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# Design Calculation or Analysis Cover Sheet

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Section 3	Phillip Minear	t	Thomas MacDonald				
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9/19/07

### DISCLAIMER

The calculations contained in this document were developed by URS Corporation and are intended solely for the use of Bechtel SAIC Company, LLC in its work for the Yucca Mountain Project.

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### ACRONYMS

COE	U.S. Army Corps of Engineers
CRWMS	Civilian Radioactive Waste Management System
CSCI	Computer Software Configuration Item
DOE	U.S. Department of Energy
DTN	Data Tracking Number
ESF	Exploratory Studies Facility
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
HEC	Hydrologic Engineering Center
HEC-RAS	Hydrologic Engineering Center, River Analysis System
HMR	Hydrometeorological Report
ITS	Important to Safety
ITWI	Important to Waste Isolation
M&O	Management and Operating Contractor
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
QARD	Quality Assurance Requirements and Description
SCS	Soil Conservation Service
STN	Software Tracking Number
TDMS	Technical Data Management System
TIN	Triangulated Irregular Network
URS	URS Corporation
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
YMP	Yucca Mountain Project

## **ABBREVIATIONS**

cfs	cubic feet per second
ft	feet
$ft^2$	square feet
ft/s	feet per second
FY	Fiscal Year
mi	miles

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### 1 PURPOSE

The purpose of this calculation is to demonstrate that the drainage features depicted in Attachment A of this calculation will adequately protect the Geologic Repository Operations Area (GROA) nuclear facilities from flooding associated with the Probable Maximum Precipitation (PMP) event. Flood control features (e.g., dikes and channels) are non-ITS and non-ITWI.

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### 2.3 DESIGN CONSTRAINTS

None.

2.4 DESIGN OUTPUTS

None.

### **3** ASSUMPTIONS

### 3.1 ASSUMPTIONS REQUIRING VERIFICATION

None.

### **3.2 ASSUMPTIONS NOT REQUIRING VERIFICATION**

### 3.2.1 Homogeneity of Watershed Properties

Watershed sub-area properties are assumed to be spatially uniform within each sub-area boundary during the entire duration of the storm.

**Rationale:** Since the relative size of the sub-areas is very small, significant variations in hydrologic properties within the sub-areas is unlikely. However, a sensitivity analysis for variations in soil types was performed in Section 6.2.4 of Reference 2.2.6. This calculation demonstrates that the effects of minor soil variations are small. Therefore, verification of this assumption is not required.

### 3.2.2 Initial Abstraction

Initial rainfall abstraction for any given watershed can vary over a relatively wide range depending on antecedent moisture conditions, season, and other factors. It was assumed that an initial rainfall abstraction (rainfall loss) of 1 inch would occur prior to rainfall runoff from the watershed to account for interception (wetting), depression storage, and rainfall required to saturate the uppermost layer of soil.

**Rationale:** Justification for this assumption is provided in Section 6.1.4.

### 3.2.3 Aging Pad Infiltration

For purposes of determining input parameters into the U.S. Army Corps of Engineers' HEC-1 computer model, it was conservatively assumed that the Aging Pads area shown on Attachment A is impervious to rainfall infiltration.

**Rationale:** The most conservative condition is assumed. Therefore, this is a bounding assumption that does not require verification.

### 3.2.4 Infiltration Rate

For all areas outside of the Aging Pads, a conservatively low rainfall infiltration rate of 1.5 inches per hour was assumed in the analysis.

#### **Rationale:**

Justification for this assumption is provided in Section 6.1.4.

### 3.2.5 Manning's Roughness Coefficient

A conservatively high Manning's n roughness coefficient of 0.09 was assumed for the HEC-1 and HEC-RAS computer calculations to provide conservatively high flow depths at project facilities.

**Rationale:** Justification for the assumed Manning's roughness coefficients is provided in Section 6.1.4.

### 3.2.6 Boundary Conditions

It was assumed that flows at upstream boundaries of the man-made channels around the Aging Pad and North Portal Facilities areas are at normal depth as determined by channel slopes and discharge. Flow was also assumed to be at normal depth at the downstream outlet of the channel system. The water surface elevation calculated by the HEC-RAS model in Segment 3 at its junction with Segment 2 was used as the downstream boundary of Segment 2. The water surface elevation calculated by the HEC-RAS model in Segment 1 was used as the downstream boundary of Segment 1 was used as the downstream boundary of Segment 1. See Figure 6-1 or 7-1 for definitions of Segments 1, 2, and 3.

**Rationale:** Upstream and downstream boundary conditions are dependent upon channel geometry and channel entrance and exit conditions at the boundaries, which are not in the scope of this analysis.

### 3.2.7 Fixed Bed Model

For the purpose of calculating PMF water surface elevations, it is assumed that channel sizes and locations, as defined by the current topography, will not change during the PMF event, i.e., a fixed bed model such as HEC-RAS can be used in the analyses.

**Rationale:** Flood channel design is not in the scope of this analysis. Sufficient watershed and sediment data are not available to predict possible changes in channel geometry and location during an extreme flood event such as the PMF. For purposes of the modeling, runoff has been directed toward the dike system. Should peak flows exceed the capacity of formed flow paths, water surface elevations adjacent to the dikes would be lower due to the overflow into adjacent channels farther away from the facilities.

### 3.2.8 Structural Integrity of the Dike System

It is assumed that structural failure of the dike system due to erosion or other factors will not occur.

Rationale: Structural design for the dike system is not in the scope of this analysis.

### 3.2.9 Flow Bulking Factor

In this study, it was conservatively assumed that flows will be bulked by 10% to account for sediment, debris, and air entrainment in the flowing water.

**Rationale:** Hydraulic equations and computer models do not account for entrainment of sediment, debris, and air bulking and must be separately accounted for by the investigator. Data are not available to estimate the amount of flow bulking at the project site during a PMF event. Justification for this assumption is provided in Section 6.1.4.

### 3.2.10 Detention Basin Design

As shown in Attachment A, runoff from the North Portal Facilities area will be detained on site and/or collected in detention ponds located at the southern and eastern boundaries of the North Portal Facilities area. It is assumed that detailed design will ensure that releases from the detention ponds through their outlet works will be controlled such that outflows will have no significant effect on peak flows in the downstream channel.

**Rationale:** The outlet works and detention storage volume for the detention ponds are not in the scope of this calculation.

### 4 METHODOLOGY

### 4.1 QUALITY ASSURANCE

This calculation was prepared in accordance with EG-PRO-3DP-G04B-00037, Calculations and Analyses (Ref. 2.1.1). The flood control structures have not been classified in the Basis of Design (Ref. 2.2.28). However, it is not anticipated that this system will perform any functions important to safety or important to waste isolation. Therefore, the approved version is designated as QA:N/A.

### 4.2 USE OF SOFTWARE

Software listed in Table 4-1 is qualified and was obtained from Software Configuration Management. The software was appropriate for the applications described in this report and the

software was used within its range of validation as required by IT-PRO-0011 (Ref. 2.1.2). The computer used to run HEC-1 and HEC-RAS software is located in the URS office in Oakland, California. The computer was a Toshiba Satellite Pro with serial number 97244164. The computers used to run ArcGIS V.9.1 are also located in the URS office in Oakland, California. The computer types and identifiers are as follows: Hewlett-Packard hpxw4400 workstation, w021xp060928 and w021xp060917; and Hewlett Packard hp workstation xw6000, w021xp-8004. The computer used to run ArcINFO V.7.2.1 is located in the Yucca Mountain Las Vegas Office, Nevada. The BSC property tag number of this computer is 700810.

Reference	Name	STN/CSCI Identifier	CPU Operating Platform	CPU Operating System
				Windows 95-
Ref. 2.2.4, Ref. 2.2.34	HEC-1 Version 4.0	30078-V4.0	PC	DOS Emulation
				Windows 95-
Ref. 2.2.5, Ref. 2.2.35	HEC-RAS Version 2.1	30079-V2.1	PC	DOS Emulation
Ref. 2.2.26, Ref.	ArcINFO V.7.2.1	STN 10033-7.2.1-00	SGI	IRIX 6.5
2.2.30				
Ref. 2.2.20, 2.2.31	ArcGIS Desktop V.9.1	STN 11205-9.1-00	PC	Windows XP

Table	4-1.	Software	Usage
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### 4.2.1 Probable Maximum Flood Calculation

The HEC-1 computer software, Version 4.0 (Ref. 2.2.34, 2.2.4, 2.2.23) was used to perform the rainfall-runoff simulations using PMP amounts. This is the same software used in the previous studies (Ref. 2.2.6, 2.2.7).

### 4.2.2 Flood Inundation Calculation

The U.S. Army Corps of Engineers, Hydrologic Engineering Center, River Analysis System software (HEC-RAS), Version 2.1 (Ref. 2.2.35, 2.2.3, 2.2.5), was used for the flood inundation analysis. This program is designed for flood inundation studies and flood risk analysis. This software performs standard backwater computations to predict water surface elevations under steady gradually varied flow conditions. HEC-RAS is one of the FEMA nationally accepted computer programs that can be used to estimate flood elevations (Ref. 2.2.15). This is the same software used in the previous studies (Ref. 2.2.6 and 2.2.7).

### 4.2.3 Generation of Digital Terrain

A composite Triangulated Irregular Network (TIN) comprising two datasets (DTN #s MO0002SPATOP00.001 (Ref. 2.2.17) and MO9906COV98462.000 (Ref. 2.2.18)) was generated using ArcINFO V.7.2.1 (Ref. 2.2.26, 2.2.27) to produce a topographic representation of the project area. The dataset MO9906COV98462.000 (Ref. 2.2.18) contains 2-foot contour data encompassing the North Portal Facilities and vicinity, whereas the dataset MO0002SPATOP00.001 (Ref. 2.2.17) consists of an output gridded (100-foot spacing) surface that covers the entire watershed. The 2 datasets have overlapping information and the goal was to use the best available data for the region analyzed. The 2-foot contours from DTN MO9906COV98462.000 (Ref. 2.2.18) were the preferred data as they have the best vertical

resolution available. The 2-foot contours were clipped to the extent of the study area. The gridded elevation points from DTN MO0002SPATOP00.001 (Ref. 2.2.17) were then clipped to the same extent, and points overlapping the area where 2-foot contours existed were eliminated.

### 4.2.4 Geoprocessing and Displaying Results

ArcGIS V.9.1 (Ref. 2.2.20) was used to extract elevation data from the TIN described in Section 4.2.3 by querying information along user-defined section lines. ArcGIS V.9.1 was also used to calculate areas of watersheds defined as polygons, lengths of streams defined as lines, and present output from HEC-RAS graphically to show inundation boundaries. The solutions are documented in sufficient detail to allow an independent checker to reproduce or verify the results without recourse to the originator.

## 4.3 PMF CALCULATION METHOD

HEC-1 (Ref. 2.2.4), which was designed to simulate the surface runoff response of a watershed to precipitation, was used to calculate the Probable Maximum Flood (PMF). The program represents the watershed as an interconnected network of hydraulic and hydrologic components. A component may be a sub-area of the watershed, river channel, reservoir, or diversion. Each component is described by its physical characteristics and mathematical relations that describe the pertinent hydrologic and hydraulic processes. In the HEC-1 software, the study area is divided into drainage sub-areas with constant hydrologic properties. Separate hydrographs can be calculated for each sub-area. This method was necessary to provide information on flows at several key locations based on the proposed surface layout.

### 4.4 INUNDATION METHOD

The computational procedure used in HEC-RAS (Ref. 2.2.5) is based on solution of the onedimensional energy equation. Energy losses consist of surface roughness and expansion/contraction losses. Energy loss by surface roughness is evaluated using Manning's equation and requires the user to define a roughness coefficient. The momentum equation is used in situations where flow is rapidly varied, such as hydraulic jumps and flow through bridges. A rigid channel boundary is used in the computations (i.e., channel cross section shapes do not change as a result of sediment deposition or scour). The HEC-RAS model uses input flows that are calculated by the HEC-1 model. Output from the model consists of water surface elevations at each user defined cross-section.

Three channel segments were analyzed using the HEC-RAS model. The channel segments are shown on Figure 7-1. Channel Segment 1 starts just north of the Aging Pads, follows the ditch and dike system towards the south and then continues south down the center of Midway Wash until it reaches Segment 2. Channel Segment 2 starts just north of the Aging Pads, and follows the ditch and dike system along the west side of the Aging Pad complex. At the southwest corner of the Aging Pad complex, Segment 2 turns east, passes through an opening in the dike, and flows east between the Aging Pads and the North Portal Facilities. At the northeast corner of the North Portal Facilities, Segment 2 turns south, follows the North Portal Loop eastern dike to its southern end, and then flows south away from the North Portal Facilities. Channel Segment 3 starts near the southwest corner of the North Portal Loop

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western dike to the southwest corner of the North Portal Facilities, turns toward the northeast, and flows under the H road through a series of culverts where it joins Segment 2 and flows out of Midway Valley. Assumption 3.2.6 was used to specify boundary conditions at the upstream and downstream ends of each Segment.

### 5 LIST OF ATTACHMENTS

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### **6 BODY OF CALCULATION**

### 6.1 MODEL INPUTS

### 6.1.1 Topographic Data

A composite TIN was used to represent the topography of the project area. Generation of the TIN is described in Section 4.2.3. 10-foot contours were generated from the TIN using ArcGIS V.9.1 (Ref. 2.2.20) and were used in conjunction with the 2-foot contours from DTN M09906COV98462.000 (Ref. 2.2.18) to delineate the watershed and sub-areas and to determine channel flow paths. Elevations at the upstream and downstream ends of the flow paths defined for the HEC-1 model were also extracted from the TIN. Figure 6-1 shows sub-areas and drainage channels used in the HEC-1 model. A schematic of how the drainage system is represented in the HEC-1 model is provided in Attachment F. Elevation data from the TIN were also extracted cross-sections are shown in Figure 7-1.

### 6.1.2 Layout Design

Preliminary layout sketches of the surface facilities, including the proposed North Portal Facilities, Aging Facilities, and dike and channel system, were used to define the extent of drainage sub-areas. A copy of the preliminary layout is provided in Attachment A. Project facilities are shown in the preliminary drawings as being protected by a ditch and dike system. The dimensions and elevations of the ditch and dike system were estimated from the drawings included in Attachment A. The dike system is included in the inundation study so that minimum elevations of the dikes could be estimated.

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### 6.1.3 Precipitation

Section 4.2.10.2 of the Project Design Criteria (Ref 2.2.1) requires repository facilities to be protected from flooding utilizing the guidance from Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants" (Ref. 2.2.33), and Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants" (Ref. 2.2.32). These regulatory guides endorse National Oceanic and Atmospheric Administration (NOAA) methodology for determination of probable maximum precipitation (PMP). The PMP for the site was determined using procedures described in the National Oceanic and Atmospheric Administration's Hydrometeorological Report No. 49 (HMR 49) (Ref 2.2.16), which is considered to provide the best estimate of PMP potential (Ref. 2.2.13, p. 43). The HMR 49 method takes into account meteorological conditions and atmospheric processes in a region, moisture-maximized rains of record, and broad-scale terrain features among other factors to determine a theoretically maximum amount of precipitation for a region or a local watershed.

HMR 49 (Ref. 2.2.16) provides procedures and data for estimating local thunderstorm PMP and general storm PMP. In general the local thunderstorm PMP is the more critical event for small watersheds and the general storm PMP is more critical for large watersheds. Evaluations of the two types of storms (thunderstorm versus general storm) are provided in the previous report (Ref. 2.2.6). The all-seasons local thunderstorm PMP was used for the analyses because it is the critical PMP event for the small watershed considered in these studies.

Using the watershed size and geographical location, the estimated 6-hour duration local storm PMP over the North Portal Facilities area (herein referred to as PMP-North Portal) was determined in the previous study (Ref. 2.2.6) to be 13.2 inches, which has a higher precipitation intensity than the general storm PMP and is therefore the more critical storm to use in the PMF determination. The temporal distribution of the total precipitation was provided in the previous report (Ref. 2.2.6) and was developed based on recommendations in HMR 49. The time series precipitation amounts used in these calculations are presented in the HEC-1 input and output files contained in Attachments B and C. The PMP-North Portal was applied to sub-areas SB1, SB2, SB3, SB4, SB5, SB6, SB13, and Aging1 in the HEC-1 model. These sub-areas are shown on Figure 6-1.

Since a local thunderstorm system affecting the South Portal area can be independent of one that occurs at the North Portal Facilities, a separate PMP value was developed for the tributary area south of the North Portal Facilities. Separate and independent PMP storms for the North and South Portal areas provide a more conservative estimate of the maximum flows at the two portals because the rainfall intensity is inversely related to the drainage area. With an area of 6.5 square miles, the local 6-hour PMP for the South Portal area was computed to be 12.9 inches and is presented in Attachment E. The PMP for the South Portal area was applied to sub-areas SB7, SB8, SB9, SB10, SB11, and SB12. The sub-areas designated as NPP1, NPP2, and NPP3 on Figure 6-1 were excluded from the HEC-1 analysis because of assumption 3.2.10, which assumes that the design of the detention ponds will result in controlling runoff from the North Portal Facilities area such that peak PMF flows would not be affected.

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#### 6.1.4 Sub-Area Properties

The unit hydrograph method was used to develop a runoff hydrograph for each sub-area. Two parameters, sub-area size and lag time, are needed to determine the unit hydrograph for each sub-area using the NRCS Dimensionless Unit Hydrograph (Ref. 2.2.23, pp. 23-24). Sub-area sizes were obtained from the topographic data using ArcGIS V.9.1 (Ref. 2.2.20) and are summarized in Table 6-1.

The lag time parameter is used to define the shape of the unit hydrograph and is defined as the time difference between the occurrence of the center of mass of excess rainfall and the peak of the unit hydrograph. There are several formulae available to calculate lag time. Five commonly used formulae were evaluated in the previous report (Ref 2.2.6, pp. 18-19, 35-37). In general, lag time values computed using the U.S. Bureau of Reclamation (USBR) empirical formula (Ref. 2.2.14, pp. 29-38) were the smallest and, therefore, most conservative (i.e., produce the largest peak flow). Based on this consideration, lag times were calculated using the USBR formula, which is presented below (Ref. 2.2.14, pp. 29-38), with the results tabulated in Table 6-1.

$$lag = C \left(\frac{L \cdot L_{ca}}{\sqrt{S}}\right)^{0.33}$$
 (hours)

where

C = 1.1 (Ref. 2.2.6, p. 19, 35-37)

L = total channel length (mi)

 $L_{ca}$  = length along the flow path from the basin outlet to the point opposite the centroid of the basin area (mi)

S = slope of the channel (ft/mi)

#### Table 6-1. Properties of Sub-Areas Used in HEC-1 Model

		Total channel	Length from centroid to		
Basin Name	Area (mi²)	length (mi)	outlet (mi)	Slope (ft/mi)	Lag time (hr)
Aging1	0.46	N/A	N/A	N/A	N/A
SB1	0.83	2.72	1.39	370	0.64
SB2	0.42	1.62	0.71	570	0.40
SB3	1.6	3.82	1.71	500	0.73
SB4	1.2	3.34	1.33	460	0.65
SB5	0.39	2.36	1.10	180	0.64
SB6	0.76	3.01	1.44	180	0.76
SB7	2.9	4.83	2.50	430	0.92
SB8	1.2	2.68	1.26	440	0.60
SB9	1.7	2.46	1.10	480	0.55
SB10	0.44	0.89	0.41	150	0.35
SB11	0.46	1.35	0.64	360	0.40
SB12	0.15	0.39	0.24	88 .	0.24
SB13	0.19	0.81	0.39	250	0.30

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An initial rainfall abstraction, or rainfall loss, is a sub-area property used in these calculations. It was assumed that an initial rainfall abstraction of 1 inch would occur prior to rainfall runoff from the watershed to account for interception (wetting), depression storage, and rainfall required to saturate the uppermost layer of soil. This assumed 1-inch initial rainfall loss is consistent with a rainfall loss measured during a July 1985 storm event (Ref. 2.2.8, p.7) and, as shown by sensitivity analyses presented in the previous report (Ref. 2.2.6, pp. 36-37), is a small enough value that the calculation results are relatively insensitive to it and, therefore, this assumption does not require confirmation.

A constant infiltration rate is also used in the calculations. Three double ring infiltrometer tests were conducted in the project vicinity that were used to estimate the constant infiltration rate used in these calculations. One test was conducted in Midway Wash at sampling location SA30 (MOL.19970513.0374, see ref 2.2.25, pp. 30-33), one was conducted in Pagany Wash at 32 cm below grade (MOL.19960112.0193, see ref 2.2.24), and one in 40 Mile Wash 200 feet south of H Road (MOL.19960112.0193, see ref. 2.2.24). A duplicate sample was collected at the 40 Mile Wash site. The infiltration rates after one hour varied from over 23 inches per hour (in/hr) at the 40 Mile Wash site, to 1.63 in/hr at the Pagany Wash site. The infiltration rate at the Midway Wash site was 5.58 in/hr.

A conservatively low rainfall infiltration rate of 1.5 inches per hour was assumed in the analysis. This is less than the lowest double infiltrometer test results and 0.3 inches per hour less than the 1.8 inches per hour infiltration rate estimated from percolation tests conducted at the ESF Muck Storage Area (Ref. 2.2.29, DTN#SNF29041993001.002). The assumed infiltration rate is consistent with hydrologic soil groups found in neighboring watersheds (Ref. 2.2.2, Table 8; Ref. 2.2.9, Tables 7 and 8) and soil particle size distributions found in Midway Valley (Ref. 2.2.19, DTN# GS921283114220.014). The influence of this assumed infiltration rate on the peak flood estimate was addressed through sensitivity analyses presented in the previous report (Ref. 2.2.6, pp. 36-37).

Bulking of flows by entrainment of sediment, debris, and air is another watershed sub-area characteristic that was considered in the studies. A review of literature regarding flow bulking suggests that bulking may not be a significant factor affecting PMF flows (Ref 2.2.6). This is because a PMF will have too much water for bulking to be significant. Bulking the PMF flow by 4 to 10 percent would be more than adequate. A bulking factor of 10 percent was assumed for the calculations, i.e., flows were increased by 10% to account for bulking and provide conservatism. Since the choice of this parameter is based primarily on literature, no confirmation is required.

### 6.1.5 Channel Properties

Manning's n roughness coefficient, which is used to calculate hydraulic losses of flows through a channel system, is needed for the HEC-1 and HEC-RAS models. Three different values for Manning's n, representing a lower limit, upper limit, and best estimate of PMF flow conditions, were considered for the analyses. The three different values for Manning's n that were considered are described below.

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### **Clear Water Flow (Lower Limit)**

Typically, a single value for Manning's n is used for the main channel, and a different coefficient is used for floodplains. Manning's n for clear flow conditions is based on typical values published in the literature (see Ref 2.2.10 pp. 101-123). A Manning's n value of 0.035 for the channel and a value of 0.05 for the floodplain would be appropriate based on ground cover and surface features shown in the project vicinity (Ref. 2.2.11, pp. 4-5; Ref. 2.2.22, pp. 6-10) and observed at the site in January 1999.

#### **High Sediment Transport (Best Estimate)**

During a PMF, the bed form is assumed to be continually changing and transporting large quantities of sediment, and may uproot plants and carry them and debris in the flow. This process will have the effect of increasing the effective roughness coefficient of the flow. Ref. 2.2.21 (pp. 197-371) lists Manning roughness coefficients for these forms and suggests increasing Manning's n by 0.02 to account for changing bed forms.

The degree of obstructions to the flow can also increase the Manning's n value. Obstructions include such things as debris deposits, exposed roots, floating vegetation that snag on downstream vegetation, and boulders. The Manning's n is increased by a value of 0.02 to account for obstructions during high sediment transport conditions, as recommended in Ref. 2.2.10 (pp. 101-123). Assuming a base roughness of 0.05 and adding values of 0.02 and 0.02 for bed forms and obstructions, respectively, results in a Manning's n value of 0.09 for high sediment transport conditions.

#### Mudflow (Upper Limit)

Under extreme sediment and debris transport conditions, a mudflow phenomenon may result in which the concentration of sediments in the water is greater than 20 percent by volume. Mudflows behave differently than clear water flow in that they have higher viscosity and internal shear stress. Calibration studies presented in the literature (Ref. 2.2.12, pp. 21-30) that simulated observed mudflows at several sites having field measurements indicated that the effective Manning's n roughness coefficient for mudflows ranged from 0.07 to 0.35. A conclusion of the calibration studies was that a Manning's n value of 0.16 provides the best fit when all data are considered.

Although it is expected that a significant amount of sediment and debris will be transported by the PMF, the amount of clear water runoff will be very large and it is unlikely that a mudflow condition will develop. On the other hand, it is likely that relatively large amounts of sediment will be transported by the runoff and a roughness that is higher than a clear water flow value of 0.035 is expected. Thus, a Manning's n roughness coefficient of 0.09 was assumed in the analyses. This assumed roughness will provide conservatively high estimates of water surface elevations without significantly underestimating peak discharges from the sub-areas since HEC-1 calculated peak flows from the sub-areas are not sensitive to assumed channel roughness. Higher Manning's n values would tend to decrease peak flows but would have no effect on the calculated lag time or time of concentration, which have a greater effect on the peak flows calculated by HEC-1. In HEC-RAS, the higher Manning's n values tend to increase water

surface elevations. The results of a sensitivity analysis were provided in a previous study (Ref. 2.2.6, Section 6.3) for the three flow scenarios discussed above.

The Muskingum-Cunge method (Ref. 2.2.23, pp. 40-41) was used to perform HEC-1 hydrograph routing along the channels through the watershed network. Inputs for the HEC-1 model are presented in Table 6-2 and include the length, slope, and channel dimensions. Dimensions of the man-made channels were taken from the preliminary drawings included in Attachment A. Dimensions of the natural channels were based on the topographic data described in Section 4.2.3. In general the attenuation of peak flows is not sensitive to the assumed channel size.

To initiate the channel routing in HEC-RAS, a normal depth flow condition, based upon channel bed slopes, roughness and discharge were assumed at the boundaries of the man-made channel system around the Aging Pads and North Portal Facilities areas. Bed slopes at the upstream boundaries of channel Segments 1, 2, and 3 (see Section 4.4 and Figures 6-1 and 7-1 for Segment definition) were estimated from the topographic data described in Section 4.2.3 and are 0.044, 0.037, and 0.033, respectively. Flows at these upstream boundaries were obtained from the HEC-1 output. At the downstream outlet of the channel system, the combined flow in the channels and the 0.025 bed slope at the outlet were used to calculate normal depth flow for Segment 3. At the downstream boundaries of Segments 1 and 2, water surface elevations at the junctions of the channel segments were calculated by the HEC-RAS model using the flow downstream from the junction and the channel slope and geometry at the junction.

Channel Name <sup>1</sup>	Length (ft)	Slope (ft/ft)	Bottom Width (ft)	Side Slope (h:1)
SB1toCP1	2400	0.02	78	3
CP1toCP2	2600	0.02	68	3
CP2toCP3	3500	0.02	88	3
CP3toCP4	4100	0.03	30	4
CP4toCP9	3000	0.02	30	20
CP5toCP6	2000	0.03	30	20
CP6toCP7	2100	0.02	30	10
CP7toCP8	2000	0.02	30	4
CP8toCP9	1700	0.02	30	4
SB7toCP5	3200	0.04	30	20
SB9toCP6	4700	0.03	. 30	20

 Table 6-2. Properties of Channels Used in HEC-1 Model

1. Channel name used in HEC-1 files, Attachment B.

### 6.1.6 Culvert Sizes

As shown in Attachment A, project facilities include a set of culverts that pass under the "H" road (H road culverts) located southeast of the North Portal Facilities area. As input to the HEC-RAS model and shown on the preliminary drawings in Attachment A, the H road culverts consist of eight 48–foot by 20-foot arch culverts. For later stages of design, other options, such as a bridge, could be used instead of the culverts to convey the PMF.

### 6.2 PROBABLE MAXIMUM FLOOD ANALYSIS

A rainfall-runoff simulation was performed using the HEC-1 computer software (Ref. 2.2.4) to determine PMF flows at pertinent locations in the vicinity of the North Portal and Aging Pad facilities. The study area encompasses Midway Valley Wash, Drillhole Wash, and Split Wash, and is bounded by Yucca Mountain to the west, and Fran Ridge and Alice Hill to the south and east. The area was divided into 17 sub-areas as presented in Figure 6-1 to provide information on flows near the surface facilities. The sub-area boundaries were modified from the previous report (Ref. 2.2.7) to reflect changes in design layout.

### 6.3 FLOOD INUNDATION ANALYSIS

Flood inundation calculations were performed for each channel Segment shown on Figure 6-1 and described in Section 4.4. Cross-sections for the HEC-RAS model (Ref. 2.2.5) for each Segment were cut from the TIN described in Section 6.1.1 using the ArcGIS software (Ref. 2.2.31, 2.2.20). Figure 7-1 shows the locations of the cross-sections.

### 7 **RESULTS AND CONCLUSIONS**

### 7.1 **PROBABLE MAXIMUM FLOOD RESULTS**

This calculation demonstrates that the designed drainage features, as depicted in Attachment A, are adequate to protect the GROA nuclear facilities from flooding associated with the Probable Maximum Precipitation (PMP) event. This conclusion is based on the peak discharges and flood inundation levels summarized below.

Table 7-1 summarizes peak discharges calculated by the HEC-1 computer software (Ref. 2.2.4) using the inputs and assumptions discussed in the preceding report sections. The complete HEC-1 inputs and results are included in Attachments B and C. In addition to the discharge for individual sub-areas, HEC-1 also calculated PMF discharges at flow concentration points where hydrographs from two or more sub-areas are combined before being routed downstream. The peak flow at a concentration point is not simply the sum of the peak flows from each contributing sub-area because the HEC-1 software routes the entire flood hydrograph downstream, and the time to reach peak flow varies between sub-areas. The locations of sub-areas and flow concentration points are shown on Figure 6-1. The HEC-1 schematic is included in Attachment F.

Sub-Area	Peak Flow from HEC-1 (cfs)	Peak Flow with 10% Bulking Factor (cfs)		Flow Concentration Point	Peak Flow from HEC-1 (cfs)	Peak Flow with 10% Bulking Factor (cfs)
SB1	4,097	4,510		CP1	6,164	6,780
SB2	2,881	3,170		CP2	18,927	20,820
SB3	7,148	7,860		CP3	20,138	22,150
SB4	5,782	6,360		CP4	25,090	27,600
Aging1	3,436	3,780	A SAN	CP5	14,235	15,660
SB5	1,925	2,120		CP6	23,427	25,770
SB6	3,290	3,620	-	CP7	24,733	27,210
SB7	10,053	11,060	4	CP8	24,935	27,430
SB8	5,757	6,330		CP9	50,219	55,240
SB9	8,684	9,550				
SB10	3,043	3,350				
SB11	2,924	3,220				
SB12	1,300	1,430	<u>.</u>			
SB13	1,555	1,710				

Table 7-1. Results of PMF Analysis

### 7.2 FLOOD INUNDATION RESULTS

### 7.2.1 Flood Inundation Along Channel Segment 1

HEC-RAS software (Ref. 2.2.5) was employed using the cross-section data described in Section 6.1.1.

Table 7-2 summarizes results of the flood routing analysis of PMF peak flow through channel Segment 1. Cross-section locations along channel Segment 1 are shown in Figure 7-1. Between cross-sections 8069 and 9716, channel Segment 1 is located adjacent to the man-made dike system. Downstream from cross-section 8069, between cross-sections 2 and 7695, the ground slopes away from the dike and flow is no longer against the dike. Channel bed, PMF water surface, and minimum top-of-bank profiles along channel Segment 1 are presented in Attachment D.

Theoretically, the peak flow along a channel reach increases gradually toward the downstream direction because the peak flow at a particular channel cross-section is only the peak flow from the drainage area upstream of this cross-section. It is not practical to calculate the peak flow for each individual cross-section. Instead, the PMF peak flows calculated for sub-areas or concentration points in Table 7-1 were applied to the appropriate cross-sections in the HEC-RAS model. For Segment 1, the PMF peak flow of 2,120 cfs for Sub-Area SB5 was used for the reach between cross-sections 2219 to 9716. Downstream of cross-section 1938, where Segment 1 merges with Segment 2, the total flow of 27,600 cfs at Flow Concentration Point CP4 was used

to account for the possibility that PMF peak flows in Segment 2 and from Sub-Area SB6 may merge into Segment 1.

Between cross-sections 7695 and 9716 and between 945 and 2219, ineffective flow areas were defined for the left (when facing downstream) portions of the cross-sections. This compensates for the possibility of an obstruction to the left of the main channel because the HEC-RAS software treats ineffective flow areas as stagnant, so they are not actively conveying. This approach keeps the majority of the PMF peak flow staying in the main flow path for more conservative flood inundation estimations. Otherwise, the HEC-RAS model would actively convey flow through the portions of the cross-section with the lowest elevations, whether these occur along the main channel or the overbanks.

Stream Cross- Section	Peak PMF Flow	Channel Invert Elevation	Water Surface Elevation	Channel Velocity	Channel Top width	Levee Elevation <sup>(1)</sup>	Levee Free Board <sup>(1)</sup>
	(cfs)	<u>(ft)</u>	(ft)	(ft/s)	(ft)	<u>(ft)</u>	(ft)
9716	2120	3858.2	3862.1	4.9	430.6	3862.4	0.3
9310	2120	3840.5	3844.4	6.6	295.8	3852.5	8.1
8892	2120	3822.5	3826.4	5.8	146.4	3837.5	11.2
8494	2120	3806.8	3811.9	5.9	256.9	3818.1	6.2
8069	2120	3790	3794.6	6.3	297.9	3800.6	6
7695	2120	3771.9	3775.8	6.1	279.4	3784.1	8.3
7306	2120	3749.2	3755.1	9.1	56.5	3771.9	16.8
7030	2120	3737.1	3745.1	7.6	61.3	3771.3	26.2
6730	2120	3730.1	3736.1	7.2	72.7	3762.2	26.1
6433	2120	3723.9	3728.8	5.8	98.5	3750.6	21.8
6041	2120	3711	3717.4	8.1	63.1	3739	21.6
5558	2120	3698	3703.3	6.1	94.3	3722.8	19.5
5180	2120	3686	3690.7	7.6	84.4	3718.8	28
4815	2120	3676.4	3681.9	5.2	104	3699	17.2
4487	2120	3668	3673.3	7.1	95.1	3688.2	14.9
4064	2120	3658	3662.9	4.8	133.3	N/A	N/A
3468	2120	3642	3645.1	7.7	100	N/A	N/A
3008	2120	3628	3634.9	4.5	124.2	N/A	N/A
2601	2120	3619.8	3623.1	8.8	99.6	N/A	N/A
2219	2120	3608	3617.2	1.3	509.4	N/A	N/A
1938	27600	3602	3612.5	8.1	1113.6	N/A	N/A
1656	27600	3594	3603.7	9.4	748.6	N/A	N/A
1426	27600	3588	3597.4	7.8	1044.3	N/A	N/A
1183	27600	3582	3589.3	9.3	998.2	N/A	N/A
945	27600	3576	3582.6	7.4	1097.1	N/A	N/A
661	27600	3568.8	3576.2	6.4	1395.8	N/A	N/A
439	27600	3563.9	3571.3	7	1361.6	N/A	N/A
240	27600	3560	3567.5	7.2	1303.2	N/A	N/A
2	27600	3556	3563.4	5.8	1349.6	N/A	N/A

 Table 7-2. Flood Inundation Results for Segment 1

(1) N/A = Not applicable. Between sections 4064 and 2, channel Segment 2 is between the dike and channel Segment 1, so levee elevations and free board have been provided for channel Segment 2 in Table 7-3.

### 7.2.2 Flood Inundation Along Channel Segment 2

Table 7-3 summarizes results of the flood routing analysis of PMF peak flows through channel Segment 2. Cross-section locations along channel Segment 2 are shown in Figure 7-1. Between cross-sections 14681 and 2799, channel Segment 2 is located adjacent to the man-made dike system. Downstream from cross-section 2589, between cross-sections 1 and 2589, the ground slopes away from the dike and flow is no longer against the dike.

Downstream from the southwest corner of the Aging Pad complex, where channel Segment 2 crosses the dike system (cross-section 10287 to 9676), the right (south) channel bank is adjacent to the North Portal Loop East dike system. Channel bed, PMF water surface, and minimum top-of-bank profiles along channel Segment 2 are presented in Attachment D.

The PMF peak flow at each cross-section was determined with a similar approach as discussed in 7.2.1.

Stream Cross- Section	Peak PMF Flow (cfs)	Channel Invert Elevation (ft)	Water Surface Elevation (ft)	Channel Velocity (ft/s)	Channel Top width (ft)	Left Levee Elevation <sup>(1)</sup> (ft)	Left Levee Free Board <sup>(1)</sup> (ft)	Right Levee Elevation <sup>(1)</sup> (ft)	Right Levee Free Board <sup>(1)</sup> (ft)
14681	4510	3858.4	3865.8	3.8	433.4	- 3868.4	2.6	N/A	N/A
14432	4510	3854.6	3861.4	6.6	407.6	3869.5	8.1	N/A	N/A
14197	4510	3850	3855.3	5.8	432.1	3860	4.7	N/A	N/A
13836	4510	3842.5	3844	5.2	421.2	3852.7	8.7	N/A	N/A
13567	4510	3824	3832.8	4.9	213.9	3844	11.2	N/A	N/A
13161	4510	3818.6	3821.3	7.4	370.5	3836.5	15.2	N/A	N/A
12844	4510	3801	3809.8	4.5	140.9	3824.5	14.7	N/A	N/A
12382	6780	3796.5	3804.4	7.7	135.5	3821	16.6	N/A	N/A
12063	6780	3790	3797	8.8	130.2	3816.5	19.5	N/A	N/A
11833	6780	3780	3786.2	12.6	105.2	3810	23.8	N/A	N/A
11529	6780	3769.7	3779.3	7.3	125.6	3800	20.7	N/A	N/A
11193	6780	3765	3775.2	6.8	129	3789.7	14.6	N/A	N/A
10949	6780	3761	3773.9	4.6	173.4	3785	11.1	N/A	N/A
10642	6780	3760	3772.2	5.3	141.2	3781	8.8	N/A	N/A
10287	6780	3760	3765.4	12.1	120.2	N/A	N/A	N/A	N/A
9909	6780	3749.1	3758.8	3.8	380.5	N/A	N/A	N/A	N/A
9676	20820	3744.7	3751.2	13.4	490.6	N/A	N/A	3757.7	6.5
9350	20820	3727	3735.4	12.9	514.2	N/A	N/A	3747	11.6
9065	20820	3712	3723.9	11.9	499.9	N/A	N/A	3732	8.1
8785	20820	3706	3721.1	8.3	412.2	N/A	N/A	3726	4.9
8483	20820	3701.8	3719	7.8	277.5	N/A	N/A	3721.8	2.8
8188	20820	3698.5	3717.6	7.1	280.3	N/A	N/A	3718.5	0.9
7927	20820	3698	3715.8	8.2	221.5	N/A	N/A	3718	2.2
7698	20820	3697	3713.8	8.8	237.5	N/A	N/A	3717	3.2

 Table 7-3. Flood Inundation Results for Segment 2

Stream Cross- Section	Peak PMF Flow	Channel Invert Elevation	Water Surface Elevation	Channel Velocity	Channel Top width	Left Levee Elevation <sup>(1)</sup>	Left Levee Free Board <sup>(1)</sup>	Right Levee Elevation <sup>(1)</sup>	Right Levee Free Board <sup>(1)</sup>
	(cfs)	(ft)	(ft)	(ft/s)	_(ft)	(ft)	_(ft)	_(ft)	(ft)
7489	20820	3696.3	3710.8	10.6	195.6	N/A	N/A	3716.3	5.5
7280	20820	3695.3	3710.1	6.2	283.6	N/A	N/A .	3715.3	5.2
7083	20820	3694	3705.7	14.1	179.2	N/A	N/A	3714	8.3
6922	20820	3688	3702.7	10.7	188	N/A	N/A	3708	5.3
6778	20820	3681.3	3696.4	15.3	187.1	3703.4	7	3702.3	6
6662	20820	3675.1	3692.5	9.5	267.2	3696.3	3.8	3702	9.5
6471	20820	3667.8	3683.3	16.2	156.8	3684.7	1.4	3696	12.7
6338	20820	3661.7	3678.9	10.6	220	N/A	N/A	3685	6.1
6147	20820	3656.9	3676.2	7.8	333.5	N/A	N/A	3677.8	1.6
5883	22150	3652	3671.7	9.6	257	N/A	N/A	3678.4	6.7
5618	22150	3646	3668.8	8.2	342.9	N/A	N/A	3675.6	6.8
5404	22150	3652.2	3665.1	10.7	533.4	N/A	N/A	3668.7	3.6
5234	22150	3648.7	3659.1	10.8	681.3	· N/A	N/A	3661	1.9
5070	22150	3643.9	3651	9.1	696.7	N/A	N/A	3659.3	8.3
4882	22150	3633.2	3644.3	7.5	859.2	N/A	N/A	3653.8	9.5
4636	22150	3623.4	3632.1	12.6	482.9	N/A	N/A	3646.4	14.3
4339	22150	3609.8	3622.5	8	552	N/A	N/A	3639.9	17.4
4085	22150	3604	3616.4	11.4	264	N/A	N/A	3634.6	18.3
3869	22150	3598	3610.9	9.8	293.6	N/A	N/A	3631.3	20.4
3657	22150	3592.7	3605.6	10.1	300.2	N/A	N/A	3626.7	21.1
3460	22150	3588	3600.9	9.5	330.6	N/A	N/A	3622.3	21.3
3257	22150	3584.7	3595.6	9.2	416.3	N/A	N/A	3617.3	21.7
3012	22150	3579	3590.5	7.2	522.4	N/A	N/A	3612.4	21.9
2799	22150	3574	3582.4	11.2	518.6	N/A	N/A	3608.6	26.2
2589	27600	3569	3576.2	5.1	1395.8	N/A	N/A	3604.4	28.2
2357	27600	3563.9	3571.3	5.8	1361.6	N/A	N/A	3599.8	28.6
2180	27600	3560	3567.5	4.8	1303.2	N/A	N/A	3595	27.5
1943	27600	3556	3563.4	5.2	1349.3		 N/A	3590.4	27
1722	27600	3552	3559.5	6	1241.9	N/A	N/A	3587.3	27.8
1499	27600	3548	3555	5.9	1471.8	N/A	 N/A	3584.3	29.3
1371	27600	3546	3552.9	4.7	1532.9	 N/A	N/A	3582.7	29.7
1190	27600	3541.2	3550.6	4.8	1630.7	N/A	N/A	3581.8	31.2
984	27600	3537.7	3546.8	5.9	1122	N/A	N/A	3581.2	34.4
882	27600	3534	3544.6	6.3	1096.5	N/A		3580.7	36
722	27600	3531.2	3540.5	6.8	1177.3	N/A	N/A	3580	39.5
577	27600	3528	35367	64	1259.1	N/A	N/A	3579.9	43.2
404	27600	3520	3531.5	72	1169.8	N/A	N/A	3580.8	49.3
183	27600	3520	3529.8	3.8	1233.8	N/A	N/A	3579.9	50 1
1	55240	3516.1	3528.7	5.1	1493.5	N/A	N/A	3570.8	42.1

(1) N/A = Not Applicable. The left and right levee and free board elevations are shown as N/A when the proposed dike is not adjacent to the channel on either the left or right sides.

### 7.2.3 Flood Inundation Along Channel Segment 3

Table 7-4 summarizes results of the flood routing analysis of PMF peak flows through channel Segment 3. Cross-section locations are shown in Figure 7-1. Between cross-sections 11551 and 6374, channel Segment 3 is located adjacent to the man-made dike system. Downstream from cross-section 6374, between cross-sections 647 and 6068, the ground slopes away from the dike and flow is no longer against the dike.

Eight 48-foot by 20-foot arch culverts were assumed to convey flow under the "H" road. These culverts can convey the PMF flow under the road with approximately 13 feet of freeboard to the road crest. In the final design, use of a bridge instead of the culverts should be considered. Downstream from the culverts, flow exits Midway Wash.

In Table 7-4, the levee elevations between cross-sections 11551 and 1599 were based on the height of the dike on the left bank of Segment 3 (facing downstream) along the North Portal Loop West, as shown in Attachment A. Between cross-sections 1184 and 647, the levee elevations shown in Table 7-4 were based on the height of the "H" Road (south of channel Segment 3) as shown in Attachment A. However, the elevation of the "H" Road is preliminary, so the downstream inundation area was not mapped in detail on Figure 7-1, and the elevations for sections downstream of cross-section 647 were not shown in Table 7-4.

Channel bed, PMF water surface, and minimum top-of-bank profiles along channel Segment 3 are presented in Attachment D.

The PMF peak flow at each cross-section was determined with a similar approach as discussed in 7.2.1. Ineffective flow areas were defined between cross-sections 10716 and 11551.

Stream Cross- Section	Peak PMF Flow	Channel Invert Elevation	Water Surface Elevation	Channel Velocity	Channel Top width	Levee Elevation	Levee Free Board
	(cfs)	(ft)	(ft)	(ft/s)	<u>(ft)</u>	(ft)	(ft)
11551	15660	3795.8	3801.8	6.9	767.6	3807.8	6
11423	15660	3790.2	3796.9	7.8	549.6	3802.2	5.3
11278	15660	3784.4	3791.2	7.8	558.2	3796.1	4.8
11135	15660	3777.4	3785.5	7.6	598	3790.1	4.6
11003	15660	3772.7	3779.4	8.4	522.8	3784.7	5.3
10837	15660	3766	3772.3	8	567.2	3777.8	5.6
10716	15660	3761.5	3767.1	8	639	3772.8	5.7
10536	15660	3754	3758.9	7.4	695	3765.4	6.5
10312	15660	3743.7	3749.6	7	699.2	3756.2	6.6
10074	15660	3734	3739.3	7.4	719.5	3746	6.7
9863	15660	3724.9	3730.2	6.3	916.3	3737.1	6.8
9681	15660	3717.1	3721.1	7.3	892.3	3729.4	8.3
9526	15660	3708.4	3714.2	6.4	819.6	3723.2	9
9328	15660	3700	3706.3	7.3	722.5	3714.7	8.4
9095	15660	3691.8	3697.6	7	657.5	3704.8	7.2
8895	15660	3684	3689.7	8	587.2	3696.6	7

#### Table 7-4. Flood Inundation Results for Segment 3

Stream Cross- Section	Peak PMF Flow (cfs)	Channel Invert Elevation (ft)	Water Surface Elevation (ft)	Channel Velocity (ft/s)	Channel Top width (ft)	Levee Elevation (ft)	Levee Free Board (ft)
8736	15660	3678	3684	74	520.1	3690.2	62
8595	15660	3673.9	3679.4	8	479.6	3684 1	4 7
8468	15660	3668	3677	6.6	526.6	3679.6	2.6
8319	15660	3665.4	3673.2	8.5	1001	3674.4	1.2
8177	15660	3660.9	3667.9	53	1337 3	3670.5	2.6
8007	15660	3658.2	3661.8	4.9	1499.5	3667.0	5.2
7811	15660	3650.8	3655.3	4.9	1558.4	3662.8	7.5
7616	15660	3644.9	3650.7	3.9	1561.6	3658.8	8.1
7380	15660	3639.5	3645.8	5.3	921.7	3655.1	9.3
7117	15660	3634	3639.4	5.8	812.6	3652.0	12.6
7014	15660	3631	3636.2	6	993.6	3650.6	14.4
6935	15660	3628.6	3632.5	5.9	1444.1	3648.5	16.0
6735	15660	3618.3	3626.4	5.2	884.3	3646.7	20.3
6374	15660	3608.6	3617	7.3	568.6	3644.2	27.2
6068	15660	3601.6	3611.2	5.2	676.2	3643.3	32.1
5842	25770	3598	3606.9	6.7	818.2	3638.8	31.9
5612	25770	3592	3601.7	6.1	1146.7	3634.5	32.8
5250	25770	3586	3594.6	6.1	828.6	3630.3	35.7
5033	25770	3582	3590.8	6.5	800.9	3624.4	33.6
4778	25770	3576	3586.5	6.3	776.3	3621.7	35.2
4479	25770	3570.6	3583	5.7	670.2	3615.0	32.0
4191	25770	3566	3580.6	5.1	762.4	3606.8	26.2
3806	27210	3560	3574.4	9.2	489.2	3603.0	28.6
3472	27210	3554	3567.4	7.4	600	3600.7	33.3
3272	27210	3551.8	3564.7	6.1	704.9	3587.9	23.2
2855	27210	3543	3557.8	8.4	468.4	3584.5	26.7
2552	27210	3538	3552.3	8	479	3581.6	29.3
2270	27210	3532	3546.9	8.5	459.2	3578.3	31.4
2191	27210	3532	3545.5	8.1	497.9	3574.3	28.8
2044	27210	3530		6.6	557	3572	28.3
1860	27430	3527.6	3541.2	7.4	487.1	3570	28.8
1599	27430	3522	3532.2	13.8	342.7	3567	34.8
1406	Culvert						
1184	27430	3513.1	3528.9	3.9	768	3533.7	4.7
1160	27430	3512	3528.9	3.8	827.2	3532.7	3.9
1139	27430	3512	3528.8	3.8	889.5	3532	3.2
1108	27430	3512	3528.7	3.8	819.9	3531.4	2.7
1060	27430	3512	3528.6	4.1	751.2	3530.8	2.2
1019	27430	3512	3528.5	4	823.9	3530.4	1.9
966	55240	3512	3527.1	9.1	712.4	3529.9	2.8
890	55240	3511.2	3525.7	10	655.9	3528.4	2.7
813	55240	3510	3524.3	10.2	729.8	3525.3	1.1
647	55240	3506	3519.3	12.5	580.9	3519.5	0.2

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# Attachment B Input File for HEC-1 Model 000-CDC-MGR0-00100-000 - 00 A Page 1 of 3

ID HEC-1 FLOOD HYDROGRAPH SIMULATION ID YUCCA MOUNTAIN FLOOD STUDY PROJECT ID ANALYSIS BY URS CORPORATION IDFILE IDENTIFICATION INFORMATION IDFILENAME\\S021emc2\yucca_pmf_study\HEC1\HEC-1\FINAL4.HC1 * this run is based on response to comments * FIND Q AT CRITICAL LOCATIONS AFTER CONSTRUCTION OF FACILITIES * NUMBER OF BASINS DEFINED USING THE 2007 DRAWINGS SHOWN IN * ATTACHMENT A.	ID ID ID ID	036 036 036 036 036 036 001
* SET BASE OF WATERSHED AT THE GAP AT ALICE HILL ID USE PMP CALCULATED FOR STORM AT PORTAL & FACILITY ID PMP obtained from previous PMF study - ANL-EBS-MD-000060 Rev 00D ID PMP - 10/1/98 (COE ENGINEERING MANUAL TIME SEQUENCE)	* ID ID	001 036 036
* TD *DIAGRAM IT 3 010CT98 0000 200 IO 3 0 * * vatersheds are input in order from NE to SW as much as possible	* ID *DIAGRAM IT IO *	001 001 036 002 040 039 001
* * *		
* KK SB1 watershed KM SCS RUNOFF COMPUTATION FOR SB1 BA 0.83 IN 3 010CT98 0000 DB	* KK KM BA IN DP	001 045 046 008 038
PI       .015       0.015       .025       .085       .085       .085	.015PI .015PI .025PI .025PI .085PI .085PI .38PI .14PI	073 073 073 073 073 073 073 073 073
PI       .04       .0	.04P1 .025P1 .025P1 .025P1 LU UD	073 073 073 073 057 112
KKSB1CP1 KM ROUTE HYDROGRAPH FROM SB1 TO CP1 RD 2400 .02 .09 TRAP 78 3 *	KK KM RD *	045 046 087 001
KK SB2 KM SCS RUNOFF COMPUTATION FOR SB2 BA 0.42 UD .40 *	KK KM BA UD	045 046 008 112
KK CP1 KM COMBINE FLOWS FROM SB1 AND SB2 HC 2 *	КК КМ НС	045 046 030
KKCP1CP2 KM ROUTE HYDROGRAPH FROM CP1 TO CP2 RD 2600 .02 .09 TRAP 68 3	KK KM RD	045 046 087
KK SB3 KM SCS RUNOFF COMPUTATION FOR SB3 BA 1.6 UD .73	KK KM BA	045 046 008
KK SB4 KM SCS RUNOFF COMPUTATION FOR SB4 BA 1.2 UD .66	KK KM BA	045 046 008
KK CP2 KM COMBINE FLOWS FROM SB3, SB4 and CP1 HC 3	* КК КМ НС	001 045 046 030
KKCP2CP3	KK	045

# Attachment B Input File for HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 2 of 3

KM RD	ROUTE 3500	HYDROGRAP .02	H FROM ( .09	CP2 TO CI	P3 TRAP	88	3			KM RD	046 087	
* KK	AGING		EDOM Da	ing nod a	TOO USING		দ্য এম	FI FMFNT		КК	045 KM	046
BA LU	0.460 1	1.5	25.5	ing pau a	1.5	100	I DOM			BA LU	008 057	040
UK	4000	.03	.1	83	50 50					UK	114 114	
RK	3500	.02	.09	17	TRAP	88	3	NÓ	50	0R	111	
*	<b>6 b c</b>									*	001	
KK KM	CP3 COMBIN	E FLOWS FR	OM CP2	and Aging	gl					KK KM	045	
HC *	2									HC	030	
KKC	P3CP4	UVDDOGDAD	UL EDOM	(CD2 TEO (1)	D4					KK	045	
RD	4100	.03	.09	CF3 10 CI	TRAP	30	4			RD	087	
* КК	SB5									кк	045	
KM BA	SCS	RUNOFF COM	IPUTATIO	N FOR SB	5					KM BA	046 008	
LU	1	1.5	0							LU	057	
*	.64											
KK KM	SB6 SCS	RUNOFF COM	PUTATIO	N FOR SB	6					KK KM	045	
BA UD	0.76									BA	008	
* vv	CD4									VV	045	
KM	COMBIN	E FLOWS FR	ROM SB5,	SB6 and (	CP3					KM	046	
HC *	3									HC	030	
KK( KM	CP4CP9 ROUTE	HYDROGRAF	H FROM	CP4 TO CI	P9					KK KM	045 046	
RD	3000	.02	.09		TRAP	30	20			RD	087	
кк	SB13									кк	045	
км ВА	SCS 0.19	RUNOFF COM	IPUTATIO	N FOR SB.	13					KM BA	008	
UD *	.30											
* E *	Bottom	of Norther	n water	shed								
*												
*												
* КК	SB7	south Port	al Area							кк	045	
KM BA	SCS RU 2.9	NOFF COMPU	JTATION	FOR SB7						KM BA	046	
PB		0 000	000	000		000	0.00		000	PB	069	
PI	.020	0.020	.020	.020	.020	.020 .	020	.020	.020	.020P1 .020PI	073	
PI PT	.030	.030	.030	.030	.030	.030 .	030	.030	.030	.030PI	073	
PI	.080	.080	.080	.080	.080	.080 .	080	.080	.080	.080PI	073	
ΡI	.080	.080	.080	.080	.080	.080 .	080	.080	.080	.080PI	073	
PI	1.10	1.10	1.10	1.10	1.10	.36	. 36	.36	.36	.36PI	073	
PI	. 04	. 18	.18	.18	.18	.16	.16	. 16	.16	.16P1	073	
ΡI	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04PI	073	
PI	.025	.025	.025	.025	.025	.025 .	025	.025	.025	.025PI	073	
PI UD	.025	.025	.025	.025	.025	.025 .	025	.025	.025	.025P1 UD	073	
*										*	001	
KKS KM	B7CP5 ROUTE	HYDROGRAF	H FROM	SB7 TO CI	P5					KK KM	045 046	
RD	3200	.04	.09		TRAP	30	20			RD	087	
кк	SB8									ĸĸ	045	
KM BA	SCS RU	NOFF COMPU	JTATION	FOR SB8						КМ вл	046	
UD	.60									UD	112	
* КК	CP5									кк	045	

Attachment B Input File for HEC-1 Model 000-CDC-MGR0-00100-000- OP A Page 3 of 3

KM HC *	COMBINE HYDROGRAPHS FROM SB7, SB8 2			KM HC	046 030
KKC	P5CP6			КК	045
КM	ROUTE HYDROGRAPH FROM CP5 TO CP6			KM	046
RD *	2000 .03 .09 TRAP	30	20	RD	087
KK	SB9			КК	045
КM	SCS RUNOFF COMPUTATION FOR SB9			KM	046
ΒÀ	1.7			BA	008
ITD	55				112
*	. 55			*	001
vvc				VV	045
KK2	BUCPO			KK.	045
KIM.	ROUTE HYDROGRAPH FROM SB9 TO CP6			KIM	046
RD *	4700 .03 .09 TRAP	30	20	RD	087
KK	SB10			KK	045
KΜ	SCS RUNOFF COMPUTATION FOR SB10			KM	046
BA	0.44			BA	008
Ш	.35			UD	112
*					<b>_</b>
кк	CP6			КК	045
KM	COMPTNE HYDROCRADHS EROM CD5 SB10 SB9			KM	046
UC	2				030
нс *	5			lic	030
KKC	P6CP7			KK	045
КM	ROUTE HYDROGRAPH FROM CP6 TO CP7			KM	046
RD	2100 .02 .09 TRAP	30	10	RD	087
*					
KK	SB11			KK	045
КM	SCS RUNOFF COMPUTATION FOR SB11			KM	046
BA	0.46			вА	008
UD	40			ID	112
*				02	
кк	CP7			кк	045
KM	COMBINE HYDROGRADHS FROM CD6 CB11			KM	046
IIC	2				030
*	2			пс	050
KKC	CP7CP8			KK	045
KΜ	ROUTE HYDROGRAPH FROM CP7 TO CP8			KM	046
RD	2000 .02 .09 TRAP	30	4	RD	087
*					
KΚ	SB12			KK	045
КM	SCS RUNOFF COMPUTATION FOR SB12			KM	046
BA	0.15			BA	008
UD	. 24			UD	112
*	<b>67</b> .0				•
КΚ	CP8			KK	045
КM	COMBINE HYDROGRAPHS FROM CP7, SB12			KM	046
HC *	2			HC	030
KKC	יסמיאמי			VV	045
KW	ROUTE HYDROGRADH FROM CDR TO CDA				045
ייטי		20	2		040
кD *	1700 .02 .09 TRAP	30	د	ЦЯ	087
*	combine south and north portal areas				
*					
КK	CP9			KK	045
KМ	COMBINE HYDROGRAPHS FROM CP4, SB13, CP8			KM	046
HC	3			HC	030
*					

\* ZZ

# Attachment C Output File from HEC-1 Model

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

1***	******	*****	******	******	*****
*					*
*	FLOOD	HYDROGRA	PH PACK	AGE (H	EC-1) *
*		JU	N 199	8	*
*		VERSI	ON 4.1	•	*
*					*
*	RUN DAT	TE 10AU	IG07 TI	ME 10:	41:35 *
*					*
***	******	* * * * * * * * *	******	******	* * * * * * * * *

1

Х	х	XXXXXXX	XX	XXX		х
Х	Х	Х	х	х		XX
Х	Х	Х	Х			х
XXXXX	XXX	XXXX	Х		XXXXX	х
Х	Х	Х	Х			х
Х	Х	Х	Х	Х		х
Х	Х	XXXXXXX	XX	XXX		XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HECIGS, HECIDB, AND HECIKW.

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

	HEC-1 INPUT	PAGE 1
LINE	ID12345678910	
1	ID HEC-1 FLOOD HYDROGRAPH SIMULATION	
2	ID YUCCA MOUNTAIN FLOOD STUDY PROJECT	
3	ID ANALYSIS BY URS CORPORATION	
4	ID FILE IDENTIFICATION INFORMATION	
5	ID FILENAME\\S021emc2\vucca pmf study\HEC1\HEC-1\FINAL4.HC1	
	* this run is based on response to comments	
	* FIND O AT CRITICAL LOCATIONS AFTER CONSTRUCTION OF FACILITIES	
	* NUMBER OF BASING DEFINED USING THE 2007 DRAWINGS SHOWN IN	
	* ATTACHMENT A	
	*	
	*	
	* SET BASE OF WATERSHED AT THE GAP AT ALICE HILL	
6	ID USE DMP CALCULATED FOR STORM AT PORTAL & FACILITY	
7	ID DMD obtained from previous PMF study - ANL-EBS-MD-000060 Rev 00D	
, A	ID DMD - 10/1/48 (COF ENGINEERING MANIAL TIME SECUENCE)	
Ū	*	
	*	
0		
5		
10		
10	11 3 0100196 0000 200	

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- coA Page 2 of 46

נו	
	<ul> <li>watersheds are input in order from NE to SW as much as possible</li> <li>*</li> <li>*</li> <li>*</li> </ul>
12 13 14 15 16	KK SB1 watershed KM SCS RUNOFF COMPUTATION FOR SB1 BA 0.83 IN 3 010CT98 0000 PB
17 18 19 20 21 22 23 24 25 26 27 28 29 20	PI       .015       0.015       .025       .025
31 32 33	<pre>KK SB1CP1 KM ROUTE HYDROGRAPH FROM SB1 TO CP1 RD 2400 .02 .09 TRAP 78 3</pre>
	* HEC-1 INPUT PAGE 2
LINE	ID1
34 35 36 37	KK SB2 KM SCS RUNOFF COMPUTATION FOR SB2 BA 0.42 UD .40 *
38 39 40	KK CP1 KM COMBINE FLOWS FROM SB1 AND SB2 HC 2 *
41 42 43	KK CP1CP2 KM ROUTE HYDROGRAPH FROM CP1 TO CP2 RD 2600 .02 .09 TRAP 68 3 *
44 45 46 47	KK SB3 KM SCS RUNOFF COMPUTATION FOR SB3 BA 1.6 UD .73 *

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Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 3 of 46

48 49 50 51	KK KM BA UD *	SB4 SCS RUNOFF COMPUTATION FOR SB4 1.2 .66	
52 53 54	КК КМ НС *	CP2 COMBINE FLOWS FROM SB3, SB4 and CP1 3	
55 56 57	KK KM RD *	CP2CP3 ROUTE HYDROGRAPH FROM CP2 TO CP3 3500 .02 .09 TRAP 88 3	
58 59 60 61 62	KK KM BA LU UK	AGING COMPUTE RUNOFF FROM Aging pad area USING OVERLAND FLOW ELEMENT 0.460 1 1.5 25.5 1 1.5 100 4000 .03 .1 83 50	
63 64	UK RK *	900 .02 .1 17 50 3500 .02 .09 TRAP 88 3 NO 50 *	
65 66 67	КК <b>КМ</b> НС *	CP3 COMBINE FLOWS FROM CP2 and Aging1 2	
		HEC-1 INPUT	PAGE 3
LINE	ID	1	
68 69 70	KK KM RD *	CP3CP4 ROUTE HYDROGRAPH FROM CP3 TO CP4 4100 .03 .09 TRAP 30 4	
71 72 73 74 75	KK KM BA LU VD *	SB5 SCS RUNOFF COMPUTATION FOR SB5 0.39 1 1.5 0 .64	
76 77 78 79	KK KM BA UD *	SB6 SCS RUNOFF COMPUTATION FOR SB6 0.76 .76	
80 81 82	KK KM HC *	CP4 COMBINE FLOWS FROM SE5,SB6 and CP3 3	

Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 4 of 46

83 84 85	KK KM RD *	CP4CP9 ROUTE 3000	HYDROGRA .02	PH FROM .09	CP4 TO C	CP9 TRAP	30	20						
86 87 88 89	KK KM BA UD *	SB13 SCS 0.19 .30	RUNOFF CO	MPUTATIO	n for se	313								
	* Bo * * * *	ottom of	Northern	watersh	ed									
		30	uch fortu	I ALCO										
90	KK	SB7	NORE COMD	זארא די די אידידי										
92	BA	2.9	NOFF COMP	UIATION	FUR SB/									
93	PB													
94	PI	.020	0.020	.020	.020	.020	.020	.020	.020	.020	.020			
95	PI	.020	0.020	.020	.020	.020	.020	.020	.020	.020	.020			
96	PI	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030			
97	P1 77	. 030	.030	.030	.030	.030	.030	.030	.030	.030	.030			
99	PT	.080	.080	.080	.080	.080	.080	.080	.080	.080	.080			
100	PI	1.10	1.10	1.10	1.10	1.10	.36	.36	.000	.000	.36			
101	PI	.18	.18	.18	.18	.18	.16	.16	.16	.16	.16			
102	. PI	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04			
103	PI	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04			
					HEC-1	INPUT						PAGE	4	
LINE	ID.	1.	2	3	4	5	6	7	8	9	10			
104	PI	.025	.025	.025	.025	.025	.025	.025	.025	.025	.025			
105	PI	.025	.025	.025	.025	.025	.025	.025	.025	.025	.025			
106	UD *	.92												
107	ĸĸ	SB7CD5												
108	KM	ROUTE	HYDROGRA	PH FROM	SB7 TO C	P5								
109	RD	3200	,04	.09		TRAP	30	20						
	*													
110	кк	SB8												
111	KM	SCS RU	NOFF COMP	UTATION	FOR SB8									
112	BA	1.2												
113	UD *	.60												
114	KK	CP5												
115	KM	COMBI	NE HYDROG	RAPHS FR	OM SB7,	SB8								
116	HC	2												
	*													
117	KK	CP5CP6												

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118 119	KM ROUTE HYDROGRAPH FROM C RD 2000 .03 .09 *	P5 TO CP6 TRAP	30 20		
120 121 122 123	KK SB9 KM SCS RUNOFF COMPUTATION F BA 1.7 UD .55 *	DR SB9			
124 125 126	KK SB9CP6 KM ROUTE HYDROG <b>R</b> APH FROM SI RD 4700 .03 .09 *	39 TO CP6 TRAP	30 20		
127 128 129 130	KK SB10 KM SCS RUNOFF COMPUTATION F BA 0.44 UD .35 *	DR SB10			
131 132 133	KK CP6 KM COMBINE HYDROGRAPHS FROM HC 3 *	M CP5, SB10, SB9			
134 135 136	KK CP6CP7 KM ROUTE HYDROGRAPH FROM C RD 2100 .02 .09	P6 TO CP7 TRAP 3	0 10		
	*				
LINE	* ID	HEC-1 INPUT	. 6 7	PAGE 5	
LINE	* ID123	HEC-1 INPUT	.67	PAGE 5	
LINE 137 138 139 140	* ID123 KK SB11 KM SCS RUNOFF COMPUTATION FO BA 0.46 UD .40 *	HEC-1 INPUT 45	.67	PAGE 5	
LINE 137 138 139 140 141 142 143	* ID123 KK SB11 KM SCS RUNOFF COMPUTATION F BA 0.46 UD .40 * KK CP7 KM COMBINE HYDROGRAPHS FROM HC 2 *	HEC-1 INPUT 45 DR SB11 M CP6, SB11	.67	PAGE 5	
LINE 137 138 139 140 141 142 143 144 145 146	* ID123 KK SB11 KM SCS RUNOFF COMPUTATION FOR BA 0.46 UD .40 * KK CP7 KM COMBINE HYDROGRAPHS FROM HC 2 * KK CP7CP8 KM ROUTE HYDROGRAPH FROM CC RD 2000 .02 .09 *	HEC-1 INPUT 45 DR SB11 M CP6, SB11 P7 TO CP8 TRAP	.67	PAGE 5	
LINE 137 138 139 140 141 142 143 144 145 146 147 148 149 150	<pre>* ID123 KK SE11 KM SCS RUNOFF COMPUTATION F0 BA 0.46 UD .40 * KK CP7 KM COMBINE HYDROGRAPHS FROM HC 2 * KK CP7CP8 KM ROUTE HYDROGRAPH FROM CC RD 2000 .02 .09 * KK SE12 KM SCS RUNOFF COMPUTATION F0 BA 0.15 UD .24 *</pre>	HEC-1 INPUT 45 DR SB11 M CP6, SB11 P7 TO CP8 TRAP DR SB12	.67	PAGE 5	

Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 6 of 46

	152 153	<pre>KM COMBINE HYDROGRAPHS FROM CP7, SB12 HC 2 *</pre>	
	154 155 156	KK CP8CP9 KM ROUTE HYDROGRAPH FROM CP8 TO CP9 RD 1700 .02 .09 TRAP 30 *	
		<ul> <li>combine south and north portal areas</li> </ul>	
	157 158 159	KK CP9 KM COMBINE HYDROGRAPHS FROM CP4, SB13, CP8 HC 3 *	
	160	* ZZ	
1	SCHEMATI	IC DIAGRAM OF STREAM NETWORK	
INPUT LINE	(V) ROUTING	(>) DIVERSION OR PUMP FLOW	
NO.	(.) CONNECTOR	(<) RETURN OF DIVERTED OR PUMPED FLOW	
12	SB1 V		
31	V SB1CP1		
34	•	SB2	
38	CP1		
41	V V CP1CP2		
44	• •	SB3	
48		. SB4 	
52	CP2 V	·····	
55	V CP2CP3		
58	•	AGING	
65	CP3 V		
68	CP3CP4		

8rd Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - OA Page 7 of 46



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Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 8 of 46

			•	
151			CP8	
	-		v	
			v	
154			CP8CP9	
			•	
157	CP9			
(***) RU 1*******	NOFF ALSO COMPUT	TED AT THI	S LOCATION	
* ELOC			(1) <b>*</b>	
* FLUC	JUN 19	JAGE (HE	() *	
*	VERSION 4.1	L	*	
*			*	
* RUN D	ATE 10AUG07 1	TIME 10:4	1:35 *	
*			*	
******	* * * * * * * * * * * * * * * *	*******	* * * * * * * *	

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

HEC-1 FLOOD HYDROGRAPH SIMULATION YUCCA MOUNTAIN FLOOD STUDY PROJECT ANALYSIS BY URS CORPORATION FILE IDENTIFICATION INFORMATION FILENAME--\\S021emc2\yucca\_pmf\_study\HEC1\HEC-1\FINAL4.HC1 USE PMP CALCULATED FOR STORM AT PORTAL & FACILITY PMP obtained from previous PMF study - ANL-EBS-MD-000060 Rev 00D PMP - 10/1/98 (COE ENGINEERING MANUAL TIME SEQUENCE)

•

OUTPUT	CONTROL	VARIABLES			
]	I PRNT	3	PRINT	CONTR	lOL
]	IPLOT	0	PLOT C	ONTRO	L
ç	OSCAL	Ο.	HYDROG	GRAPH	PL

IT

11 IO

3	PRINT CONTR	OL	
0	PLOT CONTRO	L	
0.	HYDROGRAPH	PLOT	SCALE

HYDROGRAPH TIME DATA NMIN 3 MINUTES IN COMPUTATION INTERVAL IDATE 10CT98 STARTING DATE 0000 STARTING TIME ITIME NQ 200 NUMBER OF HYDROGRAPH ORDINATES NDDATE 10CT98 ENDING DATE NDTIME 0957 ENDING TIME ICENT 19 CENTURY MARK

> COMPUTATION INTERVAL .05 HOURS TOTAL TIME BASE 9.95 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES	
PRECIPITATION DEPI	H INCHES	
LENGTH, ELEVATION	FEET	
FLOW	CUBIC FEET PER SECOND	
STORAGE VOLUME	ACRE-FEET	
SURFACE AREA	ACRES	

#### TEMPERATURE DEGREES FAHRENHEIT

#### \*\*\*

#### \*\*\*\*\*\*\*\*\*

12 KK \* SB1 \* watershed

\*\*\*\*\*\*\*\*

\*

17 PI

#### SCS RUNOFF COMPUTATION FOR SB1

15 IN TIME DATA FOR INPUT TIME SERIES JXMIN 3 TIME INTERVAL IN MINUTES JXDATE 10CT98 STARTING DATE JXTIME 0 STARTING TIME

#### SUBBASIN RUNOFF DATA

\*

14 BA SUBBASIN CHARACTERISTICS TAREA .83 SUBBASIN AREA

#### PRECIPITATION DATA

#### 16 PB STORM 13.20 BASIN TOTAL PRECIPITATION

INCREMENTA	L PRECIPIT	ATION PATT	'ERN						
.01	.01	.01	.02	.01	.02	.02	.02	.01	.02
. 02	.02	.02	.02	.02	. 02	.02	.01	.01	.01
.03	.03	.03	.03	.03	.03	.03	.03	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.08	.08	.09	.09	.09	.09	.09	.09	.09	.09
.09	.09	.09	.09	.08	.09	.09	.09	.09	.09
1.18	1.18	1.18	1.18	1.18	.38	.38	.38	.38	.38
.18	.18	.18	.18	.18	.14	.14	.14	.14	.14
.04	.04	.04	.04	.04	. 04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
. 02	. 02	.02	.02	.02	.02	.02	.02	.02	.02
. 02	.02	.02	.02	.02	.02	.02	.02	.02	.02

#### 29 LU UNIFORM LOSS RATE STRTL 1.00 INITIAL LOSS CNSTL 1.50 UNIFORM LOSS RATE RTIMP .00 PERCENT IMPERVIOUS AREA

30 UD SCS DIMENSIONLESS UNITGRAPH TLAG .64 LAG

\*\*\*

				UNIT	HYDROGRAF	ΡΗ			
				66 END-OF	-PERIOD OR	DINATES			
14.	39.	74.	115.	169.	236.	313.	399.	472.	529.
570.	597.	602.	600.	587.	559.	528.	493.	453.	407.
353.	305.	265.	233.	206.	182.	162.	146.	129.	115.
101.	88.	79.	70.	62.	55.	48.	43.	38.	33.

### Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - OA Page 10 of 46

10. 3.

	29. 9.	26. 8.	23. 7.	21. 6.	18. 6.	16. 5.	14. 5.	12. <b>4</b> .	11. 3.	
	2.	2.	<i>2.</i>	⊥. _	1. 	0.				
		INCROSE			•	~ ~				
		HYDROGRA	PH AT STAT.	ION SBI						
TOTAL F	RAINFALL =	13.20, TOT.	AL LOSS =	5.12, TOT	AL EXCESS	= 8.	.08			
PEAK FLOW	TIME		C UD	MAXIMUM AV	ERAGE FLO	W	05.00			
(CFS)	(HR)	(770)	0-HK	24 - HK	/2-n.	K 2	7.93-nk			
4097.	3.85	(CFS)	721.	435.	435		435.			
		(INCHES)	8.076	8.076	8.07	6	8.076			
		(AC-FT)	358.	358.	358	•	358.			
		CUMULATIV	E AREA =	.83 SQ MI						

\*\*\* \*\*\*

		* * *	******	* *
		*		*
31	KK	*	SB1CP1	*
		*		*
		* * *	******	* *

+

33 RD

#### ROUTE HYDROGRAPH FROM SB1 TO CP1

#### HYDROGRAPH ROUTING DATA

MUSKINGUM-CUNGE	CHANNEL	ROUTING
L	2400.	CHANNEL - LENGTH
S	.0200	SLOPE
N	.090	CHANNEL ROUGHNESS COEFFICIENT
CA	.00	CONTRIBUTING AREA
SHAPE	TRAP	CHANNEL SHAPE
WD	78.00	BOTTOM WIDTH OR DIAMETER
Z	3.00	SIDE SLOPE

#### \* \* \*

# COMPUTED MUSKINGUM-CUNGE PARAMETERS

		CONFOI	ALTON LINE					
ELEMENT	ALPHA	М	DT	DX	PEAK	TIME TO PEAK	VOLUME	MAXIMUM CELERITY
			(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)
MAIN	.17	1.59	3.00	800.00	4093.01	234.00	8.08	8.61

#### INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

M7. T.M	17	1 50	2 00	4002 01	224 00	0 00
IN ALLIN	· + /	1.59	3.00	4095.01	234.00	0.00

CONTINUITY SUMMARY (AC-FT) - INFLOW= .3575E+03 EXCESS= .0000E+00 OUTFLOW= .3576E+03 BASIN STORAGE= .1048E-01 PERCENT ERROR= .0

	* * *	* * *	* * *	***	***		***
			HYDROGRA	PH AT STATI	ION SB1CP1		
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
				6-HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	4093.	3.90		721.	435.	435.	435.
			(INCHES)	8.079	8.079	8.079	8.079
			(AC-FT)	358.	358.	358.	358.
			CUMULATIV	E AREA =	.83 SQ MI		

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SCS RUNOFF COMPUTATION FOR SB2

SUBBASIN RUNOFF DATA

36 BA SUBBASIN CHARACTERISTICS TAREA .42 SUBBASIN AREA

PRECIPITATION DATA

16 PB	STORM	13.20	BASIN T	OTAL PRECI	PITATION					
17 PI	INCREMENTAI	D PRECIPITA	TION PATT	ERN						
	.01	.01	.01	.02	.01	.02	.02	.02	.01	.02
	. 02	.02	.02	.02	.02	.02	.02	.01	.01	.01
	. 03	.03	.03	.03	.03	.03	.03	.03	.02	.02
	. 02	.02	.02	.02	.02	.02	.02	.02	.02	.02
	.08	.08	.09	.09	.09	.09	.09	.09	.09	.09
	. 09	.09	.09	.09	.08	.09	.09	.09	.09	.09
	1.18	1.18	1.18	1.18	1.18	.38	.38	.38	.38	.38
	.18	.18	.18	.18	.18	.14	.14	.14	.14	.14
	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
	. 04	.04	.04	.04	.04	.04	.04	.04	.04	.04
	. 02	.02	.02	.02	.02	.02	.02	.02	.02	.02
	. 02	. 02	.02	. 02	.02	.02	.02	.02	.02	.02

29 LU	UNIFORM LOSS	S RATE			
	STRTL		1.00	INITIAL	LOSS

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- OOA Page 12 of 46

Spo

		CNSTL RTIMP	1.50 .00	UNIFORM PERCENT	LOSS RATE IMPERVIOUS	AREA						
37 UD	SCS	DIMENSIONLESS TLAG	UNITGRA .40	PH LAG								
						* * *						
					UN	IT HYDROG	RAPH					
	20.	63.	121.	202.	42 END- 304.	OF-PERIOL 394.	0 ORDINATES 451.	474.	474.	451. 77		
	63.	52.	43.	245. 36.	29.	24.	20.	17.	14.	11.		
	9.	8. 0.	6.	5.	5.	4.	٤.	3.	2.	1.		
* * *		* * *	***		* * *		* * *					
		HYDROGRAP	H AT STA	TION	SB2							
TOTAL R	AINFALL =	13.20, TOTA	L LOSS =	5.12	2, TOTAL EX	CESS =	8.08					
PEAK FLOW	TIME		6-HR	MAXIN 24	1UM AVERAGE 1-HR	FLOW 72-HR	9.95-HR					
+ (CFS)	(HR)	(CES)	•	-			5150					
+ 2881.	3.60	(INCHES)	365. 8 076	8	220.	220.	220. 8 076					
		(AC-FT)	181.		181.	181.	181.					
		CUMULATIVE	AREA =	.42	SQ MI							
*** *** ***	*** *** *	** *** *** **	* *** **	* *** **	** *** ***	*** *** *	** *** ***	*** *** ***	*** *** *1	** *** *** *	** *** *** *** **	*
	* * * * * * * * * *	* * * * *										
38 KK	* 0	.P1 * *										
	******	***** COMBINE	FLOWS F	ROM SB1	AND SB2							
40 HC	HYDR	OGRAPH COMBIN	ATION									
		ICOMP	2	NUMBER	OF HYDROGRA	PHS TO CO	MBINE					
						***						
* * *		***	***		* * *		***					
		HYDROGRAP	н ат ѕта	TION	CP1							
PEAK FLOW	TIME		6 - HR	MAXIN 24	MUM AVERAGE 4-HR	FLOW 72-HR	9.95-HR					
+ (CFS)	(HR)	(CFS)										
		· · ·										

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- OCA Page 13 of 46

\*\*\* \*\*\* \*\*\*

.0

800

•

+ 6164.	3.75	(INCHES) (AC-FT)	1086. 8.078 539.	65 8.0 53	5. 78 9.	655. 8.078 539.	655. 8.078 539.				
		CUMULATI	VE AREA =	1.25 S	Q MI						
*** *** ***	*** *** ***	* * * * * * *	*** *** **	** *** ***	*** ***	*** *** *	** *** ***	*** *** **	* *** ***	*** *** ***	*** *** ***
	*********	***									
41 KK	* * CP1CP2	*									
	* ********	*									
		ROUT	E HYDROGRA	APH FROM C.	рі то ср	'2					
	HYDROGRA	APH ROUTING	G DATA								
43 RD	MUSKIN	IGUM-CUNGE L S N CA SHAPE WD Z	CHANNEL F 2600. .0200 .090 .00 TRAP 68.00 3.00	COUTING CHANNEL L SLOPE CHANNEL R CONTRIBUT CHANNEL S BOTTOM WI SIDE SLOP	ENGTH OUGHNESS ING AREA HAPE DTH OR D E	COEFFICIE DIAMETER	NT				
			<b>2010</b>			***					
			COMPUT	COMPUTAT	JON TIME	E PARAMETE STEP	DEAK		NOTIME	ΜΆΥΤΜΙΜ	
	811	MENI A.	LPRA	м	(MIN)	(FT)	(CFS)	PEAK (MIN)	(IN)	CELERITY (FPS)	
	Ν	1AIN	.19	1.58	3.00	866.67	6159.40	228.00	8.08	10.29	
				INTERPOLA	TED TO S	PECIFIED C	OMPUTATION	INTERVAL			
	Ν	1AIN	.19	1.58	3.00		6159.40	228.00	8.08		
CONTINUITY	SUMMARY (AC-	FT) - INF	LOW≈ .5385	5E+03 EXCE	SS= .000	0E+00 OUTF	'LOW= .5387	E+03 BASIN	STORAGE= .	.9970E-02 PER	CENT ERROR=
***	ł	***	* * *		* * *		***				
		HYDROGR.	APH AT ST	ATION CP	1CP2						
PEAK FLOW	TIME			MAXIMU	M AVERAG	E FLOW	0 05-117				
+ (CFS)	(HR)	(CFS)	6-HK	24-	RR	/2-n <b>k</b>	9.90-AK				

+

+

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 14 of 46

+	6159.	3.80		1086.	655.	655.	655.
			(INCHES)	8.080	8.080	8.080	8.080
			(AC - FT)	539.	539.	539.	539.

CUMULATIVE AREA = 1.25 SQ MI

\*\*\* \*\*\*

		****	* * * * * * * *	+ *
		*		*
44	KK	*	SB3	*
		+		-

\*\*\*\*\*\*\*\*

.

17 PI

SCS RUNOFF COMPUTATION FOR SB3

#### SUBBASIN RUNOFF DATA

46 BA SUBBASIN CHARACTERISTICS TAREA 1.60 SUBBASIN AREA

#### PRECIPITATION DATA

16 PB STORM 13.20 BASIN TOTAL PRECIPITATION

INCREMENTAL	J PRECIPIT	ATION PATT	ERN						
.01	.01	.01	.02	.01	.02	.02	.02	.01	.02
. 02	.02	.02	.02	.02	.02	.02	.01	.01	.01
.03	.03	.03	.03	.03	.03	.03	.03	.02	.02
. 02	. 02	.02	.02	.02	.02	.02	.02	.02	.02
.08	.08	.09	.09	.09	.09	.09	.09	.09	.09
.09	.09	.09	.09	.08	.09	.09	.09	.09	.09
1.18	1,18	1.18	1.18	1.18	.38	.38	.38	.38	.38
.18	.18	.18	.18	.18	.14	.14	.14	.14	.14
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
. 02	.02	.02	.02	.02	.02	.02	.02	.02	.02

#### 29 LU UNIFORM LOSS RATE STRTL 1.00 INITIAL LOSS CNSTL 1.50 UNIFORM LOSS RATE RTIMP .00 PERCENT IMPERVIOUS AREA

47 UD SCS DIMENSIONLESS UNITGRAPH TLAG .73 LAG

\* \* \*

#### UNIT HYDROGRAPH 75 END-OF-PERIOD ORDINATES

				, , , , , , , , , , , , , , , , , , , ,					
20.	54.	101.	162.	233.	314.	422.	539.	668.	778.
872.	946.	990.	1016.	1023.	1018.	998.	957.	910.	860.
806.	740.	668.	586.	516.	455.	408.	366.	327.	293.
267.	242.	217.	196.	176.	155.	140.	127.	113.	102.

#### Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 15 of 46

APD

35.

12.

4.

		92. 31. 11. 3.	82. 28. 10. 2.	73. 25. 9. 2.	66. 22. 8. 1.	59. 20. 8. 0.	53. 18. 7.	48. 16. 6.	43. 15. 5.	38. 13. 4.
	***		***	***		***	*	* *		
			HYDROGRA	PH AT STATI	ION S	5B3				
	TOTAL RA	INFALL =	13.20, TOT	AL LOSS =	5.12, 1	FOTAL EXCE	SS = 8	.08		
	PEAK FLOW	TIME			MAXIMUM	AVERAGE F	LOW			•
	(			6 - HR	24-HF	र 72	-HR	9.95-HR		
+	(CFS)	(HR)	(000)							
Ŧ	7149	3 95	(CFS)	1390	030	٥	28	939		
	/140.	5.95	(INCHES)	£ 076	8 074	. 0 . 8	076	8 076		
			(AC-FT)	689.	689	. 6	89.	689.		
			CUMULATIV	E AREA =	1.60 SQ	MI				

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		****	******	* *
		*		*
48 KK	*	SB4	*	
		*		*
		*****	******	**

SCS RUNOFF COMPUTATION FOR SB4

SUBBASIN RUNOFF DATA

50 BA SUBBASIN CHARACTERISTICS TAREA 1.20 SUBBASIN AREA

PRECIPITATION DATA

16 P	PB	STORM	13.20	BASIN 7	OTAL PRECI	PITATION					
17 P	PI	INCREMENTAL	PRECIPITAT	TION PATT	ERN						
		.01	.01	.01	.02	.01	.02	.02	.02	.01	.02
		.02	.02	.02	.02	.02	.02	.02	.01	.01	.01
		.03	. 03	.03	.03	.03	.03	.03	.03	.02	.02
		.02	. 02	.02	.02	.02	.02	.02	.02	.02	.02
		.08	.08	.09	.09	.09	.09	.09	.09	.09	.09
		.09	.09	.09	.09	.08	.09	.09	.09	.09	.09
		1.18	1.18	1.18	1.18	1.18	.38	.38	.38	.38	.38
		.18	.18	.18	.18	.18	.14	.14	.14	.14	.14
		.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
		.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
		.02	. 02	.02	.02	.02	.02	.02	.02	.02	.02
		.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

29 LU UNIFORM LOSS RATE

#### Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- coA Page 16 of 46

722.

609.

178.

54.

17.

5.

636.

669.

201.

61.

19.

6.

~	00
$\mathcal{A}$	Y V
~	2

		STRTL CNS <b>TL</b> RTIMP	1.00 1.50 .00	INITIAL UNIFORM PERCENT	LOSS LOSS RATE IMPERVIOUS	AREA		
51 UD	SCS	DIMENSIONLESS	UNITGR	APH				
		TLAG	.66	LAG				
						***		
					UN	IT HYDROG	RAPH	
	10	E 2	0.0	166		OF-PERIOD	A15	E 2 2
	19.	23.	99.	133.	227.	D14.	415.	JJJ. 710
	700. E40	160	407	350	217	2003.	240	223
	150	141	107.	111	517.	200.	249.	22J. 69
	135.	42.	123.		30.	27.	78.	21
	15	13	12	10	- JU.	27. g	24.	<b>2</b> 1. 7
	5.	4.	3.	3.	2.	2.	1.	, , 0.
***		* * *	***		· ***		***	
		HYDROGRAP	H AT ST	ATION	SB4			
TOTAL R	AINFALL =	13.20, TOTAI	LOSS	= 5.12	2, TOTAL EX	CESS =	8.08	
PEAK FLOW	TIME			MAXIN	IUM AVERAGE	FLOW		
			6 - HR	24	-HR	72-HR	9.95-HR	
(CFS)	(HR)							
		(CFS)						
5782.	3.90	(	1042.	6	29.	629.	629.	
		(INCHES)	8.076	8	076	8.076	8.076	
		(AC-FT)	517.	5	o17.	517.	517.	

CUMULATIVE AREA = 1.20 SQ MI

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* * 52 KK * CP2 * * * *******************************	•
52 KK * CP2 * * * ****************** COMBINE FLOWS FROM SB3, SB4 and CP1	
* * ************* COMBINE FLOWS FROM SB3, SB4 and CP1	
******************* COMBINE FLOWS FROM SB3, SB4 and CP1	
COMBINE FLOWS FROM SB3, SB4 and CP1	
54 HC HYDROGRAPH COMBINATION	
ICOMP 3 NUMBER OF HYDROGRAPHS TO COMBINE	
***	
MIDROGRAM AT STRITON CF2	

PEAK FLOW TIME MAXIMUM AVERAGE FLOW

#### Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - $\mathcal{OA}$ Page 17 of 46

ACO

				6 – HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	18927.	3.90	,	3519.	2122.	2122.	2122.
			(INCHES)	8.078	8.078	8.078	8.078
			(AC-FT)	1745.	1745.	1745.	1745.

CUMULATIVE AREA = 4.05 SQ MI

\*\*\* \*\*\*

HYDROGRAPH ROUTING DATA

- 37 KD MUSKINGUM-CUNGE CRANNEL KOUIIN	57 RD	MUSKINGUM-CUNGE CHANNEL ROUTING
--	-------	---------------------------------

L	3500.	CHANNEL LENGTH
S	.0200	SLOPE
N	.090	CHANNEL ROUGHNESS COEFFICIENT
CA	.00	CONTRIBUTING AREA
SHAPE	TRAP	CHANNEL SHAPE
WD	88.00	BOTTOM WIDTH OR DIAMETER
Z	30.00	SIDE SLOPE

*** COMPUTED MUSKINGUM-CUNGE PARAMETERS COMPUTATION TIME STEP									
ELEMENT	ALPHA	М	DT		DX	PEAK	TIME TO PEAK	VOLUME	MAXIMUM CELERITY
			(MIN)	•	(FT)	(CFS)	(MIN)	(IN)	(FPS)
MAIN	.26	1.41	3.00		875.00	18905.50	240.00	8.08	8.03

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN .26 1.41 3.00 18905.50 240.00 8.08

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1745E+04 EXCESS= .0000E+00 OUTFLOW= .1745E+04 BASIN STORAGE= .1214E-01 PERCENT ERROR= .0

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HYDROGRAPH AT STATION CP2CP3

PEAK FLOW TIME MAXIMUM AVERAGE FLOW

#### Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 18 of 46

				6-HR	24-HR	72-HR	9.95-HR			D PO
+	(CFS)	(HR)	(CES)							5
+	18906.	4.00	(INCHES) (AC-FT)	3520. 8.080 1745.	2122. 8.080 1745.	2122. 8.080 1745.	2122. 8.080 1745.			
			CUMULATIV	E AREA =	4.05 SQ MI					

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\* \* \* \* \* \* \* \* \* \* \* \* \*

COMPUTE RUNOFF FROM Aging pad area USING OVERLAND FLOW ELEMENT

SUBBASIN RUNOFF DATA

60 BA SUBBASIN CHARACTERISTICS TAREA .46 SUBBASIN AREA

PRECIPITATION DATA

#### 16 PB STORM 13.20 BASIN TOTAL PRECIPITATION

17 PI INCREMENTAL PRECIPITATION PATTERN

.01	.01	.01	.02	.01	.02	.02	.02	.01	.02
.02	.02	.02	.02	.02	.02	.02	.01	.01	.01
.03	.03	.03	.03	.03	.03	.03	.03	.02	.02
.02	.02	.02	. 02	.02	.02	.02	.02	.02	. 02
.08	.08	.09	.09	.09	.09	.09	.09	.09	.09
.09	.09	.09	.09	.08	.09	.09	.09	.09	.09
1.18	1.18	1.18	1.18	1.18	.38	.38	.38	.38	.38
.18	.18	.18	.18	.18	.14	.14	.14	.14	.14
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	. 04
.02	.02	.02	.02	.02	.02	.02	. 02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

61 LU	UNIFORM LOSS RATE				
	STRTL	1.00	INITIAL	LOSS	
	CNSTL	1.50	UNIFORM	LOSS RATE	
	RTIMP	25.50	PERCENT	IMPERVIOUS AREA	ŧ

LOSS RATE VARIABLES FOR SECOND OVERLAND FLOW ELEMENT STRTL 1.00 INITIAL LOSS CNSTL 1.50 UNIFORM LOSS RATE RTIMP 100.00 PERCENT IMPERVIOUS AREA

KINEMATIC WAVE

OVERLAND-FLOW ELEMENT NO. 1 L 4000. OVERI

4000. OVERLAND FLOW LENGTH

62 UK

Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 -  $\infty$ A Page 19 of 46

SKD

63	UK	S N PA DXMIN OVERLAND-FLOV L S N PA	.0300 .100 83.0 50 ELEMENT 900. .0200 .100 17.0	SLOPE ROUGHNE PERCENT MINIMUM NO. 2 OVERLAN SLOPE ROUGHNE PERCENT	SS COEFFICI OF SUBBASI NUMBER OF D FLOW LENG SS COEFFICI OF SUBBASI	ENT N DX INTERV TH ENT N	ALS			
		DXMIN	50	MINIMUM	NUMBER OF	DX INTERV	ALS			
		KINEMATIC WAVE								
64	RK	MAIN CHANNEL								
		L	3500.	CHANNEL	LENGTH					
		S	.0200	SLOPE						
		N	.090	CHANNEL	ROUGHNESS	COEFFICIE	N'T'			
		CA	.46	CONTRIB	OTING AREA					
		SHAPE	IRAP	DOTTOM	SHAPE	AMETED				
		7	3 00	STDE ST	NIDIA UK DI	ANEIER				
			5.00		NIMBER OF	DX INTERV	AT.S			
		RUPSTQ	NO	ROUTE U	PSTREAM HYD	ROGRAPH	100			
						***				
			C	OMPUTED K VARI (DT SH	INEMATIC PA ABLE TIME S OWN IS A MI	RAMETERS TEP NIMUM)				
		ELEMENT A	LPHA	М	DT	DX	PEAK	TIME TO PEAK	VOLUME	MAXIMUM
					(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)
		PLANE1	2.58	1.67	.54	80.00	2970.04	208.64	9.31	3.09
		PLANE2	2.11	1.67	.31	18.00	1189.81	194.88	13.18	1.99
		MAIN	.15	1.59	.27	70.00	3441.74	202.75	9.94	10.32

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .2461E+03 OUTFLOW= .2439E+03 BASIN STORAGE= .1963E+01 PERCENT ERROR= .1

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

		MA	IN	.15	1.59	3.00	3436.1	9 204.00	9.94
	***		***	***		* * *	* * *		
			HYDROGR	APH AT STA	ATION A	GING			
	TOTAL RA	INFALL =	13.20, TO	TAL LOSS =	= 3.17,	TOTAL EXCESS	5 = 10.03		
	PEAK FLOW	TIME			MAXIMU	M AVERAGE FLO	W		
				6 - HR	24-	HR 72-H	HR 9.95-H	R	
+	(CFS)	(HR)							
			(CFS)						
+	3436.	3.40		486.	29	7. 297	7. 297	•	
			(INCHES)	9.825	9.9	43 9.94	13 9.94	3	
			(AC-FT)	241.	24	4. 244	4. 244		



RO

CUMULATIVE AREA = .46 SO MI

#### \*\*\*

		*******	* * * * *				
		*	*				
	65 KK	* C	P3 *				
		*	*				
		******	****				
			COMBIN	E FLOWS FROM	I CP2 and Agi	.ngl	
	67 HC	HYDR	OGRAPH COMBI	NATION			
			ICOMP	2 NUM	BER OF HYDRO	GRAPHS TO C	OMBINE
						***	
	* * *		* * *	***	***	r	* * *
			HYDROGRA	PH AT STATIC	N CP3		
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
				6-HR	24 - HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	20138.	3.95		4006.	2419.	2419.	2419.
			(INCHES)	8.258	8.270	8.270	8.270
			(AC-FT)	1986.	1989.	1989.	1989.
			CUMULATIV	E AREA =	4.51 SO MI		

\*\*\* \*\*\*

ROUTE HYDROGRAPH FROM CP3 TO CP4

HYDROGRAPH ROUTING DATA

70	RD	MUSKINGUM-CUNGE	CHANNEL	ROUTING
		L	4100.	CHANNEL LENGTH
		S	.0300	SLOPE
		N	.090	CHANNEL ROUGHNESS COEFFICIENT
		CA	.00	CONTRIBUTING AREA
		SHAPE	TRAP	CHANNEL SHAPE
		WD	30.00	BOTTOM WIDTH OR DIAMETER
		Z	40.00	SIDE SLOPE

#### Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- OOA Page 21 of 46

QCD

				***				
	COMP	UTED MUSK	INGUM-CUNGE	PARAMETE STEP	RS			
ELEMENT	ALPHA	М	DT	DX	PEAK	TIME TO PEAK	VOLUME	MAXIMUM CELERITY
			(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)
MAIN	.47	1.35	3.00	820.00	20106.10	243.00	8.27	8.41
		INTERPOI	ATED TO SPI	ECIFIED C	OMPUTATION	INTERVAL		

MAIN .47 1.35 3.00 20106.10 243.00 8.27

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1989E+04 EXCESS= .0000E+00 OUTFLOW= .1989E+04 BASIN STORAGE= .7397E+00 PERCENT ERROR= .0

	* * *		* * *	* * *	***	ŧ	***
	,		HYDROGRAI	PH AT STATIO	ON CP3CP4		
	PEAK FLOW	TIME			MAXIMUM AVER	RAGE FLOW	
				6 - HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	20106.	4.05		4006.	2419.	2419.	2419.
			(INCHES)	8.259	8.271	8.271	8.271
			(AC-FT)	1987.	1989.	1989.	1989.

CUMULATIVE AREA = 4.51 SQ MI

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73 BA SUBBASIN CHARACTERISTICS TAREA .39 SUBBASIN AREA

PRECIPITATION DATA

- 16 PB STORM 13.20 BASIN TOTAL PRECIPITATION
- 17 PI INCREMENTAL PRECIPITATION PATTERN

#### Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 22 of 46

SPO

.01	.01	.01	.02	.01	.02	.02	.02	.01	.02
.02	.02	.02	.02	.02	.02	.02	.01	.01	.01
.03	.03	.03	.03	.03	.03	.03	.03	.02	.02
.02	.02	.02	.02	.02	.02	. 02	.02	.02	.02
.08	.08	.09	.09	.09	.09	.09	.09	.09	.09
.09	.09	.09	.09	.08	.09	.09	.09	.09	.09
1.18	1.18	1.18	1.18	1.18	.38	.38	.38	.38	.38
.18	.18	.18	.18	.18	.14	.14	.14	.14	.14
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

7	74	LU	UNIFORM LOSS	RATE				
			STRTL		1.00	INITIAL	LOSS	
			CNSTL		1.50	UNIFORM	LOSS RATE	
			RTIMP		.00	PERCENT	IMPERVIOUS	AREA

75 UD SCS DIMENSIONLESS UNITGRAPH TLAG .64 LAG

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				UNII 66 END-OF	HYDROGRAP	H			
6.	18.	35.	54.	80.	111.	147.	188.	222.	248.
268.	281.	283.	282.	276.	263.	248.	232.	213.	191.
166.	143.	124.	110.	97.	86.	76.	68.	61.	54.
48.	41.	37.	33.	29.	26.	23.	20.	18.	15.
14.	12.	11.	10.	8.	8.	7.	б.	5.	5.
4.	4.	З.	3.	3.	2.	2.	2.	2.	1.
1.	1.	1.	1.	Ο.	0.				

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#### HYDROGRAPH AT STATION SB5

	TOTAL RA	INFALL =	13.20, TOT	AL LOSS =	5.12, TOTAL	EXCESS =	8.08
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
				6-HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	1925.	3.85		339.	204.	204.	204.
			(INCHES)	8.076	8.076	8.076	8.076
			(AC-FT)	168.	168.	168.	168.
			CUMULATIV	E AREA =	.39 SQ MI		

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.02 .01 .02 .09 .09 .38 .14 .04 .04 .02 .02 lo

\* \* \*

#### SCS RUNOFF COMPUTATION FOR SB6

#### SUBBASIN RUNOFF DATA

78 BA SUBBASIN CHARACTERISTICS TAREA .76 SUBBASIN AREA

#### PRECIPITATION DATA

16	PB	STORM	13.20	BASIN	TOTAL	PRECIPITATION

T/ FI	INCREMENTA	U PRECIPII	ALION PALL	ERN					
	.01	.01	.01	. 02	.01	.02	.02	.02	.01
	. 02	.02	.02	.02	.02	.02	.02	.01	.01
	. 03	.03	.03	.03	.03	.03	.03	.03	.02
	. 02	.02	.02	.02	.02	.02	.02	.02	.02
	.08	.08	.09	.09	.09	.09	.09	.09	.09
	. 09	.09	.09	.09	.08	.09	.09	.09	.09
	1.18	1.18	1.18	1.18	1.18	.38	.38	.38	.38
	.18	.18	.18	.18	.18	.14	.14	.14	.14
	.04	.04	.04	.04	.04	.04	.04	.04	.04
	.04	.04	.04	.04	.04	.04	.04	.04	.04
	. 02	.02	.02	.02	.02	.02	.02	.02	.02
	.02	.02	.02	.02	.02	.02	.02	.02	.02

LU	UNIFORM LOSS RATE				
	STRTL	1.00	INITIAL	LOSS	
	CNSTL	1.50	UNIFORM	LOSS RATE	
	RTIMP	.00	PERCENT	IMPERVIOUS	AREA
	LU	LU UNIFORM LOSS RATE STRTL CNSTL RTIMP	LU UNIFORM LOSS RATE STRTL 1.00 CNSTL 1.50 RTIMP .00	LU UNIFORM LOSS RATE STRTL 1.00 INITIAL CNSTL 1.50 UNIFORM RTIMP .00 PERCENT	LU UNIFORM LOSS RATE STRTL 1.00 INITIAL LOSS CNSTL 1.50 UNIFORM LOSS RATE RTIMP .00 PERCENT IMPERVIOUS

79 UD SCS DIMENSIONLESS UNITGRAPH TLAG .76 LAG

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				UNIT	HYDROGRAF	ч			
				78 END-OF	-PERIOD OF	DINATES			
9.	23.	44.	70.	99.	135.	179.	228.	285.	336.
384.	417.	443.	461.	466.	467.	464.	450.	432.	411.
388.	364.	334.	302.	266.	236.	209.	188.	169.	152.
137.	124.	114.	103.	93.	84.	75.	67.	61.	55.
49.	45.	40.	36.	33.	29.	26.	24.	21.	19.
17.	16.	14.	13.	12.	10.	9.	8.	8.	7.
6.	б.	5.	5.	4.	4.	4.	З.	3.	3.
2.	2.	2.	1.	1.	1.	0.	Ο.		

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#### HYDROGRAPH AT STATION SB6

	TOTAL RA	INFALL =	13.20, TOTA	AL LOSS =	5.12, TOTAI	_ EXCESS =	8.08
	PEAK FLOW	TIME			MAXIMUM AVER	RAGE FLOW	
+	(CFS)	(HR)		6-HR	24-HR	72-HR	9.95-HR
			(CFS)				

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - 00A Page 24 of 46

RED

.

÷	3290.	4.00		660.	398.	398.	398.
			(INCHES)	8.076	8.076	8.076	8.076
			(AC-FT)	327.	327.	327.	327.
			CUMULATIV	E AREA =	.76 SQ MI		

*** *** ***	*** ***	*** *** *** *	** *** ***	*** *** *** *	** *** ***	*** *** ***
	******	*****				
	*	*				
80 KK	*	CP4 *				
	* * * * * * * *	* * * * * * *				
		COMBIN	ים אין אין	M SB5 SB6 and	CD3	
		COMBIN	E FLOWS FRC	,550 and	CFS	
82 HC	нүі	DROGRAPH COMBI	NATION			
		ICOMP	3 NU	MBER OF HYDRO	GRAPHS TO	COMBINE
					***	
* * *		***	***	***		***
		HYDROGPA	DH AT STATT			
		n i Drog <b>r</b> a	GI AL SIALI	UN CP4		
PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
			6-HR	24-HR	72-HR	9.95-HR
+ (CFS)	(HR)					
		(CFS)				
+ 25090.	4.05		5005.	3022.	3022.	3022.
		(INCHES)	8.222	8.231	8.231	8.231
		(AC - FT)	2482.	2485.	2485.	2485.
		CIDALLY ANTI		5 (( 00 NT		
		CUMULATIV	E AREA =	5.66 SQ MI		
*** *** ***	*** ***	*** *** *** *	** *** ***	*** *** *** *	** *** ***	*** *** ***
	******	*****				
	*	*				
83 KK	* CP4	4CP9 *				
	*	*				
	*****	*****				
		ROUTE	HYDROGRAPH	I FROM CP4 TO	CP9	

HYDROGRAPH ROUTING DATA

85 RD	MUSKINGUM-CUNGE	CHANNEL	ROUTING			
	L	3000.	CHANNEL	LENGTH		
	S	.0200	SLOPE			
	N	.090	CHANNEL	ROUGHNESS	COEFFICIENT	
	CA	.00	CONTRIBU	TING AREA		

#### Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - OOA Page 25 of 46

	SHAPE WD Z	TRAP 30.00 20.00	CHANNEL BOTTOM V SIDE SLO	SHAPE VIDTH OR DI OPE	AMETER							9°?
					***							
		COMPU	TED MUSK	INGUM-CUNGE	PARAMETE	RS						
	ELEMENT	ALPHA	COMPUTA M	ATION TIME DT	STEP DX	PEAK	TIME TO PEAK	VOLUME	MAXIMUM			
				(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)			
	MAIN	.41	1.37	3.00	1000.00	25046.78	246.00	8.23	9.46			
			INTERPOI	LATED TO SP	PECIFIED C	OMPUTATION	I INTERVAL					
	MAIN	.41	1.37	3.00		25046.78	246.00	8.23		·		
CONTINUITY SUMMARY	(AC-FT) - 1	INFLOW= .248	5E+04 EX(	CESS= .0000	E+00 OUTF	LOW= .2485	E+04 BASIN	STORAGE=	.6271E+00 PERCE	NT ERROR=	.0	
***	***	***		* * *		***						
	HYDR	OGRAPH AT SI	ATION (	CP4CP9								
PEAK FLOW TIM	1E	C UP	MAXIN	UM AVERAGE	FLOW	0.05 110						

				6-HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	25047.	4.10		5006.	3022.	3022.	3022.
			(INCHES)	8.223	8.231	8.231	8.231
			(AC-FT)	2482.	2485.	2485.	2485.
			CUMULT ATTA		E CC CO MT		
			CUMULAILY.	C ARCA =	5.66 SQ MI		

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88 BA SUBBASIN CHARACTERISTICS TÀREA .19 SUBBASIN AREA

PRECIPITATION DATA

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 26 of 46

.02 .01 .02 .09 .09 .38 .14 .04 .04

.02 .02

16 3	PB		STORM	13.20	BASIN TO	TAL PRECIP	ITATION					
17	PI	INCREMENTAL PRECIPITATION PATTERN										
			.01	.01	.01	.02	.01	.02	.02	. 02	. 01	
			.02	.02	.02	. 02	. 02	. 02	02	01	01	
			.03	.03	.03	.03	. 03	.03	.03	03	02	
			.02	.02	. 02	.02	.02	.02	.02	. 02	. 02	
			.08	.08	.09	.09	.09	. 09	.09	.09	.09	
			.09	.09	.09	.09	.08	.09	.09	.09	.09	
			1.18	1.18	1.18	1.18	1.18	.38	.38	.38	.38	
			.18	.18	.18	.18	.18	.14	.14	.14	.14	
			.04	.04	.04	.04	.04	.04	.04	.04	.04	
			.04	.04	.04	.04	.04	.04	.04	.04	.04	
			.02	.02	.02	. 02	.02	.02	.02	.02	.02	
			.02	.02	.02	.02	.02	. 02	.02	.02	.02	
74 ]	LU	UNIF	ORM LOSS R	ATE								
			STRTL	1.00	INITIAL	LOSS						
			CNSTL	1.50	UNIFORM	LOSS RATE						
			RTIMP	.00	PERCENT	IMPERVIOUS	AREA					
89 t	D SCS DIMENSIONLESS UNITGRAPH											
			TLAG	.30	LAG							
		* * *										
		UNIT HYDROGRAPH										
		32 END-OF-PERIOD ORDINATES										
		19.	56.	115.	193.	253.	280.	. 280.	257.	224.	179.	
		132.	102.	79.	63.	49.	38.	. 30.	23.	18.	14.	
		11. 1.	8. 0.	7.	5.	4.	3.	. 3.	2.	2.	1.	
	* * *		***	***		* * *		***				
			HYDROG	RAPH AT STA	TION	SB13						
	דאד ארד ד היידור	ד ד א ד ד	12 22 <b>m</b>		E 10	BOBLE DI	0000					
TC	OTAL RAIN	FALL =	13.20, T	OTAL LOSS =	5.12	, TOTAL EX	CESS =	8.08				
TC PEAK	OTAL RAIN FLOW	FALL = TIME	13.20, T	OTAL LOSS =	5.12 MAXIM	, TOTAL EX	CESS = FLOW	8.08				
PEAK	DTAL RAIN FLOW	FALL = TIME	13.20, T	OTAL LOSS = 6-HR	5.12 MAXIM 24	, TOTAL EX UM AVERAGE -HR	CESS = FLOW 72-HR	8.08 9.95-HR				
TC PEAK (CI	DTAL RAIN FLOW FS)	FALL = TIME (HR)	13.20, T	OTAL LOSS = 6-HR	5.12 MAXIM 24	, TOTAL EX UM AVERAGE -HR	CESS = FLOW 72-HR	8.08 9.95-HR				
TC PEAK (CH	DTAL RAIN FLOW FS)	FALL = TIME (HR)	13.20, T (CFS)	OTAL LOSS = 6-HR	5.12 MAXIM 24	, TOTAL EX UM AVERAGE -HR	CESS = FLOW 72-HR	8.08 9.95-HR				
TC PEAK (CH 15	DTAL RAIN FLOW FS) 555.	FALL = TIME (HR) 3.45	13.20, T (CFS)	OTAL LOSS = 6-HR 165. 8 076	5.12 MAXIM 24	, TOTAL EX UM AVERAGE -HR 00.	CESS = FLOW 72-HR 100.	8.08 9.95-HR 100.				
TC PEAK (CF 15	DTAL RAIN FLOW FS) 555.	FALL = TIME (HR) 3.45	13.20, T (CFS) (INCHES) (AC-FT)	OTAL LOSS = 6-HR 165. 8.076 82	5.12 MAXIM 24 1 8.	, TOTAL EX UM AVERAGE -HR 00. 076 1 82	CESS = FLOW 72-HR 100. 8.076 82	8.08 9.95-HR 100. 8.076 82				

CUMULATIVE AREA = .19 SQ MI

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\*\*\*\*\*\*\*\*\*\*\*\*\* \* \* 90 KK \* SB7 \*

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Elo

		* * * * * * * * * * * * *							
		SCS	RUNOFF COM	PUTATION	FOR SB7				
15	IN	TIME DATA FOR JXMIN JXDATE JXTIME	INPUT TIME 3 10CT98 0	SERIES TIME IN STARTIN STARTIN	TERVAL IN G DATE G TIME	MINUTES			
		SUBBASIN RUNOFF	DATA						
92	BA	SUBBASIN CHAR	ACTERISTICS						
		TAREA	2.90	SUBBASI	N AREA				
		PRECIPITATION	DATA						
93	PB	STORM	12.90	BASIN T	OTAL PRECI	PITATION			
94	PI	INCREMENTAL	PRECIPITAT	ION PATT	ERN				
		. 02	.02	.02	.02	.02	.02	.02	.02
		.02	.02	.02	. 02	.02	. 02	.02	.02
		. 03	.03	.03	.03	.03	.03	.03	.03
		. 03	.03	.03	.03	.03	.03	.03	.03
		.08	.08	.08	.08	.08	.08	.08	.08
		.08	.08	.08	.08	.08	.08	.08	.08
		1.10	1.10	1.10	1.10	1.10	.36	.36	.36
		.18	.18	.18	.18	.18	.16	.16	.16
		.04	.04	.04	.04	.04	.04	.04	.04
		. 04	.04	.04	.04	.04	.04	.04	.04
		. 02	.02	.02	.02	.02	.02	.02	.02
		.02	.02	.02	.02	.02	.02	.02	.02

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74 LU	UNIFORM LOSS RATE			
	STRTL	1.00	INITIAL LOSS	
	CNSTL	1.50	UNIFORM LOSS RATE	
	RTIMP	.00	PERCENT IMPERVIOUS AREA	

106 UD SCS DIMENSIONLESS UNITGRAPH TLAG .92 LAG

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UNIT HYDROGRAPH 94 END-OF-PERIOD ORDINATES 24. 51. 105. 164. 234. 313. 407. 515. 640. 779. 1474. 928. 1061. 1187. 1282. 1368. 1420. 1467. 1475. 1482. 1458. 1411. 1361. 1248. 1035. 853. 1306. 1185. 1114. 947. 771. 692. 634. 579. 409. 381. 352. 532. 486. 446. 323. 297. 273. 250. 226. 208. 192. 176. 161. 148. 137. 125. 113. 105. 96. 88. 80. 74. 68. 62. 57. 53. 48. 44. 41. 38. 34. 31. 29. 27. 24. 22. 20. 19. 17. 16. 15. 14. 13. 12. 11. 10. 9. 8. 7. 7. 6. 5. 4. 4. З. 2. 1. Ο. \*\*\* \*\*\* \* \* \* \*\*\*

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.02 .02

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.16

.04

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HYDROGRAPH AT STATION SB7

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- 00A Page 28 of 46

(P)

	TOTAL RA	INFALL =	12.90, TOT	AL LOSS =	5.30, <b>T</b> OTAL	EXCESS =	7.60	
PEAK FLOW TIME			MAXIMUM AVERAGE FLOW					
+	(CFS)	(HR)		6 - HR	24-HR	72~HR	9.95-HR	
			(CFS)					
+	10053.	4.15		2370.	1429.	1429.	1429.	
			(INCHES)	7.600	7.600	7.600	7.600	
			(AC-FT)	1175.	1175.	1175.	1175.	
			CUMULATIV	E AREA =	2.90 SQ MI			

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		***	******	**
		*		*
107	KK	*	SB7CP5	*
		*		*
		* * *	******	**

ROUTE HYDROGRAPH FROM SB7 TO CP5

HYDROGRAPH ROUTING DATA

109 RD	MUSKINGUM-CUNGE L S N CA SHAPE WD	CHANNEL 3200. .0400 .090 .00 TRAP 30.00	ROUTING CHANNEL LENGTH SLOPE CHANNEL ROUGHNESS COEFFICIENT CONTRIBUTING AREA CHANNEL SHAPE BOTTOM WIDTH OR DIAMETER
	Z	20.00	SIDE SLOPE
	Z	20.00	SIDE SLOPE

				***							
COMPUTED MUSKINGUM-CUNGE PARAMETERS											
	COMPUTATION TIME STEP										
ELEMENT	ALPHA	М	DT	DX	PEAK	TIME TO	VOLUME	MAXIMUM			
						PEAK		CELERITY			
			(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)			
MAIN	.59	1.37	3.00	800.00	10052.46	255.00	7.60	9.48			

#### INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN .59 1.37 3.00 10052.46 255.00 7.60

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1175E+04 EXCESS= .0000E+00 OUTFLOW= .1176E+04 BASIN STORAGE= .5540E-02 PERCENT ERROR= .0

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# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- >>A Page 29 of 46

#### HYDROGRAPH AT STATION SB7CP5

	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
+	(CFS)	(HP)		6-HR	24 - HR	72-HR	9.95-HR
Ċ	(CFD)	(111()	(CFS)				
+	10052.	4.25		2371.	1430.	1430.	1430.
			(INCHES)	7.600	7.601	7.601	7.601
			(AC-FT)	1176.	1176.	1176.	1176.
			CUMULATIV	E AREA =	2.90 SQ MI		

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110 KK \* SB8

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SCS RUNOFF COMPUTATION FOR SB8

#### SUBBASIN RUNOFF DATA

112 BA SUBBASIN CHARACTERISTICS TAREA 1.20 SUBBASIN AREA

#### PRECIPITATION DATA

93 PB STORM 12.90 BASIN TOTAL PRECIPITATION

#### 94 PI INCREMENTAL PRECIPITATION PATTERN

.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
1.10	1.10	1.10	1.10	1.10	.36	.36	.36	.36	.36
.18	.18	.18	.18	.18	.16	.16	.16	.16	.16
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	. 02	.02

74 LU	UNIFORM LOSS RATE				
	STRTL	1.00	INITIAL	LOSS	
	CNSTL	1.50	UNIFORM	LOSS RATE	
	RTIMP	.00	PERCENT	IMPERVIOUS AREA	

113 UD	SCS	DIMENSIONLESS	UNITGRAPH	
		TLAG	.60	LAG

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# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- 00A Page 30 of 46

781.

609.

159.

43. 12. 3. 863.

520. 136.

37.

10. 2. Ho

					,	UNIT	HYDROGE	APH ODDINATES	
		22	67	176	100	2 END-UI	406	ORDINATES 542	672
		22.	67.	120.	199.	200.	400. 011	753	687
		907. 44E	224.	324.	207.	260	223	206	181
		443.	107	540.	297.	200.	2JJ. 63	200.	48
		122.	207.	24.	22.	19	17	15	13
			25.	25.	22.	19. 6	±7.	4	
		9. 1.	0.	σ.	1.	0.	5.	1.	5.
	* * *		* * *	* * *		* * *		* * *	
			HYDROGRA	APH AT STAT	ION SBE	3			
	TOTAL RAI	NFALL =	12.90, TOT	AL LOSS =	5.30, TC	DTAL EXC	ESS =	7.60	
	PEAK FLOW	TIME			MAXIMUM A	VERAGE I	TLOW		
				6-HR	24-HR	72	2 – HR	9.95-HR	
+	(CFS)	(HR)							
			(CFS)						
+	5757.	3.80		981.	592.	5	592.	592.	
			(INCHES)	7.600	7.600	7	.600	7.600	
			(AC-FT)	486.	486.	4	186.	486.	
			CUMULATIV	/E AREA =	1.20 SQ N	11			

\*\*\* \*\*\*

		* * * * * * * * * *	****				
		*	*				
	114 KK	* CI	?5 *				
		*	*				
		******	(OMDT)		DUC FROM CR7	CDO	
			COMBI	NE HIDROGRA	PRS FROM SB7,	300	
	116 HC	HYDRO	OGRAPH COMBI	NATION			
			ICOMP	2 NU	MBER OF HYDROG	GRAPHS TO C	OMBINE
						***	
	* * *		* * *	* * *	* * *		* * *
			HYDROGRA	PH AT STATI	ON CP5		
	DEAK FLOW	TTME			MAXIMUM AVER	AGE FLOW	
	FBAR FLOR	11.11		6-HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	14235.	4.05		3351.	2021.	2021.	2021.
			(INCHES)	7.600	7.600	7.600	7.600
			(AC-FT)	1662.	1662.	1662.	1662.
			CUMULATIV	E AREA =	4.10 SQ MI		

Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 31 of 46

RPD

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		***	*****	**	
		*		*	
117	KK	*	CP5CP6	*	
		*		*	
		***	*******	**	
					DOTIM

ROUTE HYDROGRAPH FROM CP5 TO CP6

HYDROGRAPH ROUTING DATA

119	RD	MUSKINGUM-CUNGE	CHANNEL	ROUTING
		L	2000.	CHANNEL LENGTH
		S	.0300	SLOPE
		N	.090	CHANNEL ROUGHNESS COEFFICIENT
		CA	.00	CONTRIBUTING AREA
		SHAPE	TRAP	CHANNEL SHAPE
		WD	30.00	BOTTOM WIDTH OR DIAMETER
		Z	20.00	SIDE SLOPE

				* * *				
	COMI	PUTED MUSK COMPUT	INGUM-CUNG ATION TIME	E PARAMETE STEP	IRS			
ELEMENT	ALPHA	М	DT	DX	PEAK	TIME TO PEAK	VOLUME	MAXIMUM CELERITY
			(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)
MAIN	.51	1.37	3.00	1000.00	14233.66	246.00	7.60	9.39

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN .51 1.37 3.00 14233.66 246.00 7.60

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1662E+04 EXCESS= .0000E+00 OUTFLOW= .1662E+04 BASIN STORAGE= .2786E-02 PERCENT ERROR= .0

	* * *		* * *	* * *	***		***
			HYDROGRA	PH AT STAT	ION CP5CP6		
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
				6-HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	14234.	4.10		3352.	2021.	2021.	2021.
			(INCHES)	7.600	7.601	7.601	7.601
			(AC-FT)	1662.	1662.	1662.	1662.
			CUMULATIV	E AREA =	4.10 SQ MI		

Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - 06A Page 32 of 46



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		******
		* *
120	KK	* SB9 *
		* *
		*****
		SCS RUNOFF COMPUTATION FOR SB9
		SUBBASIN RUNOFF DATA
122	BА	SUBBASIN CHARACTERISTICS
		TAREA 1.70 SUBBASIN AREA
		PRECIPITATION DATA
93	PB	STORM 12.90 BASIN TOTAL PRECIPITATION
94	PT	INCREMENTAL PRECIPITATION PATTERN
		. 02 . 02 . 02 . 02 . 02
		02 02 02 02 02
		.03 .03 .03 .03 .03
		.03 .03 .03 .03 .03
		.08 .08 .08 .08 .08
		.08 .08 .08 .08 .08
		1.10 1.10 1.10 1.10 1.10
		.18 .18 .18 .18 .18
		.04 .04 .04 .04 .04
		.04 .04 .04 .04 .04
		.02 .02 .02 .02 .02
		.02 .02 .02 .02 .02
74	ттт	INTEODM LOCC DATE

/4	ЦU	UNIFURN LOSS RAIE				
		STRTL	1.00	INITIAL	LOSS	
		CNSTL	1.50	UNIFORM	LOSS RATE	
		RTIMP	.00	PERCENT	IMPERVIOUS	AREA

#### 123 UD SCS DIMENSIONLESS UNITGRAPH TLAG .55 LAG

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\* \* \*

.02

.02

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.03

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.03

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.08

.08

.36

.16

.04

.04

.02

.02

	UNIT HYDROGRAPH									
37. 1	17. 221.	353.	522.	730.	962.	1161.	1301.	1388.		
1422. 14	22. 1388.	1311.	1223.	1124.	1002.	859.	725.	618.		
535. 4	62. 400.	354.	309.	270.	232.	200.	175.	151.		
132. 1	14. 99.	85.	74.	65.	56.	49.	42.	37.		
32.	28. 24.	21.	18.	16.	14.	13.	11.	10.		
8.	7. 6.	4.	3.	2.	1.					

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Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - 00A Page 33 of 46

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SCD

		HYDR	OGRAPH AT ST	ATION	SB9					
TOTAL RA	AINFALL =	12.90,	TOTAL LOSS	= 5.3	0, TOTAL E	XCESS =	7.60			
PEAK FLOW	TIME			MAXI	MUM AVERAGI	E FLOW				
(CFS)	(HR)	(CF	6-HR	2	4 - HR	72-HR	9.95-HR			
8684.	3.75	(INCHE) (AC-F	1390. S) 7.600 T) 689.	7	838. .600 689.	838. 7.600 689.	838. 7.600 689.			
		CUMUL	ATIVE AREA =	1.70	SQ MI			ſ		
*** *** ***	*** *** **	* *** *	** *** *** *	** *** *	** *** ***	*** *** *	*** *** ***	*** *** *	** *** ***	*** *** **
	******	* * * *								
124 KK	* * SB9CI	* •6 *								
	*	*								
		R	OUTE HYDROGR	APH FROM	SB9 TO CP	6				
	HYDROGE	APH ROU	TING DATA							
126 RD	MUSKI	NGUM-CU L S N CA	NGE CHANNEL : 4700. .0300 .090 .00	ROUTING CHANNEL SLOPE CHANNEL CONTRIBI	LENGTH ROUGHNESS UTING AREA	COEFFICIE	ENT			
		SHAPE WD Z	TRAP 30.00 20.00	CHANNEL BOTTOM SIDE SLO	SHAPE WIDTH OR DI OPE	IAMETER				
						* * *				
			COMPU	TED MUSK	INGUM-CUNGI ATION TIME	E PARAMETI STEP	ERS			
	EI	EMENT	ALPHA	М	DT	DX	PEAK	TIME TO PEAK	VOLUME	MAXIMUM CELERITY
					(MIN)	(F.T.)	(CFS)	(MIN)	(1N)	(PPS)
		MAIN	.51	1.37	3.00	783.33	8680.31	234.00	7.60	8.21
				INTERPO	LATED <b>T</b> O SI	PECIFIED (	COMPUTATION	INTERVAL		

+ +

\*\*

MAIN 1.37 3.00 8680.31 7.60 .51 234.00

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6891E+03 EXCESS= .0000E+00 OUTFLOW= .6895E+03 BASIN STORAGE= .9283E-02 PERCENT ERROR= -.1

## Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - OA Page 34 of 46

Dow

	***	* * *	* * *	* * *		* * *
		HYDROGRAP	H AT STATIC	ON SB9CP6		
PEAK	FLOW TIM	1E		MAXIMUM AVERA	GE FLOW	
			6-HR	24-HR	72-HR	9.95-HR
+ (CH	FS) (HF	२)				
		(CFS)				
+ 86	580. 3.9	<del>)</del> 0	1390.	838.	838.	838.
		(INCHES)	7.604	7.604	7.604	7.604
		(AC-FT)	689.	689.	689.	689.
		CUMULATIVE	AREA =	1.70 SQ MI		

#### \*\*\*

		****	******	* *
		*		*
127	кк	*	SB10	*
		*		*
		* * * *	* * * * * * * *	* *

- SCS RUNOFF COMPUTATION FOR SB10
- SUBBASIN RUNOFF DATA
- 129 BA SUBBASIN CHARACTERISTICS TAREA .44 SUBBASIN AREA

PRECIPITATION DATA

93 PB STORM 12.90 BASIN TOTAL PRECIPITATION

94	PI	INCREMENTAL	PRECIPITATION	PATTERN

THOUGH THE THE THE THE THE THE THE THE THE TH									
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
. 02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
1.10	1.10	1.10	1.10	1.10	.36	.36	.36	.36	.36
.18	.18	.18	.18	.18	.16	.16	.16	.16	.16
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

74 LU	UNIFORM LOSS RATE				
	STRTL	1.00	INITIAL	LOSS	
	CNSTL	1.50	UNIFORM	LOSS RATE	
	RTIMP	.00	PERCENT	IMPERVIOUS	AREA

130 UD SCS DIMENSIONLESS UNITGRAPH TLAG .35 LAG

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 35 of 46

QP

\* \* \*

				UNIT	HYDROGRAN	PH PDINATEC			
				J/ HIND OF	-FRICIOD OI	CDINALED			
30.	91.	176.	303.	435.	528.	563.	563.	528.	473.
405.	318.	248.	199.	159.	131.	106.	83.	68.	55.
44.	35.	28.	23.	19.	15.	12.	10.	8.	6.
5.	4.	4.	З.	2.	1.	Ο.			
	***	***							

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

#### HYDROGRAPH AT STATION SB10

	TOTAL RA	INFALL =	12.90, TOI	'AL LOSS ≍	5.30, TOTAL	EXCESS =	7.60
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
+	(CFS)	(HR)		6 - HR	24 - HR	72-HR	9.95-HR
			(CFS)				
+	3043.	3.55	(INCHES) (AC-FT)	360. 7.600 178.	217. 7.600 178.	217. 7.600 178.	217. 7.600 178.
			CUMULATIV	E AREA =	.44 SQ MI		

\*\*\* \*\*\* \*\*\* ----\* \* \* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \*\*\* \* \* \*

		* * * * * * * * *	* * * * *				
		*	*				
	131 KK	* C	P6 *				
		*	*				
		******	* * * * *				
			COMBI	NE HYDROGRAPHS	FROM CP5	, SB10, SB9	
	133 HC	HYDR	OGRAPH COMBI	NATION			
	199 110	mibic	TCOMP		ים מעט שמ	OCRADUC TO C	
			10000	) NOME	IN OF HIDR	UGRAFAS IU C	OMPTINE
						* * *	
	* * *		***	* * *	**	*	* * *
			HYDROGRA	PH AT STATION	CP6		
	PEAK FLOW	TIME		MA	XIMUM AVE	RAGE FLOW	
				6-HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	23427.	4.00		5101.	3077.	3077.	3077.
			(INCHES)	7.601	7.602	7.602	7.602
			(AC-FT)	2530.	2530.	2530.	2530.

CUMULATIVE AREA = 6.24 SQ MI

## Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - $\sim$ A Page 36 of 46

RD

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		****	*******	* * *								
		*		*					•			
134	кк	*	CP6CP7	*								
		*		*								
		****	******	***								
				P	OUTE HYDROGI	RADH FROM	CP6 TO CP	7				
				10		CALL I LICON						
		Н	YDROGRAI	PH ROU	TING DATA							
136	RD		MUSKING	SUM - CU	NGE CHANNEL	ROUTING						
				$\mathbf{L}$	2100.	CHANNEL	LENGTH					
				S	.0200	SLOPE						
				N	.090	CHANNEL	ROUGHNESS	COEFFICIE	NT			
				CA	.00	CONTRIB	UTING AREA					
			ç	SHAPE	TRAP	CHANNEL	SHAPE					
			_	WD	300.00	BOTTOM	WIDTH OR DI	AMETER				
				7	100.00	SIDE SL	OPE					
				-	200100							
								***				
					COMPU	JTED MUSK	INGUM-CUNGE	E PARAMETE	RS			
					-	COMPUT	ATION TIME	STEP				
			ELEN	1ENT	ALPHA	M	DT	DX	PEAK	TIME TO	VOLUME	MAXIMUM
										PEAK		CELERITY
							(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)
							(,	(= - /		(,		,
			MZ	AIN	.16	1.42	3.00	525.00	23431.39	243.00	7.60	6.01
						INTERPO	LATED TO SE	PECIFIED C	OMPUTATION	INTERVAL		
			MA	AIN	.16	1.42	3.00		23431.39	243.00	7.60	

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2530E+04 EXCESS= .0000E+00 OUTFLOW= .2530E+04 BASIN STORAGE= .9920E-02 PERCENT ERROR= .0

	* * *		***	* * *	***	e	***
			HYDROGRA	PH AT STAT	ION CP6CP7	¢	
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
				6 - HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
	( <i>,</i>		(CFS)				
+	23431.	4.05		5102.	3077.	3077.	3077.
			(INCHES)	7.602	7.603	7.603	7.603
			(AC-FT)	2530.	2530.	2530.	2530.
			CUMULATIV	E AREA =	6.24 SQ MI		

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Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 37 of 46



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	* * * * *	******	* *
	*		*
137 KK	*	SB11	*

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SCS RUNOFF COMPUTATION FOR SB11

SUBBASIN RUNOFF DATA

139 BA SUBBASIN CHARACTERISTICS TAREA .46 SUBBASIN AREA

PRECIPITATION DATA

93	PB	STORM	12.9	D BASIN 7	OTAL PRECI	PITATION					
94	PI	INCREMENTAL	L PRECIPIT.	ATION PATT	TERN						
		. 02	.02	.02	.02	. 02	.02	.02	.02	.02	.02
		. 02	.02	.02	.02	.02	.02	.02	.02	.02	.02
		. 03	.03	.03	.03	.03	. 03	.03	.03	.03	.03
		. 03	.03	.03	.03	.03	.03	.03	.03	.03	.03
		. 08	.08	.08	.08	.08	.08	.08	.08	.08	.08
		.08	.08	.08	. 08	.08	.08	.08	.08	.08	.08
		1.10	1.10	1.10	1.10	1.10	.36	.36	.36	.36	.36
		.18	.18	.18	.18	.18	.16	.16	.16	.16	.16
		.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
		. 04	.04	.04	.04	.04	. 04	.04	.04	.04	.04
		.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
		.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

74 LU	UNIFORM LOSS RATE				
	STRTL	1.00	INITIAL	LOSS	
	CNSTL	1.50	UNIFORM	LOSS RATE	
	RTIMP	.00	PERCENT	IMPERVIOUS	AREA

140 UD SCS DIMENSIONLESS UNITGRAPH TLAG .40 LAG

\* \* \*

				UNIT	HYDROGRAM	PH DINATES			
				42 END-OF	-PERIOD OF	(DINALES			
22.	69.	133.	221.	333.	432.	493.	520.	520.	493.
452.	402.	337.	268.	217.	178.	146.	124.	103.	84.
69.	57.	48.	39.	32.	26.	22.	18.	15.	12.
10.	8.	7.	6.	5.	4.	4.	3.	2.	2.
1.	0.								

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HYDROGRAPH AT STATION SB11

TOTAL RAINFALL = 12.90, TOTAL LOSS = 5.30, TOTAL EXCESS = 7.60

## Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000- CA Page 38 of 46

RE

	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
+	(CFS)	(HR)		6 - HR	24-HR	72-HR	9.95-HR
			(CFS)				
+	2924.	3.60		376.	227.	227.	227.
			(INCHES)	7.600	7.600	7.600	7.600
			(AC-FT)	186.	186.	186.	186.
			CUMULATIV	E AREA =	.46 SQ MI		

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		*******	****				
		*	*				
	141 KK	* CI	27 *				
		*	*				
		*******	****				
			COMBI	NE HYDROGR	APHS FROM CP6,	SB11	
	143 HC	HYDRO	GRAPH COMBI	NATION			
			ICOMP	2 N	UMBER OF HYDRO	GRAPHS TO	COMBINE
						**	*
	***		***	* * *	***		***
			HYDROGRA	PH AT STAT	ION CP7		
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
				6 - HR	24-HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	24733.	4.05		5477.	3304.	3304.	3304.
			(INCHES)	7.601	7.603	7.603	7.603
			(AC-FT)	2716.	2717.	2717.	2717.
			CUMULATIV	E AREA =	6.70 SQ MI		

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HYDROGRAPH ROUTING DATA

Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 39 of 46

290

146 RD	MUSKINGUM-CUNGE	CHANNEL	ROUTING
	L	2000.	CHANNEL LENGTH
	S	.0200	SLOPE
	N	.090	CHANNEL ROUGHNESS COEFFICIENT
	CA	.00	CONTRIBUTING AREA
	SHAPE	TRAP	CHANNEL SHAPE
	WD	30.00	BOTTOM WIDTH OR DIAMETER
	Z	40.00	SIDE SLOPE

				***				
	COMI	PUTED MUSK	INGUM-CUNGE	PARAMETE	RS			
		COMPUT.	ATION TIME	STEP				
ELEMENT	ALPHA	М	DT	DX	PEAK	TIME TO PEAK	VOLUME	MAXIMUM CELERITY
			(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)
MAIN	.38	1.35	3.00	666.67	24724.83	246.00	7.60	7.63

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN	.38	1.35	3.00	24724.83	246.00	7.60

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2717E+04 EXCESS= .0000E+00 OUTFLOW= .2717E+04 BASIN STORAGE= .1205E-01 PERCENT ERROR= .0

	***		* * *	* * *	***	r	* * *
			HYDROGRA	PH AT STATI	ON CP7CP8		
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
				6 - HR	24 - HR	72-HR	9.95-HR
+	(CFS)	(HR)					
			(CFS)				
+	24725.	4.10		5477.	3304.	3304.	3304.
			(INCHES)	7.601	7,603	7.603	7.603
			(AC-FT)	2716.	2717.	2717.	2717.
			CUMULATIV	E AREA =	6.70 SQ MI		

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SCS RUNOFF COMPUTATION FOR SB12

SUBBASIN RUNOFF DATA

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 40 of 46

RD

#### 149 BA SUBBASIN CHARACTERISTICS TAREA .15 SUBBASIN AREA

#### PRECIPITATION DATA

93 PB	STORM	12.90	BASIN TO	OTAL PRECIP	ITATION					
94 PI	INCREMENTAL	PRECIPITAT	ION PATTI	ERN						
	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
	. 03	.03	.03	.03	.03	.03	.03	.03	.03	.03
	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
	1.10	1.10	1.10	1.10	1.10	.36	.36	.36	.36	.36
	.18	.18	.18	.18	.18	.16	.16	.16	.16	.16
	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
74 LU	UNIFORM LOSS I	RATE								
	STRTL	1.00	INITIAL	LOSS						
	CNSTL	1.50	UNIFORM	LOSS RATE						
	RTIMP	.00	PERCENT	IMPERVIOUS	AREA					
150 UD	SCS DIMENSION	LESS UNITGR	APH							
	TLAG	.24	LAG							
					***					

				UNIT	HYDROGRAF	Ч			
				26 END-OF	-PERIOD OR	DINATES			
25.	77.	163.	241.	272.	266.	231.	183.	126.	92.
69.	51.	37.	28.	20.	15.	11.	8.	6.	4.
3.	з.	2.	1.	1.	0.				

\*\*\* \*\*\* \*\*\* \*\*\*

#### HYDROGRAPH AT STATION SB12

	TOTAL RA	INFALL =	12.90, TOTA	AL LOSS =	5.30, TOTAL	EXCESS =	7.60
	PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW	
				6 - HR	24 - HR	72-HR	9.95-HR
ł	(CFS)	(HR)					
			(CFS)				
F	1300.	3.40		123.	74.	74.	74.
			(INCHES)	7.600	7.600	7.600	7.600
			(AC-FT)	61.	61.	61.	61.

CUMULATIVE AREA = .15 SQ MI

\*\*\* \*\*\*

Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 41 of 46

00

	******	****					
	*	*					
151 KK	* C	P8 *					
	*	*					
	******		NE IVDDOGDA	DUC EDOM CD2	CDIO		
		COMBI	NE HIDROGRA	PHS FROM CP/,	5812		
153 HC	HYDR	OGRAPH COMBI	NATION				
		ICOMP	2 NU	MBER OF HYDRO	GRAPHS TO C	OMBINE	
					***		
* * *		***	* * *	***		***	
		HYDROGRA	PH AT STATI	ON CP8			
PEAK FLOW	TIME			MAXIMUM AVER	AGE FLOW		
			6-HR	24-HR	72-HR	9.95-HR	
(CFS)	(HR)						
		(CFS)					
24935.	4.10	(Therea)	5599.	3378.	3378.	3378.	
		(INCHES)	7.600	7.603	7.603	7.603	
		(AC-FT)	2777.	2778.	2778.	2778.	
		CUMULATIV	E AREA =	6.85 SQ MI			
				~			

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154 KK \* CP8CP9

+

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ROUTE HYDROGRAPH FROM CP8 TO CP9

HYDROGRAPH ROUTING DATA

156	RD	MUSKINGUM-CUNGE	CHANNEL	ROUTING				
		L	1700.	CHANNEL	LENGTH			
		S	.0200	SLOPE				
		N	.090	CHANNEL	ROUGHNESS	COEFFICIENT		
		CA	.00	CONTRIBU	JTING AREA			
		SHAPE	TRAP	CHANNEL	SHAPE			
		WD	30.00	BOTTOM I	VIDTH OR DI	AMETER		
		Z	30.00	SIDE SLO	OPE			
						***		
			COMPU	JTED MUSK	INGUM - CUNGE	PARAMETERS		
				COMPUTA	ATION TIME	STEP		
		ELEMENT A	LPHA	М	DT	DX	PEAK	TIME I

$D\mathbf{T}$	DX	PEAK	TIME TO	VOLUME	MAXIMUM
			PEAK		CELERITY
(MIN)	(FT)	(CFS)	(MIN)	(IN)	(FPS)

Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000 - ooA Page 42 of 46

2PD



CONTINUITY SUMMARY (AC-FT) - INFLOW= .2778E+04 EXCESS= .0000E+00 OUTFLOW= .2778E+04 BASIN STORAGE= .2106E-01 PERCENT ERROR= .0

\*\*\* \*\*\* \*\*\* \*\*\*

HYDROGRAPH AT STATION CP8CP9

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW					
				6 - HR	24-HR	72-HR	9.95-HR		
+	(CFS)	(HR)							
			(CFS)						
+	24919.	4.15		5600.	3378.	3378.	3378.		
			(INCHES)	7.600	7.603	7.603	7.603		
			(AC - FT)	2777.	2778.	2778.	2778.		

CUMULATIVE AREA = 6.85 SQ MI

\*\*\* \*\*\*

**************************************	COMBINE
157 KK CP9 * * 157 KK CP9 * * COMBINE HYDROGRAPHS FROM CP4, SB13, CP8 159 HC HYDROGRAPH COMBINATION ICOMP 3 NUMBER OF HYDROGRAPHS TO C *** *** *** HYDROGRAPH AT STATION CP9 DEAK FLOW TIME MARPAGE FLOW	COMBINE
157 KK * CP9 * * * * COMBINE HYDROGRAPHS FROM CP4, SB13, CP8 159 HC HYDROGRAPH COMBINATION ICOMP 3 NUMBER OF HYDROGRAPHS TO *** *** *** *** HYDROGRAPH AT STATION CP9	COMBINE
* * **********************************	COMBINE
**************************************	COMBINE
COMBINE HYDROGRAPHS FROM CP4, SB13, CP8 159 HC HYDROGRAPH COMBINATION ICOMP 3 NUMBER OF HYDROGRAPHS TO *** *** *** *** *** HYDROGRAPH AT STATION CP9 DEAK FLOW TIME AVERACE FLOW	COMBINE
159 HC HYDROGRAPH COMBINATION ICOMP 3 NUMBER OF HYDROGRAPHS TO *** *** *** *** *** HYDROGRAPH AT STATION CP9	COMBINE
ICOMP 3 NUMBER OF HYDROGRAPHS TO **** *** *** *** *** HYDROGRAPH AT STATION CP9 DEAK FLOW TIME AVERACE FLOW	COMBINE
*** *** HYDROGRAPH AT STATION CP9 DEAK FLOW TIME MARANCE FLOW	
*** *** *** *** HYDROGRAPH AT STATION CP9	
HYDROGRAPH AT STATION CP9	***
PEAR FLOW IIME MAXIMUM AVERAGE FLOW	
6-HR 24-HR 72-HR	9.95-HR
+ (CFS) (HR)	
(CFS)	
+ 50219. 4.15 10769. 6499. 6499.	6499.
(INCHES) 7.884 7.890 7.890	7.890
(AC-FT) 5340. 5344. 5344.	5344.

CUMULATIVE AREA = 12.70 SQ MI

# Attachment C Output File from HEC-1 Model 000-CDC-MGR0-00100-000-00A Page 43 of 46

#### 1

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

	OPERATION	STATION	PEAK	TIME OF	AVERAGE FI	LOW FOR MAXI	MUM PERIOD	BASIN	MAXIMUM	TIME OF
+		DIATION	1.704	FEAR	6-HOUR	24-HOUR	72-HOUR	AREA	STAGE	MAX STAGE
+	HYDROGRAPH AT	SB1	4097.	3.85	721.	435.	435.	.83		
+	ROUTED TO	SB1CP1	4093.	3.90	721.	435.	435.	.83		
+	HYDROGRAPH AT	SB2	2881.	3.60	365.	220.	220.	.42		
+	2 COMBINED AT	CP1	6164.	3.75	1086.	655.	655.	1.25		
+	ROUTED TO	CP1CP2	6159.	3.80	1086.	655.	655.	1.25		
+	HYDROGRAPH AT	SB3	7148.	3.95	1390.	838.	838.	1.60		
+	HYDROGRAPH AT	SB4	5782.	3.90	1042.	629.	629.	1.20		
+	3 COMBINED AT	CP2	18927.	3.90	3519.	2122.	2122.	4.05		
+	ROUTED TO	CP2CP3	18906.	4.00	3520.	2122.	2122.	4.05		
+	HYDROGRAPH AT	AGING	3436.	3.40	486.	297.	297.	.46		
+	2 COMBINED AT	CP3	20138.	3.95	4006.	2419.	2419.	4.51		
+	ROUTED TO	CP3CP4	20106.	4.05	4006.	2419.	2419.	4.51		
+	HYDROGRAPH AT	SB5	1925.	3,85	339.	204.	204.	.39		
+	HYDROGRAPH AT	SB6	3290.	4.00	660.	398.	398.	.76		
+	3 COMBINED AT	CP4	25090.	4.05	5005.	3022.	. 3022.	5.66		
+	ROUTED TO	CP4CP9	25047.	4.10	5006.	3022.	3022	5 66		

Attachment C Output File from HEC-1 Model LHC 000-CDC-MGR0-00100-000-004 Page 44 of 46

+	HYDROGRAPH AT	SB13	1555.	3.45	165.	100.	100.	.19	
+	HYDROGRAPH AT	SB7	10053.	4.15	2370.	1429.	1429.	2.90	
+	ROUTED TO	SB7CP5	10052.	4.25	2371.	1430.	1430.	2.90	
+	HYDROGRAPH AT	SB8	5757.	3.80	981.	592.	592.	1.20	
+	2 COMBINED AT	CP5	14235.	4.05	3351.	2021.	2021.	4.10	
+	ROUTED TO	CP5CP6	14234.	4.10	3352.	2021.	2021.	4.10	
+	HYDROGRAPH AT	SB9	8684.	3.75	1390.	838.	838.	1.70	
+	ROUTED TO	SB9CP6	8680.	3,90	1390.	838.	838.	1.70	
+	HYDROGRAPH AT	SB10	3043	3.55	360.	217	217.	44	
+	3 COMBINED AT	CP6	23427	4 00	5101	3077	3077	6 24	
	ROUTED TO		22127.	4 05	5102	2077	2077	6.24	
+	HYDROGRAPH AT	CFOCF7	25451.	4.05	5102.	3077.	3077.	0.24	
+	2 COMBINED AT	SB11	2924.	3.60	376.	227.	227.	.46	
+	ROUTED TO	CP7	24733.	4.05	5477.	3304.	3304.	6.70	
+		CP7CP8	24725.	4.10	5477.	3304.	3304.	6.70	
+	HYDROGRAPH AT	SB12	1300.	3.40	123.	74.	74.	.15	
+	2 COMBINED AT	CP8	24935.	4.10	5599.	3378.	3378.	6.85	
+	ROUTED TO	CP8CP9	24919.	4.15	5600.	3378.	3378.	6.85	
+	3 COMBINED AT	CP9	50219.	4.15	10769.	6499.	6499.	12.70	
1			SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)						

INTERPOLATED TO COMPUTATION INTERVAL

Attachment C Output File from HEC-1 Model Out 000-CDC-MGR0-00100-000-004 Page 45 of 46

	ISTAQ	ELEMENT	DT	PEAK	TIME PEA	TO VOI .K	LUME DI	PEAK	TIME TO PEAK	VOLUME		
			(MIN)	(CFS)	(M	IIN) (I	IN) (MIN	(CFS)	(MIN)	(IN)		
	SB1CP1	MANE	3.00	4093.01	234.	00 8.	.08 3.0	4093.01	234.00	8.08		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW=	.3575E+03	EXCESS=	.0000E+00	OUTFLOW= .3	576E+03 BAS	IN STORAGE=	.1048E-01 PERCENT	ERROR=	.0
	CP1CP2	MANE	3.00	6159.40	) 228.	00 8.	.08 3.0	0 6159.40	228.00	8.08		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW≈	.5385E+03	EXCESS=	.0000E+00	OUTFLOW= .5	387E+03 BAS	IN STORAGE=	.9970E-02 PERCENT	ERROR=	. 0
	CP2CP3	MANE	3.00	18905.50	240.	00 8.	.08 3.0	0 18905.50	240.00	8.08		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW=	.1745E+04	EXCESS=	.0000E+00	OUTFLOW≈ .1	745E+04 BAS	IN STORAGE=	.1214E-01 PERCENT	ERROR=	. 0
	AGING	MANE	. 27	3441.74	a 202.	75 9.	.94 3.0	0 3436.19	204.00	9.94		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW=	.0000E+00	EXCESS=	.2461E+03	OUTFLOW= .2	439E+03 BAS	IN STORAGE=	.1963E+01 PERCENT	ERROR=	.1
	CP3CP4	MANE	3.00	20106.10	243.	00 8.	.27 3.0	0 20106.10	243.00	8.27		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW=	.1989E+04	EXCESS≃	.0000E+00	OUTFLOW= .1	989E+04 BAS	IN STORAGE=	.7397E+00 PERCENT	ERROR=	.0
	CP4CP9	MANE	3.00	25046.78	3 246.	00 8.	.23 3.0	0 25046.78	246.00	8.23		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW=	.2485E+04	EXCESS=	.0000E+00	OUTFLOW= .2	485E+04 BAS	IN STORAGE=	.6271E+00 PERCENT	ERROR=	.0
	SB7CP5	MANE	3.00	10052.46	5 255.	00 7.	.60 3.0	0 10052.46	255.00	7.60		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW=	.1175E+04	EXCESS=	.0000E+00	OUTFLOW= .1	176E+04 BAS	IN STORAGE=	.5540E-02 PERCENT	ERROR=	.0
	CP5CP6	MANE	3.00	14233.66	5 246.	00 7.	.60 3.0	0 14233.66	246.00	7.60		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW=	.1662E+04	EXCESS=	.0000E+00	OUTFLOW= .1	662E+04 BAS	IN STORAGE=	.2786E-02 PERCENT	ERROR=	. 0
	SB9CP6	MANE	3.00	8680.31	234.	00 7.	.60 3.0	0 8680.31	234.00	7.60		
CONTINUITY	SUMMARY	(AC-FT) -	- INFLOW=	.6891E+03	EXCESS=	.0000E+00	OUTFLOW= .6	895E+03 BAS	IN STORAGE=	.9283E-02 PERCENT	ERROR=	1



CP6CP7 MANE 3.00 23431.39 243.00 7.60 3.00 23431.39 243.00 7.60 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2530E+04 EXCESS= .0000E+00 OUTFLOW= .2530E+04 BASIN STORAGE= .9920E-02 PERCENT ERROR= .0 CP7CP8 MANE 3.00 24724.83 246.00 7.60 3.00 24724.83 246.00 7.60 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2717E+04 EXCESS= .0000E+00 OUTFLOW= .2717E+04 BASIN STORAGE= .1205E-01 PERCENT ERROR= . 0 CP8CP9 MANE 3.00 24919.09 249.00 7.60 3.00 24919.09 249.00 7.60

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2778E+04 EXCESS= .0000E+00 OUTFLOW= .2778E+04 BASIN STORAGE= .2106E-01 PERCENT ERROR= .0

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

Attachment D Input and Output from HEC-RAS 000-CDC-MGR0-00100-000 - oo A J&t Page 1 of 6

# **HEC-RAS Schematic for Segment 1**



Attachment D Input and Output from HEC-RAS 000-CDC-MGR0-00100-000 -00A JLC Page 2 of 6





Attachment D Input and Output from HEC-RAS 000-CDC-MGR0-00100-000 -004 & XT Page 3 of 6





Attachment D Input and Output from HEC-RAS 000-CDC-MGR0-00100-000-00A Page 4 of 6



# Water Surface Profile of Probable Maximum Flood for Segment 2

Attachment D Input and Output from HEC-RAS 000-CDC-MGR0-00100-000 -00A A AT Page 5 of 6

# **HEC-RAS Schematic for Segment 3**



Attachment D Input and Output from HEC-RAS 000-CDC-MGR0-00100-000-00A f KC Page 6 of 6





Note: Left levee elevations have changed from those shown between HEC-RAS stations 8468 and 2552 (North Portal Loop Road West stations 531+00 and 572+00). The revised road profile is shown in Attachment A. The revised values for levee freeboard are included in Table 7-4: Flood Inundation Results for Segment 3.

Attachment E PMP Calculations for South Portal 000-CDC-MGR0-00100-000-00A J XT 1 of 4

The procedures presented in HMR 49 (Ref. 2.2.16) were used to calculate the PMP in the vicinity of the South Portal. The calculations on the following pages (performed using United States customary units) show that the 6-hour duration local storm PMP of 12.9 inches is more severe than the largest 6-hour general storm of 5.8 inches, which was calculated to occur during the month of September. The local storm PMP hyetograph has been included in this attachment.

Attachment E PMP Calculations for South Portal 000-CDC-MGR0-00100-000-00.4 J LT 2 of 4

Table 6.1.--General-storm PMP computations for the Colorado River and Great basin Drainage Midway Valley - South Portal Area  $mi^2$  (km<sup>2</sup>) Area 6.5 , Longitude<sup>116°27</sup>of basin center Latitude 36° 51' Month September Step Duration (hrs) 12 18 24 48 72 6 A. Convergence PMP 1. Drainage average value from one of figures 2.5 to 2.16 10.8 in. (mm) 2. Reduction for barrier-65 🖁 elevation [fig. 2.18] 3. Barrier-elevation reduced PMP [step 1 X step 2] 7.0 in. (mm) 4. Durational variation [figs. 2.25 to 2.27 NA NA NA NA 🔏 and table 2.7]. 68 NA 5. Convergence PMP for indicated durations [steps 3 X 4] 4.8 NA NA NA NA NA 1n. (mm) Incremental 10 mi<sup>2</sup> (26 km<sup>2</sup>) 6. PMP [successive subtraction NA NA NA 1n. (mm) 4.8 NA NA in step 5] 7. Areal reduction [select from figs. 2.28 and 2.29] 100 NA NA NA NA NA 🕺 8. Areally reduced PMP [step 6 X step 7] 4.8 NA NA NA NA NA in. (mm) 9. Drainage average PMP [accumulated values of step 8] 4.8 NA NA NA NA NA in. (mm) B. Orographic PMP 1. Drainage average orographic index from figure 3.11a to d. <u>30</u> in.(mm) 2. Areal reduction [figure 3.20] 100 % 3. Adjustment for month [one of figs. 3.12 to 3.17] 100 % 4. Areally and seasonally adjusted 3.0 in. (mm) PMP [steps 1 X 2 X 3] 5. Durational variation [table 3.6] 32 NA NA NA NA X 6. Orographic PMP for given durations [steps 4 X 5] 1.0 NA NA NA NA In. (mm) C. Total PMP <u>5.8 NA NA NA NA In. (mm)</u> 1. Add steps A9 and B6 2. PMP for other durations from smooth curve fitted to plot of computed data. 3. Comparison with local-storm PMP (see sec. 6.3),

150

Attachment E PMP Calculations for South Portal 152 000-CDC-MGR0-00100-000 -004 JET 3 of 4 Table 6.3A.--Local-storm PMP computation, Colorado River, Great Basin and California drainages. For drainage average depth PMP. Go to table 6.3B if areal variation is required.  $mi^2$  (km<sup>2</sup>) Drainage Midway Valley - South Portal Area Area 6.5 Minimum Elevation 3520 ft (m) Latitude 36° 51' Longitude 116° 27' Steps correspond to those in sec. 6.3A. 1. Average 1-hr  $1-mi^2$  (2.6-km<sup>2</sup>) PMP for 10.3 **in. (mm)** drainage [fig. 4.5]. 2. a. Reduction for elevation. [No adjustment for elevations up to 5,000 feet (1,524 m): 5% decrease per 1,000 feet (305 m) above % 5,000 feet (1,524 m)]. 100 10.3 in. (mm) b. Multiply step 1 by step 2a. 3. Average 6/1-hr ratio for drainage [fig. 4.7]. 1.36 Duration (hr) 5 6 1/4 1/2 3/4 1 2 4. Durational variation for 6/1-hr ratio of step 3 [table 4.4]. 67 <u>85 94 100 116 124 129 133 136</u> % 5.  $1-mi^2$  (2.6-km<sup>2</sup>) PMP for indicated durations [step 2b X step 4]. 6.9 8.8 9.7 10.3 11.9 12.8 13.3 13.7 14.0 in. (mm) 6. Areal reduction [fig. 4,9]. 80 83 85 Z 87 88 89 90 91 92 7. Areal reduced PMP [steps 5 X 6]. 5.5 7.3 8.2 9.0 10.5 11.4 12.0 12.5 12.9 in. (mm) 8. Incremental PMP [successive subtraction in step 7]. 9.0 1.5 0.9 0.6 0.5 0.4 in. (mm) 5.5 1.8 0.9 0.8 } 15-min. increments 9. Time sequence of incre-Used EM 1110-2-1411 COE mental PMP according to: Method as in previous report (Ref. 2.2.6, p. 16) Hourly increments [table 4.7]. 0.4 0.6 1.5 9.0 0.9 0.5 in. (mm) Four largest 15-min. increments [table 4.8]. 5.5 1.8 0.9 0.8 in. (mm)

Attachment E PMP Calculations for South Portal 000-CDC-MGR0-00100-000 - ooA J for 4 of 4



# PMP Hyetograph for the South Portal (3-minute interval)

# Attachment F HEC-1 Schematic 000-CDC-MGR0-00100-000 -- 00A J J J Page 1 of 2

-	SCHEMATIC DI	AGRAM OF STREAM NETWORK
LINE	(V) ROUTING	(>) DIVERSION OR PUMP FLOW
NO.	(.) CONNECTOR	(<) RETURN OF DIVERTED OR PUMPED FLOW
12	SB1 V	
31	V SB1CP1	
34	. SB	·2 ·
38	CP1 V	: :
41	V CP1CP2 ·	
44	. SB	3
48		. SB4
52	CP2 V	
55	CP2CP3	
58	. AGIN	G
65	СРЗ V	
68	CP3CP4	
71	. SB.	.5
76		. SB6
80	CP4	 

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Attachment F HEC-1 Schematic 000-CDC-MGR0-00100-000-00A J &T Page 2 of 2



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