16LITCVL0389

DRAINAGE REPORT
FOR
LITCHFIELD PARK DETENTION FACILITY

June, 1989

Revised March, 1990

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1.0 INTRODUCTION

1.1 General Background

Litchfield Park Dam (also known as Murphy's Dam) was built by the Litchfield Park Properties and completed in October, 1969. The dam is located 3/4 of a mile north of Camelback Road, between Litchfield Road and Dysart Road. The dam is within an unincorporated area of Maricopa County.

Litchfield Park Dam is a flood control facility that provides stormwater detention for protection to downstream area. Two 30-inch diameter reinforced concrete pipes provide an uncontrolled outlet through the dam. In addition, two reinforced concrete spillways provide emergency relief for large storms. The reservoir is dry except during periods of stormwater runoff.

1.2 Purpose

The purpose of this Drainage Report (DR) is to analyze the flood control protection offered by the existing dam. In addition, this report will study and set parameters for the removal of this dam, and its replacement with a detention facility. Presented in this report is a hydrologic and hydraulic analysis of the drainage system. This includes the existing as well as the proposed condition. This report is intended to provide drainage information to satisfy the needs of all of the governmental agencies. This report has been updated to incorporate comments by the Flood Control District of Maricopa County (FCDMC).

1.3 Existing Reports

Numerous reports have been produced that are relevant to the study area. These reports include:

1. Phase I Inspection Report, National Dam Safety Program, Litchfield Park Detention Dam, Maricopa County, Arizona, Inventory Number 00110. (Ref. 12) Prepared by: Arizona Water Commission, Supervision of Dam Safety, February, 1980. The report concluded that with the exception of erosion gullies, small surface erosion holes, and minor brush growth, the embankment appears to be in a satisfactory condition.
2. Hydrological Evaluation, Litchfield Park Dam, Maricopa County, Arizona (Ref.

13), For Litchfield Park Properties, prepared by Dames & Moore (D&M), January 1986. The reports evaluates the impact of a 100-year storm on the Litchfield Park Dam. The tributary area assumed in the D&M Reports differs from that area used in this DR. The new detailed topographic mapping used by this DR indicates a smaller tributary, and thus a smaller flow.

3. Flow Estimation to Camelback and Dysart Roads (Ref. 14) for SunCor Development Company, prepared by Boyle Engineering Corporation April 7, 1988, revised May 17, 1988. The report evaluates Litchfield Park Dam and the flow from this dam that impacts Camelback Road. This DR generally agrees with the conclusions drawn by the Boyle report.
4. Master Drainage Report for Litchfield Ridge (Ref. 15), prepared by Wood & Associates, November 1988. The report was developed for the Litchfield Ridge Development and evaluates the flows downstream of the existing Dam.
5. Hydrology for Special Study of Luke Air Force Base, Arizona (Ref. 16), prepared by PRC Toups Corporation, January 1979. The report evaluates the effect of the 100-year storm on the two major channels that protect Luke Air Force Base. Even though the tributary area boundaries differ slightly from the PRC report to this DR, the 100-year flows are reasonably close.
6. Draft Memo Regarding the Dysart Drain (Luke Air Force Base Channel) (Ref. 17), prepared by the Corps of Engineers - Undated. The memo evaluates other reports on the Dysart Drain. The memo reports that even though many reports show the Dysart Drain to be substantially undersized, flow across the base has only occurred once since the drain was complete, and that was because construction of a bridge temporarily blocked the drain.

All of these reports provided valuable information. The results, however, vary from one report to another, due to the mapping that was available for each, the changing field conditions, and the methodology used. This DR considered all of the information available, along with detailed topographic mapping and field visits, to evaluate the hydrologic impact on this site. The topographic mapping used for this evaluation differs somewhat from the mapping used in other reports, due to datum difference (of about one foot). The spillway elevation indicated on this mapping is at elevation 1068 which is one foot different from the elevation of 1069 indicated on previous reports. Additionally, the bottom elevation of the reservoir is indicated at 1062 in the current topo, as opposed to an elevation of 1063 indicated in previous reports.

2.0 DESCRIPTION OF WATERSHED

2.1 General

The terrain throughout the watershed consists mostly of natural desert with some urbanized single family housing areas. The slopes within the watershed range from 0.2 to an excess of 10 percent. The upper watershed, which consists largely of farmland, is cut off by Luke Air Force Base and its Dysart Diversion Channel. This channel has limited capacity and some of the flow that overtops the channel will impact the site.

2.2 Rainfall Seasons

There are two separate rainfall seasons. The first occurs during the winter months from November to March when the area is subjected to occasional storms from the Pacific Ocean. While this is classified as a rainfall season, there can be periods of a month or more in this or any other season when practically no precipitation occurs. The second rainfall period occurs during July and August, when Arizona is subjected to widespread thunderstorm activity whose moisture supply originates both in the Gulf of Mexico and along Mexico's west coast. These thunderstorms are extremely variable intensity and location.

2.3 Runoff Characteristics

Generally, runoff occurs only during and immediately following heavy precipitation because arid climate and drainage characteristics are not conducive to continuous flow. The majority of the watershed consists of hydrologic Group B soils, although Group C and D soils occur within the watershed in minor proportions (Ref. 9). Generally, infiltration and transmission losses are expected to be high.

2.4 Upstream Modifications

The natural drainage basin affecting the study area extends to the white tank mountains. There have been however, a number of man-made improvements that affect runoff to the project site. These improvements include:

1. McMicken Dam and Beardsley Canal - These structures effectively eliminate runoff from the west of the Beardsley Canal.
2. Agricultural Reservoirs and Drains - A number of agricultural reservoirs are located on private property in the drainage basin upstream of the study area. These reservoirs and their collecting drains effectively reduce the volume of runoff to the project site. However, to be conservative, the HEC-1 model within this DR does not account for the impact of these agricultural features.
3. Cotton Lane and AT&SF Railroad - Runoff from the west of Cotton Lane and north of Camelback Road is conveyed south by Cotton Lane and adjacent railroad. In some locations, the dike formed by the railroad is breached, or designed channels allow flow to cross.
4. Paved and Unpaved Roads - Many roads throughout the watershed create channels that effectively convey flow throughout the watershed. These "channels" may not have the capacity to carry all of the flow that gets to them, thus creating a flow split. Many of these roads carry flow out of the watershed.
5. Dysart Diversion Channel - Starting at Reems Road on Northern Avenue, this drain diverts about 1,000 cfs of upstream runoff to the Agua Fria River. Boyle Engineering (Ref. 14) performed a field survey and established the capacity of this drain to be about 1,000 cfs.

3.0 HYDROLOGY

3.1 Methodology

The hydrologic methods to be used on this project were selected based on many discussions and input from the FCDMC. The Soil Conservation Service (SCS) method within the HEC-1 computer program was used to estimate the peak flows for the 10-, 50-, and 100-year frequency storms. The SCS Type II rainfall distribution was used for the 24-hour storm. Refer to Table 1 for precipitation data.

A computerized rainfall/runoff model was developed for the watershed using the U.S. Army Corps of Engineers Flood Hydrograph package (HEC-1). HEC-1 uses numerical parameters to describe the amount of temporal distribution of rainfall, the runoff characteristics of the watershed, and the hydraulic properties of channels that collect and convey the direct runoff to concentration points. The computer output provides runoff hydrographs at user selected locations. These hydrographs can be used to design drainage channels, detention/retention basins, or to evaluate the capacity of existing drainage facilities. The kinematic wave option was used to determine the hydrologic response of the sub-basin areas and for routing the resulting hydrographs through the tributary channels of the basin. This option was selected because runoff processes can be simulated using measurable geographic features such as overland flow elements and the shape, boundary roughness, length, and slope of channel elements. Unlike unit hydrograph techniques, the kinematic wave approach also provides for a non-linear response of runoff characteristics, i.e., peak discharge does not necessarily increase linearly with direct runoff when using the kinematic wave methodology.

A network of sub-basins and connecting channels was configured that simulates the natural drainage pattern in the basin. Plate 2 presents an illustration of the drainage patterns, sub-basin boundaries, concentration points used, and a schematic diagram of the model.

3.2 Modeling

The sub-basins were delineated based on USGS 7-1/2 minute quadrangle maps for the upper watershed, detailed topo in the vicinity of the site, and extensive field visits. Curve numbers were based on the SCS TR-55 for the appropriate land use. Refer to Table 2 for a list of the curve numbers used for this DR. At the request of the FCDMC, it is assumed that 40% of the farmland was no longer in production and reverted back to natural desert. Therefore, the curve number used for farmland was weighted 60% farmland and 40% desert. We feel this is a very conservative assumption. Lag times were based on 60% the time of concentration (Lag = 0.6 Tc). Time of concentration was calculated based on the upland method. Flow velocities used in the upland method were based on estimated flows and field estimated cross sections. Similarly, the data for the kinematic wave routing method was based on field investigation.

There are many flow splits that occur in the upper watershed. The split flow were calculated based on channel or street flow capacity calculations. The capacities were estimated from topographic mapping, aerial photographs, filed visits, and photographs. When the street or channel capacity was exceeded, weir flow calculations were used to produce the rating curve for the split. The rating curve was input into the HEC-1 computer model for the routing purpose.

3.3 Existing Condition

The watershed upstream of the Dysart Diversion Channel consists largely of farm fields. Stormwater runoff from these fields is collected in the Dysart Diversion Channel and routed east to the Agua Fria river. However, due to ground subsidence in the area, the slope on the channel has been lessened, thus reducing the capacity of the channel to about 1000 cfs. When the flow exceeds the 1000 cfs capacity of the Dysart Diversion Channel, it overtops the south bank and flows westerly. A portion of this flow (about 60 cfs) is collected in a small storm drain and diverted into the Litchfield Park Dam watershed. The 100-year storm produces a high water elevation in the existing Dam of 1067.3 with a peak flow out of the two 30" pipes of 92 cfs.

Boyle Engineering, in a report dated April 7, 1988 (Ref. 14), has done a significant amount of work addressing the flow conditions at Camelback and Dysart Roads. Boyle updated the report on May 17, 1988, subsequent to the FCDMC's technical comments. Results of this DR are in general agreement with the Boyle analysis. Minor variations in the flow volumes are resulted from the difference in curve numbers used by Boyle and CVL.

Runoff at Camelback and Dysart Roads

	100-Year	
	Boyle	CVL
Without Dam	1003 cfs	*
With Dam	717 cfs	961 cfs

*not analyzed

3.4 Proposed Condition

It is proposed to remove the existing dam due to its structural deterioration over time. The dam is to be replaced with a detention facility that can provide similar 100-year protection to the downstream property. The proposed detention facility will be designed such that the 100-year outflow does not exceed the existing 92 cfs. Additionally, the detention volume provided by the existing dam in the 100-year event is 77.3 Acre feet, and the volume provided by the designed detention facility in the 100-year event is 88.7 Acre feet.

The HEC-1 modeling for the proposed condition reflects a developed land use within the property. It was assumed that the future onsite land use is to consist of Housing, Commercial, and park space. The curve number for this area was weighted to reflect this. The HEC-1 Models show that flow releases from the proposed basin with future condition land use, do not exceed the existing flow releases from the Dam. Refer to table 3 for a summary of the flows. Therefore, it can be concluded that the detention facility will create no adverse condition on the downstream side of the project, while providing the necessary detention for the future land use.

The detention facility is designed as a dual purpose future park facility, with a sloped or terraced bottom to concentrate the low flow. Final design of the channel into the detention facility, including hydraulics, cross-section, alignment, and configuration are beyond the scope of these improvements, and should be addressed with any future improvements. This is done to allow greater flexibility for future improvements.

The outlet from the detention basin is through a 42" pipe. The pipe allows the detention basin to drain through a drainage corridor, while limiting the outflow. The detention basin is designed for the 100-year storm event per the FCDMC standards and regulations. In an event in excess of the 100 storm, the pipe will continue to outlet flow as the freeboard on the detention basin is used. As the freeboard is exceeded, the flow will sheetflow out of the basin to the South. Since the area of overflow ranges from 80 feet to 300 feet wide, and the detention basin is designed for the 100-year storm, an emergency overflow spillway is not required.

4.0 CONCLUSIONS

Based on the analysis of this report, the following conclusions are drawn:

A. Based on discussions and input from FCDMC, the flood peaks were calculated by the use of SCS Method within the HEC-1 computer program.

B. The 100-year flood peak leaving the proposed detention facility will not exceed that of the existing condition.

C. The off-site flow entering the project combined with the local on-site flow can safely be conveyed through the project. Although, the final design of the channel into the detention facility is beyond the scope of the improvements. To allow for greater flexibility, hydrology, hydraulics, cross section, alignment and configuration should be addressed with any future improvements.

D. The detailed design of the proposed detention facility is shown in the Mass Grading Plans. The design is based on generally accepted engineering practices and in accordance with local requirements.

E. Due to the fact that the proposed facility is a detention basin with capacity for the 100-year storm, there is no requirement for an emergency spillway.

F. The Flood Control District of Maricopa County and the Dam Safety Division have approved the Conceptual Drainage Report for the removal of the Litchfield Park Dam and its replacement with a detention facility. Additionally, it is recommended that the Mass Grading construction plans be approved.

5.0 REFERENCES

1. Flood Control District of Maricopa County, "Uniform Drainage Policies and Standards for Maricopa County, Arizona", February 25, 1987.

2. Flood Control District of Maricopa County, "Drainage Regulation for the Unincorporated Area of Maricopa County, Arizona", September 16, 1988.

3. City of Goodyear, "Storm Drainage Collection and Retention Requirements for Subdivisions and Site Plans", July 1984.

4. Maricopa County Department of Planning and Development, "White Tanks Agua Fria Technical Guide", January 1982.

5. Maricopa County Department of Planning and Development, "White Tanks - Agua Fria Policy & Development Guide", November 8, 1982.

6. U. S. Army Corps of Engineers, The Hydrologic Engineering Center, "HEC-1, Flood Hydrograph Package", September 1981.

7. Arizona Department of Transportation, "Hydrologic Design for Highway Drainage in Arizona", Phoenix, Arizona. December 1968.

8. U. S. Department of Agriculture, Soil Conservation Service, Technical Release 55, "Urban Hydrology for Small Watersheds", Washington, D.C., January 1975.

9. U. S. Department of Agriculture, Soil Conservation Service, in cooperation with University of Arizona Agricultural Experiment Station, "Soil Survey of Maricopa County, Arizona, Central Part", September 1977.

10. Chow Ven Te, "Handbook of Applied Hydrology", McGraw Hill, 1964.

11. Chow Ven Te, "Open Channel Hydraulics", McGraw Hill, 1959.

12. Arizona Water Commission, Supervision of Dam Safety, "Phase I Inspection Report, National Dam Safety Program, Litchfield Park Detention Dam, Maricopa County Arizona, Inventory Number 00110", February 1980.

13. Dames & Moore, "Hydrologic Evaluation, Litchfield Park Dam, Maricopa County, Arizona", January 1986.

14. Boyle Engineering Corporation, "Flow Estimation to Camelback and Dysart Roads", April 7, 1988, revised May 17, 1988.

15. Wood & Associates, Inc. "Master Drainage Report for Litchfield Ridge", November 1988.

16. PRC Toups Corporation, "Hydrology for Special Study of Luke Air Force Base, Arizona", January 1979.

17. U. S. Army Corps of Engineers, "Draft Memo Regarding Dysart Drain", undated.

18. City of Phoenix, "Storm Drain Design Manual, Subdivision on Drainage Design". September 1985.

19. U.S. Department of Transportation, Federal Highway Administration, "Hydraulic Design of Highway Culverts, Hydraulic Design Series No. 5", September, 1985.

APPENDIX

CVL

TABLES

TABLE 1

PRECIPITATION DATA *

10-YEAR 24-HOUR	50-YEAR 24-HOUR	100-YEAR 24-HOUR
2.40"	3.32"	3.75"

* From Reference 7.

TABLE 2

CURVE NUMBERS

LAND USE	SOIL TYPE A	B	C	D	
Farm Land	61	70	77	80	*
Desert	63	77	85	88	*
Single-Family Residential	--	82	87	90	+
Multi-Family Residential	--	86	89	91	+
Commercial	89	92	94	95	*
Industrial	81	88	91	93	*
Rural Farm Housing	54	70	80	85	*
Luke AFB (runway w/much graded area)	77	86	91	94	*
Golf Course & Park	49	69	79	84	*
Prison	--	87	92	94	
School	--	82	87	90	

* from TR-55 (Ref. 8)

+ from City of Phoenix Storm Drain Design Manual (Ref. 18)

TABLE 3

SUMMARY OF FLOWS

	10-YEAR 24-HOUR	50-YEAR 24-HOUR	100-YEAR 24-HOUR
Existing Condition (with Dam)	60 cfs	84 cfs	92 cfs
Proposed Condition (with Detention Facility)	43 cfs	78 cfs	88 cfs

TABLE 4

CULVERT CALCULATIONS *

ELEVATION	HEADWATER (feet)	Q* (cfs)
1059	0	0
1060	1.0'	7
1060.5	1.5'	14
1061	2.0'	20
1061.5	2.5'	30
1062	3.0'	41
1064	5.0'	77
1066	7.0'	102

* 42" RGRCP outlet pipe with headwalls.
Flows are based on inlet control square edge with headwall (Ref. 19)

HEC-1 ANALYSIS

1. EXISTING CONDITION (WITH DAM)
2. PROPOSED CONDITION (WITH DETENTION FACILITY)

HEC-1 ANALYSIS 1

EXISTING CONDITION (WITH DAM)

```
**************************************                                   **************************************
*                                    *                                   *                                    *
*   FLOOD HYDROGRAPH PACKAGE (HEC-1) *                                   *   U.S. ARMY CORPS OF ENGINEERS     *
*           FEBRUARY 1981            *                                   *   THE HYDROLOGIC ENGINEERING CENTER*
*         REVISED 04 NOV 81          *                                   *        609 SECOND STREET           *
*                                    *                                   *     DAVIS, CALIFORNIA 95616        *
* TUE, JUN 13 1989   TIME 16:42:08   *                                   *  (916) 440-3285 OR (FTS) 448-3285  *
*                                    *                                   *                                    *
**************************************                                   **************************************
```

```
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. SEE SEPTEMBER 1981 INPUT
DESCRIPTION FOR NEW DEFINITIONS.

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

       ID        LITCHFIELD PARK DAM (MURPHY'S DAM)
       ID        EXISTING HYDROLOGY
       ID        10-YEAR, 50-YEAR, 100-YEAR 24-HOUR STORMS
       ID        COE & VAN LOO CONSULTING ENGINEERS INC.       MAY 1989       JKM
       *DIAGRAM
       IT      10                      300
       IO       4       0
       JR    PREC    0.64    0.89    1.00

       KK    SUBA
       KM        RUNOFF FOR SUB BASIN A
       IN      30
       PB    3.75
       PC    .000    .020    .041    .062    .084    .107    .130    .155    .181    .208
       PC    .237    .267    .299    .333    .369    .408    .451    .498    .550    .609
       PC    .678    .766    .882   1.062   2.487   2.757   2.897   2.936   3.074   3.143
       PC   3.202   3.254   3.330   3.343   3.382   3.418   3.452   3.484   3.514   3.542
       PC   3.570   3.596   3.620   3.644   3.666   3.689   3.710   3.730   3.750   3.750
       BA    6.43
       LS              74
       UD     2.3

       KK    DIV1
       KM        DIVERSION AT WADELL RD. & REEMS RD.
       DT      D1
       DI       0     100     300     500    1000    2000    3000    4000
       DQ       0     100     200     300     320     350     375     400

       KK     RO1
       KM        ROUTE DIV1 TO STATION1
       RK   17000   0.004   0.035            TRAP      50      20

       KK    SUBB
       KM        RUNOFF FROM SUBBASIN B
       BA   11.33
       LS              74
       UD     3.5

       KK     CO1
       KM        COMBINE RO1 & SUBB
       HC       2

       KK    DIV2
       KM        DIVERSION AT OLIVE & REEMS
       DT      D2
       DI       0     100     300     500    1000    2000    4000    8000
       DQ       0     100     200     300     500    1000    2000    4000

       KK     RO2
       KM        ROUTE DIV2 TO STATION 2
       RK    5000   0.004   0.035            TRAP      50      20
```

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

  44          KK     DIV3
  45          KM          DIVERSION AT NORTHERN & REEMS
  46          DT       D3
  47          DI        0     100     300     500    1000    2000    4000    8000
  48          DQ        0     170     250     270     300     300     300     300

  49          KK      RD2
  50          KM          RETRIEVE D2
  51          DR       D2

  52          KK      RO4
  53          KM          ROUTE RD2 TO STATION 4
  54          RK    13000  0.0025   0.035           TRAP       5       6

  55          KK      RD3
  56          KM          RETRIEVE D3
  57          DR       D3

  58          KK      RO5
  59          KM          ROUTE RD3 TO STATION 5
  60          RK     8000   0.002   0.035           TRAP      10       3

  61          KK     SUBC
  62          KM          RUNOFF FROM SUBBASIN C
  63          BA     3.29
  64          LS                 73
  65          UD      2.2

  66          KK      CO2
  67          KM          COMBINE RO4, RO5, & SUBC
  68          HC        3

  69          KK      RO6
  70          KM          ROUTE CO2 TO STATION 6
  71          RK     9000   0.001   0.020           TRAP      20       2

  72          KK     SUBD
  73          KM          RUNOFF FROM SUBBASIN D
  74          BA     1.00
  75          LS                 73
  76          UD      1.6

  77          KK     DIV4
  78          KM          DIVERSION AT PEORIA & LITCHFIELD
  79          DT       D4
  80          DI        0     100     200     400    1000    2000
  81          DQ        0      50     100     150     200     250

  82          KK      RO7
  83          KM          ROUTE DIV4 TO STATION 7
  84          RK    15000   0.004   0.050           TRAP     500     100
```

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

  85           KK    SUBE
  86           KM        RUNOFF FROM SUBBASIN E
  87           BA    2.34
  88           LS              73
  89           UD     1.9

  90           KK     CO3
  91           KM        COMBINE RO6, RO7, & SUBE
  92           HC       3

  93           KK    DIV5
  94           KM        DIVERSION FROM LUKE AFB CHANNEL
  95           DT      D5
  96           DI       0     100     500    1000    1500    2000    5000
  97           DQ       0     100     500    1000    1500    1000    1000

  98           KK     RO8
  99           KM        ROUTE DIV5 TO STATION 8
 100           RK    6000   0.001   0.040            TRAP     100     100

 101           KK    DIV6
 102           KM        DIVERSION THROUGH PIPE TO LITCHFIELD PARK DAM
 103           DT      D6
 104           DI       0      60     200     500    1000    2000    5000
 105           DQ       0      60      60      60      60      60      60

 106           KK     RD6
 107           KM        RETRIEVE D6
 108           DR      D6

 109           KK    RO16
 110           KM        ROUTE RD6 TO STATION 16
 111           RK    6000   0.002   0.035            TRAP      20       4

 112           KK    SUBM
 113           KM        RUNOFF FROM SUBBASIN M
 114           BA    1.23
 115           LS              81
 116           UD     0.6

 117           KK    CO11
 118           KM        COMBINE RO16 & SUBM
 119           HC       2

 120           KK    RET1
 121           KM        LITCHFIELD PARK DAM
 122           RS       1    ELEV    1062
 123           SA       0       9      23      39      65
 124           SQ       0      32      74     192     322
 125           SE    1062    1064    1066    1068    1070
```

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

 126       KK    RO17
 127       KM         ROUTE RET1 TO STATION 17
 128       RK    4500   0.004   0.035             TRAP      20        4

 129       KK    SUBN
 130       KM         RUNOFF FROM SUBBASIN N
 131       BA    1.20
 132       LS                79
 133       UD     0.3

 134       KK    CO12
 135       KM         COMBINE RO17 & SUBN
 136       HC        2
 137       ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
 INPUT
  LINE      (V) ROUTING            (--->) DIVERSION
   NO.      (.) CONNECTOR          (<---) RETURN OF DIVERTED FLOW

    8       SUBA
              .
              .
   22         .------->       D1
   23       DIV1
              V
              V
   25        RO1
              .
              .
   28         .       SUBB
              .          .
   33        CO1..........
              .
              .
   38         .------->       D2
   36       DIV2
              V
              V
   41        RO2
              .
              .
   46         .------->       D3
   44       DIV3
              .
              .
   51         .          .<-------       D2
   49         .        RO2
              .          V
              .          V
   52         .        RO4
              .          .
              .          .
   57         .          .          .<-------       D3
   55         .          .        RO3
              .          .          V
              .          .          V
   58         .          .        RO5
              .          .          .
              .          .          .
   61         .          .          .       SUBC
              .          .          .          .
              .          .          .          .
   66         .        CO2.......................
              .          V
              .          V
   69         .        RO6
              .          .
              .          .
   72         .          .       SUBD
              .          .          .
              .          .          .
   79         .          .          .------->       D4
   77         .          .       DIV4
              .          .          V
              .          .          V
   82         .          .        RO7
              .          .          .
```

```
  85       .         .         .         SUB_
                     .         .           .
  90       .        C03.....................
           .         .
  95       .         .------->      D5
  93       .       DIV5
           .         V
           .         V
  98       .        RO8
           .         .
 103       .         .------->      D6
 101       .       DIV6
           .         .
           .         .
 103       .         .         .<-------       D6
 106       .         .        RD6
           .         .         V
           .         .         V
 109       .         .       RO16
           .         .         .
           .         .         .
 112       .         .         .         SUBN
           .         .         .            .
           .         .         .            .
 117       .         .       CO11............
           .         .         V
           .         .         V
 120       .         .       RET1
           .         .         V
           .         .         V
 126       .         .       RO17
           .         .         .
           .         .         .
 129       .         .         .         SUBN
           .         .         .            .
           .         .         .            .
 134       .         .       CO12............
(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

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

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 0.64	RATIO 2 0.89	RATIO 3 1.00
HYDROGRAPH AT	SUBA	6.43	1	FLOW	384.	859.	1100.
				TIME	14.67	14.50	14.50
DIVERSION TO	D1	6.43	1	FLOW	242.	314.	323.
				TIME	14.67	14.50	14.50
HYDROGRAPH AT	DIV1	6.43	1	FLOW	142.	545.	777.
				TIME	14.67	14.50	14.50
ROUTED TO	R01	6.43	1	FLOW	121.	490.	724.
				TIME	16.33	15.50	15.33
HYDROGRAPH AT	SUBB	11.33	1	FLOW	507.	1111.	1419.
				TIME	16.17	15.83	15.83
2 COMBINED AT	C01	17.76	1	FLOW	626.	1595.	2123.
				TIME	16.33	15.67	15.67
DIVERSION TO	D2	17.76	1	FLOW	350.	798.	1061.
				TIME	16.33	15.67	15.67
HYDROGRAPH AT	DIV2	17.76	1	FLOW	275.	798.	1061.
				TIME	16.33	15.67	15.67
ROUTED TO	R02	17.76	1	FLOW	275.	793.	1058.
				TIME	16.50	16.00	15.83
DIVERSION TO	D3	17.76	1	FLOW	231.	288.	300.
				TIME	16.50	16.00	15.33
HYDROGRAPH AT	DIV3	17.76	1	FLOW	44.	506.	758.
				TIME	16.50	16.00	15.83
HYDROGRAPH AT	RD2	0.00	1	FLOW	350.	798.	1061.
				TIME	16.50	16.00	15.83
ROUTED TO	R04	0.00	1	FLOW	348.	780.	1045.
				TIME	17.00	16.17	16.00
HYDROGRAPH AT	RD3	0.00	1	FLOW	231.	288.	300.
				TIME	17.00	16.17	16.00
ROUTED TO	R05	0.00	1	FLOW	230.	287.	300.
				TIME	16.83	16.17	16.50
HYDROGRAPH AT	SUBC	3.29	1	FLOW	185.	426.	551.
				TIME	14.50	14.33	14.33
3 COMBINED AT	C02	3.29	1	FLOW	684.	1336.	1705.
				TIME	16.67	16.00	15.67
ROUTED TO	R06	3.29	1	FLOW	681.	1334.	1703.
				TIME	17.00	16.17	15.83
HYDROGRAPH AT	SUBD	1.00	1	FLOW	70.	163.	211.

				T[illegible]	13.8[illegible]	13.[illegible]	13[illegible]
DIVERSION TO	D4	1.00	1	FLOW	35.	81.	108.
				TIME	13.83	13.67	13.67
HYDROGRAPH AT	DIV4	1.00	1	FLOW	35.	81.	108.
				TIME	13.83	13.67	13.67
ROUTED TO	R07	1.00	1	FLOW	20.	52.	70.
				TIME	21.00	18.83	18.33
HYDROGRAPH AT	SUBE	2.34	1	FLOW	146.	337.	436.
				TIME	14.17	14.00	14.00
3 COMBINED AT	C03	6.63	1	FLOW	748.	1598.	1940.
				TIME	16.83	16.00	15.67
DIVERSION TO	D5	6.63	1	FLOW	748.	1000.	1100.
				TIME	16.83	14.33	13.83
HYDROGRAPH AT	DIV5	6.63	1	FLOW	0.	508.	940.
				TIME	0.17	16.00	15.67
ROUTED TO	R08	6.63	1	FLOW	0.	484.	902.
				TIME	0.17	17.00	16.50
DIVERSION TO	D6	6.63	1	FLOW	0.	60.	60.
				TIME	0.17	15.67	15.00
HYDROGRAPH AT	DIV6	6.63	1	FLOW	0.	424.	842.
				TIME	0.17	17.00	16.50
HYDROGRAPH AT	R06	0.00	1	FLOW	0.	60.	60.
				TIME	0.17	17.00	16.50
ROUTED TO	R016	0.00	1	FLOW	0.	60.	60.
				TIME	0.17	17.50	18.17
HYDROGRAPH AT	SUBM	1.23	1	FLOW	319.	603.	737.
				TIME	12.50	12.50	12.50
2 COMBINED AT	C011	1.23	1	FLOW	319.	603.	737.
				TIME	12.50	12.50	12.50
ROUTED TO	RET1	1.23	1	FLOW	60.	84.	92.
				TIME	14.33	20.83	21.33
				** PEAK STAGES IN FEET **			
			1	STAGE	1065.32	1066.72	1067.32
				TIME	14.33	20.83	21.17
ROUTED TO	R017	1.23	1	FLOW	60.	84.	92.
				TIME	14.67	21.00	21.50
HYDROGRAPH AT	SUBN	1.20	1	FLOW	388.	764.	942.
				TIME	12.17	12.17	12.17
2 COMBINED AT	C012	2.43	1	FLOW	390.	779.	965.
				TIME	12.17	12.17	12.17

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

HEC-1 ANALYSIS 2

PROPOSED CONDITION (WITH DETENTION FACILITY)

```
*****************************************                    ****************************************
*                                       *                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *   U.S. ARMY CORPS OF ENGINEERS       *
*             FEBRUARY 1981             *                    *   THE HYDROLOGIC ENGINEERING CENTER  *
*          REVISED 14 NOV 81            *                    *          609 SECOND STREET           *
*                                       *                    *       DAVIS, CALIFORNIA 95616        *
* TUE, JUN 13 1989     TIME 16:42:55    *                    *  (916) 440-3285 OR (FTS) 448-3285    *
*                                       *                    *                                      *
*****************************************                    ****************************************


                  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. SEE SEPTEMBER 1981 INPUT
DESCRIPTION FOR NEW DEFINITIONS.

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

   1          ID        LITCHFIELD PARK DETENTION FACILITY
   2          ID        TO REPLACE LITCHFIELD PARK DAM (MURPY'S DAM)
   3          ID        PROPOSED HYDROLOGY
   4          ID        10-YEAR, 50-YEAR, 100-YEAR 24-HOUR STORMS
   5          ID        COE & VAN LOO CONSULTING ENGINEERS INC.          JUNE 1989         JKM
              *DIAGRAM
   6          IT      10                          300
   7          IO       4       0
   8          JR    PREC    0.64    0.89    1.00

   9          KK    SUBA
  10          KM        RUNOFF FOR SUB BASIN A
  11          IN      30
  12          PB    3.75
  13          PC    .000    .020    .041    .062    .084    .107    .130    .155    .181    .208
  14          PC    .237    .267    .299    .333    .369    .408    .451    .498    .550    .609
  15          PC    .678    .766    .882   1.062   2.487   2.757   2.897   2.996   3.074   3.143
  16          PC   3.202   3.254   3.300   3.343   3.392   3.418   3.452   3.484   3.514   3.542
  17          PC   3.570   3.596   3.620   3.644   3.666   3.689   3.710   3.730   3.739   3.750
  18          BA    6.43
  19          LS              74
  20          UD     2.3

  21          KK    DIV1
  22          KM        DIVERSION AT WADELL RD. & REEMS RD.
  23          DT      D1
  24          DI       0     100     300     500    1000    2000    3000    4000
  25          DQ       0     130     200     300     320     350     375     400

  26          KK     R01
  27          KM        ROUTE DIV1 TO STATION1
  28          RK   17050   0.004   0.035                    TRAP      50      20

  29          KK    SUBB
  30          KM        RUNOFF FROM SUBBASIN B
  31          BA   11.33
  32          LS              74
  33          UD     3.5

  34          KK     C01
  35          KM        COMBINE R01 & SUBB
  36          HC       2

  37          KK    DIV2
  38          KM        DIVERSION AT OLIVE & REEMS
  39          DT      D2
  40          DI       0     100     300     500    1000    2000    4000    8000
  41          DQ       0     100     200     300     500    1000    2000    4000

  42          KK     R02
  43          KM        ROUTE DIV2 TO STATION 2
  44          RK    5000   0.004   0.035                    TRAP      50      20
```

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

  45       KK    DIV3
  46       KM         DIVERSION AT NORTHERN & REEMS
  47       DT      D3
  48       DI       0     100     300     500    1000    2000    4000    8000
  49       DQ       0     100     250     270     300     300     300     300

  50       KK     RD2
  51       KM         RETRIEVE D2
  52       DR      D2

  53       KK     RD4
  54       KM         ROUTE RD2 TO STATION 4
  55       RK   13000  0.0025   0.035            TRAP       5       6

  56       KK     RD3
  57       KM         RETRIEVE D3
  58       DR      D3

  59       KK     RD5
  60       KM         ROUTE RD3 TO STATION 5
  61       RK    8000   0.002   0.035            TRAP      10       3

  62       KK    SUBC
  63       KM         RUNOFF FROM SUBBASIN C
  64       BA    3.29
  65       LS              73
  66       UD     2.2

  67       KK     CO2
  68       KM         COMBINE RO4, RO5, & SUBC
  69       HC       3

  70       KK     RO6
  71       KM         ROUTE CO2 TO STATION 6
  72       RK    9000   0.001   0.020            TRAP      20       2

  73       KK    SUBD
  74       KM         RUNOFF FROM SUBBASIN D
  75       BA    1.00
  76       LS              73
  77       UD     1.6

  78       KK    DIV4
  79       KM         DIVERSION AT PEORIA & LITCHFIELD
  80       DT      D4
  81       DI       0     100     200     400    1000    2000
  82       DQ       0      50     100     150     200     250

  83       KK     RO7
  84       KM         ROUTE DIV4 TO STATION 7
  85       RK   15000   0.004   0.050            TRAP     500     100
```

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

  86          KK   SUBE
  87          KM       RUNOFF FROM SUBBASIN E
  88          BA   2.34
  89          LS                  73
  90          UD    1.9

  91          KK    CO3
  92          KM       COMBINE R06, R07, & SUBE
  93          HC      3

  94          KK   DIV5
  95          KM       DIVERSION FROM LUKE AFB CHANNEL
  96          DT    D5
  97          DI      0     100     500    1000    1500    2000    5000
  98          DQ      0     100     500    1000    1000    1000    1000

  99          KK    R08
 100          KM       ROUTE DIV5 TO STATION 8
 101          RK   6100   0.001   0.040           TRAP     100     100

 102          KK   DIV6
 103          KM       DIVERSION THROUGH PIPE TO LITCHFIELD PARK DETENTION FACILITY
 104          DT    D6
 105          DI      0      50     200     500    1000    2000    5000
 106          DQ      0      60      60      60      60      60      60

 107          KK    R06
 108          KM       RETRIEVE D6
 109          DR    D6

 110          KK   R016
 111          KM       ROUTE R06 TO STATION 16
 112          RK   6030   0.002   0.035           TRAP      20       4

 113          KK   SUBM
 114          KM       RUNOFF FROM SUBBASIN M
 115          BA   1.23
 116          LS                  82
 117          UD    0.6

 118          KK   CO11
 119          KM       COMBINE R016 & SUBM
 120          HC      2

 121          KK   RET1
 122          KM       LITCHFIELD PARK DETENTION FACILITY
 123          RS      1    ELEV   1059.
 124          SA    0.1     6.0    10.8    14.4    19.0    19.2    20.1    21.0
 125          SQ     0.      7.     14.     20.     30.     41.     77.    102.
 126          SE  1059.   1060.  1060.5   1061.  1061.5   1062.   1064.   1065.
```

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

 127      KK   R017
 128      KM       ROUTE RET1 TO STATION 17
 129      RK   4500   0.004   0.035         TRAP       20        4

 130      KK   SUBN
 131      KM       RUNOFF FROM SUBBASIN N
 132      BA   1.20
 133      LS             79
 134      UD    0.3

 135      KK   C012
 136      KM       COMBINE R017 & SUBN
 137      HC      2
 138      ZZ
```

```
                    SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING           (--->) DIVERSION
   NO.      (.) CONNECTOR         (<---) RETURN OF DIVERTED FLOW

   9             SUBA
                    .
  23                .------->        D1
  21             DIV1
                    V
                    V
  26              R01
                    .
  29                .        SUBB
                    .           .
                    .           .
  34              C01............
                    .
                    .
  39                .------->        D2
  37             DIV2
                    V
                    V
  42              R02
                    .
                    .
  47                .------->        D3
  45             DIV3
                    .
                    .
  52                .           .<-------        D2
  50                .         R02
                    .           V
                    .           V
  53                .         R04
                    .           .
                    .           .
  58                .           .           .<-------        D3
  56                .           .         R03
                    .           .           V
                    .           .           V
  59                .           .         R05
                    .           .           .
                    .           .           .
  62                .           .           .        SUBC
                    .           .           .           .
                    .           .           .           .
  67                .         C02........................
                    .           V
                    .           V
  70                .         R06
                    .           .
                    .           .
  73                .           .        SUBD
                    .           .           .
                    .           .           .
  81                .           .           .------->        D4
  78                .           .        DIV4
                    .           .           V
                    .           .           V
  83                .           .         R07
                    .           .           .
```

```
 8?            .           .           .           SU??
               .           .           .           .
               .           .           .           .
 91            .          C03...........................
               .           .
 96            .           .------->        D5
 94            .         DIV5
               .           V
               .           V
 99            .          R08
               .           .
               .           .
 104           .           .------->        D6
 102           .         DIV6
               .           .
               .           .
 109           .           .           .<-------        D6
 107           .           .          RD6
               .           .           V
               .           .           V
 110           .           .         RO16
               .           .           .
 113           .           .           .           SUBM
               .           .           .           .
               .           .           .           .
 118           .           .         CO11.............
               .           .           V
               .           .           V
 121           .           .         RET1
               .           .           V
               .           .           V
 127           .           .         RO17
               .           .           .
               .           .           .
 13?           .           .           .           SUBN
               .           .           .           .
               .           .           .           .
 135           .           .         CO12.............

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

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

					RATIOS APPLIED TO PRECIPITATION		
OPERATION	STATION	AREA	PLAN		RATIO 1	RATIO 2	RATIO 3
					0.64	0.89	1.00
HYDROGRAPH AT	SUBA	6.43	1	FLOW	384.	859.	1100.
				TIME	14.67	14.50	14.50
DIVERSION TO	D1	6.43	1	FLOW	242.	314.	323.
				TIME	14.67	14.50	14.50
HYDROGRAPH AT	DIV1	6.43	1	FLOW	142.	545.	777.
				TIME	14.67	14.50	14.50
ROUTED TO	RO1	6.43	1	FLOW	121.	490.	724.
				TIME	16.33	15.50	15.33
HYDROGRAPH AT	SUBB	11.33	1	FLOW	507.	1111.	1419.
				TIME	16.17	15.83	15.83
2 COMBINED AT	CO1	17.76	1	FLOW	626.	1595.	2123.
				TIME	16.33	15.67	15.67
DIVERSION TO	D2	17.76	1	FLOW	350.	798.	1061.
				TIME	16.33	15.67	15.67
HYDROGRAPH AT	DIV2	17.76	1	FLOW	275.	798.	1061.
				TIME	16.33	15.67	15.67
ROUTED TO	RO2	17.76	1	FLOW	275.	793.	1058.
				TIME	16.50	16.00	15.83
DIVERSION TO	D3	17.76	1	FLOW	231.	298.	300.
				TIME	16.50	16.00	15.33
HYDROGRAPH AT	DIV3	17.76	1	FLOW	44.	506.	758.
				TIME	16.50	16.00	15.83
HYDROGRAPH AT	RD2	0.00	1	FLOW	350.	798.	1061.
				TIME	16.50	16.00	15.83
ROUTED TO	RO4	0.00	1	FLOW	348.	780.	1045.
				TIME	17.00	16.17	16.00
HYDROGRAPH AT	RD3	0.00	1	FLOW	231.	288.	300.
				TIME	17.00	16.17	16.00
ROUTED TO	RO5	0.00	1	FLOW	230.	287.	300.
				TIME	16.83	16.17	16.50
HYDROGRAPH AT	SUBC	3.29	1	FLOW	185.	426.	551.
				TIME	14.50	14.33	14.33
3 COMBINED AT	CO2	3.29	1	FLOW	684.	1336.	1705.
				TIME	16.67	16.00	15.67
ROUTED TO	RO6	3.29	1	FLOW	681.	1334.	1703.
				TIME	17.00	16.17	15.83
HYDROGRAPH AT	SUBD	1.00	1	FLOW	70.	163.	211.

				TIME	13.8[illegible]	13.[illegible]	13.[illegible]
DIVERSION TO	D4	1.00	1	FLOW	35.	81.	103.
				TIME	13.83	13.67	13.67
HYDROGRAPH AT	DIV4	1.00	1	FLOW	35.	81.	108.
				TIME	13.83	13.67	13.67
ROUTED TO	RO7	1.00	1	FLOW	20.	52.	70.
				TIME	21.00	18.83	18.33
HYDROGRAPH AT	SUBF	2.34	1	FLOW	146.	337.	436.
				TIME	14.17	14.00	14.00
3 COMBINED AT	CO3	6.63	1	FLOW	748.	1508.	1940.
				TIME	16.83	16.00	15.67
DIVERSION TO	D5	6.63	1	FLOW	748.	1000.	1000.
				TIME	16.83	14.33	13.83
HYDROGRAPH AT	DIV5	6.63	1	FLOW	0.	508.	940.
				TIME	0.17	16.00	15.67
ROUTED TO	RO8	6.63	1	FLOW	0.	484.	902.
				TIME	0.17	17.00	16.50
DIVERSION TO	D6	6.63	1	FLOW	0.	60.	60.
				TIME	0.17	15.67	15.00
HYDROGRAPH AT	DIV6	6.63	1	FLOW	0.	424.	842.
				TIME	0.17	17.00	16.50
HYDROGRAPH AT	RD6	0.00	1	FLOW	0.	60.	60.
				TIME	0.17	17.00	16.50
ROUTED TO	RO16	0.00	1	FLOW	0.	60.	60.
				TIME	0.17	17.50	18.17
HYDROGRAPH AT	SUBM	1.23	1	FLOW	343.	633.	769.
				TIME	12.50	12.50	12.50
2 COMBINED AT	CO11	1.23	1	FLOW	343.	633.	769.
				TIME	12.50	12.50	12.50
ROUTED TO	RET1	1.23	1	FLOW	43.	78.	88.
				TIME	15.33	21.00	21.67

** PEAK STAGES IN FEET **

			1	STAGE	1062.13	1064.09	1064.92
				TIME	15.33	21.00	21.67
ROUTED TO	RO17	1.23	1	FLOW	43.	78.	88.
				TIME	15.50	21.17	21.83
HYDROGRAPH AT	SUBN	1.20	1	FLOW	388.	764.	942.
				TIME	12.17	12.17	12.17
2 COMBINED AT	CO12	2.43	1	FLOW	389.	771.	953.
				TIME	12.17	12.17	12.17

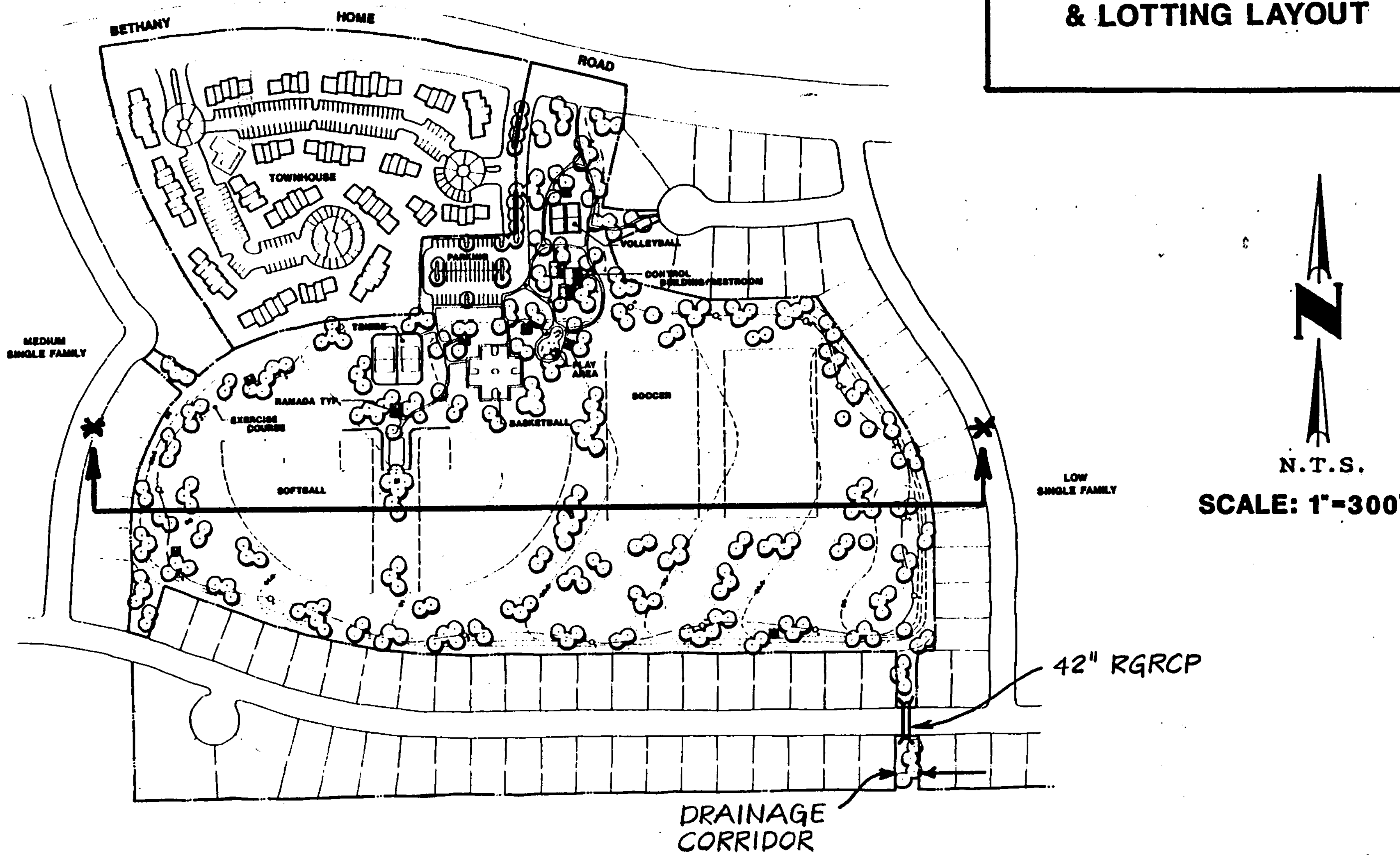
*** NORMAL END OF HEC-1 ***

PLATES

1. OFF-SITE DRAINAGE MAP AND EXISTING HEC-1 SCHEMATIC
2. CONCEPTUAL PARK AND LOTTING LAYOUT
3. DETENTION FACILITY CROSS SECTION

LITCHFIELD PARK DETENTION FACILITY

CONCEPTUAL PARK & LOTTING LAYOUT



* SEE CROSS SECTION (PLATE 3)

NOTE: LAND USE, STREET, AND PARK LAYOUT, ARE CONCEPTUAL

PLATE 2

COE & VAN LOO PHOENIX
CONSULTING ENGINEERING INC. ARIZONA

[illegible]

DETENTION FACILITY

CROSS SECTION

SCALE: 1"=200' HORIZONTAL
1"=4' VERTICAL

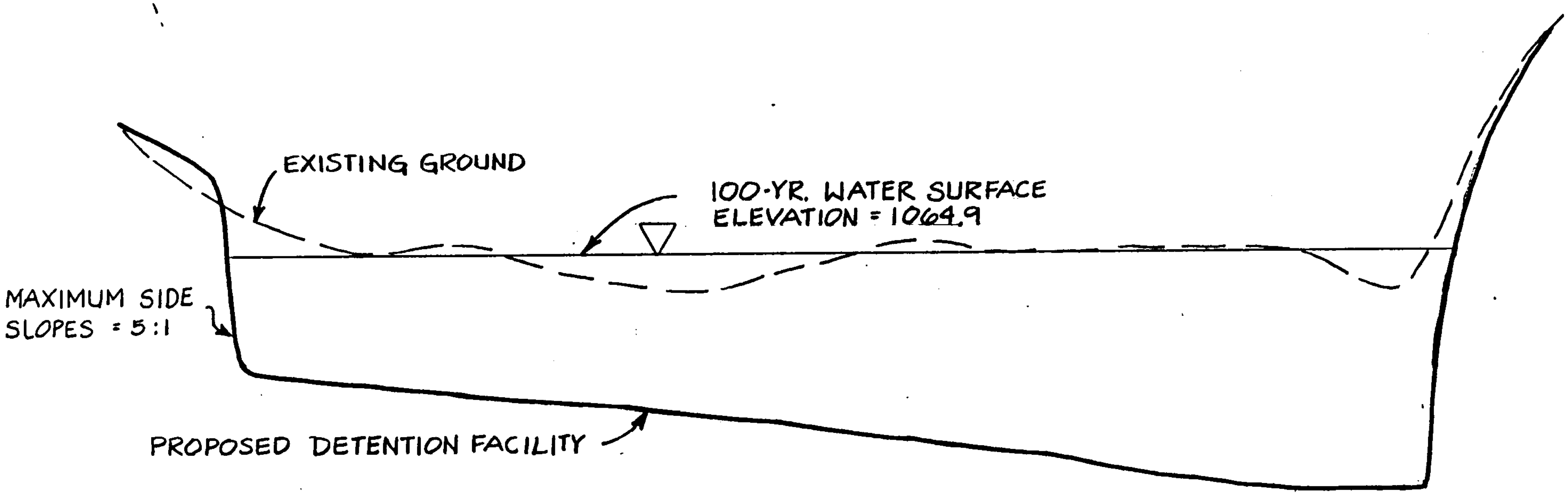


PLATE 3

COE & VAN LOO PHOENIX
CONSULTING ENGINEERING INC. ARIZONA