COUNTY OF
BERNALILLO

CITY OF
ALBUQUERQUE

# SPECIAL ASSESSMENT DISTRICT BC-83-1

# SPECIAL ASSESSMENT DISTRICT 216

FINAL

# DRAINAGE ANALYSIS

DECEMBER 1992


ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
ALBUQUERQUE, NEW MEXICO

COUNTY OF BERNALILLO

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT BC-83-1

CITY OF ALBUQUERQUE

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT 216

# DRAINAGE ANALYSIS

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DECEMBER 1992


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ALBUQUERQUE, NEW MEXICO 87108



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**DRAINAGE ANALYSIS**

**SPECIAL ASSESSMENT DISTRICT BC-83-1**
**SPECIAL ASSESSMENT DISTRICT 216**

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# I

# INTRODUCTION

County of Bernalillo Special Assessment District BC-83-1 (SAD-BC-83-1) and City of Albuquerque Special Assessment District 216 (SAD 216) were established to provide street and drainage improvements primarily located within the northeast quadrant of the Albuquerque Metropolitan area. Portions of the improvements and the area to be served lie partly within the City of Albuquerque municipal limits and portions are partly outside the City of Albuquerque municipal limits. (See Location Map, Map No. 1 included herein, a composite of Zone Atlas Pages F-15, F-16, G-15 and G-16.)

The improvements and areas located within the municipal limits of the City of Albuquerque are governed by the City of Albuquerque and the improvements and areas located outside the municipal limits are governed by the County of Bernalillo.

A Joint Powers Agreement has been entered into between the governing bodies of the City of Albuquerque and the County of Bernalillo. This Agreement identifies the special assessment district improvements project and establishes the County of Bernalillo as the lead agency for the project.

The street improvements are to consist of asphalt pavement with concrete curb and gutter and sidewalks. The drainage improvements are to provide a method of disposing of storm water runoff that affect the proposed street improvements as well as the adjacent and surrounding properties.

A study of the project area revealed that the drainage basin in which SAD BC-83-1 and SAD 216 are located is quite extensive with a major portion lying beyond the limits of the streets which will be improved by these assessment districts. Additionally, the drainage basin as it now exists has no natural outfall and as a result storm water ponding and flooding of properties occur during and after any significant rain storm.

Street improvements are included in these special assessment districts for the following streets and/or portions thereof:

Alexander Boulevard, N.E., from Carmony Road, N.E. to Yale Boulevard, N.E.

Carmony Road, N.E., from Edith Boulevard, N.E. to Yale Boulevard, N.E.

Comanche Road, N.E., from Edith Boulevard, N.E. to the West Frontage Road of Interstate 25.

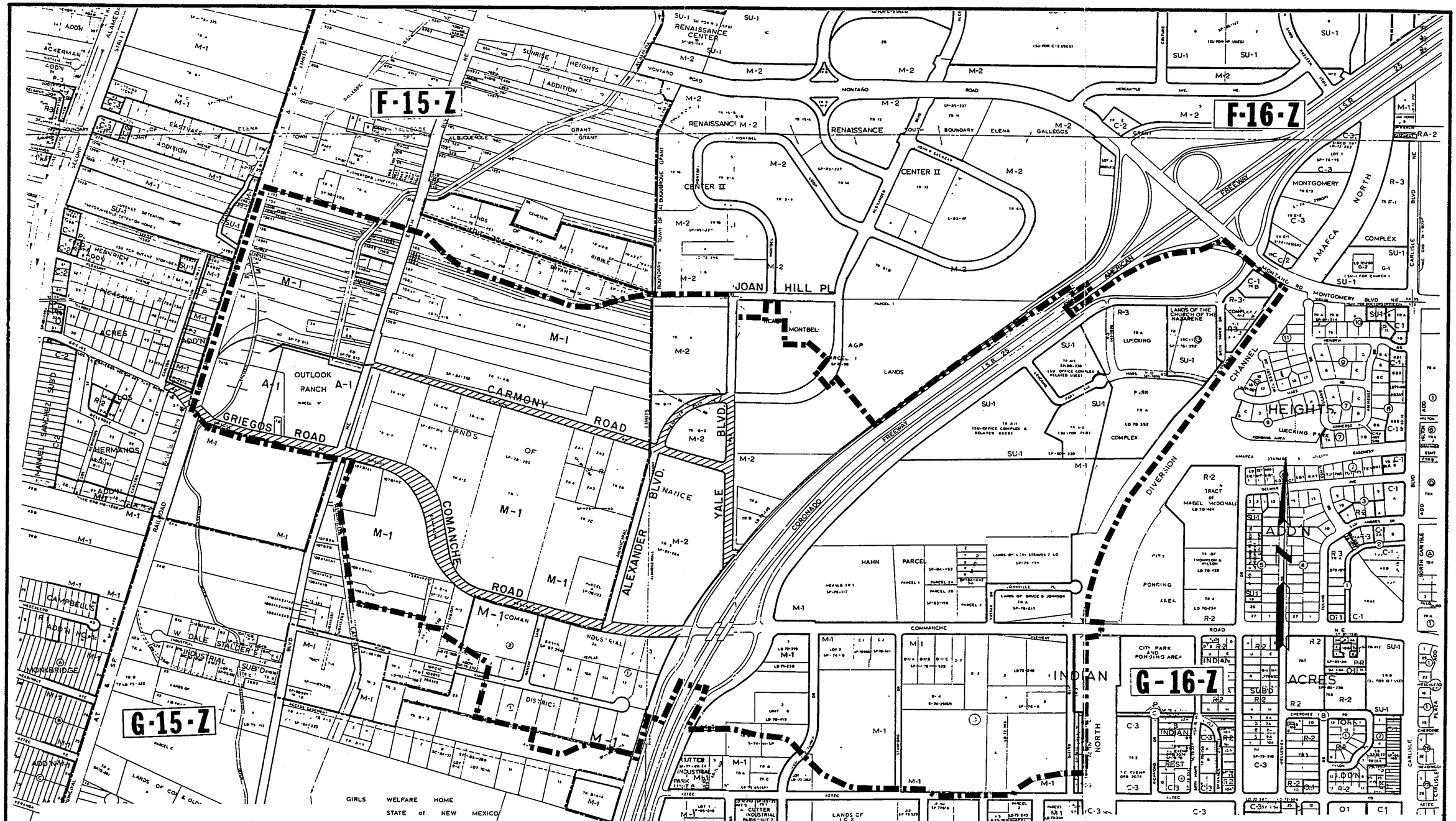
Griegos Road, N.W. and N.E., from Carlton Street, N.W. to Edith Boulevard, N.E.

Yale Boulevard, N.E., from Alexander Boulevard, N.E. to the West Frontage Road of Interstate 25.

(See enclosed Location Map, Map No. 1 for locations of streets to be improved.)

The area to be served by the drainage improvements under these special assessment districts is generally described as bounded on the west by AT&SF main line railroad tracks; on the north by an east-west line varying from 800 feet to 1000 feet north of Carmony Road, N.E. west of Interstate 25 and then extending northerly to Montano Road east of Interstate 25; on the east by the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) North Diversion Channel; on the south by an east-west line varying from 500 feet to 1000 feet south of Comanche Road, N.E.; and encompassing a total area of approximately 525 acres.

(See enclosed Location Map, Map No. 1 for limits of drainage area.)




| COUNTY OF BERNALILLO | CITY OF ALBUQUERQUE |
|---|---|
| SPECIAL ASSESSMENT DISTRICT BC-83-1 | SPECIAL ASSESSMENT DISTRICT 216 |

DRAINAGE ANALYSIS

LOCATION MAP

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
ALBUQUERQUE NEW MEXICO

| FILE No | DRAWN | CHECKED | DATE | |
|---|---|---|---|---|
| 83-347 | JCS, TL | DA | May 1989 | MAP No. 1 |

## II

## DRAINAGE AREA BOUNDARIES

The drainage area to be served by the proposed special assessment district drainage system improvements is basically the downstream remnants of the Hahn Arroyo Drainage Basin. (See the Drainage Area Map, Map No. 3 enclosed in the back of this report.)

Historically the Hahn Arroyo that presently traverses through the area drained an extensive area that extended easterly to the base of the Sandia Mountains. In the late 1960's, the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) North Diversion Channel (NDC) was constructed which intercepted the Hahn Arroyo flows generated by the drainage area east of the North Diversion Channel. As a result, the North Diversion Channel is established as the east boundary of the drainage basin.

Natural terrain and the development of properties, including street construction, along the perimeter of the area have established the north and south boundaries of the drainage basin. There is no indication, however, that the developments changed the natural basin limits any major extent.

The west boundary of the basin is established by the AT&SF mainline railroad tracks. The bed of the railroad tracks has been

elevated above the natural surface grade and creates a barrier to runoff flows originating from the east. Storm runoff waters reaching the railroad tracks accumulate along the east side of the railroad tracks and ponds. As a result, the properties adjacent to the tracks are continuously subjected to flooding.

The boundaries of this drainage area as generally described in this report and as shown on the Drainage Area Map, Map No. 3, are similar to the drainage area as outlined in the Edith Boulevard Drainage Analysis Report which was prepared by Boyle Engineering Corporation for the County of Bernalillo. The only significant difference being that the drainage area boundary, shown and described herein, reflects the minor modifications made to the boundary at the Montano Road/I-25 Interchange when the New Mexico State Highway and Transportation Department reconstructed the I-25 East and West Frontage Roads.

# III

# DRAINAGE PATTERNS AND EXISTING CONDITIONS

## A. Drainage Patterns

The drainage patterns within the drainage area are basically divided into two east-west drainage routes. The major feature within the drainage area which defines the drainage routes is Interstate 25, which bisects the upper reaches of the basin in a northeast to southwest direction. There are existing drainage structures under the Interstate which were installed when the Interstate was originally constructed and were located to pass waters under the Interstate within natural drainageway alignments, particularly the Hahn Arroyo and its tributaries.

Two major drainage structures now exist under Interstate 25.

- A double 10' x 10' box culvert located easterly of the intersection of Carmony Road and Yale Boulevard. This double box culvert was recently modified by the New Mexico State Highway and Transportation Department by plugging the south barrel and by installing a 48" diameter reinforced concrete pipe inside the north barrel. As a result, the capacity of this structure has been reduced to the capacity

of the 48 inch pipe. This structure conveys the storm water runoff from Drainage Basin A under the Interstate. (See Drainage Area Map, Map No. 3.)

- A single 10' x 5' box culvert located south and east of the intersection of Carmony Road and Yale Boulevard. This culvert conveys the storm water runoff from Drainage Basin B under the Interstate. (See Drainage Area Map, Map No. 3.)

Additionally, the New Mexico State Highway and Transportation Department has installed a 48" diameter storm drain line from Comanche Road northerly on the west side of Interstate 25 to the single 10' x 5' concrete box culvert. This 48" diameter storm drain conveys the storm water collected by the inlets at Comanche Road and Interstate 25 to the 10' x 5' box culvert mentioned above. This storm water is the runoff from Drainage Basin C.

B. **Hahn Arroyo**

1) East of Interstate 25

Storm water runoff from Drainage Basin A is directed to the 48" pipe crossing under Interstate 25 (modified 10' x 10' box culverts) by the Interstate drainage system and by natural drainageways.

Storm water runoff from Drainage Basin B is directed to the 10' x 5' box culvert crossing under Interstate 25 by the development that has taken place in this basin. Runoff

from Sub-Basin B-1 is directed across Comanche Road at Stanford Drive. North of Comanche Road a north-south earth swale carries the runoff northerly.

An existing east-west small earth channel, generally bisecting Sub-Basin B-2, collects and conveys storm waters from this sub-basin to the 10' x 5' box culvert. Also, approximately 700 feet east of I-25, this earth channel intercepts the flows from the north-south earth swale carrying the runoff waters from Sub-Basin B-1.

The small earth swales and channels that serve Sub-Basins B-1 and B-2 are lacking in maintenance, are undersized and do not have sufficient capacity to convey the 100 year storm event.

2) <u>West of Interstate 25</u>

The above described structures under Interstate 25 basically direct all storm water flows originating from the Interstate Right-of-Way and that portion of the drainage basin east of Interstate 25 into the Hahn Arroyo west of Interstate 25.

These Hahn Arroyo flows then flow in channels and overland to two 36" culvert pipes located under Yale Boulevard directly south of Carmony Road.

At the southwest corner of the intersection of Carmony Road and Yale Boulevard, a detention pond has been constructed by enlarging the Hahn Arroyo Channel that detains the runoff waters for a short period of time. Two 36" outlet pipes under Alexander Boulevard drain this detention pond into a widened channel west of Alexander Boulevard.

From the above widened channel, storm water flows to the north in two culvert pipes under Carmony Road. These two culvert pipes discharge into a 48" diameter RCP located directly north of Carmony Road. This 48" diameter RCP extends northwesterly approximately 600 feet and discharges into an open channel.

Beginning approximately 400 feet east of Edith Boulevard, a 48" diameter pipe has been installed in the Hahn Arroyo with the arroyo filled over this pipe. This pipe extends from the southeast to the northwest and at some point east of Edith Boulevard the 48" pipe connects (assumed) to three 24" pipes that outlet on the east side of Edith Boulevard.

The Hahn Arroyo Crossing at Edith Boulevard consists of a triple 6' x 6' box culvert. Downstream of this box culvert a 36" diameter RCP has been installed in the channel for approximately one hundred feet, and the channel covered over and paved. This 36" pipe discharges into a small channel that further west basically disappears, and the

water continues to sheet flow westerly to the east side of the AT&SF mainline railroad tracks.

The combination of the raised AT&SF railroad bed and an earth dike located just to the east of the tracks has created a barrier to storm waters flowing further west. No drainage facilities exist under the tracks, and ponding of storm waters occur on the east side of the tracks.

When fairly substantial rain storms occur, the ponding water flows gradually to the south along the east side of the railroad tracks, and enter an existing ponding area creating a flood plain north of Griegos Road adjacent to the railroad tracks.

With the exception of the crossing structure under Edith Boulevard, the drainage facilities along the Hahn Arroyo, west of I-25 are makeshift in nature and do not have sufficient capacity to convey the 100 year storm event. In addition, most all the existing drainageway and facilities on the Hahn Arroyo are located on private property.

C. <u>Comanche Road</u>

The second significant drainage route through the area is along Comanche Road. The portion of the drainage area drained by Comanche Road starts at Interstate 25 and consists of Drainage Areas K-1

through K-5 which are located north and south of Comanche Road. (See Drainage Area Map, Map No. 3.)

Comanche Road is presently improved with only a two lane paved roadway and storm waters are carried on each side of the paved section in shallow swales. When significant rain storms occur, the capacity of these side road swales are exceeded and the runoff flows onto and through adjacent private properties.

Additionally, storm waters carried by Comanche Road flow across Edith Boulevard and then continue west to the east side of the AT&SF railroad tracks.

Since no drainage facilities exist under the tracks, the storm water flows to the ponding area and flood plain directly north of Griegos Road. This is the same area where the storm water runoff from the Hahn Arroyo eventually accumulates.

## D. Existing Developed Conditions

It is important to note that a significant portion of the drainage area has been developed. A major portion of this development is commercial and industrial.

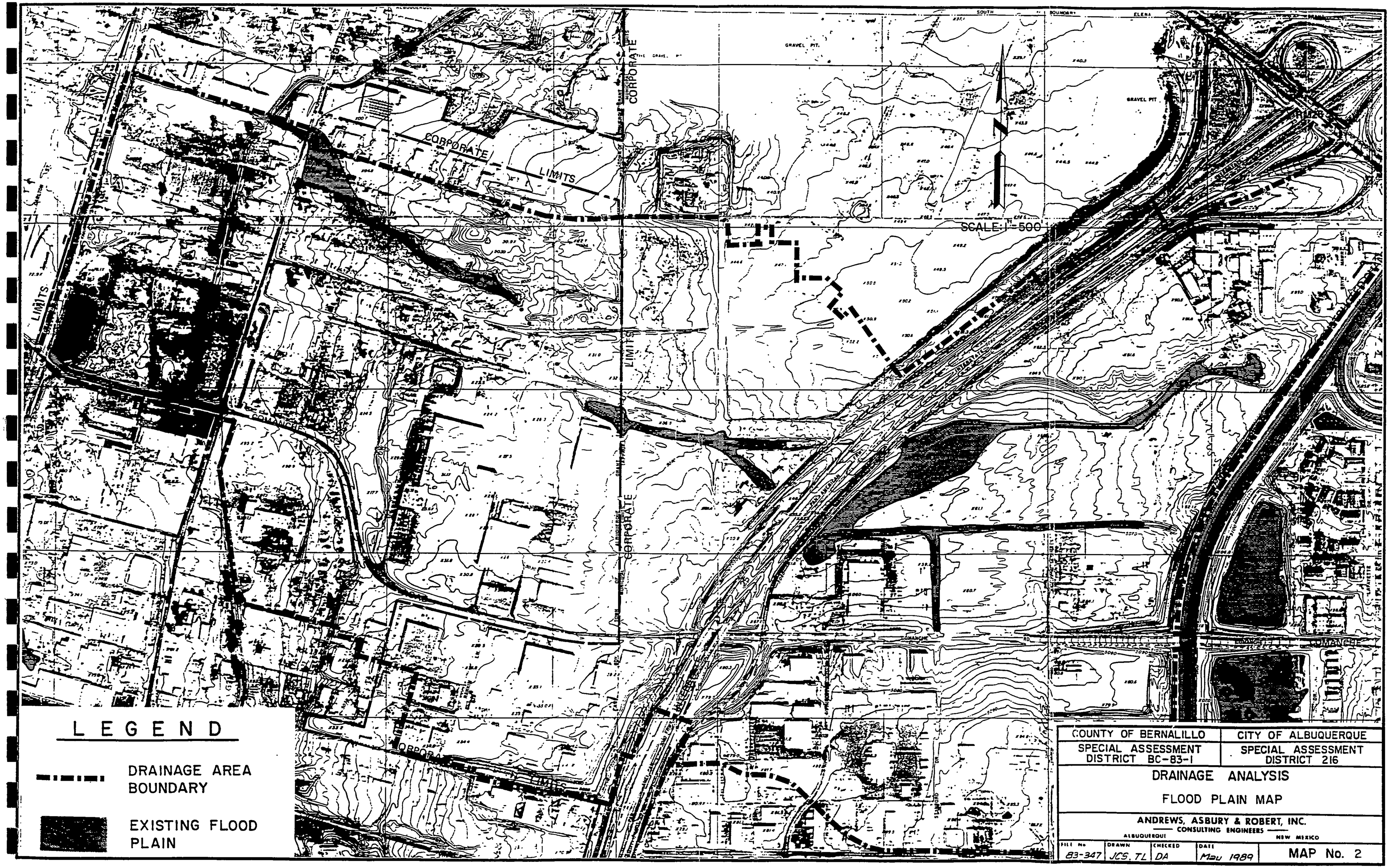
At the present time, approximately 57 percent of the area is developed, approximately 35 percent is undeveloped and 8 percent is New Mexico State Highway Department Interstate 25 Right-of-Way.

The drainage for this area is complicated since over the years various drainage criteria has been utilized when development of the properties occurred. Some of the developments detain storm water runoff, some retain portions or all of the runoff, while other developments free discharge the runoff from the properties.

The major portion of the undeveloped lands are located in Drainage Areas A and B east of Interstate 25. There are, however, individual vacant tracts spread throughout the area.

## E. Flood Plains

Presently flood plains (flood hazard areas) exist within the drainage area. These flood plains are shown on the Flood Plan Map, Map No. 2 enclosed. This map was reproduced from the National Flood Insurance Program - Flood Boundary and Floodway Map, City of Albuquerque, New Mexico, Bernalillo County, Panel No. 23.


SCALE: 1" = 500'
CORPORATE LIMITS
GRAVEL PIT
COMANCHE
LEGEND
DRAINAGE AREA BOUNDARY
EXISTING FLOOD PLAIN
COUNTY OF BERNALILLO
SPECIAL ASSESSMENT DISTRICT BC-83-1
CITY OF ALBUQUERQUE
SPECIAL ASSESSMENT DISTRICT 216
DRAINAGE ANALYSIS
FLOOD PLAIN MAP
ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
ALBUQUERQUE NEW MEXICO
FILE No. 83-347
DRAWN JCS, TL
CHECKED DA
DATE May 1989
MAP No. 2

# IV

# HYDROLOGY

The latest revision of the HYMO Computer Program (March 1992) of Revised Section 22.2, HYDROLOGY, of the City of Albuquerque Development Process Manual (DPM), Volume 2, was utilized in determining peak rates of runoff and volume of runoff from the drainage area.

## A. Rainfall

Three storms were used to analyze runoff conditions for this drainage area:

1. 100 Year 6 Hour Storm - For determining design peak flow rates.

2. 10 Year 6 Hour Storm - For determining 10 year frequency flow rates.

3. 100 Year 24 Hour Storm - For determining volume of runoff.

The rainfall presented on DPM Section 22.2 Figure E-$P_{360}$ (taken from Fig. 24, NOAA Atlas 2, Volume IV) was utilized in determining the rinfall for a 100 year frequency 6-hour storm and the 10 year

frequency storm. The 100 year 6-hour rainfall is 2.25 inches and the 10 year 6-hour rainfall is (2.25 x 0.667 =) 1.50 inches. (The 0.667 factor is from Table 3, DPM Section 22.2.)

The rainfall for a 100 year frequency 24-hour storm was taken from DPM Section 22.2 Figure F-$P_{1440}$ (taken from Fig. 30, NOAA Atlas 2, Volume IV). The 100 year 24-hour rainfall is 2.6 inches.

The 100 year 24-hour rainfall was utilized in determining volumes of runoff for sizing the detention pond due to the evacuation time being greater than 6 hours. This criteria is established by the current City of Albuquerque Drainage Ordinance and the current County of Bernalillo Drainage Ordinance.

B. <u>Soil Characteristics</u>

Hydrologic soil groups were determined from the "Soil Conservation Service - Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico (1977)".

Soils within the drainage basin consist of Hydrologic Soil Group A and Group B.

Extensive mining of gravel has historically taken place within the drainage basin. During the reclamation of the gravel mining area, mixing of the two groups of soils undoubtedly took place, therefore the drainage basin should be considered as having a combination of Group A and Group B Soils.

## C. Land Uses

Land uses utilized as a factor in determining the land treatment under Developed Conditions were taken from the City of Albuquerque and County of Bernalillo zoning maps. The Zoning (Land Use Designation) used in determining the land treatment is shown on Map No. 1 enclosed hereinbefore in this report.

## D. Land Treatment

The HYMO Computer Program provides for basin land surface treatments to be input as four (4) basic classes of treatment as follows:

| TREATMENT DESIGNATION | LAND SURFACE CONDITION (Short Description)* |
|---|---|
| A | Uncompacted Soil |
| B | Landscaping (Grass) |
| C | Compacted Soil |
| D | Impervious Areas (Pavement and Roofs) |

* (See Table 4 of Revised Section 22.2 of DPM for more complete Land Surface Treatment description).

Each subdivision and/or sub-basin was studied and analyzed to arrive at the applicable percentages of land treatments. (See Table No. 2.) Land treatments are for Developed Conditions.

## E. Time of Concentrations

Time of concentrations were determined utilizing the Upland Velocity Method for the individual sub-basins. (See Table No. 2 HYMO Basin Parameter Work Sheets.)

Sub-basin flows are then routed and added through applicable drainage facilities by the computer model.

## F. Runoff Analysis

The storm water peak runoff rates under the Proposed Developed Conditions were determined from the HYMO Model.

The following table, Table No. 1, shows the peak rates of runoff at the various Analysis Points. (See the Drainage Area Map, Map No. 3 for location of the Analysis Points.)

A summary of the Hydrology for the 100 year - 6 hour storm and the 10 year - 6 hour storm is included hereinafter in Appendix A

Detailed computer printouts of the HYMO Model are available at Bernalillo County Public Works Department and City of Albuquerque Hydrology Division.

## G. Reservoir Routing

The 100 year - 24 hour inflow hydrograph to the Griegos Pond was routed through the pond by modeling the pond as a reservoir in the HYMO Program (See Appendix A). Input to the model included the outlet works discharge curve (Figure 1, Appendix A) and the reservoir storage volume curve (Figure 2, Appendix A). Following Tables No. 1 and 2, after this section of the report, is a graph of the inflow and outflow hydrographs of the Griegos Pond for the 100 year - 24 hour storm.

The Probable Maximum Flood (PMF) was also routed through the Griegos Pond using the HYMO Program (See Appendix A). Additional input to the model included the Emergency Spillway rating curve (Figure 3, Appendix A).

# TABLE NO. 1

## PEAK RUNOFF RATES

### DEVELOPED CONDITIONS
### (6 HOUR STORM)

| ANALYSIS POINT | Q(10) (CFS) | Q(100) (CFS) |
|---|---|---|
| 1 | 18 | 30 |
| 2 | 29 | 49 |
| 3 | 60 | 101 |
| 4 | 61 | 104 |
| 5 | 63 | 109 |
| 6 | 96 | 151 |
| 6A | 70 | 109 |
| 6B | 197 | 308 |
| 7 | 241 | 377 |
| 8 | 248 | 393 |
| 9 | 70 | 110 |
| 10 | 87 | 138 |
| 11 | 63 | 65 |
| 12 | 363 | 544 |
| 13 | 376 | 565 |
| 14 | 47 | 73 |
| 15 | 413 | 627 |
| 16 | 454 | 688 |
| 17 | 519 | 789 |
| 18 | 569 | 870 |
| 19 | 71 | 111 |
| 20 | 638 | 979 |
| 21 | 636 | 971 |
| 22 | 66 | 104 |
| 23 | 37 | 93 |
| 24 | 84 | 171 |
| 25 | 114 | 212 |
| 26 | 163 | 297 |
| 27 | 167 | 301 |
| 28 | 48 | 81 |
| 29 | 40 | 63 |
| * 30 | 864 | 1376 |

* Analysis Point 30 - Includes runoff from Total Drainage Area.

# TABLE NO. 2

## HYMO BASIN PARAMETER WORKSHEET

## DEVELOPED CONDITIONS

**PROJECT:** SAD-BC-83-1 & SAD-216 **BY:** D.L.A. **DATE:** 7-3-91

| Basin | Area (Sq. Mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-1 | 0.0084 | 150 | 7.0 | 0.047 | 0.7 | 1.51 | 0.028 | 0.018 | | | | |
| | | 1,000 | 1.0 | 0.001 | 0.7 | 0.22 | 1.255 | 0.837 | | | | |
| | TOTAL = | | | | | | 1.282 | 0.855 | 81 | | | 19 |
| A-2 | 0.0195 | 150 | 5.0 | 0.033 | 2.0 | 3.65 | 0.011 | 0.008 | | | | |
| | | 275 | 4.0 | 0.015 | 0.7 | 0.84 | 0.090 | 0.060 | | | | |
| | | 850 | 8.0 | 0.009 | 0.7 | 0.68 | 0.348 | 0.232 | | | | |
| | TOTAL = | | | | | | 0.450 | 0.300 | 15 | 15 | | 70 |
| A-3 | 0.0194 | 400 | 3.0 | 0.008 | 2.0 | 1.73 | 0.064 | 0.043 | | | | |
| | | 400 | 3.0 | 0.008 | 2.0 | 1.73 | 0.064 | 0.043 | | | | |
| | | 1,550 | 1.5 | 0.001 | 3.0 | 0.93 | 0.461 | 0.308 | | | | |
| | TOTAL = | | | | | | 0.590 | 0.393 | 15 | 15 | | 70 |
| A-4 | 0.0077 | 980 | 5.0 | 0.005 | 0.7 | 0.50 | 0.544 | 0.363 | | | | |
| | | 175 | 4.0 | 0.023 | 3.0 | 4.54 | 0.011 | 0.007 | | | | |
| | | 750 | 4.0 | 0.005 | 3.0 | 2.19 | 0.095 | 0.063 | | | | |
| | | 875 | 26.0 | 0.030 | 3.0 | 5.17 | 0.047 | 0.031 | | | | |
| | TOTAL = | | | | | | 0.697 | 0.465 | 64 | | | 36 |

# TABLE NO. 2 - CONTD.

## HYMO BASIN PARAMETER WORKSHEET

## DEVELOPED CONDITIONS

**PROJECT:** SAD-BC-83-1 & SAD-216 **BY:** D.L.A. **DATE:** 7-3-91

| Basin | Area (Sq. Mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-5 | 0.0392 | 180 | 5.0 | 0.028 | 2.0 | 3.33 | 0.015 | 0.010 | | | | |
| | | 220 | 8.0 | 0.036 | 2.0 | 3.81 | 0.016 | 0.011 | | | | |
| | | 500 | 2.0 | 0.004 | 2.0 | 1.26 | 0.110 | 0.073 | | | | |
| | | 650 | 14.0 | 0.022 | 3.0 | 4.40 | 0.041 | 0.027 | | | | |
| | | 225 | 0.5 | 0.002 | 3.0 | 1.41 | 0.044 | 0.029 | | | | |
| | | 300 | 6.0 | 0.020 | 3.0 | 4.24 | 0.020 | 0.013 | | | | |
| | | 925 | 7.0 | 0.008 | 3.0 | 2.61 | 0.098 | 0.066 | | | | |
| | TOTAL = | | | | | | 0.344 | 0.229 | 15 | 15 | | 70 |
| A-6 | 0.0127 | 80 | 2.0 | 0.025 | 0.7 | 1.11 | 0.020 | 0.013 | | | | |
| | | 800 | 4.0 | 0.005 | 0.7 | 0.49 | 0.449 | 0.299 | | | | |
| | | 350 | 2.0 | 0.006 | 0.7 | 0.53 | 0.184 | 0.122 | | | | |
| | | 900 | 15.0 | 0.017 | 0.7 | 0.90 | 0.277 | 0.184 | | | | |
| | | 450 | 8.0 | 0.018 | 3.0 | 4.00 | 0.031 | 0.021 | | | | |
| | TOTAL = | | | | | | 0.961 | 0.640 | 61 | | | 39 |
| B-1 | 0.0713 | 50 | 1.0 | 0.020 | 2.0 | 2.83 | 0.005 | 0.003 | | | | |
| | | 400 | 2.0 | 0.005 | 2.0 | 1.41 | 0.079 | 0.052 | | | | |
| | | 100 | 2.0 | 0.020 | 2.0 | 2.83 | 0.010 | 0.007 | | | | |
| | | 200 | 2.0 | 0.010 | 2.0 | 2.00 | 0.028 | 0.019 | | | | |
| | | 300 | 3.0 | 0.010 | 3.0 | 3.00 | 0.028 | 0.019 | | | | |
| | | 175 | 21.0 | 0.120 | 3.0 | 10.39 | 0.005 | 0.003 | | | | |
| | | 75 | 4.0 | 0.053 | 3.0 | 6.93 | 0.003 | 0.002 | | | | |
| | | 425 | 2.5 | 0.006 | 3.0 | 2.30 | 0.051 | 0.034 | | | | |
| | | 675 | 2.0 | 0.003 | 3.0 | 1.63 | 0.115 | 0.077 | | | | |
| | TOTAL = | | | | | | 0.323 | 0.215 | | 7 | 8 | 85 |

# TABLE NO. 2 - CONTD.

## HYMO BASIN PARAMETER WORKSHEET

## DEVELOPED CONDITIONS

**PROJECT:** SAD-BC-83-1 & SAD-216 **BY:** D.L.A. **DATE:** 7-3-91

| Basin | Area (Sq. Mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-2A | 0.0213 | 130 | 26.0 | 0.200 | 0.7 | 3.13 | 0.012 | 0.008 | | | | |
| | | 650 | 2.0 | 0.003 | 2.0 | 1.11 | 0.163 | 0.109 | | | | |
| | | 100 | 8.0 | 0.080 | 3.0 | 8.49 | 0.003 | 0.002 | | | | |
| | | 90 | 2.0 | 0.022 | 3.0 | 4.47 | 0.006 | 0.004 | | | | |
| | | 400 | 1.0 | 0.003 | 3.0 | 1.50 | 0.074 | 0.049 | | | | |
| | TOTAL = | | | | | | 0.257 | 0.171 | | 7 | 7 | 86 |
| B-2B | 0.0159 | 100 | 7.0 | 0.070 | 2.0 | 5.29 | 0.005 | 0.003 | | | | |
| | | 220 | 0.5 | 0.002 | 2.0 | 0.95 | 0.064 | 0.043 | | | | |
| | | 150 | 2.0 | 0.013 | 3.0 | 3.46 | 0.012 | 0.008 | | | | |
| | | 350 | 1.0 | 0.003 | 3.0 | 1.60 | 0.061 | 0.040 | | | | |
| | | 500 | 3.0 | 0.006 | 3.0 | 2.32 | 0.060 | 0.040 | | | | |
| | TOTAL = | | | | | | 0.202 | 0.135 | | 7 | 7 | 86 |
| B-2C | 0.0189 | 75 | 3.0 | 0.040 | 2.0 | 4.00 | 0.005 | 0.003 | | | | |
| | | 500 | 2.0 | 0.004 | 2.0 | 1.26 | 0.110 | 0.073 | | | | |
| | | 400 | 2.0 | 0.005 | 2.0 | 1.41 | 0.079 | 0.052 | | | | |
| | | 130 | 6.0 | 0.046 | 2.0 | 4.30 | 0.008 | 0.006 | | | | |
| | | 75 | 2.0 | 0.027 | 1.0 | 1.63 | 0.013 | 0.009 | | | | |
| | TOTAL = | | | | | | 0.215 | 0.143 | | 7 | 7 | 86 |
| B-3A | 0.0253 | 1,200 | 18.0 | 0.015 | 2.0 | 2.45 | 0.136 | 0.091 | | | | |
| | | 600 | 2.0 | 0.003 | 2.0 | 1.15 | 0.144 | 0.096 | | | | |
| | TOTAL = | | | | | | 0.280 | 0.187 | | 7 | 7 | 86 |

# TABLE NO. 2 - CONTD.

## HYMO BASIN PARAMETER WORKSHEET

## DEVELOPED CONDITIONS

**PROJECT:** SAD-BC-83-1 & SAD-216 **BY:** D.L.A. **DATE:** 7-3-91

| Basin | Area (Sq. Mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-3B | 0.0078 | 950 | 7.0 | 0.007 | 2.0 | 1.72 | 0.154 | 0.102 | | 7 | 7 | 86 |
| B-3C | 0.0150 | 900 | 6.0 | 0.007 | 2.0 | 1.63 | 0.153 | 0.102 | | | | |
| | | 775 | 7.0 | 0.009 | 2.0 | 1.90 | 0.113 | 0.076 | | | | |
| | TOTAL = | | | | | | 0 266 | 0.178 | | 7 | 7 | 86 |
| B-4 | 0.0166 | 1,300 | 28.0 | 0.022 | 0.7 | 1.03 | 0.352 | 0.234 | | | | |
| | | 125 | 1.0 | 0.008 | 3.0 | 2.68 | 0.013 | 0.009 | | | | |
| | TOTAL = | | | | | | 0.364 | 0.243 | 75 | | | 25 |
| C-1 | 0.0398 | 50 | 2.0 | 0.040 | 2.0 | 4.00 | 0.003 | 0.002 | | | | |
| | | 150 | 2.0 | 0.013 | 2.0 | 2.31 | 0.018 | 0.012 | | | | |
| | | 350 | 2.0 | 0.006 | 2.0 | 1.51 | 0.064 | 0.043 | | | | |
| | | 440 | 5.0 | 0.011 | 2.0 | 2.13 | 0 057 | 0.038 | | | | |
| | | 300 | 11.0 | 0.037 | 3.0 | 5.74 | 0.015 | 0.010 | | | | |
| | | 350 | 6.0 | 0.017 | 3.0 | 3.93 | 0.025 | 0.017 | | | | |
| | TOTAL = | | | | | | 0.182 | 0.122 | | 7 | 8 | 85 |
| C-2 | 0.0081 | 500 | 2.0 | 0.004 | 2.0 | 1.26 | 0.110 | 0.073 | | | | |
| | | 175 | 4.0 | 0.023 | 2.0 | 3.02 | 0 016 | 0.011 | | | | |
| | | 100 | 0.5 | 0.005 | 2.0 | 1.41 | 0.020 | 0.013 | | | | |
| | | 125 | 12.0 | 0.096 | 2.0 | 6.20 | 0 006 | 0.004 | | | | |
| | | 200 | 6.0 | 0.030 | 0.7 | 1.21 | 0 046 | 0.031 | | | | |
| | TOTAL = | | | | | | 0 197 | 0.131 | | 7 | 8 | 85 |

# TABLE NO. 2 - CONTD.

## HYMO BASIN PARAMETER WORKSHEET

## DEVELOPED CONDITIONS

**PROJECT:** SAD-BC-83-1 & SAD-216 **BY:** D.L.A. **DATE:** 7-3-91

| Basin | Area (Sq. Mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C-3 | 0.0102 | 425 | 2.0 | 0.005 | 2.0 | 1.37 | 0.086 | 0.057 | | | | |
| | | 260 | 4.0 | 0.015 | 0.7 | 0.87 | 0.083 | 0.055 | | | | |
| | | 365 | 18.0 | 0.049 | 0.7 | 1.55 | 0.065 | 0.043 | | | | |
| | | 200 | 1.0 | 0.005 | 0.7 | 0.49 | 0.112 | 0.075 | | | | |
| | | 400 | 2.0 | 0.005 | 3.0 | 2.12 | 0.052 | 0.035 | | | | |
| | TOTAL = | | | | | | 0.399 | 0.266 | 68 | | | 32 |
| C-4 | 0.0020 | 300 | 1.0 | 0.003 | 2.0 | 1.15 | 0.072 | 0.048 | | | | |
| | | 800 | 26.0 | 0.033 | 0.7 | 1.26 | 0.176 | 0.117 | | | | |
| | TOTAL = | | | | | | 0.248 | 0.166 | 64 | | | 36 |
| D-1 | 0.0111 | 300 | 10.0 | 0.033 | 2.0 | 3.65 | 0.023 | 0.015 | | | | |
| | | 350 | 3.0 | 0.009 | 2.0 | 1.85 | 0.053 | 0.035 | | | | |
| | TOTAL = | | | | | | 0.075 | 0.050 | | 7 | 8 | 85 |
| D-2 | 0.0234 | 150 | 5.0 | 0.033 | 2.0 | 3.65 | 0.011 | 0.008 | | | | |
| | | 400 | 4.0 | 0.010 | 2.0 | 2.00 | 0.056 | 0.037 | | | | |
| | | 500 | 2.0 | 0.004 | 2.0 | 1.26 | 0.110 | 0.073 | | | | |
| | | 550 | 1.0 | 0.002 | 2.0 | 0.85 | 0.179 | 0.119 | | | | |
| | TOTAL = | | | | | | 0.356 | 0.237 | | 10 | 10 | 80 |
| D-3 | 0.0091 | 600 | 6.0 | 0.010 | 2.0 | 2.00 | 0.083 | 0.056 | | | | |
| | | 100 | 2.0 | 0.020 | 2.0 | 2.83 | 0.010 | 0.007 | | | | |
| | TOTAL = | | | | | | 0.093 | 0.062 | | 10 | 8 | 82 |

# TABLE NO. 2 - CONTD.

## HYMO BASIN PARAMETER WORKSHEET

## DEVELOPED CONDITIONS

**PROJECT:** SAD-BC-83-1 & SAD-216 **BY:** D.L.A. **DATE:** 7-3-91

| Basin | Area (Sq. Mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D-4 | 0.0475 | 100 | 7.0 | 0.070 | 2.0 | 5.29 | 0.005 | 0.003 | | | | |
| | | 200 | 4.0 | 0.020 | 2.0 | 2.83 | 0.020 | 0.013 | | | | |
| | | 300 | 3.0 | 0.010 | 2.0 | 2.00 | 0.042 | 0.028 | | | | |
| | | 650 | 2.0 | 0.003 | 2.0 | 1.11 | 0.163 | 0.109 | | | | |
| | | 700 | 7.0 | 0.010 | 3.0 | 3.00 | 0.065 | 0.043 | | | | |
| | TOTAL = | | | | | | 0.294 | 0.196 | | 10 | 10 | 80 |
| D-5 | 0.0588 | 550 | 1.0 | 0.002 | 2.0 | 0.85 | 0.179 | 0.119 | | | | |
| | | 1,100 | 5.0 | 0.005 | 2.0 | 1.35 | 0.227 | 0.151 | | | | |
| | | 50 | 6.0 | 0.120 | 2.0 | 6.93 | 0.002 | 0.001 | | | | |
| | | 1,100 | 20.0 | 0.018 | 3.0 | 4.05 | 0.076 | 0.050 | | | | |
| | TOTAL = | | | | | | 0.483 | 0.322 | | 10 | 10 | 80 |
| E-1 | 0.0506 | 600 | 6.0 | 0.010 | 2.0 | 2.00 | 0.083 | 0.056 | | | | |
| | | 1,500 | 24.0 | 0.016 | 3.0 | 3.79 | 0.110 | 0.073 | | | | |
| | | 700 | 3.0 | 0.004 | 3.0 | 1.96 | 0.099 | 0.066 | | | | |
| | TOTAL = | | | | | | 0.292 | 0.195 | | 10 | 8 | 82 |
| K-1 | 0.0388 | 130 | 26.0 | 0.200 | 0.7 | 3.13 | 0.012 | 0.008 | | | | |
| | | 100 | 8.0 | 0.080 | 2.0 | 5.66 | 0.005 | 0.003 | | | | |
| | | 150 | 2.0 | 0.013 | 2.0 | 2.31 | 0.018 | 0.012 | | | | |
| | | 720 | 5.0 | 0.007 | 3.0 | 2.50 | 0.080 | 0.053 | | | | |
| | | 550 | 2.5 | 0.005 | 3.0 | 2.02 | 0.076 | 0.050 | | | | |
| | TOTAL = | | | | | | 0.190 | 0.127 | | 10 | 10 | 80 |

# TABLE NO. 2 - CONTD.

## HYMO BASIN PARAMETER WORKSHEET

## DEVELOPED CONDITIONS

**PROJECT:** SAD-BC-83-1 & SAD-216 **BY:** D.L.A. **DATE:** 7-3-91

| Basin | Area (Sq. Mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K-2 | 0.0353 | 500 | 1.0 | 0.002 | 0.7 | 0.31 | 0.444 | 0.296 | | | | |
| | | 1,150 | 16.0 | 0.014 | 3.0 | 3.54 | 0.090 | 0.060 | | | | |
| | TOTAL = | | | | | | 0.534 | 0.356 | | 10 | 10 | 80 |
| K-3 | 0.0195 | 200 | 0.2 | 0.001 | 2.0 | 0.63 | 0.088 | 0.059 | | | | |
| | | 125 | 2.0 | 0.016 | 2.0 | 2.53 | 0.014 | 0.009 | | | | |
| | | 275 | 2.0 | 0.007 | 2.0 | 1.71 | 0.045 | 0.030 | | | | |
| | | 300 | 6.0 | 0.020 | 3.0 | 4.24 | 0.020 | 0.013 | | | | |
| | TOTAL = | | | | | | 0.166 | 0.111 | | 10 | 10 | 80 |
| K-4 | 0.0556 | 550 | 15.0 | 0.027 | 2.0 | 3.30 | 0.046 | 0.031 | | | | |
| | | 600 | 1.0 | 0.002 | 2.0 | 0.82 | 0.204 | 0.136 | | | | |
| | | 550 | 1.0 | 0.002 | 2.0 | 0.85 | 0.179 | 0.119 | | | | |
| | TOTAL = | | | | | | 0.430 | 0.286 | | 10 | 10 | 80 |
| K-5 | 0.0025 | 1,000 | 10.0 | 0.010 | 3.0 | 3.00 | 0.093 | 0.062 | | 10 | 10 | 80 |

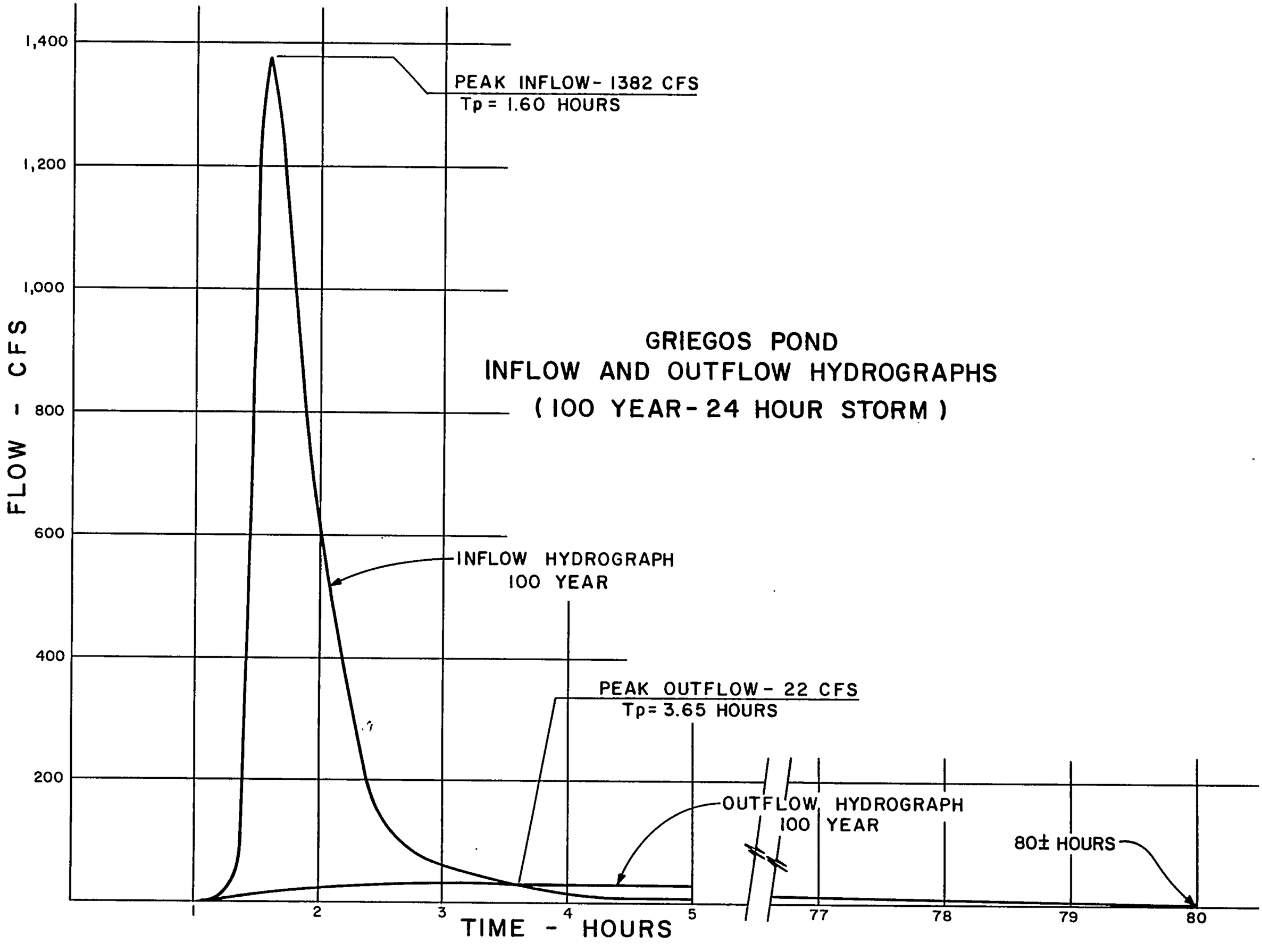
# TABLE NO. 2 - CONTD.

## HYMO BASIN PARAMETER WORKSHEET

## DEVELOPED CONDITIONS

**PROJECT:** SAD-BC-83-1 & SAD-216 **BY:** D.L.A. **DATE:** 7-3-91

| Basin | Area (Sq. Mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-1 | 0.0284 | 270 | 1.5 | 0.006 | 2.0 | 1.49 | 0.050 | 0.034 | | | | |
| | | 30 | 0.3 | 0.010 | 2.0 | 2.00 | 0.004 | 0.003 | | | | |
| | | 250 | 1.4 | 0.006 | 2.0 | 1.50 | 0.046 | 0.031 | | | | |
| | | 45 | 0.8 | 0.018 | 2.0 | 2.67 | 0.005 | 0.003 | | | | |
| | | 20 | 0.6 | 0.030 | 2.0 | 3.46 | 0.002 | 0.001 | | | | |
| | | 190 | 1.0 | 0.005 | 2.0 | 1.45 | 0.036 | 0.024 | | | | |
| | | 80 | 2.0 | 0.025 | 3.0 | 4.74 | 0.005 | 0.003 | | | | |
| | | 100 | 2.8 | 0.028 | 3.0 | 4.97 | 0.006 | 0.004 | | | | |
| | | 80 | 0.3 | 0.004 | 3.0 | 1.84 | 0.012 | 0.008 | | | | |
| | | 315 | 2.4 | 0.008 | 3.0 | 2.62 | 0.033 | 0.022 | | | | |
| | | 200 | 1.5 | 0.008 | 3.0 | 2.60 | 0.021 | 0.014 | | | | |
| | TOTAL = | | | | | | 0.221 | 0.147 | | 7 | 8 | 85 |
| P-1 | 0.0403 | 800 | 8.0 | 0.010 | 2.0 | 2.00 | 0.111 | 0.074 | | | | |
| | | 560 | 0.5 | 0.001 | 3.0 | 0.90 | 0.174 | 0.116 | | | | |
| | | 365 | 0.2 | 0.001 | 3.0 | 0.70 | 0.144 | 0.096 | | | | |
| | | 600 | 2.0 | 0.003 | 3.0 | 1.73 | 0.096 | 0.064 | | | | |
| | TOTAL = | | | | | | 0.525 | 0.350 | | 10 | 10 | 80 |
| Q-1 | 0.0366 | 550 | 7.0 | 0.013 | 2.0 | 2.26 | 0.068 | 0.045 | | | | |
| | | 200 | 2.0 | 0.010 | 2.0 | 2.00 | 0.028 | 0.019 | | | | |
| | TOTAL = | | | | | | 0.095 | 0.064 | 20 | 20 | | 60 |


GRIEGOS POND
INFLOW AND OUTFLOW HYDROGRAPHS
( 100 YEAR - 24 HOUR STORM )
PEAK INFLOW - 1382 CFS
Tp = 1.60 HOURS
INFLOW HYDROGRAPH
100 YEAR
PEAK OUTFLOW - 22 CFS
Tp = 3.65 HOURS
OUTFLOW HYDROGRAPH
100 YEAR
80± HOURS
FLOW - CFS
1,400
1,200
1,000
800
600
400
200
TIME - HOURS
1
2
3
4
5
77
78
79
80

## V

## PROPOSED DRAINAGE SYSTEM

The proposed drainage system includes the construction of two major storm drain lines. (See Storm Drain System Plan, Map No. 4 enclosed).

1) Carmony Road
2) Comanche Road

Note that the Carmony Road Storm Drain line extends to the east of Interstate 25 and this extension is designated on Map No. 4 as the West Hahn Storm Drain and West Hahn/Stanford Storm Drain.

In addition, a storm drain designated as the Railroad Storm Drain on Map No. 4 is to be constructed on the east side of the AT&SF railroad tracks.

The proposed drainage system also includes the construction of a major detention pond (Griegos Pond) located directly north of Griegos Road and immediately east of the AT&SF mainline railroad tracks. The Carmony Road Storm Drain, the Comanche Storm Drain and the Railroad Storm Drain will discharge into this pond.

Within the limits established by the Hydrologic Analysis, the drainage system as proposed will allow all undeveloped areas to be developed without restricting runoff from the increased impervious areas that would occur by the development. Also, based on approved Drainage Plans, the proposed drainage system allows developed properties, that presently have detention or retention ponds, to fill their ponds and use this pond area which previously was restricted for drainage use only.

**A. <u>Griegos Pond</u>**

A downstream detention pond, (Griegos Pond) will be located directly north of Griegos Road and immediately east of the AT&SF railroad tracks. This area is also the location of an existing designated flood plain area (see Map No. 2 included hereinbefore). The Griegos Pond will be relatively large, and requires a surface land area of approximately 8 acres with a capacity of approximately 73.7 acre feet.

This capacity (volume) considers outflow from the pond through the outlet works while the pond is filling and also allows for 5.4 acre feet of sediment. (See Appendix C, Sediment Analysis).

The discharge rate from the Griegos Pond is governed by the rate of flow allowed to be discharged into the Middle Rio Grande Conservancy District (M.R.G.C.D.) Alameda Drain west of Second Street, which is 22 cfs. This rate is the maximum allowed by license agreement with the M.R.G.C.D.

The discharge control for the Griegos Pond will be by an orifice in the outlet works box located inside the southwest corner of the pond.

A drain line will be constructed to the west which will connect the Griegos Pond to the existing storm drain line located at the intersection of Griegos Road and Carlton Street N.W.

## B. System Design

### 1) Storm Drain Plan

The proposed Storm Drainage System is outlined on the Storm Drain Plan, Map No. 4 included herein in the back of this report.

### 2) Construction Plans

Construction Plans have been prepared for the project. Applicable Storm Drain Plan Sheets of the Construction Plans are listed below and are referenced herein as a part of this report.

| SHEET NO. | DESCRIPTION |
|---|---|
| 1-1 | Title Sheet |
| 2-1 | Paving Layout Plan |
| 3-1 | Storm Drain Layout Plan |
| | Storm Drain Plan and Profile |
| 10-1 thru 10-4 | Carmony Road, NE |
| 10-5 | Yale Boulevard |
| 10-6 | Yale Boulevard & West Hahn |
| 10-7 and 10-8 | West Hahn |
| 10-9 | West Hahn/Stanford Drive |
| 10-10 | Alexander Boulevard NE |
| 10-11 | Griegos Road |

| | |
|---|---|
| 10-12 | Griegos Road & Comanche Road |
| 10-13 thru 10-15 | Comanche Road NE |
| 10-16 | Rankin Lane & Alexander Blvd |
| 10-17 & 10-18 | Railroad Storm Drain |
| 17-1 thru 17-10 | Griegos Detention Pond |

3) <u>Storm Drain Hydraulic Grade Line Calculations</u>

Hydraulic Grade Line Calculations of the Storm Drain System, as presented in the Construction Plans, are included hereinafter as Appendix B.

## VI

## CONCLUSIONS

This Storm Drainage Analysis (December 1992) presents the hydrology and peak flow rates of runoff and volumes based on the latest revision of the HYMO Computer Program (March 1992) of Revised Section 22.2, HYDROLOGY, of the City of Albuquerque Development Process Manual, Volume 2.

The Storm Drainage System presented herein is consistent with the system selected and approved by the County of Bernalillo and the City of Albuquerque on their review of various alternatives previously presented. Within the limits established by the Hydrologic Analysis included herein, the system allows the undeveloped areas to be developed without restricting runoff from the increased impervious area that will occur by the development. Also, based on approved Drainage Plans, the system permits developed properties, that presently have detention or retention ponds, to fill their ponds and use the area which was previously restricted for drainage use only.

The Alameda Drain located west of Second Street, N.W. is the only drainage facility available to ultimately convey storm water runoff from this and surrounding drainage areas to the Rio Grande, therefore this drain plays a major role in the storm drainage system.

Since this Alameda Drain has very limited capacity at the present time and even in the future (as per discussions with the Leedshill-Herkenhoff engineering firm studying the Alameda Drain), a detention facility is required to collect and store the runoff water emanating from the studied drainage area. The stored storm water then can be released to the Alameda Drain at a controlled rate of discharge. Therefore, the system requires the construction of a major detention pond (Griegos Pond) directly north of Griegos Road and immediately east of the AT&SF mainline railroad tracks.

## VII

## RIGHT-OF-WAY

Right-of-way will be required for the construction of the Griegos Pond, approximately 8 acres.

The construction of the Carmony Road Storm Drain west of Edith Boulevard will require right-of-way acquisition and/or a license agreement with the Middle Rio Grande Conservancy District.

The Railroad Storm Drain passes through private property, therefore an easement will be required for its construction.

The West Hahn/Stanford Storm Drain and the major portion of the West Hahn Storm Drain is located within an existing drainage easement. However, an easement between Yale Boulevard and I-25 will be required. Also, an easement approximately 400 feet in length west of Vassar Drive will be required.

COUNTY OF BERNALILLO

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT BC-83-1

CITY OF ALBUQUERQUE

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT 216

# DRAINAGE ANALYSIS

## APPENDIX A

## SUMMARY OF HYDROLOGY

**100 YEAR - 6 HOUR STORM**

**10 YEAR - 6 HOUR STORM**

**GRIEGOS POND - RESERVOIR ROUTING**

**DECEMBER, 1992**

# SPECIAL ASSESSMENT DISTRICT BC-83-1
# SPECIAL ASSESSMENT DISTRICT 216

## SUMMARY OF HYDROLOGY
## 100 YEAR - 6 HOUR STORM

AHYMO SUMMARY TABLE (AHYMO392) - AMAFCA VERSION OF HYMO - MARCH, 1992
INPUT FILE = SADBCDTN.IN

RUN DATE (MON/DAY/YR) =12/01/1992
USER NO.= D_ANDREW.S92

| COMMAND | DRAINAGE AREA | ANALYSIS POINT | AREA (SQ MI) | PEAK DISCHARGE (CFS) | RUNOFF VOLUME (AC-FT) | RUNOFF (INCHES) | TIME TO PEAK (HOURS) | CFS PER ACRE | NOTATION |
|---|---|---|---|---|---|---|---|---|---|
| RAINFALL TYPE= 1 | | | | | | | | | RAIN6= 2.250 |
| COMPUTE NM HYD | A-1 | | .00840 | 2.64 | .346 | .77252 | 2.300 | .490 | PER IMP= 19.00 |
| COMPUTE NM HYD | A-2 | | .01950 | 29.66 | 1.653 | 1.58978 | 1.667 | 2.376 | PER IMP= 70.00 |
| ADD HYD | | 1 | .02790 | 30.30 | 1.999 | 1.34370 | 1.667 | 1.697 | |
| ROUTE | | | .02790 | 23.75 | 1.999 | 1.34374 | 1.800 | 1.330 | |
| COMPUTE NM HYD | A-3 | | .01940 | 24.97 | 1.645 | 1.58978 | 1.767 | 2.011 | PER IMP= 70.00 |
| ADD HYD | | 2 | .04730 | 48.66 | 3.644 | 1.44462 | 1.800 | 1.607 | |
| ROUTE | | | .04730 | 48.56 | 3.644 | 1.44463 | 1.800 | 1.604 | |
| COMPUTE NM HYD | A-5 | | .03920 | 70.04 | 3.324 | 1.58978 | 1.600 | 2.792 | PER IMP= 70.00 |
| ADD HYD | | 3 | .08650 | 101.16 | 6.968 | 1.51040 | 1.667 | 1.827 | |
| ROUTE | | | .08650 | 100.87 | 6.968 | 1.51040 | 1.667 | 1.822 | |
| COMPUTE NM HYD | A-6 | | .01270 | 7.57 | .732 | 1.07998 | 2.067 | .931 | PER IMP= 39.00 |
| ADD HYD | | 4 | .09920 | 104.34 | 7.699 | 1.45529 | 1.700 | 1.643 | |
| COMPUTE NM HYD | A-4 | | .00770 | 5.47 | .425 | 1.03386 | 1.867 | 1.110 | PER IMP= 36.00 |
| ADD HYD | | 5 | .10690 | 108.61 | 8.124 | 1.42494 | 1.700 | 1.588 | |
| ROUTE | | | .10690 | 108.42 | 8.124 | 1.42494 | 1.700 | 1.585 | |
| COMPUTE NM HYD | B-1 | 6 | .07130 | 151.33 | 7.027 | 1.84783 | 1.600 | 3.316 | PER IMP= 85.00 |
| COMPUTE NM HYD | B-2A | | .02130 | 51.99 | 2.110 | 1.85761 | 1.533 | 3.814 | PER IMP= 86.00 |
| COMPUTE NM HYD | B-3A | | .02530 | 58.40 | 2.507 | 1.85761 | 1.567 | 3.606 | PER IMP= 86.00 |
| ADD HYD | | 6A | .04660 | 109.01 | 4.617 | 1.85759 | 1.567 | 3.655 | |
| ROUTE | | | .04660 | 108.81 | 4.617 | 1.85760 | 1.567 | 3.648 | |
| COMPUTE NM HYD | B-2B | | .01590 | 42.32 | 1.575 | 1.85760 | 1.500 | 4.158 | PER IMP= 86.00 |
| ADD HYD | | | .06250 | 145.98 | 6.192 | 1.85759 | 1.533 | 3.650 | |
| COMPUTE NM HYD | B-3B | | .00780 | 21.60 | .773 | 1.85761 | 1.500 | 4.327 | PER IMP= 86.00 |
| ADD HYD | | | .07030 | 166.30 | 6.965 | 1.85759 | 1.533 | 3.696 | |
| ROUTE | | | .07130 | 150.44 | 7.027 | 1.84783 | 1.600 | 3.297 | |
| ADD HYD | | 6B | .14160 | 308.12 | 13.991 | 1.85267 | 1.567 | 3.400 | |
| ROUTE | | | .14160 | 298.54 | 13.991 | 1.85267 | 1.567 | 3.294 | |
| COMPUTE NM HYD | B-2C | | .01890 | 50.30 | 1.872 | 1.85761 | 1.500 | 4.158 | PER IMP= 86.00 |
| ADD HYD | | | .16050 | 342.16 | 15.864 | 1.85325 | 1.567 | 3.331 | |
| COMPUTE NM HYD | B-3C | | .01500 | 35.28 | 1.486 | 1.85760 | 1.567 | 3.674 | PER IMP= 86.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ADD HYD | | 7 | .17550 | 377.44 | 17.350 | 1.85362 | 1.567 | 3.360 | |
| ROUTE | | | .17550 | 378.11 | 17.350 | 1.85362 | 1.567 | 3.366 | |
| COMPUTE NM HYD | B-4 | | .01660 | 15.71 | .766 | .86476 | 1.633 | 1.479 | PER IMP= 25.00 |
| ADD HYD | | 8 | .19210 | 392.95 | 18.115 | 1.76817 | 1.567 | 3.196 | |
| COMPUTE NM HYD | C-1 | 9 | .03980 | 109.74 | 3.922 | 1.84783 | 1.500 | 4.308 | PER IMP= 85.00 |
| ROUTE | | | .03980 | 106.48 | 3.922 | 1.84783 | 1.533 | 4.180 | |
| COMPUTE NM HYD | C-2 | | .00810 | 22.35 | .798 | 1.84783 | 1.500 | 4.311 | PER IMP= 85.00 |
| COMPUTE NM HYD | C-3 | | .01020 | 10.01 | .529 | .97237 | 1.633 | 1.534 | PER IMP= 32.00 |
| ADD HYD | | | .05000 | 113.95 | 4.451 | 1.66922 | 1.533 | 3.561 | |
| COMPUTE NM HYD | C-4 | | .00200 | 2.82 | .110 | 1.03386 | 1.533 | 2.202 | PER IMP= 36.00 |
| ADD HYD | | | .05200 | 116.77 | 4.562 | 1.64478 | 1.533 | 3.509 | |
| ROUTE | | | .00810 | 22.14 | .798 | 1.84785 | 1.500 | 4.270 | |
| ADD HYD | | 10 | .06010 | 138.46 | 5.360 | 1.67214 | 1.533 | 3.600 | |
| DIVIDE HYD | | | .04814 | 65.00 | 4.293 | 1.67214 | 1.433 | 2.110 | |
| | | | .01196 | 73.46 | 1.067 | 1.67214 | 1.533 | 9.594 | |
| ROUTE | | 11 | .04814 | 64.73 | 4.293 | 1.67215 | 1.733 | 2.101 | |
| ADD HYD | | 12 | .24024 | 456.35 | 22.408 | 1.74893 | 1.567 | 2.968 | |
| ROUTE | | | .24024 | 455.72 | 22.408 | 1.7489 | 1.567 | 2.964 | |
| COMPUTE NM HYD | D-1 | | .01110 | 30.62 | 1.094 | 1.84783 | 1.500 | 4.310 | PER IMP= 85.00 |
| ADD HYD | | | .11800 | 121.94 | 9.218 | 1.46472 | 1.700 | 1.615 | |
| ADD HYD | | 13 | .35824 | 565.17 | 31.626 | 1.65531 | 1.600 | 2.465 | |
| COMPUTE NM HYD | O-1 | 14 | .02840 | 72.79 | 2.799 | 1.84783 | 1.533 | 4.005 | PER IMP= 85.00 |
| ADD HYD | | 15 | .38664 | 627.66 | 34.425 | 1.66945 | 1.567 | 2.537 | |
| ROUTE | | | .38664 | 625.16 | 34.425 | 1.66945 | 1.600 | 2.526 | |
| COMPUTE NM HYD | D-2 | | .02340 | 45.89 | 2.233 | 1.78898 | 1.600 | 3.065 | PER IMP= 80.00 |
| ADD HYD | | | .41004 | 671.06 | 36.658 | 1.67627 | 1.600 | 2.557 | |
| COMPUTE NM HYD | D-3 | | .00910 | 24.68 | .878 | 1.80855 | 1.500 | 4.238 | PER IMP= 82.00 |
| ADD HYD | | 16 | .41914 | 687.72 | 37.535 | 1.67914 | 1.600 | 2.564 | |
| ROUTE | | | .41914 | 688.20 | 37.535 | 1.67914 | 1.600 | 2.566 | |
| COMPUTE NM HYD | D-4 | | .04750 | 103.45 | 4.532 | 1.78898 | 1.567 | 3.403 | PER IMP= 80.00 |
| ADD HYD | | 17 | .46664 | 789.13 | 42.067 | 1.69032 | 1.600 | 2.642 | |
| ROUTE | | | .46664 | 788.98 | 42.067 | 1.69032 | 1.600 | 2.642 | |
| COMPUTE NM HYD | D-5 | | .05880 | 97.54 | 5.610 | 1.78898 | 1.700 | 2.592 | PER IMP= 80.00 |
| ADD HYD | | 18 | .52544 | 870.50 | 47.678 | 1.70136 | 1.600 | 2.589 | |
| COMPUTE NM HYD | E-1 | 19 | .05060 | 111.18 | 4.881 | 1.80855 | 1.567 | 3.433 | PER IMP= 82.00 |
| ADD HYD | | 20 | .57604 | 978.94 | 52.558 | 1.71078 | 1.600 | 2.655 | |
| ROUTE | | 21 | .57604 | 971.43 | 52.558 | 1.71078 | 1.600 | 2.635 | |
| COMPUTE NM HYD | K-1 | 22 | .03880 | 104.41 | 3.702 | 1.78898 | 1.500 | 4.205 | PER IMP= 80.00 |
| COMPUTE NM HYD | K-2 | | .03530 | 54.31 | 3.368 | 1.78899 | 1.733 | 2.404 | PER IMP= 80.00 |
| ROUTE | | | .01196 | 54.00 | 1.067 | 1.67257 | 1.567 | 7.052 | |
| ADD HYD | | 23 | .04726 | 92.70 | 4.435 | 1.75949 | 1.600 | 3.065 | |
| ADD HYD | | 24 | .08606 | 170.83 | 8.137 | 1.77278 | 1.567 | 3.101 | |
| ROUTE | | | .08606 | 169.43 | 8.137 | 1.77279 | 1.567 | 3.076 | |
| COMPUTE NM HYD | K-3 | | .01950 | 52.48 | 1.861 | 1.78898 | 1.500 | 4.205 | PER IMP= 80.00 |
| ADD HYD | | 25 | .10556 | 211.94 | 9.998 | 1.77577 | 1.567 | 3.137 | |
| ROUTE | | | .10556 | 210.35 | 9.998 | 1.77578 | 1.567 | 3.113 | |
| COMPUTE NM HYD | K-4 | | .05560 | 97.94 | 5.305 | 1.78898 | 1.667 | 2.752 | PER IMP= 80.00 |
| ADD HYD | | 26 | .16116 | 296.60 | 15.303 | 1.78033 | 1.600 | 2.876 | |
| ROUTE | | | .16116 | 296.16 | 15.303 | 1.78033 | 1.600 | 2.871 | |
| COMPUTE NM HYD | K-5 | | .00250 | 6.74 | .239 | 1.78898 | 1.500 | 4.214 | PER IMP= 80.00 |
| ADD HYD | | 27 | .16366 | 300.72 | 15.541 | 1.78046 | 1.600 | 2.871 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| COMPUTE NM HYD | Q-1 | 28 | .03660 | 81.44 | 2.825 | 1.44713 | 1.500 | 3.477 | PER IMP= 60.00 |
| COMPUTE NM HYD | P-1 | 29 | .04030 | 63.23 | 3.845 | 1.78899 | 1.733 | 2.452 | PER IMP= 80.00 |
| ADD HYD | | | .73970 | 1272.15 | 68.100 | 1.72619 | 1.600 | 2.687 | |
| ADD HYD | | | .07690 | 108.25 | 6.670 | 1.62627 | 1.533 | 2.200 | |
| ADD HYD | | 30 | .81660 | 1376.03 | 74.769 | 1.71678 | 1.600 | 2.633 | |
| ROUTE RESERVOIR | | | .81660 | 21.02 | 29.795 | .68413 | 3.700 | .040 | AC-FT= 68.268 |
| FINISH | | | | | | | | | |

# SPECIAL ASSESSMENT DISTRICT BC-83-1
# SPECIAL ASSESSMENT DISTRICT 216

## SUMMARY OF HYDROLOGY
## 10 YEAR - 6 HOUR STORM

AHYMO SUMMARY TABLE (AHYMO392) - AMAFCA VERSION OF HYMO - MARCH, 1992
INPUT FILE = SADBC10N.IN

RUN DATE (MON/DAY/YR) =12/01/1992
USER NO.= D_ANDREW.S92

| COMMAND | DRAINAGE AREA | ANALYSIS POINT | AREA (SQ MI) | PEAK DISCHARGE (CFS) | RUNOFF VOLUME (AC-FT) | RUNOFF (INCHES) | TIME TO PEAK (HOURS) | CFS PER ACRE | NOTATION |
|---|---|---|---|---|---|---|---|---|---|
| RAINFALL TYPE= 1 | | | | | | | | | RAIN6= 1.500 |
| COMPUTE NM HYD | A-1 | | .00840 | 1.23 | .144 | .32165 | 2.333 | .228 | PER IMP= 19. |
| COMPUTE NM HYD | A-2 | | .01950 | 18.09 | .976 | .93847 | 1.667 | 1.449 | PER IMP= 70.00 |
| ADD HYD | | 1 | .02790 | 18.29 | 1.120 | .75274 | 1.667 | 1.024 | |
| ROUTE | | | .02790 | 13.60 | 1.120 | .75275 | 1.833 | .762 | |
| COMPUTE NM HYD | A-3 | | .01940 | 15.25 | .971 | .93847 | 1.767 | 1.228 | PER IMP= 70.00 |
| ADD HYD | | 2 | .04730 | 28.75 | 2.091 | .82889 | 1.800 | .950 | |
| ROUTE | | | .04730 | 28.65 | 2.091 | .82890 | 1.833 | .947 | |
| COMPUTE NM HYD | A-5 | | .03920 | 42.73 | 1.962 | .93847 | 1.600 | 1.703 | PER IMP= 70.00 |
| ADD HYD | | 3 | .08650 | 59.67 | 4.053 | .87854 | 1.667 | 1.078 | |
| ROUTE | | | .08650 | 59.65 | 4.053 | .87855 | 1.700 | 1.077 | |
| COMPUTE NM HYD | A-6 | | .01270 | 4.17 | .376 | .55569 | 2.067 | .514 | PER IMP= 39.00 |
| ADD HYD | | 4 | .09920 | 61.32 | 4.429 | .83721 | 1.700 | .966 | |
| COMPUTE NM HYD | A-4 | | .00770 | 2.92 | .214 | .52059 | 1.867 | .592 | PER IMP= 36.00 |
| ADD HYD | | 5 | .10690 | 63.49 | 4.643 | .81440 | 1.700 | .928 | |
| ROUTE | | | .10690 | 63.37 | 4.643 | .81441 | 1.700 | .926 | |
| COMPUTE NM HYD | B-1 | 6 | .07130 | 96.45 | 4.304 | 1.13193 | 1.600 | 2.114 | PER IMP= 85.00 |
| COMPUTE NM HYD | B-2A | | .02130 | 33.34 | 1.295 | 1.14006 | 1.533 | 2.446 | PER IMP= 86.00 |
| COMPUTE NM HYD | B-3A | | .02530 | 37.44 | 1.538 | 1.14006 | 1.567 | 2.312 | PER IMP= 86.00 |
| ADD HYD | | 6A | .04660 | 69.97 | 2.833 | 1.14004 | 1.567 | 2.346 | |
| ROUTE | | | .04660 | 69.98 | 2.833 | 1.14006 | 1.567 | 2.346 | |
| COMPUTE NM HYD | B-2B | | .01590 | 27.17 | .967 | 1.14006 | 1.500 | 2.670 | PER IMP= 86.00 |
| ADD HYD | | | .06250 | 93.57 | 3.800 | 1.14004 | 1.567 | 2.339 | |
| COMPUTE NM HYD | B-3B | | .00780 | 13.89 | .474 | 1.14006 | 1.500 | 2.782 | PER IMP= 86.00 |
| ADD HYD | | | .07030 | 106.41 | 4.274 | 1.14004 | 1.533 | 2.365 | |
| ROUTE | | | .07130 | 96.39 | 4.304 | 1.13193 | 1.600 | 2.112 | |
| ADD HYD | | 6B | .14160 | 197.20 | 8.579 | 1.13595 | 1.567 | 2.176 | |
| ROUTE | | | .14160 | 191.82 | 8.579 | 1.13596 | 1.600 | 2.117 | |
| COMPUTE NM HYD | B-2C | | .01890 | 32.30 | 1.149 | 1.14006 | 1.500 | 2.670 | PER IMP= 86.00 |
| ADD HYD | | | .16050 | 217.89 | 9.728 | 1.13644 | 1.567 | 2.121 | |
| COMPUTE NM HYD | B-3C | | .01500 | 22.65 | .912 | 1.14006 | 1.567 | 2.359 | PER IMP= 86.00 |
| ADD HYD | | 7 | .17550 | 240.54 | 10.640 | 1.13674 | 1.567 | 2.142 | |
| ROUTE | | | .17550 | 240.70 | 10.640 | 1.13675 | 1.567 | 2.143 | |
| COMPUTE NM HYD | B-4 | | .01660 | 7.23 | .347 | .39186 | 1.633 | .681 | PER IMP= 25.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ADD HYD | | 8 | .19210 | 247.53 | 10.987 | 1.07237 | 1.567 | 2.013 | |
| COMPUTE NM HYD | C-1 | 9 | .03980 | 70.47 | 2.403 | 1.13193 | 1.500 | 2.766 | PER IMP= 85.00 |
| ROUTE | | | .03980 | 68.08 | 2.403 | 1.13193 | 1.533 | 2.673 | |
| COMPUTE NM HYD | C-2 | | .00810 | 14.35 | .489 | 1.13193 | 1.500 | 2.768 | PER IMP= 85.00 |
| COMPUTE NM HYD | C-3 | | .01020 | 5.02 | .258 | .47378 | 1.633 | .769 | PER IMP= 32.00 |
| ADD HYD | | | .05000 | 71.72 | 2.660 | .99765 | 1.533 | 2.241 | |
| COMPUTE NM HYD | C-4 | | .00200 | 1.43 | .056 | .52059 | 1.533 | 1.117 | PER IMP= 36.00 |
| ADD HYD | | | .05200 | 73.15 | 2.716 | .97930 | 1.533 | 2.198 | |
| ROUTE | | | .00810 | 14.16 | .489 | 1.13196 | 1.500 | 2.732 | |
| ADD HYD | | 10 | .06010 | 87.15 | 3.205 | .99986 | 1.533 | 2.266 | |
| DIVIDE HYD | | | .05663 | 65.00 | 3.020 | .99986 | 1.467 | 1.793 | |
| | | | .00347 | 22.15 | .185 | .99986 | 1.533 | 9.983 | |
| ROUTE | | 11 | .05663 | 63.09 | 3.020 | .99987 | 1.600 | 1.741 | |
| ADD HYD | | 12 | .24873 | 309.79 | 14.007 | 1.05586 | 1.567 | 1.946 | |
| ROUTE | | | .24873 | 309.61 | 14.007 | 1.05586 | 1.600 | 1.945 | |
| COMPUTE NM HYD | D-1 | | .01110 | 19.66 | .670 | 1.13193 | 1.500 | 2.767 | PER IMP= 85.00 |
| ADD HYD | | | .11800 | 71.91 | 5.313 | .84427 | 1.700 | .952 | |
| ADD HYD | | 13 | .36673 | 375.89 | 19.320 | .98778 | 1.600 | 1.602 | |
| COMPUTE NM HYD | O-1 | 14 | .02840 | 46.75 | 1.714 | 1.13193 | 1.533 | 2.572 | PER IMP= 85.00 |
| ADD HYD | | 15 | .39513 | 412.94 | 21.035 | .99814 | 1.567 | 1.633 | |
| ROUTE | | | .39513 | 414.29 | 21.035 | .99814 | 1.600 | 1.638 | |
| COMPUTE NM HYD | D-2 | | .02340 | 28.93 | 1.354 | 1.08458 | 1.600 | 1.932 | PER IMP= 80.00 |
| ADD HYD | | | .41853 | 443.22 | 22.388 | 1.00297 | 1.600 | 1.655 | |
| COMPUTE NM HYD | D-3 | | .00910 | 15.73 | .534 | 1.1009 | 1.500 | 2.700 | PER IMP= 82.00 |
| ADD HYD | | 16 | .42763 | 453.77 | 22.922 | 1.00506 | 1.600 | 1.658 | |
| ROUTE | | | .42763 | 454.73 | 22.922 | 1.00506 | 1.600 | 1.662 | |
| COMPUTE NM HYD | D-4 | | .04750 | 65.41 | 2.748 | 1.08458 | 1.567 | 2.152 | PER IMP= 80.00 |
| ADD HYD | | 17 | .47513 | 518.66 | 25.670 | 1.01301 | 1.600 | 1.706 | |
| ROUTE | | | .47513 | 518.20 | 25.670 | 1.01301 | 1.600 | 1.704 | |
| COMPUTE NM HYD | D-5 | | .05880 | 61.31 | 3.401 | 1.08458 | 1.700 | 1.629 | PER IMP= 80.00 |
| ADD HYD | | 18 | .53393 | 568.58 | 29.071 | 1.02089 | 1.600 | 1.664 | |
| COMPUTE NM HYD | E-1 | 19 | .05060 | 70.55 | 2.971 | 1.10092 | 1.567 | 2.179 | PER IMP= 82.00 |
| ADD HYD | | 20 | .58453 | 637.50 | 32.042 | 1.02781 | 1.600 | 1.704 | |
| ROUTE | | 21 | .58453 | 635.32 | 32.042 | 1.02781 | 1.600 | 1.698 | |
| COMPUTE NM HYD | K-1 | 22 | .03880 | 66.30 | 2.244 | 1.08458 | 1.500 | 2.670 | PER IMP= 80.00 |
| COMPUTE NM HYD | K-2 | | .03530 | 34.07 | 2.042 | 1.08458 | 1.733 | 1.508 | PER IMP= 80.00 |
| ROUTE | | | .00347 | 10.58 | .185 | 1.00135 | 1.567 | 4.767 | |
| ADD HYD | | 23 | .03877 | 36.58 | 2.227 | 1.07710 | 1.733 | 1.475 | |
| ADD HYD | | 24 | .07757 | 84.16 | 4.471 | 1.08084 | 1.533 | 1.695 | |
| ROUTE | | | .07757 | 84.17 | 4.471 | 1.08085 | 1.567 | 1.696 | |
| COMPUTE NM HYD | K-3 | | .01950 | 33.33 | 1.128 | 1.08458 | 1.500 | 2.670 | PER IMP= 80.00 |
| ADD HYD | | 25 | .09707 | 113.63 | 5.599 | 1.08159 | 1.533 | 1.829 | |
| ROUTE | | | .09707 | 112.76 | 5.599 | 1.08159 | 1.567 | 1.815 | |
| COMPUTE NM HYD | K-4 | | .05560 | 61.64 | 3.216 | 1.08458 | 1.667 | 1.732 | PER IMP= 80.00 |
| ADD HYD | | 26 | .15267 | 163.25 | 8.815 | 1.08267 | 1.600 | 1.671 | |
| ROUTE | | | .15267 | 163.62 | 8.815 | 1.08268 | 1.600 | 1.675 | |
| COMPUTE NM HYD | K-5 | | .00250 | 4.28 | .145 | 1.08458 | 1.500 | 2.675 | PER IMP= 80.00 |
| ADD HYD | | 27 | .15517 | 166.50 | 8.960 | 1.08270 | 1.600 | 1.677 | |
| COMPUTE NM HYD | Q-1 | 28 | .03660 | 47.65 | 1.616 | .82812 | 1.500 | 2.034 | PER IMP= 60.00 |
| COMPUTE NM HYD | P-1 | 29 | .04030 | 39.70 | 2.331 | 1.08458 | 1.733 | 1.539 | PER IMP= 80.00 |
| ADD HYD | | | .73970 | 801.82 | 41.002 | 1.03933 | 1.600 | 1.694 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ADD HYD | | .07690 | 63.17 | 3.948 | .96251 | 1.533 | 1.284 | |
| ADD HYD | 30 | .81660 | 863.13 | 44.950 | 1.03209 | 1.600 | 1.652 | |
| ROUTE RESERVOIR | | .81660 | 16.98 | 23.050 | .52924 | 3.333 | .032 | AC-FT= 40.879 |
| FINISH | | | | | | | | |

SPECIAL ASSESSMENT DISTRICT BC-83-1
SPECIAL ASSESSMENT DISTRICT 216

GRIEGOS POND
RESERVOIR ROUTING

100 YEAR - 24 HOUR STORM

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*
***************************** Add Hydrographs ******************************
*
*   COMBINE FLOWS AT AP #'S 21,27,28,29
*
ADD HYD              ID=10  HYD NO=100  ID I=10  ID II=11
*
*   TOTAL FLOW AT AP # 30
*
PRINT HYD            ID=10 CODE=0
                                   PARTIAL HYDROGRAPH   100.00
```

```
RUNOFF VOLUME =      1.98489 INCHES      =      86.4454 ACRE-FEET
PEAK DISCHARGE RATE =    1381.89 CFS  AT   1.600 HOURS   BASIN AREA =    .8166 SQ. MI.
```

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*
*************** Route Hydrograph Through Reservior *****************
*
ROUTE RESERVOIR      ID=12   HYD NO=100  INFLOW ID=10   CODE=10
```

| OUTFLOW (CFS) | STORAGE (AC-FT) | ELEVATION (FT) |
|---|---|---|
| 0.0 | 0.000 | 65.5 |
| 1.2 | 0.113 | 65.75 |
| 2.8 | 0.225 | 66.0 |
| 3.3 | 0.661 | 66.24 |
| 3.9 | 0.697 | 66.26 |
| 4.7 | 1.133 | 66.5 |
| 6.1 | 2.789 | 67.0 |
| 11.2 | 14.968 | 70.0 |
| 16.5 | 37.739 | 75.0 |
| 20.5 | 63.865 | 80.0 |
| 21.2 | 69.803 | 81.0 |
| 21.5 | 72.772 | 81.5 |
| 21.6 | 73.663 | 81.65 |
| 89.9 | 75.741 | 82.0 |
| 538.2 | 81.679 | 83.0 |
| 1207.4 | 87.618 | 84.0 |
| 2039.5 | 93.556 | 85.0 |

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

| TIME (HRS) | INFLOW (CFS) | ELEV (FEET) | VOLUME (AC-FT) | OUTFLOW (CFS) |
|---|---|---|---|---|
| .00 | .00 | 65.50 | .000 | .00 |
| .50 | .00 | 65.50 | .000 | .00 |
| 1.00 | .00 | 65.50 | .000 | .00 |
| 1.50 | 1060.55 | 68.08 | 7.168 | 7.93 |
| 2.00 | 649.12 | 77.43 | 50.452 | 18.45 |
| 2.50 | 151.09 | 80.12 | 64.562 | 20.58 |
| 3.00 | 55.06 | 80.61 | 67.505 | 20.93 |
| 3.50 | 25.98 | 80.73 | 68.224 | 21.01 |
| 4.00 | 16.24 | 80.73 | 68.203 | 21.01 |
| 4.50 | 12.12 | 80.68 | 67.908 | 20.98 |
| 5.00 | 10.71 | 80.61 | 67.508 | 20.93 |
| 5.50 | 10.70 | 80.54 | 67.083 | 20.88 |
| 6.00 | 11.54 | 80.47 | 66.678 | 20.83 |
| 6.50 | 12.18 | 80.41 | 66.312 | 20.79 |
| 7.00 | 11.86 | 80.35 | 65.953 | 20.75 |
| 7.50 | 11.47 | 80.29 | 65.579 | 20.70 |
| 8.00 | 11.07 | 80.22 | 65.190 | 20.66 |
| 8.50 | 10.72 | 80.16 | 64.788 | 20.61 |
| 9.00 | 10.38 | 80.09 | 64.373 | 20.56 |
| 9.50 | 10.07 | 80.01 | 63.947 | 20.51 |
| 10.00 | 9.78 | 79.93 | 63.511 | 20.45 |
| 10.50 | 9.49 | 79.85 | 63.065 | 20.38 |
| 11.00 | 9.24 | 79.76 | 62.611 | 20.31 |
| 11.50 | 8.97 | 79.67 | 62.149 | 20.24 |
| 12.00 | 8.75 | 79.58 | 61.681 | 20.17 |
| 12.50 | 8.51 | 79.49 | 61.206 | 20.09 |
| 13.00 | 8.30 | 79.40 | 60.725 | 20.02 |
| 13.50 | 8.11 | 79.31 | 60.239 | 19.94 |
| 14.00 | 7.93 | 79.21 | 59.748 | 19.87 |
| 14.50 | 7.76 | 79.12 | 59.252 | 19.79 |
| 15.00 | 7.59 | 79.02 | 58.753 | 19.72 |
| 15.50 | 7.41 | 78.93 | 58.249 | 19.64 |
| 16.00 | 7.24 | 78.83 | 57.743 | 19.56 |
| 16.50 | 7.11 | 78.73 | 57.232 | 19.48 |
| 17.00 | 6.95 | 78.63 | 56.720 | 19.41 |
| 17.50 | 6.84 | 78.53 | 56.205 | 19.33 |
| 18.00 | 6.70 | 78.43 | 55.687 | 19.25 |
| 18.50 | 6.56 | 78.34 | 55.168 | 19.17 |
| 19.00 | 6.47 | 78.24 | 54.646 | 19.09 |
| 19.50 | 6.35 | 78.14 | 54.124 | 19.01 |
| 20.00 | 6.23 | 78.04 | 53.600 | 18.93 |
| 20.50 | 6.11 | 77.93 | 53.075 | 18.85 |
| 21.00 | 6.02 | 77.83 | 52.548 | 18.77 |
| 21.50 | 5.92 | 77.73 | 52.021 | 18.69 |
| 22.00 | 5.82 | 77.63 | 51.493 | 18.61 |
| 22.50 | 5.72 | 77.53 | 50.964 | 18.52 |
| 23.00 | 5.65 | 77.43 | 50.435 | 18.44 |
| 23.50 | 5.55 | 77.33 | 49.906 | 18.36 |
| 24.00 | 5.46 | 77.23 | 49.376 | 18.28 |
| 24.50 | 2.33 | 77.12 | 48.799 | 18.19 |
| 25.00 | .50 | 76.98 | 48.098 | 18.09 |
| 25.50 | .15 | 76.84 | 47.365 | 17.97 |
| 26.00 | .06 | 76.70 | 46.629 | 17.86 |
| 26.50 | .02 | 76.56 | 45.894 | 17.75 |
| 27.00 | .01 | 76.42 | 45.164 | 17.64 |
| 27.50 | .00 | 76.28 | 44.438 | 17.53 |
| 28.00 | .00 | 76.14 | 43.716 | 17.42 |
| 28.50 | .00 | 76.01 | 42.998 | 17.31 |
| 29.00 | .00 | 75.87 | 42.285 | 17.20 |
| 29.50 | .00 | 75.73 | 41.577 | 17.09 |

PEAK DISCHARGE = 21.019 CFS - PEAK OCCURS AT HOUR 3.70
MAXIMUM WATER SURFACE ELEVATION = 80.741
MAXIMUM STORAGE = 68.2644 AC-FT INCREMENTAL TIME= .050000HRS

*
* OUTFLOW FROM GRIEGOS POND TO 36" PIPE
*
PRINT HYD ID=12 CODE=1

PARTIAL HYDROGRAPH 100.00

RUNOFF VOLUME = 1.04559 INCHES = 45.5372 ACRE-FEET
PEAK DISCHARGE RATE = 21.02 CFS AT 3.700 HOURS BASIN AREA = .8166 SQ. MI.

# SPECIAL ASSESSMENT DISTRICT BC-83-1
# SPECIAL ASSESSMENT DISTRICT 216

## GRIEGOS POND
## RESERVOIR ROUTING

## PROBABLE MAXIMUM FLOOD

```
*
**************************** Add Hydrographs ******************************
*
*   THIS COMMAND ADDS THE TWO HYDROGRAPHS (THE OVERLAND FLOW FROM AREA "D"
*   AND THE STORM DRAIN PIPE FLOW FROM COMANCHE AND CARMONY AND AREA "P")
*
ADD HYD              ID=10  HYD NO=120  ID I=12  ID II=10
*
*   TOTAL FLOW INTO GRIEGOS POND
*
PRINT HYD            ID=10  CODE=1

                                    PARTIAL HYDROGRAPH   120.00

    RUNOFF VOLUME =     14.73027 INCHES      =     289.3222 ACRE-FEET
    PEAK DISCHARGE RATE =    2214.06 CFS  AT   2.500 HOURS   BASIN AREA =    .3683 SQ. MI.


*
*************** Route Hydrograph Through Reservior *****************
*
ROUTE RESERVOIR      ID=19 HYD NO=121 INFLOW ID=10 CODE=10
                     OUTFLOW (CFS)   STORAGE (AC-FT)    ELEVATION (FT)
                        0.0              0.000                65.5
                        1.2              0.113                65.75
                        2.8              0.225                66.0
                        3.3              0.661                66.24
                        3.9              0.697                66.26
                        4.7              1.133                66.5
                        6.1              2.789                67.0
                       11.2             14.968                70.0
                       16.5             37.739                75.0
                       20.5             63.865                80.0
                       21.2             69.803                81.0
                       21.5             72.772                81.5
                       21.6             73.663                81.65
                       89.9             75.741                82.0
                      538.2             81.679                83.0
                     1207.4             87.618                84.0
                     2039.5             93.556                85.0
```

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

| TIME (HRS) | INFLOW (CFS) | ELEV (FEET) | VOLUME (AC-FT) | OUTFLOW (CFS) |
|---|---|---|---|---|
| .00 | .00 | 65.50 | .000 | .00 |
| .33 | .00 | 65.50 | .000 | .00 |
| .67 | 16.49 | 65.70 | .091 | .97 |
| 1.00 | 72.94 | 66.52 | 1.211 | 4.77 |
| 1.33 | 124.22 | 67.25 | 3.789 | 6.52 |
| 1.67 | 174.53 | 68.21 | 7.693 | 8.15 |
| 2.00 | 226.63 | 69.50 | 12.954 | 10.36 |
| 2.33 | 1640.43 | 73.55 | 31.134 | 14.96 |
| 2.67 | 1987.02 | 83.53 | 84.807 | 890.71 |
| 3.00 | 1548.72 | 84.48 | 90.476 | 1607.91 |
| 3.33 | 1273.33 | 84.13 | 88.383 | 1314.64 |
| 3.67 | 1018.71 | 83.87 | 86.831 | 1118.74 |
| 4.00 | 695.27 | 83.39 | 83.978 | 797.26 |
| 4.33 | 454.40 | 82.98 | 81.545 | 528.08 |
| 4.67 | 320.61 | 82.65 | 79.595 | 380.84 |
| 5.00 | 245.62 | 82.43 | 78.280 | 281.60 |
| 5.33 | 203.12 | 82.30 | 77.518 | 224.05 |
| 5.67 | 179.00 | 82.23 | 77.079 | 190.89 |
| 6.00 | 164.74 | 82.18 | 76.825 | 171.72 |
| 6.33 | 110.65 | 82.12 | 76.427 | 141.69 |
| 6.67 | 48.75 | 81.96 | 75.515 | 82.48 |
| 7.00 | 26.19 | 81.82 | 74.643 | 53.82 |
| 7.33 | 15.30 | 81.71 | 74.014 | 33.13 |
| 7.67 | 10.10 | 81.64 | 73.631 | 21.60 |
| 8.00 | 6.92 | 81.58 | 73.268 | 21.56 |
| 8.33 | 4.85 | 81.51 | 72.835 | 21.51 |
| 8.67 | 3.43 | 81.43 | 72.356 | 21.46 |
| 9.00 | 2.41 | 81.34 | 71.846 | 21.41 |
| 9.33 | 1.71 | 81.25 | 71.313 | 21.35 |
| 9.67 | 1.22 | 81.16 | 70.765 | 21.30 |
| 10.00 | .87 | 81.07 | 70.208 | 21.24 |
| 10.33 | .60 | 80.97 | 69.644 | 21.18 |
| 10.67 | .36 | 80.88 | 69.075 | 21.11 |
| 11.00 | .21 | 80.78 | 68.501 | 21.05 |
| 11.33 | .12 | 80.68 | 67.927 | 20.98 |
| 11.67 | .08 | 80.59 | 67.353 | 20.91 |
| 12.00 | .05 | 80.49 | 66.779 | 20.84 |
| 12.33 | .03 | 80.39 | 66.207 | 20.78 |
| 12.67 | .02 | 80.30 | 65.636 | 20.71 |
| 13.00 | .01 | 80.20 | 65.067 | 20.64 |
| 13.33 | .01 | 80.11 | 64.500 | 20.57 |
| 13.67 | .00 | 80.01 | 63.934 | 20.51 |
| 14.00 | .00 | 79.91 | 63.370 | 20.42 |
| 14.33 | .00 | 79.80 | 62.809 | 20.34 |
| 14.67 | .00 | 79.69 | 62.250 | 20.25 |
| 15.00 | .00 | 79.58 | 61.693 | 20.17 |
| 15.33 | .00 | 79.48 | 61.139 | 20.08 |
| 15.67 | .00 | 79.37 | 60.587 | 20.00 |
| 16.00 | .00 | 79.27 | 60.037 | 19.91 |
| 16.33 | .00 | 79.16 | 59.489 | 19.83 |
| 16.67 | .00 | 79.06 | 58.944 | 19.75 |
| 17.00 | .00 | 78.95 | 58.402 | 19.66 |
| 17.33 | .00 | 78.85 | 57.861 | 19.58 |
| 17.67 | .00 | 78.75 | 57.323 | 19.50 |
| 18.00 | .00 | 78.65 | 56.787 | 19.42 |
| 18.33 | .00 | 78.54 | 56.253 | 19.33 |
| 18.67 | .00 | 78.44 | 55.721 | 19.25 |
| 19.00 | .00 | 78.34 | 55.192 | 19.17 |
| 19.33 | .00 | 78.24 | 54.665 | 19.09 |
| 19.67 | .00 | 78.14 | 54.140 | 19.01 |

PEAK DISCHARGE = 1669.097 CFS - PEAK OCCURS AT HOUR 2.87
MAXIMUM WATER SURFACE ELEVATION = 84.555
MAXIMUM STORAGE = 90.9127 AC-FT INCREMENTAL TIME= .033333HRS

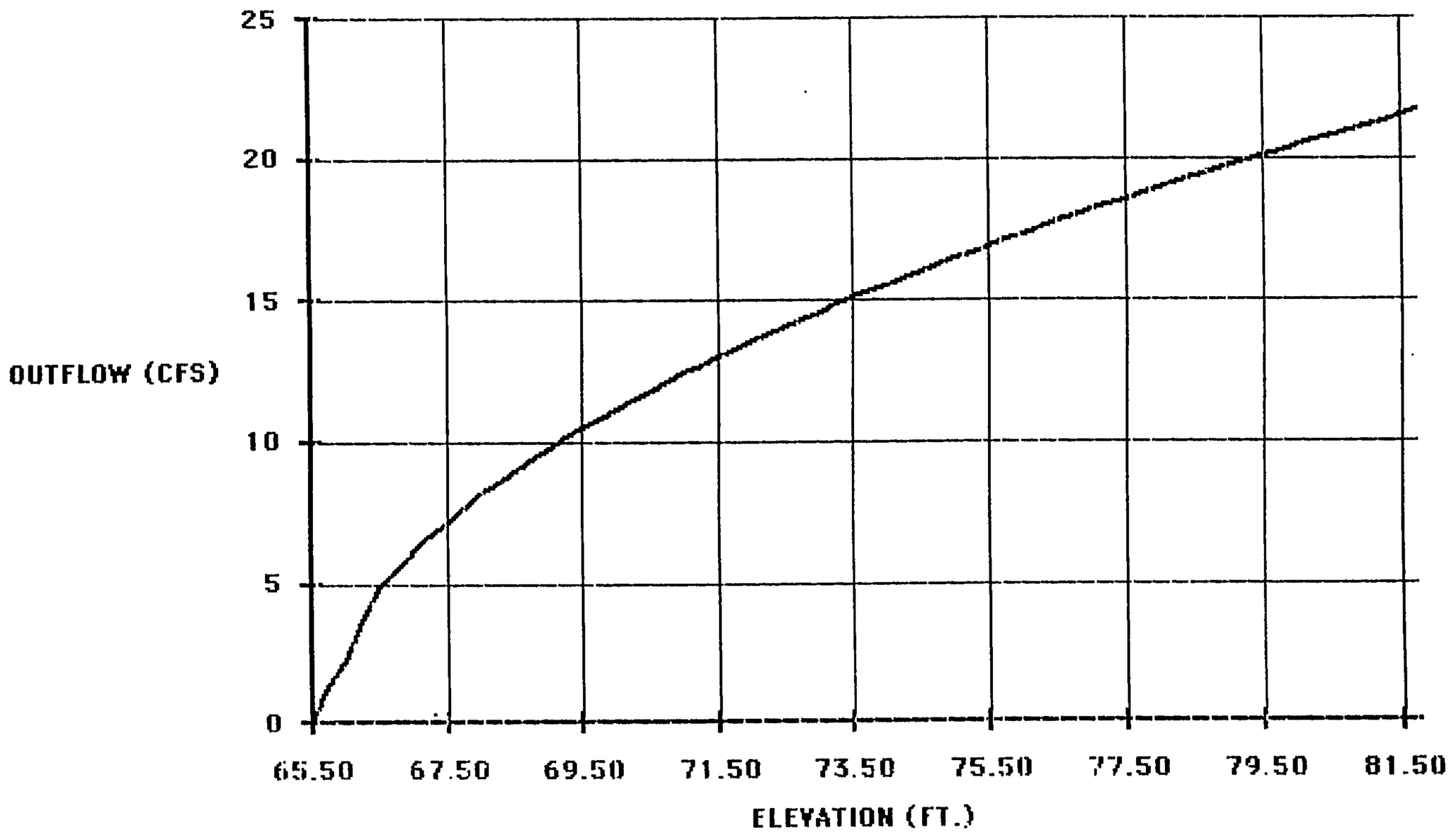
*
* OUTFLOW FROM GRIEGOS POND TO 36" PIPE
*
PRINT HYD ID=19 CODE=1

PARTIAL HYDROGRAPH 121.00

RUNOFF VOLUME = 11.99912 INCHES = 235.6789 ACRE-FEET
PEAK DISCHARGE RATE = 1669.10 CFS AT 2.867 HOURS BASIN AREA = .3683 SQ. MI.

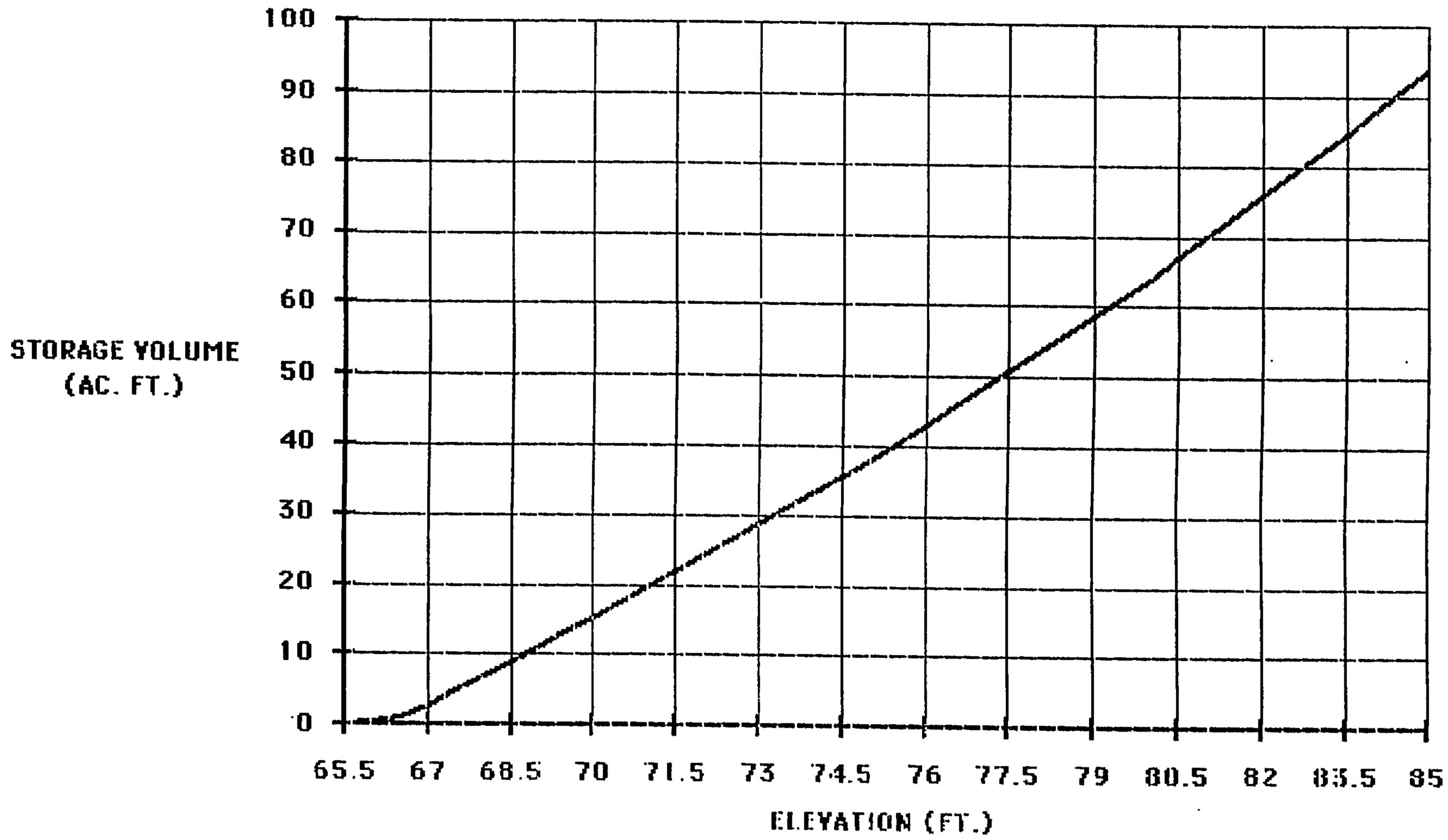
## FIGURE 1

GRIEGOS POND - OUTLET WORKS DISCHARGE CURVE



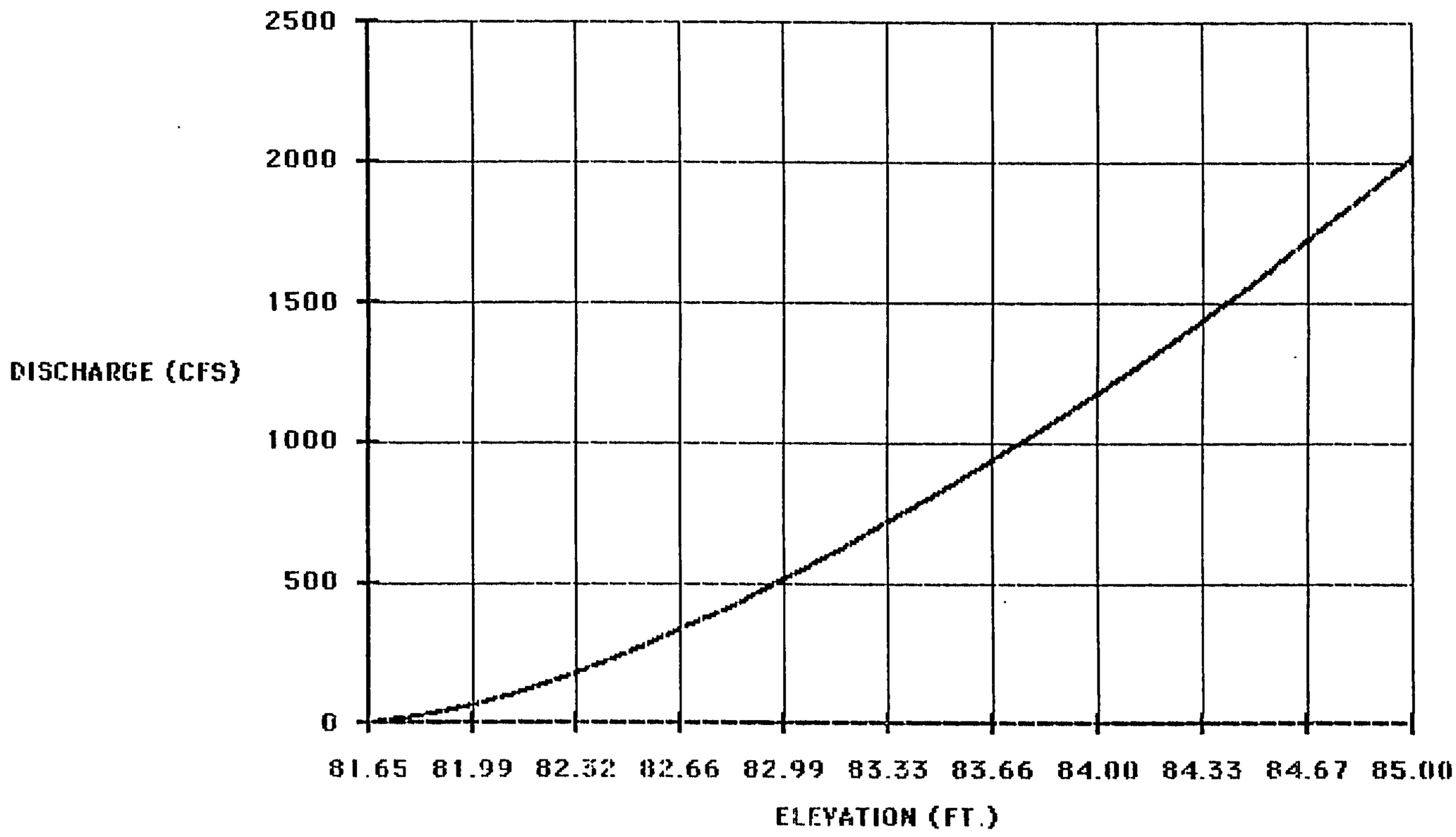
## FIGURE 2

GRIEGOS POND - STORAGE VOLUME CURVE



## FIGURE 3

GRIEGOS POND - SPILLWAY RATING CURVE



COUNTY OF BERNALILLO

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT BC-83-1

CITY OF ALBUQUERQUE

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT 216

# APPENDIX B

## STORM DRAIN HYDRAULIC GRADE LINE CALCULATIONS

**DECEMBER, 1992**

SPECIAL ASSESSMENT DISTRICT BC-83-1
SPECIAL ASSESSMENT DISTRICT 216

## STORM DRAIN
## HYDRAULIC GRADE LINE CALCULATIONS

REFERENCES

1. City of Albuquerque Development Process Manual: Volume 2

   Manhole Losses: $k_{mh} = 0.05$ for full depth manholes
   $k_{mh} = 0.025$ for tee manholes

   Pipe Bend Losses: $k_b = 0.2\sqrt{\Delta/90}$

   Transition Losses: $h_t = 0.2 * [h_{v1} - h_{v2}]$

2. Applied Hydraulics in Engineering, 2nd Edition by Morris & Wiggert.

   Junction Losses: $k_j = [1 + 2*(A_m/A_b)*\cos\theta]*[Q_b/Q_m]^2$

3. Handbook of Hydraulics, 5th Edition by King & Brater.

   Expansion Bulkhead Losses - $k_{bh}$ from Table 6-7 (values of $k_{bh}$ for determining loss of head due to sudden enlargements in pipes)

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Carmony Rd. Storm Drain** **Manning's "n" = 0.013** **Sheet 1 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(enl) | Σh | | | |
| 2+99 | OUTLET | | | | | | | | | | | | | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 82.49 | 6.39 | 76.10 |
| | RCP | 96 | 1,020 | 50.27 | 20.29 | .01244 | 88 | | | | 1.09 | | | | | 1.09 | | | |
| | | | | | | | | | | | | | | | | | 83.59 | 6.39 | 77.19 |
| 3+87 | BEND | | | | | | | 45 | | | | 0.90 | | | | 0.90 | | | |
| | | | | | | | | | | | | | | | | | 84.49 | 6.39 | 78.10 |
| | RCP | 96 | 1,020 | 50.27 | 20.29 | .01244 | 8 | | | | 0.10 | | | | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 84.59 | 6.39 | 78.20 |
| 3+95 | MH | | | | | | | | | | | | | 0.16 | | 0.16 | | | |
| | | | | | | | | | | | | | | | | | 84.75 | 6.39 | 78.36 |
| | RCP | 96 | 1,020 | 50.27 | 20.29 | .01244 | 545 | | | | 6.78 | | | | | 6.78 | | | |
| | | | | | | | | | | | | | | | | | 91.53 | 6.39 | 85.14 |
| 9+40 | BEND | | | | | | | 4 | | | | 0.27 | | | | 0.27 | | | |
| | | | | | | | | | | | | | | | | | 91.80 | 6.39 | 85.41 |
| | RCP | 96 | 1,020 | 50.27 | 20.29 | .01244 | 8 | | | | 0.10 | | | | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 91.90 | 6.39 | 85.51 |
| 9+48 | MH | | | | | | | | | | | | | 0.16 | | 0.16 | | | |
| | | | | | | | | | | | | | | | | | 92.06 | 6.39 | 85.67 |
| | RCP | 96 | 1,020 | 50.27 | 20.29 | 01244 | 18 | | | | 0.22 | | | | | 0.22 | | | |
| | | | | | | | | | | | | | | | | | 92.28 | 6.39 | 85.89 |
| 9+66 | JUNC | | | | | | | | 48 | 46 | | | 0.45 | | | 0.45 | | | |
| | | | | | | | | | | | | | | | | | 92.74 | 5.13 | 87.60 |
| | RCP | 96 | 914 | 50.27 | 18.18 | .00999 | 86 | | | | 0.86 | | | | | 0.86 | | | |
| | | | | | | | | | | | | | | | | | 93.60 | 5.13 | 88.46 |
| 0+52 | BEND | | | | | | | 4 | | | | 0.22 | | | | 0.22 | | | |
| | | | | | | | | | | | | | | | | | 93.81 | 5.13 | 88.68 |
| | RCP | 96 | 914 | 50.27 | 18.18 | .00999 | 8 | | | | 0.08 | | | | | 0.08 | | | |
| | | | | | | | | | | | | | | | | | 93.89 | 5.13 | 88.76 |
| 0+60 | MH | | | | | | | | | | | | | 0.12 | | 0.12 | | | |
| | | | | | | | | | | | | | | | | | 94.01 | 4.81 | 89.20 |

-- **NOTE: STA. 10+00 BACK = 0+00 AHEAD**

-- **SEE PLAN SHEETS: 10-1 & 10-2**

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Carmony Rd. Storm Drain** **Manning's "n" = 0.013** **Sheet 2 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(en1) | Σh | 94.01 | 4.81 | 89.20 |
| | RCP | 96 | 885 | 50.27 | 17.61 | .00936 | 4 | | | | 0.04 | | | | | 0.04 | | | |
| | | | | | | | | | | | | | | | | | 94.05 | 4.81 | 89.24 |
| 0+64 | BH | | | | | | | | | | | | | | 0.56 | 0.56 | | | |
| | | | | | | | | | | | | | | | | | 94.61 | 6.23 | 88.38 |
| | RCP | 90 | 885 | 44.18 | 20.03 | .01321 | 386 | | | | 5.10 | | | | | 5.10 | | | |
| | | | | | | | | | | | | | | | | | 99.71 | 6.23 | 93.48 |
| 4+50 | MH | | | | | | | | | | | | | 0.16 | | 0.16 | | | |
| | | | | | | | | | | | | | | | | | 99.87 | 6.23 | 93.64 |
| | RCP | 90 | 885 | 44.18 | 20.03 | .01321 | 142 | | | | 1.88 | | | | | 1.88 | | | |
| | | | | | | | | | | | | | | | | | 101.74 | 6.23 | 95.51 |
| 5+56 | SOFFIT | | | | | | | | | | | | | | | | | | |
| -- | SEE OPEN CHANNEL FLOW CALCULATION SHEETS FOR HYDRAULIC ANALYSIS FROM 5+92 TO 17+90. | | | | | | | | | | | | | | | | | | |
| 17+98 | SOFFIT | | | | | | | | | | | | | | | | | | |
| | RCP | 84 | 740 | 38.48 | 19.23 | .01335 | 192 | | | | 2.56 | | | | | 2.56 | 20.15 | 5.74 | 14.41 |
| | | | | | | | | | | | | | | | | | 22.71 | 5.74 | 16.97 |
| 19+90 | MH | | | | | | | | | | | | | 0.14 | | 0.14 | | | |
| | | | | | | | | | | | | | | | | | 22.85 | 5.47 | 17.38 |
| | RCP | 84 | 722 | 38.48 | 18.76 | .01270 | 349 | | | | 4.43 | | | | | 4.43 | | | |
| | | | | | | | | | | | | | | | | | 27.28 | 5.47 | 21.82 |
| 23+39 | MH | | | | | | | | | | | | | 0.13 | | 0.13 | | | |
| | | | | | | | | | | | | | | | | | 27.42 | 5.39 | 22.03 |
| | RCP | 84 | 717 | 38.48 | 18.63 | .01253 | 8 | | | | 0.10 | | | | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 27.52 | 5.39 | 22.13 |
| 23+47 | JUNC | | | | | | | | 24 | 90 | | | 0.00 | 0.13 | | 0.13 | | | |
| | | | | | | | | | | | | | | | | | 27.65 | 5.29 | 22.37 |
| | RCP | 84 | 710 | 38.48 | 18.45 | .01229 | 43 | | | | 0.53 | | | | | 0.53 | | | |
| | | | | | | | | | | | | | | | | | 28.18 | 5.29 | 22.90 |
| 23+90 | MH | | | | | | | | | | | | | 0.13 | | 0.13 | | | |
| | | | | | | | | | | | | | | | | | 28.31 | 5.09 | 23.21 |

-- SEE PLAN SHEETS: 10-2, 10-3 & 10-4

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Carmony Rd. Storm Drain / Yale Blvd & West Hahn Storm Drain** **Manning's "n" = 0.013** **Sheet 3 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(enl) | Σh | 28.31 | 5.09 | 23.21 |
| | RCP | 84 | 697 | 38.48 | 18.11 | .01184 | 52 | | | | 0.62 | | | | | 0.62 | | | |
| | | | | | | | | | | | | | | | | | 28.92 | 5.09 | 23.83 |
| 24+42 | MH | | | | | | | | | | | | | 0.12 | | 0.12 | | | |
| | | | | | | | | | | | | | | | | | 29.05 | 4.91 | 24.14 |
| | RCP | 84 | 684 | 38.48 | 17.77 | .01140 | 8 | | | | 0.09 | | | | | 0.09 | | | |
| | | | | | | | | | | | | | | | | | 29.14 | 4.91 | 24.23 |
| 24+50 | JUNC | | | | | | | | 36 | 60 | | | 0.05 | | | 0.05 | | | |
| | | | | | | | | | | | | | | | | | 29.18 | 4.54 | 24.64 |
| | RCP | 84 | 658 | 38.48 | 17.10 | .01055 | 412 | | | | 4.35 | | | | | 4.35 | | | |
| | | | | | | | | | | | | | | | | | 33.53 | 4.54 | 28.99 |
| 28+54 | MH | | | | | | | | | | | | | 0.11 | | 0.11 | | | |
| | | | | | | | | | | | | | | | | | 33.64 | 4.54 | 29.10 |
| | RCP | 84 | 658 | 38.48 | 17.10 | .01055 | 8 | | | | 0.08 | | | | | 0.08 | | | |
| | | | | | | | | | | | | | | | | | 33.73 | 4.54 | 29.19 |
| 28+62 | JUNC | | | | | | | | 36 | 60 | | | 0.29 | | | 0.29 | | | |
| | | | | | | | | | | | | | | | | | 34.01 | 3.69 | 30.33 |
| | RCP | 84 | 593 | 38.48 | 15.41 | .00857 | 8 | | | | 0.07 | | | | | 0.07 | | | |
| | | | | | | | | | | | | | | | | | 34.08 | 3.69 | 30.40 |
| 28+70 | BEND | | | | | | | 38 | | | | 0.48 | | | | 0.48 | | | |
| | | | | | | | | | | | | | | | | | 34.56 | 3.69 | 30.87 |
| | RCP | 84 | 593 | 38.48 | 15.41 | .00857 | 77 | | | | 0.66 | | | | | 0.66 | | | |
| | | | | | | | | | | | | | | | | | 35.22 | 3.69 | 31.53 |
| 29+47 | BEND | | | | | | | 38 | | | | 0.48 | | | | 0.48 | | | |
| | | | | | | | | | | | | | | | | | 35.69 | 3.69 | 32.01 |
| | RCP | 84 | 593 | 38.48 | 15.41 | .00857 | 8 | | | | 0.07 | | | | | 0.07 | | | |
| | | | | | | | | | | | | | | | | | 35.76 | 3.69 | 32.08 |
| 13+41 | MH | | | | | | | | | | | | | 0.09 | | 0.09 | | | |
| | | | | | | | | | | | | | | | | | 35.85 | 3.62 | 32.23 |
| | RCP | 84 | 588 | 38.48 | 15.28 | .00843 | 4 | | | | 0.03 | | | | | 0.03 | | | |
| | | | | | | | | | | | | | | | | | 35.89 | 3.62 | 32.26 |

-- **NOTE: 29+46.93 CARMONY RD. = 13+33.24 YALE BLVD.**

-- **SEE PLAN SHEETS: 10-4 & 10-6**

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Yale Blvd. & West Hahn Storm Drain** **Manning's "n" = 0.013** **Sheet 4 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(en1) | Σh | 35.89 | 3.62 | 32.26 |
| 13+45 | BH | | | | | | | | | | | | | | 0.60 | 0.60 | | | |
| | | | | | | | | | | | | | | | | | 36.49 | 6.72 | 29.78 |
| | RCP | 72 | 588 | 28.27 | 20.80 | .01917 | 21 | | | | 0.40 | | | | | 0.40 | | | |
| | | | | | | | | | | | | | | | | | 36.89 | 6.72 | 30.18 |
| 13+66 | JUNC | | | | | | | | 48 | 90 | | | 0.23 | | | 0.23 | | | |
| | | | | | | | | | | | | | | | | | 37.12 | 4.46 | 32.67 |
| | RCP | 72 | 479 | 28.27 | 16.94 | .01272 | 102 | | | | 1.30 | | | | | 1.30 | | | |
| | | | | | | | | | | | | | | | | | 38.42 | 4.46 | 33.97 |
| 14+68 | MH | | | | | | | | | | | | | 0.11 | | 0.11 | | | |
| | | | | | | | | | | | | | | | | | 38.53 | 4.46 | 34.08 |
| | RCP | 72 | 479 | 28.27 | 16.94 | .01272 | 8 | | | | 0.10 | | | | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 38.64 | 4.46 | 34.18 |
| 14+76 | BEND | | | | | | | 62 | | | | 0.74 | | | | 0.74 | | | |
| | | | | | | | | | | | | | | | | | 39.38 | 4.46 | 34.92 |
| | RCP | 72 | 479 | 28.27 | 16.94 | .01272 | 347 | | | | 4.42 | | | | | 4.42 | | | |
| | | | | | | | | | | | | | | | | | 43.79 | 4.46 | 39.33 |
| 18+15 | MH | | | | | | | | | | | | | | | | | | |

-- **SEE OPEN CHANNEL FLOW CALCULATION SHEETS FOR HYDRAULIC ANALYSIS FROM 18+15 TO 18+34.**

-- **SEE PLAN SHEET: 10-6**

588 - 479 = 109 CFS

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Yale Blvd. Storm Drain (10+74 to 13+95)** **Manning's "n" = 0.013** **Sheet 5 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(en1) | Σh | | | |
| 13+95 | MH | | | | | | | | | | | | | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 32.17 | 1.84 | 30.33 |
| | RCP | 36 | 77 | 7.07 | 10.89 | .01326 | 75 | | | | 0.99 | | | | | 0.99 | | | |
| | | | | | | | | | | | | | | | | | 33.17 | 1.84 | 31.32 |
| 12+20 | MH | | | | | | | 50 | | | | 0.17 | | 0.06 | | 0.23 | | | |
| | | | | | | | | | | | | | | | | | 33.39 | 1.14 | 32.26 |
| | RCP | 30 | 42 | 4.91 | 8.56 | .01043 | 146 | | | | 1.52 | | | | | 1.52 | | | |
| | | | | | | | | | | | | | | | | | 34.92 | 1.14 | 33.78 |
| 10+74 | SOFFIT | | | | | | | | | | | | | | | 0.00 | | | |

-- SEE OPEN CHANNEL FLOW CALCULATIONS FOR HYDRAULIC ANALYSIS FROM 10+74 TO 7+25.

-- SEE PLAN SHEET: 10-5

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: West Hahn Storm Drain (9+78 to 15+35)** **Manning's "n" = 0.013** **Sheet 6 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(enl) | Σh | E.G. | h(v) | H.G. |
| 9+78 | SOFFIT | | | | | | | | | | | | | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 53.12 | 2.33 | 50.79 |
| | RCP | 48 | 154 | 12.57 | 12.25 | .01143 | 54 | | | | 0.62 | | | | | 0.62 | | | |
| | | | | | | | | | | | | | | | | | 53.74 | 2.33 | 51.41 |
| 10+32 | MH | | | | | | | | | | | | | 0.04 | | 0.04 | | | |
| | | | | | | | | | | | | | | | | | 53.78 | 1.77 | 52.02 |
| | RCP | 48 | 134 | 12.57 | 10.66 | .00866 | 275 | | | | 2.38 | | | | | 2.38 | | | |
| | | | | | | | | | | | | | | | | | 56.16 | 1.77 | 54.40 |
| 13+06 | MH | | | | | | | 7 | | | | 0.07 | | 0.03 | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 56.27 | 1.28 | 54.99 |
| | RCP | 48 | 114 | 12.57 | 9.07 | .00626 | 55 | | | | 0.34 | | | | | 0.34 | | | |
| | | | | | | | | | | | | | | | | | 56.61 | 1.28 | 55.33 |
| 13+62 | MH | | | | | | | | | | | | | 0.03 | | 0.03 | | | |
| | | | | | | | | | | | | | | | | | 56.64 | 1.28 | 55.37 |
| | RCP | 48 | 114 | 12.57 | 9.07 | .00626 | 174 | | | | 1.09 | | | | | 1.09 | | | |
| | | | | | | | | | | | | | | | | | 57.73 | 1.28 | 56.46 |
| 15+36 | MH | | | | | | | | | | | | | | | 0.00 | | | |

-- SEE PLAN SHEET: 10-8

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: West Hahn/Stanford Drive S.D.** **Manning's "n" = 0.013** **Sheet 7 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(en1) | Σh | | | |
| 1+00 | SOFFIT | | | | | | | | | | | | | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 53.28 | 2.49 | 50.79 |
| | RCP | 48 | 159 | 12.57 | 12.65 | .01219 | 538 | | | | 6.56 | | | | | 6.56 | | | |
| | | | | | | | | | | | | | | | | | 59.83 | 2.49 | 57.35 |
| 6+38 | MH | | | | | | | | | | | | | 0.06 | | 0.06 | | | |
| | | | | | | | | | | | | | | | | | 59.89 | 2.49 | 57.41 |
| | RCP | 48 | 159 | 12.57 | 12.65 | .01219 | 8 | | | | 0.10 | | | | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 59.99 | 2.49 | 57.51 |
| 6+46 | BEND | | | | | | | 60 | | | | 0.41 | | | | 0.41 | | | |
| | | | | | | | | | | | | | | | | | 60.40 | 2.49 | 57.91 |
| | RCP | 48 | 159 | 12.57 | 12.65 | .01219 | 97 | | | | 1.18 | | | | | 1.18 | | | |
| | | | | | | | | | | | | | | | | | 61.58 | 2.49 | 59.09 |
| 7+42 | BEND | | | | | | | 60 | | | | 0.41 | | | | 0.41 | | | |
| | | | | | | | | | | | | | | | | | 61.99 | 2.49 | 59.50 |
| | RCP | 48 | 159 | 12.57 | 12.65 | .01219 | 4 | | | | 0.05 | | | | | 0.05 | | | |
| | | | | | | | | | | | | | | | | | 62.03 | 2.49 | 59.55 |
| 7+46 | INLET | | | | | | | | | | | | | | | 0.00 | | | |

-- SEE PLAN SHEET: 10-9

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Alexander Blvd Storm Drain (North of Carmony Rd.)** **Manning's "n" = 0.013** **Sheet 8 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(en) | Σh | | | |
| 1+88 | MH | | | | | | | | | | | | | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 22.45 | 0.08 | 22.37 |
| | RCP | 24 | 7 | 3.14 | 2.23 | .00095 | 52 | | | | 0.05 | | | | | 0.05 | | | |
| | | | | | | | | | | | | | | | | | 22.50 | 0.08 | 22.42 |
| 2+40 | MH | | | | | | | | | | | | | | | 0.00 | | | |

-- SEE PLAN SHEET: 10-10

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Comanche/Griegos Rd. Storm Drain** **Manning's "n" = 0.013** 

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(enl) | Σh | E.G. | h(v) | H.G. |
| 17+40 | OUTLET | | | | | | | | | | | | | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 75.42 | 4.02 | 71.40 |
| | RCP | 60 | 316 | 19.63 | 16.09 | .01464 | 160 | | | | 2.34 | | | | | 2.34 | | | |
| | | | | | | | | | | | | | | | | | 77.76 | 4.02 | 73.74 |
| 19+00 | BEND | | | | | | | 53 | | | | 0.62 | | | | 0.62 | | | |
| | | | | | | | | | | | | | | | | | 78.38 | 4.02 | 74.36 |
| | RCP | 60 | 316 | 19.63 | 16.09 | .01464 | 8 | | | | 0.12 | | | | | 0.12 | | | |
| | | | | | | | | | | | | | | | | | 78.50 | 4.02 | 74.48 |
| 19+08 | MH | | | | | | | | | | | | | 0.10 | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 78.60 | 3.95 | 74.65 |
| | RCP | 60 | 313 | 19.63 | 15.94 | .01437 | 151 | | | | 2.17 | | | | | 2.17 | | | |
| | | | | | | | | | | | | | | | | | 80.77 | 3.95 | 76.82 |
| 20+59 | MH | | | | | | | | | | | | | 0.10 | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 80.86 | 3.90 | 76.97 |
| | RCP | 60 | 311 | 19.63 | 15.84 | .01418 | 391 | | | | 5.55 | | | | | 5.55 | | | |
| | | | | | | | | | | | | | | | | | 86.41 | 3.90 | 82.51 |
| 24+50 | MH | | | | | | | | | | | | | 0.10 | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 86.51 | 3.85 | 82.66 |
| | RCP | 60 | 309 | 19.63 | 15.74 | .01400 | 155 | | | | 2.17 | | | | | 2.17 | | | |
| | | | | | | | | | | | | | | | | | 88.68 | 3.85 | 84.83 |
| 26+05 | MH | | | | | | | | | | | | | 0.10 | | 0.10 | | | |
| | | | | | | | | | | | | | | | | | 88.77 | 3.85 | 84.93 |
| | RCP | 60 | 309 | 19.63 | 15.74 | .01400 | 8 | | | | 0.11 | | | | | 0.11 | | | |
| | | | | | | | | | | | | | | | | | 88.88 | 3.85 | 85.04 |
| 26+13 | JUNC | | | | | | | | 42 | 45 | | | 0.30 | | | 0.30 | | | |
| | | | | | | | | | | | | | | | | | 89.19 | 2.83 | 86.36 |
| | RCP | 60 | 265 | 19.63 | 13.50 | .01030 | 57 | | | | 0.59 | | | | | 0.59 | | | |
| | | | | | | | | | | | | | | | | | 89.77 | 2.83 | 86.95 |
| 26+71 | MH | | | | | | | | | | | | | 0.06 | | 0.06 | | | |
| | | | | | | | | | | | | | | | | | 89.84 | 2.46 | 87.38 |
| | RCP | 60 | 247 | 19.63 | 12.58 | .00895 | 4 | | | | 0.04 | | | | | 0.04 | | | |
| | | | | | | | | | | | | | | | | | 89.87 | 2.46 | 87.41 |

-- SEE PLAN SHEETS: 10-11, 10-12

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Comanche/Griegos Rd. Storm Drain** **Manning's "n" = 0.013** **Sheet 10 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(entl) | Σh | 89.87 | 2.46 | 87.41 |
| 26+75 | BH | | | | | | | | | | | | | | 0.54 | 0.54 | | | |
| | | | | | | | | | | | | | | | | | 90.41 | 6.00 | 84.41 |
| | RCP | 48 | 247 | 12.57 | 19.66 | 02941 | 347 | | | | 10.21 | | | | | 10.21 | | | |
| | | | | | | | | | | | | | | | | | 100.62 | 6.00 | 94.62 |
| 30+27 | MH | | | | | | | | | | | | | 0.14 | | 0.14 | | | |
| | | | | | | | | | | | | | | | | | 100.76 | 5.62 | 95.14 |
| | RCP | 48 | 239 | 12.57 | 19.02 | .02754 | 8 | | | | 0.22 | | | | | 0.22 | | | |
| | | | | | | | | | | | | | | | | | 100.98 | 5.62 | 95.36 |
| 30+35 | JUNC | | | | | | | | 18 | 90 | | | 0.04 | | | 0.04 | | | |
| | | | | | | | | | | | | | | | | | 101.02 | 4.72 | 96.30 |
| | RCP | 48 | 219 | 12.57 | 17.43 | .02312 | 166 | | | | 3.84 | | | | | 3.84 | | | |
| | | | | | | | | | | | | | | | | | 104.85 | 4.72 | 100.14 |
| 32+07 | MH | | | | | | | | | | | | | 0.11 | | 0.11 | | | |
| | | | | | | | | | | | | | | | | | 104.96 | 4.34 | 100.63 |
| | RCP | 48 | 210 | 12.57 | 16.71 | .02126 | 8 | | | | 0.17 | | | | | 0.17 | | | |
| | | | | | | | | | | | | | | | | | 105.13 | 4.34 | 100.80 |
| 32+15 | JUNC | | | | | | | | 18 | 90 | | | 0.00 | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 105.13 | 4.30 | 100.84 |
| | RCP | 48 | 209 | 12.57 | 16.63 | 02106 | 103 | | | | 2.17 | | | | | 2.17 | | | |
| | | | | | | | | | | | | | | | | | 107.30 | 4.30 | 103.01 |
| 33+22 | MH | | | | | | | | | | | | | 0.11 | | 0.11 | | | |
| | | | | | | | | | | | | | | | | | 107.41 | 4.30 | 103.11 |
| | RCP | 48 | 209 | 12.57 | 16.63 | .02106 | 8 | | | | 0.17 | | | | | 0.17 | | | |
| | | | | | | | | | | | | | | | | | 107.58 | 4.30 | 103.28 |
| 33+30 | JUNC | | | | | | | | 24 | 90 | | | 0.02 | | | 0.02 | | | |
| | | | | | | | | | | | | | | | | | 107.60 | 3.74 | 103.86 |
| | RCP | 48 | 195 | 12.57 | 15.52 | .01833 | 169 | | | | 3.10 | | | | | 3.10 | | | |
| | | | | | | | | | | | | | | | | | 110.69 | 3.74 | 106.96 |
| 35+05 | MH | | | | | | | | | | | | | 0.09 | | 0.09 | | | |
| | | | | | | | | | | | | | | | | | 110.79 | 3.66 | 107.12 |
| | RCP | 48 | 193 | 12.57 | 15.36 | 01796 | 39 | | | | 0.70 | | | | | 0.70 | | | |
| | | | | | | | | | | | | | | | | | 111.49 | 3.66 | 107.82 |

--- SEE PLAN SHEETS: 10-12 &10-13

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Comanche/Griegos Rd. Storm Drain** **Manning's "n" = 0.013** **Sheet 11 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(t) | h(j) | h(mh) | h(enl) | Σh | | | |
| 35+44 | JUNC | | | | | | | | 18 | 45 | | | 0.24 | | | 0.24 | 111.49 | 3.66 | 107.82 |
| | RCP | 48 | 178 | 12.57 | 14.16 | .01527 | 102 | | | | 1.56 | | | | | 1.56 | 111.73 | 3.12 | 108.62 |
| 36+46 | MH | | | | | | | | | | | | | 0.08 | | 0.08 | 113.29 | 3.12 | 110.17 |
| | RCP | 48 | 178 | 12.57 | 14.16 | .01527 | 8 | | | | 0.12 | | | | | 0.12 | 113.37 | 3.12 | 110.25 |
| 36+54 | BEND | | | | | | | 45 | | | | 0.44 | | | | 0.44 | 113.49 | 3.12 | 110.37 |
| | RCP | 48 | 178 | 12.57 | 14.16 | .01527 | 50 | | | | 0.76 | | | | | 0.76 | 113.93 | 3.12 | 110.81 |
| 36+89 | BEND | | | | | | | 45 | | | | 0.44 | | | | 0.44 | 114.69 | 3.12 | 111.58 |
| | RCP | 48 | 178 | 12.57 | 14.16 | .01527 | 8 | | | | 0.12 | | | | | 0.12 | 115.13 | 3.12 | 112.02 |
| 36+97 | MH | | | | | | | | | | | | | 0.07 | | 0.07 | 115.26 | 3.12 | 112.14 |
| | RCP | 48 | 168 | 12.57 | 13.37 | .01361 | 190 | | | | 2.59 | | | | | 2.59 | 115.33 | 2.78 | 112.55 |
| 38+92 | MH | | | | | | | | | | | | | 0.07 | | 0.07 | 117.91 | 2.78 | 115.14 |
| | RCP | 48 | 168 | 12.57 | 13.37 | .01361 | 8 | | | | 0.11 | | | | | 0.11 | 117.98 | 2.78 | 115.20 |
| 39+00 | JUNC | | | | | | | | 18 | 30 | | | 0.03 | | | 0.03 | 118.09 | 2.78 | 115.31 |
| | RCP | 48 | 163 | 12.57 | 12.97 | .01281 | 243 | | | | 3.11 | | | | | 3.11 | 118.12 | 2.61 | 115.51 |
| 41+42 | MH | | | | | | | | | | | | | 0.07 | | 0.07 | 121.23 | 2.61 | 118.62 |
| | RCP | 48 | 163 | 12.57 | 12.97 | .01281 | 8 | | | | 0.10 | | | | | 0.10 | 121.30 | 2.61 | 118.69 |
| | | | | | | | | | | | | | | | | | 121.40 | 2.61 | 118.79 |

-- SEE PLAN SHEETS: 10-13 & 10-14

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Comanche/Griegos Rd. Storm Drain** **Manning's "n" = 0.013** **Sheet 12 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(enl) | Σh | | | |
| 41+50 | JUNC | | | | | | | | 24 | 60 | | | 0.08 | | | 0.08 | 121.40 | 2.61 | 118.79 |
| | RCP | 48 | 150 | 12.57 | 11.94 | .01085 | 235 | | | | 2.55 | | | | | 2.55 | 121.48 | 2.21 | 119.27 |
| 44+39 | MH | | | | | | | | | | | | | 0.06 | | 0.06 | 124.03 | 2.21 | 121.82 |
| | RCP | 48 | 150 | 12.57 | 11.94 | .01085 | 8 | | | | 0.09 | | | | | 0.09 | 124.09 | 2.21 | 121.88 |
| 44+47 | JUNC | | | | | | | | 18 | 60 | | | 0.08 | | | 0.08 | 124.18 | 2.21 | 121.96 |
| | RCP | 48 | 140 | 12.57 | 11.14 | .00945 | 188 | | | | 1.78 | | | | | 1.78 | 124.26 | 1.93 | 122.33 |
| 46+35 | MH | | | | | | | | | | | | | 0.04 | | 0.04 | 126.03 | 1.93 | 124.10 |
| | RCP | 48 | 130 | 12.57 | 10.35 | .00815 | 87 | | | | 0.71 | | | | | 0.71 | 126.07 | 1.66 | 124.41 |
| 47+22 | MH | | | | | | | | | | | | | 0.04 | | 0.04 | 126.78 | 1.66 | 125.12 |
| | RCP | 48 | 130 | 12.57 | 10.35 | .00815 | 8 | | | | 0.07 | | | | | 0.07 | 126.82 | 1.66 | 125.16 |
| 47+30 | JUNC. | | | | | | | | 36 | 45 | | | 1.24 | | | 1.24 | 126.89 | 1.66 | 125.23 |
| | RCP | 48 | 70 | 12.57 | 5.57 | .00236 | 8 | | | | 0.02 | | | | | 0.02 | 128.13 | 0.48 | 127.65 |
| 47+38 | JUNC | | | | | | | | 18 | 90 | | | 0.00 | | | 0.00 | 128.15 | 0.48 | 127.67 |
| | RCP | 48 | 65 | 12.57 | 5.17 | .00204 | 4 | | | | 0.01 | | | | | 0.01 | 128.15 | 0.42 | 127.74 |
| 47+42 | BH | | | | | | | | | | | | | | 0.30 | 0.30 | 128.16 | 0.42 | 127.75 |
| | RCP | 36 | 65 | 7.07 | 9.20 | .00945 | 199 | | | | 1.88 | | | | | 1.88 | 128.46 | 1.31 | 127.15 |
| | | | | | | | | | | | | | | | | | 130.34 | 1.31 | 129.03 |

-- SEE PLAN SHEET: 10-14

**SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit**

**PROJECT: SAD-BC-83-1** **LINE: Comanche/Griegos Rd. Storm Drain** **Manning's "n" = 0.013** **Sheet 13 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(en) | Σh | E.G. | h(v) | H.G. |
| 49+42 | MH | | | | | | | | | | | | | 0.05 | | 0.05 | 130.34 | 1.31 | 129.03 |
| | | | | | | | | | | | | | | | | | 130.39 | 0.94 | 129.45 |
| | RCP | 36 | 55 | 7.07 | 7.78 | .00676 | 4 | | | | 0.03 | | | | | 0.03 | | | |
| | | | | | | | | | | | | | | | | | 130.42 | 0.94 | 129.48 |
| 49+46 | JUNC | | | | | | | | 24 | 45 | | | 0.19 | | | 0.19 | | | |
| | | | | | | | | | | | | | | | | | 130.61 | 0.57 | 130.03 |
| | RCP | 36 | 43 | 7.07 | 6.08 | .00413 | 322 | | | | 1.33 | | | | | 1.33 | | | |
| | | | | | | | | | | | | | | | | | 131.94 | 0.57 | 131.36 |
| 52+70 | MH | | | | | | | | 18 | 90 | | | 0.00 | 0.05 | 0.09 | 0.15 | | | |
| | | | | | | | | | | | | | | | | | 132.08 | 1.03 | 131.05 |
| | RCP | 30 | 40 | 4.91 | 8.15 | .00946 | 154 | | | | 1.46 | | | | | 1.46 | | | |
| | | | | | | | | | | | | | | | | | 133.54 | 1.03 | 132.51 |
| 54+25 | MH | | | | | | | | 18,24 | 45,70 | | | 0.45 | 0.03 | 0.08 | 0.56 | | | |
| | | | | | | | | | | | | | | | | | 134.10 | 0.63 | 133.47 |
| | RCP | 24 | 20 | 3.14 | 6.37 | .00777 | 144 | | | | 1.12 | | | | | 1.12 | | | |
| | | | | | | | | | | | | | | | | | 135.22 | 0.63 | 134.59 |
| 55+70 | MH | | | | | | | | | | | | | | | | | | |

-- SEE PLAN SHEETS: 10-14 & 10-15

## SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit

**PROJECT: SAD-BC-83-1** **LINE: Rankin Ln. Storm Drain** **Manning's "n" = 0.013** **Sheet 14 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(enl) | Σh | | | |
| 0+15 | WYE | | | | | | | | | | | | | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 28.96 | 1.31 | 27.65 |
| | RCP | 36 | 65 | 7.07 | 9.20 | .00945 | 35 | | | | 0.33 | | | | | 0.33 | | | |
| | | | | | | | | | | | | | | | | | 29.29 | 1.31 | 27.98 |
| 0+10 | MH | | | | | | | 45 | | | | 0.19 | | 0.07 | | 0.25 | | | |
| | | | | | | | | | | | | | | | | | 29.54 | 1.31 | 28.23 |
| | RCP | 36 | 65 | 7.07 | 9.20 | .00945 | 40 | | | | 0.38 | | | | | 0.38 | | | |
| | | | | | | | | | | | | | | | | | 29.92 | 1.31 | 28.61 |
| 0+50 | MH | | | | | | | | | | | | | | | 0.00 | | | |

-- SEE PLAN SHEET: 10-16

**SUMMARY OF HYDRAULIC CALCULATIONS -- Closed Conduit**

**PROJECT: SAD-BC-83-1** **LINE: Rail Road Storm Drain** **Manning's "n" = 0.013** **Sheet 15 of 45**

| | | | | | | | | BEND | JUNCTION | | LOSSES | | | | | | E.G. | h(v) | H.G. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STA. | STRUC. | D | Q | A | V | S(f) | L | Δ | D | Ø | h(f) | h(b) | h(j) | h(mh) | h(enl) | Σh | | | |
| 0+26 | OUTLET | | | | | | | | | | | | | | | 0.00 | | | |
| | | | | | | | | | | | | | | | | | 74.05 | 0.55 | 73.50 |
| | RCP | 48 | 75 | 12.57 | 5.97 | .00271 | 17 | | | | 0.05 | | | | | 0.05 | | | |
| | | | | | | | | | | | | | | | | | 74.10 | 0.55 | 73.55 |
| 0+43 | SOFFIT | | | | | | | | | | | | | | | 0.00 | | | |

-- **SEE OPEN CHANNEL FLOW CALCULATION SHEETS FOR HYDRAULIC ANALYSIS FROM 0+43 TO 15+42.**

-- **SEE PLAN SHEET: 10-17**

CARMONY RD. STORM DRAIN: (SEE PLAN SHEET 10-2)

5+92 TO 8+50:

SEE IF FLOW IS SUBCRITICAL OR SUPERCRITICAL.

$Q = 885$ CFS ; $S_o = 3.05\%$ ; DIA = 90" ; $n = .013$

CALCULATE NORMAL DEPTH:

| $y$ | $Q$ |
|---|---|
| 4.50 | 903 |
| 4.46 | 873 |
| 4.44 | 885 |

$y_N = 4.44$ FT.

CALCULATE CRITICAL DEPTH:

| $y$ | $\frac{Q^2 T W}{g A^3}$ |
|---|---|
| 7.00 | 1.1516 |
| 7.10 | 1.012 |
| 7.11 | 0.9976 |

$y_c = 7.11$ FT.

SINCE, $y_N < y_c$, FLOW IS SUPERCRITICAL.

FLOW IS SUBCRITICAL DOWNSTREAM OF 5+92 AND SUPER CRITICAL UPSTREAM OF 5+92 THUS,

A HYDRAULIC JUMP TAKES PLACE AT 6+20±.

SEE SHEET 36 OF 45 FOR BACKWATER CURVE CALCULATIONS.

CONTD. →

CARMONY RD. STORM DRAIN: (SEE PLAN SHEETS 10-2 & 10-3)

8+50 TO 15+08:

SEE IF FLOW IS SUBCRITICAL OR SUPERCRITICAL.

$Q = 870$ CFS ; $S_o = 1.17\%$ ; DIA. = 90" ; $n = .013$

CALCULATE NORMAL DEPTH:

| y | Q |
|---|---|
| 7.25 | 889 |
| 7.40 | 873 |
| 7.41 | 871 |
| 7.42 | 869 |

$y_N = 7.41$ FT.

CALCULATE CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 7.0 | 1.1129 |
| 7.05 | 1.0461 |
| 7.10 | 0.9780 |
| 7.08 | 1.0054 |
| 7.09 | 0.9917 |

$y_c = 7.08$ FT.

SINCE $y_N > y_c$, FLOW IS SUBCRITICAL.

FLOW IS SUPERCRITICAL DOWNSTREAM OF 8+50 AND SUBCRITICAL UPSTREAM OF 8+50. THUS, FLOW PASSES THROUGH CRITICAL DEPTH AT 8+50.

SEE SHEET 37 OF 45 FOR BACKWATER CURVE CALCS.

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CARMONY RD. STORM DRAIN: (SEE PLAN SHEET 10-3)

15+08 TO 17+42:

SEE IF FLOW IS SUBCRITICAL OR SUPERCRITICAL.

$Q = 828$ CFS ; $S_o = 1.17\%$ ; DIA. = 90" ; $n = .013$.

CALCULATE NORMAL DEPTH:

| y | Q |
|---|---|
| 6.40 | 860 |
| 6.38 | 814 |
| 6.10 | 827 |
| 6.11 | 828 |

$y_N = 6.11$ FT.

CALCULATE CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 7.00 | 1.0080 |
| 7.01 | 0.9960 |

$y_c = 7.01$ FT.

SINCE $y_N < y_c$, FLOW IS SUPERCRITICAL.

FLOW IS SUBCRITICAL DOWNSTREAM OF 15+08 AND SUPERCRITICAL UPSTREAM OF 15+08 THUS,

A HYDRAULIC JUMP TAKES PLACE AT 15+08 ±.

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CARMONY RD. STORM DRAIN (SEE PLAN SHEET 10-3)

17+42 TO 17+50:

$Q = 800$ CFS ; $S = 1.17\%$ ; DIA = 90" ; $n = .013$

CALCULATE NORMAL DEPTH:

| y | Q |
|---|---|
| 6.00 | 814 |
| 5.95 | 807 |
| → 5.90 | 800 |

$y_N = 5.90$ FT.

CALCULATE CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 7.00 | 0.9410 |
| → 6.95 | 0.9967 |
| 6.94 | 1.0078 |

$y_c = 6.95$ FT.

SINCE $y_N < y_c$, FLOW IS SUPERCRITICAL.

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CARMONY RD. STORM DRAIN: (SEE PLAN SHEET 10-3)

17+50 TO 17+58:

Q = 770 CFS ; S = 1.17 % ; DIA. = 90" ; n = .013

CALCULATE NORMAL DEPTH:

| y | Q |
|---|---|
| 5.75 | 779 |
| 5.70 | 771 |
| → 5.69 | 770 |

$y_N = 5.69$ FT.

CALCULATE CRITICAL DEPTH:

| y | $\frac{Q^2 T_W}{g A^3}$ |
|---|---|
| 6.75 | 1.281 |
| 6.80 | .0767 |
| 6.85 | .0255 |
| → 6.87 | .0051 |
| 6.88 | .9949 |

$y_c = 6.87$ FT.

SINCE $y_N < y_c$, FLOW IS SUPERCRITICAL.

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CARMONY RD. STORM DRAIN: (SEE PLAN SHEET 10-3)

17+58 TO 17+62:

$Q = 740$ CFS; $S = 1.17\%$; DIA = 90"; $n = .013$

CALCULATE NORMAL DEPTH:

| y | Q |
|---|---|
| 5.50 | 739 CFS |
| 5.51 | 741 CFS |

$y_N = 5.50$ FT

CALCULATE CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 6.80 | 0.9944 |
| 6.79 | 1.0039 |

$y_c = 6.79$ FT.

SINCE $y_N < y_c$; FLOW IS SUPERCRITICAL.

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CARMONY RD. STORM DRAIN: (SEE PLAN SHEET 10-3 & 10-4)

17+62 TO 19+90:

Q = 740 CFS ; $S_o$ = 0.85% ; DIA. = 84" ; n = .013.

FIND CAPACITY OF 84" PIPE USING MANNING'S EQ.

$Q_{CAP}$ = 591 CFS.

MAX. CAPACITY AT (.938)(84") = 635 CFS.

FROM 17+62 TO 19+90, FLOW WILL BE UNDER PRESSURE.

FLOW IS SUPERCRITICAL DOWNSTREAM FROM 17+62, SO FLOW PASSES THROUGH CRITICAL DEPTH AT 17+62.

CALCULATE CRITICAL DEPTH: (84")

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 6.40 | 1.3279 |
| 6.50 | 1.1849 |
| 6.60 | 1.039 |
| 6.62 | 1.0090 |
| 6.63 | 0.9939 |

$y_c$ = 6.63 FT.

SEE SHEET 38 OF FOR BACKWATER CURVE CALCS.

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YALE BLVD. & WEST HAHN STORM DRAIN: (SEE PLAN SHEET 10-6)

18+15.36 TO 18+33.99 :

10'x5' BOX SECTION ; Q = 479 CFS ; n = .013 ; S = 15% ;

FIND NORMAL DEPTH :

| y | Q |
|---|---|
| 1.08 | 393 |
| 1.10 | 456 |
| 1.13 | 475 |
| → 1.14 | 482 |

$y_N = 1.14$ FT.

FIND CRITICAL DEPTH :

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 4 | 1.1134 |
| 4.15 | 0.7819 |
| 4.13 | 0.9618 |
| → 4.14 | 1.0042 |
| 4.15 | 0.9969 |

$y_c = 4.15$ FT.

?

EVALUATE FLOW IN 10'x5' BOX CULVERT UNDER I-25.

10'x5' BOX; Q = 479 CFS ; n = .013 ; S = .0173

(UPSTREAM OF 18+33.99)

FIND NORMAL DEPTH :

| y | Q |
|---|---|
| 2.30 | 469 |
| 2.35 | 484 |
| 2.34 | 481.3654 |
| → 2.33 | 478.58 |

$y_N = 2.33$ FT.

SINCE $y_N < y_c$ UPSTREAM OF 18+15.36 AND FLOW IS SUBCRITICAL DOWNSTREAM OF 18+15.36, A HYDRAULIC JUMP TAKES PLACE AT 18+75 ±.

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YALE BLVD. STORM DRAIN: (SEE PLAN SHEET 10-5)

10+42 TO 10+74

Q = 42 CFS ; S = 5.83% ; n = .013 ; 30" RCP

FIND NORMAL DEPTH:

| y | Q |
|---|---|
| 1.18 | 33 |
| 1.20 | 46 |
| 1.15 | 43 |
| 1.13 | 42 |

$y_N = 1.13$ FT.

FIND CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 2.18 | 1.47 |
| 2.16 | 0.93 |
| 2.17 | 1.005 |

$y_c = 2.17$ FT.

SINCE $y_N < y_c$; FLOW IS SUPERCRITICAL.

FLOW IS SUBCRITICAL DOWNSTREAM OF 10+74 AND SUPERCRITICAL UPSTREAM OF 10+74, THUS,

A HYDRAULIC JUMP TAKES PLACE AT 10+65±.

10+00 TO 10+42: (EXISTING PIPE)

Q = 42 CFS ; S = .55% ; n = .013 ; 30" RCP

PIPE CAPACITY (FULL) = 30.5 CFS

MAX. PIPE CAPACITY AT DEPTH = (.938)(2.5) = 33 CFS

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⊛ SEE SHEETS 39 & 40 OF 45 FOR BACKWATER CURVE CALCS.

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YALE BLVD. STORM DRAIN: CONTD. (SEE PLAN SHEET 10-5)

10+00 TO 10+42: CONTD.

FLOW IN THIS SECTION IS UNDER PRESSURE.

7+25 TO 10+00: (EXISTING PIPE)

$Q = 23$ CFS; $S = .55\%$; $n = .013$; 30" RCP;

FROM SIMILAR CALCS FROM ABOVE,

$y_N = 1.62$ FT; $y_c = 1.63$, SO FLOW IS AT CRITICAL DEPTH.

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WEST HAHN STORM DRAIN: (EAST OF INTERSTATE 25)

EVALUATE FLOW IN 10'x5' BOX CULVERT UNDER I-25;

Q = 396 CFS ; S = .0173 ; n = .013 . (DOWNSTREAM OF 0+99.20)

CALCULATE NORMAL DEPTH:

| y | Q |
|---|---|
| 2.50 | 528 |
| 2.18 | 382 |
| → 2.05 | 396.62 |

$y_N = 2.05$ FT.

(SEE PLAN SHEET 10-7)

CALCULATE CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 3.00 | 1.80 |
| 4.00 | 0.76 |
| → 3.65 | 1.0015 |

$y_c = 3.65$ FT

SINCE $y_N < y_c$, FLOW IS SUPERCRITICAL IN 10'x5' CULVERT.

0+99.20 TO 1+91.56 ;

8'x5' BOX SECTION; Q = 351 CFS ; S = .002 ; n = .013 .

FIND NORMAL DEPTH:

| y | Q |
|---|---|
| 4.99 | 348.24 |
| 5.02 | 351 |

SINCE 5.02' > 5.0', FLOW IN THIS SECTION IS UNDER PRESSURE AND IS SUBCRITICAL.

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Project SAD-BC-83-1 Sheet 27 of 45
OPEN CHANNEL FLOW CALCS. Job No.
By DA Chk'd Date 1-19-92

WEST HAHN STORM DRAIN; CONT. (EAST OF I-25)

0+99.20 TO 1+91.56:

SINCE THE FLOW DOWNSTREAM OF STATION 1+00.30 IS SUPERCRITICAL AND THE FLOW UPSTREAM OF 1+00.30 IS SUBCRITICAL, THE FLOW PASSES THROUGH CRITICAL DEPTH AT 1+00.30. BELOW IS THE CALCULATION OF CRITICAL DEPTH AT 1+00.30.

FIND CRITICAL DEPTH: (SEE PLAN SHEET 10-7)

| $y$ | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 4.00 | 0.9341 |
| 3.90 | 1.0078 |
| → 3.91 | 1.0001 |

$y_c = 3.91$

* - SEE SHEET 41 OF 45 FOR BACKWATER CURVE CALCULATIONS.

1+91.56 TO 7+76.71

8'X5' BOX SECTION; Q=323CFS; n=.013; S=.002

FIND NORMAL DEPTH:

| $y$ | $Q$ |
|---|---|
| 4.0 | 260.57 |
| 4.5 | 331.11 |
| 4.71 | 323. |

$y_N = 4.71$ FT.

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WEST HAHN STORM DRAIN; CONT. (EAST OF I-25)

(SEE PLAN SHEET 10-7)

1+91.56 TO 7+76.71:

FIND CRITICAL DEPTH:

| $y$ | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 2.00 | 6.33 |
| 4.00 | 0.79 |
| → 3.70 | 0.9995 |

$y_c = 3.70$ FT.

SINCE $y_N > y_c$, FLOW IS SUBCRITICAL.

7+76.71 TO 9+77.68:

8'X5' BOX SECTION, Q=303CFS, n=.013; S=.002;

FIND NORMAL DEPTH;

| $y$ | $Q$ |
|---|---|
| 4.60 | 313 |
| 4.55 | 304 |
| 4.49 | 303 |

$y_N = 4.49$ FT

FIND CRITICAL DEPTH;

| $y$ | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 3.65 | 0.9162 |
| 3.60 | 1.0391 |
| 3.55 | 1.0042 |
| 3.55 | 0.9958 |

$y_c = 3.55$ FT.

SEE SHEET 42 OF 45 FOR BACKWATER CURVE CALCS.

SINCE $y_N > y_c$; FLOW IS SUBCRITICAL.

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PREMIER DISTRIBUTING STORM DRAIN LINE: (SEE PLAN SHEET 10-10)

1+00 TO 1+55.18

$Q = 11.5$ CFS ; $S = 11.36\%$ ; $n = .013$ ; 30" RCP.

FIND NORMAL DEPTH:

| $y$ | $Q$ |
|---|---|
| 1.00 | 46.7 |
| 0.50 | 12.14 |
| → 0.49 | 11.652 |

$y_N = 0.49$ FT.

FIND CRITICAL DEPTH:

| $y$ | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| .10 | 1.632 |
| .25 | 0.6945 |
| .15 | 0.9552 |
| → .14 | 0.9876 |

$y_c = 1.14$ FT.

SINCE $y_N < y_c$; FLOW IS SUPERCRITICAL.

FLOW AT 1+00 IS IN THE 90" RCP IN CARMONY RD. A HYDRAULIC JUMP MUST TAKE PLACE IN THE PREMIER STORM DRAIN TO GET THE SUPERCRITICAL FLOW INTO THE CARMONY RD. STORM DRAIN.

SEE PLOT OF THE HGL ON PLAN SHEET 10-10.

CONT. →

PREMIER DISTRIBUTING STORM DRAIN LINE; CONT.

1+55.18 TO 2+78.47: (SEE PLAN SHEET 10-10)

Q = 11.5 CFS; S = 3.51%; n = .013; 30" RCP

FIND NORMAL DEPTH:

| y | Q |
|---|---|
| 1.0 | 25.97 |
| 0.70 | 13.1938 |
| → 0.65 | 11.4062 |

$y_N = 0.65$ FT

SINCE $y_N < y_c$; FLOW IS SUPERCRITICAL.

UPSTREAM OF 2+78.47 (EXISTING 18" RCP);

Q = 11.5 CFS; S = 1.0%; n = .013; 18" RCP.

PIPE CAPACITY (FULL) = 10.5 CFS

MAX. CAPACITY AT (.938)(18") = 11.3 CFS

THUS, FLOW IS UNDER PRESSURE.

FLOW IS SUPERCRITICAL DOWNSTREAM OF 2+78.47 AND SUBCRITICAL UPSTREAM OF 2+78.47 THUS, FLOW PASSES THROUGH CRITICAL DEPTH AT 2+78.47.

SEE SHEET 43 OF 45 FOR BACKWATER CURVE CALCS.

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Project SAD-RC-83-1 Sheet 31 of 45
OPEN CHANNEL FLOW CALCS Job No.
By DA Chk'd Date 1-23-92

ALEXANDER BLVD. (JUST SOUTH OF CARMONY RD)

0-60.39 TO 1+43.00 (SEE PLAN SHEET 10-10)

Q=3 CFS; n=.013; S=0.01; 24" RCP.

FIND NORMAL DEPTH:

| y | Q |
|---|---|
| 0.50 | 3.11 |
| → 0.49 | 2.99 |

$y_N = 0.49$ FT

FIND CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 1.00 | 0.1442 |
| 0.80 | 0.3389 |
| → 0.60 | 1.0287 |
| 0.61 | 0.9648 |

$y_c = 0.60$ FT.

SINCE $y_N < y_c$; FLOW IS SUPERCRITICAL.

1+43.00 TO 1+87.50

Q = 5 CFS; n=.013; S=.01; 24" RCP

CALCULATIONS ARE SIMILAR TO THOSE ABOVE WITH $y_N = 0.64$ FT. AND $y_c = 0.79$ FT.

FLOW IS SUPERCRITICAL.

RAILROAD STORM DRAIN (SEE PLAN SHEET 10-17)

0+43 TO 0+82:

SEE IF FLOW IS SUBCRITICAL OR SUPERCRITICAL.

Q = 75 CFS ; S = 10.96% ; DIA. = 48" ; n = .013

CALCULATE NORMAL DEPTH:

| y | Q |
|---|---|
| 1.00 | 65.13 |
| 1.10 | 78.18 |
| 1.07 | 75.10 |

$y_N = 1.07$ FT.

CALCULATE CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 2.15 | 1.20 |
| 2.60 | 1.03 |
| 2.62 | 1.00 |

$y_c = 2.62$ FT.

SINCE $y_N < y_c$, FLOW IS SUPERCRITICAL.

FLOW IS SUBCRITICAL DOWNSTREAM OF 0+43, AND AND SUPERCRITICAL UPSTREAM OF 0+43 THUS, A HYDRAULIC JUMP TAKES PLACE AT 0+60±.

SEE SHEET 44 OF 45 FOR BACKWATER CURVE CALCS.

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RAILROAD STORM DRAIN; CONTD. (SEE PLAN SHEET 10-17)

0+82 TO 2+00:

SEE IF FLOW IS SUBCRITICAL OR SUPERCRITICAL:

Q = 75 CFS ; S = 0.15% ; DIA = 48" ; n = .013.

CHECK PIPE CAPACITY WHEN FLOWING FULL USING MANNINGS EQ

$Q_{CAP}$ = 55.7 CFS

CHECK Q WHEN DEPTH = (0.938)(DIA.) = 3.57 FT;

→ $Q_{CAP}$ = 60.0 CFS < 75 CFS

THUS, FLOW IS UNDER PRESSURE, THUS, FLOW IS SUBCRITICAL. FLOW WILL PASS THROUGH CRITICAL DEPTH AT 0+82.

SEE SHEET 45 OF 45 FOR BACKWATER CURVE CALCS.

2+00 TO 2+60:

Q = 70 CFS ; DIA = 48" ; S = .15% ; n = .013

SINCE Q > $Q_{CAP}$ ; FLOW IS UNDER PRESSURE AND THUS, IS SUBCRITICAL.

2+60 TO 3+50

Q = 66 CFS ; DIA. = 48" ; S = .15% ; n = .013

SINCE Q > $Q_{CAP}$ ; FLOW IS UNDER PRESSURE AND THUS, IS SUBCRITICAL.

3+50 TO 4+90:

Q = 60 CFS ; DIA. = 48" ; S = .15% ; n = .013.

SINCE Q > $Q_{CAP}$ ; FLOW IS UNDER PRESSURE AND THUS, IS SUBCRITICAL.

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RAILROAD STORM DRAIN; CONT'D (SEE PLAN SHEETS 10-17 & 10-18)

4+90 TO 5+75:

Q = 52 CFS ; DIA = 48" ; S = .15% ; n = .013.

SEE IF FLOW IS SUBCRITICAL OR SUPERCRITICAL.

CALCULATE NORMAL DEPTH:

| y | Q |
|---|---|
| 3.5 | 58.6 |
| 3.0 | 50.9 |
| 3.06 | 52.0 |

$y_N = 3.06$ FT.

CALCULATE CRITICAL DEPTH:

| y | $\frac{Q^2 TW}{g A^3}$ |
|---|---|
| 2.0 | 1.35 |
| 2.2 | 0.94 |
| 2.17 | 1.00 |

$y_c = 2.17$ FT.

SINCE $y_N > y_c$; FLOW IS SUBCRITICAL.

5+75 TO 9+81.48:

Q = 49 CFS ; DIA = 48" S = .15% ; n = .013

CALCS SIMILAR TO THOSE ABOVE,

$y_N = 2.91$ FT ; FLOW IS SUBCRITICAL.

9+81.48 TO 9+92:

CONT'D. ⇒

Q = 46 CFS ; DIA = 42", S = .15% ; n = .013

QCAP = 39 CFS ; FLOW IS UNDER PRESSURE AND THUS IS SUBCRITICAL.

RAILROAD STORM DRAIN; CONTD. (SEE PLAN SHEET 10-18)

9+92 TO 12+07:

Q = 30 CFS; DIA = 42"; S = .15%; n = .013

CALCS SIMILAR TO THOSE ON PREVIOUS PAGE;

$y_N = 2.30$ FT., FLOW IS SUBCRITICAL.

12+07 TO 12+97:

Q = 23 CFS; DIA = 42"; S = .15%; n = .013

CALCS SIMILAR TO THOSE ABOVE;

$y_N = 1.93$ FT., FLOW IS SUBCRITICAL.

12+97 TO 13+92:

Q = 16 CFS; DIA = 42"; S = .15%; n = .013

CALCS SIMILAR TO THOSE ABOVE.

$y_N = 1.56$ FT; FLOW IS SUBCRITICAL.

13+92 TO 15+42:

Q = 8 CFS; DIA = 42"; S = .15%; n = .013

CALCS SIMILAR TO THOSE ABOVE.

$y_N = 1.08$ FT. FLOW IS SUBCRITICAL.

**BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD**



PROJECT: SAD-BC-83-1
CARMONY RD. STORM DRAIN
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 7.11') AT STATION 8+50
FLOW IS SUPERCRITICAL DOWNSTREAM (DOWNSTATION) FROM STATION 8+50
BELOW IS THE CALCULATION OF THE BACKWATER CURVE DOWNSTREAM (DOWNSTATION) FROM STATION 8+50

Circular (>) Half Full
Diameter (D) = 7.50
S(o) = 0.0305
n = 0.013
Q(cfs) = 885

| Y (FT) | THETA (Ø) (DEGREES) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | Σl. (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.11 | 52.7255 | 43.3034 | 20.1111 | 2.1532 | 20.4372 | 6.4857 | 13.5957 | 0.011435 | | | | | |
| | | | | | | | | | 2.2118 | 21.1805 | 0.011850 | 16.5 | |
| 6.44 | 88.3303 | 40.3672 | 17.7808 | 2.2703 | 21.9237 | 7.4635 | 13.9035 | 0.012262 | | | | | 16.5 |
| | | | | | | | | | 2.2718 | 23.0738 | 0.013570 | 58.4 | |
| 5.78 | 114.4508 | 36.5341 | 16.0712 | 2.2733 | 24.2239 | 9.1118 | 14.8918 | 0.014944 | | | | | 74.9 |
| | | | | | | | | | 2.2373 | 25.9137 | 0.017469 | 157.3 | |
| 5.11 | 137.4716 | 32.0612 | 14.5645 | 2.2013 | 27.6035 | 11.8316 | 16.9416 | 0.020255 | | | | | 232.2 |
| | | | | | | | | | 2.1347 | 30.0492 | 0.025007 | 709.0 | |
| 4.44 | 158.7940 | 27.2351 | 13.1689 | 2.0681 | 32.4948 | 16.3961 | 20.8361 | 0.030506 | | | | | 941.2 |

## BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD



PROJECT: SAD-BC-83-1
CARMONY RD. STORM DRAIN
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 7.08') AT STATION 8+50
FLOW IS SUBCRITICAL UPSTREAM (UPSTATION) FROM STATION 8+50
BELOW IS THE CALCULATION OF THE BACKWATER CURVE UPSTREAM (UPSTATION) FROM STATION 8+50

Circular (>) Half Full
Diameter (D) = 7.50
S(o) = 0.0117
n = 0.013
Q(cfs) = 870

| Y (FT) | THETA (Ø) (DEGREES) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.08 | 54.7539 | 43.2017 | 19.9784 | 2.1624 | 20.1381 | 6.2973 | 13.3773 | 0.011040 | | | | | |
| | | | | | | | | | 2.1495 | 20.0772 | 0.011061 | 6.1 | |
| 7.16 | 49.1731 | 43.4648 | 20.3436 | 2.1365 | 20.0162 | 6.2212 | 13.3812 | 0.011083 | | | | | 6.1 |
| | | | | | | | | | 2.1190 | 19.9562 | 0.011139 | 28.0 | |
| 7.25 | 42.0788 | 43.7269 | 20.8079 | 2.1015 | 19.8962 | 6.1469 | 13.3969 | 0.011195 | | | | | 34.1 |
| | | | | | | | | | 2.0821 | 19.8515 | 0.011283 | 59.5 | |
| 7.33 | 34.6362 | 43.9246 | 21.2951 | 2.0627 | 19.8067 | 6.0917 | 13.4217 | 0.011373 | | | | | 93.6 |
| | | | | | | | | | 2.0371 | 19.7717 | 0.011524 | 210.2 | |
| 7.41 | 25.1562 | 44.0805 | 21.9155 | 2.0114 | 19.7366 | 6.0487 | 13.4587 | 0.011679 | | | | | 303.8 |

## BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD



PROJECT: SAD-BC-83-1
CARMONY RD. STORM DRAIN
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 6.63') AT STATION 17+62
FLOW IS SUBCRITICAL UPSTREAM (UPSTATION) FROM STATION 17+62
BELOW IS THE CALCULATION OF THE BACKWATER CURVE UPSTREAM (UPSTATION) FROM STATION 17+62

Circular (>) Half Full
Diameter (D) = 7.00
S(o) = 0.0086
n = 0.013
Q(cfs) = 740

| Y (FT) | THETA (Ø) (DEGREES) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.63 | 53.1662 | 37.7034 | 18.7435 | 2.0115 | 19.6269 | 5.9816 | 12.6116 | 0.011548 | | | | | |
| | | | | | | | | | 1.9960 | 19.5584 | 0.011587 | -2.3 | |
| 6.72 | 46.1477 | 37.9683 | 19.1722 | 1.9804 | 19.4899 | 5.8984 | 12.6184 | 0.011627 | | | | | -2.3 |
| | | | | | | | | | 1.9584 | 19.4265 | 0.011725 | -7.5 | |
| 6.82 | 36.9103 | 38.2173 | 19.7365 | 1.9364 | 19.3630 | 5.8218 | 12.6418 | 0.011825 | | | | | -9.8 |
| | | | | | | | | | 1.9091 | 19.3195 | 0.011997 | -11.1 | |
| 6.91 | 26.0429 | 38.3897 | 20.4003 | 1.8818 | 19.2760 | 5.7696 | 12.6796 | 0.012174 | | | | | -20.9 |
| | | | | | | | | | 1.8159 | 19.2523 | 0.012736 | -14.9 | |
| 7.00 | 0.0000 | 38.4846 | 21.9912 | 1.7500 | 19.2285 | 5.7412 | 12.7412 | 0.013346 | | | | | -35.8 |

## BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD



PROJECT: SAD-BC-83-1
YALE BLVD. STORM DRAIN
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 2.17') AT STATION 10+42
FLOW IS SUPERCRITICAL DOWNSTREAM (UPSTATION) FROM STATION 10+42
BELOW IS THE CALCULATION OF THE BACKWATER CURVE DOWNSTREAM (UPSTATION) FROM STATION 10+42

Circular (>) Half Full
Diameter (D) = 2.50
S(o) = 0.0583
n = 0.013
Q(cfs) = 42

| Y (FT) | THETA (Ø) (DEGREES) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.17 | 85.2162 | 4.5253 | 5.9949 | 0.7549 | 9.2812 | 1.3376 | 3.5076 | 0.009540 | | | | | |
| | | | | | | | | | 0.7559 | 9.8592 | 0.010746 | 2.0 | |
| 1.91 | 116.2589 | 4.0241 | 5.3176 | 0.7568 | 10.4371 | 1.6915 | 3.6015 | 0.012024 | | | | | 2.0 |
| | | | | | | | | | 0.7409 | 11.3286 | 0.014572 | 8.4 | |
| 1.65 | 142.6738 | 3.4370 | 4.7413 | 0.7249 | 12.2200 | 2.3188 | 3.9688 | 0.017456 | | | | | 10.4 |
| | | | | | | | | | 0.6956 | 13.6004 | 0.022846 | 25.6 | |
| 1.39 | 167.1384 | 2.8036 | 4.2076 | 0.6663 | 14.9807 | 3.4848 | 4.8748 | 0.029355 | | | | | 36.0 |
| | | | | | | | | | 0.6254 | 17.2361 | 0.042285 | 134.5 | |
| 1.13 | 191.0173 | 2.1548 | 3.6866 | 0.5845 | 19.4914 | 5.8993 | 7.0293 | 0.059177 | | | | | 170.5 |

# BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD

PROJECT: SAD-BC-83-1
YALE BLVD. STORM DRAIN
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 2.17') AT STATION 10+42
FLOW IS SUBCRITICAL UPSTREAM (DOWNSTATION) FROM STATION 10+42
BELOW IS THE CALCULATION OF THE BACKWATER CURVE UPSTREAM (DOWNSTATION) FROM STATION 10+42

Circular (>) Half Full
Diameter (D) = 2.50
S(o) = 0.0055
n = 0.013
Q(cfs) = 42

| Y (FT) | THETA (Ø) (DEGREES) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.17 | 85.2162 | 4.5253 | 5.9949 | 0.7549 | 9.2812 | 1.3376 | 3.5076 | 0.009540 | | | | | |
| | | | | | | | | | 0.7500 | 9.1536 | 0.009360 | -1.9 | |
| 2.25 | 73.7396 | 4.6533 | 6.2452 | 0.7451 | 9.0259 | 1.2650 | 3.5150 | 0.009181 | | | | | -1.9 |
| | | | | | | | | | 0.7358 | 8.9096 | 0.009097 | -7.1 | |
| 2.34 | 58.6161 | 4.7764 | 6.5752 | 0.7264 | 8.7932 | 1.2006 | 3.5406 | 0.009014 | | | | | -9.0 |
| | | | | | | | | | 0.7127 | 8.7163 | 0.009085 | -10.7 | |
| 2.42 | 41.2193 | 4.8615 | 6.9547 | 0.6990 | 8.6393 | 1.1590 | 3.5790 | 0.009159 | | | | | -19.7 |
| | | | | | | | | | 0.6620 | 8.5977 | 0.009753 | -13.6 | |
| 2.50 | 0.0000 | 4.9088 | 7.8540 | 0.6250 | 8.5561 | 1.1368 | 3.6368 | 0.010429 | | | | | -33.3 |

# BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD

PROJECT: SAD-BC-83-1
WEST HAHN STORM DRAIN -- EAST OF INTERSTATE 25
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 3.91') AT STATION 1+00.30
FLOW IS SUBCRITICAL UPSTREAM (UPSTATION) FROM STATION 1+00.30
BELOW IS THE CALCULATION OF THE BACKWATER CURVE UPSTREAM (UPSTATION) FROM 1+00.30

BOX SECTION
HEIGHT = 5.0000
WIDTH = 8.0000
S(o) = 0.0020
n = 0.0130
Q(cfs) = 351

| Y (FT) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.91 | 31.2800 | 15.8200 | 1.9772 | 11.2212 | 1.9552 | 5.8652 | 0.003862 | | | | | |
| | | | | | | | | 2.0106 | 10.8588 | 0.003537 | -16.66 | |
| 4.18 | 33.4400 | 16.3600 | 2.0440 | 10.4964 | 1.7108 | 5.8908 | 0.003233 | | | | | -16.66 |
| | | | | | | | | 2.0764 | 10.1669 | 0.002970 | -74.12 | |
| 4.46 | 35.6800 | 16.9200 | 2.1087 | 9.8374 | 1.5027 | 5.9627 | 0.002724 | | | | | -90.78 |
| | | | | | | | | 2.1380 | 9.5567 | 0.002524 | -197.33 | |
| 4.73 | 37.8400 | 17.4600 | 2.1672 | 9.2759 | 1.3361 | 6.0661 | 0.002335 | | | | | -288.11 |
| | | | | | | | | 1.8529 | 9.0255 | 0.002725 | -178.76 | |
| 5.00 | 40.0000 | 26.0000 | 1.5385 | 8.7750 | 1.1957 | 6.1957 | 0.003300 | | | | | -466.87 |

# BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD

PROJECT: SAD-BC-83-1
WEST HAHN STORM DRAIN -- EAST OF INTERSTATE 25
9+79.49 OF THE WEST HAHN STORM DRAIN IS A JUNCTION POINT OF FLOWS FROM COMANCHE & STANFORD AND VASSAR.
THE FLOW IN THE 48"RCP FROM VASSAR IS UNDER PRESSURE AS IS THE FLOW IN THE 48"RCP FROM STANFORD AND COMANCHE.
BELOW IS THE CALCULATION OF THE BACKWATER CURVE DOWNSTREAM (DOWNSTATION) FROM 9+78.49

BOX SECTION
HEIGHT = 5.0000
WIDTH = 8.0000
S(o) = 0.0020
n = 0.0130
Q(cfs) = 303

| Y (FT) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.00 | 40.0000 | 26.0000 | 1.5385 | 7.5750 | 0.8910 | 5.8910 | 0.002459 | | | | | |
| | | | | | | | | 1.8674 | 7.6761 | 0.001950 | -1,636.00 | |
| 4.87 | 38.9600 | 17.7400 | 2.1962 | 7.7772 | 0.9392 | 5.8092 | 0.001613 | | | | | -1,636.00 |
| | | | | | | | | 2.1838 | 7.8755 | 0.001666 | -215.27 | |
| 4.75 | 38.0000 | 17.5000 | 2.1714 | 7.9737 | 0.9873 | 5.7373 | 0.001721 | | | | | -1,851.27 |
| | | | | | | | | 2.1577 | 8.0859 | 0.001785 | -342.79 | |
| 4.62 | 36.9600 | 17.2400 | 2.1439 | 8.1981 | 1.0436 | 5.6636 | 0.001851 | | | | | -2,194.06 |
| | | | | | | | | 2.1297 | 8.3168 | 0.001922 | -880.77 | |
| 4.49 | 35.9200 | 16.9800 | 2.1154 | 8.4354 | 1.1049 | 5.5949 | 0.001995 | | | | | -3,074.83 |

**BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD**

PROJECT: SAD-BC-83-1
PREMIER DISTRIBUTING STORM DRAIN
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 1.14') AT STATION 2+78.47
FLOW IS SUPERCRITICAL DOWNSTREAM (DOWNSTATION) FROM STATION 2+78.47
BELOW IS THE CALCULATION OF THE BACKWATER CURVE DOWNSTREAM (DOWNSTATION) FROM STATION 2+78.47

Circular (>) Half Full
Diameter (D) = 2.50
S(o) = 0.0351
n = 0.013
Q(cfs) = 11.5

| Y (FT) | THETA (Ø) (DEGREES) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.14 | 190.0967 | 2.1797 | 3.7067 | 0.5880 | 5.2760 | 0.4322 | 1.5722 | 0.004302 | | | | | |
| | | | | | | | | | 0.5657 | 5.6923 | 0.005272 | 0.9 | |
| 1.02 | 201.2052 | 1.8826 | 3.4644 | 0.5434 | 6.1086 | 0.5794 | 1.5994 | 0.006406 | | | | | 0.9 |
| | | | | | | | | | 0.5190 | 6.6684 | 0.008116 | 4.1 | |
| 0.90 | 212.5199 | 1.5910 | 3.2175 | 0.4945 | 7.2282 | 0.8113 | 1.7113 | 0.010171 | | | | | 5.0 |
| | | | | | | | | | 0.4656 | 8.0902 | 0.013806 | 14.2 | |
| 0.77 | 225.1628 | 1.2846 | 2.9417 | 0.4367 | 8.9522 | 1.2444 | 2.0144 | 0.018413 | | | | | 19.2 |
| | | | | | | | | | 0.4079 | 10.1456 | 0.025902 | 68.7 | |
| 0.65 | 237.3702 | 1.0142 | 2.6754 | 0.3791 | 11.3390 | 1.9965 | 2.6465 | 0.035672 | | | | | 87.9 |

# BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD

PROJECT: SAD-BC-83-1
RAIL ROAD STORM DRAIN
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 2.62') AT STATION 0+82
FLOW IS SUPERCRITICAL DOWNSTREAM (DOWNSTATION) FROM STATION 0+82
BELOW IS THE CALCULATION OF THE BACKWATER CURVE DOWNSTREAM (DOWNSTATION) FROM STATION 0+82

Circular (>) Half Full
Diameter (D) = 4.00
S(o) = 0.1096
n = 0.013
Q(cfs) = 75

| Y (FT) | THETA (Ø) (DEGREES) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.62 | 143.8812 | 8.7229 | 7.5440 | 1.1563 | 8.5981 | 1.1479 | 3.7679 | 0.004637 | | | | | |
| | | | | | | | | | 1.1121 | 9.5065 | 0.005971 | 1.4 | |
| 2.23 | 166.7924 | 7.2012 | 6.7442 | 1.0678 | 10.4149 | 1.6843 | 3.9143 | 0.007566 | | | | | 1.4 |
| | | | | | | | | | 1.0089 | 11.8052 | 0.010484 | 6.5 | |
| 1.85 | 188.6020 | 5.6838 | 5.9829 | 0.9500 | 13.1954 | 2.7037 | 4.5537 | 0.014193 | | | | | 7.9 |
| | | | | | | | | | 0.8748 | 15.6343 | 0.022240 | 22.6 | |
| 1.46 | 211.3280 | 4.1498 | 5.1896 | 0.7996 | 18.0732 | 5.0721 | 6.5321 | 0.033503 | | | | | 30.5 |
| | | | | | | | | | 0.7105 | 22.9152 | 0.063049 | 139.7 | |
| 1.07 | 235.4199 | 2.7020 | 4.3487 | 0.6213 | 27.7572 | 11.9637 | 13.0337 | 0.110628 | | | | | 170.2 |

# BACKWATER CURVE CALCULATIONS -- DIRECT STEP METHOD

PROJECT: SAD-BC-83-1
RAIL ROAD STORM DRAIN
FLOW PASSES THROUGH CRITICAL DEPTH (Y(c) = 2.62') AT STATION 0+82
FLOW IS SUBCRITICAL UPSTREAM (UPSTATION) FROM STATION 0+82
BELOW IS THE CALCULATION OF THE BACKWATER CURVE UPSTREAM (UPSTATION) FROM STATION 0+82

Circular (>) Half Full
Diameter (D) = 4.00
S(o) = 0.0015
n = 0.013
Q(cfs) = 75

| Y (FT) | THETA (Ø) (DEGREES) | A (SQ FT) | WP (FT) | R (FT) | V (FT/SEC) | V^2/2g (FT) | E (FT) | S(f) (FT/FT) | R(m) (FT) | V(m) (FT/SEC) | S(f)(m) (FT/FT) | L (FT) | ΣL (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.62 | 143.8812 | 8.7229 | 7.5440 | 1.1563 | 8.5981 | 1.1479 | 3.7679 | 0.004637 | | | | | |
| | | | | | | | | | 1.1803 | 8.0471 | 0.003952 | -30.4 | |
| 2.97 | 121.9748 | 10.0052 | 8.3087 | 1.2042 | 7.4961 | 0.8725 | 3.8425 | 0.003339 | | | | | -30.4 |
| | | | | | | | | | 1.2104 | 7.1205 | 0.002992 | -116.6 | |
| 3.31 | 98.1605 | 11.1197 | 9.1399 | 1.2166 | 6.7448 | 0.7064 | 4.0164 | 0.002666 | | | | | -147.0 |
| | | | | | | | | | 1.1991 | 6.4841 | 0.002512 | -242.1 | |
| 3.66 | 67.8024 | 12.0514 | 10.1996 | 1.1816 | 6.2233 | 0.6014 | 4.2614 | 0.002360 | | | | | -389.1 |
| | | | | | | | | | 1.0908 | 6.0958 | 0.002519 | -286.3 | |
| 4.00 | 0.0000 | 12.5664 | 12.5664 | 1.0000 | 5.9683 | 0.5531 | 4.5531 | 0.002712 | | | | | -675.4 |

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THE ELEVATIONS OF THE HYDRAULIC GRADE LINES AT/IN THE GRIEGOS DETENTION POND WERE CALCULATED SEPERATELY FOR EACH STORM DRAIN LINE ENTERING THE POND. (THE CARMONY RD. STORM DRAIN, COMANCHE-GRIEGOS RD. STORM DRAIN AND THE RAILROAD STORM DRAIN.) THE GRIEGOS DETENTION POND WAS ASSUMED TO BE EMPTY WHEN THE STORM BEGAN.

## HGL CALCULATIONS:

### CARMONY RD. STORM DRAIN:

$T_p = 1.60$ HOURS.

VOLUME OF RUNOFF IN POND AT $T_p = 1.6$ HRS $= 16.4$ AC.FT.

WATER SURFACE ELEVATION WITH VOLUME $= 16.4$ AC.FT. $= 70.4$ FT.

(SEE NEXT 2 SHEETS FOR CALCULATIONS)

### COMANCHE-GRIEGOS RD. STORM DRAIN:

IDENTICAL TO CARMONY RD. STORM DRAIN.

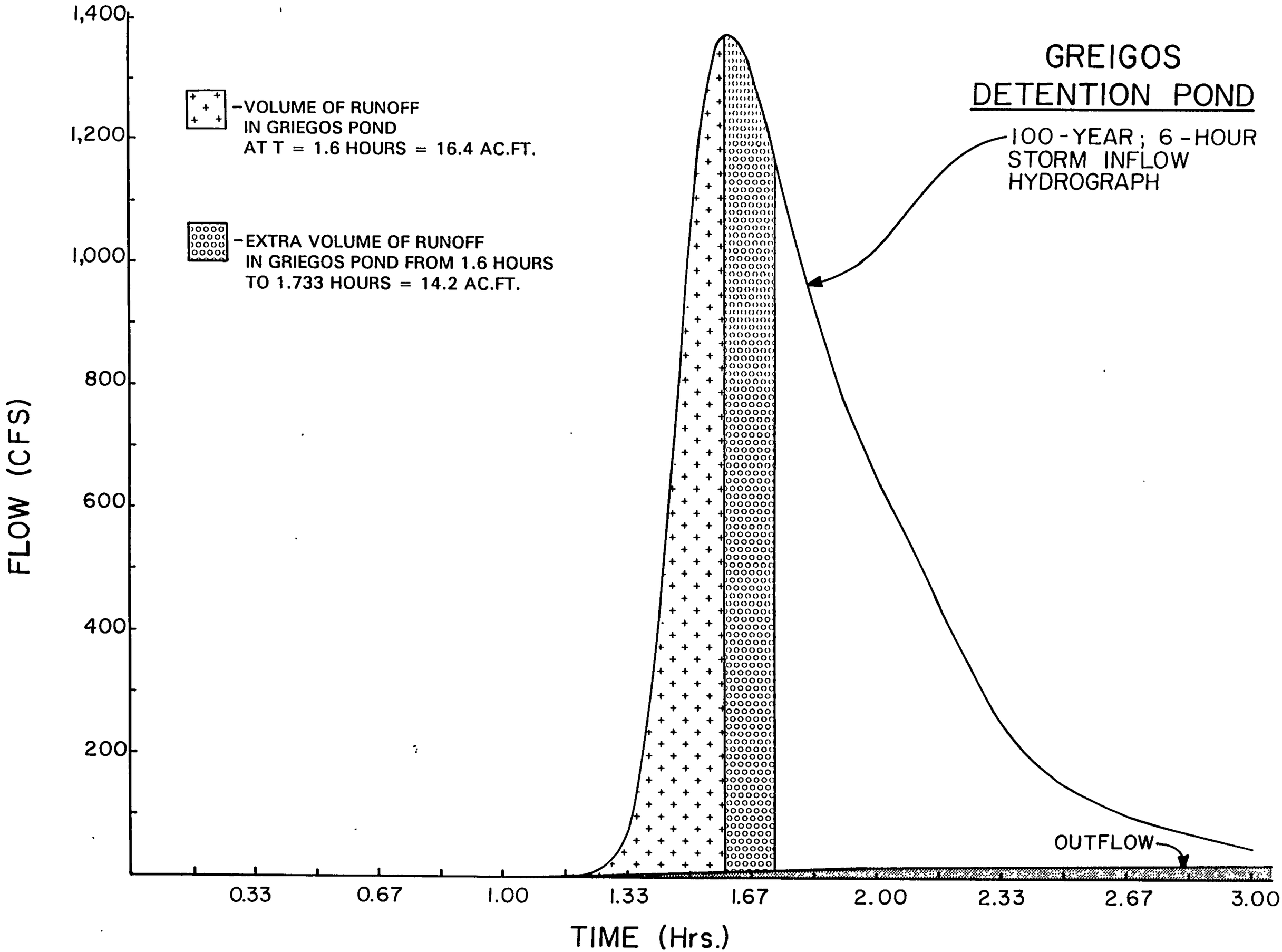
### RAIL ROAD STORM DRAIN:

$T_p = 1.733$ HRS.

VOLUME OF RUNOFF IN POND AT $T_p = 1.733$ HRS $= 30.6$ AC.FT.

WATER SURFACE ELEVATION WITH VOLUME $= 30.6$ AC.FT $= 73.5$ FT.

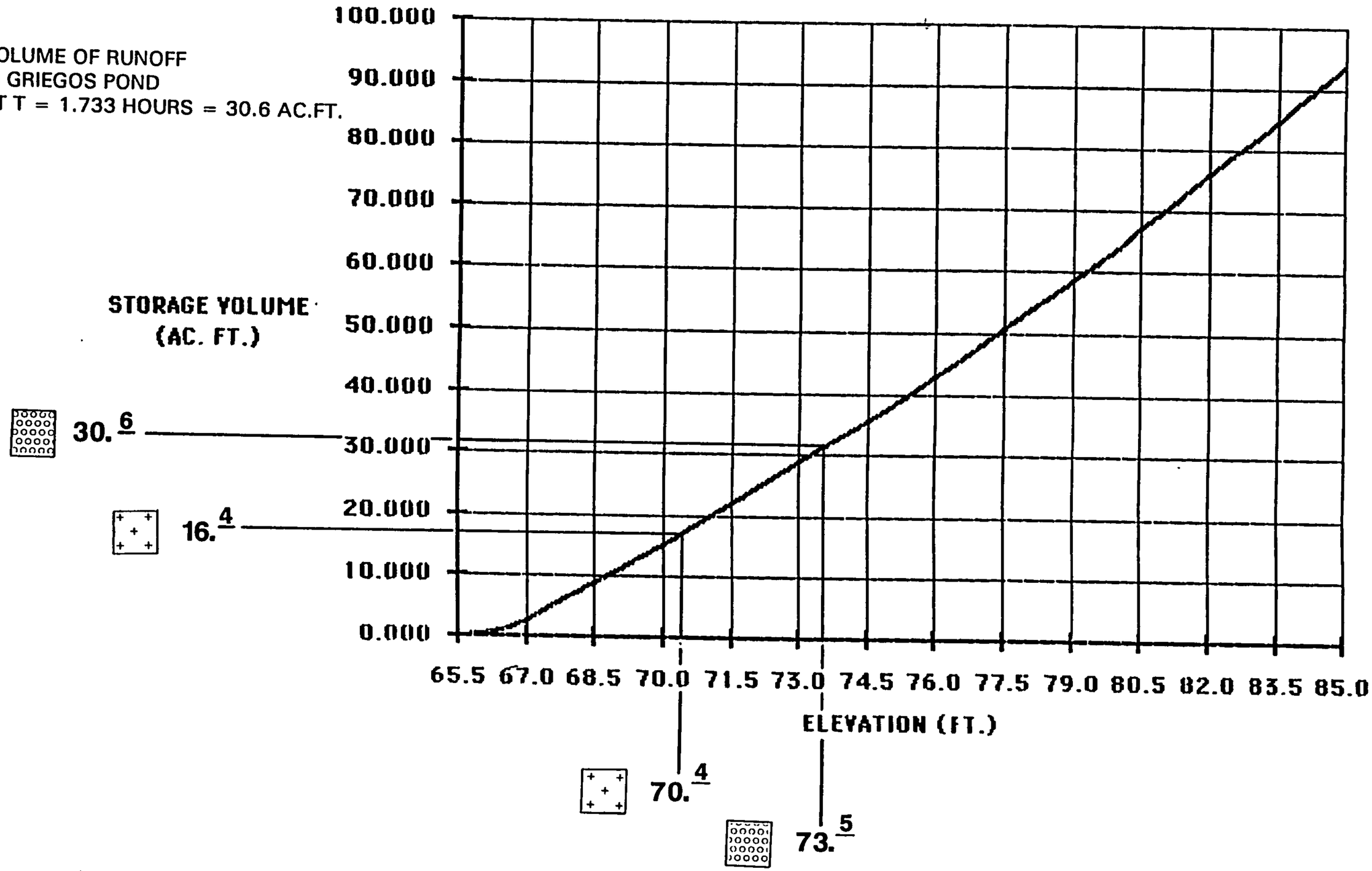
(SEE NEXT 2 SHEETS FOR CALCULATIONS)


GREIGOS
DETENTION POND
100-YEAR; 6-HOUR
STORM INFLOW
HYDROGRAPH
-VOLUME OF RUNOFF
IN GRIEGOS POND
AT T = 1.6 HOURS = 16.4 AC.FT.
-EXTRA VOLUME OF RUNOFF
IN GRIEGOS POND FROM 1.6 HOURS
TO 1.733 HOURS = 14.2 AC.FT.
OUTFLOW
FLOW (CFS)
1,400
1,200
1,000
800
600
400
200
0.33
0.67
1.00
1.33
1.67
2.00
2.33
2.67
3.00
TIME (Hrs.)

- VOLUME OF RUNOFF IN GRIEGOS POND AT T = 1.6 HOURS = 16.4 AC.FT.

- VOLUME OF RUNOFF IN GRIEGOS POND AT T = 1.733 HOURS = 30.6 AC.FT.

## GRIEGOS POND - STORAGE VOLUME CURVE



# DRAINAGE ANALYSIS

| | |
|---|---|
| COUNTY OF BERNALILLO | CITY OF ALBUQUERQUE |
| NEW MEXICO | NEW MEXICO |
| PUBLIC WORKS DEPARTMENT | PUBLIC WORKS DEPARTMENT |
| SPECIAL ASSESSMENT DISTRICT BC-83-1 | SPECIAL ASSESSMENT DISTRICT 216 |

## APPENDIX C

## SEDIMENT ANALYSIS

DECEMBER 1992

SPECIAL ASSESSMENT DISTRICT BC-83-1
SPECIAL ASSESSMENT DISTRICT 216

## SEDIMENT ANALYSIS

### A. GENERAL

This sediment analysis performed for the drainage basin being served by the Special Assessment District BC 83-1 and the Special Assessment District 216 Project includes an analysis for both existing conditions and developed conditions. The analysis for the basin under the present partially developed condition (Existing Conditions) is presented first, then is followed by the analysis assuming the basin fully developed (Developed Conditions). As stated in the drainage analysis report, approximately 65 percent of the drainage area including Interstate 25 right-of-way, is presently developed and approximately 35 percent of the area is undeveloped. Although the undeveloped portion of the drainage basin may generate a greater amount of sediment, the storm water runoff from the undeveloped areas will be substantially less than from the developed portion (See Table C-1, in Sub-Appendix "C-2"). As the undeveloped areas are improved with buildings, pavement and landscaping, the potential for sediment reaching the storm drain system will be reduced.

References used in performing this sediment analysis are listed in Paragraph E, of this Appendix C.

## B. EXISTING CONDITIONS

### 1) ALLUVIAL FLOOD HAZARD ANALYSIS

Special Assessment District BC 83-1 and Special Assessment District 216 drainage basin is not subject to any alluvial flood hazards. The North Diversion Channel which acts as the eastern boundary of the drainage basin, intercepts all flows from the east, thus, intercepting any and all alluvial flood hazards (See FEMA's FLOODWAY Flood Boundary and Floodway Maps, Community Parcel Numbers 350002 0016 and 350002 0023).

### 2) ANNUAL SEDIMENT YIELD ANALYSIS:

Universal Soil Loss Equation (USLE):

A = R*K*L*S*C*P

A = Annual Soil Loss Ratio (tons/acre per year)
R = Rainfall Factor = 35
K = Soil Erodibility Factor = 0.59
LS = Topographic Factor = 0.40
C = Crop Management Factor = 1.0
P = Erosion-Control-Practice Factor = 1.0

Sub-Appendix "C-1" of this sediment analysis contains documentation on how the coefficients R,K,LS,C,P were determined.

A = (35) (0.59) (0.40) (1.0) (1.0) = 8.3 tons/acre per year
= (8.3 tons/acre) (522 acres) = 4,333 tons

= (4,333 tons) (2000 lb./ton) (1 cu.ft./90 lb.) (1 ac./43560 sq.ft.) = 2.2 ac.ft./yr

The USLE computes upland erosion from watersheds on an average annual basis. It includes the detachment and transport components, but it does not account for the deposition component. Therefore, the USLE cannot be used to compute sediment yield. The sediment yield is calculated by multiplying the annual soil loss by a factor, ranging from 0 to 1, called the Sediment-Delivery Ratio (SDR). Sediment delivery ratios have been calculated from specific areas, but no generalized equations or techniques are yet available to universally determine a sediment delivery ratio. Ref. No. 7 and Ref. No. 8 refer to the fact that SDR varies approximately in inverse proportion to the 0.20 power of the drainage area. Documentation on how the SDR was arrived appears in Sub-Appendix "C-1", where an average SDR value of 0.45 was calculated. Thus,

Annual Sediment Yield = (0.45) (2.2 ac.ft./yr) = <u>0.99 ac.ft./yr.</u>

In order to check the accuracy of the sediment yield calculated above, a comparison was made with the result Elliott M. Flaxman calculated in his study of sediment yield in the Western United States (Ref. No. 3). Flaxman's result was an average sediment yield of 0.32 ac.ft./sq.mile per year. Calculating this:

Flaxman's annual Sediment Yield = (0.32 ac.ft./sq.mile per year) 0.8156 mile

= 0.26 ac.ft./yr. <0.99 ac.ft./yr

Comparing the USLE result with a second reference (Ref. No. 1). Bohannan-Huston, Inc. of Albuquerque, New Mexico, stated in the Black Arroyo Sediment Issues Report, that the average annual sediment yield per square mile was 1.0 ac.ft. thus:

Bohannan's Annual Sediment Yield - (1.0 ac.ft./sq.mile per year) (0.8156 sq. mile)

= 0.82 ac.ft./yr. ≈ 0.99 ac.ft./yr.

The Flaxman method indicates considerably less sediment than the USLE method for this basin, however, the USLE results compared favorably with the second reference. Therefore, the calculations for the annual sediment yield for the SAD-BC-83-1 and SAD-216 project appear to be reasonable. Thus, the annual sediment yield under existing conditions is determined to be 0.99 ac.ft./yr. This sediment will be collected at the outlet of the drainage basin, the Griegos Detention Pond.

In order to compare existing conditions flow rates to system capacity the storm water peak runoff rates under

existing conditions were determined from the HYMO model. (See Sub Appendix "C-2", Hydrology of Existing Conditions). In addition, the existing conditions 100 year inflow hydrograph to the Griegos Pond was routed through the Pond to determine volumes in the Griegos Pond under existing conditions.

Checking the capacity of the Griegos Pond:

<u>Drainage Data for Griegos Pond</u>
<u>Existing Conditions (24 hr. storm)</u>
<u>Clear Water Runoff Only</u>

| | |
|---|---|
| Peak Inflow to Griegos Pond | = 624 cfs |
| Peak Outflow from Griegos Pond | = 16.1 cfs |
| Total Runoff Volume entering Griegos Pond | = 45.1 ac.ft. |
| Maximum Runoff Volume in Griegos Pond | = 36.0 ac.ft. |
| Volume Capacity of Griegos Pond | = 73.7 ac.ft |
| Maximum Water Surface Elevation in Griegos Pond | = 74.6 ft. |
| Spillway Elevation in Griegos Pond | = 81.65 ft. |

Reviewing the Griegos Pond Storage Curve (see Fig. 1 of Appendix A), and the data displayed above, there are 73.7-36.0 = 37.7 ac. ft. of storage capacity available for the annual sediment yield of 0.99 ac. ft.

3) <u>100-YEAR STORM EVENT SEDIMENT YIELD ANALYSIS:</u>

<u>Modified Universal Soil Loss Equation:</u>

The MUSLE allows the estimation of soil losses for each precipitation event throughout the year, thereby becoming

an event model rather than an average annual runoff model. Below is the sediment yield calculations for a 100-year storm event. The full equation defining the MUSLE is:

$$Y = 95\ [Q * qp]^{0.56}\ K*L*S*C*P$$

Y = Sediment yield from an individual storm through sheet and rill erosion, (tons)
Q = Storm Runoff Volume = 45.1 ac.ft.
qp = Peak Runoff Rate = 624 cfs
K,L,S,C,P = as defined previously for the USLE

$$Y = (95)\ [(45.1)\ (624)]^{0.56}\ (0.59)\ (0.40)\ (1.0)\ (1.0)$$

= 6,955 tons/100-yr. event

= 6,955 tons (2000 lb./ton) (1 cu.ft./90lb) (1 ac./43560 sq.ft.)

= <u>3.55 ac.ft./100-yr. event</u>

Again, reviewing the Griegos Pond Storage Curve (see Fig. 1 of Appendix A) and the data presented above, there are 37.7 ac. ft. of storage capacity available for the sediment yield of 3.55 ac. ft. produced by the 100-year event.

4) <u>BULKING FACTOR</u>

A Bulking Factor is a measure of the amount of sediment carried by the storm water runoff. Bulking Factor is defined in <u>this analysis</u> as the ratio of the volume of sediment to the volume of clear water runoff.

Bulking Factor (B.F.) = (sediment / clear water runoff)

With the data and calculations previously presented, the Bulking Factor for a 100-year storm event is:

Bulking Factor = 3.55 ac.ft./45.1 ac.ft.
= 8%

In reviewing Ref. No. 1, and consulting the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) personnel, a Bulking Factor of 15% to 25% for <u>undeveloped conditions</u> is considered appropriate for the Albuquerque area. With approximately 65 percent of the S.A.D. BC 83-1 drainage basin presently developed and approximately 35 percent of the area undeveloped a B.F. of 8% is considered reasonable.

C. <u>DEVELOPED CONDITIONS:</u>

Measured sediment yield data is essentially nonexistent for urban watersheds. Sediment yield varies dramatically as land use changes. Urban sediment yield methods are largely yet to be developed, however, the method previously described will be used with a decrease in the yield by a percentage. Most soil erosion models have been developed for rural watersheds and rely on some variation of the USLE to calculate sediment runoff. Thus, parameter estimates in urban areas may reflect only the best

judgement of the practicing engineer. With this in mind, the developed conditions Soil Erodibilty Factor parameter (K) for the S.A.D. - BC-83-1 project area will be estimated to be one third that of existing conditions.

1) <u>ANNUAL SEDIMENT YIELD ANALYSIS:</u>

<u>Universal Soil Loss Equation:</u>

A = R*K*L*S*C*P

A,R,L,S,C,P = as defined previously for existing conditions

K = Soil Erodibilty Factor = 0.20 = 1/3 of existing conditions value

A = (35) (0.20) (0.40) (1.0) (1.0) = 2.8 tons/acre per year

= (2.8 tons/acre) (522 acres) = 1,462 tons

= 1,462 tons (2000 lb./ton) (1 cu.ft./90 lb.) (1 ac./43560 sq.ft.)

= 0.75 ac.ft./yr.

Since the Sediment Delivery Ratio is the ratio of sediment yield to gross sediment production, the Sediment Delivery Ratio will be considerably higher for developed conditions as compared to existing conditions. A conservative estimate would be that the SDR will double under developed conditions from 0.45 to 0.90.

Annual Sediment Yield = (0.90) (0.75 ac.ft./yr.) = <u>0.68 ac.ft./yr</u>

Checking the capacity of the Griegos Pond:

Drainage Data for Griegos Pond
Developed Conditions (24 hr storm)
Clear Water Runoff Only

| | |
|---|---|
| Peak Inflow to Griegos Pond | = 1,382 cfs |
| Peak Outflow from Griegos Pond | = 21.0 cfs |
| Total Runoff Volume entering Griegos Pond | = 86.4 ac. ft. |
| Maximum Runoff Volume in Griegos Pond | = 68.3 ac. ft. |
| Volume Capacity of Griegos Pond | = 73.7 ac. ft. |
| Maximum Water Surface Elevation in Griegos Pond | = 80.7 ft. |
| Spillway Elevation in Griegos Pond | = 81.65 ft. |

Reviewing the Griegos Pond Storage Curve (see Fig. 1 of Appendix A), and the data displayed above, there are 73.7-68.3 = 5.4 acre. ft. of storage capacity available for the annual sediment yield of 0.68 ac. ft.

2) 100-YEAR STORM EVENT SEDIMENT YIELD ANALYSIS:

Modified Universal Soil Loss Equation:

$$Y = (95)\ [Q\ qp]^{0.56}\ K*L*S*C*P$$

Y,L,S,C,P = as defined previously

Q = Storm Runoff Volume = 86.4 ac. ft.

qp = Peak runoff Rate = 1,382 cfs

K = as defined previously for the developed conditions USLE

$$Y = (95)\ [(86.4)\ (1{,}382)]^{0.56}\ (0.20)\ (0.40)\ (1.0)\ (1.0)$$

= 5,296 tons/100-year event

= 5,296 tons (2000 lb./ton) (1 cu. ft./90 lb.)
(1 ac./43560 sq.ft.

= <u>2.8 ac.ft./100-yr. event</u>

Again, reviewing the Griegos Pond Storage Curve (see Fig. 1 of Appendix A) and the data presented above, there are 5.4 ac. ft. of storage capacity available for the sediment yield of 2.8 ac. ft. produced by the 100-year event.

3) <u>BULKING FACTOR:</u>

With the data and calculations previously presented, the Bulking Factor for a 100-year storm event is:

Bulking Factor = 2.8 ac. ft. / 86.4 ac. ft.

= 3.2%

A bulking factor of 3.2% for the drainage area when completely developed appears appropriate considering the bulking factor of 8% calculated in the existing condition section.

To provide capacity for this bulking the hydraulic analysis was performed on the proposed storm drain system for the S.A.D.-BC-83-1 and SAD-216 project with a Developed Conditions Bulking Factor of five percent (5%) included in the flows (See appendix B of Drainage Analysis). Also, see

the appropriate storm drain plan and profile sheets of the construction plans for the plots of the hydraulic grade lines that includes the Developed Conditions Bulking Factor.

A hydraulic analysis on the proposed storm drain pipe system using the existing conditions hydrology with a Bulking Factor of eight percent (8%) was not performed. After reviewing the developed conditions point flows (and a B.F. of 5%) and then comparing them to the existing conditions point flows (and a B.F. of 8%), and discovering the rather large difference in flows (developed condition flows were substantially greater than existing condition flows, Table 1 of the Report and Table C-1 of Sub Appendix C-2), it was determined the existing conditions analysis would not be applicable.

## D. CONCLUSIONS

From the analysis presented, the system, when constructed, will have sufficient capacity not only to handle the existing conditions, but also the future developed conditions including sediment that is anticipated to be present. It is, therefore, concluded that the system as proposed, along with proper maintenance, will provide the capacity desired throughout the life of the system.

1) Maintenance Program

Along with the normal maintenance of the storm drain piping system a program for inspection and maintenance of the Griegos Pond is proposed to be adopted by the County of Bernalillo. The program shall include, as a minimum, annual inspections and the follow up of maintenance operations as deemed necessary by the inspections. These maintenance operations shall include the removal of sediment from the pond periodically to maintain pond capacity.

In addition, the New Mexico State Engineer's staff will make periodic inspections of the Griegos Pond structure. The Owner will be advised of any deficiencies found during the inspection with a request or order for correction.

E. SEDIMENT ANALYSIS REFERENCES:


1. Bohannan-Huston, Inc. (1990). "Black Arroyo Sediment Issues," Albuquerque, New Mexico.

2. Buffington, Darrel L., P.E. and Byres, Patrick J., P.E. (1989) "Geotechnical Investigation Report for S.A.D. BC 83-1," Geo-Test Inc., Santa Fe, New Mexico.

3. Flaxman, E.M. (1972). "Predicting Sediment Yield in the Western United States," Journal of the Hydraulics Division, ASCE, Vol. 98 HY 12, pp. 2073-2085.

4. Holtz, Robert D., Kovacs, William D. (1981). "an Introduction to Geotechnical Engineering," Englewood Cliffs, N.J.: Prentice-Hall, Inc.

5. Lindeburg, Michael R. (1989). "Civil Engineering Reference Manual," Belmont, CA.: Professional Publications, Inc.

6. Meyer, L.D. and Ports, M.A. (July 26-29, 1976). "Prediction and Control of Urban Erosion and Sedimentation," National Symposium on Urban Hydrology, Hydraulics, and Sediment Control, Lexington, Kentucky.

7. Ponce, Victor Miguel. (1989). "Engineering Hydrology Principles and Practices,: New Jersey: Prentice-Hall, Inc.

8. U.S. Army Corps of Engineers. (1989). "Sedimentation Investigations in Rivers and Reservoirs," Engineer Manual EM 1110-2-4000, Office of the Chief of Engineers, Washington D.C.

# SEDIMENT ANALYSIS

COUNTY OF BERNALILLO

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT BC-83-1

CITY OF ALBUQUERQUE

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT 216

## SUB APPENDIX C-1

DETERMINATION OF
UNIVERSAL SOIL LOSS EQUATION COEFFICIENTS
FOR
SEDIMENT ANALYSIS

DECEMBER 1992

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project SAD-BC-83-1 Sheet ____ of ____
SEDIMENT ANALYSIS - R Job No. ____
By DA Chk'd ____ Date 7-15-91

RAINFALL FACTOR (R):

FROM FIG. 15-2; R = 35; REF. NO. 7

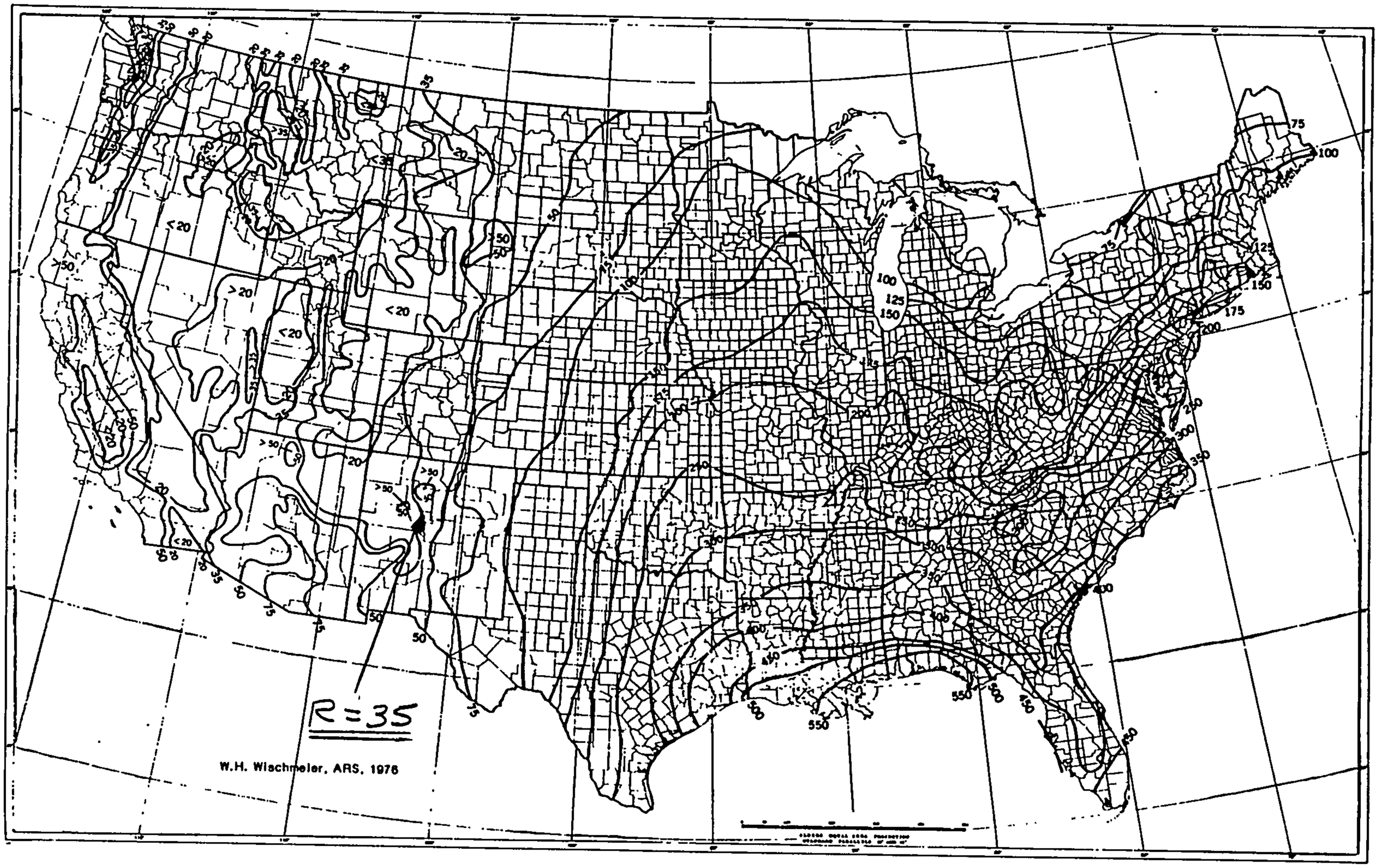



**Figure 15-2** Rainfall factor R in the universal soil loss equation [41].

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project SAD-BC-83-1 Sheet ____ of ____
SEDIMENT ANALYSIS - K Job No. ____
By DA Chk'd ____ Date 7-15-91

## SOIL ERODIBILITY FACTOR (K):

USING THE SIEVE ANALYSIS AND ATTERBERG LIMIT TEST RESULTS, THE NOMOGRAPH IN FIG. 3 WAS USED TO DETERMINE THE SOIL ERODIBILITY FACTOR (K).

AVG. % SILT AND VERY FINE SAND = 62

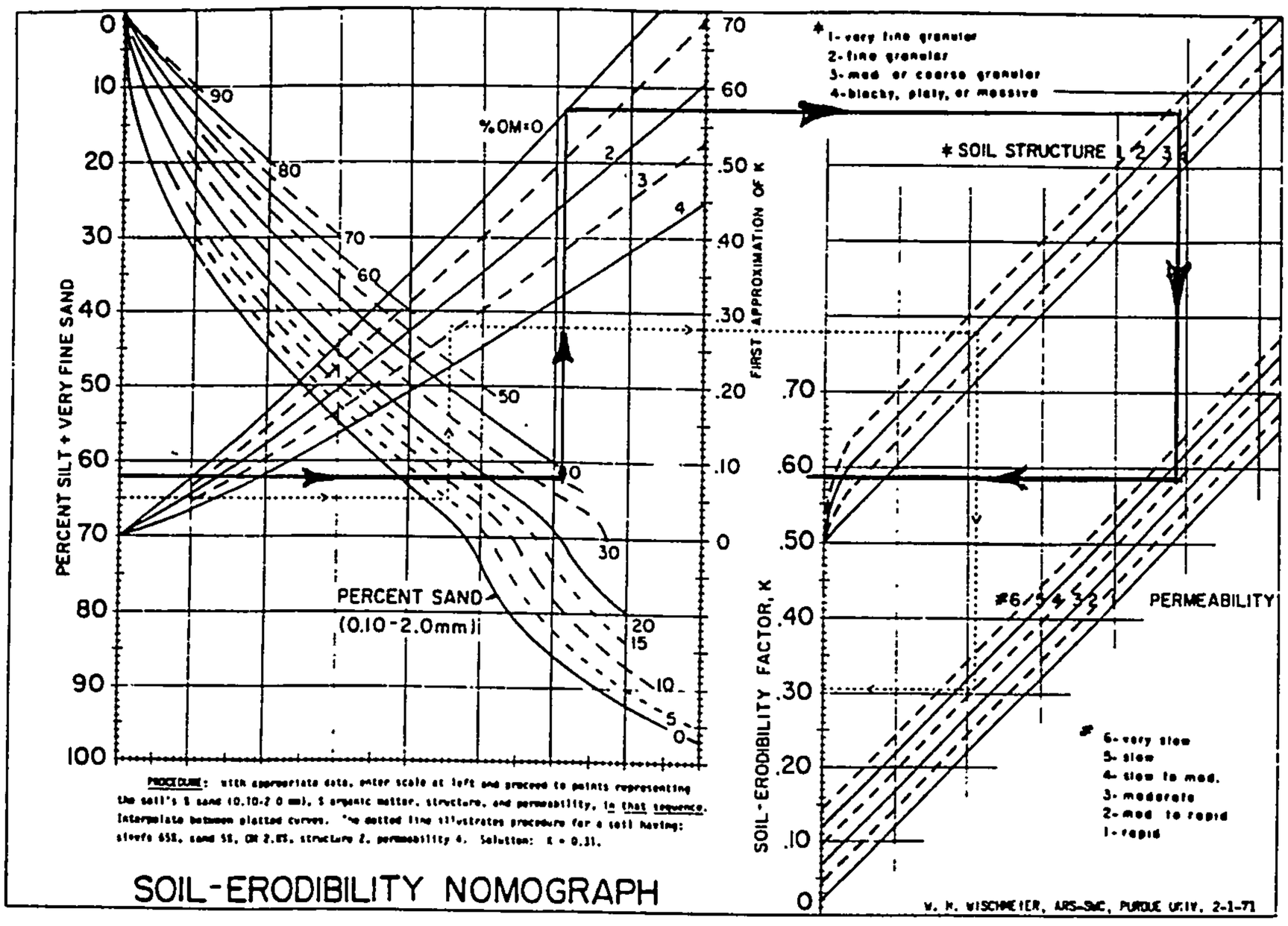
AVG. % SAND = 35

% ORGANIC MATERIAL = 0

SOIL STRUCTURE - VERY FINE GRANULAR TO FINE GRANULAR

PERMEABILITY - SLOW TO MODERATE;

FROM FIG. 3; K = 0.59 REF. NO. 6




K=0.59

Figure 3. Soil erodibility nomograph for determining K-factor values (from Ref. 6).

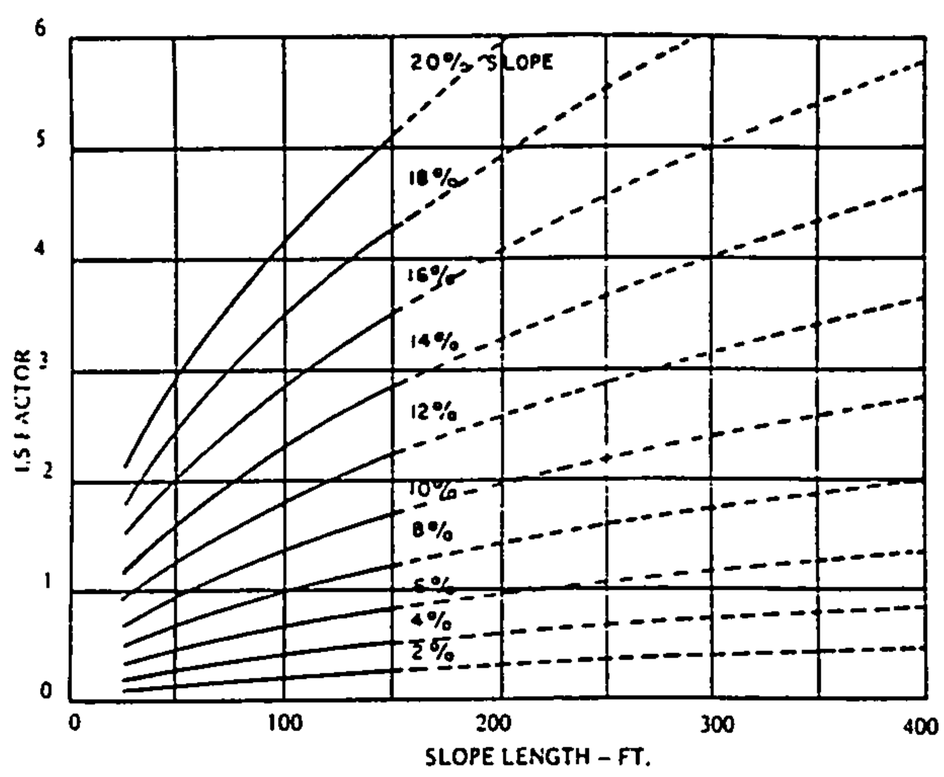



Figure 4. Topographic effect graph used to determine LS-factor values for different combinations of slope steepness and slope length (from Ref. 3).

natural slopes tend to flatten along their lower portions which encourages deposition and heavy vegetation often traps sediment below the upland slopes. However, urban erosion sources often lack locations where deposition is likely to occur, and in such cases, the delivery ratio will approach 1. A sediment delivery ratio is largely a characteristic of a watershed itself, so precise estimation of delivery ratios is quite difficult.

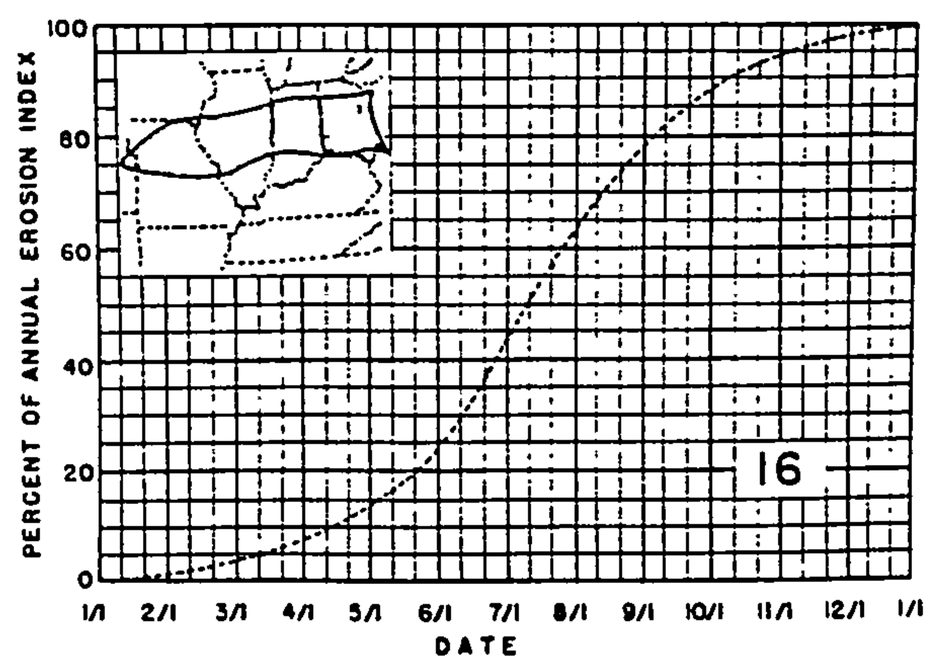



Figure 5. Average annual distribution of the rainfall erosion potential, R, for the shaded portion of the United States (from Ref. 3).

## Using the Universal Soil Loss Equation

To illustrate the procedure for predicting upland soil losses for specific site conditions, assume that a watershed undergoing development has the following characteristics:

Location: Cincinnati, Ohio

Soil and Topography (see Figure 6):
2 ac of Cincy sandy loam consisting of 60% sand (including 10% very fine sand), 25%

GEO-TEST

- Revised -
December 24, 1992

RECEIVED
ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS

| DATE | ANDREWS |
|---|---|
| DEC 29 1992 | JA |
| JOB 347 | ASBURY |
| COMMENTS | J.E.M. |
| FILE ☑ | |

Andrew, Asbury and Robert, Inc.
149 Jackson Street, N.E.
Albuquerque, New Mexico 87108

ATTENTION: John Andrews

IN RE: Sedimentation Samples
County SAD BC-83-1
Bernalillo County, New Mexico

Gentlemen:

Transmitted herewith are the results of the sieve analysis and Aterberg Limits testing for samples delivered to our office July 11, 1991. Unified Soil Classification (USC) of the samples are also indicated on the attached tabulation.

Based on these results, factors to be used with the soil credibility nomograph are as follows:

| | |
|---|---|
| Percent silty and Very fine sand (-80 sieve) | 51 to 72 |
| Percent sand (+80 to -4 sieve) | 27 to 43 |
| Permeability | Slow to Moderate |
| Soil Structure | Very fine granular to Fine Granular |

Should there be any questions concerning these results, please call.

Respectfully Submitted:

GEO-TEST, INC.

Patrick J. Byres, P.E.

GEO-TEST, INC.
4220 PARKWAY DRIVE
SANTA FE,
NEW MEXICO
87501
(505) 471-1101

4609 PALO DURO NE
ALBUQUERQUE,
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87110
(505) 883-0074

# TABULATION OF TEST RESULTS

| Sample Identification | USC | LL | PI | 200 | 100 | 40 | 10 | 4 | 3/8 | 1/2 | 3/4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site A | SM | NV | NP | 24 | 51 | 61 | 79 | 94 | 99 | 100 | |
| Site B | SM | NP | NP | 26 | 72 | 87 | 97 | 99 | 99 | 99 | 100 |
| Site C | SM | NV | NP | 29 | 69 | 84 | 96 | 98 | 99 | 99 | 100 |

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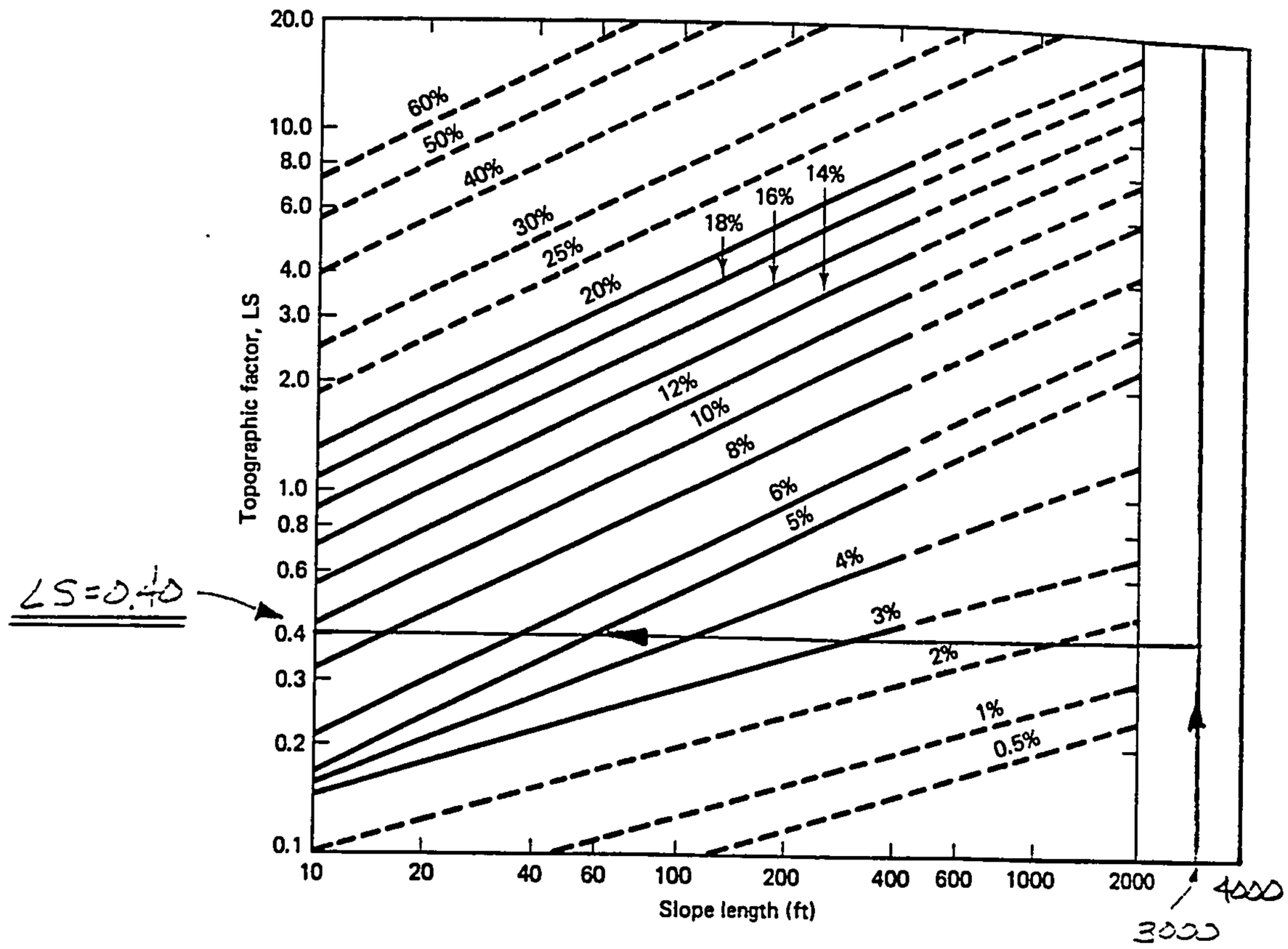
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project SAD-BC-83-1 Sheet ____ of ____
SEDIMENT ANALYSIS - L.S. Job No. ____
By DA Chk'd ____ Date 7-15-91

TOPOGRAPHIC FACTOR (LS):

AVG. LENGTH = 3,000 FT.
AVG. SLOPE = 1.34 %

FROM FIG. 15.3; LS = 0.40. REF. NO. 7




*The dashed lines represent estimates for slope dimensions beyond the range of lengths and steepnesses for which data are available.

**Figure 15-3** Topographic factor LS in the universal soil loss equation [41].

Streambank erosion and streambed degradation can be significant in certain cases. Changes in channel alignment and/or removal of natural vegetation from stream banks may cause increased bank erosion. Streambed degradation, typically downstream of reservoirs, can also constitute an additional source of sediment.

Methods for determining soil loss due to the various types of channel erosion include the following: (1) comparing aerial photographs taken at different times to assess the growth rate of channels, (2) performing river cross-sectional surveys to determine changes in cross-sectional area, (3) assembling historical data to determine the average age and growth rate of channels, and (4) performing field studies to evaluate the annual growth rate of channels.

Field surveys can often provide sufficient data to estimate streambank erosion as follows [41]:

$$S = HLR \tag{15-7}$$

in which $S$ = annual volume of streambank erosion; $H$ = average height of bank; $L$ = length of eroded bank, each side of channel if both sides are eroding; and $R$ = annual rate of bank recession (net rate if one side is eroding while the other is depositing).

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Project SAD-BC-83-1 Sheet ____ of ____
SEDIMENT ANALYSIS Job No. ____
By DA Chk'd ____ Date 7-15-91

COVER AND MANAGEMENT FACTOR - (C);

ALSO KNOWN AS "CROP-MANAGEMENT FACTOR":

VALUES OF "C" RANGE FROM AS LITTLE AS 0.0001 FOR UNDISTURBED FOREST LAND TO A MAXIMUM OF 1.0 FOR DISTURBED AREAS WITH NO VEGETATION.

FOR THE SAD-BC-83-1 PROJECT, C = 1.0

EROSION-CONTROL-PRACTICE FACTOR - (P);

NO EROSION-CONTROL-PRACTICE NEAR OR AROUND THE SAD-BC-83-1,

THUS, P = 1.0

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
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Telephone (505) 265-6631

Project SAD-BC-83-1 Sheet ____ of ____
SEDIMENT ANALYSIS - SDR Job No. ____
By DA Chk'd ____ Date 7-15-91

# SEDIMENT DELIVERY RATIO (SDR):

FROM FIG. 3-4; SDR = 0.30 REF. NO. 8
FROM FIG 3-5; SDR = 0.30 REF. NO. 8
FROM FIG. 15-4; SDR = 0.34 REF. NO. 7
FROM EQUATION 3-7; REF. NO. 8

$$\frac{SDR2}{SDR1} = \left(\frac{A1}{A2}\right)^{0.20} \Rightarrow \frac{SDR2}{1.0} = \left(\frac{.001\,Mi^2}{.8156\,Mi^2}\right)^{.20}$$

$$SDR2 = \underline{\underline{0.26}}$$

## AVERAGE:

$$\text{AVG. SDR} = \frac{0.30 + 0.30 + 0.34 + 0.26}{4} = 0.30$$

DUE TO THE PAVED STREETS AND STORM DRAIN SYSTEM TO BE CONSTRUCTED - INCREASE SDR BY 50%.

THEREFORE, USE:

$$SDR = 1.5 \times 0.30 = \underline{\underline{0.45}}$$

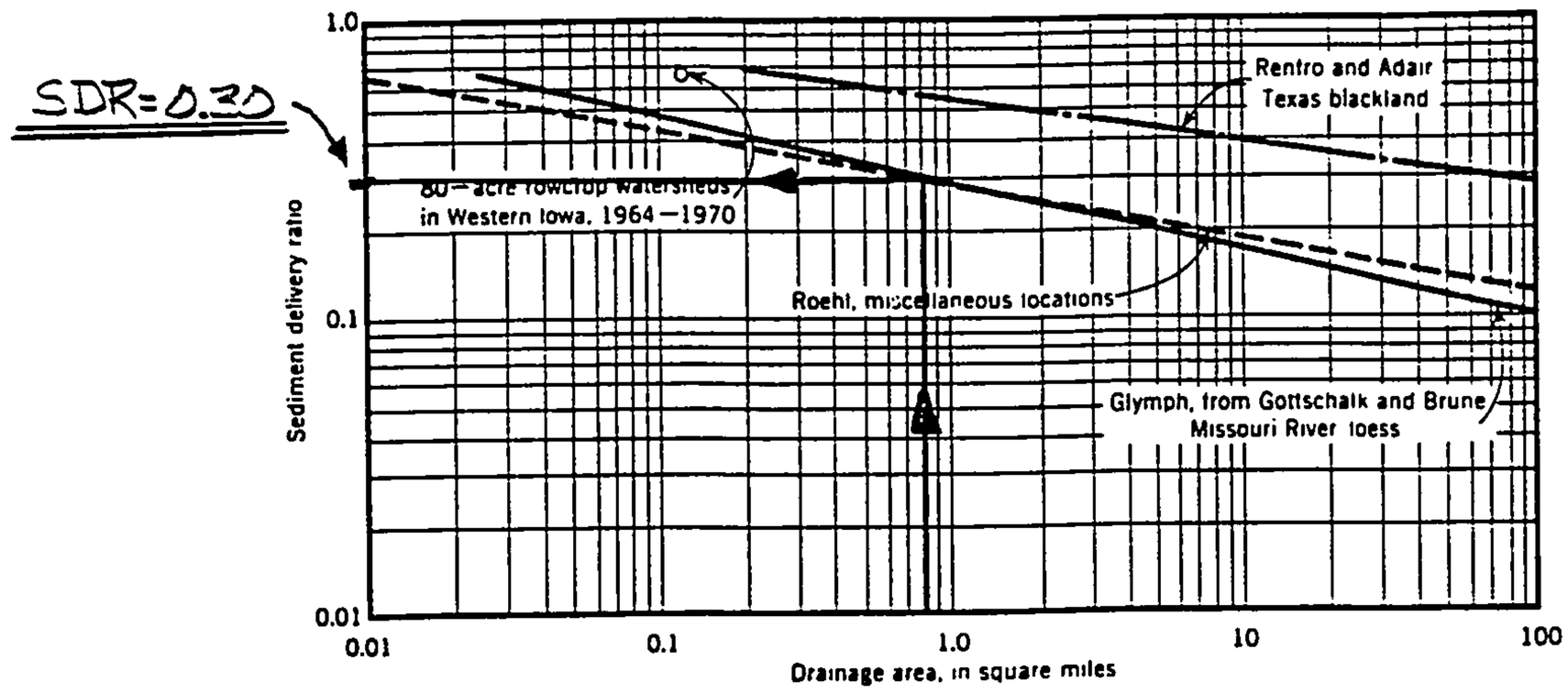


Figure 3-4. Sediment delivery ratios calculated for various watersheds (from item 2, Appendix A, courtesy of The American Society of Civil Engineers)

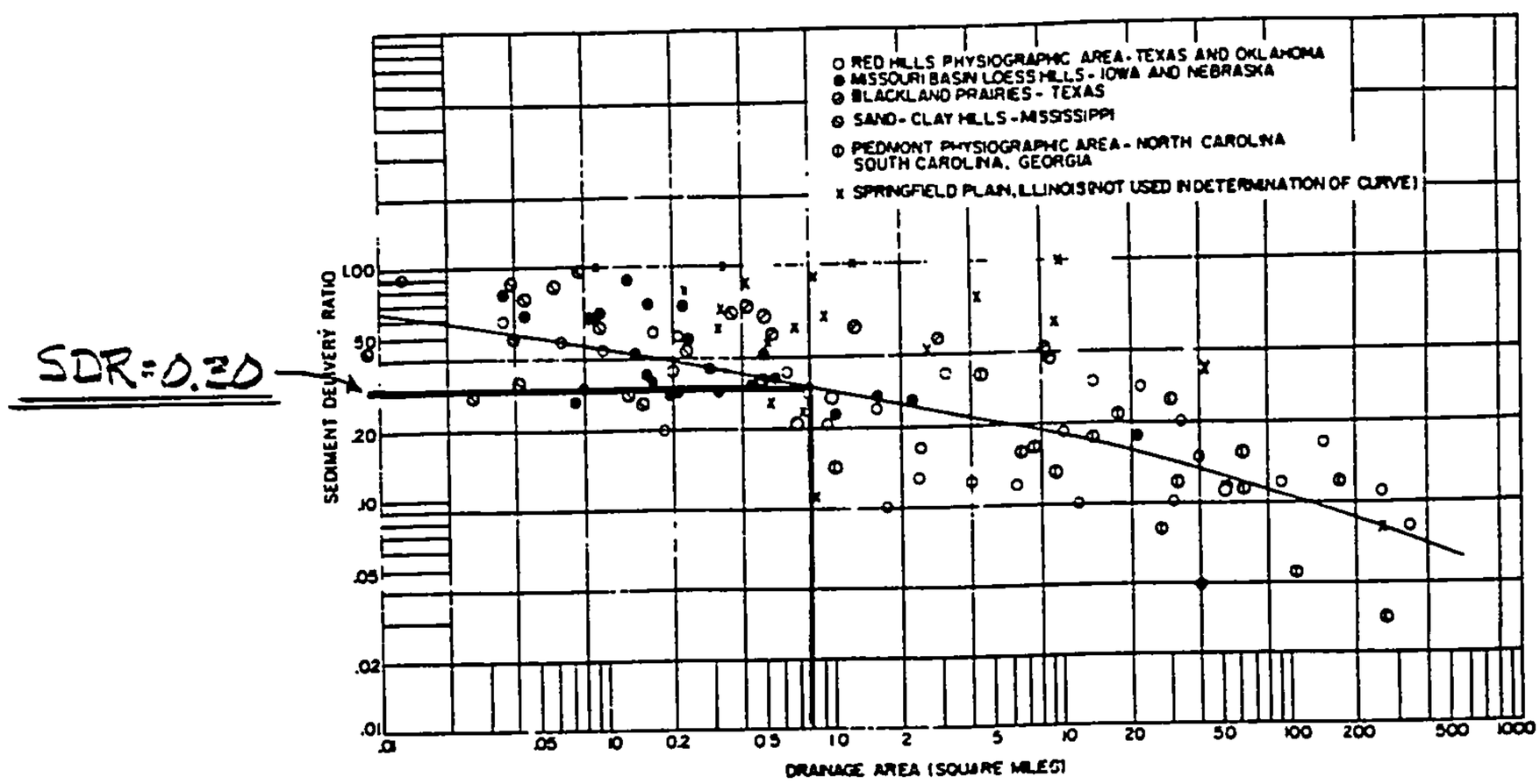


Figure 3-5. Example of scatter in the data (from item 2, Appendix A, courtesy of The American Society of Civil Engineers)

often indicates both a high erosion rate and a high SDR. High channel density is usually an indication of an efficient transport system and, consequently, of a high SDR.

**Estimation of Sediment-delivery Ratios.** The SDR is the ratio of sediment yield to gross sediment production. Sediment yield can be evaluated by one of several methods. At reservoir locations, estimates of sediment yield can be obtained by reservoir sedimentation surveys. Alternatively, sediment yield can be evaluated by direct measurement of sediment load at the point of interest. Estimates of gross sediment production from upland sources can be obtained using either the USLE formula or a regionally derived formula for sheet and rill erosion. When warranted, this estimate can be augmented by field estimates of gully and channel erosion.

In the absence of actual measurements, statistical analysis can be used to develop regional regression equations to predict SDRs. The simplest SDR prediction equation is that based solely on drainage area, as shown in Fig. 15-4. This figure shows that SDR varies approximately in inverse proportion to the $\frac{1}{5}$ power of the drainage area. Other sources, however, have quoted values of this power as low as $\frac{1}{8}$ [2]. The fact remains that the greater the drainage area, the smaller the catchment relief and the greater the chances for sediment deposition within the catchment. Consequently, the smaller the catchment's SDR. Rough estimates of SDR can be obtained from Fig. 15-4, but caution is recommended for more refined studies.

An example of the use of statistical analysis for the estimation of sediment-delivery ratios is given by Roehl [34]. Using data from the southeast Piedmont region of the United States, he developed the following predictive equation:

$$\mathrm{SDR} = 31{,}623(10A)^{-0.23}\left(\frac{L}{R}\right)^{-0.51} B^{-2.79} \tag{15-9}$$

in which SDR = sediment-delivery ratio in percentage; $A$ = drainage area in square miles; $L/R$ = dimensionless ratio of catchment length-to-relief (length measured parallel to main drainageway, relief measured as the elevation difference between drainage divide and outlet); and $B$ = weighted mean bifurcation ratio, defined as the the ratio of the number of streams in a given order to the number of streams in the next higher order. Values of SDR measured by Roehl in the Piedmont area were in the range 3.7 to 59.4 percent.

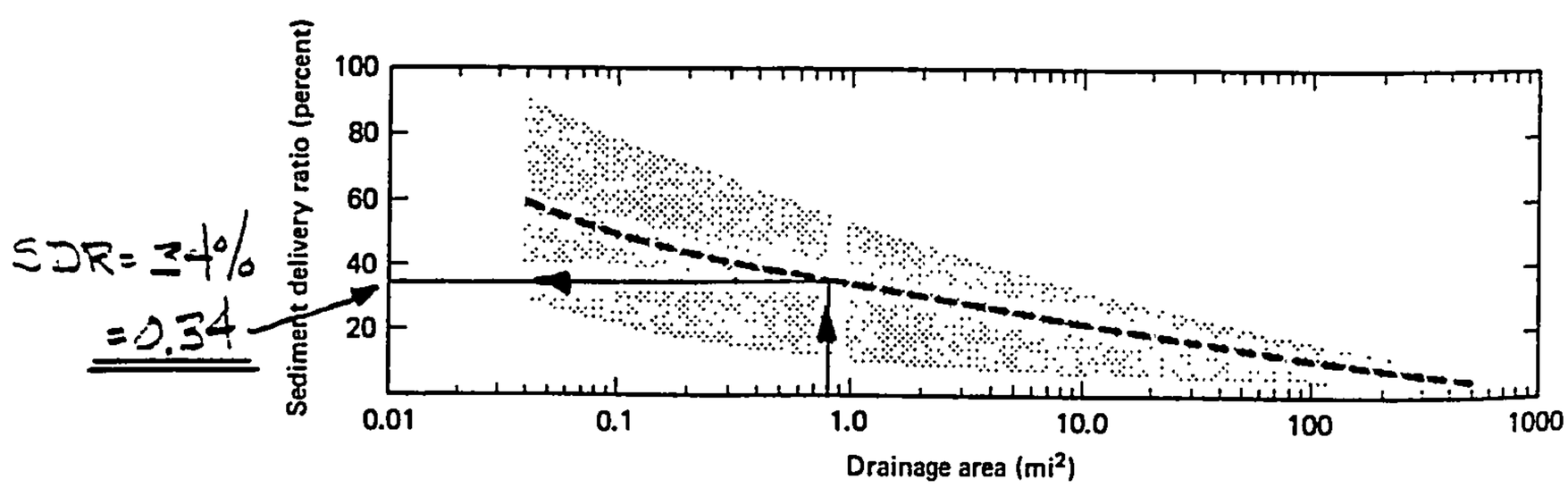


**Figure 15-4** Relationship between sediment-delivery ratio and drainage area [41].

(2) Construction Sites. The significance of selecting coefficients can be illustrated by looking at the soil erodibility factor, K. Published coefficients for crop land imply regular tillage of the soil, and that disturbs the natural armor layer which forms during rain events. The significance of this, the soil erodibility factor, K, for a construction site is not the same as published for crop land in the USLE manual. Soil in a construction area would be expected to exhibit similar erosion to agricultural land during the first rain event after the ground was disturbed, but successive rainfall events would erode that soil at a reduced rate because the construction site is not plowed regularly.

(3) Erosion Mechanisms. The channelization of surface water runoff due to construction may increase gully and channel erosion significantly, and the USLE would miss that altogether because it is formulated for sheet and rill erosion.

(4) Sediment Transport. There is no transport function in the USLE, and a watershed sediment delivery ratio must be applied to account for overland deposition. However, the validity of results is questionable when the USLE is applied to subareas in excess of a few square miles.

3-14. Sediment Delivery Ratio. With the addition of a sediment delivery ratio (SDR), the USLE can be extended to areas of several square miles. The SDR is a factor, ranging from 0 to 1, to multiply times the annual soil loss to obtain the annual sediment yield for the watershed. Sediment delivery ratios have been calculated for specific areas, but no generalized equations or techniques are yet available to universally determine a sediment delivery ratio. The SDR is proportional to drainage area, and the available data indicates the ratio may vary with the 0.2 power, in the form of:

$$(SDR2 / SDR1) = (A1 / A2)^{0.2} \qquad (3\text{-}7)$$

where:

A1 = reference drainage area, square miles
A2 = desired drainage area, square miles
SDR1 = sediment delivery ratio for reference drainage area
SDR2 = desired sediment delivery ratio

Vanoni item [2] suggests using a reference drainage area of .001 and a SDR1 of 1.0 in this equation. Figure 3-4 illustrates sediment delivery ratio-drainage area relationships for different regions in the United States, and Figure 3-5 shows a generalized relationship drawn through a mass of data points from various regions. Any arbitrary sediment delivery ratio selected solely on the basis of drainage area could be in considerable error; other factors (soil moisture, channel density, land use, conservation treatment, soil type, rainfall intensity, topographic relief, and so forth) must also affect the SDR in some manner.

3-15. Modified Universal Soil Loss Equation (MUSLE). The Universal Soil Loss Equation was modified by Williams [69] with the resulting equation termed the Modified USLE (MUSLE). The MUSLE allows the estimation of soil losses for each precipitation event throughout the year, thereby becoming an event model

# SEDIMENT ANALYSIS

COUNTY OF BERNALILLO

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT BC-83-1

CITY OF ALBUQUERQUE

NEW MEXICO

PUBLIC WORKS DEPARTMENT

SPECIAL ASSESSMENT DISTRICT 216

## SUB APPENDIX C-2

HYDROLOGY OF EXISTING CONDITIONS

DECEMBER 1992

## TABLE B-1

## PEAK RUNOFF RATES

### EXISTING CONDITIONS
### (6 HOUR STORM)

| ANALYSIS POINT | Q(10) (CFS) | Q(100) (CFS) |
|---|---|---|
| 1 | 13 | 24 |
| 2 | 14 | 29 |
| 3 | 18 | 42 |
| 4 | 22 | 49 |
| 5 | 25 | 54 |
| 6 | 46 | 86 |
| 6A | 20 | 40 |
| 6B | 76 | 146 |
| 7 | 93 | 175 |
| 8 | 101 | 191 |
| 9 | 66 | 105 |
| 10 | 82 | 133 |
| 11 | 63 | 65 |
| 12 | 164 | 255 |
| 13 | 171 | 288 |
| 14 | 36 | 61 |
| 15 | 200 | 328 |
| 16 | 207 | 350 |
| 17 | 210 | 372 |
| 18 | 217 | 389 |
| 19 | 16 | 36 |
| 20 | 229 | 420 |
| 21 | 229 | 420 |
| 22 | 17 | 47 |
| 23 | 24 | 77 |
| 24 | 35 | 114 |
| 25 | 50 | 143 |
| 26 | 60 | 173 |
| 27 | 63 | 177 |
| 28 | 7 | 28 |
| 29 | 6 | 16 |
| * 30 | 300 | 624 |

* Analysis Point 30 - Includes runoff from Total Drainage Area.

# TABLE B-2

## HYMO BASIN PARAMETER WORKSHEET

## EXISTING CONDITIONS

**PROJECT: SAD-BC-83-1 & SAD-216 BY: D.L.A. DATE: 7-3-91**

| Basin | Area (sq.mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-1 | 0.0084 | 150 | 7.0 | 0.047 | 0.7 | 1.51 | 0.028 | 0.018 | | | | |
| | | 1,000 | 1.0 | 0.001 | 0.7 | 0.22 | 1.255 | 0.837 | | | | |
| | TOTAL | | | | | | 1.282 | 0.855 | 81 | | | 19 |
| A-2 | 0.0195 | 150 | 5.0 | 0.033 | 2.0 | 3.65 | 0.011 | 0.008 | | | | |
| | | 275 | 4.0 | 0.015 | 0.7 | 0.84 | 0.090 | 0.060 | | | | |
| | | 850 | 8.0 | 0.009 | 0.7 | 0.68 | 0.348 | 0.232 | | | | |
| | TOTAL | | | | | | 0.450 | 0.300 | 20 | 20 | 22 | 38 |
| A-3 | 0.0194 | 400 | 3.0 | 0.008 | 0.7 | 0.61 | 0.183 | 0.122 | | | | |
| | | 400 | 3.0 | 0.008 | 2.0 | 1.73 | 0.064 | 0.043 | | | | |
| | | 1,550 | 1.5 | 0.001 | 3.0 | 0.93 | 0.461 | 0.308 | | | | |
| | TOTAL | | | | | | 0.709 | 0.473 | 72 | 8 | | 20 |
| A-4 | 0.0077 | 980 | 5.0 | 0.005 | 0.7 | 0.50 | 0.544 | 0.363 | | | | |
| | | 175 | 4.0 | 0.023 | 3.0 | 4.54 | 0.011 | 0.007 | | | | |
| | | 750 | 4.0 | 0.005 | 3.0 | 2.19 | 0.095 | 0.063 | | | | |
| | | 875 | 26.0 | 0.030 | 3.0 | 5.17 | 0.047 | 0.031 | | | | |
| | TOTAL | | | | | | 0.697 | 0.465 | 64 | | | 36 |
| A-5 | 0.0392 | 900 | 14.0 | 0.016 | 0.7 | 0.87 | 0.286 | 0.191 | | | | |
| | | 2,100 | 23.0 | 0.011 | 1.0 | 1.05 | 0.557 | 0.372 | | | | |
| | TOTAL | | | | | | 0.844 | 0.562 | 84 | 7 | | 9 |

# TABLE B-2

## HYMO BASIN PARAMETER WORKSHEET

## EXISTING CONDITIONS

**PROJECT: SAD-BC-83-1 & SAD-216 BY: D.L.A. DATE: 7-3-91**

| Basin | Area (sq.mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-6 | 0.0127 | 80 | 2.0 | 0.025 | 0.7 | 1.11 | 0.020 | 0.013 | | | | |
| | | 800 | 4.0 | 0.005 | 0.7 | 0.49 | 0.449 | 0.299 | | | | |
| | | 350 | 2.0 | 0.006 | 0.7 | 0.53 | 0.184 | 0.122 | | | | |
| | | 900 | 15.0 | 0.017 | 0.7 | 0.90 | 0.277 | 0.184 | | | | |
| | | 450 | 8.0 | 0.018 | 3.0 | 4.00 | 0.031 | 0.021 | | | | |
| | TOTAL | | | | | | 0.961 | 0.640 | 61 | | | 39 |
| B-1 | 0.0713 | 300 | 5.0 | 0.017 | 1.0 | 1.29 | 0.065 | 0.043 | | | | |
| | | 325 | 3.0 | 0.009 | 1.0 | 0.96 | 0.094 | 0.063 | | | | |
| | | 70 | 6.0 | 0.086 | 1.0 | 2.93 | 0.007 | 0.004 | | | | |
| | | 300 | 8.0 | 0.027 | 1.0 | 1.63 | 0.051 | 0.034 | | | | |
| | | 600 | 8.0 | 0.013 | 1.0 | 1.15 | 0.144 | 0.096 | | | | |
| | | 750 | 11.0 | 0.015 | 3.0 | 3.63 | 0.057 | 0.038 | | | | |
| | | 100 | 2.0 | 0.020 | 2.0 | 2.83 | 0.010 | 0.007 | | | | |
| | TOTAL | | | | | | 0.428 | 0.285 | 30 | 3 | 29 | 38 |
| B-2A | 0.0213 | 200 | 30.0 | 0.150 | 0.7 | 2.71 | 0.020 | 0.014 | | | | |
| | | 180 | 2.0 | 0.011 | 0.7 | 0.74 | 0.068 | 0.045 | | | | |
| | | 130 | 4.0 | 0.031 | 0.7 | 1.23 | 0.029 | 0.020 | | | | |
| | | 150 | 1.0 | 0.007 | 0.7 | 0.57 | 0.073 | 0.049 | | | | |
| | | 200 | 2.0 | 0.010 | 3.0 | 3.00 | 0.019 | 0.012 | | | | |
| | | 400 | 1.0 | 0.003 | 3.0 | 1.50 | 0.074 | 0.049 | | | | |
| | TOTAL | | | | | | 0.283 | 0.189 | 50 | | | 50 |

# TABLE B-2

## HYMO BASIN PARAMETER WORKSHEET

## EXISTING CONDITIONS

**PROJECT: SAD-BC-83-1 & SAD-216 BY: D.L.A. DATE: 7-3-91**

| Basin | Area (sq.mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-2B | 0.0159 | 100 | 7.0 | 0.070 | 0.7 | 1.85 | 0.015 | 0.010 | | | | |
| | | 220 | 0.5 | 0.002 | 2.0 | 0.95 | 0.064 | 0.043 | | | | |
| | | 150 | 2.0 | 0.013 | 3.0 | 3.46 | 0.012 | 0.008 | | | | |
| | | 350 | 1.0 | 0.003 | 3.0 | 1.60 | 0.061 | 0.040 | | | | |
| | | 500 | 3.0 | 0.006 | 3.0 | 2.32 | 0.060 | 0.040 | | | | |
| | TOTAL | | | | | | 0.212 | 0.141 | 33 | | | 67 |
| B-2C | 0.0189 | 75 | 3.0 | 0.040 | 2.0 | 4.00 | 0.005 | 0.003 | | | | |
| | | 500 | 2.0 | 0.004 | 2.0 | 1.26 | 0.110 | 0.073 | | | | |
| | | 400 | 2.0 | 0.005 | 2.0 | 1.41 | 0.079 | 0.052 | | | | |
| | | 130 | 6.0 | 0.046 | 2.0 | 4.30 | 0.008 | 0.006 | | | | |
| | | 75 | 2.0 | 0.027 | 1.0 | 1.63 | 0.013 | 0.009 | | | | |
| | TOTAL | | | | | | 0.215 | 0.143 | 10 | | 23 | 67 |
| B-3A | 0.0253 | 1,200 | 18.0 | 0.015 | 0.7 | 0.86 | 0.389 | 0.259 | | | | |
| | | 600 | 2.0 | 0.003 | 2.0 | 1.15 | 0.144 | 0.096 | | | | |
| | TOTAL | | | | | | 0.533 | 0.355 | 100 | | | |
| B-3B | 0.0078 | 950 | 7.0 | 0.007 | 0.7 | 0.60 | 0.439 | 0.293 | 100 | | | |
| B-3C | 0.0150 | 900 | 6.0 | 0.007 | 0.7 | 0.57 | 0.437 | 0.292 | | | | |
| | | 775 | 7.0 | 0.009 | 0.7 | 0.67 | 0.324 | 0.216 | | | | |
| | TOTAL | | | | | | 0.761 | 0.507 | 100 | | | |

# TABLE B-2

## HYMO BASIN PARAMETER WORKSHEET

## EXISTING CONDITIONS

**PROJECT: SAD-BC-83-1 & SAD-216 BY: D.L.A. DATE: 7-3-91**

| Basin | Area (sq.mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-4 | 0.0166 | 1,300 | 28.0 | 0.022 | 0.7 | 1.03 | 0.352 | 0.234 | | | | |
| | | 125 | 1.0 | 0.008 | 3.0 | 2.68 | 0.013 | 0.009 | | | | |
| | TOTAL | | | | | | 0.364 | 0.243 | 75 | | | 25 |
| C-1 | 0.0398 | 50 | 2.0 | 0.040 | 2.0 | 4.00 | 0.003 | 0.002 | | | | |
| | | 150 | 2.0 | 0.013 | 2.0 | 2.31 | 0.018 | 0.012 | | | | |
| | | 350 | 2.0 | 0.006 | 2.0 | 1.51 | 0.064 | 0.043 | | | | |
| | | 440 | 5.0 | 0.011 | 2.0 | 2.13 | 0.057 | 0.038 | | | | |
| | | 300 | 11.0 | 0.037 | 3.0 | 5.74 | 0.015 | 0.010 | | | | |
| | | 350 | 6.0 | 0.017 | 3.0 | 3.93 | 0.025 | 0.017 | | | | |
| | TOTAL | | | | | | 0.182 | 0.122 | | 20 | | 80 |
| C-2 | 0.0081 | 500 | 2.0 | 0.004 | 2.0 | 1.26 | 0.110 | 0.073 | | | | |
| | | 175 | 4.0 | 0.023 | 2.0 | 3.02 | 0.016 | 0.011 | | | | |
| | | 100 | 0.5 | 0.005 | 2.0 | 1.41 | 0.020 | 0.013 | | | | |
| | | 125 | 12.0 | 0.096 | 2.0 | 6.20 | 0.006 | 0.004 | | | | |
| | | 200 | 6.0 | 0.030 | 0.7 | 1.21 | 0.046 | 0.031 | | | | |
| | TOTAL | | | | | | 0.197 | 0.131 | | 20 | | 80 |
| C-3 | 0.0102 | 425 | 2.0 | 0.005 | 2.0 | 1.37 | 0.086 | 0.057 | | | | |
| | | 260 | 4.0 | 0.015 | 0.7 | 0.87 | 0.083 | 0.055 | | | | |
| | | 365 | 18.0 | 0.049 | 0.7 | 1.55 | 0.065 | 0.043 | | | | |
| | | 200 | 1.0 | 0.005 | 0.7 | 0.49 | 0.112 | 0.075 | | | | |
| | | 400 | 2.0 | 0.005 | 3.0 | 2.12 | 0.052 | 0.035 | | | | |
| | TOTAL | | | | | | 0.399 | 0.266 | 68 | | | 32 |

# TABLE B-2

## HYMO BASIN PARAMETER WORKSHEET

## EXISTING CONDITIONS

**PROJECT: SAD-BC-83-1 & SAD-216 BY: D.L.A. DATE: 7-3-91**

| Basin | Area (sq.mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C-4 | 0.0020 | 300 | 1.0 | 0.003 | 2.0 | 1.15 | 0.072 | 0.048 | | | | |
| | | 800 | 26.0 | 0.033 | 0.7 | 1.26 | 0.176 | 0.117 | | | | |
| | TOTAL | | | | | | 0.248 | 0.166 | 64 | | | 36 |
| D-1 | 0.0111 | 750 | 20.0 | 0.027 | 0.7 | 1.14 | 0.182 | 0.122 | 93 | | | 7 |
| D-2 | 0.0234 | 150 | 5.0 | 0.033 | 2.0 | 3.65 | 0.011 | 0.008 | | | | |
| | | 400 | 4.0 | 0.010 | 2.0 | 2.00 | 0.056 | 0.037 | | | | |
| | | 500 | 2.0 | 0.004 | 2.0 | 1.26 | 0.110 | 0.073 | | | | |
| | | 550 | 1.0 | 0.002 | 2.0 | 0.85 | 0.179 | 0.119 | | | | |
| | TOTAL | | | | | | 0.356 | 0.237 | 100 | | | |
| D-3 | 0.0091 | 600 | 6.0 | 0.010 | 0.7 | 0.70 | 0.238 | 0.159 | | | | |
| | | 100 | 2.0 | 0.020 | 0.7 | 0.99 | 0.028 | 0.019 | | | | |
| | TOTAL | | | | | | 0.266 | 0.177 | 74 | | | 26 |
| D-4 | 0.0475 | 100 | 7.0 | 0.070 | 0.7 | 1.85 | 0.015 | 0.010 | | | | |
| | | 200 | 4.0 | 0.020 | 0.7 | 0.99 | 0.056 | 0.037 | | | | |
| | | 300 | 3.0 | 0.010 | 0.7 | 0.70 | 0.119 | 0.079 | | | | |
| | | 650 | 2.0 | 0.003 | 2.0 | 1.11 | 0.163 | 0.109 | | | | |
| | | 700 | 7.0 | 0.010 | 3.0 | 3.00 | 0.065 | 0.043 | | | | |
| | TOTAL | | | | | | 0.418 | 0.278 | 100 | | | |

# TABLE B-2

## HYMO BASIN PARAMETER WORKSHEET

## EXISTING CONDITIONS

**PROJECT: SAD-BC-83-1 & SAD-216 BY: D.L.A. DATE: 7-3-91**

| Basin | Area (sq.mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D-5 | 0.0588 | 550 | 1.0 | 0.002 | 0.7 | 0.30 | 0.512 | 0.341 | | | | |
| | | 1,100 | 5.0 | 0.005 | 2.0 | 1.35 | 0.227 | 0.151 | | | | |
| | | 50 | 6.0 | 0.120 | 2.0 | 6.93 | 0.002 | 0.001 | | | | |
| | | 1,100 | 20.0 | 0.018 | 3.0 | 4.05 | 0.076 | 0.050 | | | | |
| | TOTAL | | | | | | 0.816 | 0.544 | 62 | 5 | 7 | 26 |
| E-1 | 0.0506 | 2,000 | 30.0 | 0.015 | 1.0 | 1.22 | 0.454 | 0.302 | | | | |
| | | 1,000 | 4.0 | 0.004 | 3.0 | 1.90 | 0 146 | 0.098 | | | | |
| | TOTAL | | | | | | 0.600 | 0.400 | 40 | 6 | 40 | 14 |
| K-1 | 0.0388 | 130 | 26.0 | 0.200 | 0.7 | 3.13 | 0.012 | 0.008 | | | | |
| | | 100 | 10.0 | 0.100 | 1.0 | 3.16 | 0.009 | 0.006 | | | | |
| | | 150 | 2.0 | 0.013 | 1.0 | 1.15 | 0.036 | 0.024 | | | | |
| | | 720 | 8.0 | 0.011 | 3.0 | 3.16 | 0.063 | 0.042 | | | | |
| | | 550 | 2.5 | 0.005 | 3.0 | 2.02 | 0.076 | 0.050 | | | | |
| | TOTAL | | | | | | 0.195 | 0.130 | 85 | | | 15 |
| K-2 | 0.0353 | 500 | 1.0 | 0.002 | 0.7 | 0.31 | 0.444 | 0.296 | | | | |
| | | 1,150 | 16.0 | 0.014 | 3.0 | 3.54 | 0.090 | 0.060 | | | | |
| | TOTAL | | | | | | 0.534 | 0.356 | 47 | | | 53 |
| K-3 | 0.0195 | 200 | 0.2 | 0.001 | 2.0 | 0.63 | 0.088 | 0.059 | | | | |
| | | 125 | 2.0 | 0.016 | 2.0 | 2.53 | 0.014 | 0.009 | | | | |
| | | 275 | 2.0 | 0.007 | 2.0 | 1.71 | 0.045 | 0.030 | | | | |
| | | 300 | 6.0 | 0.020 | 3.0 | 4.24 | 0.020 | 0.013 | | | | |
| | TOTAL | | | | | | 0 166 | 0.111 | 48 | | | 52 |

# TABLE B-2

## HYMO BASIN PARAMETER WORKSHEET

## EXISTING CONDITIONS

**PROJECT: SAD-BC-83-1 & SAD-216 BY: D.L.A. DATE: 7-3-91**

| Basin | Area (sq.mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K-4 | 0.0556 | 550 | 15.0 | 0.027 | 2.0 | 3.30 | 0.046 | 0.031 | | | | |
| | | 600 | 1.0 | 0.002 | 2.0 | 0.82 | 0.204 | 0.136 | | | | |
| | | 550 | 1.0 | 0.002 | 2.0 | 0.85 | 0.179 | 0.119 | | | | |
| | TOTAL | | | | | | 0.430 | 0.286 | 90 | | | 10 |
| K-5 | 0.0025 | 1,000 | 10.0 | 0.010 | 3.0 | 3.00 | 0.093 | 0.062 | | 20 | | 80 |
| 0-1 | 0.0284 | 270 | 1.5 | 0.006 | 2.0 | 1.49 | 0.050 | 0.034 | | | | |
| | | 30 | 0.3 | 0.010 | 2.0 | 2.00 | 0.004 | 0.003 | | | | |
| | | 250 | 1.4 | 0.006 | 2.0 | 1.50 | 0.046 | 0.031 | | | | |
| | | 45 | 0.8 | 0.018 | 2.0 | 2.67 | 0.005 | 0.003 | | | | |
| | | 20 | 0.6 | 0.030 | 2.0 | 3.46 | 0.002 | 0.001 | | | | |
| | | 190 | 1.0 | 0.005 | 2.0 | 1.45 | 0.036 | 0.024 | | | | |
| | | 80 | 2.0 | 0.025 | 3.0 | 4.74 | 0.005 | 0.003 | | | | |
| | | 100 | 2.8 | 0.028 | 3.0 | 5.02 | 0.006 | 0.004 | | | | |
| | | 80 | 0.3 | 0.004 | 3.0 | 1.84 | 0.012 | 0.008 | | | | |
| | | 315 | 2.4 | 0.008 | 3.0 | 2.62 | 0.033 | 0.022 | | | | |
| | | 200 | 1.5 | 0.008 | 3.0 | 2.60 | 0.021 | 0.014 | | | | |
| | TOTAL | | | | | | 0.221 | 0.147 | 20 | 5 | 13 | 62 |
| P-1 | 0.0403 | 800 | 8.0 | 0.010 | 0.7 | 0.70 | 0.317 | 0.212 | | | | |
| | | 560 | 0.5 | 0.001 | 3.0 | 0.90 | 0.174 | 0.116 | | | | |
| | | 365 | 0.2 | 0.001 | 3.0 | 0.70 | 0.144 | 0.096 | | | | |
| | | 600 | 2.0 | 0.003 | 3.0 | 1.73 | 0.096 | 0.064 | | | | |
| | TOTAL | | | | | | 0.732 | 0.488 | 78 | | 15 | 7 |

# TABLE B-2

## HYMO BASIN PARAMETER WORKSHEET

## EXISTING CONDITIONS

**PROJECT: SAD-BC-83-1 & SAD-216 BY: D.L.A. DATE: 7-3-91**

| Basin | Area (sq.mi.) | Length (ft.) | d Elev (ft.) | Slope (ft/ft) | K | V (ft/s) K√Slope | t(c) (hrs.) Length/V | t(p) (hrs.) 2/3 * t(c) | Surface Treatment Percent A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-1 | 0.0366 | 550 | 7.0 | 0.013 | 0.7 | 0.79 | 0.193 | 0.129 | | | | |
| | | 200 | 2.0 | 0.010 | 0.7 | 0.70 | 0.079 | 0.053 | | | | |
| | TOTAL | | | | | | 0.273 | 0.182 | 96 | | | 4 |

FILE COPY

# City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

KEN SCHULTZ
MAYOR

CLARENCE V. LITHGOW
CHIEF
ADMINISTRATIVE OFFICER

DAN WEAKS
DEPUTY CAO
PUBLIC SERVICES

FRED E. MONDRAGON
DEPUTY CAO
DEVELOPMENT & ENTERPRISE SERVICES

RAY R. BACA
DEPUTY CAO
PUBLIC SAFETY

June 29, 1989

Martin Garcia
Bernalillo County Public Works Department
2400 Broadway Boulevard, SE
Albuquerque, New Mexico 87106

RE: DRAINAGE REPORT FOR SAD 216
RECEIVED JUNE 19, 1989

Dear Mr. Garcia:

I have reviewed the referenced plan and forward the following comments:

1. Need a table in the report which indicates drainage basin Q, CN, TC, etc.

2. What is the capacity of the inlets of Comanche road west of the Pan American Freeway. These inlets are for the existing 48" storm drain. Can the inlets handle 99 cfs.

3. Area E-1 would have to use retention ponds until Edith storm drain by other is constructed. Their benefit would not be available until this storm drain is built. Please discuss.

4. Would the flows from K-1 continue west on Rankin Road. Would Rankin Lane have to be built to convey the flows to Comanche Road?

5. What is analysis pt. 28 used for?

6. What is the capacity of the existing 48" pipe in the 10' x 10' box culvert? Does it have capacity for developed free discharge?

Should you need to discuss these comments, please call me at 768-2650.

Cordially,

for Bernie J. Montoya
Carlos A. Montoya, P.E.
City/County Floodplain Administrator

xc: Lee Lunsford

CAM/bsj
(WP+1138)

# Federal Emergency Management Agency

Washington, D.C. 20472

NOV 19 1991

NOV 14 1991

Mr. Gilbert Aldaz, P.E., L.S.
Floodplain Administrator for the
City of Albuquerque
P.O. Box 1293
Albuquerque, New Mexico 87103

Community: City of Albuquerque,
Bernalillo County,
New Mexico
Community No.: 350002

Dear Mr. Aldaz:

This is in response to a letter, dated October 15, 1991, from you and Mr. Clifford Anderson, P.E., L.S., of the Albuquerque Metropolitan Arroyo Flood Control Authority, which submitted Section 22.2 Hydrology of the Development Process Manual, Volume 2, Design Criteria for the City of Albuquerque, New Mexico, dated August 1991, and a revised computer program titled AHYMO991 (Version September, 1991). Your letter discussed storm duration, infiltration, storm distribution, and other pertinent information relative to the National Flood Insurance Program (NFIP) in the vicinity of Albuquerque, New Mexico.

We are pleased to note the inclusion of suggestions contained in our letter addressed to you, dated February 7, 1991. These modifications, along with improvements in infiltration rates from continuing studies and emphasis on sedimentation and alluvial fan processes, should provide satisfactory information for the future processing of studies related to the NFIP in the vicinity of Albuquerque, New Mexico. The Federal Emergency Management Agency is impressed with the high level of professional involvement, the extent of resources invested, and the coordination of activities included in your efforts to reduce future flood damages.

We thank you for the opportunity to provide comments. Should you have any questions regarding this matter, please do not hesitate to contact Matthew B. Miller of our Headquarters staff in Washington, D.C., at (202) 646-3461.

Sincerely,

William R. Locke

William R. Locke
Chief, Risk Studies Division
Federal Insurance Administration

cc: Mr. Clifford E. Anderson, P.E., L.S.

**City of Albuquerque**
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

August 13, 1991

Boleslo Romero, Deputy Director
Bernalillo County Public Works Department
2400 Broadway Boulevard, SE
Albuquerque, New Mexico 87102

RE: DRAINAGE REPORT FOR SPECIAL ASSESSMENT DISTRICT
BC-83-1-COUNTY OF BERNALILLO/SPECIAL ASSESSMENT DISTRICT 216
CITY OF ALBUQUERQUE

Dear Mr. Romero:

Based on the information received July 15, 1991 it appears that the hydrology may be acceptable to FEMA's new guidelines.

Since the pond takes longer than 24 hours to drain, (80 hours), you may need to consider a longer storm duration if it increases the maximum pool elevation from that determined for the shorter duration. I have attached a copy of a FEMA letter dated June 5, 1991 regarding this issue.

If you should have any questions concerning these comments, please do not hesitate to call me at 768-2650.

Cordially,

Gilbert Aldaz, P.E. & L.S.
City/County Floodplain Administrator

xc: Fred Aguirre
Lee Lunsford
John Andrews
Martin Garcia

GA
wp+1138

# Federal Emergency Management Agency

Washington, D.C. 20472

FEB 7 1991

FEB 12 1991

Mr. Gilbert Aldaz, P.E., L.S.
Floodplain Administrator for the
City of Albuquerque
P.O. Box 1293
Albuquerque, New Mexico 87103

Community: City of Albuquerque,
Bernalillo County,
New Mexico
Community No.: 350002

Dear Mr. Aldaz:

This is in follow-up to our letter of December 19, 1990 (copy enclosed), in which we informed you that we were in the process of reviewing the report entitled Draft Revision of Section 22.2, Development Process Manual, dated September 1990. This report included the September 1990 version of the HYMO hydrologic model (AHYMO 990) and was accompanied by several supporting technical documents, the last of which was received on December 26, 1990. At this time, we wish to provide the City of Albuquerque with our comments resulting from this review, provide guidance on future Flood Insurance Rate Map (FIRM) revision request submittals, and clarify the data requirements associated with the FIRM revision requests submitted to date.

Review of the Development Process Manual

With regard to the September 1990 report, we are in general agreement with the methods of hydrologic analyses presented therein, as they apply specifically to the City of Albuquerque and surrounding areas. We wish to provide further comments on the three issues addressed below, storm duration, infiltration, and storm distribution. With the exception of the issue of storm distribution, FEMA will accept the methods of hydrologic analysis discussed in the city's Development Process Manual for use in the preparation of the technical data submitted in support of a FIRM revision request.

o Storm Duration

The city's Development Process Manual recommends that a 6-hour duration storm be used for projects without detention facilities. It furthermore states that for facilities which hold water for longer than 6 hours, longer duration storms are to be considered to establish runoff values. Our general criteria for assessing a proper storm duration will be dependent on a review of the following three factors: the primary consideration of the analysis, watershed characteristics, and the size of the watershed.

- The Primary Consideration (Volume of Runoff vs. Peak Flow)

Our October 29, 1990 letter to you contained the following general statement regarding storm duration:

"FEMA's position regarding the duration of rainfall is that the storm must extend for a period long enough to include all rainfall excess when the volume of the runoff hydrograph is an important consideration. This includes conditions when detention storage is involved, when sediment processes are a significant factor, and when combining and routing subbasin hydrographs to obtain watershed runoff. When the peak flow is the primary concern, and it is established that the use of a longer duration storm would not increase the peak flow, shorter duration storms are acceptable."

The requestor must accept responsibility for providing documentation to FEMA sufficient to demonstrate that all rainfall excess has been included when volume of runoff is the primary consideration.

- Watershed Characteristics (Pervious vs. Impervious)

  An impervious watershed is likely to have additional rainfall excess from longer duration storms. Therefore, when the primary consideration is the volume of runoff, the hydrologic analysis should reflect longer storm durations than would be appropriate for a pervious watershed or for a situation where volume of runoff is not the primary consideration.

- Size of Watershed

  The generally accepted criterion is that the storm duration for a watershed should be at least as long as the time required for flow to travel from the outer limit of the watershed to the point of interest. The city's Development Process Manual accurately points out that, given volumetric considerations and a very large watershed, it is possible that a storm duration greater than 24 hours would be appropriate.

When a hydrologic methodology involving a Soil Conservation Service (SCS) curve number is used, it should be noted that the SCS National Engineering Handbook and other SCS publications, such as the TR-55 and TR-20 hydrologic procedures manuals, stress the need to use 24-hour storm durations when applying SCS procedures. Other curve numbers can be derived from shorter duration storms or assigned to reproduce results from other infiltration procedures. However, the use of these alternative curve numbers with SCS procedures is inappropriate. In addition, the application of any such alternative curve numbers in a non-SCS methodology must be fully documented.

o Infiltration

FEMA recognizes and commends the considerable effort expended by various organizations to derive the initial abstraction/uniform infiltration (IA/INF) values discussed in the city's Development Process Manual and employed by the AHYMO 990 model. We also realize that the Development Process Manual and the IA/INF values are still undergoing development. We ask that any new information or research that alters the infiltration values be forwarded to us along with an updated Development Process Manual and AHYMO model.

Our review of the infiltration information submitted to date has revealed the following concerns:

- There appears to be some disparity in infiltration parameter values provided by the various organizations, as reflected in the submitted technical documents. The values utilized by the AHYMO 990 model cannot be readily attributed to the results of any one of these documents.

- The IA/INF method appears to significantly underestimate the runoff values when compared to an analysis of an observed storm of 7-hour duration, the results of which are presented in a paper entitled A Comparison of I.A./INF. and S.C.S. CN Methods Using HYMO, prepared by Mr. Clifford E. Anderson.

While FEMA will accept the infiltration values and methodology presented in the city's Development Process Manual, we ask that the city investigate these concerns and provide a discussion of their resolution along with any further revised version of the manual.

o Storm Distribution

The city's Development Process Manual recommends that 6- and 24-hour rainfall distributions be peaked at 30 minutes from the beginning of the storm. This is reflected in the options for analysis presented in the AHYMO 990 hydrologic model. We have determined that, for both 6- and 24-hour storm durations, this early bulking of the hyetograph in the AHYMO 990 model causes a significant reduction in peak flows and runoff volumes when compared with the HEC-1 model, which places the highest rainfall concentration in the middle of the hyetograph. These differences are more pronounced, and thus a concern, when pervious watersheds are involved; the differences are negligible for impervious watersheds.

FEMA recognizes that there are meteorological factors specific to the City of Albuquerque and surrounding areas that may make the rainfall distribution utilized by the HEC-1 model inappropriate. Discussions with the National Weather Service indicate that in the City of Albuquerque the most intense rainfall is more likely to occur closer to the beginning of the storm than in the middle of

the storm. This meteorological factor is further noted in a Soil Conservation Service (SCS) manual entitled Peak Rates of Discharge for Small Watersheds, Chapter 2 for New Mexico. The SCS, for hydrologic analyses within the City of Albuquerque, has placed the maximum 1-hour rainfall in the 6th hour of a 24-hour storm.

While we recognize that the most intense rainfall can occur early in storms in the vicinity of Albuquerque, we believe that placing the maximum 1-hour rainfall in the first hour of the 6- and 24-hour storms may unduly reflect the effects of initial infiltration. We suggest that the city consider adopting an alternative arrangement of hourly rainfall. A reasonable compromise to the descending arrangement of hourly rainfall presented in AHYMO 990 is presented below.

| | Hourly Rainfall (in.) | |
|---|---|---|
| | AHYMO 990[1] | Preferred Arrangement[2] |
| 1st Hour | 1.8700 | 0.0758 |
| 2nd Hour | 0.1129 | 1.8700 |
| 3rd Hour | 0.0758 | 0.1129 |
| 4th Hour | 0.0571 | 0.0571 |
| 5th Hour | 0.0459 | 0.0459 |
| 6th Hour | 0.0383 | 0.0383 |

[1]These values are taken from Rainfall Type=1 in the AHYMO 990 model
[2]Can be used in Rainfall Type=1 and 2

Our preferred arrangement moves the 1-hour maximum rainfall to the second hour and puts the value of the hourly rainfall that is closest to the average value of the other five hourly increments in the first hour. This arrangement, using hourly values from AHYMO 990, produces results that are about midway between those obtained by HEC-1 and AHYMO 990. With this compromise, FEMA would have greater assurance that revision requests based on a AHYMO 990 analysis would contain reasonable estimates of the base (100-year) flood.

General Guidance On Future Submittals

In addition to the comments regarding your community's Development Process Manual and the AHYMO 990 hydrologic model, we would like to provide general guidance regarding the quality and format of material submitted in support of a revision request for the City of Albuquerque. FEMA's ability to review and provide a timely response to revision requests is directly related to the completeness and quality of the technical data and supporting documentation associated with the request. FEMA has established and provided to the city review criteria regarding revision requests; the city should perform a cursory evaluation of each request with respect to these criteria prior to forwarding it to FEMA.

This evaluation should ensure that the requestor has provided a suitable write-up to explain a proposed or existing development and the methodologies used to analyze its impact on flood hazards in the area. In addition, any evaluation by the city should take into account that the technical issues of particular concern for the evaluation of flood hazards in the region include proper hydrologic methodologies, alluvial fan flooding, and the impact of sedimentation. When transmitting a request to FEMA, the city would greatly assist our review by providing a discussion of its viewpoint on the impact of sedimentation and/or the existence of known inactive or active alluvial fans in the project area, as well as a determination regarding the request's proper application of the Development Process Manual and AHYMO model. Again, any contribution made by the city in this regard will greatly assist, and most assuredly expedite, FEMA's processing of a revision request.

Data Requirements

The data requirements specified for each revision request in our May 11, 1990 letter were derived from the criteria outlined in our March 8, 1990 letter. The data requirements related to the issue of hydrology have been reevaluated based on our review of the city's Development Process Manual. Please refer to Appendix A of this letter for an indication of the additional data required to continue processing of the revision requests referenced in our May 11, 1990 letter, as well as those received since that date. This is with the exception of the most recent submittal reflecting the proposed Cerro Colorado Landfill, which will be addressed in a subsequent letter, in approximately two weeks.

The required items indicated in Appendix A, including the necessary initial fees, should be submitted to the following address:

Federal Emergency Management Agency
Federal Insurance Administration
Office of Risk Assessment
500 C Street, S.W., Room 422
Washington, DC 20472

Attention: Charles A. Lindsay

The case numbers referenced in Appendix A should be included on any check or money order for identification purposes and sent by Registered Mail, Return Receipt Requested. Our processing of these requests has been suspended pending receipt of the requested additional data and, if applicable, the necessary initial fees.

This further review and discussion of hydrologic issues within the City of Albuquerque is designed to better provide the city with FEMA's hydrologic review criteria. We wish to reiterate that FEMA's requirements for flood insurance mapping purposes do not dictate community storm drain or flood control facility design standards, unless the community so desires. These requirements are necessary because most requests for revisions involve a reduction in the area covered by the base flood.

Please note that FEMA's viewpoint on the issues of the Rational Runoff Formula, Sedimentation, and Alluvial Fan Flooding Analysis, as presented in our March 8 and October 29, 1990 letters (copies enclosed) still apply. Also note that FEMA's review and discussion of the city's Development Process Manual and the AHYMO 990 model does not preclude the use of other methods of hydrologic analysis previously accepted for use by FEMA and other Federal agencies.

We sincerely appreciate the assistance the City of Albuquerque has shown in providing the information necessary to resolve our concerns and we trust that this letter further defines FEMA's position regarding information required to revise the City of Albuquerque's FIS. However, if you have any further questions pertaining to the above material, please call Matthew B. Miller at (202) 646-3461.

Sincerely,

William R. Locke
Acting Chief, Risk Studies Division
Federal Insurance Administration

Enclosures

cc: The Honorable Louis Saavedra, Mayor of the City of Albuquerque
Mr. Robert E. Gurule, Director of the Department of Public Works for the City of Albuquerque
Mr. Alex Abeyta, Jr., County Manager for Bernalillo County
Mr. Martin Garcia, Special Assessments Engineer, Bernalillo County
Mr. Clifford E. Anderson, P.E., L.S., Albuquerque Metropolitan Arroyo Flood Control Authority
Mr. Dwight Andrews, Investment Asset Management, Inc.
Mr. Jake Bordenave, P.E., Bordenave Designs
Mr. David L. Smith, Easterling & Associates, Inc.
Mr. Dennis A. Lorenz, Espey, Huston & Associates, Inc.
Mr. Kerry L. Davis, P.E./Ms. Sandi Orton, Bohannan-Huston, Inc.
Ms. Laura Milne, Bohannan-Huston, Inc.
Mr. John A. Andrews, P.E., Andrew, Asbury & Robert, Inc.
Mr. Donald Dixon, P.E., Holmes & Narver
Mr. Steven J. Metro, P.E., Wilson & Company

Request: Storm Drainage System - Special Assessment District 216 and BC-83-1 in the City of Albuquerque and the Unincorporated Areas of Bernalillo County

Requestor: Mr. Gilbert Aldaz, P.E., L.S.
Floodplain Administrator for the City of Albuquerque

The following additional data are required so that we can continue the review of this request:

- An initial fee of $735.00 for a conditional Letter of Map Revision (LOMR) review. The Federal Emergency Management Agency (FEMA) has implemented a reimbursement procedure to recover costs associated with reviewing proposed projects, thus reducing the expense to taxpayers. The initial fee is the minimum charge associated with our reviewing a project of this type. However, additional costs could be required after review and before issuing a conditional LOMR depending on the complexity of the review required. You will be notified of the estimated total processing cost if it is anticipated that, due to the extent of the review required, the total cost will exceed $1,500. In that situation, our review would be suspended pending written authorization from you to proceed.

- Hydrologic analyses of the storm sewer project determining the 100-year peak discharge values in accordance with the criteria set forth in this letter.

- Hydraulic analyses of the project incorporating the 100-year peak discharges calculated in the revised hydrologic analyses.

- Technical analyses of the effects of sediment on the storm drainage system and detention pond that must address, but are not limited to, the criteria on the design of channel improvement projects set forth in our March 8, 1990 letter.

Federal Emergency Management Agency

Region VI, Federal Center, 800 North Loop 288
Denton, Texas 76201-3698

RECEIVED
OCT - 8 1990
OLOGY DIVISION

NTH

October 4, 1990

Mr. Gilbert Aldaz, P.E., L.S.
City/County Floodplain Administrator
Post Office Box 1293
Albuquerque, New Mexico 87103

Re: Request for Conditional Letter of Map Revision;
City of Albuquerque SAD-216 &
Bernalillo County SAD BC-83-1 (storm drains);
City of Albuquerque, New Mexico

Dear Mr. Aldaz:

Your submission of the referenced request was received by this office on October 3, 1990. After cursory review by this office, the request was forwarded to our Technical Evaluation Consultant (TEC), via FEMA National Office, for detailed review. You will be notified of their comments, recommendations, and determinations upon completion of that review.

Should there be questions in the interim, feel free to contact me at (817) 898-9284.

Sincerely,

Kenneth W. Davis, P.E., L.S.
Civil Engineer
Natural and Technological
Hazards Division

cc: Mr. Matt Miller, FEMA National Office

FILE COPY


# City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103


September 27, 1990

Diane Leatherwood
Emergency Management Specialist
Region VI, Federal Center
800N. Loop 288
Denton, Texas 76201-3698

RE: REQUEST FOR CONDITIONAL LETTER OF MAP REVISION FOR THE CITY OF ALBUQUERQUE SAD-216 AND BERNALILLO COUNTY SAD BC-83-1

Dear Ms. Leatherwood:

The purpose of this letter is to request a Conditional L.O.M.R. for the referenced site. The request is a City of Albuquerque and Bernalillo County funded project. We are proposing to confine the 100 year floodplain to the proposed storm drain and alleviate 100-year floodplains as shown on the attached FIRM panels 350002-0016 and 350002-0023. Enclosed with this letter is the following information:

1. Drainage Report and Construction Drawings for the Storm Drain system.

2. Community Firm Panels 350002-0016 and 350002-0023 that identifies the 100 year floodplain proposed to be removed with these storm drain improvements.

If you should have any questions concerning this submittal, please do not hesitate to call me at (505) 768-2650.

Cordially,

Gilbert Aldaz, P.E. & L.S.
City/County Floodplain Administrator

xc: Martin Garcia, Bernalillo County
Lee Lunsford, City of Albuquerque
John Andrews, Andrew, Asbury and Roberts

Enclosure

GA
wp+1596

RECEIVED
AUG 16 1990
HYDROLOGY DIVISION

BOARD OF COUNTY COMMISSIONERS
EUGENE M. GILBERT, CHAIRMAN
DISTRICT 3
ALBERT "AL" VALDEZ, VICE CHAIRMAN
DISTRICT 2
HENRY GABALDON, MEMBER
DISTRICT 1
PATRICIA "PAT" CASSIDY, MEMBER
DISTRICT 4
JACQUELYN SCHAEFER, MEMBER
DISTRICT 5
VICKIE FISHER, COUNTY MANAGER

# County of Bernalillo

State of New Mexico

2400 BROADWAY S.E.
ALBUQUERQUE, NEW MEXICO 87102

ALVIN J. CAMPBELL, SHERIFF
PATRICK J. PADILLA, TREASURER
GLADYS M. DAVIS, CLERK
SAM L. PEREA, ASSESSOR
THOMAS J. MESCALL, PROBATE JUDGE

August 13, 1990

John Andrews
Andrews, Asbury & Robert, Inc.
149 Jackson Street NE
Albuquerque, NM 87108

RE: Comanche Griegos SAD BC-83-1

Mr. Andrews:

As you are aware approximately seven weeks have elapsed since you were given comments on your submittal of Resolution No. 2.

Due to a growing concern on this project, we request you provide a schedule with target submittal dates for Resolution No. 2 correspondence and the information required to submit to FEMA for a map revision. Also, as previously discussed, we request that you submit your pavement design for review by Bernalillo County as soon as possible since a possible revision on the pavement section can have a major impact on the project.

Please respond no later than August 20, 1990 on the proposed dates. We will now be conducting bi-weekly progress meetings. These are to be held at County Public Works and shall be between the County project manager and the consultant. Please coordinate this with your project manager. If you have any questions contact Martin J. Garcia.

Sincerely,

Boleslo A. Romero

Boleslo A. Romero
Engineering Division Manager

JR:MG:sf

xc: John Ramsey, Director of Public Works
Lee Lunsford, COA SAD Engineer
Martin Garcia, EIT, County SAD Engineer
R. Foglesong, County Drainage Engineer
Gilbert Aldaz, County Floodplain Administrator

FILE COPY

# City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

August 13, 1990

Bolesio Romero, Deputy Director
Bernalillo County Public Works Department
2400 Broadway Boulevard, SE
Albuquerque, New Mexico 87102

RE: DRAINAGE REPORT FOR SPECIAL ASSESSMENT DISTRICT BC-83-1-COUNTY OF BERNALILLO/SPECIAL ASSESSMENT DISTRICT 216-CITY OF ALBUQUERQUE

Dear Mr. Romero:

Based on the information received August 8, 1990 the above referenced drainage report is approved. Please be advised that prior to sign-off on the work order drawings by Hydrology, the following additional information must be addressed:

1. Calculations for sizing the catch basins must be submitted.

2. Since the proposed Griegos pond volume falls under State Engineer jurisdiction, please provide their acknowledgement and approval.

3. Attached are comments provided to you by this office from Loren Meinz, dated November 30, 1990. Please address these comments prior to sign-off.

4. Attached is a letter dated July 30, 1990 from this office regarding a conditional letter of map revision submittal for FEMA. Please submit two complete binded reports with the items identified on the letter dated July 30, 1990.

If you should have any questions concerning these comments, please do not hesitate to call me at 768-2650.

Cordially,

Gilbert Aldaz, P.E. & L.S.
City/County Floodplain Administrator

xc: Fred Aguirre
Lee Lunsford
John Andrews
Martin Garcia

wp+1138

FILE COPY

# City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

July 3, 1990

Boleslo Romero, Deputy Director
Bernalillo County Public Works Department
2400 Broadway Boulevard, SE
Albuquerque, New Mexico 87102

RE: COUNTY OF BERNALILLO - SPECIAL ASSESSMENT DISTRICT BC-83-1
CITY OF ALBUQUERQUE - SPECIAL ASSESSMENT DISTRICT 216

Dear Mr. Romero:

The purpose of this letter is to advise you that there are official FEMA 100-year floodplains in the above referenced SAD. The improvements being proposed will alter and possibly delete the 100-year floodplains. If a formal submittal is not made to FEMA for a Letter of Map Revision request, then the individuals that have property in the floodplain will continue to be subject to flood insurance requirements.

I think it is important that if these property owners are being assessed for storm drain improvements, then we should try to secure a Letter of Map Revision. Please be advised that FEMA has initiated new requirements in order to secure Letter of Map Revisions, the following criteria will be required:

1. Hydrologic analysis of the project using a 100-year, 24-hour rainfall in a rainfall-runoff model to obtain peak discharge and volume values.

2. Hydraulic analysis of the storm drain system incorporating the 100-year peak discharge calculated in the hydrologic analysis.

3. Indications of potential for blockage of channels or storm drains by sediment/debris from overland flow.

PUBLIC WORKS DEPARTMENT

Walter H. Nickerson, Jr., P.E.
Assistant Director Public Works

ENGINEERING GROUP

Telephone (505) 768-2500

AN EQUAL OPPORTUNITY EMPLOYER

4. A Flood Insurance Rate Map that identifies which floodplains will be removed and the floodplains which will be changed due to the storm drain improvements.

If you decide the Letter of Map Revision is needed, please submit two drainage reports and two sets of construction plans that includes the above reference criteria. I will then make a formal submittal to FEMA for a Letter of Map Revision request. Please respond in writing at your earliest convenience, thanks.

Cordially,

Gilbert Aldaz, P.E. & L.S.
City/County Floodplain Administrator

xc: Fred Aguirre
Lee Lunsford
John Andrews
Martin Garcia

GA
(WP+1138)

# City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103


April 30, 1990

Boleslo Romero, Deputy Director
Bernalillo County Public Works Department
2400 Broadway Boulevard, SE
Albuquerque, New Mexico 87102

RE: COUNTY OF BERNALILLO - SPECIAL ASSESSMENT DISTRICT BC-83-1
CITY OF ALBUQUERQUE - SPECIAL ASSESSMENT DISTRICT 216

Dear Mr. Romero:

An updated drainage report is required in order to review and approve the proposed storm drainage infrastructure east of Interstate 25.

If you should have any questions, please do not hesitate to call me at 768-2650.

Cordially,

Fred J. Aguirre, P.E.
Hydrologist

xc: Lee Lunsford
John Andrews
Martin Garcia

GA:FJA
(WP+1138)


PUBLIC WORKS DEPARTMENT

Walter H. Nickerson, Jr., P.E.
Assistant Director Public Works

ENGINEERING GROUP

Telephone (505) 768-2500



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FILE COPY

# City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

KEN SCHULTZ
MAYOR

December 20, 1989

Boleslo Romero, Deputy Director
Bernalillo County Public Works Department

Albuquerque, New Mexico 871

RE: COUNTY OF BERNALILLO - SPECIAL ASSESSMENT DISTRICT BC-83-1
CITY OF ALBUQUERQUE - SPECIAL ASSESSMENT DISTRICT 216

Dear Mr. Romero:

In accordance with our meeting on December 7, 1989, I am requesting that the following improvements (see attachment) be added to the City of Albuquerque Special Assessment District 216 and the County of Bernalillo Special Assessment District BC-83-1, for which the county is the lead agency.

DESCRIPTION OF IMPROVEMENTS

1. The improvements to the drainageway from the outlet end of the existing 5' x 10' concrete box culvert under Interstate 25 to Yale Boulevard, NE. This drainageway is within the Klines Industrial Park Subdivision. Some additional drainage easement will be required for these improvements.

2. The improvements to the drainageway east of Interstate 25 (I-25) from the inlet end of the 5' x 10' concrete box culvert under I-25 easterly to Vassar Drive, NE. This drainageway lies within the adjacent to the northerly boundary of the MEXALB TRACT and the HAHN PARCEL.

   The improvements will require som99additional drainage easement from the Comanche Business Park Subdivision on which the City presently has a blanket drainage easement.

3. The improvements to the drainageway extending northerly from Comanche Road, NE to the drainageway mentioned in Item 2 above. This drainageway is along an extended alignment of Stanford Drive, NE.

These improvements will provide a complete link between the upstream property owners identified for assessment and the major downstream improvements to be constructed under the subject S.A.D. These improvements will also facilitate the ability to demonstrate "Complete Benefits" to the district's upstream property owners.

If these improvements are not included with this S.A.D., we may miss our opportunity to construct and prorate the cost of these improvements to all the property owners benefiting from these improvements. Also, if these improvements are not constructed with this S.A.D., control discharge would be required on all the upstream property owners, and thereby reducing their benefits.

Cordially,

Fred J. Aguirre, P.E.
Hydrologist

xc: Lee Lunsford
John Andrews
Martin Garcia

Enclosure

FJA/bsj
(WP+1138)

# CITY OF ALBUQUERQUE
# PUBLIC WORKS DEPARTMENT

ENGINEERING GROUP

INTER-OFFICE CORRESPONDENCE

TO: Roger Green, Chairman; DRC

FROM: Loren Meinz, Hydrology Division

SUBJECT: City Engr. Proj. No. 3960

STANDARD DRC REVIEW COMMENT SHEET
November 30, 1989

PROJECT:
SAD ~~210~~ 216

PROJECT DESCRIPTION STATUS: Preliminary Design Review

GENERAL COMMENTS:

1) Sheet 27 - Headwall details for pipe entrance are missing.

2) Hydraulic grade lines need to be shown on the drawings.

3) Sheet 25 - Some of the existing culverts under roadway areas are not indicated for removal. All existing culverts should be removed if they will be non functional after project completion.

4) There are currently several detention ponds existing in the area that will be "cut-off" when the new drainage system is complete. What happens to the old ponds?

5) Submit complete flow information for the system proposed. ie, pipe capacities, pipe flows (Q100), street flows, inlet flows, and general system design data. It would be convenient to show some of this information on the overall storm drainage layout plan, Sheet 3.

6) Sheet 26 - Is there sufficient street flow on Carmony between Yale and Alexander to require eight (8) Type "A" inlets? Calculations need to be submitted.

7) Connecting storm drains from inlets to manholes should be designed to connect to manholes at as low an elevation as possible.

8) Sheet 29 - Railroad approval/permit is required for installation of storm facilities in RR right-of-way.

9) Sheet 29 - Manhole at Sta. 18+80 should be 8' dia. std. manhole. Connect 60" pipes directly to manhole, with no line bend.

10) Sheet 29 - No details are shown for the inlet structure Sta. 14+95 in Griegos Pond.

11) Sheet 30,31,32 - No details shown for type "L" inlets.

12) Sheet 33 - Plans indicate cross-flow at intersection of Alexander St. Locate inlets to prevent gutter cross-flow.

13) Manholes for all storm sewer, other than T-type manholes, should be type "E" instead of type "C".

14) Storm sewer in Comanche Rd. from Edith east to the Frontage Road appears to be planned very deep. Investigate designing for shallower depth since line size is small (24"-48") and utility conflicts do not appear to be a problem.

15) Submit final design information upon completion of design sufficient to submit for modification of the FEMA 100 yr. floodplain maps.

finis

FILE COPY

# City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

KEN SCHULTZ
MAYOR

September 27, 1989

Martin Garcia
Bernalillo County Public Works Department
2400 Broadway Boulevard, SE
Albuquerque, New Mexico 87106

RE: REVISED DRAINAGE REPORT FOR SAD 216
RECEIVED JULY 19, 1989

Dear Mr. Garcia:

I have reviewed the responses from your consultant, regarding the drainage comments provided by Carlos Montóya for City Hydrology. The consultant has addressed all the City's comments, the drainage report is thereby approved.

If you have any questions, please do not hesitate to call me at 768-2650.

Cordially,

Gilbert Aldaz, P.E. & L.S.
City/County Floodplain Administrator

GA/bsj
(WP+1138)

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# County of Bernalillo

State of New Mexico

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THOMAS J. MESCALL, PROBATE JUDGE

AUG 1989
Received
PWD/Engineering
Project Review

August 14, 1989

Mr. John Andrews
Andrews Asbury & Robert Inc.
149 Jackson NE
Albuquerque, NM 87103

Mr. Andrews:

As of this date our office has not received a letter of concurrence on the submittal dates shown in our letter of July 28, 1989 to your firm.

Please respond by August 21, 1989 with either a letter of concurrence on the submittal dates or a project schedule with justification for the change on the submittal dates.

Sincerely,

John Ramsey
Public Works Director

JR:MRG:srf

xc: B. A. Romero, Engineering Manager
M. J. Garcia, SAD Engineer
C. Lovato, Project Engineer
L. Lunsford, City of Albuquerque SAD Engineer
C. Montoya, City of Albuquerque Drainage Engineer
R. Foglesong, Drainage Engineer

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GLADYS M. DAVIS, COUNTY CLERK
JOSEPH F. THOMSON, ASSESSOR
ROBERT H. SCOTT, PROBATE JUDGE

RECEIVED
ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS

| DATE JUL 29 1989 | ANDREWS JA |
|---|---|
| JOB 347 | ASBURY |
| COMMENTS | J.E.M. |
| FILE ☒ | |

July 28, 1989

Mr. John Andrews
Andrews, Asbury & Robert Inc.
149 Jackson NE
Albuquerque, NM 87108

Dear Mr. Andrews;

Per your telephone conversation with Martin Garcia of this office on July 27, 1989, this letter shall amend the dates of our July 24, 1989 letter which specified submittal dates for this project. The submittal dates shall be as follows:

1. July 24, 1989 - Approval of Drainage Report.

2. October 10, 1989 - Preliminary Resolution No. 2, Preliminary Design Phase Documents in a draft form, and Special Assessment Documents in a draft form.

3. October 23, 1989 Resolution No. 2, Preliminary Design Phase Documents, and Special Assessment Documents.

If you have any questions, please call Martin Garcia, who will be able to assist you.

Sincerely,

John Ramsey
Director of Public Works

JR:MG:srf

xc: B. A. Romero, Engineering Manager
M. J. Garcia, SAD Engineer
C. Lovato, Project Engineer
R. Foglesong, Drainage Engineer
L. Lunsford, City of Albuquerque SAD Engineer
Carlos Montoya, City of Albuquerque Drainage Engineer

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THOMAS J. MESCALL, PROBATE JUDGE

July 11, 1989

John Andrews
Andrews, Asbury, & Robert, Inc.
149 Jackson NE
Albuquerque, NM 87108

RE: **DRAINAGE REPORT FOR SAD BC-83-1**

Mr. Andrews:

Attached are the comments for the drainage report your firm submitted on June 16, 1989 for this project. In an effort to keep this project within schedule we ask that you address these comments and re-submit a revised drainage report by Wednesday, July 19, 1989.

Sincerely,

John Ramsey
Public Works Director

JR:MG:srf

xc: B. A. Romero, Engineering Manager
Carl Lovato, Project Engineer
M. Garcia, SAD Engineer
C. Montoya, City of Albuquerque Public Works
Lee Lunsford, City of Albuquerque Public Works
R. Foglesong, Drainage Engineer

BOARD OF COUNTY COMMISSIONERS
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ALEX ABEYTA, COUNTY MANAGER

July 11, 1989

# County of Bernalillo

State of New Mexico

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THOMAS J. MESCALL, PROBATE JUDGE

BERNALILLO COUNTY PUBLIC WORKS COMMENTS:

1. Drainage area C-4 is not identified on drainage area map.

2. The last paragraph on page 4 is contradictory.

3. The last paragraph on page 5 - Drainage Area Boundaries should be identical -- not similar.

4. Page 28 in reference to right-of-way -- right-of-way costs are assessable for storm drainage systems.

5. At Analysis Point No. 2, the time to peak is shown as 33 minutes. Downstream, at Analysis Point No. 3 the time to peak is 18 minutes. Please clarify.

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# County of Bernalillo

State of New Mexico

2400 BROADWAY S.E.
ALBUQUERQUE, NEW MEXICO 87102

RECEIVED
JUL 27 1989
HYDROLOGY SECTION

ALVIN W. CAMPBELL, SHERIFF
PATRICK J. PADILLA, TREASURER
GLADYS M. DAVIS, CLERK
SAM L. PEREA, ASSESSOR
THOMAS J. MESCALL, PROBATE JUDGE

July 24, 1989

Mr. John Andrews
Andrews, Asbury, & Robert Inc.
149 Jackson NE
Albuquerque, NM 87103

RE: Special Assessment District BC-83-1 - Drainage Report/
Design Submittal Dates.

Mr. Andrews:

The Drainage Report and Amendment to the Drainage Report submitted by your firm on June 16, 1989 and July 19, 1989 respectively are hereby approved as of June 24, 1989. We request that Item No. 4 on page one of the amendment dated July 19, 1989 be revised to read "assessable" rather than accessible".

We concur with your recommendation that the "Free Dishcarge" alternate be the preferred alternate for design. However approval of this alternate is conditional upon your demonstration to us that the benefits of the alternate exceed the costs of the improvements.

It is requested that you proceed with Preliminary Design Documents as identified in Exhibit I-9 of Supplemental Agreement No. 2 to Engineering Services Agreement Dated June 8, 1988. This letter shall establish dates for the following submittals:

1. September 12, 1989 - Preliminary Resolution No. 2, Preliminary Design Phase Documents in a draft form, and Special Assessment Documents in a draft form.

2. September 24, 1989 - Resolution No. 2, Preliminary Design Phase Documents, and Special Assessment Documents.

If you have any questions on the preceding, please call Martin Garcia who will be able to assist you.

Sincerely,

John Ramsey
Director of Public Works

JR:MG:srf

xc: B. A. Romero, Engineering Manager
M. J. Garcia, SAD Engineer
C. Lovato, Project Engineer
R. Foglesong, Drainage Engineer
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