Return to
Tim Mitros

DRAINAGE MEMORANDUM FOR PIKES PEAK COMMUNITY COLLEGE NORTH CAMPUS COLORADO SPRINGS, COLORADO EL PASO COUNTY

October 7, 1996

URS Greiner

DRAINAGE MEMORANDUM FOR
PIKES PEAK COMMUNITY COLLEGE
NORTH CAMPUS
COLORADO SPRINGS, COLORADO
EL PASO COUNTY

October 7, 1996

Prepared for:
DAVIS PARTNERSHIP, P.C.
1175 Sherman Street, Suiite 3100
DENVER, CO 80203-3027

Prepared by:
URS CONSULTANTS, INC.
1040 S. 8TH STREET, SUITE 100
COLORADO SPRINGS, CO 80906

URS PROJECT NO. 67.42154

Drainage Memorandum
for Pikes Peak Community College North Campus

I. GENERAL LOCATION AND PROPERTY DESCRIPTION

The Pikes Peak Community College (PPCC) North Campus is located along the northern Colorado Springs city limits. The site is bounded to the north by state highway 83 (SH-83), proposed Fairlane Technology Park to the south, New Life Church to the west, and unplatted land to the east. Other development within proximity to the site include the International Bible Society in the Northgate Development to the north.

The site is located within the northwest 1/4 of Section 21, Township 12 south, Range 67 west and consists of approximately 75 acres as shown on Figure 1. Planned development consists of a 121,000 sqft building on a 60,000 sqft footprint. Full development of the site is not currently known.

The terrain is generally flat with gentle slopes ranging between 1% to 2% from the northeast to the southwest. A high point is located at the center of the property extending from near the northern property line. The vegetation is typical eastern Colorado prairie grasses with no shrubs. There are no well defined drainages on the property. Runoff generally sheet flows through the property before being intercepted by drainage ditches located outside of the property.

The site and surrounding areas have soil characteristics of Hydrologic Soil group A with isolated areas having characteristics of Hydrologic Soil Group B as classified by the Soil Conservation Service.

There are no irrigation facilities, utilities, or other encumbrances that affect the drainage analysis.

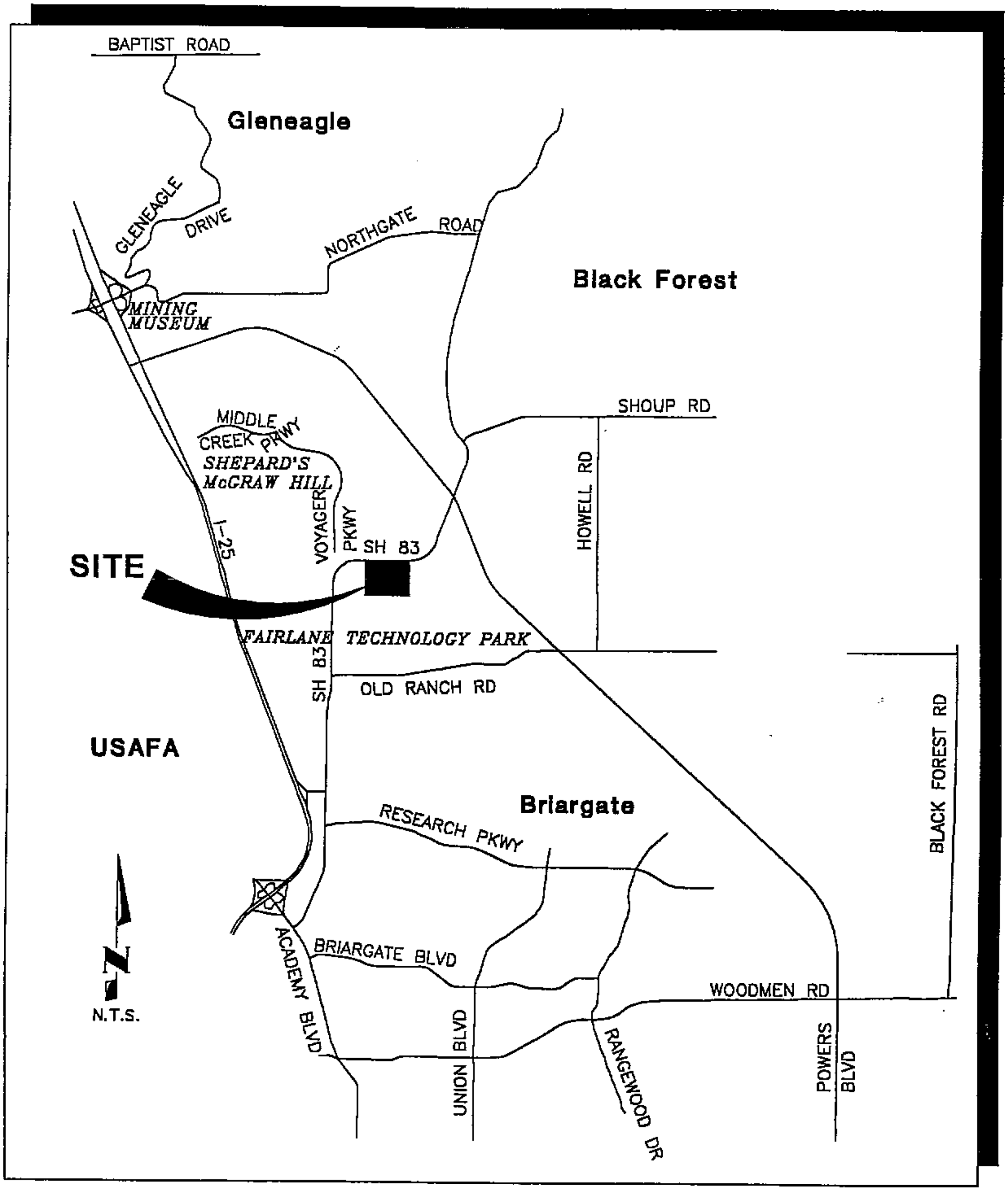
No portion of this site is located within a designated FEMA Floodplain.

II. DRAINAGE BASINS AND SUB-BASINS

The following report was used as a reference in developing this Drainage Memorandum:

Title:	<u>Fairlane Technology Park</u> <u>Master Development Drainage Report</u>
Date:	October 22, 1993, Revised January 6, 1994
Owner:	Ford Colorado Properties
Engineer:	URS Consultants, Inc.

This report makes certain assumptions that would require the implementation of proposed regional detention facilities based on the then current 10 year and 100 year design storms. To this date, improvements as discussed in the MDDP have been minimal in regards to the immediate area around the proposed site. Detention pond "A" has been constructed southwest of the site, north of



VICINITY MAP

FIG1.DWG RJS 09/05/96

URS CONSULTANTS, INC.
COLORADO SPRINGS, COLORADO

PROJ NO. 67.42154

PIKES PEAK COMMMUNITY COLLEGE
NORTH CAMPUS BUILDING

FIGURE 1

Old Ranch Road and east of I-25. Detention pond "A" serves the development within the southern portion of Fairlaine Technology Park. Detention pond "B" is proposed east of I-25, west of SH-83 and south of Stout Allen Road. Development that will trigger the need for detention pond "B" is not currently known. Adjacent property owners have constructed on-site detention facilities to meet the historical flow requirements. It is anticipated that improvements to Stout Allen will constitute a need for the proposed pond.

The site is located between the Black Squirrel and Kettle Creek Basins and drains directly into Monument Creek, west of the Air Force Academy property line. Off- site flows as identified in the MDDP were Basin O-1 and O-2. Basin O-1 enters the eastern property line and drains to the south into the Kettle Creek Basin. Basin O-2 is conveyed beneath SH-83 via a 24" corrugated metal pipe (CMP) along the north property line. Flow is intercepted by a roadside ditch traversing along SH-83 to the west.

The 74 acre site was considered as a basin for drainage analysis purposes. Historic and developed flows were analyzed to determin allowable flow release rates from the site. The site was subdivided into sub-basin 1-1 and sub-basin 1-2. Sub-basin 1-1 consists of the developed area of the site, which includes the building and parking facilities. Sub-basin 1-2 largely consists of undeveloped areas not intercepted by a roadside ditch along the access road.

The existing basins lying in and around the proposed development are illustrated in Figures 2 and 3.

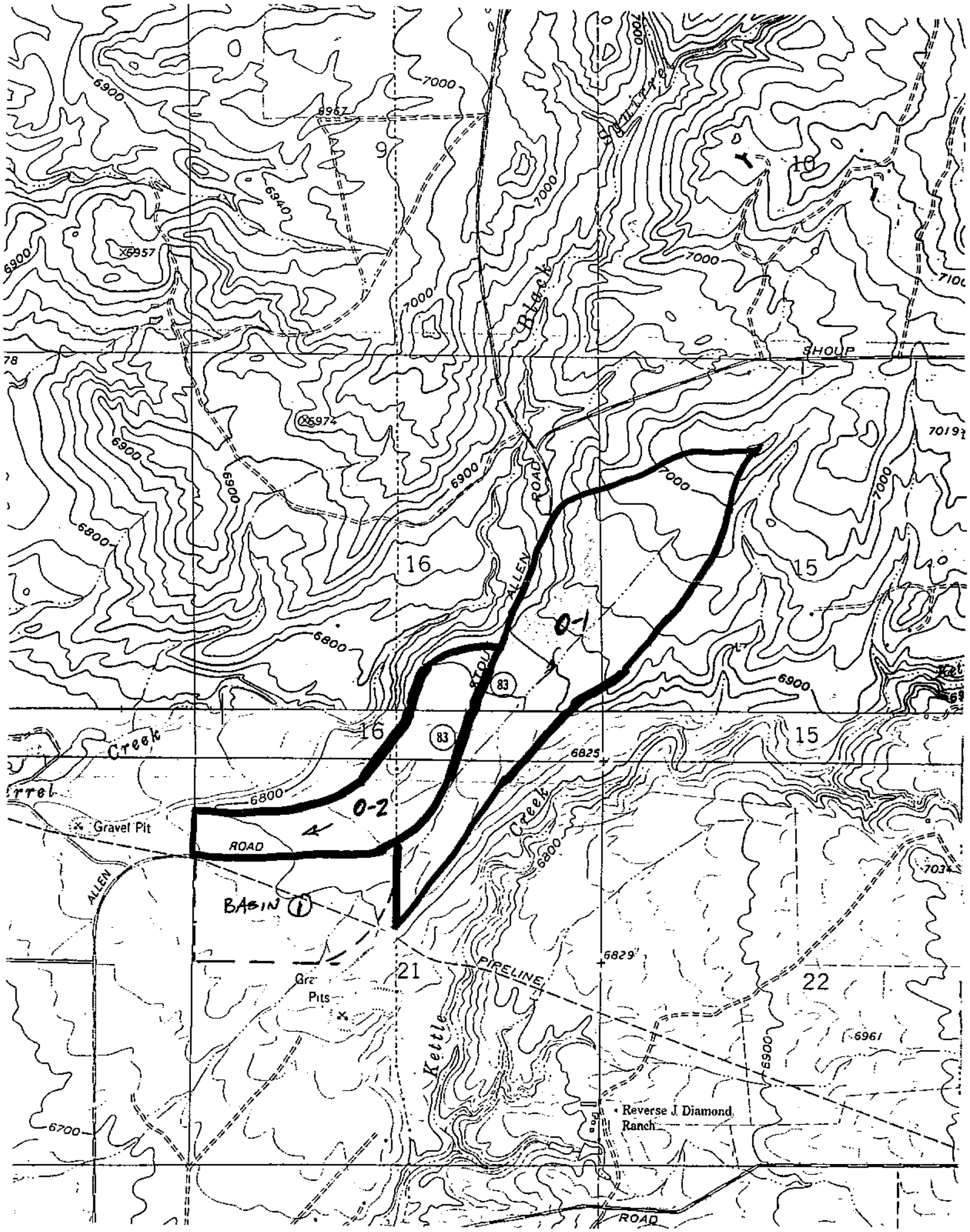
III. DRAINAGE DESIGN CRITERIA

A. SCS Hydrologic Criteria

Basin areas were calculated using a planimeter on USGS topographic maps and working drawings. Time of concentration was estimated using the SCS procedures described in the Drainage Criteria Manual. Based upon the Drainage Criteria Manual requirement to use type B soil conditions for type A soils after development, the SCS curve number selected from Table 5-5 of the Drainage Criteria Manual for undeveloped conditions was 68 and 75 for developed conditions. The 100-year, 24 hour storm rainfall intensity selected from the NOAA isopluvial map in Figure 5-4e from the Drainage Criteria Manual was 4.4 inches per hour. The 5-year, 24 hour storm rainfall intensity selected from the NOAA isopluvial maps was 2.6 inches per hour.

The HEC-1 computer model results and SCS calculations are located in the Appendix.

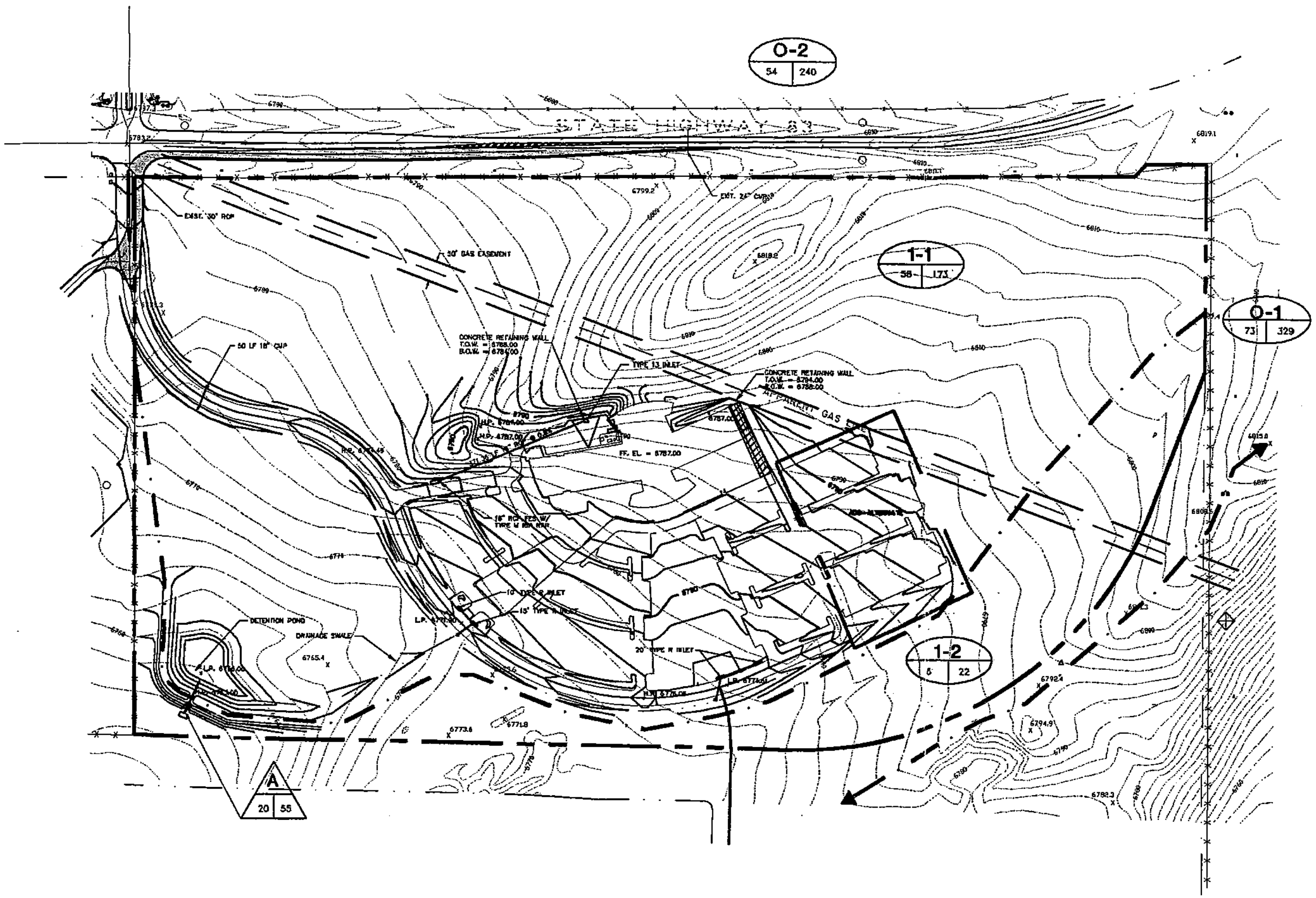
Peak design flows are also shown on the drainage design drawing and tabulated in Table 1.



HISTORIC BASIN MAP

FIG1.DWG RJS 09/05/96

URS CONSULTANTS, INC. COLORADO SPRINGS, COLORADO PROJ NO. 67.42154	PIKES PEAK COMMMUNITY COLLEGE NORTH CAMPUS BUILDING	FIGURE 2



1"=300'

300 0 300 600

PIKES PEAK COMMUNITY COLLEGE
NORTH CAMPUS BUILDING

DEVELOPED DRAINAGE BASIN MAP

LEGEND

O-2 (5 YR/24 HR, 100 YR/24 HR)	BASIN NO.
A (5 YR/24 HR, 100 YR/24 HR)	DESIGN POINT
— — —	SITE BASIN BOUNDARY
— · —	SITE SUB-BASIN/OFF SITE-BASIN
======	EXISTING CONTOURS
═════	PROPOSED CONTOURS

URS CONSULTANTS, INC.

PROJ. NO. 67.42154

FIGURE 3

RJS 09/05/96

Table 1
Summary of Basin Flows

Basin No.	Historic Q5 Q100 (cfs)	Developed Q5 Q100 (cfs)	Flow (+) increase (-) decrease (cfs)	% Change (+) increase (-) decrease
O-1	73	n/a	n/a	n/a
	329	n/a	n/a	n/a
O-2	54	n/a	n/a	n/a
	240	n/a	n/a	n/a
Basin 1	37	63	26	70.3%
	147	196	49	33.3%
Sub-basin 1-1	31	58	27	87.1%
	124	173	49	39.5%
Sub-basin 1-2	6	n/a	n/a	n/a
	22	n/a	n/a	n/a
Sub-basin 1-1*	31	20	-11	-35.5%
(Design Pt. A)	124	55	-69	-55.6%
Sub-basin 1-1 (+) 1-2	37	26	-11	-29.7%
	146	77	-69	-47.3%

* Denotes HEC-1 Run w/ Detention Pond

B. Detention Ponds

An iterative process utilizing HEC-1 detention pond routing was used to size the required detention pond facilities. Release rates from the detention pond (sub-basin 1-1) when combined with historic flows from sub-basin 1-2 was maintained below historic levels for the site basin 1.

III. Drainage Facility Design

General

Off-site flows entering the site will continue to follow historic patterns. Proposed development will not alter these drainage patterns. Historic flow patterns within the site will be altered by development. Sub-basin 1-1 will sheetflow through out the basin and will be intercepted by natural drainage ways and roadside ditches located along the internal access road. Flow will be conveyed to the detention pond to release at below historic rates. Sub-basin 1-2 will follow historic patterns and will not be altered. The detention pond will decrease the developed flow leaving the entire site to 26 cubic feet per second (cfs) and 77 cfs for the 5 and 100 year storms, respectively.

Detention Facilities

A detention pond will be located at the southwest corner of the property to maintain flowrates leaving the property at historic levels or below. Flow intercepted by drainage swales will be directed to the pond. The outlet structure will consist of a single 36" Reinforced Concrete Pipe (RCP) with an invert elevation of 6757.50 ft and invert out elevation of 6755.00. The culvert will discharge into a riprap stilling basin to dissipate energy and overflow to follow historic sheetflow drainage patterns. The pond will have a surface area of 1.4 acres and a storage volume of 4.4 acre-ft. The maximum stage and discharge elevation for the 100 year and 5 year storm is 6762.00 ft. and 55 cfs and 6758.53 and 23 cfs, respectively. A 20 ft. wide emergency spillway with an elevation of 6763.00 ft. will be in place should the outlet structure become inoperable. The spillway will be capable of passing the 100 year design storm. The detention pond will consist of a trapezoidal berm with a 5:1 slope at the upstream face and a 3:1 slope on the downstream face. Buried rip rap will be used along the emergency spillway to reduce erosion.

Inlets
A CDOT Type 13 inlet will be located at a low point in the rear service area of the building. This will drain local runoff from the rear parking area, roof and embankment. An 18" RCP will convey flow to a drainage swale and eventually discharge to the detention pond.

Four CDOT Type R inlets will be used to collect surface runoff from the parking areas. The inlets will consist of 10 ft., 15 ft., and two 20 ft. Runoff will spill onto the internal access road and be intercepted by inlets as shown on figure 3. Runoff will then be discharged into the drainage swale and into the detention pond.

Area drain inlets will be located near the building to capture local runoff directed into them. The area drains will consist of a 12" x 12" perforeted lid and discharge into the roof drain collection system. Collection lines will discharge into standard 4 ft. diameter manholes, and ultimately downstream into CDOT Type R inlets described above via 10"/12" PVC pipe.

Culverts
A 36" CMP with flared end sections will be located along a sump condition along the internal access road and convey flow from the north to the south side of the road. Extension of an existing 30" RCP located at the highway access south of SH-83 and Jet Stream Drive will be installed as required by the proposed paving in the area.

IV. EROSION CONTROL

The contractor will be responsible for implementing best management practices to prevent the loss of soil from the site. During construction the detention pond will act as the primary erosion control feature as runoff will deposit suspended solids. Periodic maintenance will be required during construction. Silt fences and hay bales will be utilized as required to minimize site erosion. Commercially available products will be utilized to prevent the erosion of all areas of cut and fill.

APPENDICES

EXHIBIT 5.5-2

URS Consultants, Inc.
CALCULATION COVER SHEET

Client: Davis Partnership **Project Name:** PPCC
Project/Calculation Number: 42154
Title: DRAINAGE Analysis.
Total number of pages (including cover sheet): 10
Total number of computer runs: 4
Prepared by: Ron Sanchez **Date:** 2/96
Checked by: Charles H. Cothern **Date:** 8/25/96

Description and Purpose:
Determine Historic + Developed Flows for site.

Design bases/references/assumptions:
City/County Drainage Manual.
HEC-1

Remarks/conclusions:

$Q_{H_{100}} = 147$ cfs $Q_{D_{100}} = 196$ cfs

$Q_{H_5} = 37$ cfs $Q_{D_5} = 63$ cfs

Calculation Approved by: Charles H. Cothern 8/25/96
Project Manager/Date

Revision No.:	**Description of Revision:**	**Approved by:**

Project Manager/Date

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*      BY THE COE IN FEBRUARY 1981      *
*           REVISED 02 AUG 88           *
*                                       *
*  RUN DATE  02/26/1996  TIME  09:13:11 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*     DODSON AND ASSOCIATES, INC.       *
*   HYDROLOGIST AND CIVIL ENGINEERS     *
*      7015 W TIDWELL SUITE 107         *
*        HOUSTON, TEXAS  77092          *
*           (713) 895-8322              *
*                                       *
*****************************************
```

CKC 8/25/96

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

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

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

```
                                      HEC-1 INPUT                                                PAGE  1

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

   1          ID        MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154-5H.INP
   2          ID        USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
   3          ID        USING THE   5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
   4          ID        RUN DATE 02-1996
              *DIAGRAM
   5          IT       5 02FEB96     800     300
   6          IO       5

   7          KK    BAS-1
   8          KM       RUNOFF FROM BASIN 1
   9          BA    .116
  10          LS       0      68
  11          UD    .114
  12          IN      15
  13          PB       0
  14          PC   0.000   0.001   0.004   0.008   0.012   0.016   0.021   0.026   0.031   0.037
  15          PC   0.043   0.049   0.055   0.061   0.066   0.072   0.083   0.101   0.120   0.138
  16          PC   0.156   0.195   0.260   1.040   1.820   1.885   1.950   1.989   2.028   2.054
  17          PC   2.080   2.106   2.132   2.145   2.158   2.171   2.184   2.197   2.210   2.223
  18          PC   2.236   2.246   2.256   2.265   2.275   2.283   2.295   2.304   2.314   2.324
  19          PC   2.334   2.343   2.353   2.362   2.370   2.379   2.387   2.395   2.402   2.410
  20          PC   2.418   2.425   2.431   2.438   2.444   2.451   2.457   2.464   2.470   2.477
  21          PC   2.483   2.490   2.496   2.503   2.509   2.516   2.522   2.529   2.535   2.542
  22          PC   2.548   2.551   2.555   2.558   2.561   2.564   2.568   2.571   2.574   2.577
  23          PC   2.581   2.584   2.587   2.590   2.594   2.597   2.600
  24          ZZ
```

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

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

   7      BAS-1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```


```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*      BY THE COE IN FEBRUARY 1981      *
*           REVISED 02 AUG 88           *
*                                       *
*  RUN DATE  02/26/1996  TIME  09:13:11 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*     DODSON AND ASSOCIATES, INC.       *
*   HYDROLOGIST AND CIVIL ENGINEERS     *
*      7015 W TIDWELL SUITE 107         *
*        HOUSTON, TEXAS  77092          *
*           (713) 895-8322              *
*                                       *
*****************************************
```

```
                    MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154-5H.INP
                    USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
                    USING THE   5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
                    RUN DATE 02-1996

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

  IT        HYDROGRAPH TIME DATA
                  NMIN          5  MINUTES IN COMPUTATION INTERVAL
                 IDATE     2FEB96  STARTING DATE
                 ITIME       0800  STARTING TIME
                    NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE     3FEB96  ENDING DATE
                NDTIME       0855  ENDING TIME
                 ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL    .08 HOURS
                   TOTAL TIME BASE  24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BAS-1	37.	6.08	4.	1.	1.	.12		

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

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*      BY THE COE IN FEBRUARY 1981     *
*          REVISED 02 AUG 88           *
*                                      *
* RUN DATE  02/26/1996  TIME  09:10:34 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*     DODSON AND ASSOCIATES, INC.      *
*  HYDROLOGIST AND CIVIL ENGINEERS     *
*     7015 W TIDWELL SUITE 107         *
*       HOUSTON, TEXAS  77092          *
*          (713) 895-8322              *
*                                      *
****************************************
```

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

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

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

```
                                   HEC-1 INPUT                                        PAGE  1

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

   1        ID        MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154-100H.INP
   2        ID        USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
   3        ID        USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
   4        ID        RUN DATE 02-1996
            *DIAGRAM
   5        IT       5 02FEB96     800     300
   6        IO       5

   7        KK   BAS-1
   8        KM       RUNOFF FROM BASIN 1
   9        BA    .116
  10        LS       0      68
  11        UD   0.114
  12        IN      15
  13        PB       0
  14        PC   0.000   0.002   0.007   0.013   0.020   0.026   0.035   0.044   0.053   0.063
  15        PC   0.073   0.083   0.092   0.103   0.112   0.122   0.141   0.172   0.202   0.233
  16        PC   0.264   0.330   0.440   1.760   3.080   3.190   3.300   3.366   3.432   3.476
  17        PC   3.520   3.564   3.608   3.630   3.652   3.674   3.696   3.718   3.740   3.762
  18        PC   3.784   3.801   3.817   3.834   3.850   3.867   3.883   3.900   3.916   3.933
  19        PC   3.949   3.966   3.982   3.997   4.011   4.025   4.039   4.052   4.066   4.079
  20        PC   4.092   4.103   4.114   4.125   4.136   4.147   4.158   4.169   4.180   4.191
  21        PC   4.202   4.213   4.224   4.235   4.246   4.257   4.268   4.279   4.290   4.301
  22        PC   4.312   4.318   4.323   4.329   4.334   4.340   4.345   4.351   4.356   4.362
  23        PC   4.367   4.373   4.378   4.384   4.389   4.395   4.400
  24        ZZ
```

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

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

   7       BAS-1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```


```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*      BY THE COE IN FEBRUARY 1981     *
*          REVISED 02 AUG 88           *
*                                      *
* RUN DATE  02/26/1996  TIME  09:10:34 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*     DODSON AND ASSOCIATES, INC.      *
*  HYDROLOGIST AND CIVIL ENGINEERS     *
*     7015 W TIDWELL SUITE 107         *
*       HOUSTON, TEXAS  77092          *
*          (713) 895-8322              *
*                                      *
****************************************
```

```
                    MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154-100H.INP
                    USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
                    USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
                    RUN DATE 02-1996

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

  IT        HYDROGRAPH TIME DATA
                   NMIN            5  MINUTES IN COMPUTATION INTERVAL
                  IDATE       2FEB96  STARTING DATE
                  ITIME         0800  STARTING TIME
                     NQ          300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE       3FEB96  ENDING DATE
                 NDTIME         0855  ENDING TIME
                  ICENT           19  CENTURY MARK

              COMPUTATION INTERVAL     .08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BAS-1	147.	6.00	14.	5.	4.	.12		

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

```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*     BY THE COE IN FEBRUARY 1981      *
*          REVISED 02 AUG 88           *
*                                      *
* RUN DATE  02/26/1996  TIME  09:16:11 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*     DODSON AND ASSOCIATES, INC.      *
*   HYDROLOGIST AND CIVIL ENGINEERS    *
*      7015 W TIDWELL SUITE 107        *
*        HOUSTON, TEXAS  77092         *
*           (713) 895-8322             *
*                                      *
****************************************
```

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

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

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


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

  1         ID         MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154-5D.INP
  2         ID         USING UNDEVELOPED CRITERIA TO DETERMINE DEVELOPED FLOWS
  3         ID         USING THE   5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
  4         ID         RUN DATE 02-1996
            *DIAGRAM
  5         IT       5 02FEB96     800     300
  6         IO       5

  7         KK   BAS-1
  8         KM        RUNOFF FROM BASIN 1
  9         BA    .116
 10         LS       0      74
 11         UD    .114
 12         IN      15
 13         PB       0
 14         PC   0.000   0.001   0.004   0.008   0.012   0.016   0.021   0.026   0.031   0.037
 15         PC   0.043   0.049   0.055   0.061   0.066   0.072   0.083   0.101   0.120   0.138
 16         PC   0.156   0.195   0.260   1.040   1.820   1.885   1.950   1.989   2.028   2.054
 17         PC   2.080   2.106   2.132   2.145   2.158   2.171   2.184   2.197   2.210   2.223
 18         PC   2.236   2.246   2.256   2.265   2.275   2.283   2.295   2.304   2.314   2.324
 19         PC   2.334   2.343   2.353   2.362   2.370   2.379   2.387   2.395   2.402   2.410
 20         PC   2.418   2.425   2.431   2.438   2.444   2.451   2.457   2.464   2.470   2.477
 21         PC   2.483   2.490   2.496   2.503   2.509   2.516   2.522   2.529   2.535   2.542
 22         PC   2.548   2.551   2.555   2.558   2.561   2.564   2.568   2.571   2.574   2.577
 23         PC   2.581   2.584   2.587   2.590   2.594   2.597   2.600
 24         ZZ
```

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

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

   7      BAS-1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```


```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*     BY THE COE IN FEBRUARY 1981      *
*          REVISED 02 AUG 88           *
*                                      *
* RUN DATE  02/26/1996  TIME  09:16:11 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*     DODSON AND ASSOCIATES, INC.      *
*   HYDROLOGIST AND CIVIL ENGINEERS    *
*      7015 W TIDWELL SUITE 107        *
*        HOUSTON, TEXAS  77092         *
*           (713) 895-8322             *
*                                      *
****************************************
```

MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154-5D.INP
USING UNDEVELOPED CRITERIA TO DETERMINE DEVELOPED FLOWS
USING THE 5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
RUN DATE 02-1996

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

  IT          HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     2FEB96  STARTING DATE
                   ITIME       0800  STARTING TIME
                      NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     3FEB96  ENDING DATE
                  NDTIME       0855  ENDING TIME
                   ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL    .08 HOURS
                 TOTAL TIME BASE  24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BAS-1	63.	6.00	6.	2.	2.	.12		

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

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*     BY THE COE IN FEBRUARY 1981       *
*          REVISED 02 AUG 88            *
*                                       *
* RUN DATE  02/26/1996  TIME  09:14:53  *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*     DODSON AND ASSOCIATES, INC.       *
*  HYDROLOGIST AND CIVIL ENGINEERS      *
*     7015 W TIDWELL SUITE 107          *
*       HOUSTON, TEXAS  77092           *
*          (713) 895-8322               *
*                                       *
*****************************************
```

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

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

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


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

  1         ID        MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154-100D.INP
  2         ID        USING UNDEVELOPED CRITERIA TO DETERMINE DEVELOPED FLOWS
  3         ID        USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
  4         ID        RUN DATE 02-1996
            *DIAGRAM
  5         IT       5 02FEB96     800     300
  6         IO       5

  7         KK   BAS-1
  8         KM       RUNOFF FROM BASIN 1
  9         BA    .116
 10         LS       0      74
 11         UD   0.114
 12         IN      15
 13         PB       0
 14         PC   0.000   0.002   0.007   0.013   0.020   0.026   0.035   0.044   0.053   0.063
 15         PC   0.073   0.083   0.092   0.103   0.112   0.122   0.141   0.172   0.202   0.233
 16         PC   0.264   0.330   0.440   1.760   3.080   3.190   3.300   3.366   3.432   3.476
 17         PC   3.520   3.564   3.608   3.630   3.652   3.674   3.696   3.718   3.740   3.762
 18         PC   3.784   3.801   3.817   3.834   3.850   3.867   3.883   3.900   3.916   3.933
 19         PC   3.949   3.966   3.982   3.997   4.011   4.025   4.039   4.052   4.066   4.079
 20         PC   4.092   4.103   4.114   4.125   4.136   4.147   4.158   4.169   4.180   4.191
 21         PC   4.202   4.213   4.224   4.235   4.246   4.257   4.268   4.279   4.290   4.301
 22         PC   4.312   4.318   4.323   4.329   4.334   4.340   4.345   4.351   4.356   4.362
 23         PC   4.367   4.373   4.378   4.384   4.389   4.395   4.400
 24         ZZ
```

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

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

   7       BAS-1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*     BY THE COE IN FEBRUARY 1981       *
*          REVISED 02 AUG 88            *
*                                       *
*  RUN DATE  02/26/1996  TIME  09:14:53 *
*                                       *
*****************************************
```

```
***************************************
*                                     *
*    DODSON AND ASSOCIATES, INC.      *
*  HYDROLOGIST AND CIVIL ENGINEERS    *
*    7015 W TIDWELL SUITE 107         *
*      HOUSTON, TEXAS  77092          *
*         (713) 895-8322              *
*                                     *
***************************************
```

```
                    MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154-100D.INP
                    USING UNDEVELOPED CRITERIA TO DETERMINE DEVELOPED FLOWS
                    USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
                    RUN DATE 02-1996

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

    IT         HYDROGRAPH TIME DATA
                      NMIN          5  MINUTES IN COMPUTATION INTERVAL
                     IDATE     2FEB96  STARTING DATE
                     ITIME       0800  STARTING TIME
                        NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE     3FEB96  ENDING DATE
                    NDTIME       0855  ENDING TIME
                     ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BAS-1	196.	6.00	19.	6.	6.	.12		

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

URS
CONSULTANTS, INC.

URS JOB NO. 42154 PAGE ___ OF ___
DATE 2/23/96 BY RJS. CHECKED BY exc 8/25/96 (date)
CLIENT Davis Partnership
PROJECT PPC

SUBJECT DRAINAGE

DETERMINE DEVELOPED FLOW

SITE CHARACTERISTICS

Hydrolic soil group: A/B
Elev: High = 6818.2
Low = 6756.
Flow length = 2200 LF.

$T_C = \left(\frac{11.9(L^3)}{H}\right)^{0.385} = \underline{0.19\,hr}$

$T_L = 3/5\,T_C = \underline{0.114\,hr}$

		CN
Acreage =	74.29 ac.	68
Developed Area =	14.45	98
GRASS AREA	1.41	68

$\text{Weighted } \overline{CN} = \frac{14.45(98) + 59.84(68)}{74.29} = 74$ ✓

FROM HEC-1.

HISTORIC FLOW Q_{100} = 147 cfs.
Q_5 = 37 cfs.

Developed Flows Q_{100} = 196 cfs.
Q_5 = 63 cfs.

ΔQ_{100} = 196 - 147 = 49 cfs ~ 33.3%
ΔQ_5 = 63 - 37 = 26 cfs ~ 70.3%.

Drainage.

EXHIBIT 5.3-1
URS Consultants, Inc.
CALCULATION COVER SHEET

Client: Davis Partnership Project Name: PPCC

Project/Calculation Number: 67421524

Title: Historic/ Developed Basin 1 HEC 1 w/ POND.

Total number of pages (including cover sheet): 14

Total number of computer runs: 6

Prepared by: Ron Sanchez Date: 8/30/96

Checked by: Charles K. Cotter Date: 9/1/96

Description and Purpose:

Determine Historic & Developed flows for Basin 1-1, 1-2

Design bases/references/assumptions:

City/County Criteria

HEC-1

Remarks/conclusions:

	Historic	Developed	Developed w/ Pond	TOTAL
Basin 1-1	Q_{100} = 124 cfs	Q_{100} = 173 cfs.	Q_{100} = 55 cfs.	Q_{100} = 77 cfs
	Q_5 = 31 cfs	Q_5 = 58 cfs.	Q_5 = 20 cfs.	Q_5 = 26 cfs
Basin 1-2	Q_{100} = 22 cfs	Q_{100} = N/A		
	Q_5 = 6 cfs	Q_5 = N/A		

Less than Historic for site.

Calculation Approved by: Charles K. Cotter 9/1/96

Project Manager/Date

Revision No.: Description of Revision: Approved by:

Project Manager/Date

OAM 5.3 - 03/10/95

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*      BY THE COE IN FEBRUARY 1981     *
*           REVISED 02 AUG 88          *
*                                      *
* RUN DATE  08/30/1996  TIME  12:11:23 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*     DODSON AND ASSOCIATES, INC.      *
*  HYDROLOGIST AND CIVIL ENGINEERS     *
*     7015 W TIDWELL SUITE 107         *
*       HOUSTON, TEXAS  77092          *
*          (713) 895-8322              *
*                                      *
****************************************
```

CKE 9/1/96

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

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

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


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

   1        ID          MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154B1-5H.INP
   2        ID          USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
   3        ID          USING THE   5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
   4        ID          RUN DATE 02-1996
            *DIAGRAM
   5        IT       5 02FEB96     800     300
   6        IO       5

   7        KK   BS1-1
   8        KM         RUNOFF FROM SUB-BASIN 1-1
   9        BA    .098
  10        LS       0      68
  11        UD   0.114
  12        IN      15
  13        PB       0
  14        PC   0.000   0.001   0.004   0.008   0.012   0.016   0.021   0.026   0.031   0.037
  15        PC   0.043   0.049   0.055   0.061   0.066   0.072   0.083   0.101   0.120   0.138
  16        PC   0.156   0.195   0.260   1.040   1.820   1.885   1.950   1.989   2.028   2.054
  17        PC   2.080   2.106   2.132   2.145   2.158   2.171   2.184   2.197   2.210   2.223
  18        PC   2.236   2.246   2.256   2.265   2.275   2.283   2.295   2.304   2.314   2.324
  19        PC   2.334   2.343   2.353   2.362   2.370   2.379   2.387   2.395   2.402   2.410
  20        PC   2.418   2.425   2.431   2.438   2.444   2.451   2.457   2.464   2.470   2.477
  21        PC   2.483   2.490   2.496   2.503   2.509   2.516   2.522   2.529   2.535   2.542
  22        PC   2.548   2.551   2.555   2.558   2.561   2.564   2.568   2.571   2.574   2.577
  23        PC   2.581   2.584   2.587   2.590   2.594   2.597   2.600
  24        ZZ
```

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

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

   7       BS1-1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```


```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*      BY THE COE IN FEBRUARY 1981     *
*           REVISED 02 AUG 88          *
*                                      *
* RUN DATE  08/30/1996  TIME  12:11:23 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*     DODSON AND ASSOCIATES, INC.      *
*  HYDROLOGIST AND CIVIL ENGINEERS     *
*     7015 W TIDWELL SUITE 107         *
*       HOUSTON, TEXAS  77092          *
*          (713) 895-8322              *
*                                      *
****************************************
```

MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154B1-5H.INP
USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
USING THE 5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
RUN DATE 02-1996

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

  IT          HYDROGRAPH TIME DATA
                    NMIN           5  MINUTES IN COMPUTATION INTERVAL
                   IDATE      2FEB96  STARTING DATE
                   ITIME        0800  STARTING TIME
                      NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE      3FEB96  ENDING DATE
                  NDTIME        0855  ENDING TIME
                  ICENT           19  CENTURY MARK

             COMPUTATION INTERVAL    .08 HOURS
                  TOTAL TIME BASE  24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BS1-1	31.	6.08	3.	1.	1.	.10		

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

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*      BY THE COE IN FEBRUARY 1981      *
*           REVISED 02 AUG 88           *
*                                       *
*  RUN DATE  08/30/1996  TIME  12:07:29 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*     DODSON AND ASSOCIATES, INC.       *
*  HYDROLOGIST AND CIVIL ENGINEERS      *
*     7015 W TIDWELL SUITE 107          *
*       HOUSTON, TEXAS  77092           *
*          (713) 895-8322               *
*                                       *
*****************************************
```

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

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

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

HEC-1 INPUT

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

  1       ID        MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154B1-1H.INP
  2       ID        USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
  3       ID        USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
  4       ID        RUN DATE 02-1996
          *DIAGRAM
  5       IT       5 02FEB96     800     300
  6       IO       5

  7       KK   BS1-1
  8       KM       RUNOFF FROM SUB-BASIN 1-1
  9       BA    .098
 10       LS       0      68
 11       UD   0.114
 12       IN      15
 13       PB       0
 14       PC   0.000   0.002   0.007   0.013   0.020   0.026   0.035   0.044   0.053   0.063
 15       PC   0.073   0.083   0.092   0.103   0.112   0.122   0.141   0.172   0.202   0.233
 16       PC   0.264   0.330   0.440   1.760   3.080   3.190   3.300   3.366   3.432   3.476
 17       PC   3.520   3.564   3.608   3.630   3.652   3.674   3.696   3.718   3.740   3.762
 18       PC   3.784   3.801   3.817   3.834   3.850   3.867   3.883   3.900   3.916   3.933
 19       PC   3.949   3.966   3.982   3.997   4.011   4.025   4.039   4.052   4.066   4.079
 20       PC   4.092   4.103   4.114   4.125   4.136   4.147   4.158   4.169   4.180   4.191
 21       PC   4.202   4.213   4.224   4.235   4.246   4.257   4.268   4.279   4.290   4.301
 22       PC   4.312   4.318   4.323   4.329   4.334   4.340   4.345   4.351   4.356   4.362
 23       PC   4.367   4.373   4.378   4.384   4.389   4.395   4.400
 24       ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

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

   7      BS1-1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```


```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*      BY THE COE IN FEBRUARY 1981      *
*           REVISED 02 AUG 88           *
*                                       *
*  RUN DATE  08/30/1996  TIME  12:07:29 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*     DODSON AND ASSOCIATES, INC.       *
*  HYDROLOGIST AND CIVIL ENGINEERS      *
*     7015 W TIDWELL SUITE 107          *
*       HOUSTON, TEXAS  77092           *
*          (713) 895-8322               *
*                                       *
*****************************************
```

MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154B1-1H.INP
USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
RUN DATE 02-1996

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

  IT          HYDROGRAPH TIME DATA
                     NMIN            5  MINUTES IN COMPUTATION INTERVAL
                    IDATE       2FEB96  STARTING DATE
                    ITIME         0800  STARTING TIME
                       NQ          300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE       3FEB96  ENDING DATE
                   NDTIME         0855  ENDING TIME
                    ICENT           19  CENTURY MARK

                COMPUTATION INTERVAL      .08 HOURS
                     TOTAL TIME BASE    24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BS1-1	124.	6.00	12.	4.	4.	.10		

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

```
*****************************************                    *****************************************
*                                       *                    *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *     DODSON AND ASSOCIATES, INC.       *
*      BY THE COE IN FEBRUARY 1981      *                    *  HYDROLOGIST AND CIVIL ENGINEERS      *
*           REVISED 02 AUG 88           *                    *     7015 W TIDWELL SUITE 107          *
*                                       *                    *       HOUSTON, TEXAS  77092           *
*  RUN DATE  08/30/1996  TIME  12:12:42 *                    *          (713) 895-8322               *
*                                       *                    *                                       *
*****************************************                    *****************************************

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

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

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

```
                                        HEC-1 INPUT                                          PAGE  1

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

   1           ID        MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154B2-5H.INP
   2           ID        USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
   3           ID        USING THE   5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
   4           ID        RUN DATE 02-1996
               *DIAGRAM
   5           IT      5 02FEB96     800     300
   6           IO      5

   7           KK   BS1-2
   8           KM        RUNOFF FROM SUB-BASIN 1-2
   9           BA   .0182
  10           LS      0      68
  11           UD   0.126
  12           IN      15
  13           PB       0
  14           PC   0.000   0.001   0.004   0.008   0.012   0.016   0.021   0.026   0.031   0.037
  15           PC   0.043   0.049   0.055   0.061   0.066   0.072   0.083   0.101   0.120   0.138
  16           PC   0.156   0.195   0.260   1.040   1.820   1.885   1.950   1.989   2.028   2.054
  17           PC   2.080   2.106   2.132   2.145   2.158   2.171   2.184   2.197   2.210   2.223
  18           PC   2.236   2.246   2.256   2.265   2.275   2.283   2.295   2.304   2.314   2.324
  19           PC   2.334   2.343   2.353   2.362   2.370   2.379   2.387   2.395   2.402   2.410
  20           PC   2.418   2.425   2.431   2.438   2.444   2.451   2.457   2.464   2.470   2.477
  21           PC   2.483   2.490   2.496   2.503   2.509   2.516   2.522   2.529   2.535   2.542
  22           PC   2.548   2.551   2.555   2.558   2.561   2.564   2.568   2.571   2.574   2.577
  23           PC   2.581   2.584   2.587   2.590   2.594   2.597   2.600
  24           ZZ

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

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

   7        BS1-2

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```


```
*****************************************                    *****************************************
*                                       *                    *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *     DODSON AND ASSOCIATES, INC.       *
*      BY THE COE IN FEBRUARY 1981      *                    *  HYDROLOGIST AND CIVIL ENGINEERS      *
*           REVISED 02 AUG 88           *                    *     7015 W TIDWELL SUITE 107          *
*                                       *                    *       HOUSTON, TEXAS  77092           *
*  RUN DATE  08/30/1996  TIME  12:12:42 *                    *          (713) 895-8322               *
*                                       *                    *                                       *
*****************************************                    *****************************************
```

MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154B2-5H.INP
USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
USING THE 5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
RUN DATE 02-1996

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

  IT        HYDROGRAPH TIME DATA
                  NMIN          5  MINUTES IN COMPUTATION INTERVAL
                 IDATE     2FEB96  STARTING DATE
                 ITIME       0800  STARTING TIME
                    NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE     3FEB96  ENDING DATE
                NDTIME       0855  ENDING TIME
                 ICENT         19  CENTURY MARK

           COMPUTATION INTERVAL      .08 HOURS
                TOTAL TIME BASE    24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BS1-2	6.	6.08	1.	0.	0.	.02		

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

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*      BY THE COE IN FEBRUARY 1981      *
*           REVISED 02 AUG 88           *
*                                       *
* RUN DATE  08/30/1996  TIME  12:08:31 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*     DODSON AND ASSOCIATES, INC.       *
*   HYDROLOGIST AND CIVIL ENGINEERS     *
*     7015 W TIDWELL SUITE 107          *
*        HOUSTON, TEXAS  77092          *
*           (713) 895-8322              *
*                                       *
*****************************************
```

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

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

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

```
                                  HEC-1 INPUT                                                PAGE  1

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

  1         ID        MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154B2-1H.INP
  2         ID        USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
  3         ID        USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
  4         ID        RUN DATE 02-1996
            *DIAGRAM
  5         IT       5 02FEB96     800     300
  6         IO       5

  7         KK   BS1-2
  8         KM          RUNOFF FROM SUB-BASIN 1-2
  9         BA   .0182
 10         LS       0      68
 11         UD   0.126
 12         IN      15
 13         PB       0
 14         PC   0.000   0.002   0.007   0.013   0.020   0.026   0.035   0.044   0.053   0.063
 15         PC   0.073   0.083   0.092   0.103   0.112   0.122   0.141   0.172   0.202   0.233
 16         PC   0.264   0.330   0.440   1.760   3.080   3.190   3.300   3.366   3.432   3.476
 17         PC   3.520   3.564   3.608   3.630   3.652   3.674   3.696   3.718   3.740   3.762
 18         PC   3.784   3.801   3.817   3.834   3.850   3.867   3.883   3.900   3.916   3.933
 19         PC   3.949   3.966   3.982   3.997   4.011   4.025   4.039   4.052   4.066   4.079
 20         PC   4.092   4.103   4.114   4.125   4.136   4.147   4.158   4.169   4.180   4.191
 21         PC   4.202   4.213   4.224   4.235   4.246   4.257   4.268   4.279   4.290   4.301
 22         PC   4.312   4.318   4.323   4.329   4.334   4.340   4.345   4.351   4.356   4.362
 23         PC   4.367   4.373   4.378   4.384   4.389   4.395   4.400
 24         ZZ
```

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

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

   7      BS1-2

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```


```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*      BY THE COE IN FEBRUARY 1981      *
*           REVISED 02 AUG 88           *
*                                       *
* RUN DATE  08/30/1996  TIME  12:08:31 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*     DODSON AND ASSOCIATES, INC.       *
*   HYDROLOGIST AND CIVIL ENGINEERS     *
*     7015 W TIDWELL SUITE 107          *
*        HOUSTON, TEXAS  77092          *
*           (713) 895-8322              *
*                                       *
*****************************************
```

MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154B2-1H.INP
USING UNDEVELOPED CRITERIA TO DETERMINE HISTORIC FLOWS
USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
RUN DATE 02-1996

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

  IT        HYDROGRAPH TIME DATA
                  NMIN          5  MINUTES IN COMPUTATION INTERVAL
                 IDATE     2FEB96  STARTING DATE
                 ITIME       0800  STARTING TIME
                    NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE     3FEB96  ENDING DATE
                NDTIME       0855  ENDING TIME
                 ICENT         19  CENTURY MARK

          COMPUTATION INTERVAL      .08 HOURS
               TOTAL TIME BASE    24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BS1-2	22.	6.00	2.	1.	1.	.02		

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

```
****************************************                    ****************************************
*                                      *                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *     DODSON AND ASSOCIATES, INC.      *
*      BY THE COE IN FEBRUARY 1981     *                    *  HYDROLOGIST AND CIVIL ENGINEERS     *
*           REVISED 02 AUG 88          *                    *     7015 W TIDWELL SUITE 107         *
*                                      *                    *        HOUSTON, TEXAS  77092         *
*  RUN DATE  08/15/1996  TIME  16:04:46 *                   *           (713) 895-8322             *
*                                      *                    *                                      *
****************************************                    ****************************************
```

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

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

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


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

  1           ID        MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154D1-1D.INP
  2           ID         USING  DEVELOPED CRITERIA TO DETERMINE  DEVELOPED FLOWS W/ DET.POND
  3           ID        USING THE   5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
  4           ID       OUTLET STRUCTURE: 36" CMP
  5           ID       RUN DATE : 08/08/96
              *DIAGRAM
  6           IT       5 02FEB96     800     300
  7           IO       5

  8           KK   BAS-1
  9           KM       RUNOFF FROM BASIN 1
 10           BA    .098
 11           LS       0      75
 12           UD   0.114
 13           IN      15
 14           PB       0
 15           PC   0.000   0.001   0.004   0.008   0.012   0.016   0.021   0.026   0.031   0.037
 16           PC   0.043   0.049   0.055   0.061   0.066   0.072   0.083   0.101   0.120   0.138
 17           PC   0.156   0.195   0.260   1.040   1.820   1.885   1.950   1.989   2.028   2.054
 18           PC   2.080   2.106   2.132   2.145   2.158   2.171   2.184   2.197   2.210   2.223
 19           PC   2.236   2.246   2.256   2.265   2.275   2.283   2.295   2.304   2.314   2.324
 20           PC   2.334   2.343   2.353   2.362   2.370   2.379   2.387   2.395   2.402   2.410
 21           PC   2.418   2.425   2.431   2.438   2.444   2.451   2.457   2.464   2.470   2.477
 22           PC   2.483   2.490   2.496   2.503   2.509   2.516   2.522   2.529   2.535   2.542
 23           PC   2.548   2.551   2.555   2.558   2.561   2.564   2.568   2.571   2.574   2.577
 24           PC   2.581   2.584   2.587   2.590   2.594   2.597   2.600

 25           KK   DPOUT
 26           KM       ROUTE POND THROUGH 1-36" CMP
 27           SV       0     .75    1.92    3.67   4.425   5.175   5.175
 28           SE    6756    6758    6760    6762    6763    6764    6765
 29           SQ       0      15      35      55      62     137     268
 30           RS       1    ELEV    6756
 31           ZZ
```

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

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

   8      BAS-1
              V
              V
  25      DPOUT

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```


```
****************************************                    ****************************************
*                                      *                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *     DODSON AND ASSOCIATES, INC.      *
```

```
*      BY THE COE IN FEBRUARY 1981        *
*           REVISED 02 AUG 88             *
*                                         *
  RUN DATE  08/15/1996  TIME  16:04:46 *
*                                         *
*******************************************
```


```
*   HYDROLOGIST AND CIVIL ENGINEERS   *
*      7015 W TIDWELL SUITE 107       *
*        HOUSTON, TEXAS  77092        *
*          (713) 895-8322             *
*                                     *
***************************************
```


```
                MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 15401-1D.INP
                 USING  DEVELOPED CRITERIA TO DETERMINE  DEVELOPED FLOWS W/ DET.POND
                USING THE   5-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
               OUTLET STRUCTURE: 36" CMP
               RUN DATE : 08/08/96

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

   IT         HYDROGRAPH TIME DATA
                     NMIN           5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      2FEB96  STARTING DATE
                    ITIME        0800  STARTING TIME
                       NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      3FEB96  ENDING DATE
                   NDTIME        0855  ENDING TIME
                    ICENT          19  CENTURY MARK

               COMPUTATION INTERVAL     .08 HOURS
                    TOTAL TIME BASE   24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BAS-1	58.	6.00	6.	2.	2.	.10		
ROUTED TO	DPOUT	20.	6.25	6.	2.	2.	.10	6758.53	6.25

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

```
*****************************************                              ***************************************
*                                       *                              *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                              *     DODSON AND ASSOCIATES, INC.     *
*       BY THE COE IN FEBRUARY 1981     *                              *  HYDROLOGIST AND CIVIL ENGINEERS    *
*            REVISED 02 AUG 88          *                              *     7015 W TIDWELL SUITE 107        *
*                                       *                              *       HOUSTON, TEXAS  77092         *
*  RUN DATE  08/15/1996  TIME  11:51:13 *                              *         (713) 895-8322              *
*                                       *                              *                                     *
*****************************************                              ***************************************


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


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

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


                                    HEC-1 INPUT                                                   PAGE  1

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

  1           ID         MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154D1-1D.INP
  2           ID          USING  DEVELOPED CRITERIA TO DETERMINE  DEVELOPED FLOWS W/ DET.POND
  3           ID         USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
  4           ID        OUTLET STRUCTURE: 36" CMP
  5           ID        RUN DATE : 08/08/96
              *DIAGRAM
  6           IT       5 02FEB96     800     300
  7           IO       5

  8           KK   BAS-1
  9           KM        RUNOFF FROM BASIN 1
 10           BA    .098
 11           LS       0      75
 12           UD   0.114
 13           IN      15
 14           PB       0
 15           PC   0.000   0.002   0.007   0.013   0.020   0.026   0.035   0.044   0.053   0.063
 16           PC   0.073   0.083   0.092   0.103   0.112   0.122   0.141   0.172   0.202   0.233
 17           PC   0.264   0.330   0.440   1.760   3.080   3.190   3.300   3.366   3.432   3.476
 18           PC   3.520   3.564   3.608   3.630   3.652   3.674   3.696   3.718   3.740   3.762
 19           PC   3.784   3.801   3.817   3.834   3.850   3.867   3.883   3.900   3.916   3.933
 20           PC   3.949   3.966   3.982   3.997   4.011   4.025   4.039   4.052   4.066   4.079
 21           PC   4.092   4.103   4.114   4.125   4.136   4.147   4.158   4.169   4.180   4.191
 22           PC   4.202   4.213   4.224   4.235   4.246   4.257   4.268   4.279   4.290   4.301
 23           PC   4.312   4.318   4.323   4.329   4.334   4.340   4.345   4.351   4.356   4.362
 24           PC   4.367   4.373   4.378   4.384   4.389   4.395   4.400

 25           KK   DPOUT
 26           KM        ROUTE POND THROUGH 1-36" CMP
 27           SV       0     .75    1.92    3.67   4.425   5.175   5.175
 28           SE    6756    6758    6760    6762    6763    6764    6765
 29           SQ       0      15      35      55      62     137     268
 30           RS       1    ELEV    6756
 31           ZZ

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

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

   8      BAS-1
             V
             V
  25      DPOUT

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
*****************************************                              ***************************************
*                                       *                              *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                              *     DODSON AND ASSOCIATES, INC.     *
```

```
*     BY THE COE IN FEBRUARY 1981      *        *   HYDROLOGIST AND CIVIL ENGINEERS   *
*          REVISED 02 AUG 88           *        *       7015 W TIDWELL SUITE 107      *
*                                      *        *        HOUSTON, TEXAS  77092        *
* RUN DATE  08/15/1996  TIME  11:51:13 *        *           (713) 895-8322            *
*                                      *        *                                     *
****************************************        ***************************************
```

MAJOR STORM HYDROLOGY FOR THE BASIN - INPUT FILE 154D1-1D.INP
USING DEVELOPED CRITERIA TO DETERMINE DEVELOPED FLOWS W/ DET.POND
USING THE 100-YEAR 24-HOUR STORM IN THE CITY/COUNTY CRITERIA
OUTLET STRUCTURE: 36" CMP
RUN DATE : 08/08/96

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

    IT        HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     2FEB96  STARTING DATE
                   ITIME       0800  STARTING TIME
                      NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     3FEB96  ENDING DATE
                  NDTIME       0855  ENDING TIME
                   ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL    .08 HOURS
                 TOTAL TIME BASE  24.92 HOURS

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

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	BAS-1	173.	6.00	17.	5.	5.	.10		
ROUTED TO	DPOUT	55.	6.25	16.	5.	5.	.10	6762.02	6.25

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

EXHIBIT 5.3-1
URS Consultants, Inc.
CALCULATION COVER SHEET

Client: Davis Partnership Project Name: PPCC
Project/Calculation Number: 42154
Title: Offsite Flows
Total number of pages (including cover sheet): 3
Total number of computer runs:
Prepared by: D. Sandy Date: 8/30/96
Checked by: Charles K. Colthen Date: 9/1/96

Description and Purpose:

Determine off site flows.

Design bases/references/assumptions:

City/County Criteria

Remarks/conclusions:

Calculation Approved by: Charles K. Colthen 9/1/96
Project Manager/Date

Revision No.: Description of Revision: Approved by:

Project Manager/Date

DETERMINE OFFSITE DRAINAGE

BASIN O-1

CHARACTERISTICS AREA = 131.3 Ac.
Hi elev = 7040 ft
Low elev = 6810 ft.
Flow Length = 7300 ft.

SOIL GROUP = B.
CN: = 61 - Range land Good CONDITION.

TIME OF CONC.

$$T_C = \left(\frac{11.9L^3}{H}\right)^{.385}$$

$$= \left[\frac{(11.9)\left(\frac{7300}{5280}\right)^3}{(7040-6810)}\right]^{.385} = .46\ hr = 27.8\ min.$$

DIRECT Runoff

$P_5 = 2.6$ in/hr
$P_{100} = 4.4$ in/hr.

$$Q = \frac{(P-0.2S)^2}{(P+0.8S)} \qquad S = \frac{1000}{CN} - 10$$

$S = 6.39$

$$Q_5 = \frac{(2.6-0.2(6.39))^2}{2.6+0.8(6.39)} = .23\ in$$

$$Q_{100} = \frac{(4.4-0.2(6.39))^2}{4.4+0.8(6.39)} = 1.02\ in$$

Peak Runoff

$$Q_p = \frac{484\,A\,Q}{t_p}$$

$$Q_5 = \frac{484\left(\frac{131.3}{640}\right).23}{.67(.46)} = \underline{73\ cfs}$$

$$Q_{100} = \frac{484\left(\frac{131.3}{640}\right)1.02}{.67(.46)} = \underline{328.6\ cfs}$$

BASIN O-2

CHARACTERISTICS

AREA = 71.62 Ac
Hi Elev = 6880 ft.
Low Elev = 6800
Flow Length = 4,000
SOIL GROUP = B.
CN = 61

Time of Conc Tc

$$T_c = \left[\frac{11.9\left(\frac{4{,}000}{5280}\right)^3}{80}\right]^{.385} = .35 \text{ hr}$$

$$T_P = .67(.35) = .23 \text{ hr.}$$

Direct Runoff

See Basin O-1

Peak Runoff

$$Q_5 = \frac{484\left(\frac{71.62}{640}\right).23}{.23} = \underline{54 \text{ cfs}}$$

$$Q_{100} = \frac{484\left(\frac{71.62}{640}\right)1.02}{.23} = \underline{240.2 \text{ cfs}}$$

EXHIBIT 5.3-1
URS Consultants, Inc.
CALCULATION COVER SHEET

Client: Davis Partnership Project Name: Pikes Peak College

Project/Calculation Number: 42154

Title: Detention Pond

Total number of pages (including cover sheet): ~~7~~ 14

Total number of computer runs:

Prepared by: R. Sandry Date: 8/30/96

Checked by: Charles K. Colthen Date: 9/1/96

Description and Purpose:

Size Detention structures.

Design bases/references/assumptions:

Remarks/conclusions:

Calculation Approved by: ______________________

Project Manager/Date

Revision No.:	Description of Revision:	Approved by:

Project Manager/Date

Assumptions

Location of PPCC has altered drainage patterns. (BASIN 2) Approx. 11.66 acres follow historic patterns. Remaining (BASIN 1) 62.63 acres drains into detention pond.

REQ'D size detention pond such that discharge from detention plus historic drainage from 11.66 acres does not exceed historic flows for the site.

SOLN: Use Hec-1 to size detention pond.

1) Historic Runoff for site.

$Q_{100} = 147$ cfs.

$Q_5 = 37$ cfs.

2) Determine Runoff for Basin ① + ②.

Site Characteristics.

BASIN 1 (See Previous Calcs), A = 62.63
Developed $\overline{CN} = 75$

BASIN 2

Hydrologic Soil Group B.

Elev: Hi: 6807
6770

Flow length: 2,000 LF

$T_c = \left(\frac{11.9(L^3)}{H}\right)^{0.385} = 0.211$

$T_{lag} = 3/5(.21) = 0.126$

Area = 11.66

CN = 68 ✓

URS CONSULTANTS, INC.

URS JOB NO. 42154 PAGE 3 OF 4

DATE 8/30/96 BY RJB. CHECKED BY CKE 9/1/96 (date)

CLIENT Davis Partnership.

PROJECT TACC

SUBJECT

Determine Allowable discharge from POND.

HISTORIC FLOW FROM SITE = 147 cfs. ✓

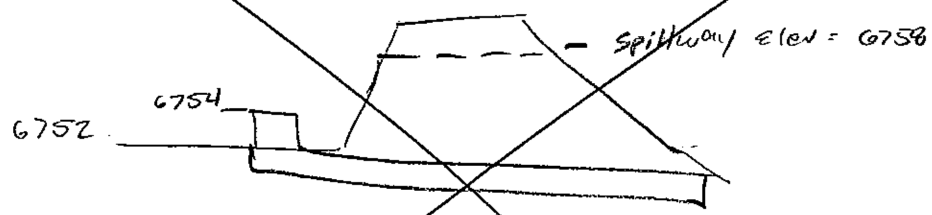
HISTORIC FLOW (B1+B2) = 146 cfs. ✓

HISTORIC BASIN 1 = 124 cfs.
" BASIN 2 = 22 cfs

Developed BASIN 1 = 173 cfs

ALLOWABLE DISCHARGE from Basin 1-1 = **124 cfs**

~~ROUTE DEVELOPED FLOW THROUGH POND~~



~~- BASED ON ACTUAL TOPO OF PROPOSED POND PEAK FLOW FOR 100 YR. DEVELOPED will be.~~

~~Q = 115 cfs , elev = 6757.84.~~

URS CONSULTANTS, INC.

URS JOB NO. 421521 PAGE 4 OF [illegible]
DATE 8/16/96 BY [illegible] CHECKED BY [illegible] 9/1/96 (date)
CLIENT Davis Partnership
PROJECT [illegible]
SUBJECT Det Pond - Stage-Discharge

SIZE INLET FOR STORM ROUTING

	ELEV.	18" CMP HW/D	Q	WEIR	TOTAL		24" CMP HW/D	Q	TOTAL		
INV =	6757.0	0	0				0	0	0		
	6760.0	2	11	22			1.5	18	36		
	6762.0	3.3	16	32			2.5	29	58		
TOP OF SPILLWAY	6763.0	4	18	36			3	32	64		
↓	6764.0	4.6	20	67	87	107	3.5	35	67	102	137
WEIR FLOW	6765.0	5.3	22	190	212	234	4	37	190	227	264

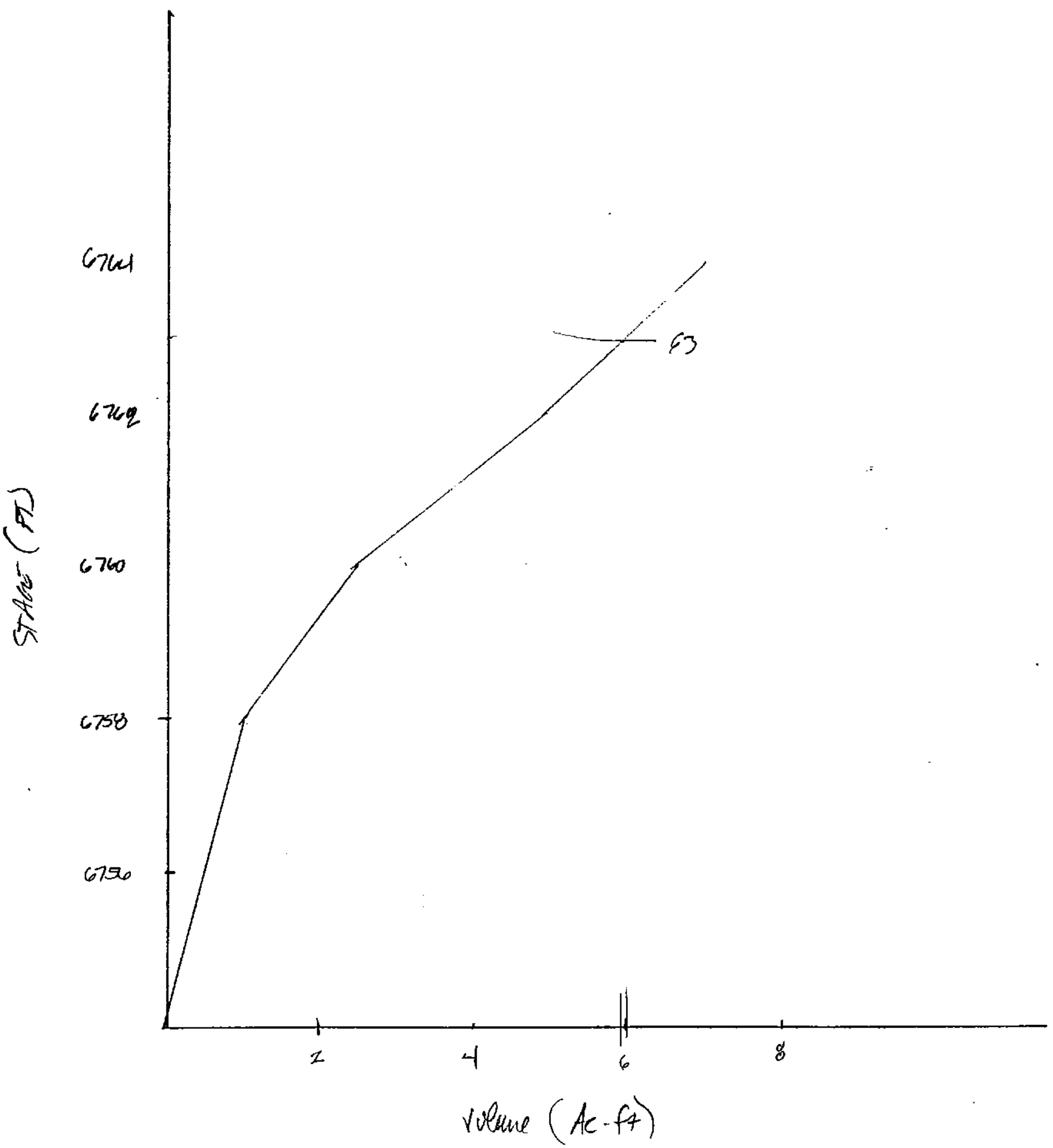
ELEV.	30" HW/D	Q				36" HW/D	Q		
6757.0		0	0			0			
6760	1.2	26	52			1.0	35	70	
6762	2	40	80			1.67	55	110	
6763	2.4	45	90			2.0	62	124	
6764	2.8	51	118	169		2.3	70	137	207
6765	3.2	56	246	302		2.67	78	268	346

154-CID? = 55 cfs WSL = 6762.01

30" @ 2.5% V = 8.0 fps.

URS
CONSULTANTS, INC.

URS JOB NO. J7 151 PAGE 5 OF 14
DATE 8/6/94 BY RJf CHECKED BY 9/6 9/1/94 (date)
CLIENT Davis Partnership.
PROJECT DRCC North Extension
SUBJECT Detention Pond.



STORAGE ROUTING FORM

1. INFLOW HYDROGRAPH GENERATION
   a. Hydrograph method used:
   b. Time interval selected for routing:
   (inflow hydrograph attached)

2. APPROXIMATE FLOW REDUCTION DUE TO ROUTING
   a. Peak inflow: Q_p = ________ ft³/s
   b. Upstream storage: S = ________ ft³
   c. Time to peak: t_p = ______ min

$$Q_r = Q_p - \frac{S}{80\,t_p} =$$

3. ELEVATION - DISCHARGE RELATIONSHIP FOR TRIAL CULVERT

ELEVATION ft								
DISCHARGE ft³/s								

4. ELEVATION - STORAGE RELATIONSHIP FOR UPSTREAM PONDING

ELEVATION ft	AREA ft²	INCREMENTAL VOLUME ft³	ACCUMULATED VOLUME ft³	
6756	16925		0	
		43750		
6758	26825		43750	1.0
		67850		
6760	41025		111600	~~2.6~~ 2.56
		101830		
6762	60805		213430	4.89
		151083		
6764	90278		363708	6.9

5. STORAGE - OUTFLOW RELATIONSHIP

Elevation ft	Discharge (O) ft³/s	Storage (S) ft³	2s/Δt ft³/s	2s/Δt + O ft³/s

6. STORAGE - INDICATION ROUTING TABLE

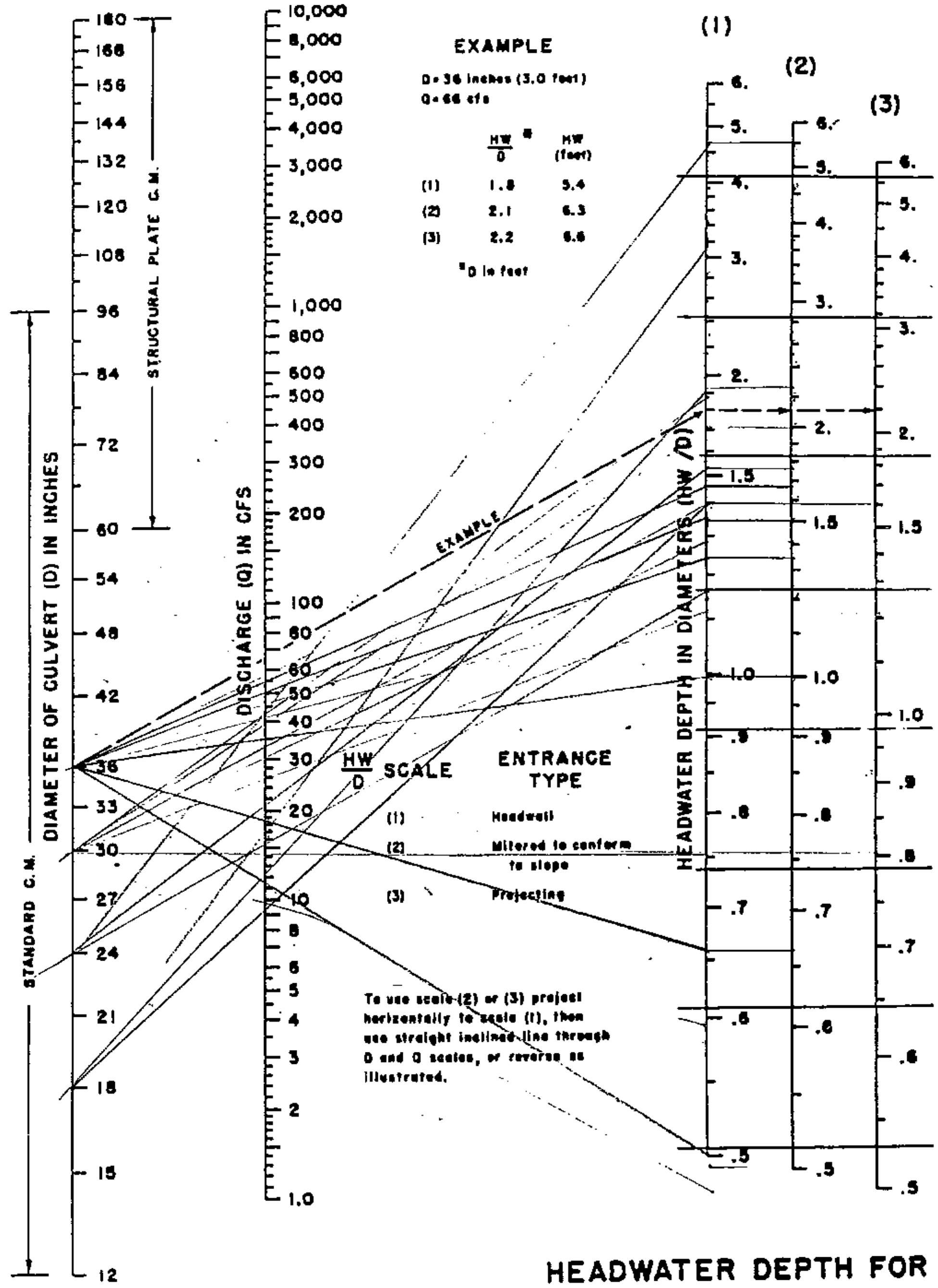
(1) TIME min	(2) INFLOW (I) ft³/s	(3) 2s/Δt − O ft³/s	(4) 2s/Δt + O ft³/s	(5) OUTFLOW (O) ft³/s

HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date
OCT. 1987

Figure
11 - 3



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

SIZE RIP RAP STILLING BASIN FOR DET. POND.

Assumptions

$Q = 55$ cfs. full flow conditions $TW = 1.0'$

$Y/d_0 = .94$

$A/d_0^2 = .7662$ $A = 6.89 ft^2$

$R/d_0 = .2896$ $R = .8688$

FROM DRAINAGE CRITERIA MANUAL.

$\therefore$ $V = Q/A = 8$ fps.

$y = 2.82$ ft

$y_e = \left(\frac{A}{2}\right)^{1/2} = 1.88$

$F = \frac{V}{\sqrt{32.2 y_e}} = \frac{8}{\sqrt{32.2(1.88)}} = 1.03$

$\frac{TW}{y_e} = \frac{1.0}{1.88} = 0.53 \leq 0.75$ O.K.

Size Rip RAP (Try) $\frac{d_{50}}{y_e} = 0.2$ $\therefore d_{50} = 0.376$

$\frac{h_s}{y_e} = 1.0$ $h_s = 1.88$

$\frac{h_s}{d_{50}} = \frac{1}{.376} = 2.65$ $2 < \frac{h_s}{d_{50}} < 4$ $\therefore$ OK.

O.K.
use $d_{50} = 9''$
$h_s = 1.5'$

Try $\frac{d_{50}}{y_e} = .25$ $d_{50} = .47$

$\frac{h_s}{y_e} = .30$ $h_s = 0.56'$

$\frac{h_s}{d_{50}} = \frac{0.56}{.47} = 1.19$

URS
CONSULTANTS, INC.

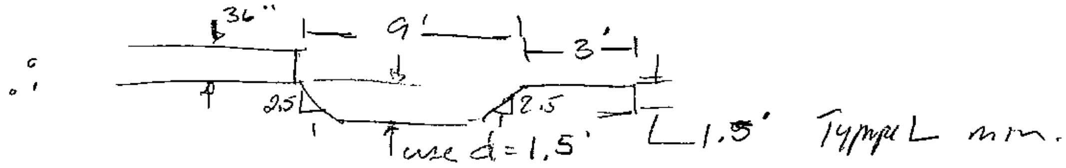
URS JOB NO. 42154 PAGE 9 OF 14

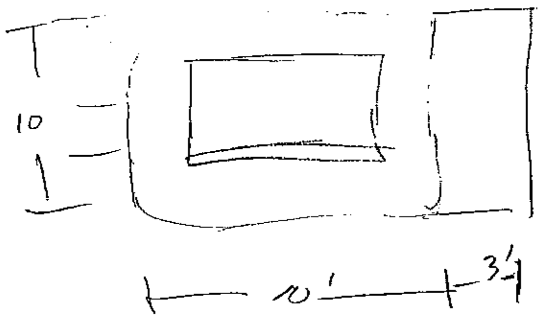
DATE 8/20/96 BY [illegible] CHECKED BY [illegible] 9/1/96 (date)

CLIENT Davis Partnership.

PROJECT TPCC

SUBJECT





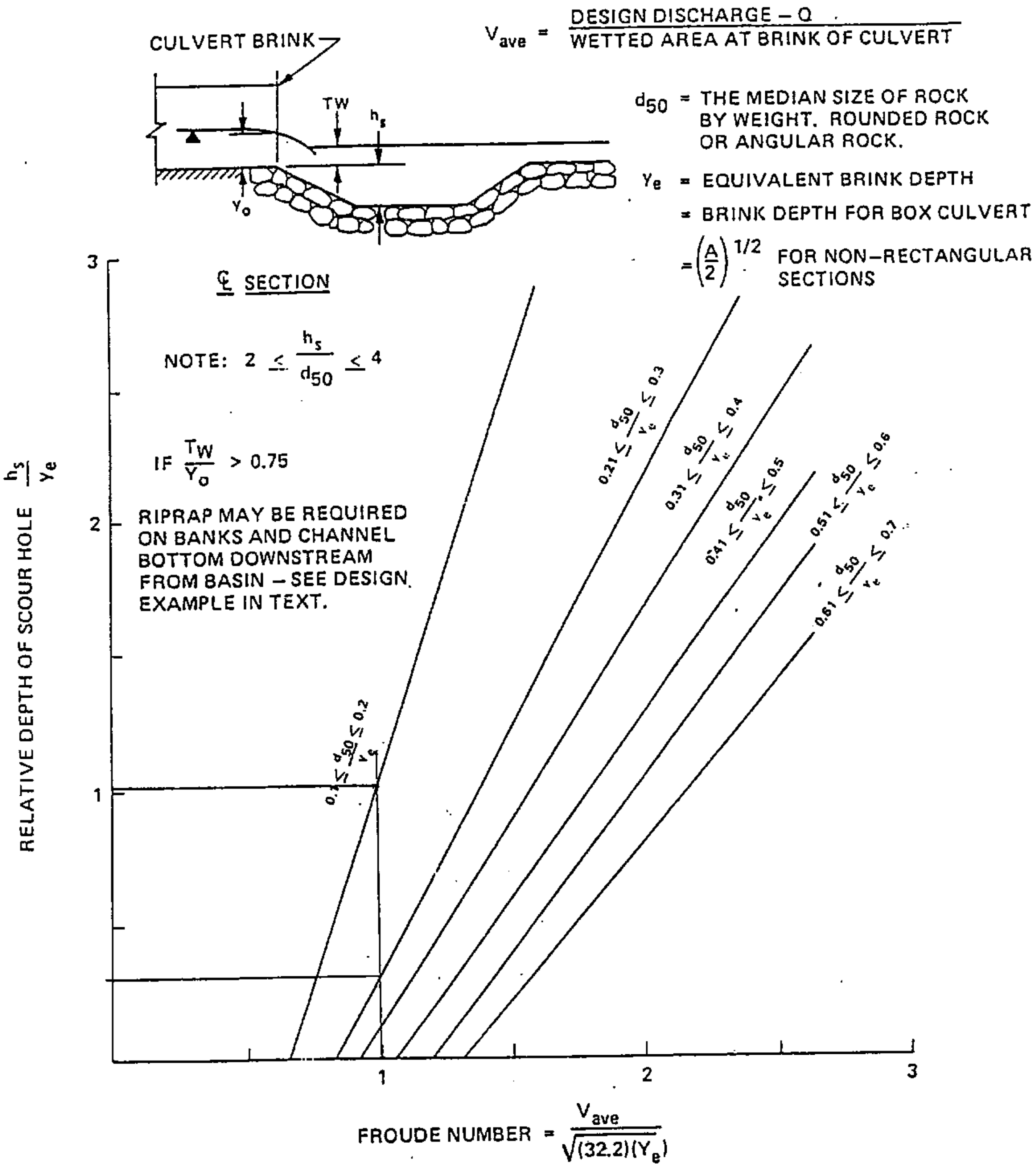


FIGURE 10-C.4 RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

TABLE 10.1 GEOMETRIC ELEMENTS FOR CIRCULAR SECTION

$\frac{y}{d_0}$	$\frac{A}{d_0^2}$	$\frac{P}{d_0}$	$\frac{R}{d_0}$	$\frac{T}{d_0}$	$\frac{D}{d_0}$	$\frac{A\sqrt{D}}{d_0^{5/2}}$	$\frac{AR^{2/3}}{d_0^{8/3}}$
0.01	0.0013	0.2003	0.0066	0.1990	0.0066	0.0001	0.0000
0.05	0.0147	0.4510	0.0326	0.4359	0.0336	0.0027	0.0015
0.10	0.0409	0.6435	0.0635	0.6000	0.0682	0.0107	0.0065
0.15	0.0739	0.7954	0.0929	0.7141	0.1034	0.0238	0.0152
0.20	0.1118	0.9273	0.1206	0.8000	0.1398	0.0418	0.0273
0.25	0.1535	1.0472	0.1466	0.8660	0.1774	0.0646	0.0427
0.30	0.1982	1.1593	0.1709	0.9165	0.2162	0.0921	0.0610
0.35	0.2450	1.2661	0.1935	0.9539	0.2568	0.1241	0.0820
0.40	0.2934	1.3694	0.2142	0.9798	0.2994	0.1603	0.1050
0.45	0.3428	1.4706	0.2331	0.9950	0.3446	0.2011	0.1298
0.50	0.3927	1.5708	0.2500	1.0000	0.3928	0.2459	0.1558
0.55	0.4426	1.6710	0.2649	0.9950	0.4448	0.2949	0.1825
0.60	0.4920	1.7722	0.2776	0.9798	0.5022	0.3438	0.2092
0.65	0.5404	1.8755	0.2881	0.9539	0.5666	0.4066	0.2358
0.70	0.5872	1.9823	0.2962	0.9165	0.6408	0.4694	0.2608
0.75	0.6318	2.0944	0.3017	0.8660	0.7296	0.5392	0.2840
0.80	0.6736	2.2143	0.3042	0.8000	0.8420	0.6177	0.3045
0.85	0.7115	2.3462	0.3033	0.7141	0.9964	0.7098	0.3212
0.90	0.7445	2.4981	0.2980	0.6000	1.2408	0.8285	0.3324
0.94[a]	0.7662	2.6467	0.2896	0.4750	1.6130	0.9725	0.3353
0.95	0.7707	2.6906	0.2864	0.4359	1.7682	1.0242	0.3349
1.00	0.7854	3.1416	0.2500	0.0000	∞	∞	0.3117

[a]Maximum flow occurs at 0.94 full depth.

Example 10.1

For the channel section shown in Figure 10.2, determine the geometric elements.

Solution

$y = 36$ in. or 3 ft $\quad d_0 = 60$ in. or 5 ft

$$\frac{y}{d_0} = \frac{3}{5} = 0.6$$

From Table 10.1:

$$\frac{A}{d_0^2} = 0.492, \qquad A = 0.492(5)^2 = 12.3 \text{ ft}^2$$

$$\frac{P}{d_0} = 1.7722, \qquad P = 1.7722(5) = 8.861 \text{ ft}$$

$$\frac{R}{d_0} = 0.2776, \qquad R = 0.2776(5) = 1.39 \text{ ft}$$

$$\frac{Z_c}{d_0^{5/2}} = \frac{A\sqrt{D}}{d_0^{5/2}} = 0.3438, \qquad A\sqrt{D} = 0.03438(5)^{5/2} = 1.92$$

$$\frac{Z}{d_0^{8/3}} = \frac{AR^{2/3}}{d_0^{8/3}} = 0.2092, \qquad AR^{2/3} = 0.2092(5)^{8/3} = 15.29$$

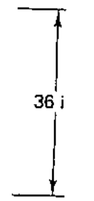


Figure 10.2 Partial full circular channel section of Example 10.1.

10.3 TYPES OF FLOW

The flow in an open channel is classifie
flow with respect to space and time. If th
section of the channel, the flow is know
varied or nonuniform flow, the depth chan
the change in the depth occurs abruptly o
flow; otherwise, it is a gradually varied fl

If the depth of flow does not change
ation, it is referred to as the steady flow.
time. Combining the space and time crite
classified as follows:

Type of Flow
Steady uniform flow
Steady gradually varied flow
Steady rapidly varied flow
Unsteady gradually varied flow
Unsteady rapidly varied flow

For an unsteady uniform flow, the de
always remaining parallel to the channel bott
dition. Even the steady uniform flow is diffi
irregular section and in artificial channels b
The steady uniform flow, however, is a funda
all channel design problems. The effect of tl
uniform flow condition to determine the cha
putation of flow in natural streams, the stead
time interval under consideration. The unste
wave in the channel which is outside the sco
veyance channel.

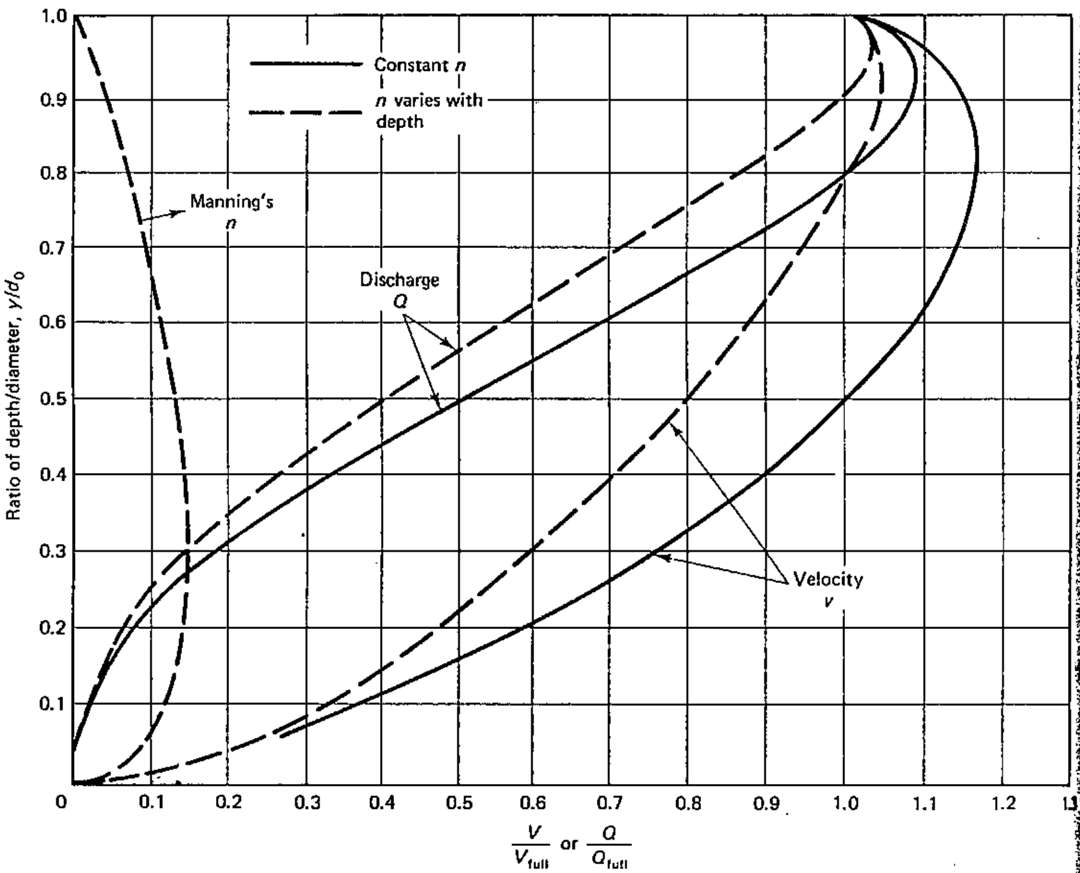


Figure 10.11 Hydraulic elements of a circular section.

Solution

1. From Table 10.4, $n = 0.018$.
2. $S = \dfrac{1}{4500} = 2.22 \times 10^{-4}$.
3. $\dfrac{y_n}{d_0} = \dfrac{1.5}{3} = 0.5$.
4. From Table 10.1, $\dfrac{AR^{2/3}}{d_0^{8/3}} = 0.1558$.
5. $AR^{2/3} = 0.1558(3)^{8/3} = 2.92$.
6. $Q = \dfrac{1.49}{0.018}(2.92)(2.22 \times 10^{-4})^{1/2} = 3.60$ cfs.

Alternative Solution From Figure 10.11 for constant n, y/d_0 of 0.5, $Q/Q_{full} = 0.5$,

$$Q_{full} = \frac{1.49}{0.018}\left[\frac{\pi}{4}(3)^2\right]\left(\frac{3}{4}\right)^{2/3}(2.22 \times 10^{-4})^{1/2} = 7.19 \text{ cfs}$$

$$Q = 0.5Q_{full} = 0.5(7.19) = 3.60 \text{ cfs}$$

Example 10.8

A trapezoidal channel of 450 cfs with a nor the channel are 685 if $n = 0.02$.

Solution Refer to Fi

1. This is a problem
2. $A = \frac{1}{2}(25 + 42.$
   $P = 25 +$
   $R = \dfrac{A}{P} =$
3. $S = \left[\dfrac{Q}{(1.49/n)AR}\right.$
4. $\dfrac{H_1 - H_2}{L} = S$ or
   $L = \dfrac{H_1 -}{S}$

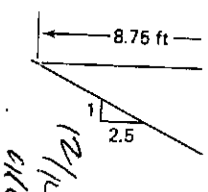
Example 10.9

The channel of Example (a) normal depth, (b) cri

Solution

(a) 1. $S = \dfrac{0.1}{100} = 0.0$

2. $\dfrac{Qn}{S^{1/2}} = \dfrac{30(0.025}{(0.001)^{1/2}}$
3. $A = (4 + 4y)y$
   $P = 4 +$
   $R = \dfrac{(4 +}{4 +}$



Figure

FHWA CULVERT ANALYSIS, HY-8, VERSION 4.1

CURRENT DATE	CURRENT TIME	FILE NAME	FILE DATE
08-15-1996	15:08:48	PPCC	08-15-1996

áá

CULVERT AND CHANNEL DATA

áá

CULVERT NO. 1		DOWNSTREAM CHANNEL	
CULVERT TYPE:	3.0 FT CIRCULAR	CHANNEL TYPE :	TRAPEZOIDAL
CULVERT LENGTH =	47.0 FT	BOTTOM WIDTH =	10.0 FT
NO. OF BARRELS =	1.0	TAILWATER DEPTH =	-0.9 FT
FLOW PER BARREL =	55.0 CFS	TOTAL DESIGN FLOW =	55.0 CFS
INVERT ELEVATION =	55.3 FT	BOTTOM ELEVATION =	53.0 FT
OUTLET VELOCITY =	9.8 FPS	NORMAL VELOCITY =	3.1 FPS

áá

áá

RIPRAP STILLING BASIN -- FINAL DESIGN

áá

THE LENGTH OF THE BASIN	= 12.0 FT
THE LENGTH OF THE POOL	= 9.0 FT
THE LENGTH OF THE APRON	= 3.0 FT
THE WIDTH OF THE BASIN AT THE OUTLET	= 10.0 FT
THE DEPTH OF POOL BELOW CULVERT INVERT	= 0.6 FT
THE THICKNESS OF THE RIPRAP ON THE APRON	= 2.5 FT
THE THICKNESS OF THE RIPRAP ON THE REST OF THE BASIN	= 1.9 FT
THE BASIN OUTLET VELOCITY	= 3.7 FPS
THE DEPTH OF FLOW AT BASIN OUTLET	= 1.5 FT

Type L

áá

14/ul
ckr 9/1/96

FHWA CULVERT ANALYSIS, HY-8, VERSION 4.1

CURRENT DATE	CURRENT TIME	FILE NAME	FILE DATE
08-15-1996	15:09:12	PPCC	08-15-1996

ááá
CULVERT AND CHANNEL DATA
ááá

CULVERT NO. 1 | DOWNSTREAM CHANNEL

CULVERT TYPE:	3.0 FT CIRCULAR	CHANNEL TYPE :	TRAPEZOIDAL
CULVERT LENGTH =	47.0 FT	BOTTOM WIDTH =	10.0 FT
NO. OF BARRELS =	1.0	TAILWATER DEPTH =	-0.9 FT
FLOW PER BARREL =	55.0 CFS	TOTAL DESIGN FLOW =	55.0 CFS
INVERT ELEVATION =	55.3 FT	BOTTOM ELEVATION =	53.0 FT
OUTLET VELOCITY =	9.8 FPS	NORMAL VELOCITY =	3.1 FPS

ááá

ááá
RIPRAP STILLING BASIN -- FINAL DESIGN
ááá

THE LENGTH OF THE BASIN	=	12.0 FT
THE LENGTH OF THE POOL	=	9.0 FT
THE LENGTH OF THE APRON	=	3.0 FT
THE WIDTH OF THE BASIN AT THE OUTLET	=	10.0 FT
THE DEPTH OF POOL BELOW CULVERT INVERT	=	0.3 FT
* THE THICKNESS OF THE RIPRAP ON THE APRON	=	3.5 FT
* THE THICKNESS OF THE RIPRAP ON THE REST OF THE BASIN	=	2.6 FT
THE BASIN OUTLET VELOCITY	=	3.6 FPS
THE DEPTH OF FLOW AT BASIN OUTLET	=	1.5 FT

ááá

Type M RipRap

* USE Depth of 1.5' Below culvert to Lower
Rip Rap Thickness to 1.5' at all areas.

EXHIBIT 5.3-1
URS Consultants, Inc.
CALCULATION COVER SHEET

Client: [illegible] Project Name: [illegible]

Project/Calculation Number: [illegible]

Title: [illegible]

Total number of pages (including cover sheet): 14

Total number of computer runs: ____________

Prepared by: [illegible] Date: ____________

Checked by: Charles R. Colther Date: 9/1/96

Description and Purpose:

Size Site drainage facilities

Design bases/references/assumptions:

Rational Method.

Remarks/conclusions:

Calculation Approved by: Charles R. Colther 9/1/96

Project Manager/Date

Revision No.:	Description of Revision:	Approved by:

Project Manager/Date

OAM 5.3 - 03/10/95

Determine Flows for each drainage area.

(#1)

A = 20.38 Ac
Hi elev = 6818
Low ele = 6774
Length = 1300'

Time of Conc:

$$T = \left(\frac{11.9 L^3}{H}\right)^{.385} = .12 \text{ hr} = 7.18 \text{ MIN.}$$

Rainfall Intensity

i_{100} = 7.25 in/hr. | i_5 = 4.5
Tc = 7 min

Runoff

Q = CiA
C = .45 (15% IMP.)

∴ Q_{100} = .45(7.25)(20.38) = **66.5 cfs.**
Q_5 = **41.3 cfs.**

(#2)

A = 2.5
Hi = 6787
Low = 6772.
L = 900.

Tc = 7 min.

∴ Q = CiA
C = .90 (90% IMP.)

Q_{100} = .90(7.25)(2.5) = **16.3 cfs.**
Q_5 = .90(4.5)(2.5) = **10.1 cfs**

URS CONSULTANTS, INC.

URS JOB NO. [illegible] PAGE 3 OF 13
DATE [illegible] BY [illegible] CHECKED BY [illegible] 9/1/96 (date)
CLIENT [illegible]
PROJECT [illegible]
SUBJECT [illegible]

(#3).

$A = 3.32$ Ac.
Hi = 6787.
low = 6772.
L = 950.

$T_c = 7.5$ min.

$Q = CiA$.

$C = .90$ ∴ $Q_{100} = 3.32(7.25)(.90) = $ <u>21.7 cfs.</u>

$Q_5 = $ <u>13.4 cfs.</u>

(#4).

$A = 12.94$ Ac.
Hi = 6818
low = 6775.
L = 1375

$T_c = 7.7$ min.

$Q = CiA$

$C = .70$ (65% impervious)

$Q_{100} = .70(7.25)(12.94) = $ <u>65.6 cfs.</u>

$Q_5 = 40.76$.

URS
CONSULTANTS, INC.

URS JOB NO. 41131 PAGE 4 OF 12
DATE ______ BY ______ CHECKED BY ______ (date)
CLIENT ______
PROJECT ______
SUBJECT ______

CURB INLET DESIGN

$Q_1 = 16.3$ cfs. $Q_3 = 65.6$ cfs.
$Q_2 = 21.7$ cfs.

SIZE INLET: (NON-DEPRESSED)

$Q = 3.0 L d^{1.5}$

Solve for L

$L = \frac{Q}{3 d^{1.5}}$

For	$d = 0.5$, Q_1 16.3 L = 15.3.	$d = 0.7$ $Q = 16.3$ L = 9.2'	$d = 0.7$ $Q = 65.6$ L = 37.3'
	$d = 0.5$ Q_2 21.7 L = 20.4	$d = 0.7$ $Q = 21.7$ L = 12.3'	

(WEIR FLOW)

USE 10' & 15' INLET. + 40' INLET.

TYPE R M-604-12

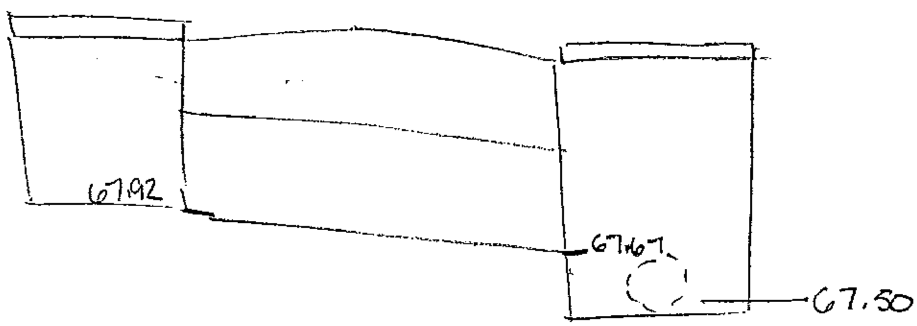
SIZE CULVERTS AT INLET DISCHARGE

USE Chart 8.

INLET ①
$Q_{100} = 16.3 + 3.3 = 19.6$ cfs
$Q_5 = 10.01 + 1.93 = 11.94$
} 24" 3.0" Depth

Inlet ②
$Q_{100} = 19.6 + 21.7 = 41.3$ cfs.
$Q_5 = 11.94$ $13.4 = 25.34$
} 30" RCP. 4.5' Basin

Inlet ③
$Q_{100} = 65.6 + 6.04 = 71.6$ cfs
$Q_5 = 40.76 + 3.52 = 44.28$
} 42" RCP 4.5' Basin
36" " 6.0'
30"



URS CONSULTANTS, INC.

URS JOB NO. ____ PAGE ____ OF ____

DATE ____ BY ____ CHECKED BY ____ 7/1/96 (date)

CLIENT ____

PROJECT ____

SUBJECT Roof Drain Sizing

Size Roof Drain Collectors.

Use Rational Method.

Typical Area Drained = $A = .33$ Ac.

$C = .90$

$i_{100} = 9.0$

$i_5 = 5.25$

$t_c = 5$ min

$Q_5 = .90(.33)(5.25) = \underline{1.56 \text{ cfs}}$

$Q_{100} = .90(.33)(9) = \underline{2.67 \text{ cfs}}$

AREA DRAINS

AREA (A) - SW A = .078 Ac.

(B) SE A = 0.036.

(A) $Q_5 = (.9)(.078)(5.25) = 0.37$ cfs.
$Q_{100} = (.9)(.078)(9) = \underline{0.63 \text{ cfs.}}$

(B) $Q_5 = .9(.086)(5.25) = .40$
$Q_{100} = .9(.086)(9) = \underline{.70 \text{ cfs.}}$

} R-4030 - 15" DRAIN IN 15" RCP.

(C) A: 1.07

$Q_5 = (.9)(5.25)(1.07) = \underline{5.06 \text{ cfs}}$
$Q_{100} = (.9)(9)(1.07) = \underline{8.67 \text{ cfs.}}$

} Use Type B inlet.

URS CONSULTANTS, INC.

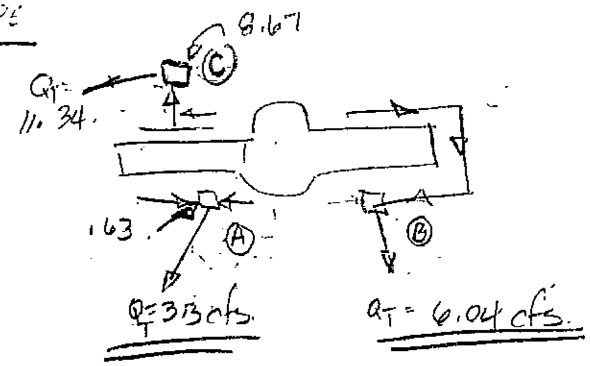
URS JOB NO. ______ PAGE ___ OF ___
DATE ______ BY ______ CHECKED BY ___ 9/1/96 (date)
CLIENT ______
PROJECT ______
SUBJECT Site Drainage

Size Drain Pipe

(A) Area (A)
Q = 3.3 cfs

(B) 6.04 cfs

(C) 11.34 cfs



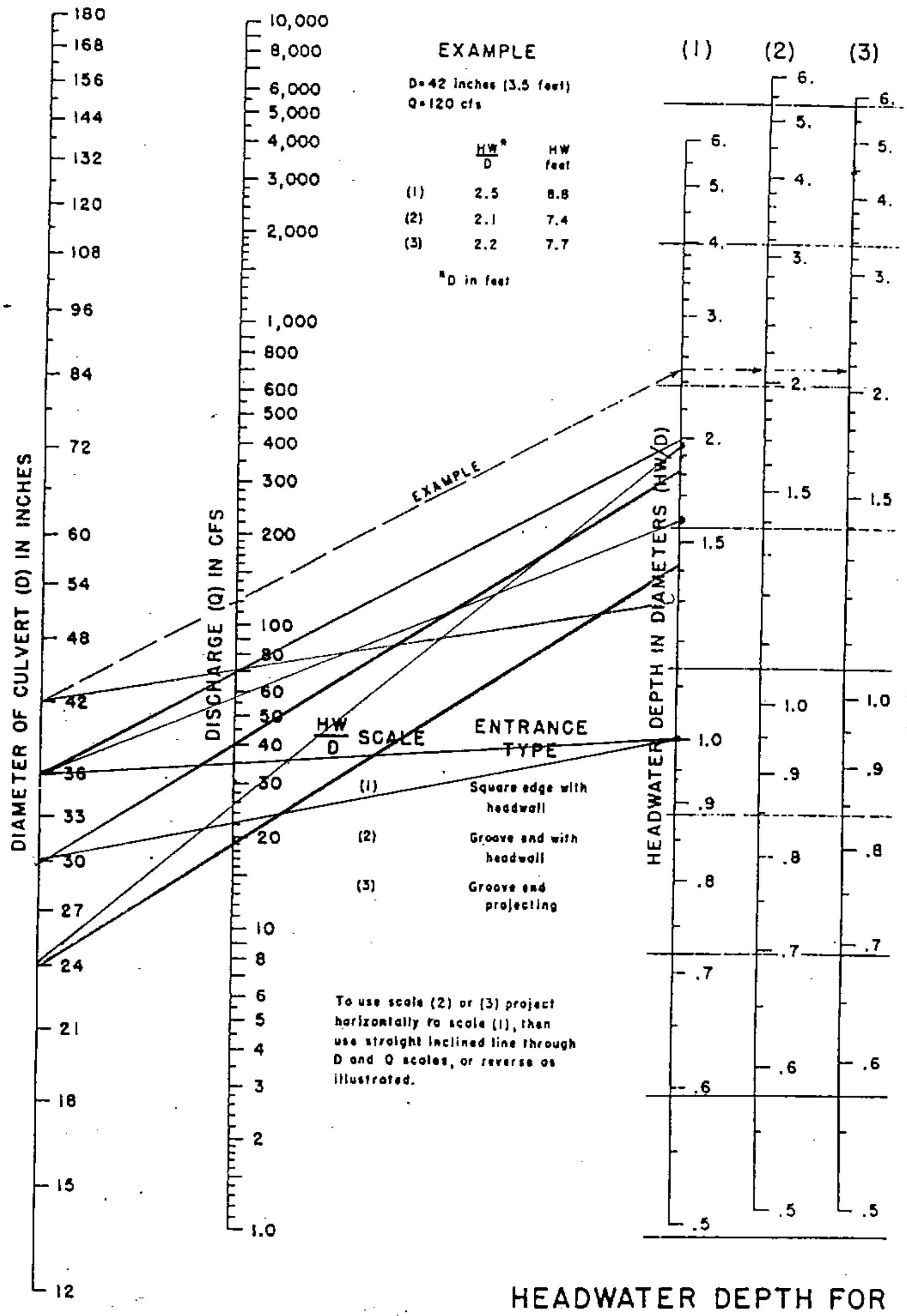
Pipe Size

	Slope 1.0%	1.5%	2.0%	2.5
Q = 3.3	.97 (12")	.90	.85	.82 (10/12")
Q = 6.04	1.22 (14")	1.13	1.07	1.03 (12")
Q = 11.34	1.52 (18")	1.43	1.36	1.30 (18")
Q = 2.67	.9 (10")	.83	.79	.76 (10")

Recommendations

Area (A) - 10" Drainline PVC
(B) - 12" PVC
(C) - 18" RCP

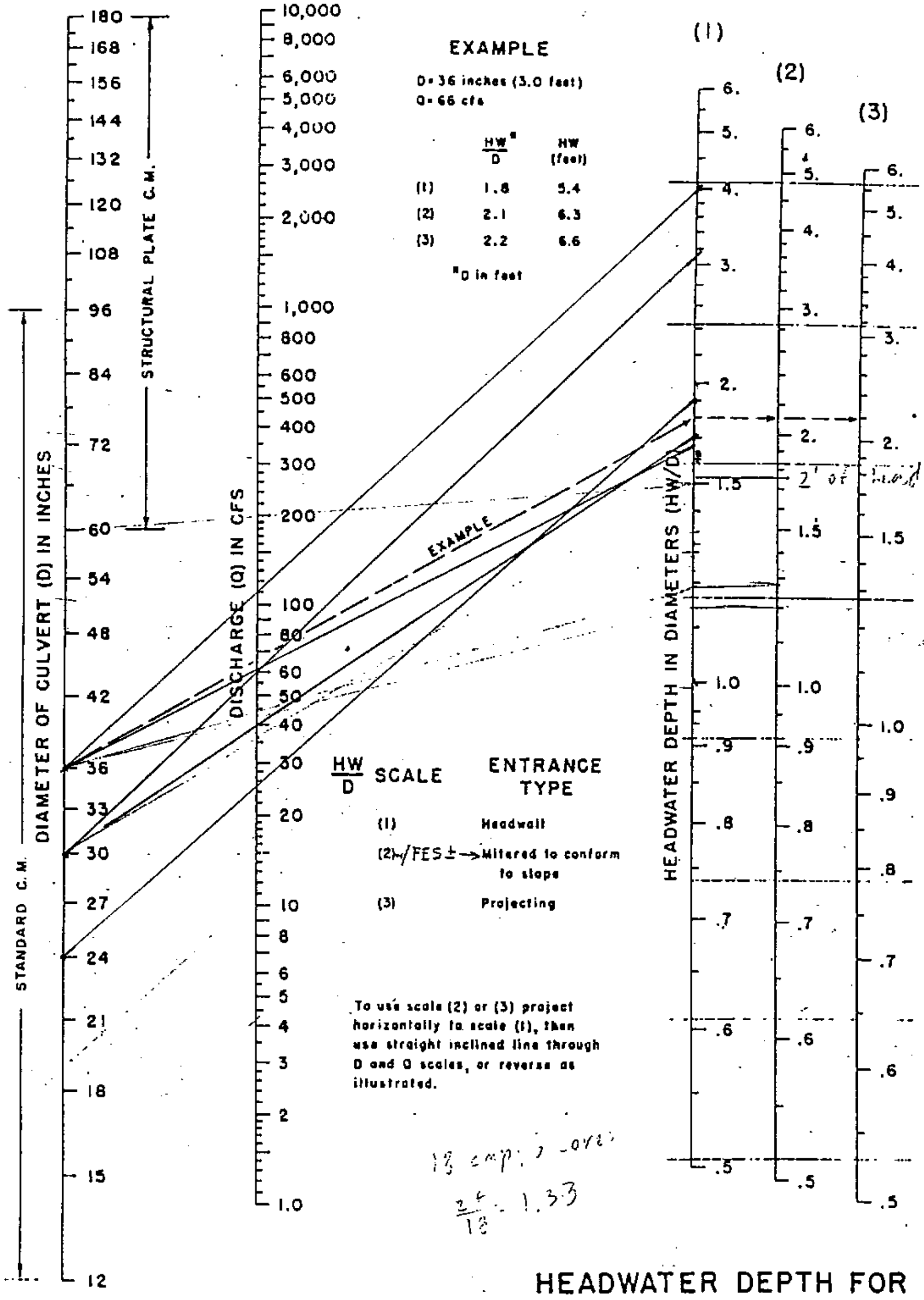
CHART 2



HEADWATER DEPTH FOR
CONCRETE PIPE CULVERTS
WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

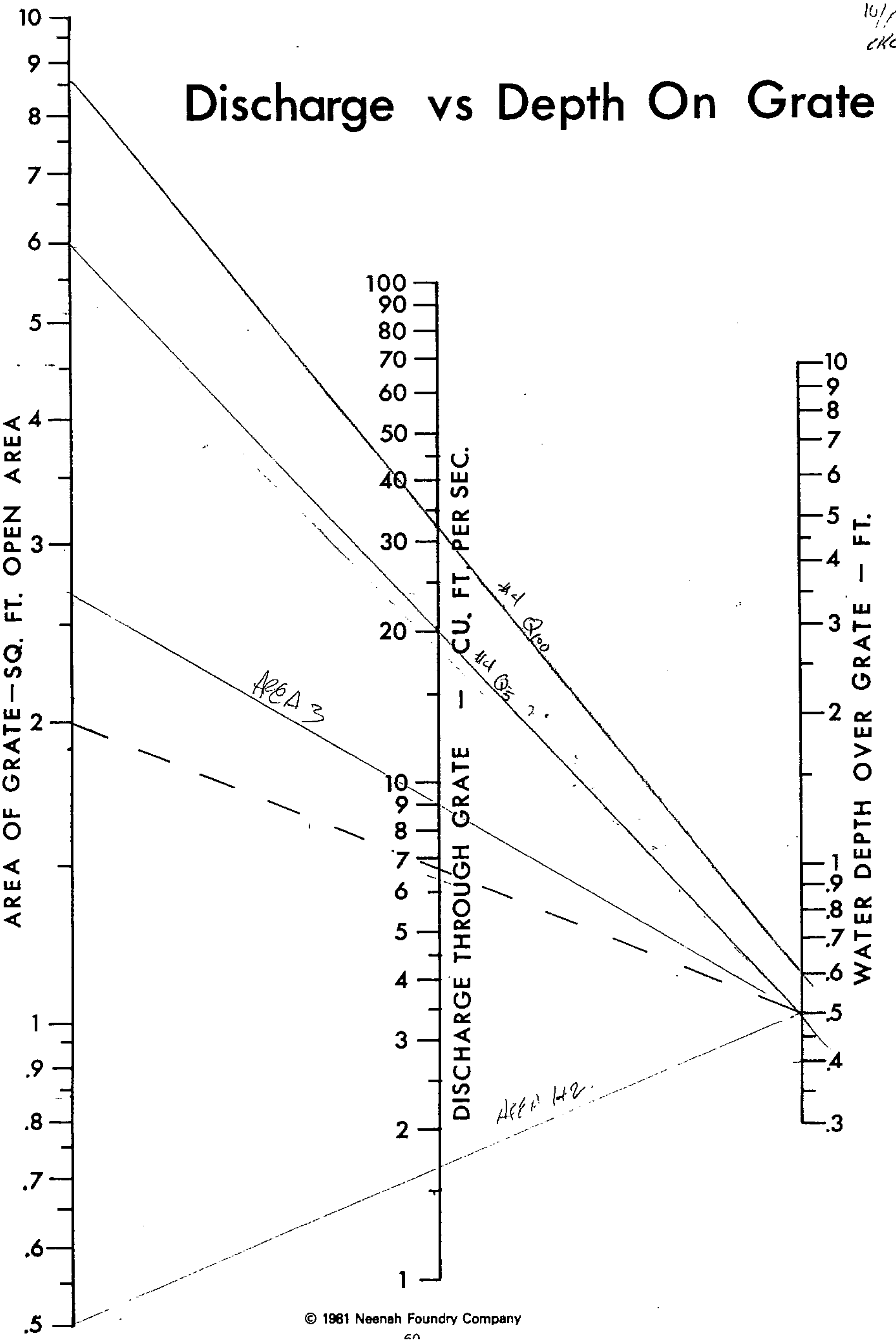
CHART 5



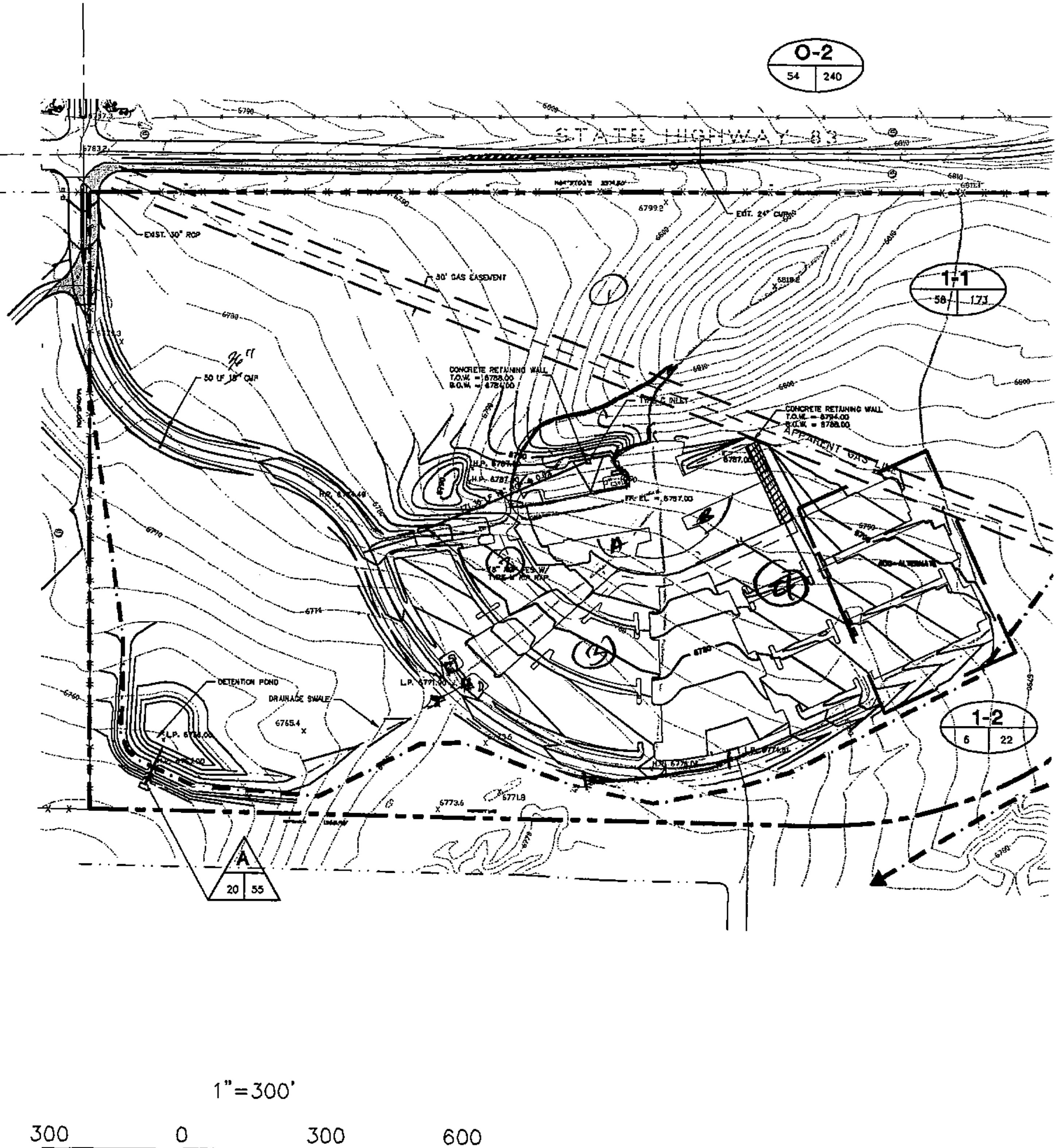
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN 1963

Discharge vs Depth On Grate

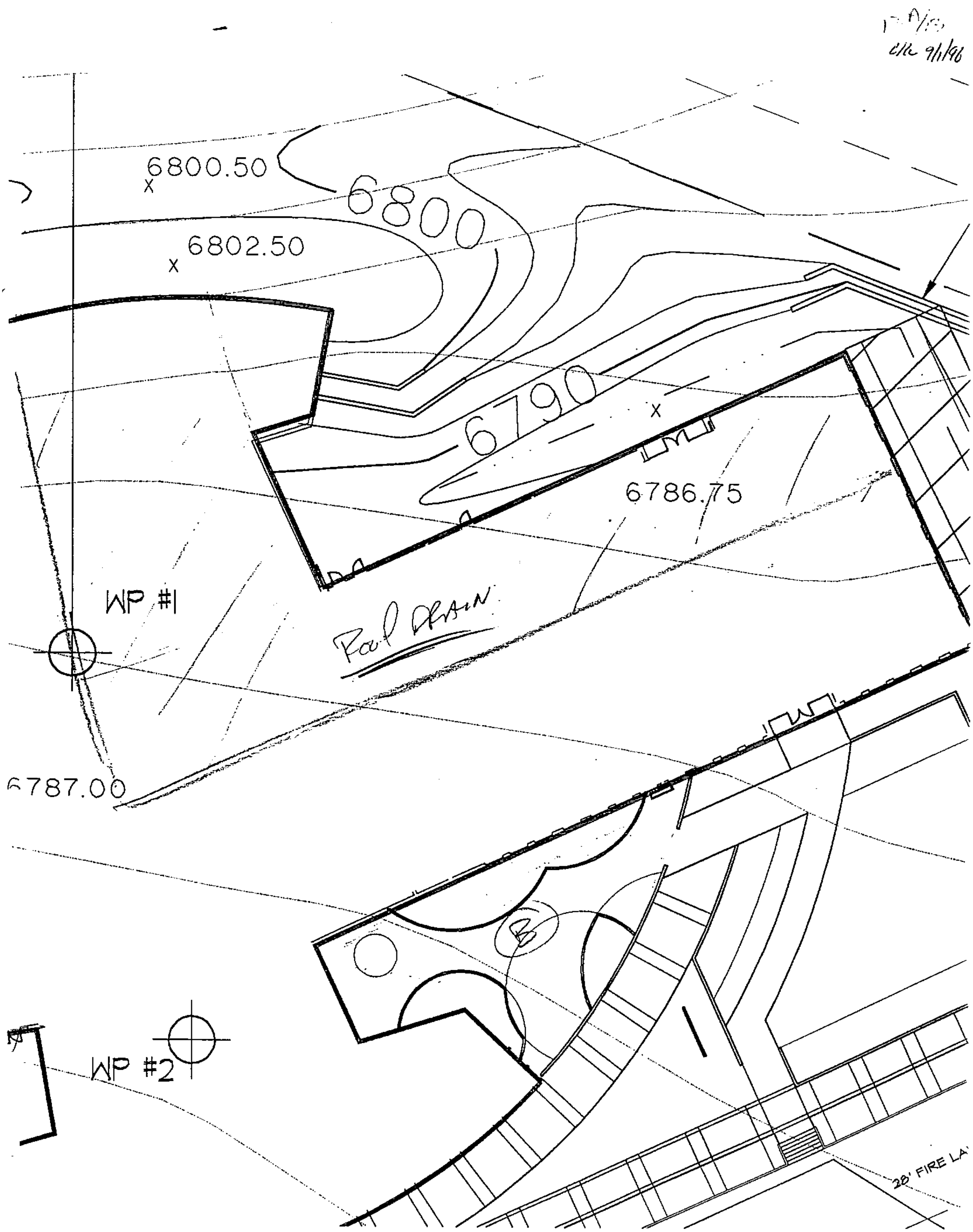


17/13
9/1/96

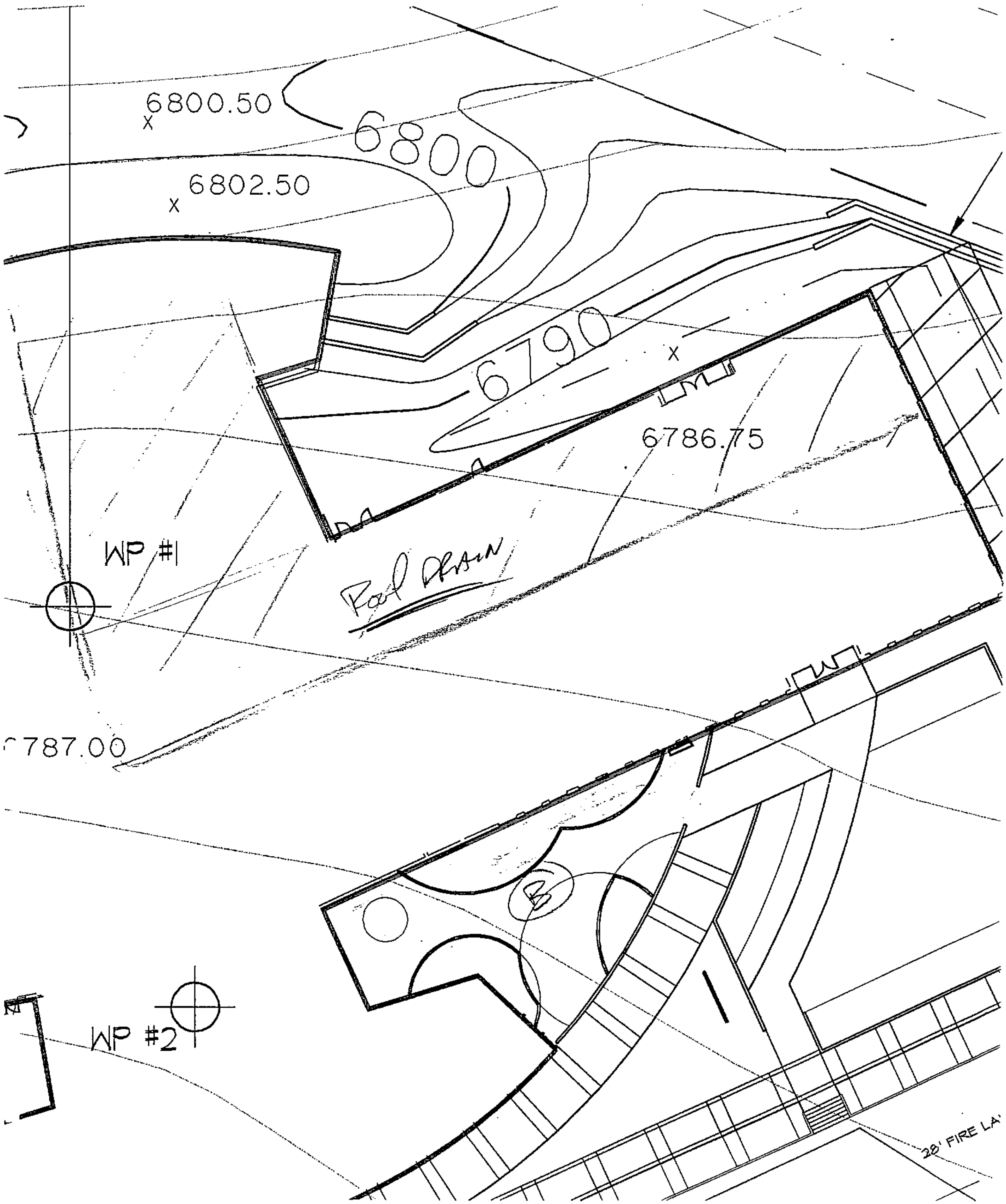


1"=300'

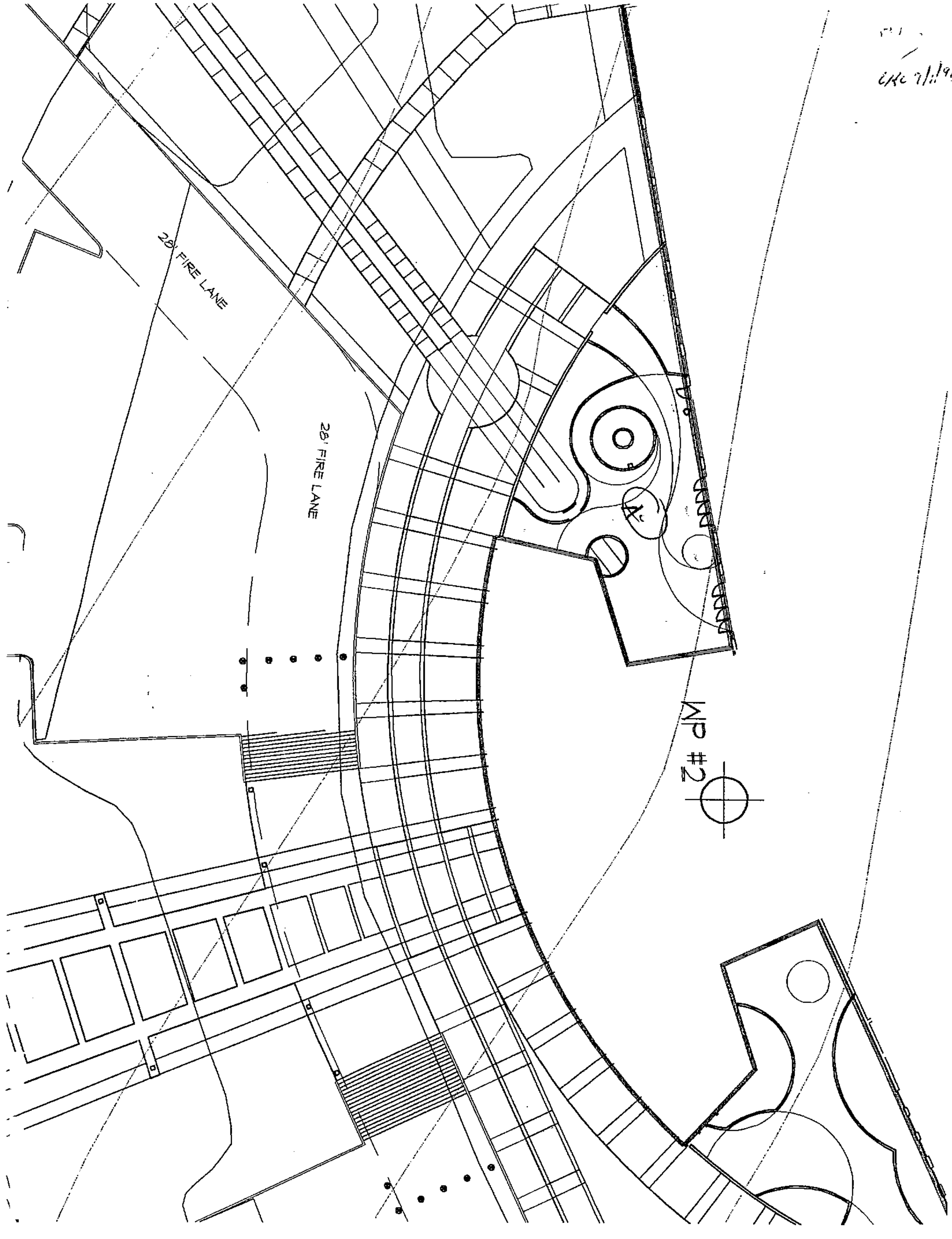
300 0 300 600


6800.50
6802.50
6800
6790
6786.75
Pool DRAIN
WP #1
6787.00
B
WP #2
28' FIRE LA

13A/13



6800.50
6802.50
6800
6790
6786.75
WP #1
Roof DRAIN
6787.00
WP #2
28' FIRE LA


28' FIRE LANE
28' FIRE LANE
MP #2