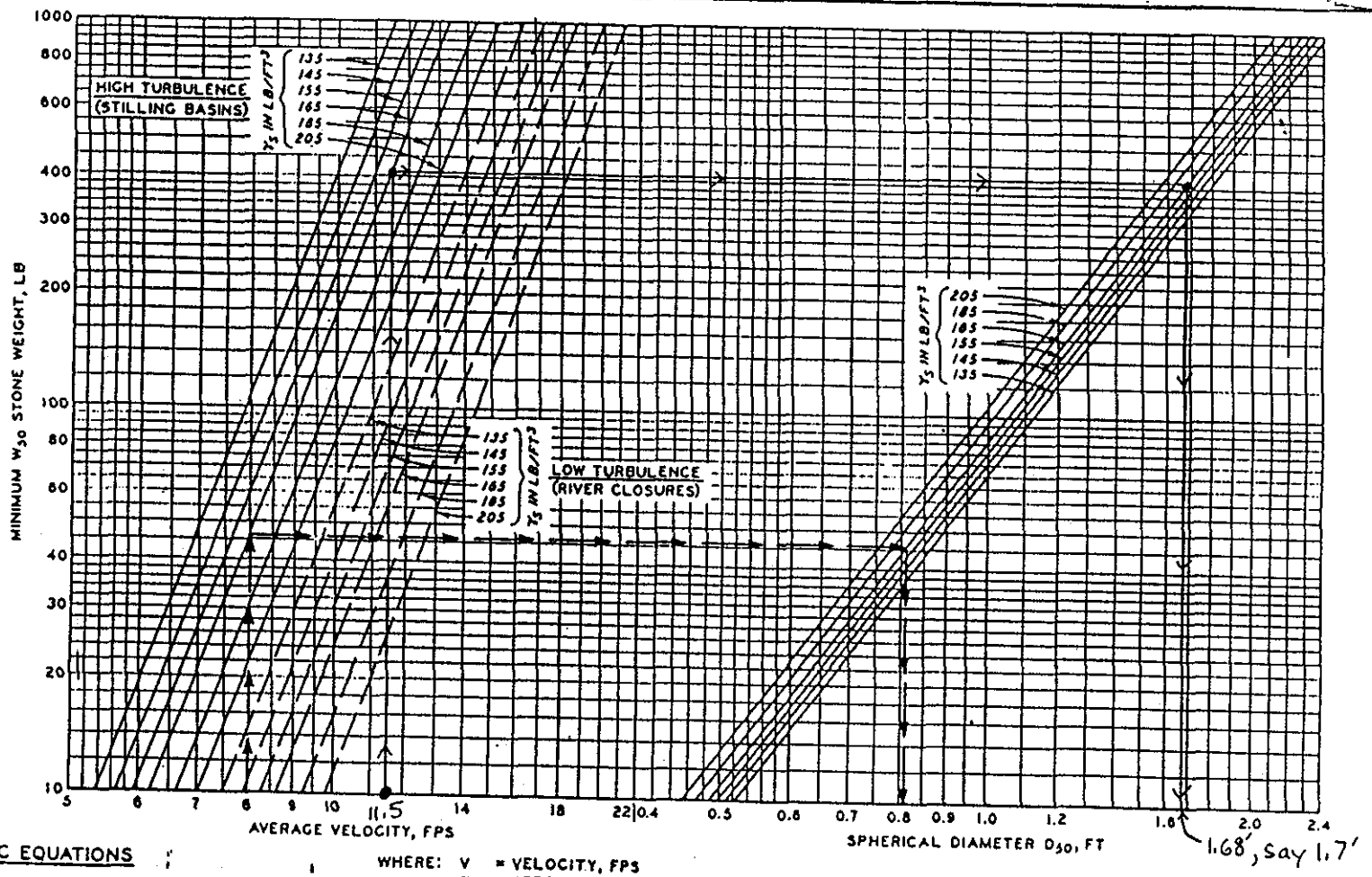
(6) U. S. Army Engineer District, Portland, CE, McNary Dam - Second Step Cofferdam Closure. Bonneville Hydraulic Laboratory Report No. 51-1, 1956.

(7) U. S. Army Engineer Waterways Experiment Station, CE, Velocity Forces on Submerged Rocks. Miscellaneous Paper No. 2-265, Vicksburg, Miss., April 1958.

(8) U. S. Bureau of Reclamation, Stilling Basin Performance; An Aid in Determining Riprap Sizes, by A. J. Peterka. Hydraulic Laboratory Report No. HYD-409, Denver, Colo., 1956.

(9) Mavis, F. T. and Laushey, L. M., "A reappraisal of the beginning of bed movement - competent velocity." Second Meeting, International Association for Hydraulic Structure Research, Stockholm, Sweden, 1948. See also Civil Engineering, vol 19 (January 1949), pp 38, 39, and 72.

(10) U. S. Army, Office, Chief of Engineers, Engineering and Design; Hydraulic Design of Flood Control Channels. EM 1110-2-1601, Washington, D. C., 1 July 1970.



BASIC EQUATIONS

$$V = C\left[2g\left(\frac{\gamma_s - \gamma_w}{\gamma_w}\right)\right]^{1/2}(D_{50})^{1/2}$$

$$D_{50} = \left(\frac{6W_{50}}{\pi\gamma_s}\right)^{1/3}$$

WHERE:
- V = VELOCITY, FPS
- γ_s = SPECIFIC STONE WEIGHT, LB/FT³
- γ_w = SPECIFIC WEIGHT OF WATER, 62.5 LB/FT³
- W_{50} = WEIGHT OF STONE. SUBSCRIPT DENOTES PERCENT OF TOTAL WEIGHT OF MATERIAL CONTAINING STONE OF LESS WEIGHT.
- D_{50} = SPHERICAL DIAMETER OF STONE HAVING THE SAME WEIGHT AS W_{50}
- C = ISBASH CONSTANT (0.86 FOR HIGH TURBULENCE LEVEL FLOW AND 1.20 FOR LOW TURBULENCE LEVEL FLOW)
- g = ACCELERATION OF GRAVITY, FT/SEC²

STONE STABILITY
VELOCITY VS STONE DIAMETER

HYDRAULIC DESIGN CHART 712-1
(SHEET 1 OF 2)

REV 8-56, 9-70 WES 8-57

9/9

SUBJECT

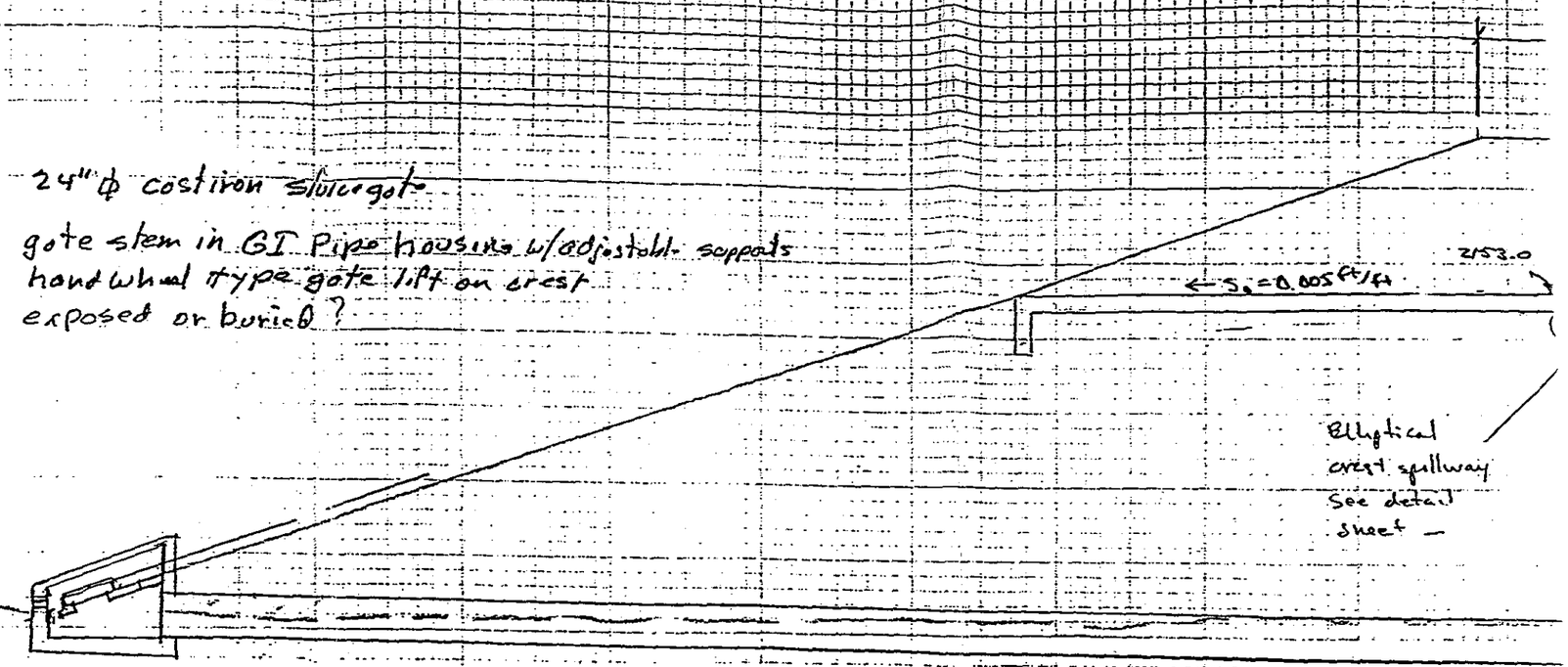
CH2M HILL

PROJECT NO. BY SHEET NO. DATE

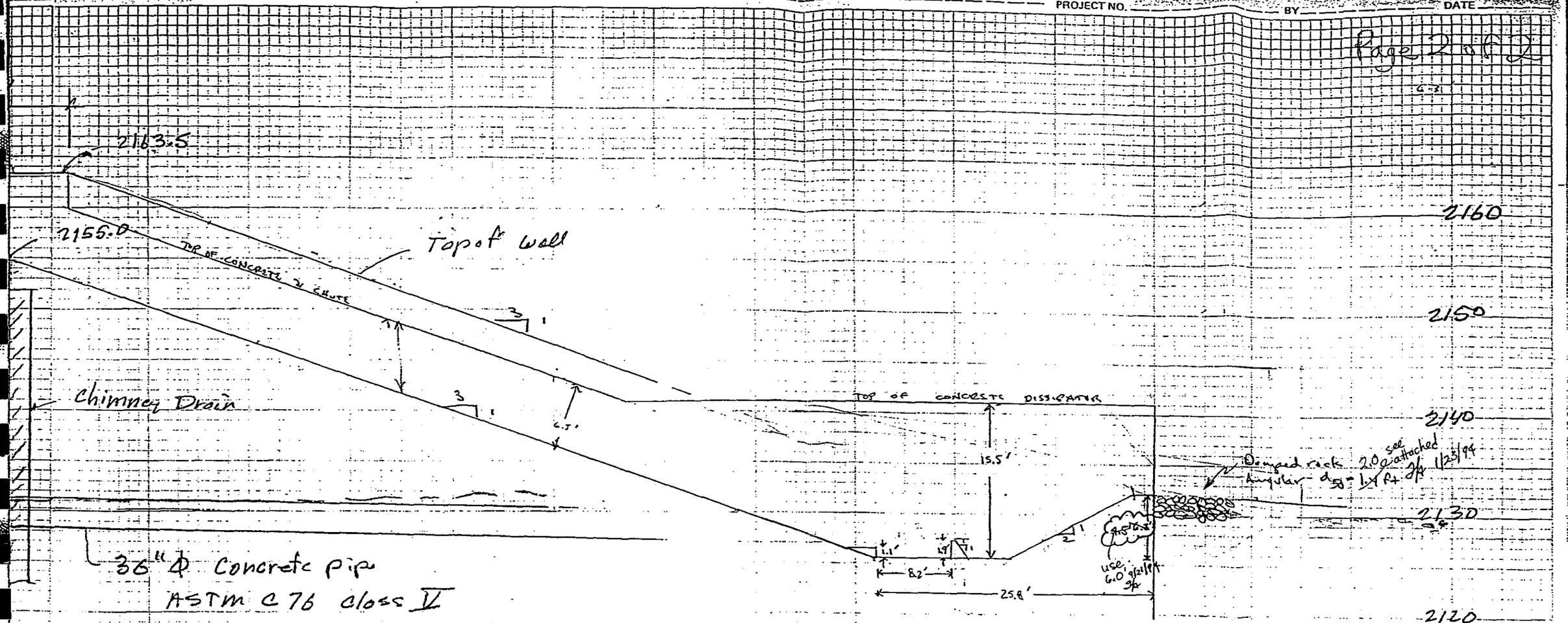
Page 1 of 2

24" ϕ cast iron sluice gate

gate stem in GI Pipe housing w/adjustable supports
hand wheel type gate lift on crest
exposed or buried?



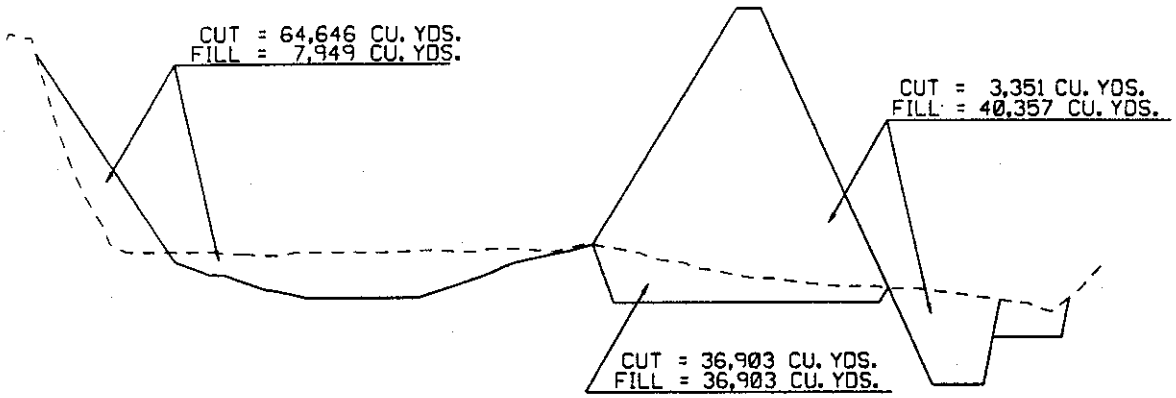
Page 2 of 2



Cosandra Wash
Spillway profile

Earthwork

EARTHWORK SUMMARY CALCULATIONS



CUT VOLUMES

BANK MEASURE TOTAL = 104,900 CU. YDS.
SWELL FACTOR = 1.0
TOTAL CUT (LOOSE) = 104,900 CU. YDS.

FILL VOLUMES

BANK MEASURE TOTAL = 85,209 CU. YDS.
ZONE 2 MATERIAL -2,900 CU. YDS.
BANK MEASURE TOTAL = 82,309 CU. YDS.
SHRINKAGE FACTOR = 1.15
TOTAL FILL (LOOSE) = 94,655 CU. YDS.

TOTAL CUT = 104,900 CU. YDS.
TOTAL FILL = -94,655 CU. YDS.
WASTE = 10,245 CU. YDS.

204 EXCAVATION FOR DAM & DETENTION BASIN PERIMETER SLOPES

DAM FOUNDATION EXCAVATION = 36,903 CU. YDS.
DAM EMBANKMENT EXCAVATION = 3,351 CU. YDS.
TOTAL = 40,254 CU. YDS.

USE 40,800 CU. YDS. IN BID

210 BORROW EXCAVATION

BANK MEASURE TOTAL = 64,646 CU. YDS.

USE 65,100 CU. YDS. IN BID

211-1 FILL CONSTRUCTION

BANK MEASURE DAM FOUNDATION REPLACEMENT = 36,903 CU. YDS.
BANK MEASURE DETENTION BASIN = 7,949 CU. YDS.
BANK MEASURE DAM EMBANKMENT = 40,357 CU. YDS.
85,209 CU.YDS.
ZONE 2 MATERIAL -2,900 CU. YDS.
82,309 CU.YDS.

USE 85,500 CU. YDS. IN BID

CH2M HILL

CH2M HILL
EARTHWORK VOLUME CALCULATIONS
PROJ DESCRIPTION: CASANDRO WASH DAM & DETENTION BASIN
PROJ #: SWW35441.CV

VOLUMES FOR DAM FOUNDATION EXC & REPLACEMENT (FROM EXST GROUND TO FOUNDATION PAY LIMIT)

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
997		0		
	18			57
1015		172		
	85			541
1100		172		
	15			369
1115		1155		
	90			3850
1205		1155		
	45			3016
1250		2464		
	50			4563
1300		2464		
	50			3965
1350		1818		
	50			3599
1400		2069		
	50			4344
1450		2623		
	50			4269
1500		1988		
	50			3362
1550		1643		
	50			3982
1600		2658		
	20			984
1620		0		
TOTAL - BANK MEASURE				36,903

CH2M HILL
EARTHWORK VOLUME CALCULATIONS
PROJ DESCRIPTION: CASANDRO WASH DETENTION BASIN
PROJ #: SWW35441.CV

PREPARED BY: W PAIZ/ PHX

EARTHWORK QUANTITIES FOR DAM EMBANKMENT ONLY

CUT VOLUMES

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
South				
400		19.2		
	50			18
350		0		
	50			98
300		106		
	50			308
250		227		
	50			477
200		288		
	50			285
150		19.5		
	50			100
100		89		
	50			156
50		79		
	50			114
North				
0		44		
	50			69
50		30		
	50			42
100		15		
	50			28
150		15		
	50			28
200		15		

FILL VOLUMES **FILL VOLUMES**

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
400		354		
	50			1097
350		831		
	50			1168
300		430		
	50			609
250		228		
	50			408
200		213		
	50			274
150		83		
	50			484
100		440		
	50			831
50		457		
	50			1394
0		1048		
	50			2737
50		1908		
	50			3218
100		1567		
	50			3880
150		2623		
	50			5490
200		3306		

CH2M HILL
EARTHWORK VOLUME CALCULATIONS
PROJ DESCRIPTION: CASANDRO WASH DETENTION BASIN
PROJ #: SWW35441.CV

PREPARED BY: W PAIZ/ PHX

EARTHWORK QUANTITIES FOR DAM EMBANKMENT ONLY

CUT VOLUMES

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
BEGIN SPILLWAY				
200		550		
	80			1630
280		550		
END SPILLWAY				
280		0		
	20			0
300		0		
	50			0
350		0		
	50			0
400		0		
	50			0
450		0		
TOTAL - BANK MEASURE				3,351

FILL VOLUMES

FILL VOLUMES

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
BEGIN SPILLWAY				
200		1903		
	80			5639
280		1903		
END SPILLWAY				
280		3432		
	20			2542
300		3432		
	50			5381
350		2380		
	50			3611
400		1520		
	50			1594
450		202		
TOTAL - BANK MEASURE				40,357

CH2M HILL
EARTHWORK VOLUME CALCULATIONS
PROJ DESCRIPTION: CASANDRO WASH DETENTION BASIN
PROJ #: SWW35441.CV

PREPARED BY: W PAIZ/ PHX

EARTHWORK QUANTITIES FOR DETENTION BASIN AREA ONLY

CUT VOLUMES

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
WEST				
100		1172		
	50			2910
150		1971		
	50			4189
200		2553		
	50			5042
250		2892		
	50			5752
300		3320		
	50			6724
350		3942		
	50			6893
400		3502		
	50			5819
450		2783		
	50			4351
500		1916		
	50			4138
550		2553		
	50			5269
600		3137		
	50			5422
650		2719		
	50			4052
700		1657		

FILL VOLUMES

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
100		1445		
	50			2133
150		859		
	50			1471
200		730		
	50			1028
250		380		
	50			757
300		438		
	50			486
350		87		
	50			323
400		262		
	50			316
450		79		
	50			168
500		102		
	50			152
550		62		
	50			153
600		103		
	50			136
650		44		
	50			188
700		159		

FILL VOLUMES

CH2M HILL
EARTHWORK VOLUME CALCULATIONS
PROJ DESCRIPTION: CASANDRO WASH DETENTION BASIN
PROJ #: SWW35441.CV

PREPARED BY: W PAIZ/ PHX

EARTHWORK QUANTITIES FOR DETENTION BASIN AREA ONLY

CUT VOLUMES

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
	50			2569
750		1118		
	50			1276
800		260		
	50			241
850		0		
	50			0
900		0		
	900			0
TOTAL - BANK MEASURE				64,646

FILL VOLUMES

STATION	DIFFERENCE, FT	AREA, SF		VOLUME, CY
	50			393
750		265		
	50			245
800		0		
	50			0
850		0		
	50			0
900		0		
	900			0
0				
TOTAL - BANK MEASURE				7,949

FILL VOLUMES

CASANDRO WASH DAM
EARTHWORK COMPS.

6-2-94
SHW35441.PS

DAM CUT AND FILLS

STA	DIST FT	CUT AREA SQ FT	VOLUME CU YD	FILL AREA SQ FT	VOLUME CU YD
0		0		480	
	100		0.00		4870.37
100		0		2150	
	75		0.00		7652.78
175		0		3360	
	0		0.00		0.00
175		0		2420	
	85		0.00		7429.63
260		0		2300	
	0		0.00		0.00
260		0		3440	
	40		0.00		4548.15
300		0		2700	
	100		0.00		8351.85
400		0		1810	
	100		0.00		4648.15
500		0		700	
	100		333.33		1759.26
600		180		250	
	100		740.74		1111.11
700		220		350	
	100		407.41		1944.44
800		0		700	
TOTAL DAM			1,481		42,316

× 1.15
48663

TOT CUT = 62,017 cy

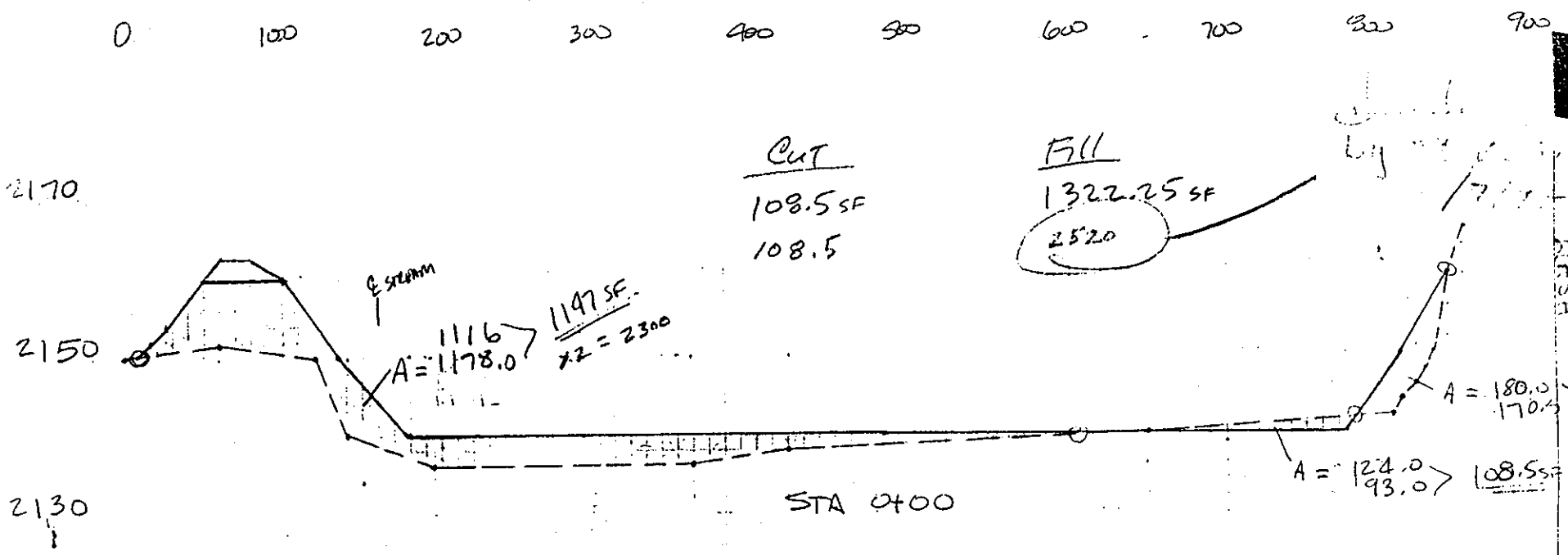
TOT COMP. FILL = 62,173 cy

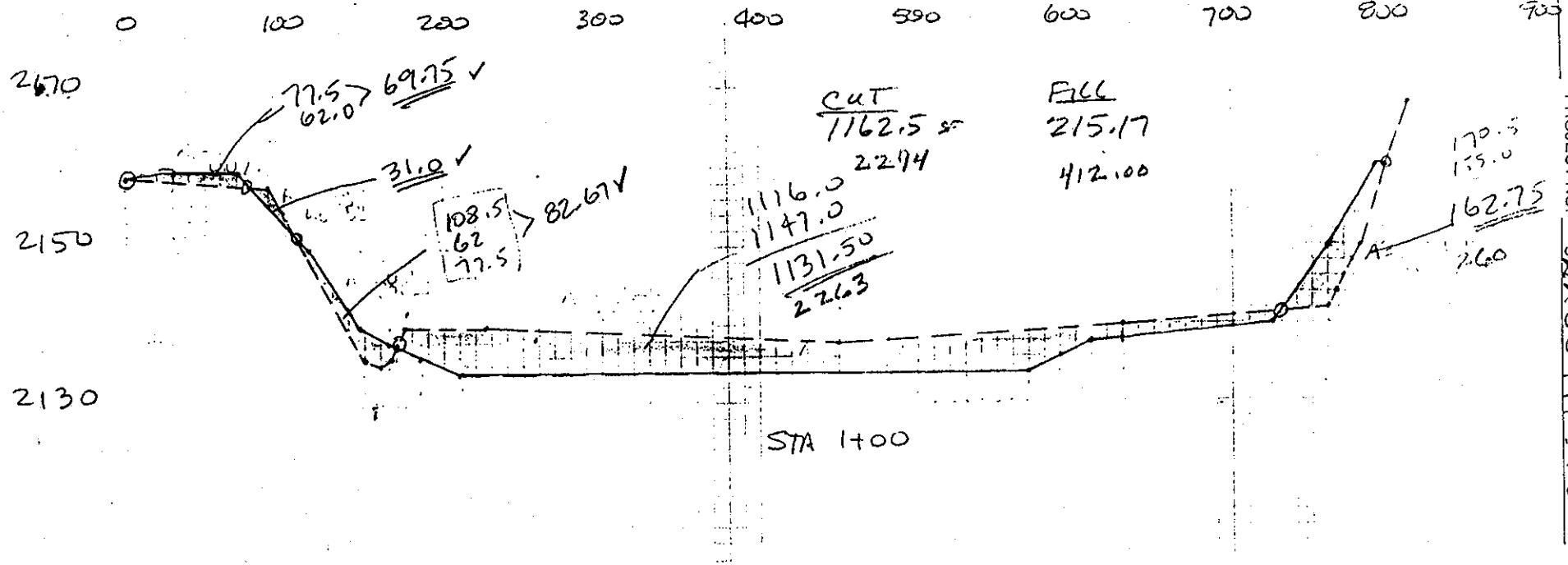
RESERVOIR CUT AND FILLS

STA	DIST FT	CUT AREA SQ FT	VOLUME CU YD	FILL AREA SQ FT	VOLUME CU YD
0		108.5		2520	
	100		4391.67		5429.62963
100		2263		412	
	100		10394.44		1837.037037
200		3350		580	
	100		12962.96		1148.148148
300		3650		40	
	100		11101.85		601.8518519
400		2345		285	
	100		9083.33		870.3703704
500		2560		185	
	100		8629.63		861.1111111
600		2100		280	
	100		3972.22		1000
700		45		260	
TOTAL RESERVOIR =			60,536		11,748

× 1.15

13510 CY.





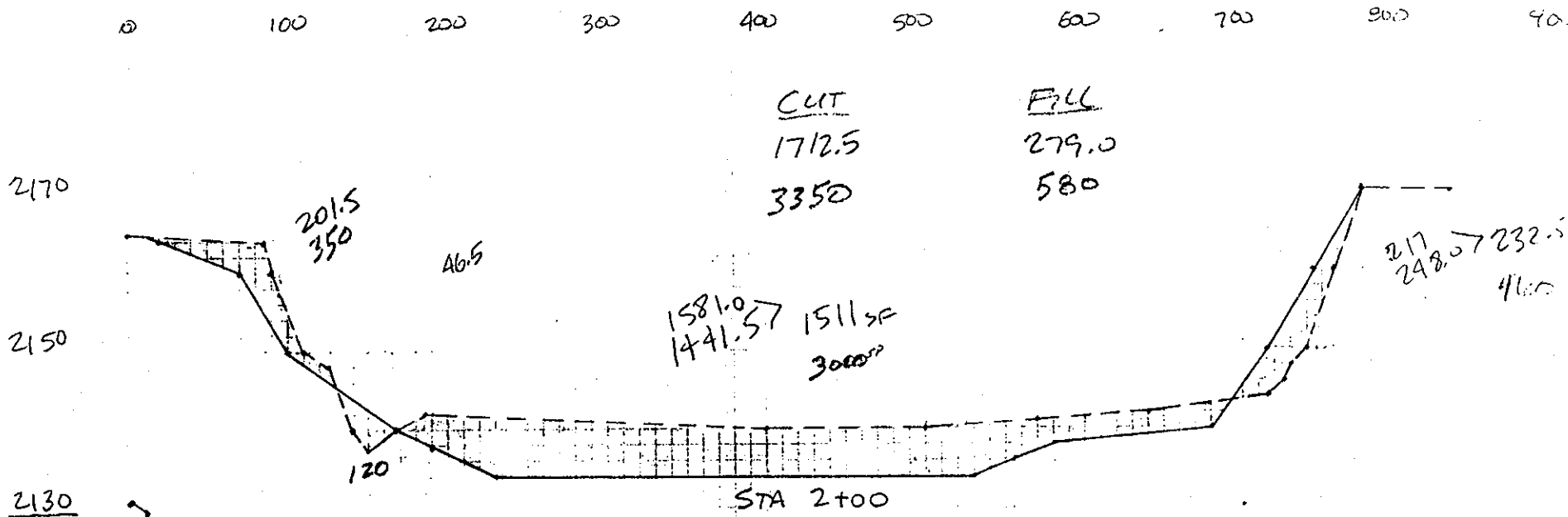
SUBJECT: SANDRO FLASH

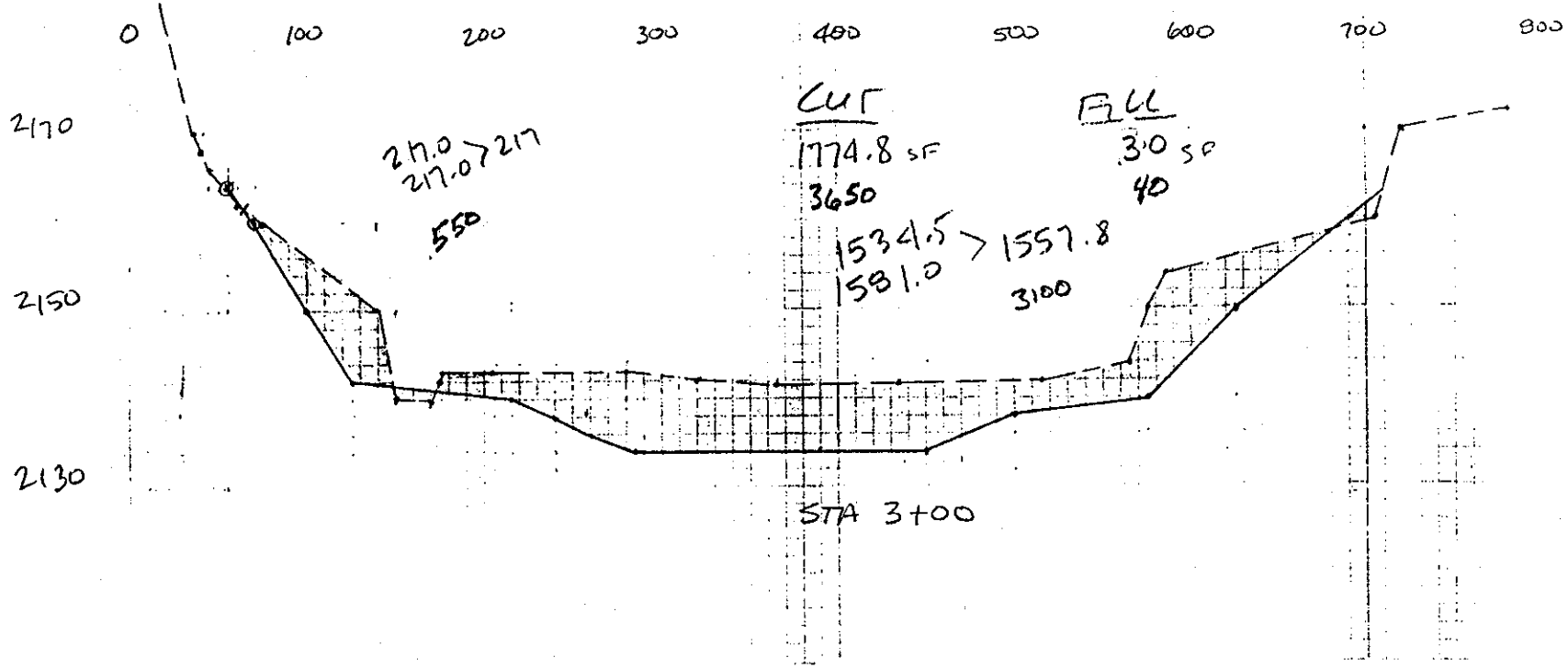
SHEET NO. 1 of 4 DATE 6-2-94

PROJECT NO. SAK13J441.P5

CH2M HILL

REV 9/93 FORM 18P





CASANDRO WASH DAM

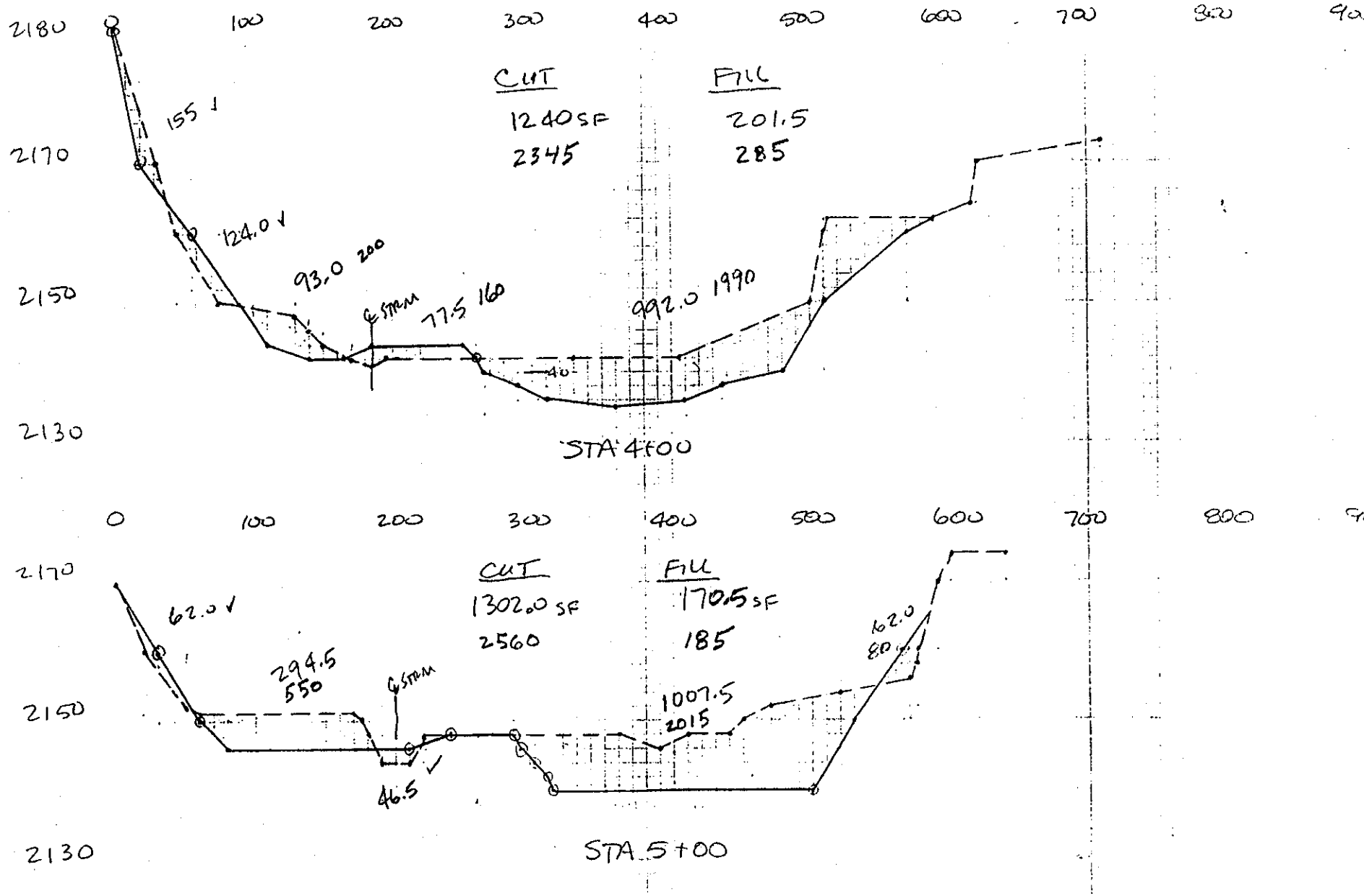
SHEET NO. 2 OF 4 DATE 6-2-94

PROJECT NO. 5H1/35441.P5

CHECKED BY STEVE P.

CH2M HILL

REV 9/93 FORM 188



SUBJECT CASANDRA WASH DAM

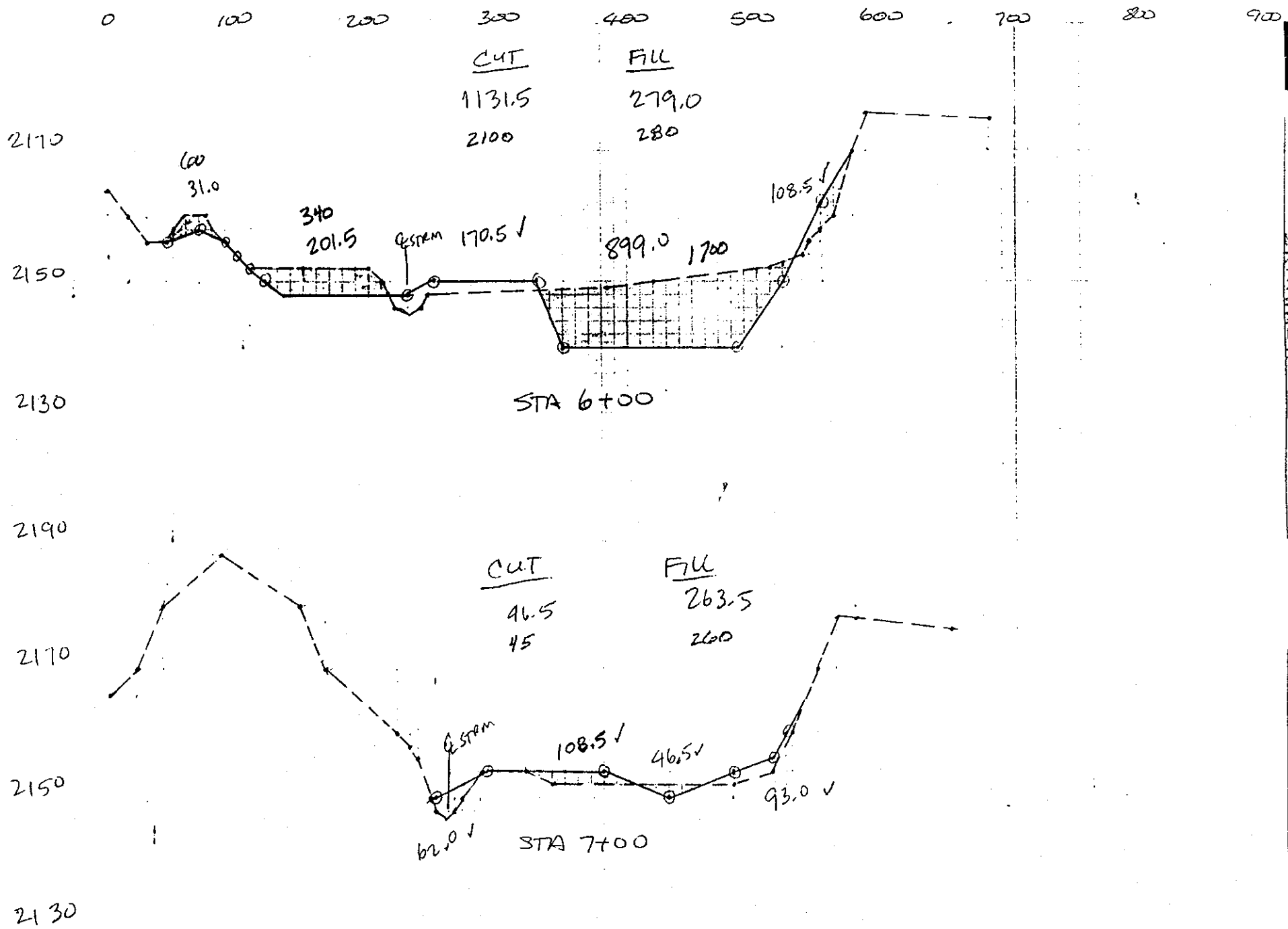
EARTH WORK

SHEET NO. 3 of 4 DATE 6-2-94

PROJECT NO.

CH2M HILL

REVISED FORM 1.1.88



SUBJECT: CASANDRO WASH DAM
EARTHWORK

SHEET NO. 4 of 4 DATE 6-2-94
PROJECT NO.

CH2M HILL

REV 0.03 FORM 188

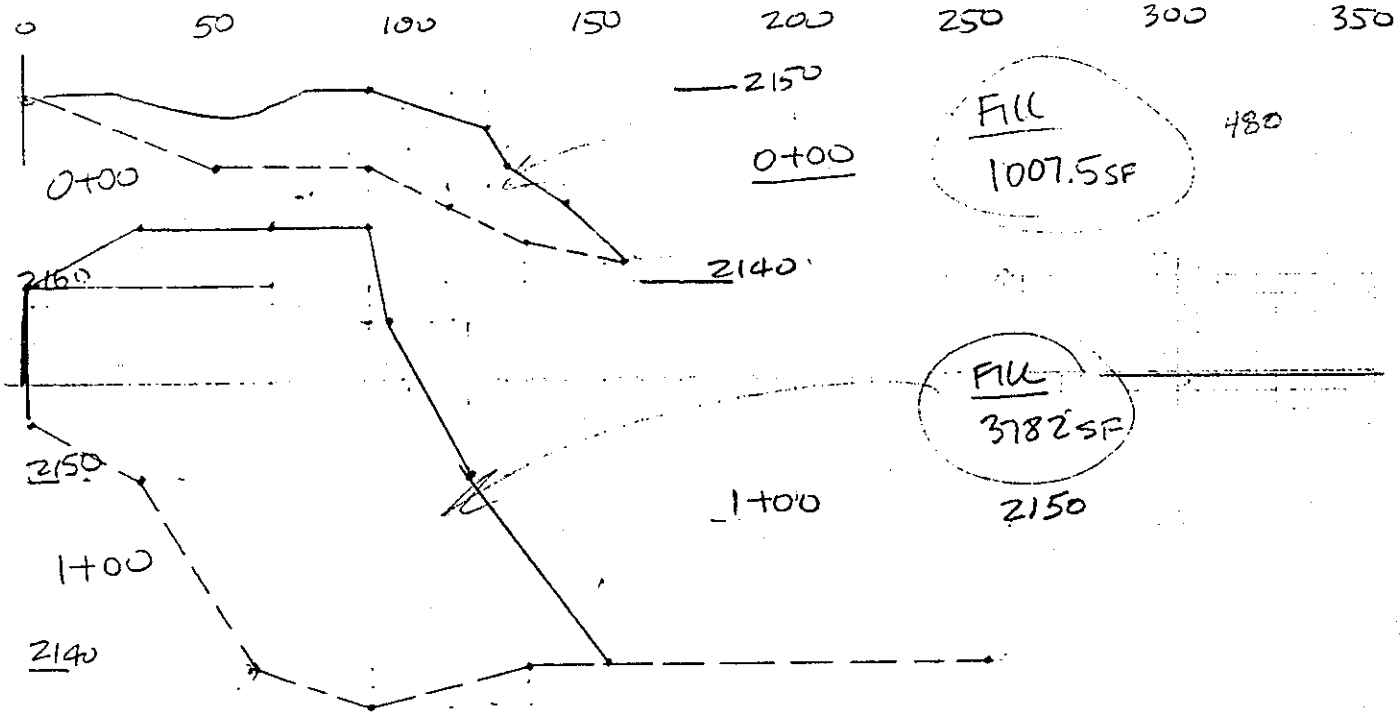
CH2M HILL

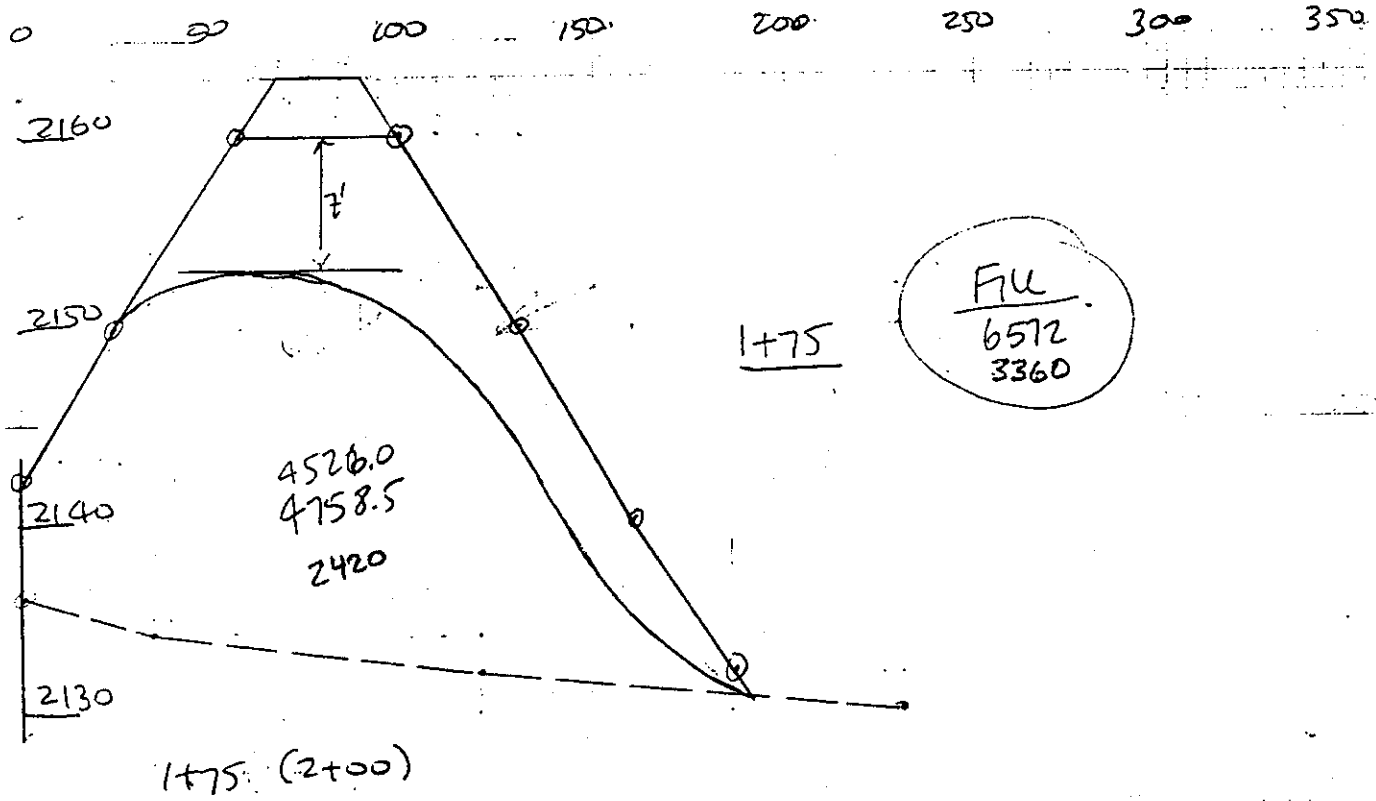
SUBJECT: Dam Alignment

BY: [illegible]

SHEET NO. 1 of 4 DATE

PROJECT NO.

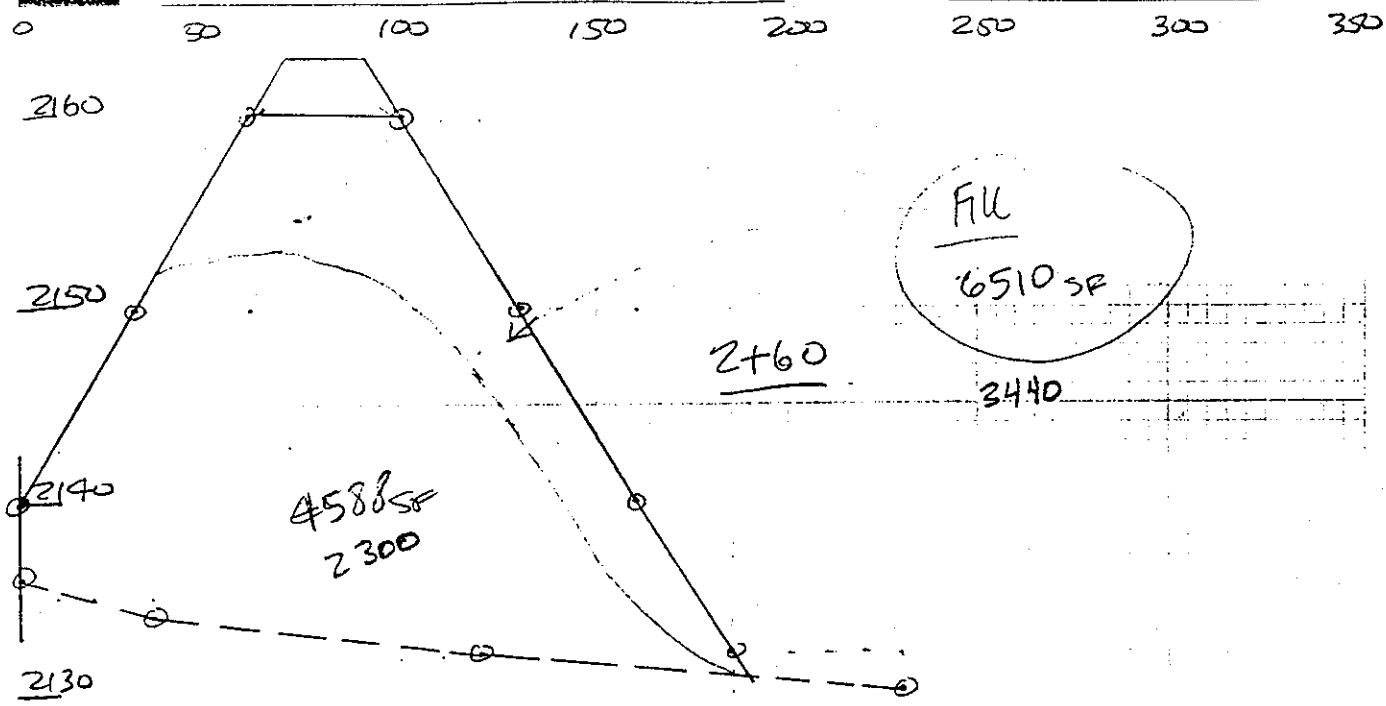


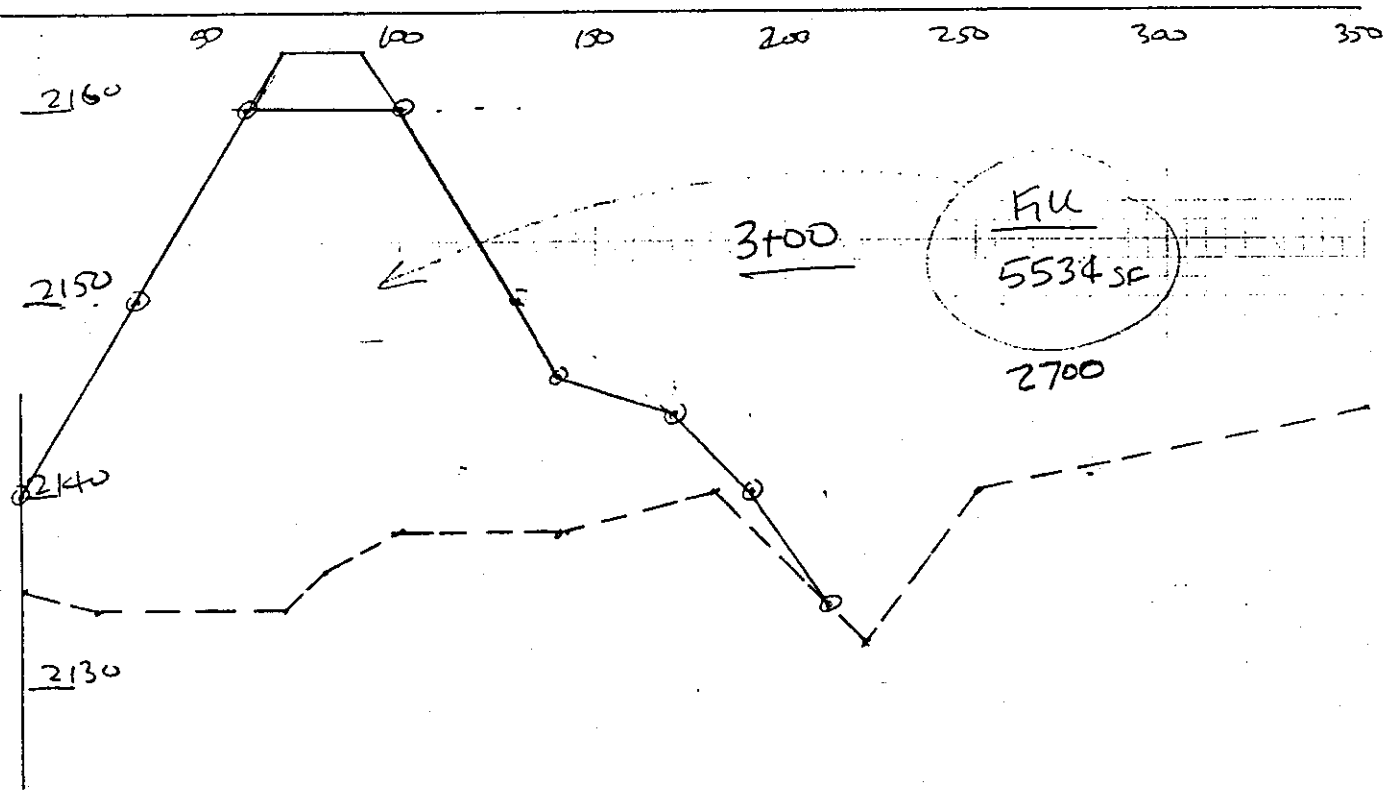


SUBJECT _____ BY _____

SHEET NO. 2 of 4 DATE _____

PROJECT NO. _____

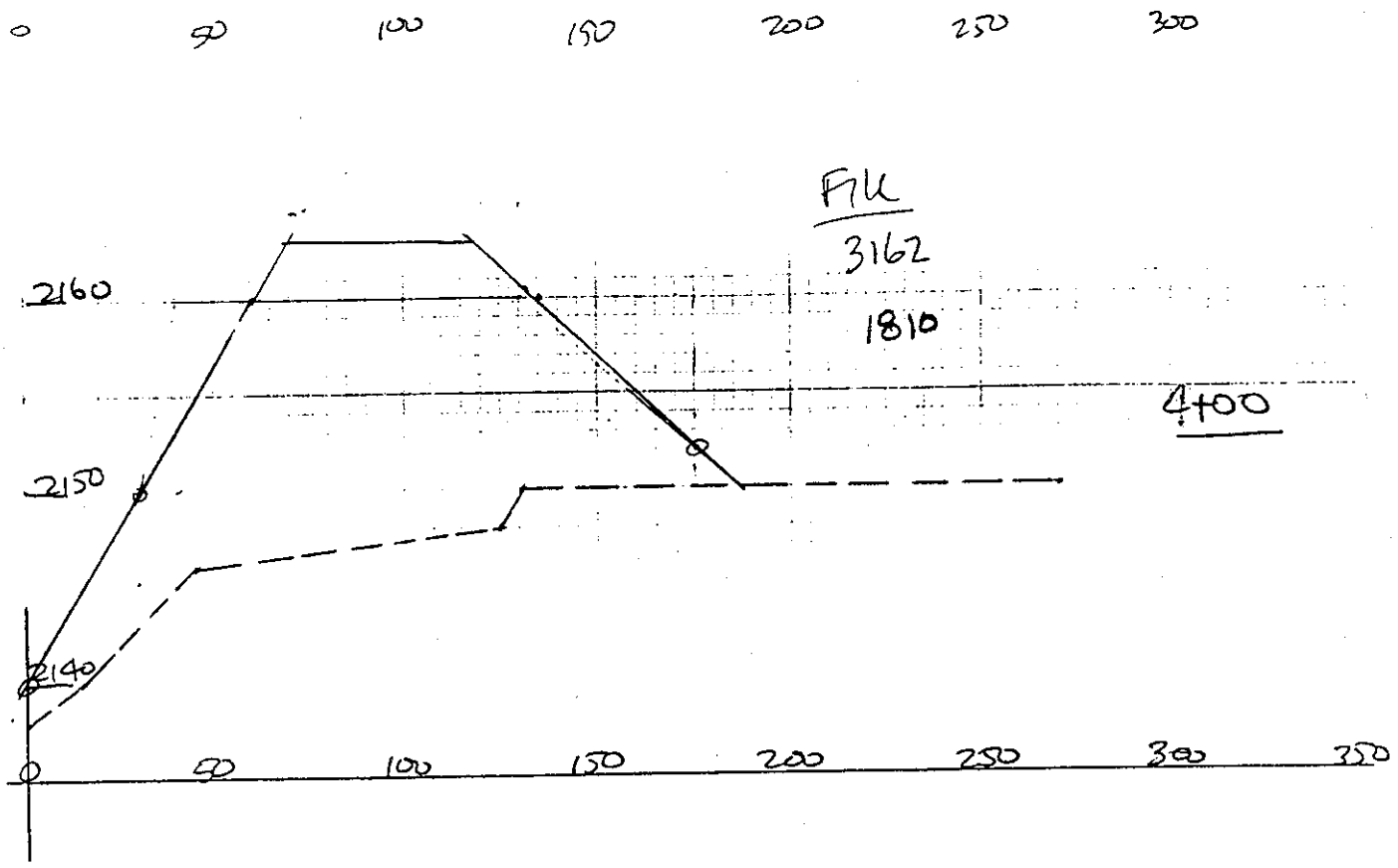


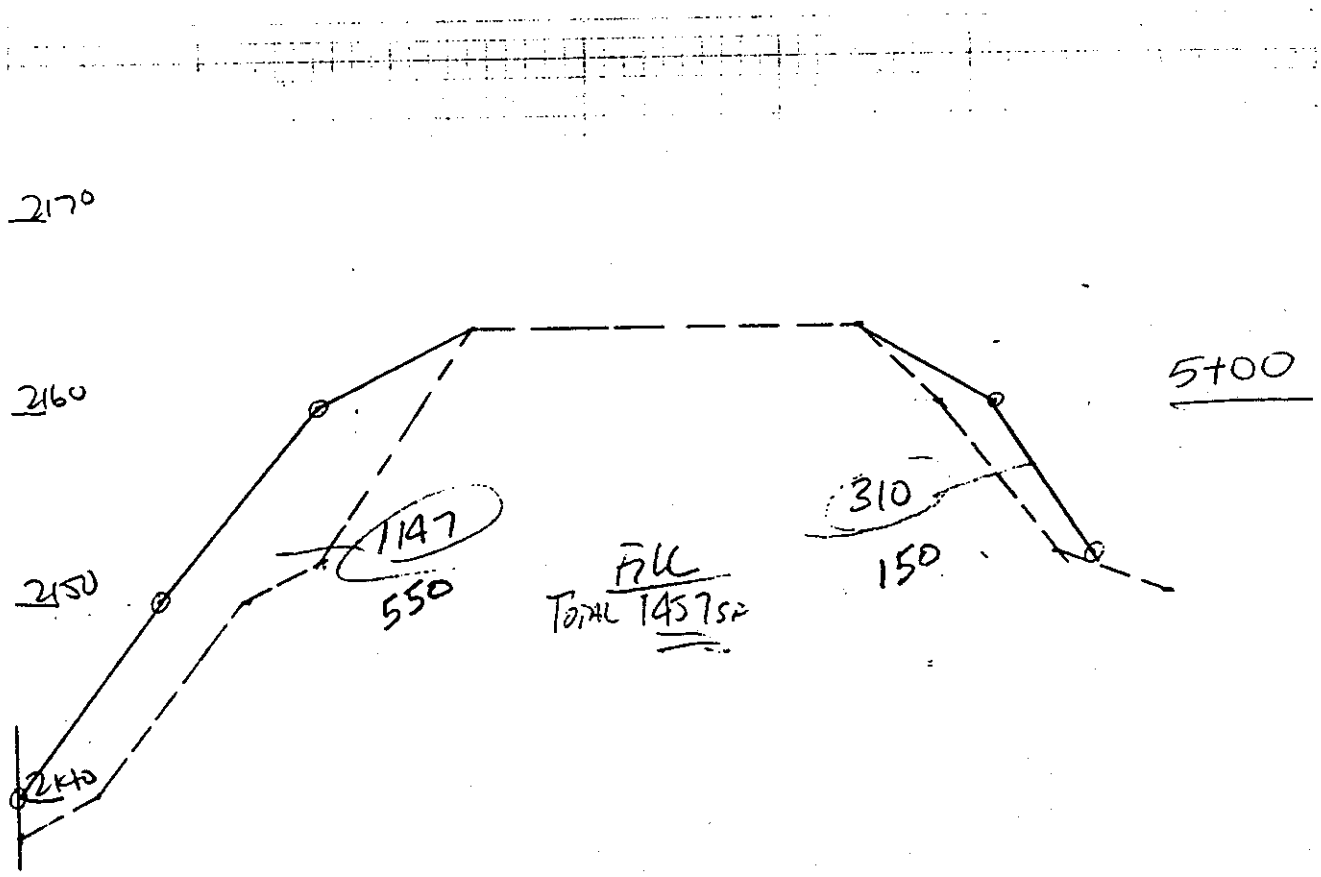


SUBJECT _____ BY _____

SHEET NO. 3 of 4 DATE _____

PROJECT NO. _____



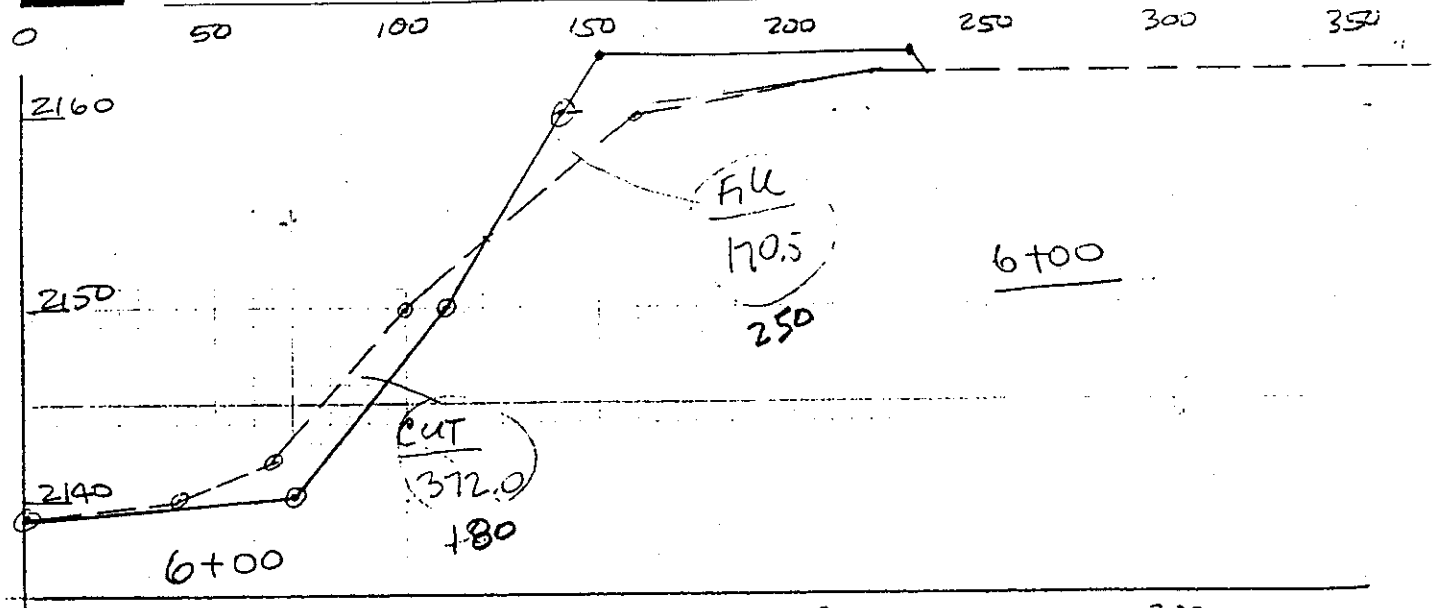


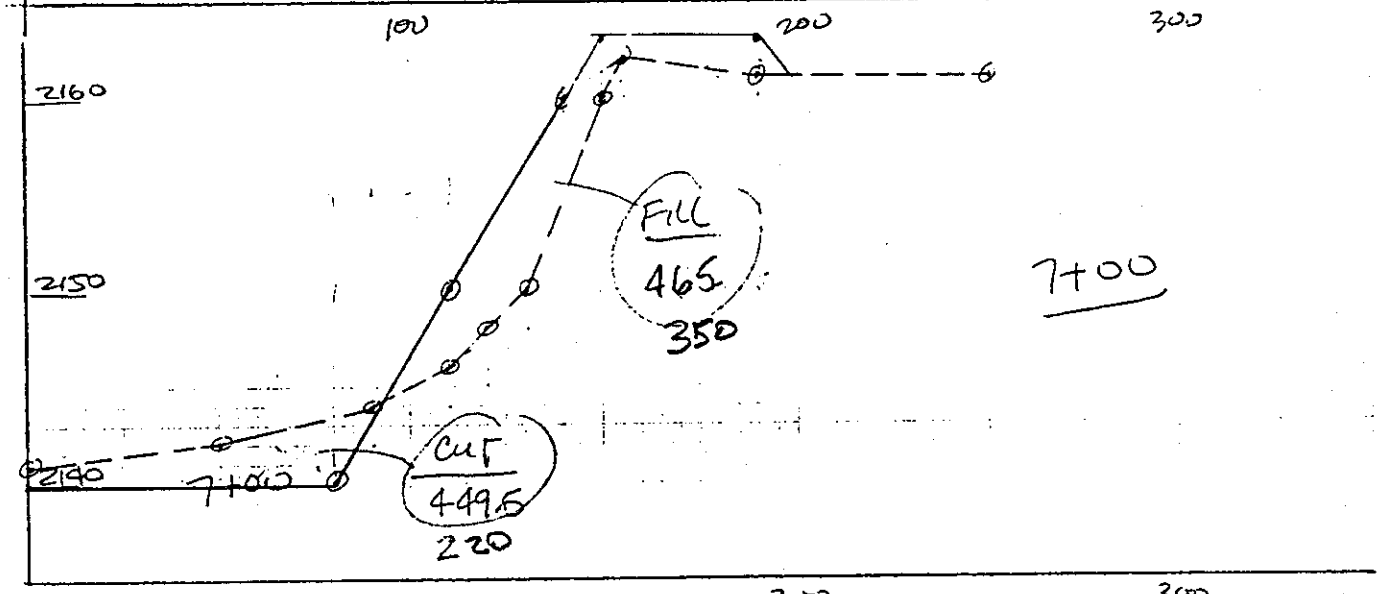
CH2M HILL

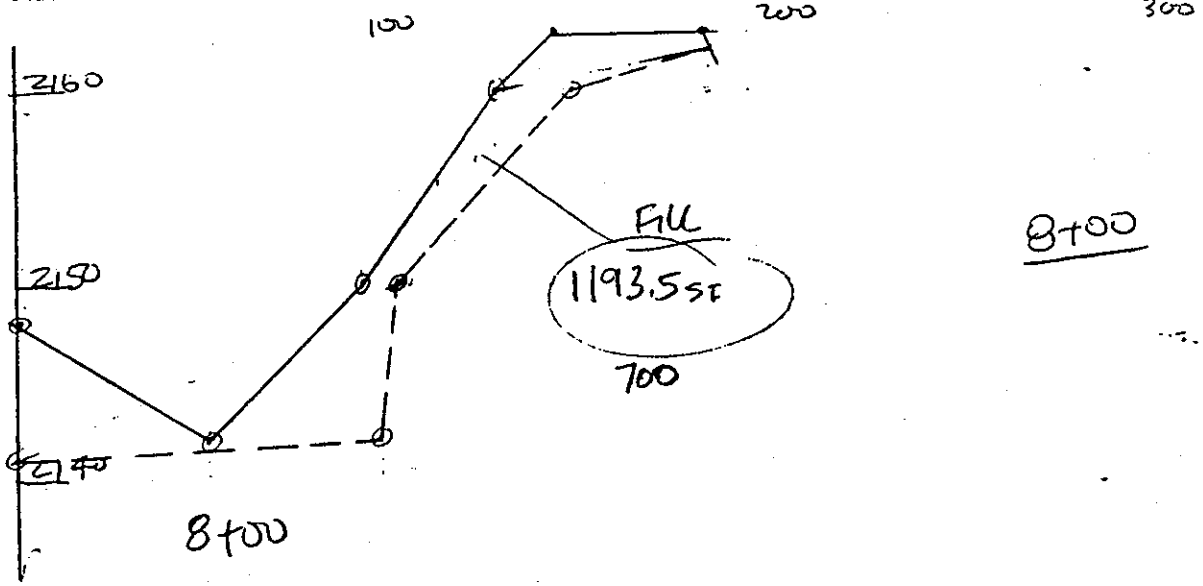
SUBJECT _____ BY _____

SHEET NO. 4 of 4 DATE _____

PROJECT NO. _____







CH2M HILL

SUBJECT _____ BY _____

SHEET NO. 1 of 2 DATE _____

PROJECT NO. _____

RESERVOIR

STA	DIST (FT)	CUT AREA (FT²)	CUT VOLUME (YD³)	FILL AREA (FT²)	FILL VOLUME (YD³)
0+00		108.5		1322.3	
	100		2353.7		2847.2
1+00		1162.5		215.2	
	100		5324.1		915.2
2+00		1712.5		279.0	
	100		6458.0		572.2
3+00		1774.8		30.0	
	100		5583.0		428.7
4+00		1240.0		201.5	
	100		4707.4		688.9
5+00		1302.0		170.5	
	100		4506.5		832.4
6+00		1131.5		279.0	
	100		2181.5		1004.6
7+00		46.5		263.5	
TOTAL RESERVOIR			31,114.2		7,289.2
DAM					
0+00 (BEGIN DAM)		0		1007.5	
	100		0		8869.4
1+00		0		3782.0	
	75		0		14,380.6
1+75 (END DAM)		0		6572.0	
1+75 (BEGIN SPILLWAY)		0		4758.5	
	85		0		14,712.1
2+60 (END SPILLWAY)		0		4588.0	
2+60 (BEGIN DAM)		0		6510.0	
	40		0		8,921.5
3+00		0		5534.0	
	100		0		16,103.7
4+00		0		3162.0	
	100		0		8553.7
5+00		0		1457.0	
	100		688.9		3013.9
6+00		372.0		170.5	
	100		1521.3		1,176.9
7+00		449.5		465.0	
	100		832.4		3071.3
8+00 (END DAM)		0		1193.5	
			3042.6		78,803.1

DEVDAT FORM 1RR

TOTAL VOLUMES	CUT (YD^3)	FILL (YD^3)
RESERVOIR	31,114.2	7,289.2
DAM	3,042.6	78,803.1
	34,156.8	86,092.3
NET (FILL)		51,935.5

CH2M HILL

SUBJECT: DAM ALIGNMENT
PROPOSED GRADE X-SEC.

BY: [illegible]
SHEET NO. 1 of 1 DATE
PROJECT NO.

0+00	2150/90	2148/120	2146/125	2144/140			
1+00	2160/0	2160/65	2158/90	2150/115	2140/150		
2+00	2140/0	2150/35	2160/60	2160/90	2132/185		
1+75	2142/0	2150/25	2160/58	2160/100	2150/130	2140/160	2132/185
spillway							
2+60	2140/0	2150/30	2160/60	2160/100	2150/130	2140/160	2132/185
3+00	2140/0	2150/30	2160/60	2160/100	2150/130	2146/140	2144/170
	2140/190	2134/210					
4+00	2140/0	2150/30	2160/60	2160/130	2152/175		
5+00	2140/5	2150/38	2160/80	2160/255	2152/280		
6+00	2140/70	2150/110	2160/140				
7+00	2140/80	2150/110	2160/140				
8+00	2148/0	2142/50	2150/90	2160/125			

CH2M HILL

SUBJECT: DAM ALIGNMENT
EXST GRND X-SEC

SHEET NO. 1 of 1 DATE
PROJECT NO.

0+00	2150 / 0	2146 / 50	2146 / 90	2144 / 110	2142 / 130	2141 / 155
1+00	2153 / 0	2150 / 30	2140 / 60	2138 / 90	2140 / 130	2140 / 250
2+00	2136 / 0	2134 / 35	2132 / 120	2130 / 230		
3+00	2135 / 0	2134 / 20	2134 / 70	2136 / 80	2138 / 100	2138 / 140
	2140 / 180	2132 / 220	2140 / 250	2144 / 350		
4+00	2138 / 0	2140 / 15	2146 / 45	2148 / 125	2150 / 130	2150 / 270
5+00	2138 / 0	2140 / 20	2150 / 60	2160 / 80	2164 / 120	2164 / 220
	2160 / 240	2152 / 270	2150 / 300			
6+00	2139 / 0	2140 / 40	2142 / 65	2150 / 100	2160 / 160	2162 / 230
	2162 / 370					
7+00	2141 / 0	2142 / 50	2144 / 90	2146 / 110	2148 / 120	2150 / 130
	2160 / 150	2162 / 155	2161 / 190	2161 / 250		
8+00	2141 / 0	2142 / 95	2150 / 100	2160 / 145	2162 / 180	

SUBJECT CHSANDWICH WASH
EXST GRND X-SEC DATA
(See attached Dwg)

BY [illegible]
SHEET NO. 1 of 4 DATE 6/2/94
PROJECT NO. SWW 35441.CV

0+00 2150/0, 2151.7/60, 2150/120, 2140/140, ℄ stream 160 2136/195,
2136/360, 2138/420, 2140/650, 2142/805, 2144/810
2146/820, 2148/825, 2150/830, 2160/840, 2166/850 (2166.7)

1+00 2159/0, 2158/90, 2136/150, ℄ stream 2135 160, 2136/165
2138/170, 2140/175, 2140/225, 2138/450, 2140/630,
2142/760, 2144/765, 2146/770, 2148/775, 2150/780, 2160/795
2168/810,

2+00 2165/0, 2164/85, 2160/90, 2150/110, 2148/125, 2140/140
℄ stream 2137.5 150, 2140/168, 2142/175, 2140/400, 2140/500
2141/570, 2142/640, 2144/715, 2146/725, 2148/730, 2150/740
2160/758, 2170/775, 2170/830

SUBJECT: EXST GRND X-SEC

BY:

SHEET NO. 2 of 4 DATE:

PROJECT NO.:

3+00

2181 / 0	2180 / 10	2170 / 35	2168 / 40	2166 / 45	
2164 / 55	2162 / 60	2160 / 75	2150 / 140	2140 / 150	& STATION 2140 / 170
2142 / 173	2143 / 175	2143 / 205	2143 / 280	2142 / 320	2141.5 / 365
2141.5 / 435	2142 / 515	2144 / 565	2150 / 575	2154 / 585	
2160 / 705	2170 / 720	2172 / 780			

4+00

2180 / 0	2170 / 30	2160 / 45	2150 / 75	2148 / 128	2146 / 138
2144 / 150	2142 / 170	& STATION / 185	2142 / 195	2142 / 330	
2142 / 405	2150 / 500	2160 / 510	2162 / 512	2162 / 540	
2164 / 615	2170 / 620	2173 / 710			

CH2M HILL

SUBJECT: EXST GRND X-SEC

BY:

SHEET NO. 3 of 4 DATE:

PROJECT NO.

5+00

2170 / 0	2160 / 20	2152 / 50	2154 / 60	2151 / 170
2150 / 175	2148 / 180	2144 / 190	℄ STREAM / 200	
2144 / 210	2148 / 220	2148 / 360	2146 / 390	
2148 / 410	2148 / 440	2150 / 450	2152 / 470	
2154 / 520	2156 / 570	2158 / 573	2160 / 575	2170 / 590
2174 / 600	2174 / 640			

6+00

2164 / 0	2160 / 15	2156 / 30	2156 / 45	2158 / 50
2160 / 58	2160 / 75	2158 / 80	2152 / 110	2152 / 150
2152 / 200	2150 / 210	2148 / 215	2146 / 220	℄ STREAM / 230
2146 / 240	2148 / 245	2149 / 385	2150 / 420	2152 / 510
2154 / 535	2156 / 540	2158 / 550	2160 / 560	2170 / 575
2176 / 585	2175 / 680			

CH2M HILL

SUBJECT: EXST GRND X-SEC

SHEET NO. 4 of 4 DATE

PROJECT NO.

7+00

2166 / 0	2170 / 20	2180 / 40	2188 / 85	2180 / 145
2170 / 165	2160 / 220	2158 / 230	2156 / 235	
~~2150 / 245~~	~~2148 / 250~~	~~[illegible] / 260~~	2148 / 265	2150 / 270
2154 / 285	2154 / 320	2152 / 340	2152 / 480	
2154 / 510	2160 / 525	2170 / 545	2178 / 560	2178 / 575
2176 / 650				

CH2M HILL

SUBJECT: [illegible]

PROPOSED GRADE X-SECT.

BY: _____

SHEET NO. 1 of 2 DATE _____

PROJECT NO. _____

0+00

2152 / 15	2154 / 25	2160 / 50	2160 / 100	2150 / 135
2140 / 180	2140 / 480	2140 / 775	2150 / 810	2160 / 840

1+00

2160 / 30	2160 / 70	2150 / 115	2140 / 148	2138 / 165
2136 / 185	2134 / 210	2134 / 570	2136 / 590	2138 / 610
2140 / 725	2150 / 760	2160 / 790		

2+00

2164 / 40	2160 / 70	2150 / 100	2140 / 165	2138 / 190
2136 / 210	2134 / 230	2134 / 530	2136 / 555	2138 / 580
2140 / 580	2150 / 715	2160 / 745		

3+00

2164 / 55	2160 / 70	2150 / 100	2142 / 125	2140 / 215	
2138 / 240	2136 / 260	2134 / 285	2134 / 450	2136 / 480	2138 / 500
2140 / 575	2150 / 625	2160 / 690			

CH2M HILL

SUBJECT: PROPOSED GRADE X-SEC

BY:

SHEET NO. 2 of 2 DATE

PROJECT NO.

4+00	2150 / 0	2170 / 20	2160 / 55	2150 / 90	2144 / 110
	2142 / 140	2142 / 165	2144 / 185	2144 / 250	2142 / 260
	2140 / 265	2138 / 290	2136 / 310	2135 / 360	2136 / 410
	2138 / 435	2140 / 480	2150 / 510	2160 / 570	

5+00	2160 / 30	2150 / 60	2146 / 80	2146 / 210	2146 / 240
	2148 / 285	2146 / 290	2144 / 300	2142 / 308	2140 / 312
	2140 / 500	2150 / 530	2160 / 565		

6+00	2156 / 45	2158 / 70	2156 / 90	2154 / 100	2152 / 110
	2150 / 120	2148 / 135	2148 / 230	2150 / 250	2150 / 330
	2140 / 360	2140 / 485	2150 / 520	2160 / 550	

7+00	2150 / 250	2154 / 290	2154 / 380	2150 / 430	2154 / 480
	2156 / 510	2160 / 520			

Structural Calculations

1" = 100'

DENSE TREES

2170
2160
2150
2140
2134
R=50'
33'(38)
ANT.

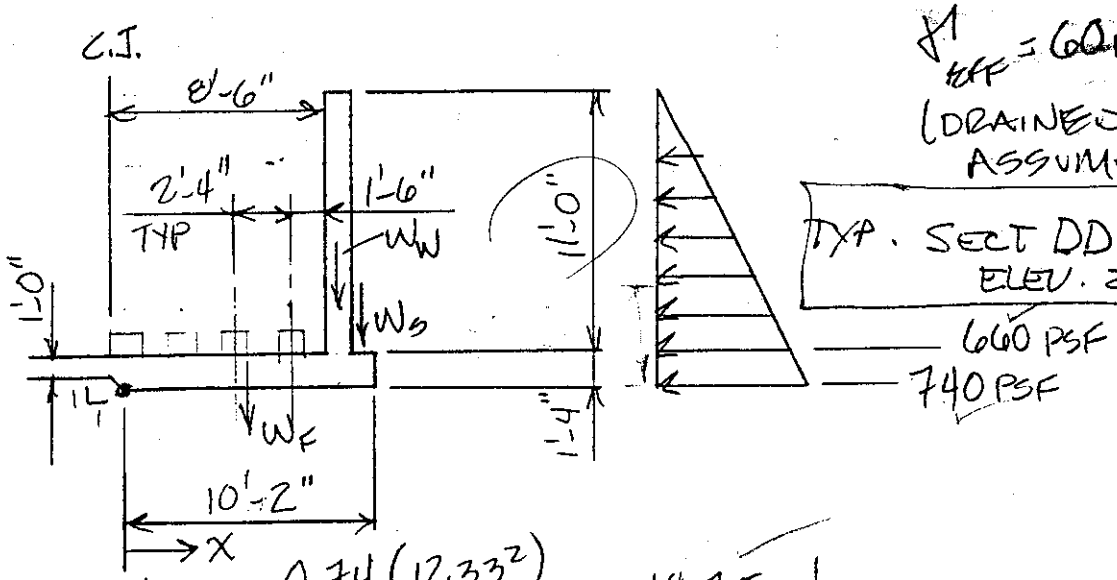
SUBJECT CASANDRO WASH DAM BY MJ COOPER

SHEET NO. 1 of ___ DATE 1/4/95

SPILLWAY — SIDE WALLS PROJECT NO. SWW35441.PS.

γ_{EFF} = 60 PCF (Assumed DRAINED TO EL. 2139)

(DRAINED CONDITION ASSUMED)



TYP. SECT DD DOWN TO ELEV. 2130

$$M_{OT} = \frac{0.74(12.33^2)}{6} = 18.75 \text{ 'k}$$

COMPONENT	WT	X	WT·X
W_W	$= (1)(11)(.150) = 1.65$ K/FT	8.67	14.30
W_F	$= (1.33)(10.17)(.150) = 2.03$ K/FT	5.08	10.32
W_S	$= (1)(11)(.120) = 1.32$ K/FT	9.67	12.76
	$\Sigma = 5.00$		$\Sigma = 37.38 = M_{REST}$

$$SF = \frac{M_{REST}}{M_{OT}} = \frac{37.38}{18.75} = 1.99 \quad \underline{OK}$$

$$\bar{X} = \frac{37.38}{5.00} = 7.48' \; ; \; e = 7.48 - \frac{10.17}{2} = 2.40'$$

$$q = \frac{P}{A} \pm \frac{M}{S} \qquad S = \frac{bd^2}{6} = \frac{1(10.17^2)}{6} = 17.2$$

$$q = \frac{5.00}{10.17} \pm \frac{18.75 - (5.00)(2.2)}{17.2} = \begin{cases} 940 \text{ PSF} \\ 40 \text{ PSF} \end{cases}$$

REV 9/93 FORM 18C

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SUBJECT CHEANDEO WASH DAM BY MJ COOPER
SHEET NO. 2 of ___ DATE 1/11/95
SPILLWAY - SIDE WALLS PROJECT NO. SCWN35441.PS
CH2M HILL

☐ CK DWG

AT BASE OF WALL:

$$M = \frac{(0.66\ KSF)(11')^2}{6} = 13.31\ k/FT$$

$$d = 12'' - 2''\ CLR - \frac{0.88}{2} = 9.56''$$ (#6 ASSUMED)

$a = 1.59$ (LIMIT f_s TO 22 ksi, SPACING) 6" ASSUMED

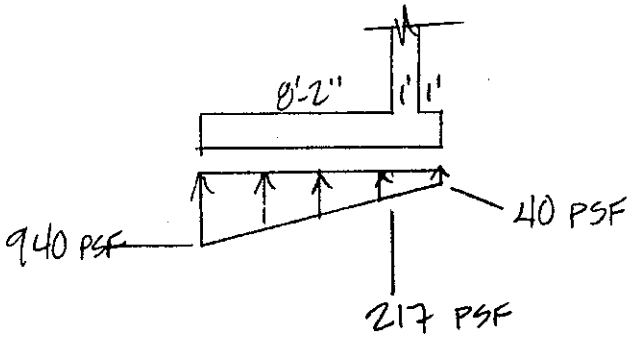
$$A_s = \frac{M}{ad} = \frac{13.31}{1.59(9.56)} = 0.88\ IN^2/FT \therefore \underline{\#6@6}$$

LONGITUDINAL STEEL IN WALL:

$$A_s = (0.0033)(12^2) = 0.48\ IN^2/FT \text{ TOTAL}$$

USE #5@12 EA FACE (0.62 IN^2/FT)

FOOTING REINF:



LONG. REINF:

$$A_s = 0.0033(12)(16) = 0.63\ IN^2/FT$$

SAY #5@12 T&B

AT FACE OF WALL:

$$M = (217\ PSF)\left(\frac{8.17^2}{2}\right) + \left(\frac{1}{2}\right)(723)\left(\frac{2}{3}\right)(8.17^2) = 23.33\ k/FT$$

$$d = 16'' - 3''\ CLR - \frac{0.88}{2} = 12.56''$$

$$A_s = \frac{23.33}{1.59(12.56)} = 1.19\ IN^2/FT \text{ T\&B} \therefore \cancel{\#7@6}$$

OR (1) ADD #7 ~~#6~~@12 TO WALL REINF.

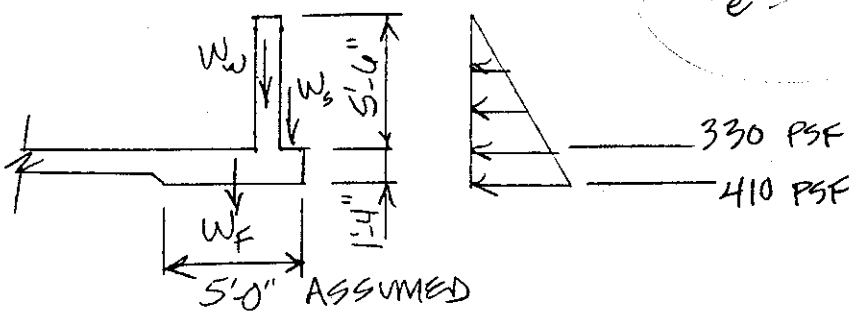
ONLY BOTTOM OR #6@9" FOR FACE

NO $A_s \geq 1.06 = .31 + .31 = \#5@12 + \#6@12$

REV 9/93 FORM T8C.4C

BACKFILL HT VARIES FROM 11' TO 0'. CHECK SECTION @ MID HT

$\gamma_e = 60$ PCF



$$M_{OT} = \frac{0.410(6.83^2)}{6} = 3.19 \text{ k/FT}$$

COMPONENT	WT	X	WT·X
W_W	(1)(5.5)(.150) = 0.82 K/FT	3.5	2.87
W_F	(1.33)(5.0)(.150) = 1.00 K/FT	2.5	2.50
W_S	(1)(5.5)(.120) = 0.66 K/FT	4.5	2.97
	Σ = 2.48		8.34

$$SF = \frac{8.34}{3.19} = 2.61 \quad \underline{OK}$$

$$\bar{X} = \frac{8.34}{2.48} = 3.36' \; ; \quad e = 3.36 - \frac{5.0}{2} = 0.86'$$

$$S = \frac{1(5^2)}{6} = 4.17 \text{ FT}^3$$

$$q = \frac{P}{A} \pm \frac{M}{S}$$

$$= \frac{2.48}{5.0} \pm \frac{3.19 - 2.48(0.86)}{4.17} = \begin{cases} 750 \text{ PSF} \\ 250 \text{ PSF} \end{cases}$$

0.50 0.25

SUBJECT CASANDRO WASH DAM SPILLWAY - ENTRANCE APRON WALLS
BY MJ COOPER
SHEET NO. 4 of ___ DATE 1/11/95
PROJECT NO. SWN35441.PS

AT BASE OF WALL:

$$M = \frac{0.33(5.5^2)}{6} = 1.66 \text{ ik/ft}$$

HT x .060

DO SPECS USE $f_s = 22$ ksi OK IF YES

$$d = 12'' - 2''\text{CLR} - \frac{0.88}{2} = 9.56''$$

#6 ASSUMED

$a = 1.28$ (12" SPACING ASSUMED ∴ $f_s = 18$ ksi)

$$A_s = \frac{1.66}{1.28(9.56)} = 0.14 \text{ in}^2/\text{ft}$$ USE #5@12 MIN

(TEMP. STEEL $= 0.0033(12^2) = 0.48 \text{ in}^2/\text{ft}$

OR $0.24 \text{ in}^2/\text{ft}$ EA FACE)

DETERMINE WALL HT WHERE #5@12 IS ADEQUATE:

$$M = A_s \cdot a \cdot d$$
$$= 0.31(1.36)(9.56) = 4.03 \text{ ik/ft}$$

#5 @ 19 ksi

$$HT = \left[\frac{6(4.03)}{.060 \text{ kcf}}\right]^{1/3} = 7.30' \text{ SAY } 7'-3'' \pm$$

DETERMINE WALL HT WHERE #6@12 IS ADEQUATE:

$$M = 0.44(1.28)(9.56) = 5.38 \text{ ik/ft}$$

#6 @ 18 ksi

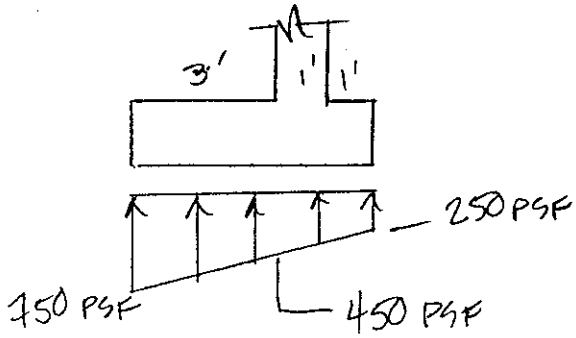
$$HT = \left[\frac{6(5.38)}{0.060 \text{ kcf}}\right]^{1/3} = 8.13' \text{ SAY } 8'-0''$$

∴ TRANSITION FROM #6@6 TO #5@12 DIRECTLY ? #8 AND #6.

REV 9/93 FORM 18C

SUBJECT CASANDRO WASH DAM BY MJ COOPER
SPILLWAY – ENTRANCE APRON WALLS
SHEET NO. 5 of ___ DATE 1/11/95
PROJECT NO. SWN 35441.PS

FOOTING REINF:



AT FACE OF WALL:

$$M = 250\left(\frac{3^2}{2}\right) + \frac{1}{2}(300)\left(\frac{2}{3}\right)(3^2) = 2.03\ ^{\prime}k$$

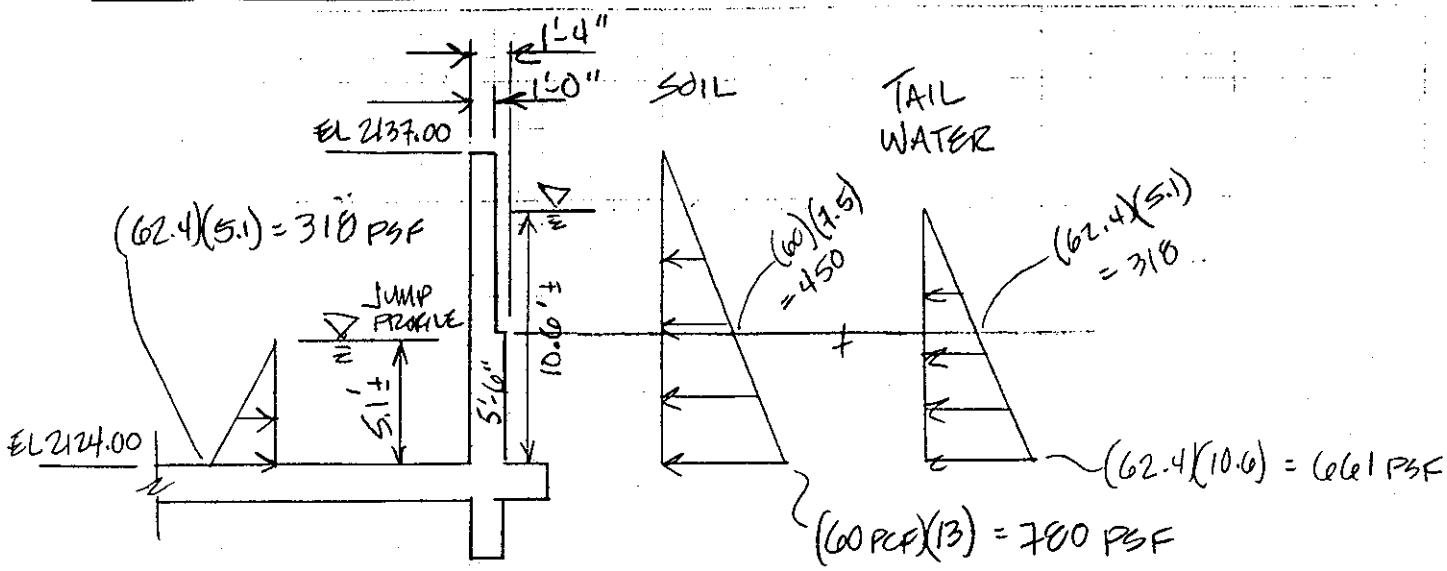
$$d = 12.56''$$

$$A_s = \frac{2.03}{1.36\,(12.56)} = 0.12\ IN^2/FT \quad \text{USE } \#\cancel{5}\ 6\ @\ 12\ MIN$$

T&B

SUBJECT CASANDRO WASH DAM
STILLING BASIN
- SIDE WALLS

BY MJ COOPER
SHEET NO. 6 of ____ DATE 1/17/95
PROJECT NO. SWW 35441.P5



$$M_{BASE} = \underbrace{\frac{(0.780)(13^2)}{6}}_{\text{SOIL}} + \underbrace{\frac{(0.661)(10.6^2)}{6}}_{\text{TAIL WATER}} - \underbrace{\frac{(0.318)(5.1^2)}{6}}_{\text{HYD. JUMP}}$$

$$= 33.0 \text{ k/FT}$$

$$d = 16'' - 2''\text{CLR} - \overset{\#8 \text{ ASSUMED}}{1/2} = 13.5''$$

$a = 1.59$ (f_s = 22 ksi @ 6" ASSUMED SPCG)

$$A_s = \frac{M}{ad} = \frac{33.0}{1.59(13.5)} = 1.54 \text{ IN}^2/\text{FT} \Rightarrow \#8 @ 12''$$

$\boxed{\therefore \#8 @ 6}$

$$M_{STEP} = \frac{(0.450)(7.5^2)}{6} + \frac{(0.318)(5.1^2)}{6} = 5.60 \text{ k/FT}$$

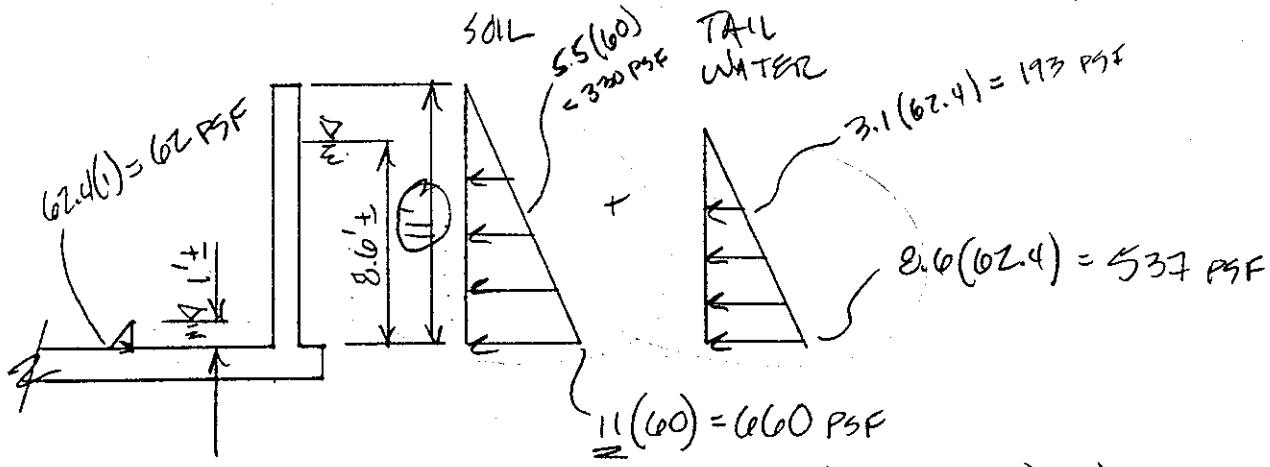
$$d = 12'' - 2''\text{CLR} - \overset{\#8 \text{ ASSUMED}}{1/2''} = 9.5''$$

$a = 1.28$ (f_s = 18 ksi, 12" SPACING)

$$A_s = \frac{5.60}{1.28(9.5)} = 0.46 \text{ IN}^2/\text{FT} \quad \underline{\#7 @ 12}$$

SUBJECT CASANDIKO WASH DAM — STILLING BASIN — SIDE WALLS
BY M J COOPER
SHEET NO. 7 of
DATE 1/18/95
PROJECT NO. SWW3541.PS

CHECK SECTION OF SIDE WALL WHERE THICKENED PORTION OF LOWER STEM ENDS (WHERE TOP OF WALL CHANGES FROM 3:1 SLOPE TO LEVEL)



$$M_{BASE} = \frac{0.660(11^2)}{6} + \frac{0.537(8.6^2)}{6} - \frac{(.062)(1^2)}{6}$$

$$= 19.9 \text{ k/FT}$$

$d \approx 9.5''$, $a = 1.59$ (22ksi, 6" SPCG)

$$A_s = \frac{19.9}{9.5(1.59)} = 1.32 \text{ IN}^2/\text{FT}$$

USE #8@6

0.66 = #8@12"

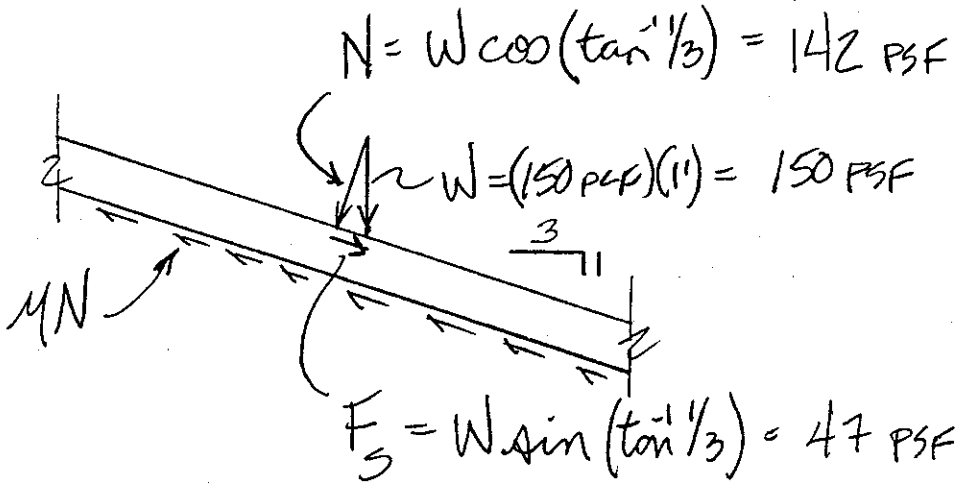
CHECK $M_{MID-HT} = \frac{0.330(5.5^2)}{6} + \frac{0.193(3.1^2)}{6} = 1.97$ k/FT

SUBJECT CASANDRO WASH DAM BY MJ COOPER

SHEET NO. 8 of ____ DATE 1/27/94

FLOOR SLAB PROJECT NO. SNW 35441.P5

SLIDING CHECK

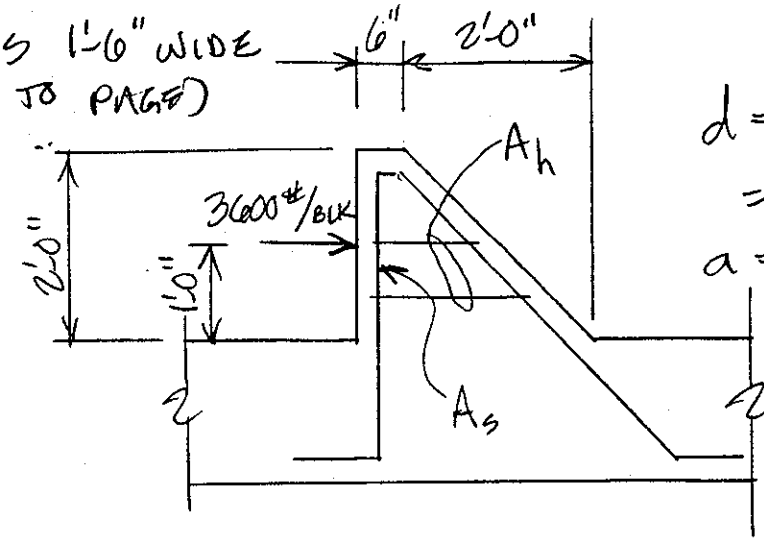


RESISTANCE = μN

$= 0.4(142 \text{ PSF}) = 57 \text{ PSF}$

SAFETY FACTOR $= \dfrac{57 \text{ PSF}}{47 \text{ PSF}} = 1.21$ O.K.

BLOCK IS 1'-6" WIDE
(NORMAL TO PAGE)



$d = 30" - 2" \text{ CLR} - \frac{1}{2}"(\pm)$
$= 27.5"$
$a = 12"$

$\frac{a}{d} = 0.44 < 1.0$

FOR WORKING STRESS APPROACH

USE 55% OF MAXIMUM STRENGTH FOR SHEAR AS GIVEN IN ACI CH. 11 (ACI A.7.8)

$$\phi V_n \leq 0.55 \left[\phi f'_c b_w d\right]$$
$$\leq 0.55 \left[0.85 (4000 \text{ psi})(18)(27.5)\right]$$
$$\leq 925^k >> 3.6^k$$

• A_f TO RESIST MOMENT

$$M = \left[Va + N(h-d)\right] \qquad N = 0.2V$$
$$= \left[3.6\left(\tfrac{12}{12}\right) + 0.2(3.6)\left(\frac{30-27.5}{12}\right)\right] = 3.75 \text{ ik}$$

$a = 1.59$ (6" SPACING)

$$A_f = \frac{3.75}{1.59(27.5)} = 0.09 \text{ IN}^2$$

• A_n TO RESIST TENSILE FORCE

$$A_n = \frac{N}{0.55 f_y}$$

$$= \frac{0.2(3.6^k)}{0.55(60)} = 0.02 \text{ IN}^2$$

• A_v TO RESIST SHEAR

$$A_v = \frac{V}{0.55 f_y}$$

$$= \frac{3.6}{0.55(60)} = 0.11 \text{ IN}^2$$

• $$A_s = \left\{ \begin{array}{l} (A_f + A_n) \\ (2A_v/3 + A_n) \end{array} \right\}_{MAX}$$

$$= \left\{ \begin{array}{l} (0.09 + 0.02) = 0.11 \text{ IN}^2 \\ \left(2\frac{(0.11)}{3} + 0.02\right) = 0.09 \text{ IN}^2 \end{array} \right\}_{MAX = 0.11 \text{ IN}^2}$$

USE <u>3 #6</u> FOR "TOUGHNESS"

• $A_h = 0.5(A_s - A_n)$

$= 0.5(0.11 - 0.02) = 0.05 \text{ IN}^2$ USE <u>2 #5</u> MIN

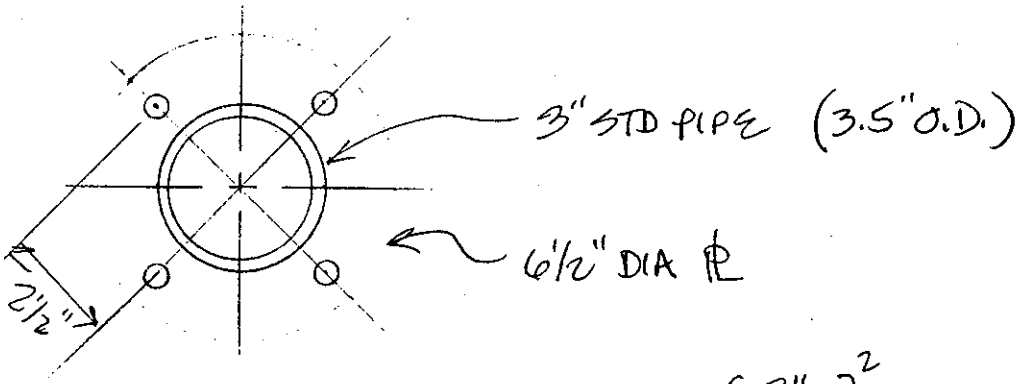
SUBJECT CASANDRO WASH DAM BY MJ COCKERL
SHEET NO. 11 of ____ DATE 1/25/95
FENCE MOUNT DETAIL PROJECT NO. SWW35441.P5

FENCE ON WALL

ASSUME BOLTS TO DEVELOP YIELD IN POST

$$M_{YIELD} = F_y S$$
$$= (36\,ksi)(1.72\,in^3) = 61.9\ k\text{-}in$$

TRY 4 BOLTS



$$I_{BOLT\ GROUP} = \Sigma d^2 = 4\left[\frac{2\tfrac{1}{2}}{\sqrt{2}}\right]^2 = 12.5\,in^2$$

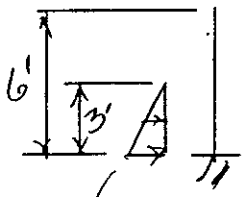
$$\frac{Mc}{I} = \frac{61.9\left(2\tfrac{1}{2}/\sqrt{2}\right)}{12.5} = 8.75^k$$

∴ 3/4" ϕ A307 BOLT
(8.8^k ALLOWABLE)

SUBJECT CASANDRO WASH DAM BY MJ COOPER
SHEET NO. 12 of ____ DATE 1/25/95
FENCE MOUNT DETAIL PROJECT NO. SWW35441.PS

FENCE ON APRON

ASSUME BOLTS TO FAIL WITH STATIC HEAD HALFWAY UP FENCE



$(62.4)(3) = 187$ PSF

$$M = \frac{0.187(3^2)}{6}(10' \text{ TRIB}) = 2.8 \text{ k}$$
$$= 33.7 \text{ k-IN}$$

$$\frac{Mc}{I_{BOLTS}} = \frac{33.7(2\tfrac{1}{2}/\sqrt{2})}{12.5} = 4.8^k$$

4 BOLTS

$$A_{YIELD} = \frac{4.8^k}{36 \text{ ksi}} = 0.13 \text{ IN}^2$$

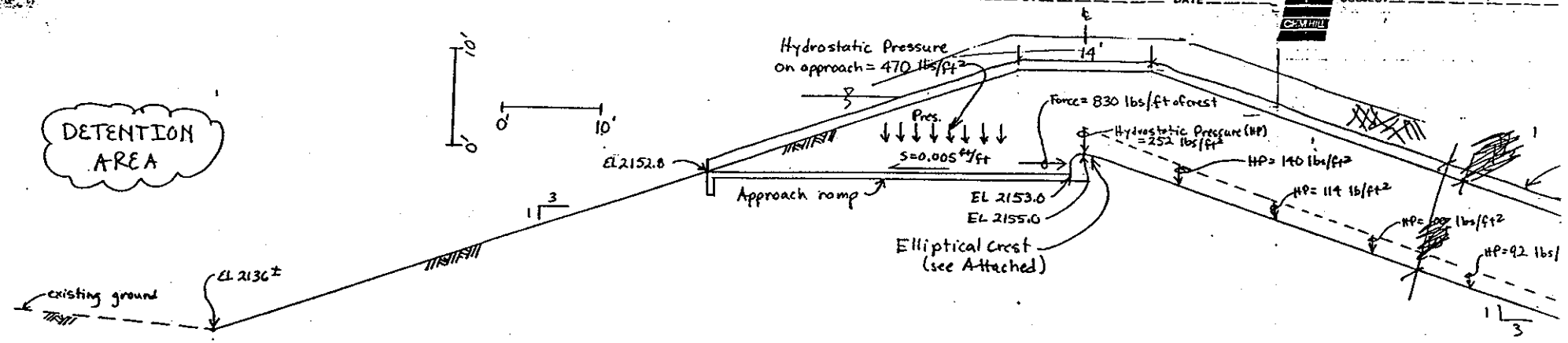
$$3/8'' \phi \text{ BOLT} = \frac{\pi(0.375^2)}{4} = 0.11 \text{ IN}^2$$

OK

REV 9/93 FORM 18C

PROJECT NO. _____ BY _____ DATE _____ SHEET NO. ____ OF ____ SUBJECT _____

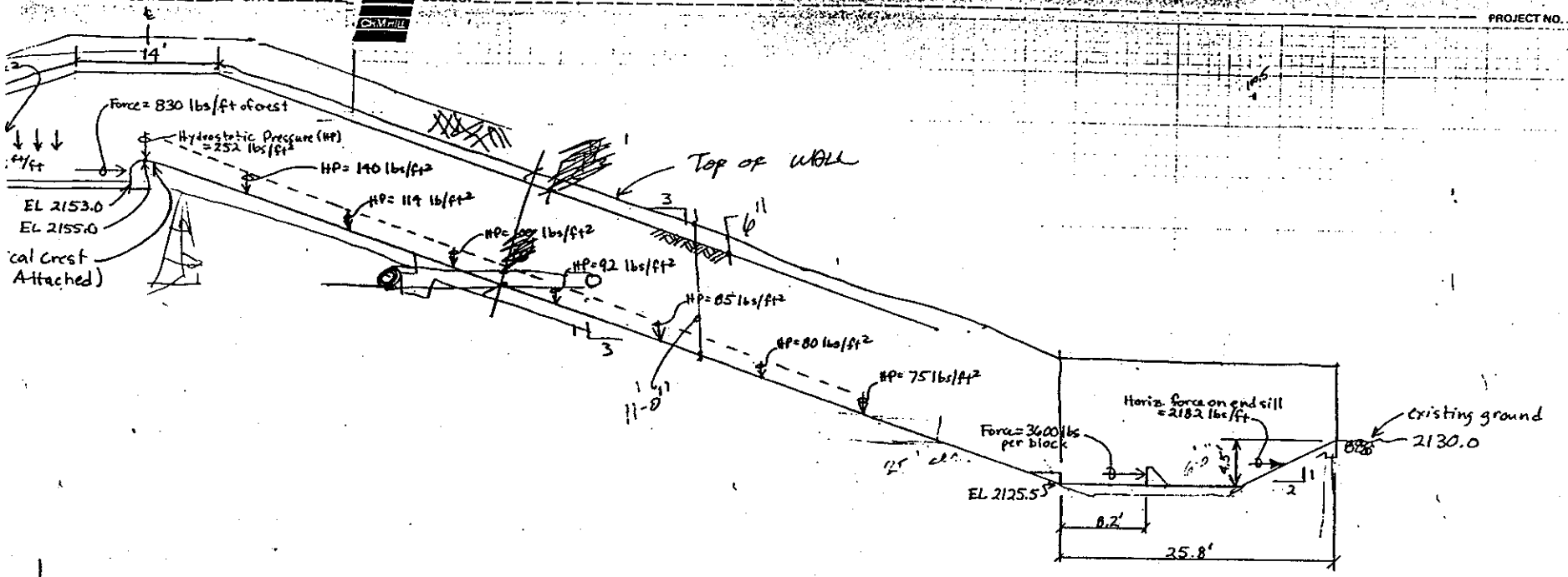
CH2M HILL



1" = 10'

SHEET NO. ____ OF ____

BY ____ DATE ____ SUBJECT ____ PROJECT NO. ____

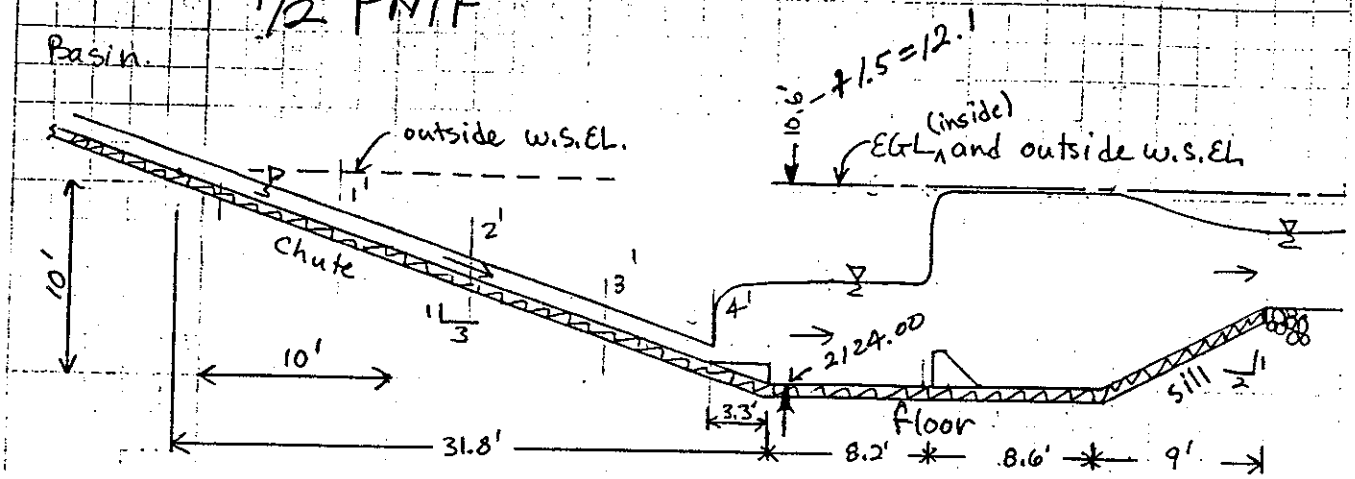


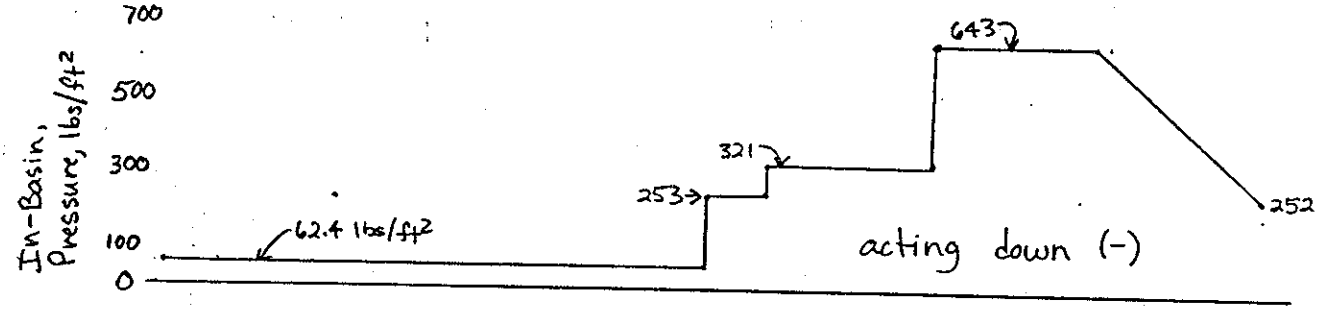
For vertical forces and hydrostatic pressures, see attached.

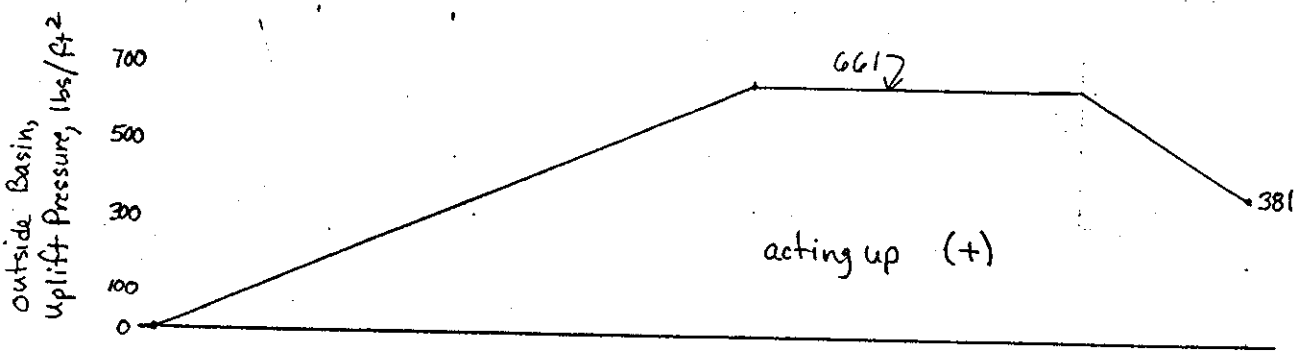
Results - forces per foot of basin width and hydrostatic pressures
- momentum forces are shown but are not factored into the hydrostatic pressures because their distribution is unknown.

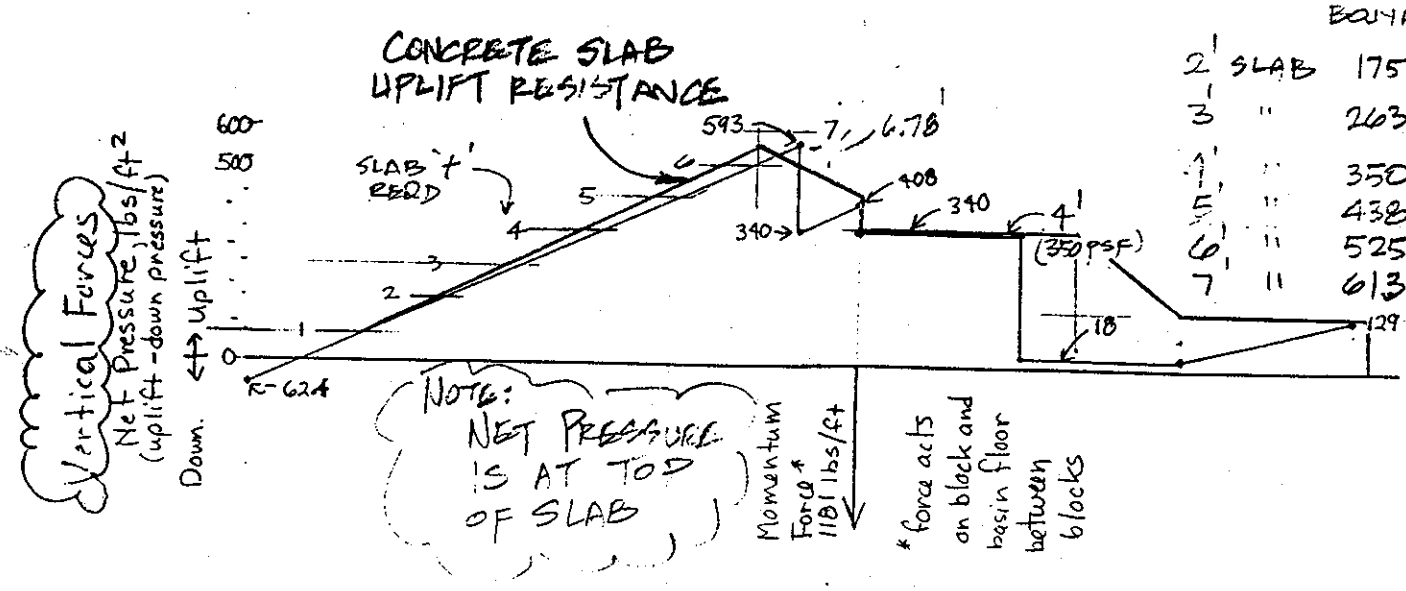
1/2 PMF

Basin.









	BOUYANT WT.
2' SLAB	175 PSF
3' "	263
4' "	350
5' "	438
6' "	525
7' "	613

MEMORANDUM

CH2M HILL

TO: Bob Morrison Sr./RDD

COPIES: Steve Walker/PHX
Tom Wolf/PHX

FROM: John Livingston/PHX

DATE: January 9, 1995

SUBJECT: Final Geotechnical Recommendations
Casandro Wash Spillway and Stilling Basin

PROJECT: SWW35441.GT.30

The spillway for the Casandro Wash Dam will consist of an 80 feet wide opening in the center of the earthfill dam. The height of the opening is approximately 8.5 feet below the crest of the dam. Vertical walls will form the sides of the opening. An ogee crest will be constructed at approximately the centerline of the dam. Retaining walls approximately 11 feet high will form the sides of the chute. A stilling basin approximately 6 feet deep below the downstream channel invert will be constructed at the downstream toe of the dam. Dragons teeth concrete chute blocks will slow the water down and cause a hydraulic jump under the design flows. A concrete slab will form the floor of the chute and stilling basin.

Spillway Entrance Walls and Footings

At the crest of the dam beneath the ogee crest a cutoff wall should be constructed under the concrete slab extending to a depth of 5 feet below the base of the slab. Laterally, the cutoff wall should extend 8 feet beyond the outside of the chute walls into the embankment fill. To the extent possible this wall and all footings in the spillway entrance area should be poured neat against compacted embankment material. All wall footings should be sized for a vertical dead load pressure not to exceed 1500 psf with a one third increase allowed for short term loading caused by wind or seismic forces. Where footings will be close to the upstream face of the dam the footings should be buried sufficiently deep to allow their zone of influence to be entirely within the embankment and not closer to the upstream face than 4 feet. This will allow for some erosion and still provide for adequate embedment. The footing influence zone is a line at 1 horizontal to 1 vertical downward and outward from the base of the footings.

Entrance walls allowed to rotate should be designed for an active earth pressure of 60 pcf per foot of depth. These walls will have compacted embankment backfill with no drainage system. Water will seep behind the walls when the spillway is operating. The water will seep out as the reservoir drains. No large unbalanced water pressures are anticipated.

Chute Walls

Drainage will be provided under the chute floor slab with an 8-inch thick granular material.

This drainage layer will wrap around the wall footing and up the chute walls about 2 feet and will prevent hydrostatic pressure from occurring in the chute wall backfill. The chute walls should also be designed for an earth pressure of 60 psf per foot of depth. The drainage system for the chute slab will tie into the chimney drain near the top of the chute. Other outlet pipes will be provided near the main construction joints.

Stilling Basin Walls

In the stilling basin the retaining walls may be designed for a passive resistance of 175 pcf per foot of depth. The soil backfill behind the walls may become nearly saturated when the stilling basin is operating at maximum flow but the soil should drain as the water in the stilling basin drains. With no water in the stilling basin the lateral earth pressure is anticipated to be 60 psf per foot of depth. Backfill soil unit weight is approximately 115 pcf.

An underdrain system is planned for the floor of the stilling basin which will remove uplift pressure on the floor slab. No weep holes will be required in the floor slab. Water will exit the underdrain system through pipes that penetrate the stilling basin walls.

Sliding resistance can be computed by multiplying the footing pressure by a friction coefficient of 0.4.

18

MEMORANDUM

CH2M HILL

Post-it™ brand fax transmittal memo 7671	# of pages ▸
To Mike Cooper/RDD	From John Livingston
Co.	Co. PHX.
Dept.	Phone #
Fax #	Fax #

TO: Steve Walker
Bob Morrison

FROM: John Livingston

DATE: January 12, 1995

SUBJECT: Casandro Wash Dam Stilling Basin Uplift Analysis

PROJECT: SWW35441.PS

I have performed an uplift analysis for the stilling basin and spillway chute for Casandro Wash Dam. This memo presents the analysis and recommendations for drainage.

Stilling Basin Analysis and Recommendations

Water will occupy the stilling basin from direct precipitation, flow from the outlet pipe, and flow over the spillway. The flow from direct precipitation and from the outlet pipe will be relatively calm flows and no hydraulic jump is anticipated. The water will simply fill up the stilling basin and go over the downstream lip of the stilling basin into the natural stream channel. The stilling basin will gradually drain through the low level gravity outlet at the bottom of the stilling basin.

When the spillway operates at the design flow of 0.5 PMF a hydraulic jump will occur in the stilling basin. The hydraulic jump will appear as a series of waves which rise up to a maximum water depth of approximately 10.6 feet based on the hydraulic calculations. I understand that no rip rap will be provided so significant erosion will occur when the flows are high enough to carry off the sandy soil. A concrete cutoff wall has been provided to prevent scour from undermining the stilling basin. As the spillway operates water will tend to seep into the ground downstream of the stilling basin. Seepage will move under the cutoff wall and may reach the underside of the stilling basin floor. This condition will take one or more days to develop if the ground is dry but if the outlet has been flowing for a couple of days then the ground will already be partially saturated and the seepage pressures will develop much quicker.

The magnitude of the seepage or uplift pressure could equal the maximum water surface in the hydraulic jump which was taken to be Elevation 2134.6. With the floor of the stilling basin at Elevation 2122.5 the maximum uplift pressure is estimated to be 755 psf. This force will be resisted by the weight of the concrete and overlying water in the stilling basin.

The calculated pressure distributions under the stilling basin are shown on the attached two figures. For the specific water surface and hydraulic jump shape shown the factors of safety against uplift were plotted. With no drainage, the factor of safety was 0.4 in one area of the basin and safety factors below one were calculated for quite large areas. It

19

would take up to approximately 3 additional feet of concrete added to the floor to resist the undrained uplift pressures. The cost for the added concrete is on the order of $20-30,000. This is much higher than for an underdrain system and therefore an evaluation was made of the uplift pressures with an underdrain system.

The attached figures show the general layout for relieving pressures under the stilling basin and part way up the spillway chute. A 12-inch thick layer of granular filter material similar to the chiminey drain material would be placed under the horizontal portion of the stilling basin and up to Elevation 2134 on the spillway chute. Several slotted PVC pipes would be placed in the drain material to convey the seepage water to an outlet located in the chute wall at the invert Elevation 2126.0 This drain pipe would have no valves and would only require a screen to prevent rodents from eating and nesting in the pipe. When the spillway operates the pipe would not have any flow until the hydraulic pressure under the slab was equal to Elevation 2126. Based on the attached figures the minimum factor of safety would be 1.3 with the underdrain system normally operating. Should the system deteriorate due to contamination of the filter material with silt then the safety factor could drop to 0.8 over a small area of the basin, however this possiblilty is quite low and any silt that enters the underdrain will likely flush out when the seepage water is discharged. this is an appropirate system for the low frequency that the spillway will be used.

Spillway Chute Analysis and Recommendations

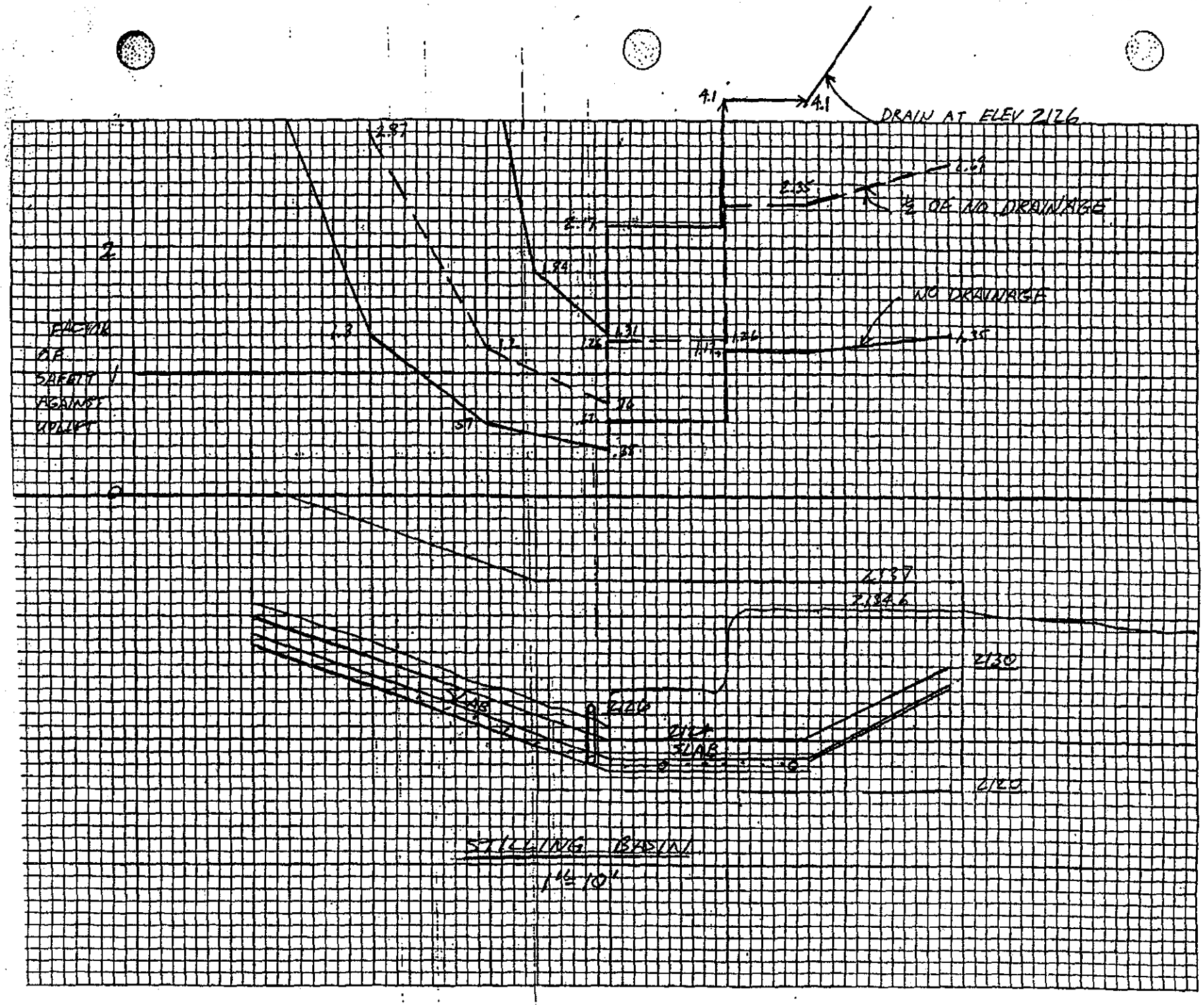
The soil underlying the spillway chute will be embankment material which is a silty sandy soil. The spillway will have a 3:1 slope. The concrete slab will have joints with waterstop material so that seepage through the joints will not occur. The only way seepage could get under the slab is if cracks occur and water seeps into the underlying embankment. This condition is very undesirable because the water could migrate along the soil-concrete interface and build up hydrostatic pressure which could cause the slab to crack or be lifted up. The 12-inch slab can only resist 2.4 feet of water pressure before it is lifted, therefore it is very important that the seepage pressure be minimized under the chute slab.

An 8-inch thick granular filter drain will be provided under the chute slab. This zone will convey seepage water to outlet pipes extending through the chute walls. The outlets will be positioned sufficiently high on the walls to prevent backflow of the water in the chute. The drainage layer will also serve an important function of providing a surface on which to place the rebar and concrete. The sandy embankment soil would be severely disturbed and hard to walk on without a granular drainage layer. The drainage layer will also serve as a filter to prevent silt particles from being sucked up through cracks in the slab. This would occur if negative pressures developed at vertical offsets in the slab and soil particles were sufficiently small to be carried up through the cracks.

CH2M HILL

SUBJECT: CASANDRO WASH
STILLING BASIN

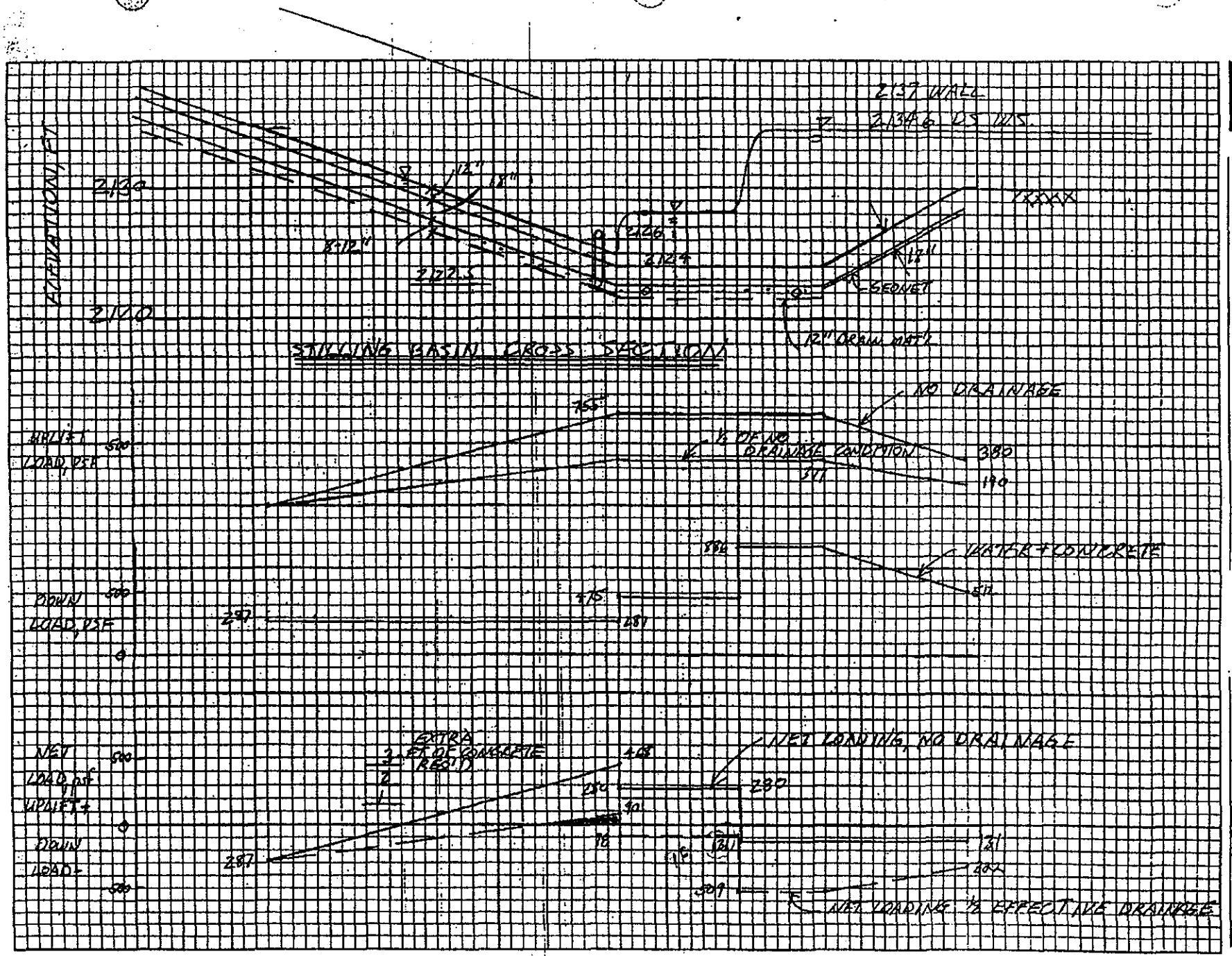
BY: T. KIRKPATRICK
SHEET NO. 20 of
DATE 1/12/95
PROJECT NO. SUW 3544.F3



CH2M HILL

SUBJECT CASAWALPA WASH
STILLING BASIN

BY T. Livingston
SHEET NO. 21 of ___ DATE 1/12/95
PROJECT NO. SWW 35441.P5



CH2M HILL

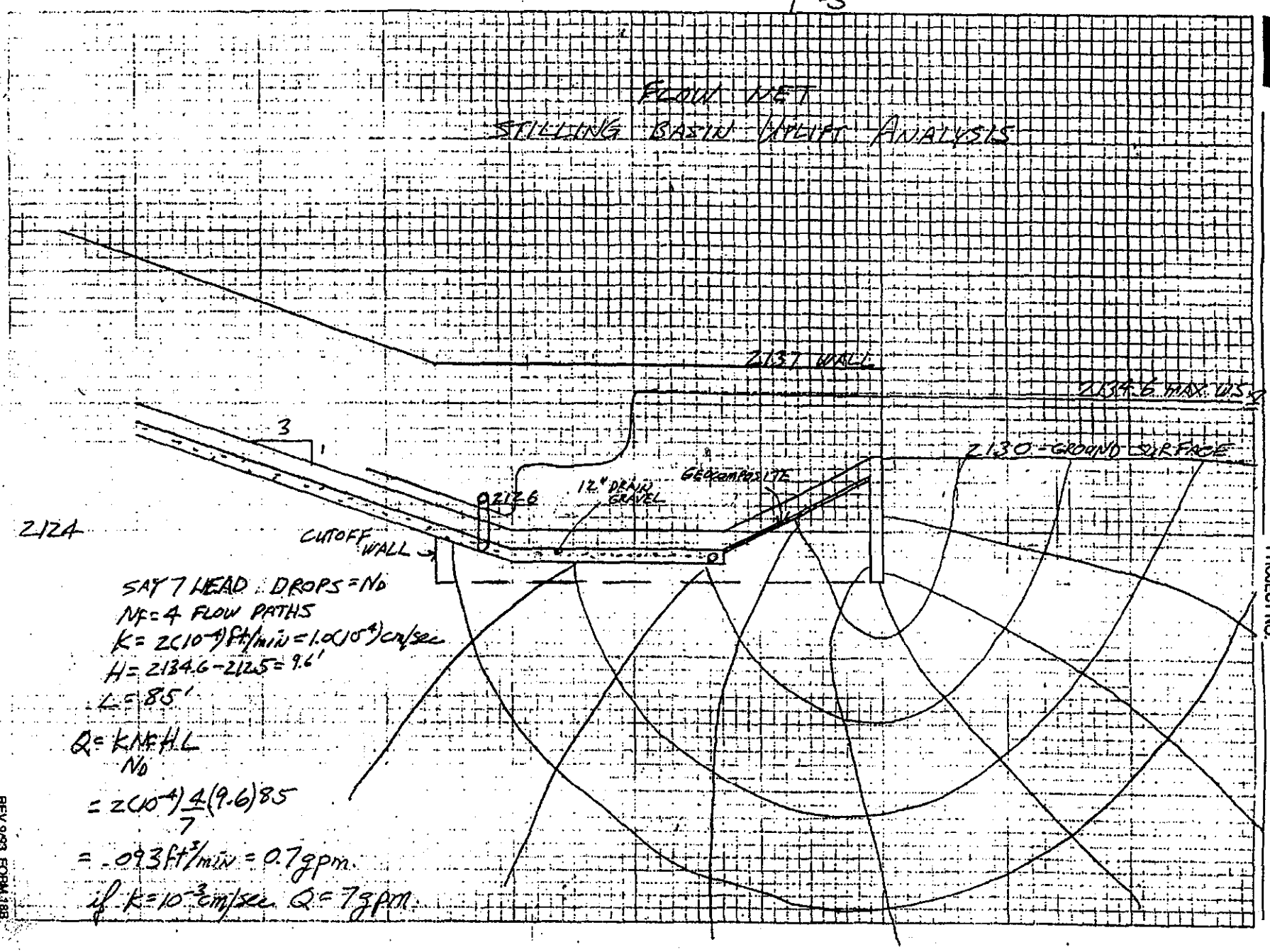
SHEET NO. 11 of ___ DATE ___

PROJECT NO. ___

1" = 5'

FLOW NET

STILLING BASIN UPLIFT ANALYSIS



SAY 7 HEAD DROPS = N_D

$N_F = 4$ FLOW PATHS

$K = 2(10^{-4})$ ft/min $= 1.0(10^{-4})$ cm/sec

$H = 2134.6 - 2125 = 9.6'$

$L = 85'$

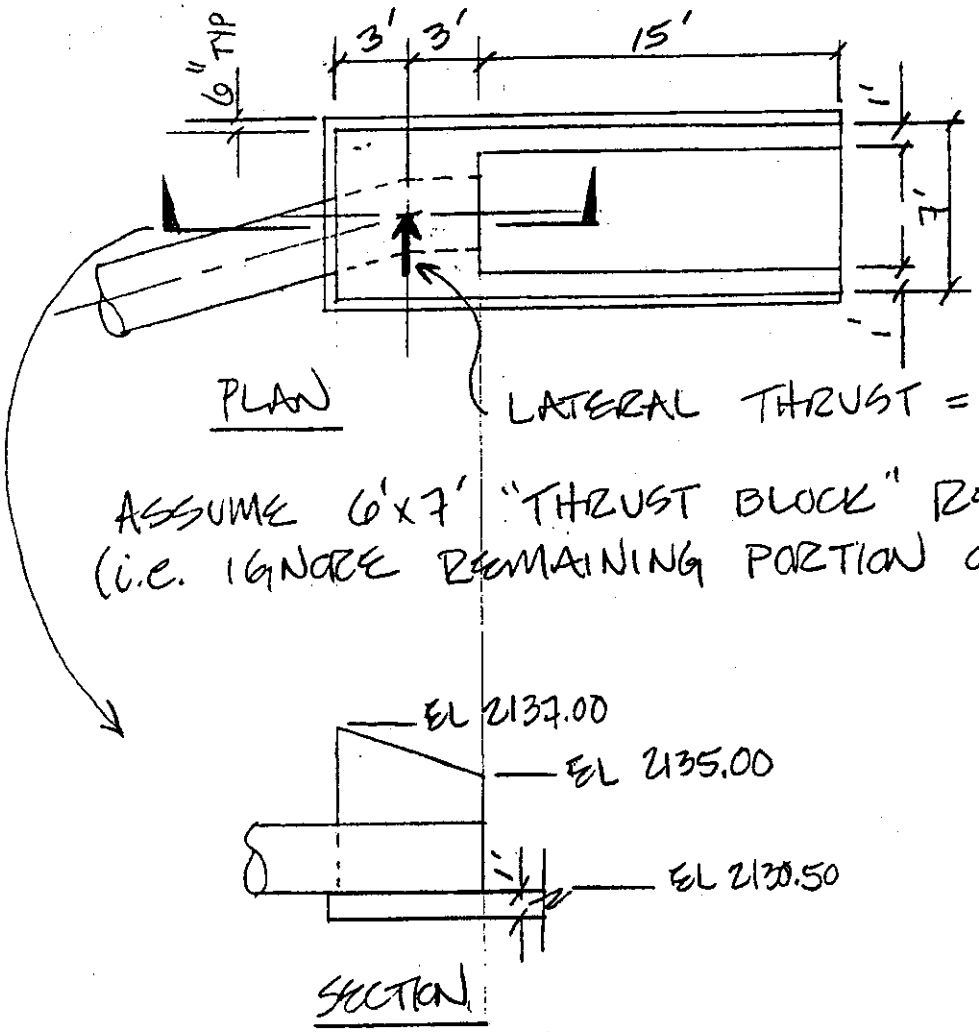
$Q = K N_F H L / N_D$

$= 2(10^{-4}) \frac{4}{7} (9.6) 85$

$= .093$ ft³/min $= 0.7$ gpm.

if $K = 10^{-3}$ cm/sec $Q = 7$ gpm.

OUTLET STRUCTURE



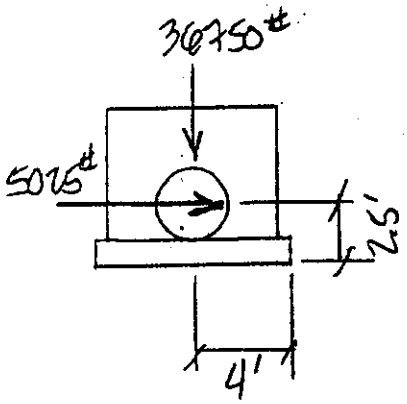
LATERAL THRUST = 5025#

ASSUME 6'x7' "THRUST BLOCK" RESISTS FORCE:
(i.e. IGNORE REMAINING PORTION OF STRUCTURE)

$$\text{CONC. VOLUME} \simeq \underbrace{\tfrac{1}{2}(6.5+4.5)(6')(7')}_{\text{BLOCK}} - \underbrace{\tfrac{\pi}{4}(3^2)(6')}_{\text{PIPE}} + \underbrace{(7')(8')(1')}_{\text{FTG}}$$

$$= 245\ \text{FT}^3$$

$$WT = (245\ \text{FT}^3)(150) = 36{,}750\ \#$$



$$M_{OT} = (5025)(2.5) = 12{,}560\ '\#$$

$$M_{REST} = (36{,}750)(4) = 147{,}000\ '\#$$

$$SF = \frac{147{,}000}{12560} = 11.7 \quad \underline{\underline{OK}}$$

SLIDING:

$$\text{RESISTANCE} \simeq 0.4(36750) = 14{,}700^{\#}$$

$$SF = \frac{14700}{5025} = 2.9 \quad \underline{\underline{OK}} \quad (\text{IGNORING PASSIVE!})$$

BEARING PRESSURE

$$S = \frac{bd^2}{6} = \frac{(7')(8')^2}{6} = 74.7\ FT^3$$

$$\frac{P}{A} \pm \frac{M}{S} \simeq \frac{36750^{\#}}{(7')(8')} \pm \frac{12560'^{\#}}{74.7\ FT^3}$$

$$= 656 \pm 168 = \begin{cases} 824\ PSF\ MAX \\ 488\ PSF\ MIN \end{cases}$$

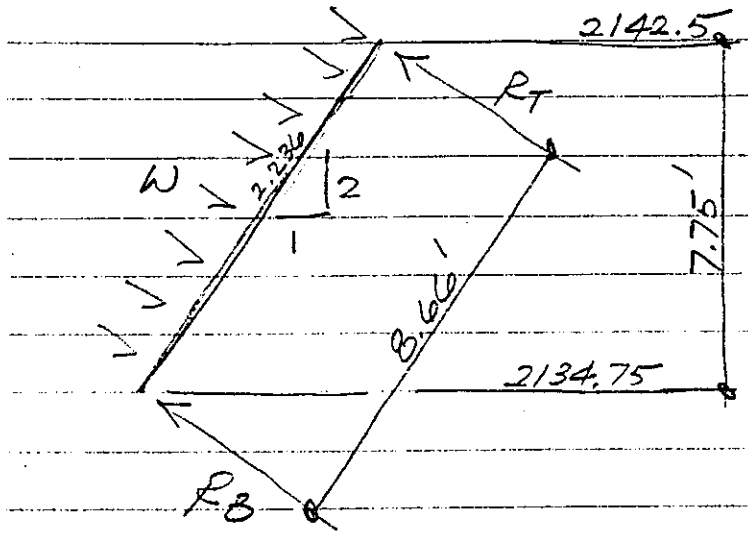
$\underline{\underline{OK}}$

CH2M HILL

BAR SCREENS
CASANDRO DAM

SHEET NO. 1 of ___ DATE 1/23/95
PROJECT NO. ___

R. MORRISON SR.



LOADING – ASSUME RACK PARTIALLY BLOCKED TO DEVELOP 25% OF 1/2 PMF HEAD

$$\frac{2160 - 2134.75}{4} = 6.31'$$

USE 10' HD. DIFF.

$P = 10 \times 62.5\ \#/CF = 625\ \#/ft^2$

(40% HD DIFF.

BARS @ 4" O.C.

$W = .33' \times 625\ \#/ft^2 = 206\ \#/'$

$$R_T = R_B = \frac{206 \times 8.66'}{2} = 892\ \#$$

$$M = \frac{206 \times 8.66^2}{8} = 1931\ '\#\ \times \frac{12''/'}{1000} = 23.17\ ''K$$

TRY 3/8" × 4" BAR

$$S = \frac{.375 \times 4^2}{6} = 1.00\ in^3$$

$$f_b = \frac{M}{S} = \frac{23.17\ ''K}{1.0\ in^3} = 23.17\ KSI$$

$F_b =$

REV 7/84 FORM 3

REV 9/93 FORM 18B

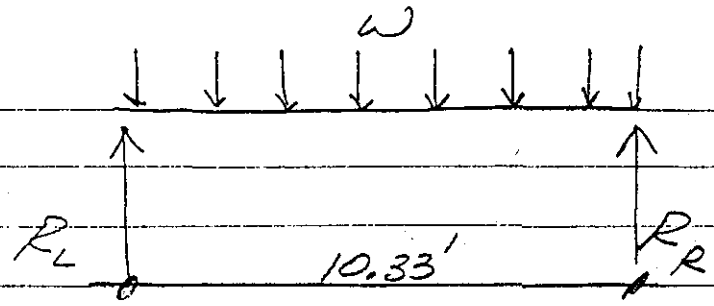
CH2M HILL

BAR SCREENS
CASANDRO DAM

SHEET NO. 2 of ____ DATE 1/23/95
PROJECT NO. ____

R. MORRISON JR.

(OFFICE)



USE SAME BLOCKED HD. DIFF. AS SLOPED RACK

$P = 625\ \#/ft^2$

BARS @ 2" OC.

$$w = .17' \times 625\ \#/ft^2 = 106\ \#/ft$$

$$R_L = R_R = \frac{106 \times 10.33'}{2} = 547\ \#$$

$$M = \frac{106 \times 10.33^2}{8} = 1414'\#' \times \frac{12''/'}{1000} = 17.0''k$$

TRY 3/8" x 4" BAR $S = 1.00\ in^3$

$$f_b = \frac{17.0''k}{1.00\ in^3} = 17.0\ ksi$$

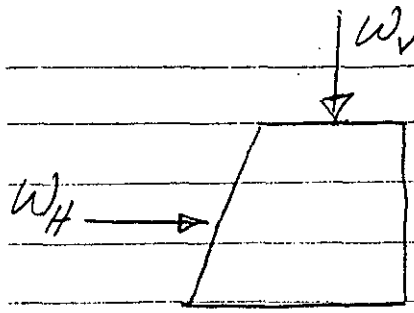
REV 7/84 FORM 3

CH2M HILL

BAR SCREEN
CASANDRO DAM

SHEET NO. 3 of 3 DATE 1/23/95
PROJECT NO.

R. MORRISON Sr.
(OFFICE)



CONCRETE BEAM

LOAD W_V

HORIZ. RACK $= 625^{\#/ft^2} \times \frac{10.33'}{2} = 3228^{\#/'}$

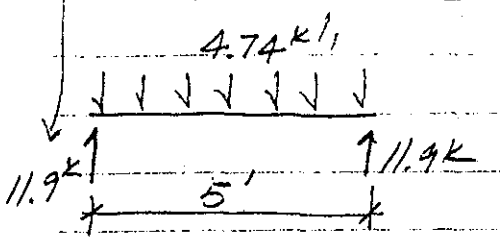
VERT RACK $= 625^{\#/ft^2} \times \frac{8.66'}{2} \times \frac{1}{2.236} = 1210^{\#/'}$

$v = \frac{11.9^k}{13.5 \times 12} = .074$ WT. BM. $\cong 1' \times 2' \times 150^{\#/ft^3} = 300$

$f_v = 1.1\sqrt{f'_c} = 69.6$ USE #3@8"

$4738^{\#/'}$

VERTICAL DESIGN – W_V.



$M = \frac{4.74 \times 5^2}{8} = 14.8^{'k}$

$d_b = \sqrt{\frac{75 \times 14800^{'k}}{72 \times 300}} = 7.02''$ $d_a \cong 13.5$

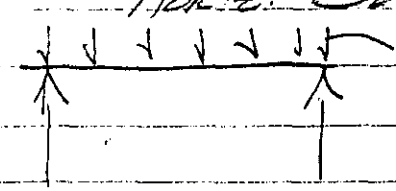
$f'_c = 4000$ psi
$f_y = 60{,}000$ psi

$A_s = \frac{14.8}{13.5 \times 1.76} = .62 \text{ in}^2$

USE $3^{\#}6$

$A_s = 1.32 \text{ in}^2$

HORIZ. DESIGN – W_H



$w = 2 \times 1210^{\#/'} = 2420^{\#/'}$

$M = \frac{2.42 \times 5^2}{8} = 7.56$ $d \cong 10''$

$A_s = \frac{7.56}{1.76 \times 10} = .43 \text{ in}^2$ $2^{\#}6$

$A_s = .88$

REV 7/84 FORM 3

REV 9/93 FORM 18B

CH2M HILL

CASANDRO DAM

SHEET NO. 1 of 1 DATE 1/21/95

PROJECT NO.

R. MORRISON SR.

ORIFICE PLATE

$$H_D = 25' \times 62.5 = 1563\ \#/ft^2 \times \frac{ft^2}{144\ in^2} = 10.85\ psi$$

LONGEST CANTILEVER DIST. 6"

$$M = 10.85\ \#/in^2 \times \frac{6^2}{2} = 195\ ''\#$$

1½" PL $\quad S = \frac{1'' \times .5^2}{6} = .0417\ in^3$

$$f_b = \frac{195''\#}{.0417} = 4676\ psi \quad OK.$$

TOTAL IN FORCE

$$F_i = 20'' \times 21'' - \frac{\pi \times 16^2}{4} = 219\ in^2 \times 10.85$$

$$= 2376\ \#$$

CLAMPING FORCE

$$F_c = (32'' \times 27'') - (20'' \times 21'') = 444\ in^2$$

$$\times\ 10.85\ psi$$

$$4817\ \#$$

$4817 > 2376$ OK

REV 9/93 FORM 18B

Appendix D.

Detailed Cost Estimate

SUMMARY OF CONSTRUCTION COST OPINION

PROJECT: CASANDRO WASH DAM

ITEM NO.	DESCRIPTION	UNIT	APPROX. QUANTITY	UNIT COST	EXTENTED AMOUNT
107	NPDES Permits	LS	1	10,000.00	10,000
201	Clearing and Grubbing	LS	1	13,488.60	13,489
202	Mobilization	LS	1	47,479.28	47,479
204	Excavation for Dam	CY	40,800	1.87	76,378
210	Borrow Excavation	CY	65,100	2.17	141,246
211-1	Fill Construction Zone 1 Matl	CY	85,500	2.68	228,926
211-2	Fill Construction Zone 2 Matl	CY	2,900	19.21	55,720
211-3	Finish Grading	AC	15	626.54	9,398
220	Riprap	CY	427	47.56	20,306
301	Subgrade Preparation	SY	14,925	0.79	11,829
310	Aggregate Base Course (4-inch)	SY	3,525	1.70	5,984
350	Remove & Abondon Sewer	LS	1	6,203.49	6,203
405	Survey Monuments	EA	14	214.20	2,999
420	Chain Link Fence (6-foot)	LF	360	14.56	5,241
421	Wire Fence (4-foot)	LF	3,325	5.68	18,876
430	Landscaping	AC	15	1,242.75	18,641
505-1	Concrete Spillway & Stilling Bsn	CY	860	317.87	273,365
505-2	Inlet/Outlet Structure	CY	26	685.28	17,817
505-3	Miscellaneous Concrete	CY	5	364.14	1,821
515	Sedimentation Markers	EA	2	187.43	375
615	Sanitary Sewer (12-inch)	LF	1,442	43.81	63,174
618-1	Reinforced Conc Pipe (36-inch)	LF	148	114.89	17,003
618-2	PVC Drain Pipe (8-inch)	LF	365	26.30	9,598
621	CMP Culvert (24-inch)	LF	88	22.38	1,970
625-1	Stnd Manhole (MAG 420)	EA	3	2,677.50	8,033
625-2	Drop Manhole (MAG)	EA	1	3,748.50	3,749
635-1	Drain Pipe System (4-Inch)	LF	425	4.92	2,091
635-2	Drain Pipe System (12-Inch)	LF	260	14.89	3,872

TOTAL	1,075,584

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 107 NPDES Permits	1	LS	$ 10,000.00	$10,000
	SUBTOTAL ITEM NO. 107				$10,000
	MARK-UPS:				
	OVERHEAD & PROFIT	0%			$0
	BONDS & INSURANCE	0%			$0
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 107				$10,000

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 201 Clearing and Grubbing	18.2	AC	$ 692.00	$12,594
	SUBTOTAL ITEM NO. 201				$12,594
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$630
	BONDS & INSURANCE	2%			$264
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 201				$13,489

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 202 Mobilization	3%	LS	$ 1,028,104.32	**$30,843**
	SUBTOTAL ITEM NO. 202				**$44,332**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$2,217
	BONDS & INSURANCE	2%			$931
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 202				**$47,479**

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 204-1				
	Excavation for Dam				
	1. Dam Foundation, w/scraper & dozer	36,900	CY	$ 1.75	$64,575
	2. Dam Embankment, Stilling Basin, w/scarper & dozer	3,400	CY	$ 1.75	$5,950
	3. Excavate for Riprap at toe of Stilling Basin, w/ dozer	500	CY	$ 1.58	$790
	SUBTOTAL ITEM NO. 204-1				$71,315
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$3,566
	BONDS & INSURANCE	2%			$1,498
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 204-1				$76,378

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 210				
	Borrow Excavation				
	1. Basin Excavation used for Borrow	48,600	CY	$ 2.13	**$103,518**
	Remaining Excavation of Basin not used for Borrow:				
	2a. Required excavation, fill & compaction at basin	9,200	CY	$ 1.75	**$16,100**
	2b. Excavate & waste, Assume onsite spread of excess material	7,300	CY	$ 1.68	**$12,264**
	SUBTOTAL ITEM NO. 210				**$131,882**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$6,594
	BONDS & INSURANCE	2%			$2,770
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 210				**$141,246**

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 211-1				
	Fill Construction (Zone 1 Material)				
	1. Replace excavated volume from Dam Foundation	42,400	CY	$ 2.50	**$106,000**
	2. Dam Embankment volume (less Zone 2 Matl)	43,100	CY	$ 2.50	**$107,750**
	SUBTOTAL ITEM NO. 211-1				**$213,750**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$10,688
	BONDS & INSURANCE	2%			$4,489
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 211-1				**$228,926**

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 211-2				
	Fill Construction (Zone 2 Material)				
	1. Material Cost	2,900	CY	$ 15.40	$44,660
	2. Placement Cost	2,900	CY	$ 2.54	$7,366
	SUBTOTAL ITEM NO. 211-2				$52,026
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$2,601
	BONDS & INSURANCE	2%			$1,093
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 211-2				$55,720

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 211-3				
	Finish Grading				
	1. Finish Grading	15	AC	$ 585.00	**$8,775**
	SUBTOTAL ITEM NO. 211-3				**$8,775**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$439
	BONDS & INSURANCE	2%			$184
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 211-3				**$9,398**

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 220				
	Riprap				
	1. Riprap placed at toe of stilling basin, 24" dia	474	CY	$ 40.00	$18,960
	SUBTOTAL ITEM NO. 220				$18,960
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$948
	BONDS & INSURANCE	2%			$398
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 220				$20,306

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 301				
	Subgrade Preparation				
	1. Subgrade under Dam, 3 passes w/ wheel roller 10 tons	11,400	SY	$ 0.74	$8,436
	2. Subgrade under Roadways	3,525	SY	$ 0.74	$2,609
	SUBTOTAL ITEM NO. 301				$11,045
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$552
	BONDS & INSURANCE	2%			$232
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 301				$11,829

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 310				
	Aggregate Base Course (4 - inch)				
	1. Material Cost	300	CY	$ 12.75	$3,825
	2. Placement Cost	3,525	SY	$ 0.50	$1,763
	SUBTOTAL ITEM NO.310				$5,588
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$279
	BONDS & INSURANCE	2%			$117
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 310				$5,984

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 350				
	Remove & Abondon Sewer:				
	1. Remove & Salvage Manhole Rims & Covers	4	EA	$ 150.00	$600
	2a. Remove Top 5 ft of Manhole	3	EA	$ 150.00	$450
	2b. Plug inlets & outlets	3	EA	$ 150.00	$450
	2c. Backfill Manhole to finish grade	3	EA	$ 100.00	$300
	3. Remove Manhole completely	1	EA	$ 250.00	$250
	4. Cap end of abandon VCP	2	EA	$ 150.00	$300
	Remove 10" VCP completely:				
	5a. Trench excavation, 7 ft deep average	212	CY	$ 2.77	$587
	5b. Remove 10" VCP	340	LF	$ 3.25	$1,105
	5c. Backfill with concrete slurry	50	CY	$ 35.00	$1,750
	SUBTOTAL ITEM NO.350				$5,792
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$290
	BONDS & INSURANCE	2%			$122
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 350				$6,203

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 405				
	Survey Monuments (MAG 120-2, Type B)				
	1. Survey monuments, Type A	8	EA	$ 200.00	$1,600
	2. Survey monuments, Type B	6	EA	$ 200.00	$1,200
	SUBTOTAL ITEM NO.405				$2,800
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$140
	BONDS & INSURANCE	2%			$59
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 405				$2,999

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 420				
	Chain Link Fence (6-Foot)				
	1. 6-Foot Chain Link Fence	356	LF	$ 11.50	$4,094
	2. Gate 13 ft wide	1	EA	$ 800.00	$800
	SUBTOTAL ITEM NO.420				$4,894
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$245
	BONDS & INSURANCE	2%			$103
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 420				$5,241

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 421				
	Wire Fence (4-Strands)				
	1. Wire Fence	3,325	LF	$ 5.00	**$16,625**
	2. Gate 13 ft wide	1	EA	$ 500.00	**$500**
	3. Pedestrian / Equestrian Access	1	EA	$ 500.00	**$500**
	SUBTOTAL ITEM NO.421				**$17,625**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$881
	BONDS & INSURANCE	2%			$370
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 421				**$18,876**

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 430				
	Landscaping Planting				
	1. Seed Mix Type A	4.43	AC	$ 1,350.00	$5,981
	2. Seed Mix Type B	9.14	AC	$ 1,250.00	$11,425
	SUBTOTAL ITEM NO.430				$17,406
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$870
	BONDS & INSURANCE	2%			$366
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 430				$18,641

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 505-1				
	Concrete Spillway and Stilling Basin				
	1. Cut-off wall - 12" thk	55.7	CY	$ 511.00	$28,463
	2. Cut-off wall - 18" thk	51.1	CY	$ 407.00	$20,798
	3. Slab on grade, top of spillway, no slope - 12" thk	126.7	CY	$ 179.00	$22,679
	4. OGEE Crest	47.4	CY	$ 300.00	$14,220
	5. Slab on grade, spillway slope - 12" thk	271.6	CY	$ 189.00	$51,332
	6. Slab Construction Corbels	33.3	CY	$ 200.00	$6,660
	7. Slab on grade, stilling basin, no slope- 18" thk	74.8	CY	$ 169.00	$12,641
	8. Slab on grade, stilling basin, w/slope - 18" thk	53.3	CY	$ 175.00	$9,328
	9. Diffuser Blocks, Chutes	1.6	CY	$ 200.00	$320
	10. Diffuser Blocks, Floor	4.2	CY	$ 200.00	$840
	11. Walls, top of spillway - 12" thk	26.5	CY	$ 511.00	$13,542
	12. Cut-off wall, cntr top of spillway - 12" thk	5.6	CY	$ 511.00	$2,862
	13. Walls, placed on slope of spillway - 12" thk	72.4	CY	$ 753.00	$54,517
	14. Walls in stilling basin - 12" t hk	19.4	CY	$ 511.00	$9,913
	15. Walls in stilling basin - 16" t hk	16.2	CY	$ 440.00	$7,128
	SUBTOTAL ITEM NO.505-1				$255,243
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$12,762
	BONDS & INSURANCE	2%			$5,360
	CONTINGENCY	0%			$0
	ESCALATION @ 3% *per year*	0%			$0
	TOTAL ITEM NO. 505-1				$273,365

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 505-2				
	Inlet / Outlet Structures for Outlet Pipe				
	1. Outlet Structure:				
	a. Slab on grade, 12" thk	5.3	CY	$ 179.00	$954
	b. Walls, 12" thk	1.7	CY	$ 511.00	$869
	c. Mass Conc	4.6	CY	$ 200.00	$920
	2. Inlet Structure:				
	a. Metal grating and misc steel	1	LS	$ 1,000.00	
	b. Slab on grade, 12" thk	4.7	CY	$ 179.00	$848
	c. Walls, 8" thk	6.4	CY	$ 700.00	$4,445
	d. Mass Conc	3	CY	$ 200.00	$600
	e. SS Slide Gate	1	LS	$ 8,000.00	$8,000
	SUBTOTAL ITEM NO.505-2				$16,636
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$832
	BONDS & INSURANCE	2%			$349
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 505-2				$17,817

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 505-3				
	Miscellaneous Concrete				
	1. Gate Lift Pedestal	2	CY	$ 400.00	$800
	2. Gate Stem Pedestals and misc.	3	CY	$ 300.00	$900
	SUBTOTAL ITEM NO.505-3				$1,700
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$85
	BONDS & INSURANCE	2%			$36
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 505-3				$1,821

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM

90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: TOM WOLF / PHX

PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 515				
	Sedimentation Markers				
	1. 4" dia steel pipe x 9 ft	2	EA	$ 100.00	$200
	2. Fill with concrete	2	EA	$ 25.00	$50
	3. Paint markings	2	EA	$ 25.00	$50
	4. Placement in concrete base	2	EA	$ 25.00	$50
	SUBTOTAL ITEM NO.515				$350
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$18
	BONDS & INSURANCE	2%			$7
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 515				$375

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 615				
	Sanitary Sewer (12-inch DIP)				
	1a. 12" DIP, Material	1,442	LF	$ 14.68	$21,169
	1b. 12" DIP, Placement in trench	1,442	LF	$ 3.60	$5,191
	2. Corrosion Protection, poly wrap pipe	1,442	LF	$ 3.19	$4,600
	3. Trench Excavation	4,339	CY	$ 2.51	$10,891
	4. Trench Backfill, native material	4,250	CY	$ 3.62	$15,385
	5. Trench Backfill, concrete slurry	50	CY	$ 35.00	$1,750
	SUBTOTAL ITEM NO 615				$58,986
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$2,949
	BONDS & INSURANCE	2%			$1,239
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO 615				$63,174

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 618-1				
	Reinforced Concrete Pipe (36-inch)				
	1a. 36" RCP , Material	148	LF	$ 36.00	$5,328
	1b. Placement of 36" RCP in trench	148	LF	$ 36.00	$5,328
	2. Trench Excavation	88	CY	$ 2.51	$221
	3. Concrete block support	30	EA	$ 5.00	$150
	4. Backfill with concrete slurry	39	CY	$ 35.00	$1,365
	5. Backfill with Zone 2 material	27	CY	$ 17.94	$484
	6. Fabricated Steel Pipe Bends	1	EA	$ 3,000.00	$3,000
	SUBTOTAL ITEM NO.618-1				$15,876
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$794
	BONDS & INSURANCE	2%			$333
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 618-1				$17,003

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 618-2				
	PVC Drain Pipe (8-inch)				
	1a. 8" PVC, material	365	LF	$ 10.55	$3,851
	1b. 8" PVC, placement	365	LF	$ 8.10	$2,957
	2. 8" PVC - 45 deg elbow, material & labor	2	EA	$ 45.00	$90
	3. Cleanout	1	EA	$ 200.00	$200
	4. Outlet and Riser	1	EA	$ 1,000.00	$1,000
	5. Trench excavation	80	CY	$ 2.51	$201
	6. Backfill, Zone 2 matl	37	CY	$ 17.94	$664
	SUBTOTAL ITEM NO.618-2				$8,962
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$448
	BONDS & INSURANCE	2%			$188
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 618-2				$9,598

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM

90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: TOM WOLF / PHX

PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 621				
	CMP Culverts (24-inch)				
	1a. 24" CMP Culvert, material	88	LF	$ 8.40	$739
	1b. Placement, 24" CMP	88	LF	$ 8.00	$704
	2a. 24" Flared Ends, material	2	EA	$ 88.00	$176
	2b. Placement, 24" Flared end	2	EA	$ 110.00	$220
	SUBTOTAL ITEM NO.621				$1,839
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$92
	BONDS & INSURANCE	2%			$39
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 621				$1,970

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 625-1 Standard Manhole (MAG 420) 1. 48" dia Manhole with ring and cover	3	EA	$ 2,500.00	$7,500
	SUBTOTAL ITEM NO.625-1				$7,500
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$375
	BONDS & INSURANCE	2%			$158
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 625-1				$8,033

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 625-2 Drop Manhole (MAG 420) 1. 48" dia Drop Manhole with ring and cover	1	EA	$ 3,500.00	$3,500
	SUBTOTAL ITEM NO.625-2				$3,500
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$175
	BONDS & INSURANCE	2%			$74
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 625-2				$3,749

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM

90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: TOM WOLF / PHX

PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 635-1				
	Drain Pipe System (4-Inch)				
	4a. 4" PVC slotted, material	425	LF	$ 1.50	$638
	4b. Placement, 4" PVC slotted	425	LF	$ 1.08	$459
	5a. 4" PVC - 90 deg elbow, material	16	EA	$ 8.00	$128
	5b. Placement, 4" PVC - 90 deg elbow	16	EA	$ 27.00	$432
	6a. 4" PVC - TEE, material	8	EA	$ 10.00	$80
	6b. Placement, 4" TEE	8	EA	$ 27.00	$216
	SUBTOTAL ITEM NO.635-1				$1,953
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$98
	BONDS & INSURANCE	2%			$41
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 635-1				$2,091

ESTIMATE SUMMARY

PROJECT: CASANDRO WASH DAM
90% DESIGN - CONSTRUCTION COST ESTIMATE

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: TOM WOLF / PHX
PROJ.NO.:SWW 35441.PS

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
	ITEM NO. 635-2				
	Drain Pipe System				
	1a. 12" PVC, material	78	LF	$ 7.00	$546
	1b. Placement, 12" PVC	78	LF	$ 1.62	$126
	2a. 12" PVC Slotted, material	102	LF	$ 8.00	$816
	2b. Placement, 12" PVC slotted	102	LF	$ 1.62	$165
	3a. 12" PVC -90 deg elbow, material	8	EA	$ 117.00	$936
	3b. Placement, 12" PVC - 90 deg elbow	8	EA	$ 40.00	$320
	7. Concrete block pipe supports	16	EA	$ 5.00	$80
	8. Trench Excavation	35	CY	$ 2.51	$88
	9. Backfill, Zone 2	30	CY	$ 17.94	$538
	SUBTOTAL ITEM NO.635-2				$3,616
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$181
	BONDS & INSURANCE	2%			$76
	CONTINGENCY	0%			$0
	ESCALATION @ 3% per year	0%			$0
	TOTAL ITEM NO. 635-2				$3,872

Appendix E.

Value Engineering Meeting

MEETING NOTES

CH2M HILL

DATE:	May 2, 1994
PROJECT:	SWW35441.MC.10
SUBJECT:	Casandro Wash Detention Dam Value Engineering and Review Board Meeting
MEETING DATE:	April 12, 1994 (8:30 a.m. to 4:15 p.m.)
LOCATION:	Fire Station Meeting Room, Wickenburg, Arizona
ATTENDEES:	See Attached List
REVIEW BOARD MEMBERS:	Peter Binney, Larry Roth, Roger Lindquist
AGENDA:	Attached
HANDOUTS:	Attached
PREPARED BY:	Roger Lindquist

Summary

The purpose of the meeting was to present the work accomplished to date on the Casandro Wash Detention Dam for information and review by the dam review board and client representatives. The project hydrology and geology were presented, followed by a brief site visit and observation of test pits. After the site visit, the project was broken down into the major elements and the opinion of conceptual level construction cost for each element presented. Just before lunch, a brainstorming session was held to develop ideas for improving the conceptual design and reducing the cost. Following lunch, the meeting focused on evaluating the ideas, eliminating the less acceptable ones, and developing the ideas to be presented to the design team for further review.

Decisions

The following decisions were made at the conclusion of the meeting:

1. The Design Flood--½ PMF (5400 cfs), with 3 feet of freeboard; full PMF (10,900 cfs) without overtopping the dam, with just a few inches of freeboard.

2. Storage--Provide approximately 157 ac-ft of flood storage to contain the 100-year flood below the spillway crest, less the flow released from the orifice, plus 2 ac-ft for sediment storage.

3. Upstream Development--Assume the upstream drainage area is fully developed to the present zoning regulations

4. Sediment Accumulation--Assume sediment is removed every 5 years with an 5-year accumulation of average sediment yield (5 years at average 0.4 ac ft/yr). This storage of 2 ac-ft will be below the lip of the outlet orifice.

5. Reservoir Level at Start of Flood--Assume the reservoir is empty at the start of the flood.

6. Dam Crest Elevation--Assume the dam crest will be between elevation 2161 and 2163 because of abutment topography constraints. Construct wide flat dike across the right abutment to fill in the low spot (only about 2 or 3 feet high). Leave house in place, and buttress the area around the house. Excavate the trash and loose soil from the slope around the house. Remolded embankment permeability is about 1×10^{-4} cm/sec, and foundation permeability is about 1×10^{-3} cm/sec. Angle of friction is about 38 to 40 degrees. Settlement of foundation and embankment are expected to be small.

7. Dam Section--Even though the reservoir will normally be emptied quickly after every storm (assumed completely empty within seven days), assume there is a remote chance that the reservoir will remain full long enough for steady state seepage to develop. So, leave the chimney drain in as shown, and extend it in a trench so it is a few feet below foundation excavation. Assume the dam is a homogenous dam with a chimney drain; no core will be included. No special slope erosion protection will be provided, similar to Sunset Dam.

8. Outlet--Assume an outlet will be provided with an orifice that limits the discharge to 20 cfs (with water surface about 3 feet below the spillway crest). Also provide the outlet with a gate that will allow up to 340 cfs (capacity of downstream drainage facility). Gate will be operated by a stem up the sloping face of the dam. Provide a trash rack around both the orifice and gate. Outlet pipe will be 36-inches in diameter. The stilling basin for the outlet pipe will be the spillway stilling basin. The outlet will be backfilled with concrete or a pourable backfill. Seepage collars

perpendicular to the pipe centerline may be excavated and poured against undisturbed ground. A drainage backfill may be used for the downstream 30 to 50 feet of the outlet pipe.

9. Maintenance Access--Provide truck access to the reservoir for removal of sediment, to each abutment for maintenance and inspection, and to downstream toe for repair after severe flooding.

10. Horse/Motorbike Access--Access through the reservoir for horse and bike traffic will be allowed via maintenance road but away from the dam.

11. Fencing--Delay final decision until O&M staff review, but consider fencing around the spillway and outlet similar to Sunset Dam.

12. Relocation of Sewer Pipe--Develop reservoir excavation to leave as much of the sewer pipe undisturbed in the reservoir as possible but still excavate the required embankment footprint and provide the needed flood storage. Relocate/replace sewer pipe under dam, so pipe is not interfering with the foundation excavation of the dam or the excavation of the stilling basin. Sewer pipe should be concrete encased under the embankment.

13. Spillway Entrance--Further develop the spillway entrance as an ogee crest to pass the ½ and full PMF. Check the width reduction of the entrance, entrance coefficient, etc., during final hydraulic computations of the spillway so the flood is safely passed without dam overtopping.

14. Spillway Chute--Evaluate the convergence angle of chute, the freeboard on the training walls, and the construction materials. Consider soil cement (CSA or RCC) using onsite materials with a strength of about 2000 psi. Consider constructing the walls with soil cement. Soil cement shall be placed in layers about 10 feet wide with 2- or 3-foot-high steps. State Dam Safety will be concerned about seepage along the spillway walls, so discuss this issue with them and use cutoff walls if necessary.

15. Spillway Stilling Basin--Consider providing a soil-cement-lined stilling basin. Consider shortening basin by having a deep, lined pool with a high downstream end weir. Fill stilling basin with sand that will wash out when used in flood.

16. Water for Construction--Assume water needed for construction will be about 50 to 100 gallons per cubic yard of fill. Discuss with City about supply that may be available as well as preferred timing for construction or storage requirements.

17. Waste Material--Assume waste excavation material may be placed downstream of dam, probably on right abutment area downstream from house. Client should review potential for some waste material to be hauled from site for use in other civil projects.

18. Structures in Reservoir--County will arrange for removal of all structures, debris, and obstructions in reservoir.

19. Inert Debris in Reservoir--Inert debris may be buried downstream of dam.

20. Debris--Other solid waste unsuitable for incorporation in fill areas will be taken to City landfill.

Design Team Review

The following suggestions were made to the design team for further review:

- *New Dam Alignment and Elevation*--The advantage of modifying the dam axis alignment is to provide better downstream alignment of the spillway discharge. The advantage to locating the dam downstream and raising the crest of the dam and spillway is to reduce the excavation required in the reservoir and to balance the cut and fill volume. The suggested dam crest elevation is 2163, with the spillway wide enough to pass the ½ PMF with the 3 feet of freeboard and pass the full PMF with just a few inches of freeboard. Recalculate the volume of fill in the dam, and consider steepening the downstream face to 2:1 if necessary, but remember that erosion control and maintenance will be better on a flatter slope. Consider reducing the crest width to 15 feet.

- *Raise the Crest of the Dam Along Alternate II to Elevation 2,163*--This concept would determine if the storage could be obtained while reducing the volume of excess excavation in the reservoir.

Casandro Wash Value Engineering Meeting
April 12, 1994
Agenda

8:30 - 8:50:	Goals and Objectives
8:50 - 9:10:	**Hydrology and Hydraulics** - Precipitation - 100-year Flood - 1/2, Full PMF - Outlet Criteria/consideration/controls/operation - Hydraulic design concepts of spillway and outlet works - Dam Configuration, top width, hydraulic structures, etc. - Sediment yield
9:10 - 9:30:	**Geology and Geotechnical** - Site Constraints: Private property, access - General geology, seismicity and background information - Foundation strength, settlement, cutoff etc. - Construction materials - core, random, filters, drains and erosion protection - Stability analysis: Static and dynamic - Cross sections, alternatives - Construction cost estimates - Discussion of performance of similar adjacent dams, risk, allowable seepage, maintenance, landscaping etc.
9:30 - 11:00:	**Break and site inspection, observe test pits**
11:00 - 12:00:	**Break down costs into major components and functions** - Embankment - foundation, cutoff, fill material, cross section, erosion protection - Outlet works - Intake, conduit, stilling basin, diversion during construction etc. - Spillway - type, location, materials, entrance, chute, stilling basin, etc.
12:00 - 1:30:	**Lunch**
1:30 - 2:30:	**Breakout Discussion Session**
2:30 - 4:30:	**Identification and Development of VE suggestions to address possible cost savings in the major items; discussion**
4:30 - 4:45:	**Wrap up**
5:00:	**Depart from meeting**

SUBJECT MCFCD
CASANDRO WASH
DETENTION DAM

BY _____ DATE _____
SHEET NO. ____ OF ____
PROJECT NO. _____

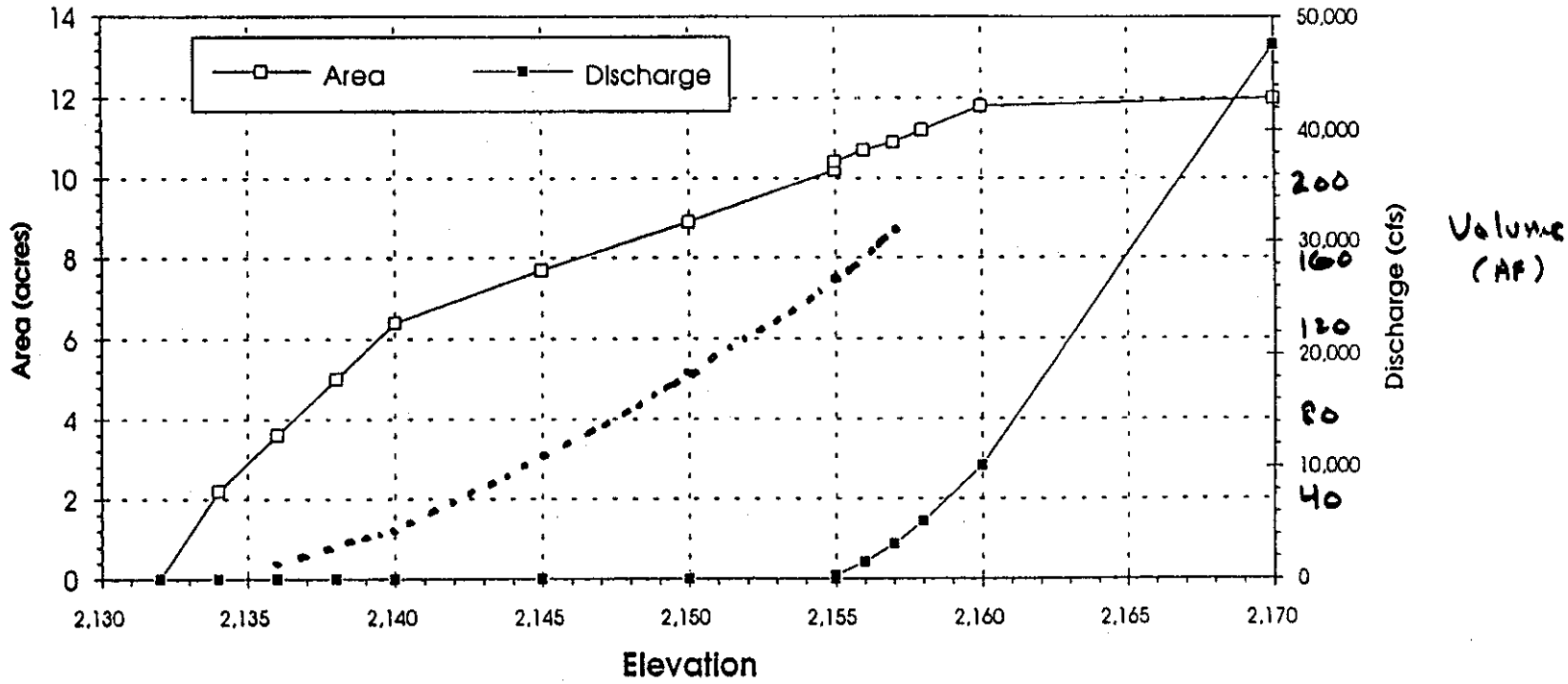
VALUE ENGINEERING MEETING

APRIL 12, 1994

WICKENBURG, AZ

ATTENDEES LIST

NAME	POSITION/REPRESENTING	PHONE
Ton Wolf	CIVIL DES./CH2M HILL	966-8188
Steve Walker	PM CH2M Hill	"
Willie Aziz	Cost Estimator/CH2M Hill	"
Michael Lopez	Proj Mgr / FCD	506-1501
Stan Smith	F.C.D	506-1501
Dawn Stayle	Project Assistant/CH2M	966-8188
Larry Roth	Geotechnical Engr / CH2M Hill	510-251-2426
PETER BINNEY	HYDRAULIC ENGR/ CH2M HILL	303-771-0900
Warren Rosebraugh	CE / FCD	506-1501
Ed Raleigh	Engineering/FCD	" "
Jon Fuller	Hydrol. / CH2m	966 8188
Roger Lindquist	Civil/Geotech/CH2mHill	503-752-42
Shawn Livingston	Geotechnical/CH2mHill	966-8188.
Sandy Storey	FCDMC (until noon)	506-1501
Jan Opstierne	FCDMC (until noon)	506-1501
DAVID ALLARD	GEOTECHNICAL ENGINEER	966-8188

FORM 38

AREA-DISCHARGE VS. ELEVATION RELATIONSHIPS