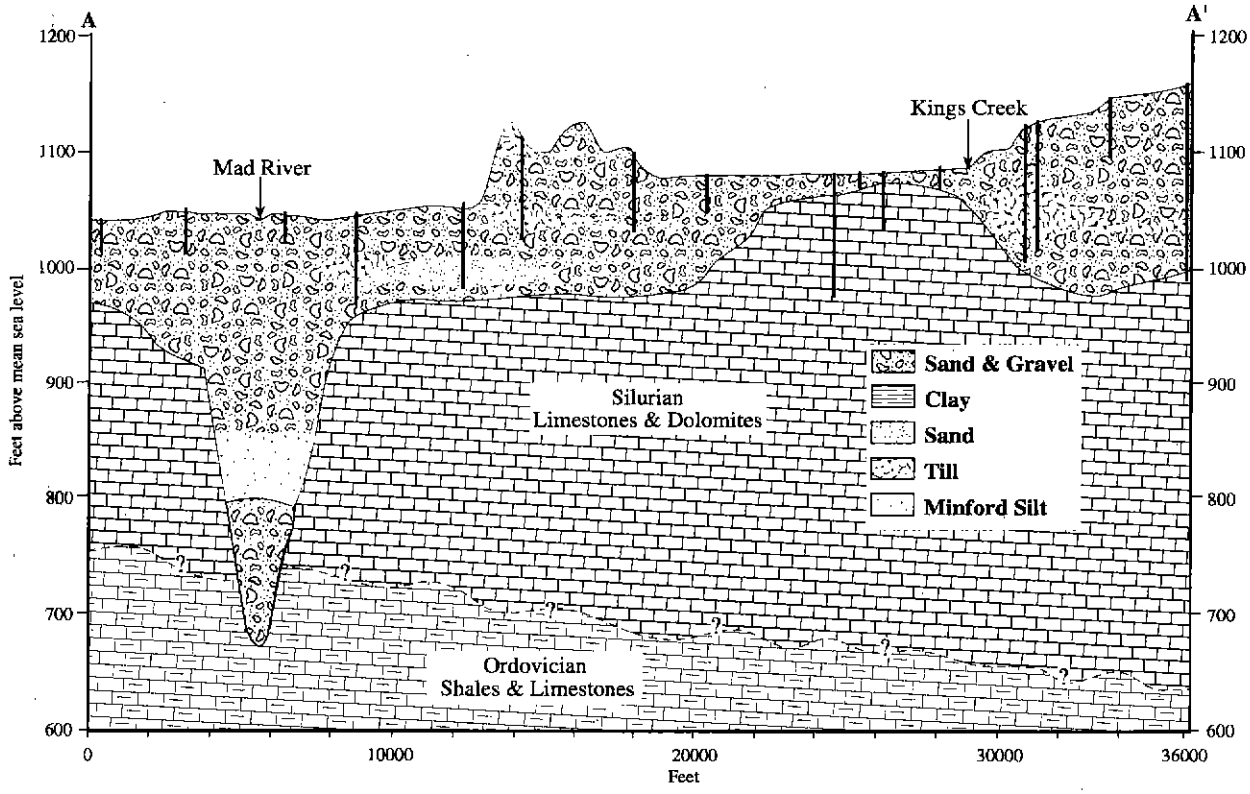
289-1

Identification of the Hydrologic System and Nonpoint Source Impacts in the Mad River Watershed



Published by:
Ohio Department of Natural Resources
Division of Water
Water Resources Section
July 1996

Identification of the Hydrologic System and Nonpoint Source Impacts in the Mad River Watershed

by

Wayne Jones, Mike Schiefer, and Eric B. Sainey

OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
WATER RESOURCES SECTION

JULY, 1996

This publication was financed in part through a grant from Ohio Environmental Protection Agency under provisions of Section 319 of the Clean Water Act as amended in 1987.

ABSTRACT

The effects of nonpoint source pollution on the Mad River watershed were assessed by defining the hydrologic system and investigating water quality variations within the watershed. The 2 year study focused on understanding the interaction between ground water and surface water. Ground water levels were recorded during a series of quarterly synoptic surveys of 64 domestic water wells. Water table maps were constructed which showed the direction of ground water flow is toward the Mad River and its' tributaries.

Ground water quality data shows certain wells consistently approach or exceed the safe drinking water standard of 10 milligrams per liter (mg/L) for nitrate. These high nitrate levels are concentrated mainly in the Kings Creek subwatershed, where the mean nitrate concentration is nearly 5.0 mg/L. Major ion analysis of ground water reveals a calcium-magnesium bicarbonate water type similar to the surface water of the Mad River with total dissolved solids (TDS) ranging from 125 to 665 mg/L.

Ground water pollution potential mapping using the DRASTIC system was used to identify areas in which sensitive land use activities would be inappropriate.

Hydrograph separation and gain/loss studies for all tributaries of the river shows a median percent of annual total streamflow due to base flow at 76.1 percent near Urbana (Koltun, 1995).

A HEC-1 model of ground water recharge and its' effect on surface water flow has helped determine the best times for the application of agricultural chemicals in sensitive ground water recharge areas.

TABLE OF CONTENTS

TITLE PAGE 1
ABSTRACT 2
TABLE OF CONTENTS 3
LIST OF FIGURES 6
LIST OF TABLES 8
ACKNOWLEDGMENTS 9
CHAPTER 1-INTRODUCTION 10
1.1 Reason for the Study 10
1.2 Funding Source 10
1.3 Cooperators 10
1.4 Location 10
1.5 Physiography 13
1.6 Climate 13
CHAPTER 2-GEOLOGIC FRAMEWORK 13
2.0 Geologic Introduction 13
2.1 Soils 13
2.2 Previous Studies and Investigations 17
2.3 Drainage 17
2.31 Present Drainage 17
2.32 Teays Stage Drainage 17
2.33 Deep Stage 20
2.4 Glacial Geology 20
2.41 Ice Advances 20
2.42 Glacial Deposits 20
2.8 Bedrock Geology 28
2.81 Overview 28
2.82 Ordovician 28
2.83 Silurian 28
2.84 Devonian 28
2.9 Hydrology 31
2.91 Glacial Aquifers 31
2.92 Bedrock Aquifers 31
CHAPTER 3-GEOLOGIC INVESTIGATIONS 31
3.1 Stream Gage 31
3.2 Observation Well 33
3.3 Cross-Sections 33
CHAPTER 4-HYDROGEOLOGIC AQUIFER CHARACTERIZATION 33
4.1 Water Level Analysis 38
4.11 How the Wells Were Selected 38
4.12 Collecting Static Water Level Data 38
4.13 Water Table Surface Map Construction 38

4.14 Trends in the Data 41
4.15 Static Water Level Results 41

CHAPTER 5 WATER QUALITY ANALYSIS 42

5.1 Methodology 42
5.2 Ground Water Sampling Techniques 42
5.3 Surface Water Sampling Techniques 43

5.4 Natural Water Chemistry 43
5.41 Chemical Parameters 43
5.42 Variations 45

5.5 Contaminant Water Chemistry 45
5.51 Ammonia Contamination 48
5.52 Nitrate Contamination 48
5.53 Nitrate in the Urbana Well Field 53
5.54 Pesticide Contamination 53

5.6 Statistical Evaluation 54
5.61 Scatterplots 54
5.62 Piper Trilinear and Stiff Diagrams 54
5.63 Mean Values 54
5.64 Normalization of Data 54
5.65 Watershed Sub-Division 62
5.66 Probability Plots 62

CHAPTER 6-BASE FLOW STUDIES 62

6.1 Introduction 62
6.2 Procedure 62
6.3 Gaging Station Record 70
6.4 Analysis and Results 70
6.5 Final Summary 70

CHAPTER 7 RAINFALL-RUNOFF SIMULATION MODEL 70

7.1 Introduction 70

7.2 Stream Hydrology 76
7.21 Basin Geomorphology 76
7.22 Characteristics of Flow 76
7.23 Land Use and Hydro-Modifications 77
7.24 Relationship of Annual Precipitation and Runoff 77

7.3 Sources of Data 80
7.31 Data for Watershed Parameters 80
7.32 Stream Flow Data 82
7.33 Climatological Data 82
7.34 Data for Antecedent Moisture Condition 82

7.4 Model Description 82
7.41 General Description of Model 82
7.42 Stream Network 82
7.43 Subbasin Discharge Hydrographs 84
7.44 Hydrologic Routing of Stream Flow 84
7.45 Computer Model and Input Parameters 86

7.5 Methodology 86
7.51 General Approach to Modeling 86
7.52 Estimation of Model Parameters 86
7.53 Calibration of the Rainfall-Runoff Model 88
7.6 Finding and Results 88
7.61 Findings from Analysis of Base Flow Measurements 88
7.62 Findings from Composite Recession Curve Analysis 89
7.63 Findings from Hydrograph Separation Analysis 91
7.64 Findings Regarding Goodness of Fit of Hydrographs 91
7.65 Findings Regarding Rainfall-Runoff Events and Season of Year 94
7.7 Application 94
7.71 Predictive and Interpretive Uses of the Model 94
7.72 Procedures for Applying the Model 99
7.8 Conclusions 99
CHAPTER 8 DRASTIC MAPPING FOR CHAMPAIGN AND LOGAN COUNTIES 102
8.1 Introduction 102
CHAPTER 9-FACTORS THAT AFFECT WATER QUALITY 103
9.1 Land Use 103
9.2 Feedlots 104
9.3 Septic Systems 104
9.4 Crop Production 104
9.5 Geology 105
9.6 Well Construction 105
CHAPTER 10-RESULTS AND DISCUSSION 106
10.1 Ground Water/Surface Water Interaction 106
CHAPTER 11-RECOMMENDATIONS AND FUTURE STUDIES 106
11.1 Suggestion for Planning and Future Studies in the Watershed 106
References 108
Unpublished Data 113
APPENDIX A DOMESTIC WELL LOG RECORDS 114
APPENDIX B1 WATER LEVEL MEASUREMENTS 188
APPENDIX B2 WATER TABLE MAPS 190
APPENDIX C WATER QUALITY DATA 194
APPENDIX D1 AVERAGE CHEMICAL COMPOSITION 208
APPENDIX D2 PIPER TRILINEAR DIAGRAMS 212
APPENDIX D3 NON–NORMALIZED WATER CHEMISTRY DATA 214
APPENDIX D4 NORMALIZED WATER CHEMISTRY DATA 222
APPENDIX E HEC–1 COMPUTER MODEL 230

LIST OF FIGURES

Figure 2.1 Mad River watershed 11
Figure 2.2 Location map of NPS study area 12
Figure 2.3 Generalized Champaign County soils map 16
Figure 2.4 Tertiary Teays Stage drainage 18
Figure 2.5 Pre-glacial Logan and Champaign Counties 19
Figure 2.6 Deep Stage drainage 21
Figure 2.7 Late Wisconsinan sublobes. 23
Figure 2.8 Generalized Logan and Champaign surficial county glacial map 24
Figure 2.9 Outwash levels in Champaign and Logan Counties 26
Figure 2.10 Surficial glacial map of west central Ohio 27
Figure 2.11 Sample buried valleys in Champaign and Logan Counties 32
Figure 3.1 Well log and drilling report 34
Figure 3.2 West Liberty observation well gamma log 35
Figure 3.3 Cross-section of Mad River basin 36
Figure 3.4. Cross-section of Kings Creek area 37
Figure 4.1 Well log and drilling report 39
Figure 4.2 Mad River water table map December, 1993 40
Figure 5.1 Average dissolved chemical composition of ground water 44
Figure 5.2 Specific Conductivity vs. TDS (mean values for all ground water data) 46
Figure 5.3 Specific Conductivity vs. TDS (mean values for all data) 47
Figure 5.4 Ammonia as nitrogen for Champaign County, Ohio 49
Figure 5.5 Casing length vs. NO3 for 3/95 ground water data 51
Figure 5.6 Depth to aquifer vs. nitrate for 3/95 ground water data 52
Figure 5.7 NO3 vs. NH3 for 6/95 ground water data 55
Figure 5.8 Calcium vs. hardness (mean values of all data) 56
Figure 5.9 Calcium vs. magnesium (mean values for all data) 57
Figure 5.10 Regression plot for chloride vs. conductivity 58
Figure 5.11 Piper diagram for North subwatershed 59
Figure 5.12 Piper diagram for South subwatershed 60
Figure 5.13 Piper diagram for Kings Creek subwatershed 61
Figure 5.14 Stiff diagram for various wells 63
Figure 5.15 Statistical analysis of raw nitrate data 64
Figure 5.16 Statistical analysis of normalized nitrate data 65
Figure 5.17 Probability of ground water having a minimum concentration of nitrate, North subwatershed (mean values of all data) 67
Figure 5.18 Probability of ground water having a minimum concentration of nitrate, Southern sub-watershed (mean values of all data) 68
Figure 5.19 Probability of ground water having a minimum concentration of nitrate, Kings Creek subwatershed (mean values of all data) 69
Figure 6.1 Streamflow and base flow duration curves for the Mad River near Zanesfield, Ohio 71
Figure 6.2 Streamflow and base flow curves for the Mad River near Urbana, Ohio 72
Figure 6.3 Streamflow and base flow duration curves for the Mad River near St. Paris Pike (at Eagle City), Ohio 73

Figure 6.4 Streamflow and base flow duration curves for the Mad River near Springfield, Ohio .. 74
Figure 6.5 Streamflow and base flow duration curves for the Mad River near Dayton, Ohio 75
Figure 7.1 Upper Mad River subbasins 78
Figure 7.2 Daily flow-duration curve, Mad River near Urbana 1925-31, 1939-94 79
Figure 7.3 Annual precipitation vs. runoff, Mad River near Urbana 1925-31, 1939-45 81
Figure 7.4 Instantaneous discharge measurements for the Upper Mad River basin 83
Figure 7.5 Stream network model schematic for the Upper Mad River basin 85
Figure 7.6 Base flow diagram illustrating HEC-1 parameters 87
Figure 7.7 Relation of base flows for the Upper Mad River basin 90
Figure 7.8 Composite base flow recession curve (ground water depletion curve), Mad River near Urbana 92
Figure 7.9 Ground water storage-discharge relationship, Mad River near Urbana 93
Figure 7.10 Hydrograph separation analysis Mad River near Urbana, June 11-24, 1944 95
Figure 7.11 Relationship of curve number and soil moisture condition 96
Figure 7.12 Dimensionless curvilinear unit hydrographs and equivalent triangular hydrographs 97
Figure 7.13 Simulated vs. observed runoff hydrographs for the Mad River near Urbana 98
Figure 7.14 Runoff hydrographs for the Mad River near Urbana, Summer, 1977 100
Figure 7.15 Runoff hydrograph for the Mad River near Urbana, Winter, 1977 101

LIST OF TABLES

Table 2.1 Precipitation data for the Urbana station 14
Table 2.2 Precipitation data for the West Liberty station 15
Table 2.3 Glacial Stages of the Pleistocene Epoch 22
Table 2.4 Chronology of the Wisconsinan and Pre-Illinoian stages in Western Ohio 22
Table 2.5 General bedrock stratigraphy of Champaign County 29
Table 2.6 General bedrock stratigraphy of Logan County 30
Table 5.1 Residential wells in each subbasin 66

ACKNOWLEDGMENTS

The preparation of the Mad River NPS project report involved the contribution and work of a number of individuals. Grateful acknowledgment is given to the following individuals for their technical review, text authorship, field work, graphical reproduction, report editing, and preparation. The authors would like to acknowledge the editorial review of this report by several individuals at the USGS office in Columbus.

Report production:	Wayne Jones Mike Schiefer Eric Sainey
Report editing:	Mike Hallfrisch Mike Angle J. Gerrie McCall Rebecca Petty
Field Work:	Wayne Jones Eric Sainey Mike Hallfrisch Mike Angle Lydia Cumming Paul Spahr Mike Schiefer
Graphical reproduction:	Wayne Jones David Orr Eric Sainey
Desktop publishing and report design:	David Orr

I am especially grateful to the careful editorial review of the manuscript provided by J. Gerrie McCall and Mike Hallfrisch at the Ohio Department of Natural Resources, Division of Water and to Greg Koltun, Rod Sheets, Jim Sherwood, Martha Jagucki and Jeffery de Roche at the United States Geologic Survey, Water Resources Division in Columbus, Ohio. This report is better for their effort.

CHAPTER 1-INTRODUCTION

1.1 Reason for the Study

The Mad River Nonpoint Source (NPS) Project began as a request from the Top of Ohio Resource Conservation & Development Project (RC&D) for a presentation about the geology and hydrogeology of the Mad River watershed. The turnout was small, but a subsequent presentation on the same subject generated greater interest. Further meetings were held that included major landowners in the valley and representatives of state agencies and local organizations. With strong local interest and agency involvement, the Mad River Steering Committee was formed. Chaired by a local landowner, the committee began defining problems in the watershed and generating a plan of action. All parties involved felt that a clear understanding of how the ground water/surface water system works would be the first step. After discussion with staff members at the Ohio Department of Natural Resources (ODNR) and the Ohio Environmental Protection Agency (OEPA), ODNR Division of Water (DOW) submitted a proposal to OEPA for a Section 319 nonpoint source grant for fiscal year 1993.

The Mad River Steering Committee also applied for funding for an educational and land-practice-based project. Groups that were involved directly with this application are TOP of Ohio RC&D Council, OSU Extension Champaign County, OSU Extension Logan County, and Logan County Soil and Water District. Concerns of these groups about the ground water/surface water system, the impacts of nonpoint source pollution on that system, and the effects of agriculture were the basis of their project.

The Mad River and its tributaries constitute Hydrologic Group 58 in the OEPA Nonpoint Source Assessment. Nine streams or stream segments within Hydrologic Group 58 are listed as nonpoint-source-impaired. Nettles Creek is impaired by crop and livestock production as well as pasture. Kings Creek is impaired by crop and livestock production, pasture, on-site wastewater treatment systems, and streambank modifications. The Mad River between Macochee Creek and Kings Creek is impaired by on-site wastewater treatment systems and crop and livestock production. The Mad River (from Nettles Creek to Macochee Creek) is a nonpoint-source-threatened stream. The other five impaired stream segments are outside of the study area.

According to the assessment, ground water areas impacted by nonpoint source pollution include sites in Logan (Monroe Township) and Champaign (Salem and Urbana Townships) Counties.

1.2 Funding Source

This publication was financed in part through a grant from Ohio Environmental Protection Agency under provisions of Section 319 of the Clean Water Act as amended in 1987.

1.3 Cooperators

Assistance from many sources has helped make this project and report possible. The Division of Water would like to recognize the work of the United States Geological Survey (USGS) Water Resources Division, Ohio Environmental Protection Agency (OEPA), The Ohio State University Extension in Champaign and Logan Counties, Madmen Chapter of Trout Unlimited, TOP of Ohio Resource Conservation & Development Project (RC&D), and the Mad River Steering Committee.

1.4 Location

The headwaters of the Mad River are located in north-central Logan County. The river passes through Champaign, Clark, and Greene Counties, and ends in Montgomery County at its confluence with the Great Miami River (Figure 2.1).

The chosen study area includes much of Champaign County and the southern portion of Logan County (Figure 2.2). The study area is roughly bounded in the north by the town of West Liberty and in the south by the Champaign County seat, Urbana. The study area is approximately 10.5 miles (east-west) by 17.5 miles (north-south). This includes an area of approximately 180 square miles. The project focuses on the Mad River and encompasses all tributaries and ground water within the study boundaries.

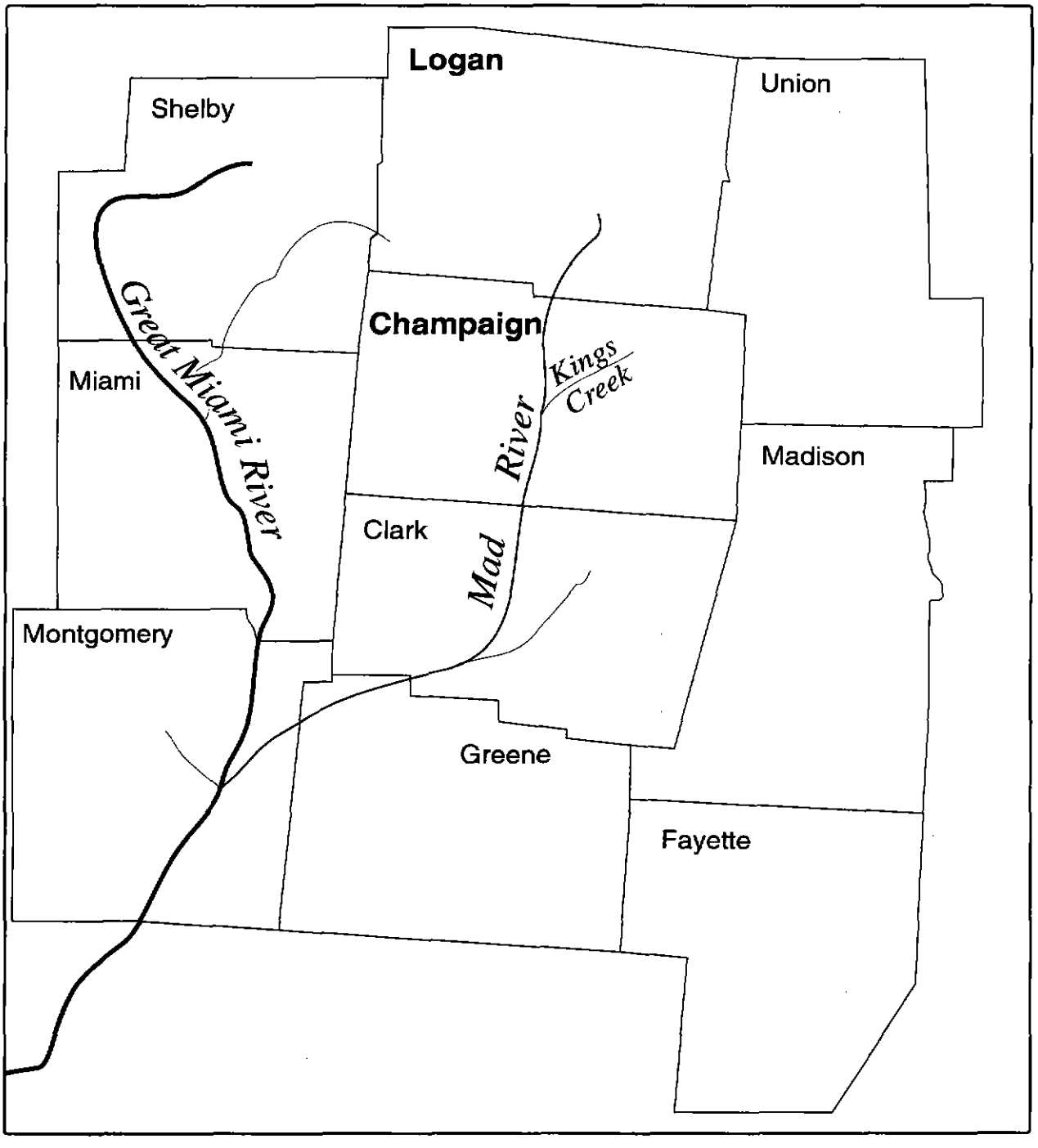


Figure 2.1 Mad River watershed

Figure 2.2 Location map of NPS study area

1.5 Physiography

Champaign and Logan Counties lie within the Till Plains Region of the Central Lowlands Physiographic Province (Fenneman, 1938). This type of physiography is characterized by moderate to low topographic relief. Major glacial features, such as rolling end morainal hills and slightly sloping outwash terraces, are common. Small streams and numerous tributaries cut across the land surface throughout the study area.

The maximum relief in the study area is 495 feet. The highest elevation, 1460 feet Above Mean Sea Level (AMSL), is located in the northeastern section of the project area near the Ohio Caverns. The southwestern section, where the Mad River Valley exits the study area, contains the lowest elevation at 965 feet AMSL.

The physiography of the region lends itself to many agricultural activities. Cash crops such as corn and soybeans and livestock dominate the land use in the study area. Also, because of the abundance of ground water resources, several large manufacturing companies have moved to the area.

1.6 Climate

The National Weather Service stations are located in West Liberty in Logan County and Urbana in Champaign County. From a thirty-year record at the Urbana station (1961 to 1990) the mean annual temperature for this time period is 49.3 degrees Fahrenheit, and mean precipitation over the same period of 38.39 inches per year (U.S. Department of Commerce, 1992; and Harstine, 1991) (Table 2.1). The West Liberty station has a 25 year period of record of precipitation with a mean value of 36.21 inches per year (Miami Conservancy District, 1996: U.S. Department of Commerce, 1992; and Harstine, 1991) (Table 2.2).

CHAPTER 2-GEOLOGIC FRAMEWORK

2.0 Geologic Introduction

2.1 Soils

Soil types were used extensively to identify the composition of the underlying parent material. Soils are also used as a parameter in the DRASTIC mapping process (See Chapter 8). The definition of a soil used for this project is synonymous with the Natural Resources Conservation Service (NRCS) definition. NRCS considers the soil profile to comprise the upper 5 to 6 feet of material. As in the DRASTIC mapping process, in areas where the bedrock surface is extremely shallow (less than 2 feet) the soil profile is considered to be absent.

Those soil characteristics deemed most important for the purposes of this project were parent material for the soil type, slope, and drainage characteristics. The material which forms the soil is called parent material.

The parent material can give valuable information about the earth materials that underlie a certain soil type. For example, several soils in Champaign County only develop in glacial outwash, so the presence of this soil type indicates that the underlying sediments are glacial outwash.

The slope of the land defines the topographic setting in which a particular soil type occurs. Some soils are found on flat river terraces, while other soils are present in areas of high relief. Identification of the soil gives insight into the topographic expression of the land surface.

Drainage characteristics are very important to the effective recharge of an aquifer system. The textural composition of the soil together with slope of the land determine drainage. If the soils primarily contain clay, rainfall is slow to penetrate and overland runoff to the nearest surface water body predominates. If the soil type is very permeable, such as in the case of a sand or sandy loam, a much higher recharge value for the aquifer is appropriate.

The main focus of this study is the central portion of the Mad River Valley. The Fox-Lippencott soil association dominates this area of the valley (Figure 2.3). Underlain by valley-fill outwash deposits, these soil types are nearly level to sloping, well-drained sandy loams.

Table 2.1 Precipitation data for the Urbana station

Date	Precipitation	30 Year Average
9/93	4.85	2.91
10/93	1.93	2.23
11/93	5.26	3.04
12/93	2.15	2.74
1/94	3.23	1.67
2/94	1.02	2.00
3/94	1.90	2.86
4/94	3.81	3.05
5/94	2.61	3.91
6/94	4.53	3.54
7/94	2.15	4.14
8/94	2.39	3.45
9/94	1.35	2.91
10/94	0.65	2.23
11/94	2.89	3.04
12/94	2.17	2.74
1/95	2.09	1.67
2/95	2.34	2.00
3/95	2.21	2.86
4/95	4.21	3.05
5/95	7.26	3.91
6/95	4.13	3.54
7/95	9.77	4.14
8/95	7.24	3.45
9/95	1.01	2.91
10/95	4.12	2.23
11/95	2.68	3.04
12/95	1.60	2.74

Table 2.2 Precipitation data for the West Liberty station

Date	Precipitation	Yearly Average
9/93	4.33	3.03
10/93	2.08	2.56
11/93	6.52	2.96
12/93	2.28	2.49
1/94	2.93	1.90
2/94	0.94	1.65
3/94	D.N.R.	2.84
4/94	3.14	3.35
5/94	2.14	3.94
6/94	4.65	3.54
7/94	1.76	4.22
8/94	5.17	3.17
9/94	0.97	3.03
10/94	0.80	2.56
11/94	2.78	2.96
12/94	2.20	2.49
1/95	2.54	1.90
2/95	0.92	1.65
3/95	2.24	2.84
4/95	5.19	3.35
5/95	6.96	3.94
6/95	5.54	3.54
7/95	4.99	4.22
8/95	6.09	3.17
9/95	0.85	3.03
10/95	4.09	2.56
11/95	2.78	2.96
12/95	1.71	2.49

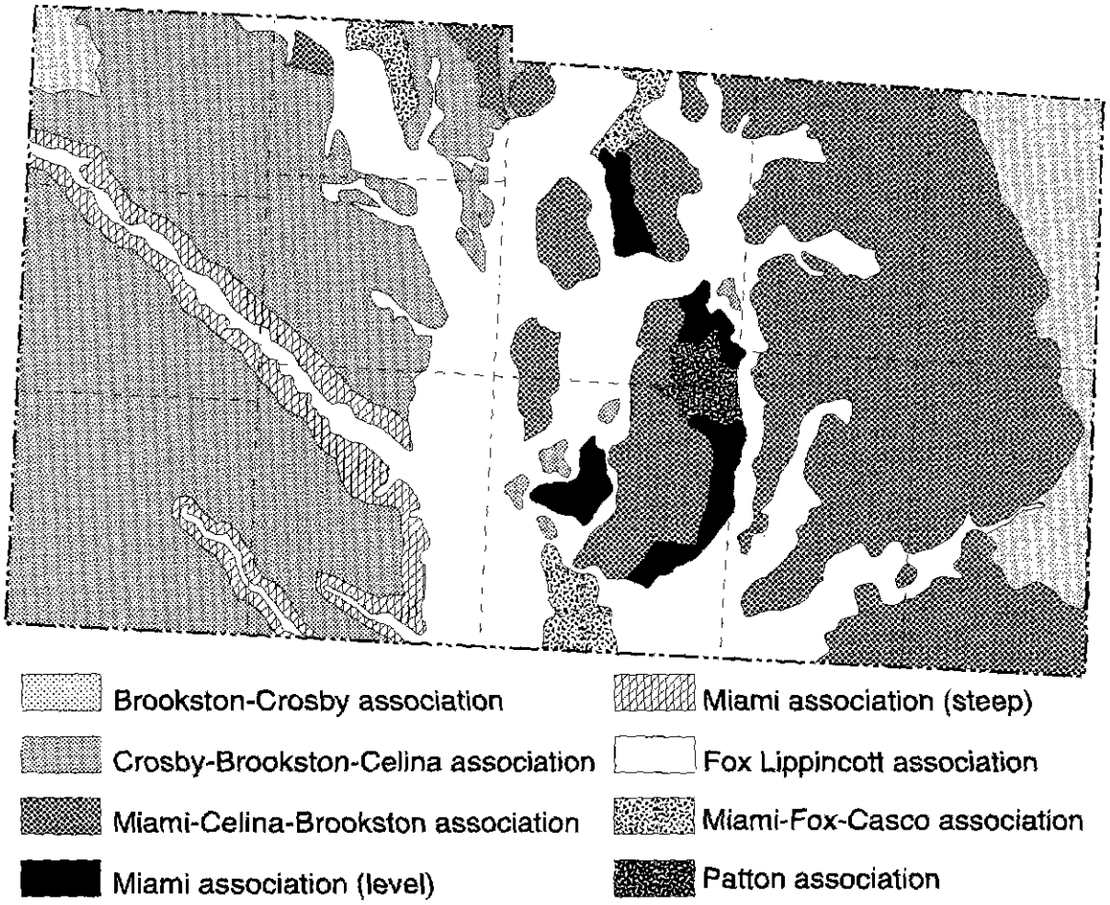


Figure 2.3 Generalized Champaign County soils map
(Modified from Ritchie et al., 1971)

Poorly-drained Brookston-Crosby Association soils are found in the far eastern portion of the county (Figure 2.3). These fine-grained clay loam soils formed out of late Wisconsinan ground moraine with low slope.

West of this area is the Miami-Celina-Brookston Association (Figure 2.3). Located on the Cable Moraine with a rolling steeper-slope, these till-based soils vary from fine- to medium-grained and moderately well-drained to very poorly-drained.

West of the Mad River Valley, the Brookston-Celina Association extends from the extensive upland ground moraine deposits to the Farmersville Moraine (Figure 2.3). These medium- to fine-grained soils are moderately drained.

Several other less widespread associations exist within the county. A complete listing of these soils may be found in the Soil Survey of Champaign County, Ohio (Ritchie et al., 1971).

2.2 Previous Studies and Investigations

The study of the extensive ground water reserves of the Mad River Valley began with Orton in 1874. Hill (1878) wrote the first report on the geology of Champaign County. Leverett (1897) looked at the hydrogeologic capacities of Ohio and Indiana glacial deposits. County-wide water information was presented by Fuller and Clapp (1912). Harker and Bernhagen (1943), Norris et al. (1948), Norris et al. (1952), Norris et al. (1952), and Norris and Eagon (1971) chronicled the water resources of the Mad River Valley as it passed through Clark, Green, and Montgomery Counties. Forsyth (1956) studied the glacial geology in Logan County. Norris and Spicer (1958) wrote the definitive paper on the Teays Valley in west-central Ohio. Feulner (1960) defined the ground water resources of Champaign County. Janssens (1964), Quinn (1972), and Quinn and Goldthwait (1979) helped defined the complex glacial history of this area.

2.3 Drainage

2.31 Present Drainage

The Mad River and its tributaries drain the central portion of Champaign County. The Mad River joins the Great Miami River at Dayton in northern Montgomery County. The main tributaries to the Mad River in the study area are Macochee Creek, Mud Run, Macochee Ditch, Gladys Creek, Muddy Creek, and Kings Creek (Figure 7.1).

The eastern third of the Champaign County is drained by Little Darby Creek of the Scioto River drainage basin, with the additional tributaries of Spain Creek, Treacle Creek, and a portion of the Big Darby Creek.

In the far west-northwestern portion of Champaign County, surface flow is northwestward into the Great Miami River in Shelby and Miami Counties. Drainage occurs through Indian Creek, Lee Creek, and Mosquito Creek.

Within the study area Macochee Creek is the largest tributary that enters the Mad River in Logan County.

2.32 Teays Stage Drainage

Prior to Pleistocene glaciation, the main drainage system in Ohio was the Teays River (Figure 2.4). The major drainage-way in Ohio in Tertiary times, the Teays had its head waters in the Piedmont of North Carolina, entering Ohio just east of Portsmouth. Flowing up the present channel of the Scioto River, the Teays turned to the northwest in Ross County, and exited the state in Mercer County (Norris and Spicer, 1958). The river entered the central portion of Champaign County, flowed to the northwest exiting the county near the Logan County border (Figure 2.5). The Teays was a very mature river system with broad, flat valleys deeply incised into the bedrock surface (Kulibert, 1977).

Central Champaign and southern Logan Counties' pre-glacial bedrock surface had moderate to slightly rolling relief, except where the Teays or its major tributaries were present (Quinn and Goldthwait, 1979). The major trunk of the Teays River had over 500 feet of relief from the bedrock surface in some portions of Champaign County (Janssens, 1964).

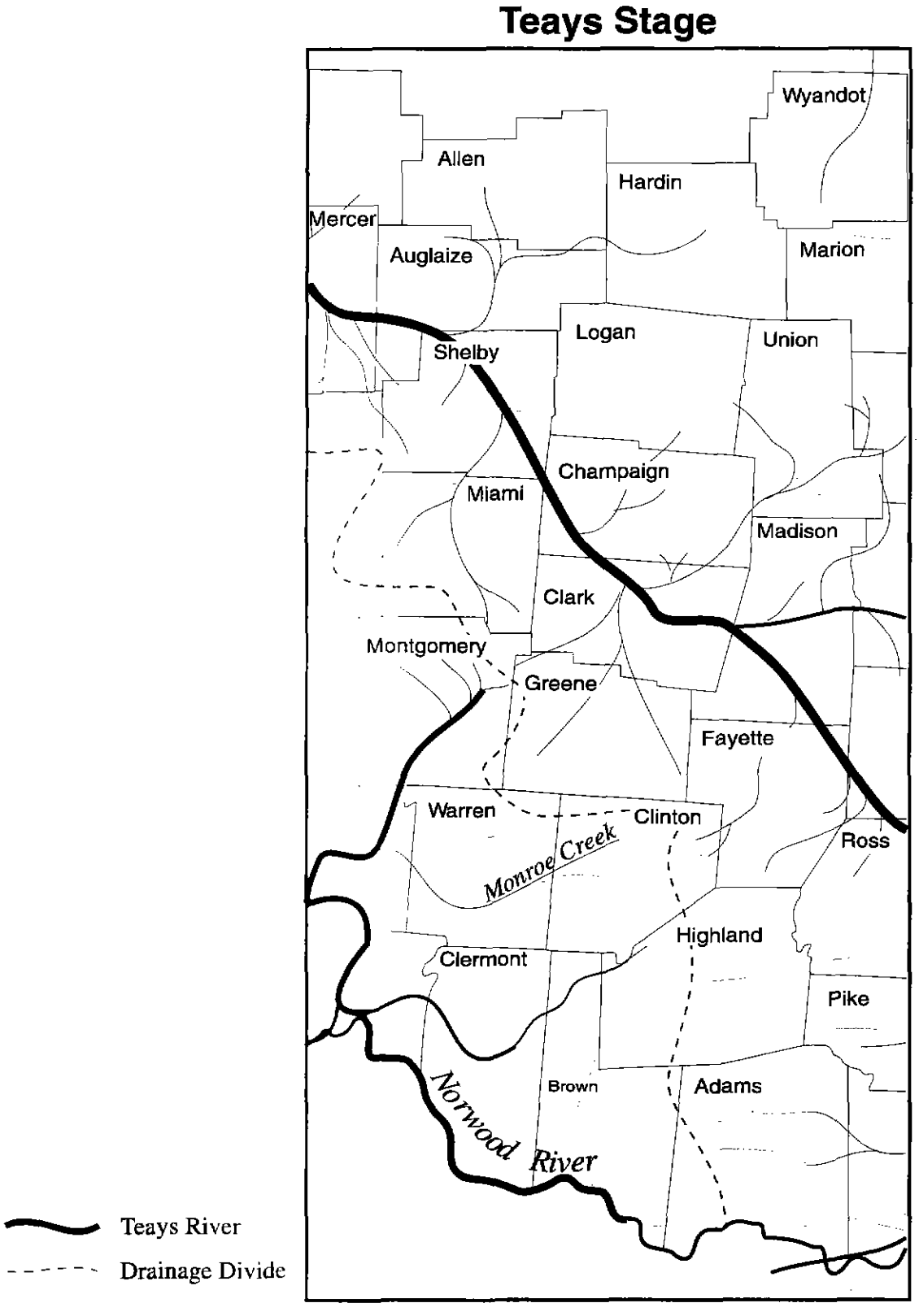


Figure 2.4 Tertiary Teays Stage drainage
(Modified from Stout et al., 1943)

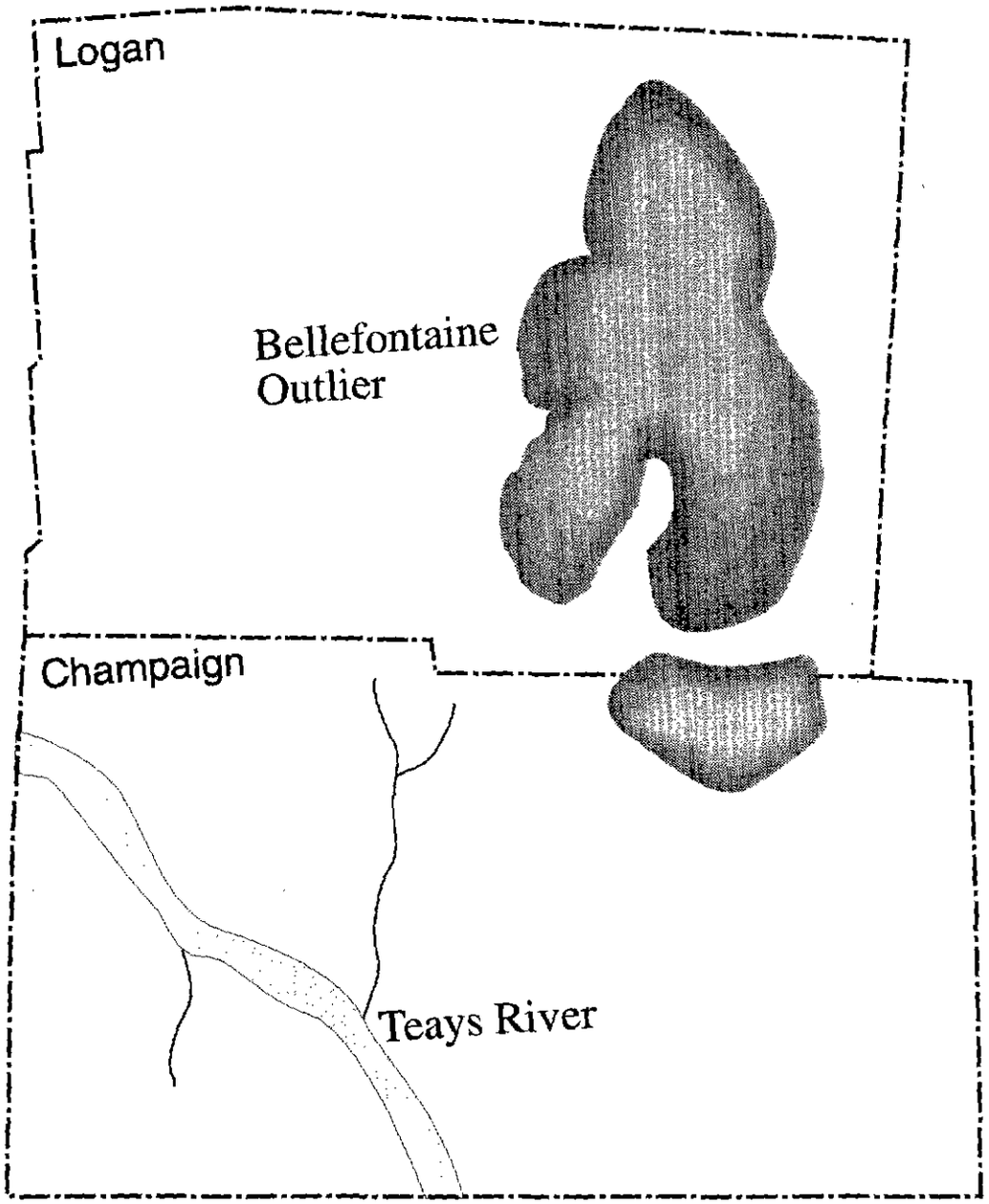


Figure 2.5 Pre-glacial Logan and Champaign Counties
(Modified from Ohio Department of Natural Resources, 1988)

The Teays Valley and its major tributaries are often identified by the presence of Minford Silt within the buried valley. Minford Silt, which is pre-Illinoian in age, is found in the deepest portions of the buried valley sediments. Minford Silts are plastic, highly laminated silts and clays that are well distributed throughout the Teays System (Stout et al., 1943). These sediments were deposited in deep, quiet water that was ponded in a lake-like environment (Stout et al., 1943).

2.33 Deep Stage

Teays Stage (pre-glacial) drainage in Champaign and Logan Counties was to the northwest. Pre-Illinoian ice blocked the present course of the Teays River. All stream valleys north of the pre-Illinoian boundary were filled with glacial drift (Figure 2.6). Drainage south of the boundary was greatly altered. Flow in the Teays ceased as water ponded (Stout et al., 1943).

Once the drainage divides were breached, new drainage (Deep Stage) developed with a new flow direction of north to south-southwest. During Deep Stage, Champaign County was drained by what was known as the Middletown River, which was a major tributary to the Cincinnati River (Stout et al., 1943). The confluence of the Middletown River and the Cincinnati River occurred in southern Butler County (Stout et al., 1943) (Figure 2.6). Deep Stage drainage of Champaign County closely resembles the current course of the Mad River.

2.4 Glacial Geology

2.41 Ice Advances

The Pleistocene Epoch (2 million to 10,000 years before present) was a period of continental glaciation in North America. Four distinct episodes of ice advance occurred during the Pleistocene. These episodes are called the Nebraskan, Kansan, Illinoian, and Wisconsinan. Only the last two (Illinoian and Wisconsinan) have left identifiable deposits in Champaign County (Quinn and Goldthwait, 1979) (Table 2.3).

The earliest recorded glaciation in Ohio is the Pre-Illinoian (Kansan). This ice sheet flowed out of western Pennsylvania across northeastern Ohio to the southwest, with its border in northern Logan County (Stout et al., 1943). The effect of pre-Illinoian ice on the study area is that of extensive erosion south of the terminal boundary of the ice caused by the release of meltwaters from glacial activity. Stream reversals, land dissection, and new stream gradients were part of this landscape modification process.

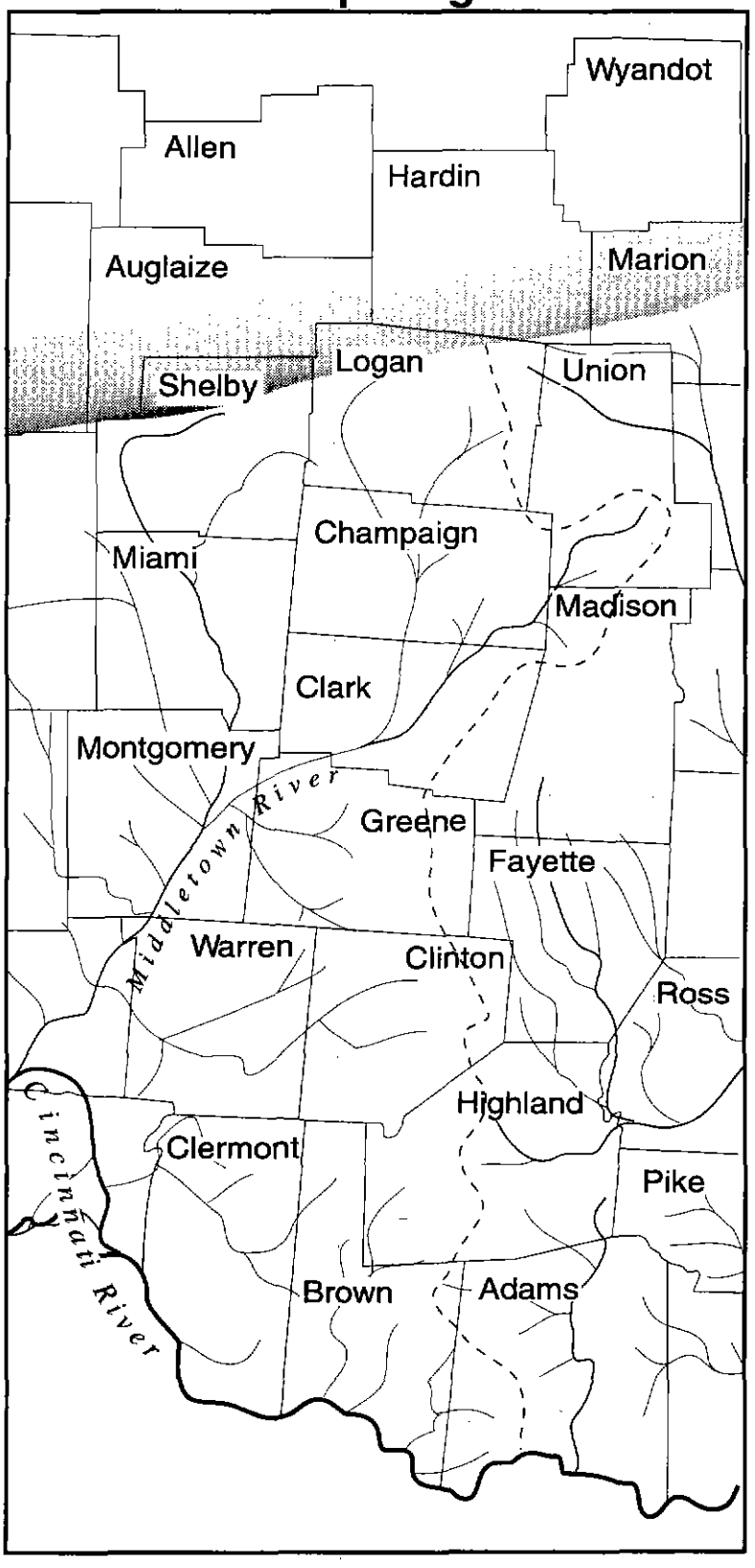
Illinoian deposits are found in the buried valleys of the pre-glacial Teays Stage drainage system (Richards et al., 1973). Illinoian sediment in Champaign County varies from glacial till to fine-grained slack-water (lacustrine) deposits.

As Wisconsinan ice of the Erie Lobe advanced into southwestern Ohio, the bedrock outlier in Logan and Champaign Counties modified the ice path (Forsyth, 1956). The outlier is a bedrock high located in eastern Logan and northeastern Champaign Counties that influenced the path of Wisconsinan ice (Figure 2.5). Many theories offer explanations, but the evidence shows that the ice sheet split into two lobes around the outlier. The lobes then aligned in a north-south direction, moving east-west across Champaign County in an interlobate pattern. The western lobe is referred to as the Miami Lobe and the eastern lobe is called the Scioto Lobe (Quinn and Goldthwait, 1979) (Figure 2.7). The two ice sheets advance and retreat across Champaign County account for the extensive nature of the deposits present (Table 2.4).

2.42 Glacial Deposits

The wide variety of glacial deposits found in Champaign and Logan Counties includes glacial till, kames, eskers (ice-contact features), outwash, and lacustrine deposits (Figures 2.8). Ground moraine and end moraine are other landforms that express glacial activity. In the modern river valleys, these deposits are covered by a mantle of recent alluvium.

Glacial till is a heterogenous, non-sorted, non-stratified mixture of sand, silt, and clay deposited directly by glacial ice. Tills can be either a melt-out "ablation" till or a compact "lodgement" till. Moving ice deposits a hard lodgement till; melting ice deposits a less compact ablation till. The greatest thicknesses of till can be found in the eastern and western portions of the county. The



Drainage Divide

Border of Kansan or Pre–Kansan Glacier

Figure 2.6 Deep Stage drainage
(Modified from Stout et al., 1943)

Table 2.3 Glacial Stages of the Pleistocene Epoch

GLACIAL STAGES OF THE PLEISTOCENE EPOCH	
WISCONSINAN	10,000 B.P.*
sangamon interglacial	70,000 B.P.*
ILLINOIAN	132,000 B.P.*
PRE-ILLINOIAN	730,000 B.P.*
*B.P.= Years before the present, indicates approximate end of the event referred to.	

Modified from Ohio Department of Natural Resources, 1988

Table 2.4 Chronology of the Wisconsinan and Pre-Illinoian stages in Western Ohio

CHRONOLOGY OF DEPOSITS OF THE WISCONSINAN AND PRE-ILLINOIAN GLACIAL STAGES IN WESTERN OHIO			
SUBSTAGE	MIAMI SUBLOBE	SCIOTO SUBLOBE	TIME
Late Wisconsinan	Ice gone	Ice Gone	10,000-14,400 B.P.
Late Wisconsinan	Union City Moraine	Powell Moraine	14,800 B.P.
Late Wisconsinan	Erie Interstade	Erie Interstade	17,200 B.P.
Late Wisconsinan	Farmersville Moraine (Boulder Belt) M.R.Valley Train	Cable Moraine (Boulder Belt) M.R. Valley Train	17,500 B.P.
Late Wisconsinan	W.L. Moraine Urbana Outwash Springfield Moraine Kennard Outwash	Reesville/Cuba Moraine	23,000 B.P.
Pre-Illinoian	Sidney Interstadial	Sidney Interstadial	55,000 B.P.
Pre-Illinoian	Whitewater Drift	Gahanna Drift	79,000 B.P.

Modified from Ohio Department of Natural Resources, 1988.

Figure 2.7 Late Wisconsinan sublobes.
(Modified from Ohio Division of Geologic Survey, 1995)

Figure 2.8 Generalized Logan and Champaign surficial county glacial map
(After Forsyth, 1956: and Modified from Ohio Division of Geologic Survey, 1995)

Farmersville and Cable morainal areas may have over 100 feet of till, whereas till thicknesses in the center of the county on the Springfield and West Liberty Moraines are generally 20 feet or less. Ground moraine till thicknesses are quite variable, ranging from less than 20 feet to greater than 100 feet.

End or terminal moraines dominate the surficial deposits in Champaign County (Figure 2.10) (Goldthwait et al. 1961). An end moraine is a mound or ridge of unsorted, unstratified glacial drift, composed mostly of glacial till, deposited by the action of glacial ice. From west to east the end moraines are: the Farmersville Moraine, the West Liberty Moraine, the Springfield Moraine, the Cable Moraine, and a small portion of the Powell Moraine (Table 2.4). The Farmersville, West Liberty, and Springfield Moraines were deposited by Miami Lobe ice, and the Cable and the Powell Moraines were deposited by Scioto Lobe ice (Quinn and Goldthwait, 1979).

The Farmersville Moraine runs north-south in the western portion of the county. This moraine is underlain by till instead of the thick outwash found elsewhere (Quinn and Goldthwait, 1979). The Farmersville Moraine overlies a portion of the buried Teays River channel, making the depth to bedrock greater than 500 feet in some areas (Norris and Spicer, 1958).

The West Liberty Moraine runs north to south in the middle of the county. This moraine is composed of a thin veneer of glacial till covering extensive outwash deposits at depth. The underlying outwash is continuous with the Urbana Outwash (Quinn and Goldthwait, 1979). Till found below the outwash may represent a pre-late Wisconsinan deposition.

The Springfield Moraine, like all the end moraines in Champaign County, runs north to south. The till mantle is very thin, covering extensive Kennard Outwash deposits (Quinn and Goldthwait, 1979). Till found at depth is probably of pre-late Wisconsinan age (Quinn and Goldthwait, 1979). Kettle lakes are found on the Springfield Moraine, indicating the overlap of Miami Lobe ice in the northeast corner of Urbana township (Quinn and Goldthwait, 1979).

The Cable Moraine runs north-south and is located in the eastern-most portion of the county. The Cable Moraine is a composite of several moraines located north of Champaign County. Quinn and Goldthwait (1979) used boulder counts to correlate the composition of the Cable Moraine. Drift thicknesses on the Cable Moraine are quite extensive, ranging from 20 feet near Kings Creek to greater than 300 feet east-southeast of the City of Cable (Quinn and Goldthwait, 1979).

The Powell Moraine is located in the far northeast corner of the county and, because of its small size, is not important in this county. The Powell Moraine marks the outer edge of deposition of younger, more clay-rich glacial till (Dreimanis and Goldthwait, 1973).

Kames, eskers, and kame terraces are the major ice-contact features found within the study area. A kame is a low mound, knob, hummock, or ridge composed of stratified sand and gravel deposited by a subglacial or superglacial stream.

In Champaign County kames join together to form terraces. Kame terrace complexes are present along East Fork, Gladys Creek, Nettles Creek, and Kings Creek. The most extensive kame terrace complex in the county is located around Springhills. Springhills was named for springs and seeps found where the coarse outwash deposits are interbedded with less permeable materials.

An esker is a long, narrow ridge composed of stratified sand and gravel that was deposited by a subglacial stream flowing between ice walls in a retreating glacier. Only one esker has been identified in Champaign County. The Siegenthaler Esker is located in northwest Harrison Township and is currently an Ohio Department of Natural Resources Nature Preserve (ODNR, Division of Natural Areas and Preserves, 1988).

Because of the configuration of the ice during the Wisconsinan glacial period, Champaign County has extensive deposits of outwash. Outwash consists of sand and gravel deposits that are well sorted by water flowing from the ice sheet. Goldthwait (1952) has identified three distinct outwash layers (Figure 2.9) (Table 2.4).

The oldest and highest outwash layer is the Kennard Outwash. Known as the Clifton Outwash in Clark County, the Kennard Outwash can be traced from southern Logan County to Clifton Gorge in Greene County (Dreimanis and Goldthwait, 1973).

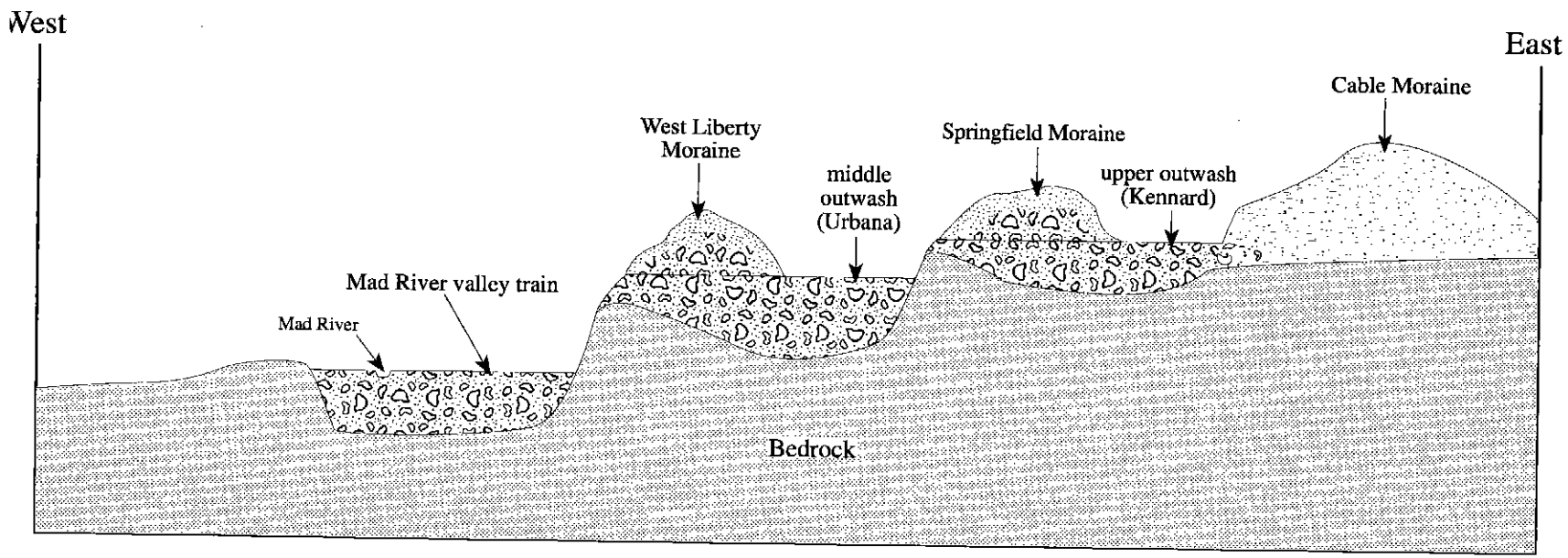
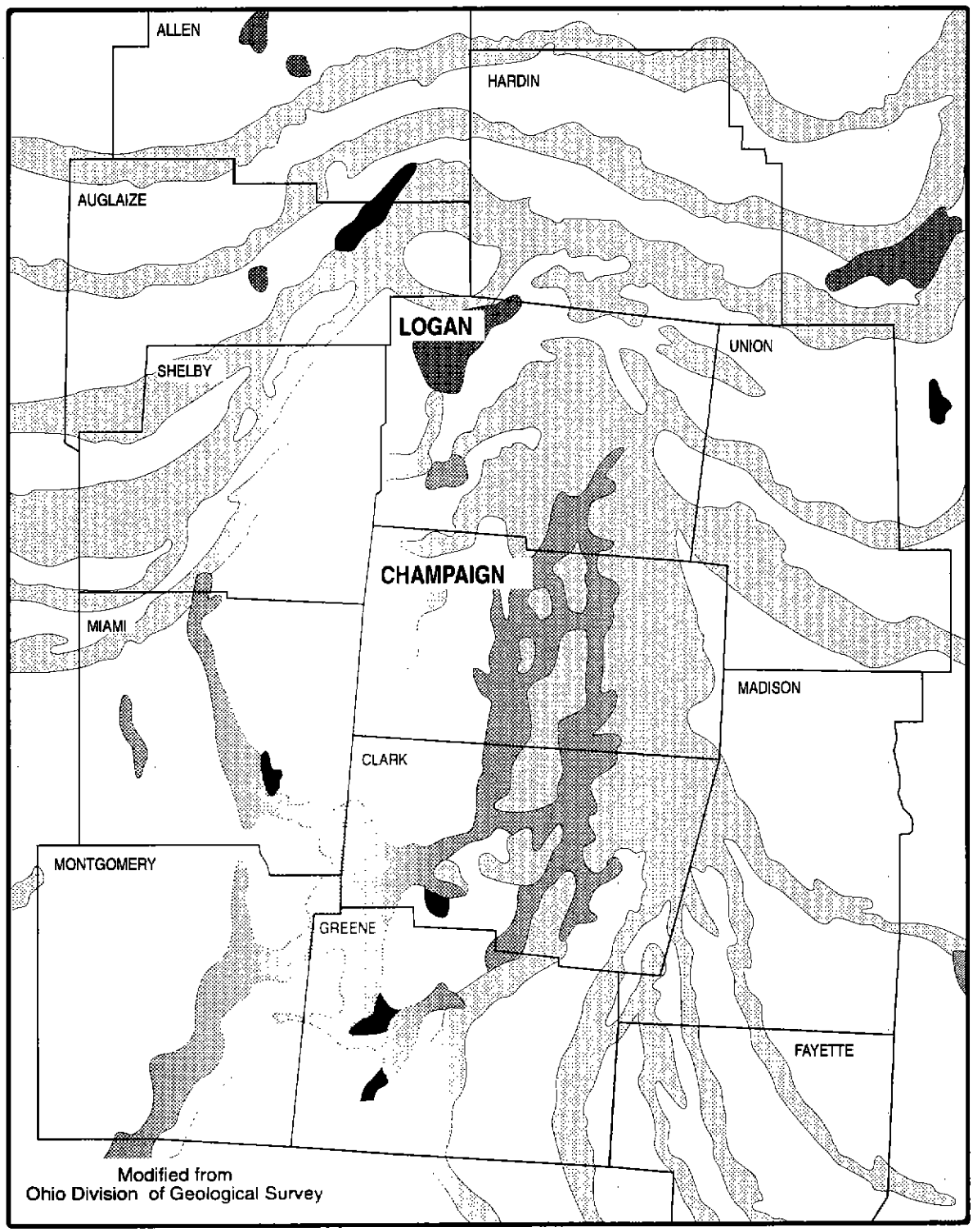


Figure 2.9 Outwash levels in Champaign and Logan Counties
(Modified from Ohio Department of Natural Resources, 1988)



Kames and eskers
Outwash
Lake deposits
Ground moraine
End moraine

Figure 2.10 Surficial glacial map of west central Ohio
(Modified from Ohio Division of Geological Survey, 1995)

The Urbana (or Intermediate) Outwash is concentrated in the east of the Springfield Moraine in the Kings Creek-Urbana area. As with the Kennard Outwash, much of the Urbana Outwash is buried beneath the Springfield Moraine. No ice contact features are associated with this outwash (Quinn and Goldthwait, 1979).

Valley Train deposits are the same as outwash, except that they are confined to previous drainage channels. The Mad River Valley Train runs from the Zanesfield area in Logan County to the Great Miami River at Dayton in Montgomery County, making it the largest continuous outwash deposit in Ohio (Quinn and Goldthwait, 1979; Dumouchelle et al., 1993; and Dumouchelle and deRoche, 1991).

Lacustrine deposits of fine laminated sand, silt, and clays are present northeast of Urbana (Quinn and Goldthwait, 1979). Janssens (1964) found the thicknesses of these sediments to range from 4 to 15 feet. Other more localized lacustrine deposits undoubtedly exist within the county.

2.8 Bedrock Geology

2.81 Overview

The consolidated deposits of Champaign and Logan Counties are of Ordovician, Silurian, and Devonian ages (Table 2.5 and 2.6). Because of the extensive glacial deposits and depth to the bedrock surface in most areas, very few bedrock exposures are present in Champaign County. Glacial activity has greatly modified the bedrock surface in Champaign County. The presence of sand and gravel aquifers at shallow depths in the study area means that few water wells have been drilled deeply enough to encounter bedrock.

2.82 Ordovician

The Ordovician-aged rocks in Champaign and Logan Counties are found in the deep buried valleys, such as Teays Stage drainage. These rocks consist of blue-gray calcareous shale interbedded with thin limestone. No surface exposures of Ordovician rocks are present in Champaign County. These rocks are covered by large thicknesses of drift and are described based on their distribution in Clark County and elsewhere in southwestern Ohio. The limestone is fossiliferous and vuggy. The dolomite contains shale clasts with fossil fragments and calcite-filled vugs (Swinford and Slucher, 1995).

2.83 Silurian

The Silurian Limestones and Dolomites present in Champaign and Logan Counties serve as valuable aquifers at several locations. These rocks consist of the Salina Group in the western half of Champaign County and the Tymochtee, Greenfield, and Salina Undifferentiated in the eastern half of the county (Swinford, personal communication) (Table 2.5). The Silurian Formations present in Logan County include Sub-Lockport Undifferentiated, Lockport Dolomite, Greenfield Dolomite, Tymochtee Dolomite, and Salina Undifferentiated (Table 2.6).

The Lockport Dolomite is dolomite with sparse shale or chert of Lower Silurian age. The Lockport is overlain by the Greenfield; a light gray crystalline dolomite. The Greenfield shows some vuggyness and, near the upper and lower contacts, extensive solution-enlarged fractures are present (Swinford and Slucher, 1995). The Tymochtee Dolomite is a medium-light-gray dolomite with limited porosity and some vuggyness. The Salina Undifferentiated is the uppermost Silurian Formation. This bedrock is a light-gray to yellowish-brown, finely crystalline dolomite (Swinford and Slucher, 1995). The Salina Undifferentiated has vuggy areas present, but primary porosity is controlled by fractures.

2.84 Devonian

The Devonian rocks present in the study area are limited to the Bellefontaine Outlier. The bedrock geology on the Bellefontaine Outlier is very complex with the best descriptions available in Swinford and Slucher (1995) and Hansen (1991). Consisting of limestones and shales, these rocks are sometimes overlain by thin layers of sand and gravel. The Devonian Limestones on the perimeter of the outlier serve as moderate-yield aquifers for residential use, but the shales are poor water producers. Devonian Limestones (Columbus and Lucas Undifferentiated) have many solution features and sinkholes (karst) throughout the Outlier. Often, the Devonian units are too high in the section and too thin to comprise an aquifer.

Table 2.5 General bedrock stratigraphy of Champaign County

GENERAL STRATIGRAPHIC COLUMN FOR CHAMPAIGN COUNTY			
SYSTEM	SERIES	FORMATIONS	
		WESTERN HALF OF COUNTY	EASTERN HALF OF COUNTY
DEVONIAN	UPPER	OHIO SHALE	
	MIDDLE	COLUMBUS-LUCAS UNDIF.	
SILURIAN	UPPER	SALINA UNDIF.	SALINA UNDIF.
			TYMOCHTEE
			GREENFIELD
ORDOVICIAN	UPPER	UNDIF. ORDOVICIAN	

Table 2.6 General bedrock stratigraphy of Logan County

GENERAL BEDROCK STRATIGRAPHY OF LOGAN COUNTY				
SYSTEM	SERIES	GROUP	STRATIGRAPHIC UNIT	
DEVONIAN			OHIO SHALE	CHAGRIN MEMBER
				HURON MEMBER
			OLENTANGY SHALE	
			DELAWARE LIMESTONE	
			COLUMBUS LIMESTONE	DELHI MEMBER
				BELLEPOINT MEMBER
SILURIAN	UPPER	SALINA	SALINA UNDIFFERENTIATED	
			TYMOCHTEE DOLOMITE	
			GREENFIELD DOLOMITE	
	LOWER	SALINA	LOCKPORT DOLOMITE	
			SUB-LOCKPORT UNDIFFEREENTIATED	
ORDOVICIAN	UPPER		ORDOVICIAN UNDIFFERENTIATED	

2.9 Hydrology

2.91 Glacial Aquifers

Ground water in Champaign County is obtained mainly from the unconsolidated glacial aquifers. Sand and gravel aquifers are found throughout the study area, while bedrock aquifers were mapped only on the outlier, in a small part of the Kings Creek area and the southwest portion of the study area.

In Logan County, glacial aquifers are common in the study area, but glacial and bedrock aquifers are more evenly distributed elsewhere.

The glacial deposits vary from deep, outwash-filled buried valleys to sand and gravel interbedded in glacial till in end moraines (Figure 2.8).

An extensive network of buried valleys is present in Champaign County (Struble, 1987a and 1987b) (Figure 2.11). Most of these valleys contain coarse sand and gravel, but they may also have silts, clays, and glacial tills. Outwash deposits underlie some present-day river valleys and occur in most pre-glacial river valleys (Feulner, 1960, 1961).

The thickest sequences of outwash deposits are found in the current course of the Mad River (Feulner, 1960; Walton and Scudder, 1960; and Jones, 1995 a&b). Known as the Mad River Valley Train, these outwash deposits are in direct hydraulic communication with the Mad River and have the potential to produce up to 1000 gallons per minute to properly constructed, large-diameter wells (Schmidt,1982, 1985, 1991). Outwash deposits not directly connected to a surface stream are still capable of large yields in areas where the deposits are coarse and thick.

Schmidt (1985) rated most of the sand and gravel deposits in Champaign County as having the potential to yield up to 100 gallons per minute (gpm) to properly constructed wells. Higher yields are obtained where the deposits are sufficiently thick and coarse. Sand and gravel interbedded in glacial till in central Jackson Township and southwestern Mad River Township were rated as capable of yielding 3 to 8 gpm by Schmidt (1985). There is little areal extent to these deposits and a large amount of non-water-bearing clay may overlie the sand and gravel, which reduces recharge to the aquifer.

2.92 Bedrock Aquifers

The Ordovician bedrock is present at the bottom of the deep buried drainage channels and is not used as an aquifer in Champaign County. The Ordovician bedrock is considered a non-water-bearing unit in the rest of southwestern Ohio.

The Silurian limestones generally yield sufficient water for residential supplies. Water moves primarily through the bedrock via a fracture system. Water travels mainly through joints, fractures, and bedding planes with little movement through the matrix of the rock. The Silurian limestones and dolomites are present in most of the study area at depth, but thick permeable outwash deposits overlying the limestones precludes their use as aquifers.

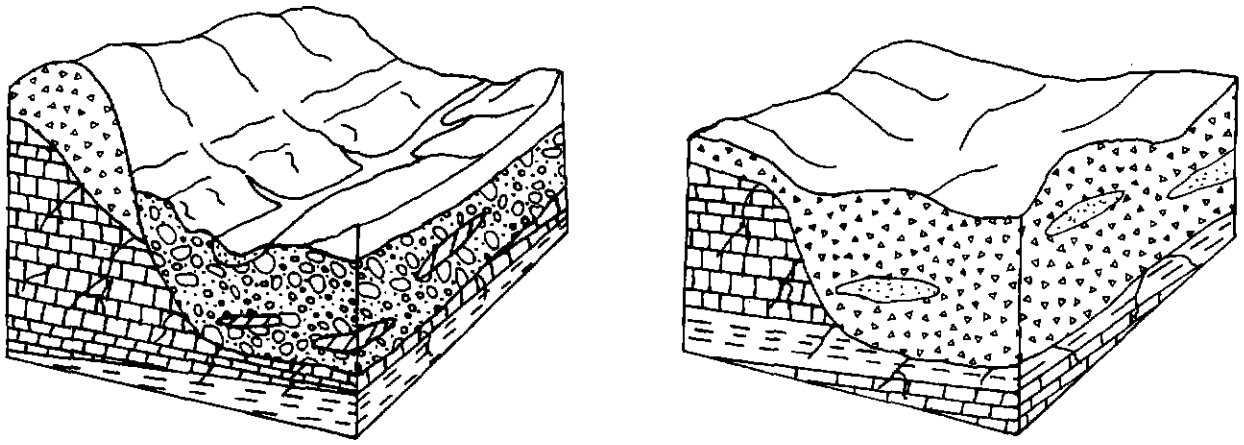
The Devonian Shales are found in the northern part of the county, east of the Mad River. The depth to bedrock is shallow, and no sand and gravel is present. Some residential wells are finished in the Devonian Shales, with yields that are rated as 3 to 8 gallons per minute (Schmidt, 1985).

CHAPTER 3-GEOLOGIC INVESTIGATIONS

3.1 Stream Gage

A stream gage is operated by the United States Geologic Survey (USGS) on the Mad River at Urbana. The Urbana gage has a drainage area of 162 square miles. In the past, USGS had maintained a gage at Zanesfield in Logan County, but currently the Urbana gage is the northernmost on the Mad River (USGS, 1991).

DOW commissioned the USGS to install a gage in southern Logan County on the Mad River to help provide the surface water data needed for this project. The gage was installed in December, 1993 on the Mad River east of West Liberty on State Route 245 in Logan County. The drainage area of 36.6 square miles consists of outwash valleys and bedrock-controlled uplands.



(a) (b)

The buried valleys were created by pre-glacial or interglacial rivers which downcut deeply into the bedrock. The differing glacial deposits filling these valleys can be best illustrated by describing the two common forms within Champaign and Logan Counties.

One common form of buried valley deposits (Block Diagram a) is best exemplified by the Mad River Valley. The valley, which is occupied by a modern river and floodplain, contains abundant outwash and kame deposits, and is easy to distinguish from the surrounding till and bedrock uplands. The depth to water is usually less than 30 feet. The upper portion of the valley commonly contains 50 to 100 feet of sand and gravel outwash with minor till or lacustrine deposits. Yields over 500 gpm are possible from properly constructed wells. Soils are typically loams or sandy loams. The streams are usually in direct hydraulic connection with the aquifer. Recharge is typically high.

The other common form of buried valley (Block Diagram b) is best exemplified by the Teays River Valley in far western Champaign County. These valley types are typically overlain by end moraines, and the rolling topography makes it difficult to distinguish the valleys from the surrounding areas. They may contain either intermittent streams or no streams at all. The aquifer consists of thin lenses of sand and gravel interbedded in very thick sequences of fine-grained till and lacustrine deposits. Yields are commonly less than 25 gpm. Soils are usually clay loams. Depth to water is typically greater than 50 feet. Recharge is generally moderate to low.

Figure 2.11 Sample buried valleys in Champaign and Logan Counties

Understanding the interaction between ground water and surface water is a major objective of this project. The Mad River has been recognized since Leverett's work in 1902 as having an exceptionally large base-flow component to surface water flow. The biggest question was how much ground water is contributed to the Mad River during base-flow conditions. ODNR-DOW commissioned USGS to separate the base-flow component of streamflow on the Mad River. Because there was no established rating curve on the new gage at West Liberty, it could not be used as a part of the base-flow separation study. A detailed discussion of this procedure and the results can be found in Chapter 6.

3.2 Observation Well

An important part of any aquifer analysis is an examination of fluctuation in ground water levels over time. The trends in the elevation of the water table with respect to seasonal changes can be tied to the occurrence of precipitation. ODNR-DOW operates an observation well network of 120 wells across the state of Ohio, collecting continuous water level data on the major aquifer systems (Cashell, personal communication). As part of this project, the DOW commissioned the drilling of a new observation well in Community Park in West Liberty. West Liberty's well field is also located in this park, providing an opportunity to examine the effects of pumping on the aquifer system. In addition, the new stream gage installed by USGS is located 200 yards from the observation well.

The well was completed in sand and gravel with a total depth of 72 feet (Figure 3.1). The capacity of the well was estimated by the drilling contractor as 200 gallons per minute (Figure 3.1).

To help clarify the data reported on the water well log, a natural gamma log was run on the well. A gamma log is the measurement of the gamma radiation given off by the natural earth materials using a device that functions like a Geiger counter. The time constant is set to measure the counts in 5-, 10-, 20-, or 50-second intervals, which are displayed on a screen. Lower counts generally indicate sand and gravel, and higher counts indicate clay or glacial till. Interpretation of the gamma log clearly identifies the 27 feet of outwash in which the observation well is finished (Figure 3.2). The gamma log supported the information on the geologic formations present on the well driller's log (Figure 3.1).

3.3 Cross-Sections

Two cross-sections (A-A' and B-B' in Figure 2.2) were constructed to help clarify the areal extent of the geologic deposits in the valley and uplands areas. Of greatest interest are the depth to the bedrock surface and the thickness of the glacial outwash deposits. The cross-section A-A' extended west to east across the Mad River and Kings Creeks Valleys (Figure 3.3). The remanent valley from the pre-glacial Teays River is visible in this cross-section. More importantly, this cross-section clearly shows the shallow depth to bedrock near Kings Creek. The second cross-section, B-B', is oriented in a north to south direction, passing across Kings Creek (Figure 3.4). Kings Creek is shown to have a very shallow depth to bedrock. Cross-section B-B' clearly shows an increased amount of glacial till in the morainal area adjacent to the Kings Creek Valley. Both cross-sections show the large amount of sand and gravel present within the study area.

The geologic information used to construct the cross-sections included the maps and reports of Schumaker (1991a and 1991b), Schumaker and Slucher (1994), Swinford (1991a and 1991b), (1992a, 1992b, 1992c, 1992d, 1992e, 1992f, 1992g, 1992h), Swinford and Slucher (1994, 1991a, 1991b, 1991c, 1992a, 1992b), Vormelker (1990a, 1990b, 1991a, 1991b, 1991c, 1991d, 1992), Vormelker and Swinford (1992a and 1992b). Other information used for the construction of the cross-sections included water well logs, 7.5 minute bedrock topography maps, geological maps from the Ohio Geological Survey, and the work of Norris and Spicer (1958).

CHAPTER 4-HYDROGEOLOGIC AQUIFER CHARACTERIZATION

4.1 Water Level Analysis

4.11 How the Wells Were Selected

Water level measurements were taken at 64 wells across the study area on a quarterly basis (Appendix A, B). The purpose of these measurements was twofold. First, it was necessary to determine the

DNR 7802.93
TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

779981

Permit Number

COUNTY LOGAN TOWNSHIP LIBERTY SECTION/LOT No. S (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) CITY W LIBERTY (LIONS CLUB) PROPERTY ADDRESS STATE ROUTE 245 EAST (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY LIONS CLUB PARK, EAST SIDE OF WEST LIBERTY

CONSTRUCTION DETAILS

CASING

Borehole Diameter 7-7/8 in.

[1] Diameter 6 in. Length 60 ft. Wall Thickness SDR 17 in.
[2] Diameter 8 in. Length 7' 8" ft. Wall Thickness in.

Type: [1] Steel [2] Galv. [1] PVC [2] [1] [2] Other

Joints: [1] Threaded [2] [1] Welded [2] [1] Solvent [2] Other CERTA LOK

Liner: Length Type Wall Thickness in.

SCREEN

Type (wire wrapped, louvered, etc.) MACHINE SLOT Material PVC

Length 12 ft. Diameter 6 in.

Set between 71 ft. and 59 ft. Slot 0.050 in.

GROUT

Material BENSEAL/EZ MUD Volume used 105 GAL

Method of installation 1" TREMIE TUBE

Depth: placed from 50 ft. to SURFACE ft.

GRAVEL PACK (Filter Pack)

Material #4 PARRY SAND Volume used 900 LBS

Method of Installation GRAVITY

Depth: placed from 72 ft. to 50 ft.

Pitless Device [X] Adapter [ ] Preassembled unit

Use of Well OBSERVATION WELL

[X] Rotary [ ] Cable [ ] Augered [ ] Driven [ ] Dug [ ] Other

Date of Completion 05/27/94

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
TOP SOIL	0	2
SAND & GRAVEL	2	33
GRAY SANDY CLAY & GRAVEL	33	43
GRAY CLAY	43	45
SAND & GRAVEL	45	72

RECEIVED
JUN 30 1994
ODNR DIV. OF WATER

Note: Well log is approximate, based on driller's general description of materials and approx. depths.

*If additional space is needed to complete well log, use next consecutively numbered form.

WELL TEST

[ ] Bailing [ ] Pumping* [X] Other AIR LIFT

Test rate 200 gpm Duration of test 1 hrs.

Drawdown 20 ft.

Measured from: [ ] top of casing [X] ground level [ ] Other

Static Level (depth to water) 8.25 ft. Date: 05/27/94

Quality (clear, cloudy, taste, odor) CLEAR

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

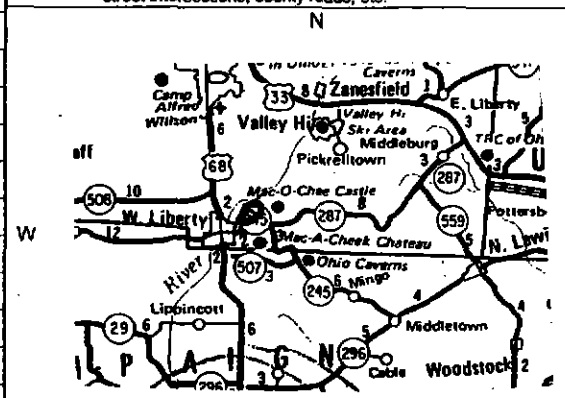
Type of pump Capacity gpm

Pump set at ft.

Pump installed by

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm SPROWLS DRILLING COMPANY

Address 565 WEST CHERRY STREET; P.O. BOX 107

City, State, Zip SUNBURY OH 43074

Signed

Date 6/7/94

ODH Registration Number 1731

5548

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

Figure 3.1 Well log and drilling report

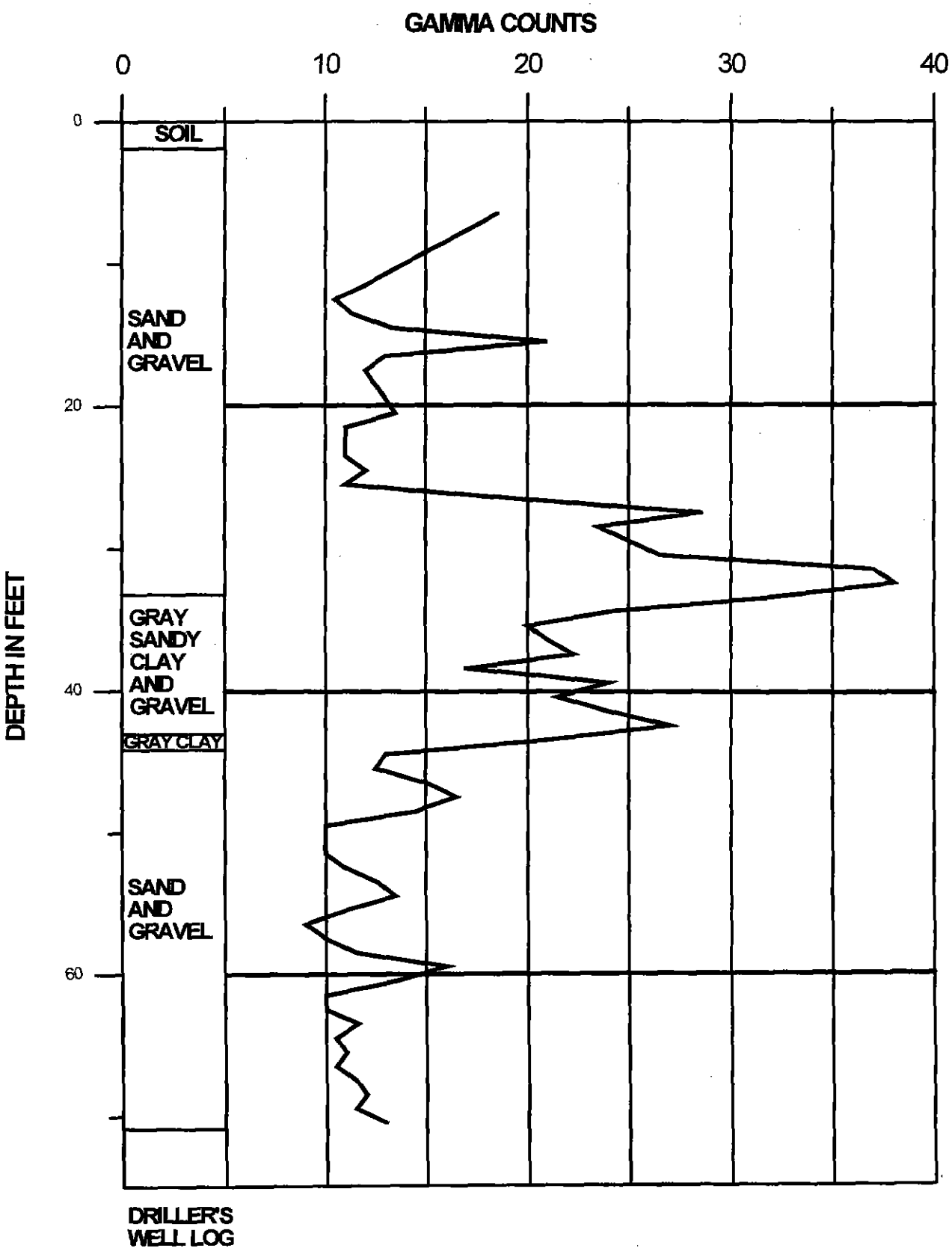


Figure 3.2 West Liberty observation well gamma log

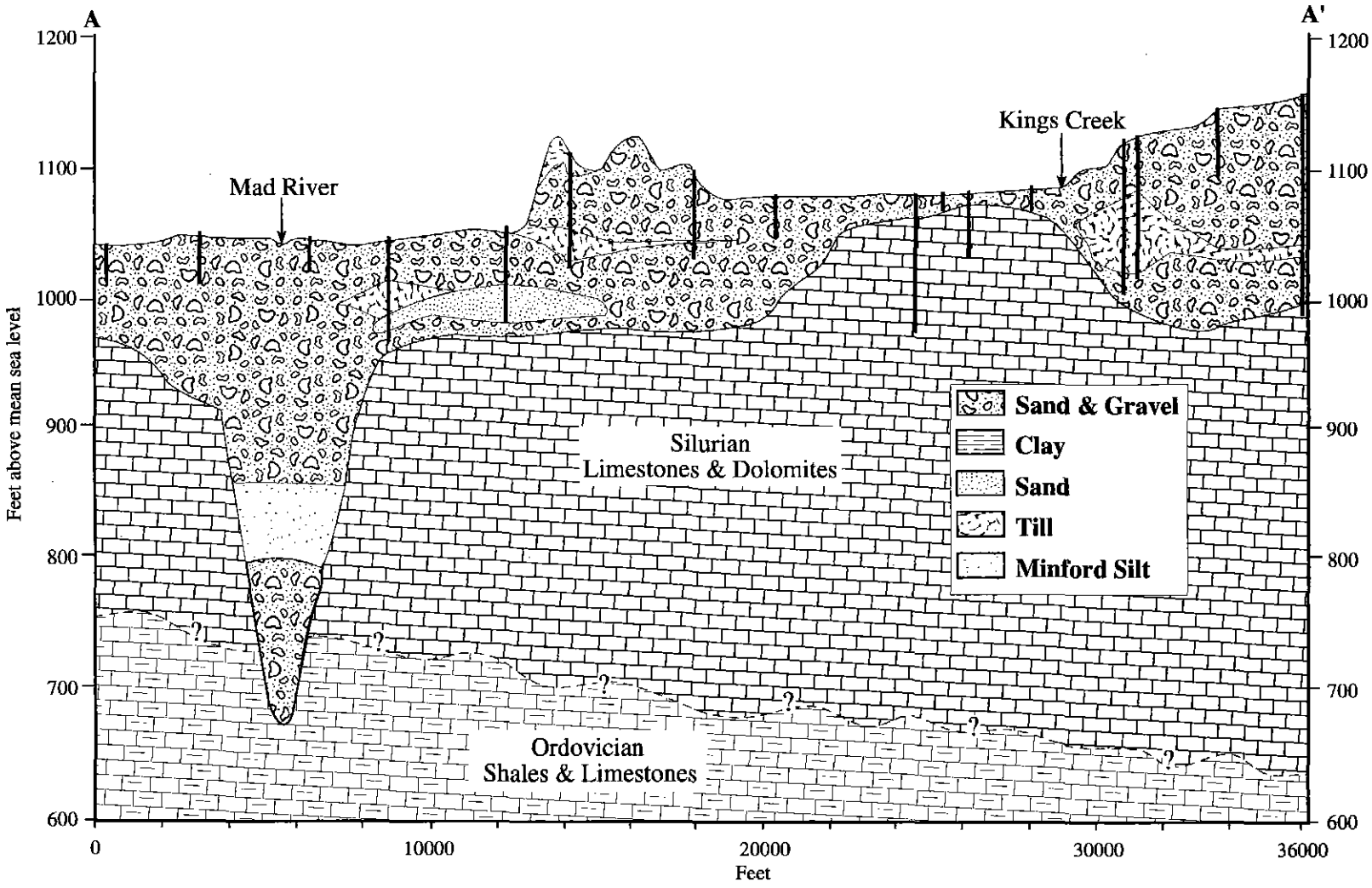


Figure 3.3 Cross-section of Mad River basin

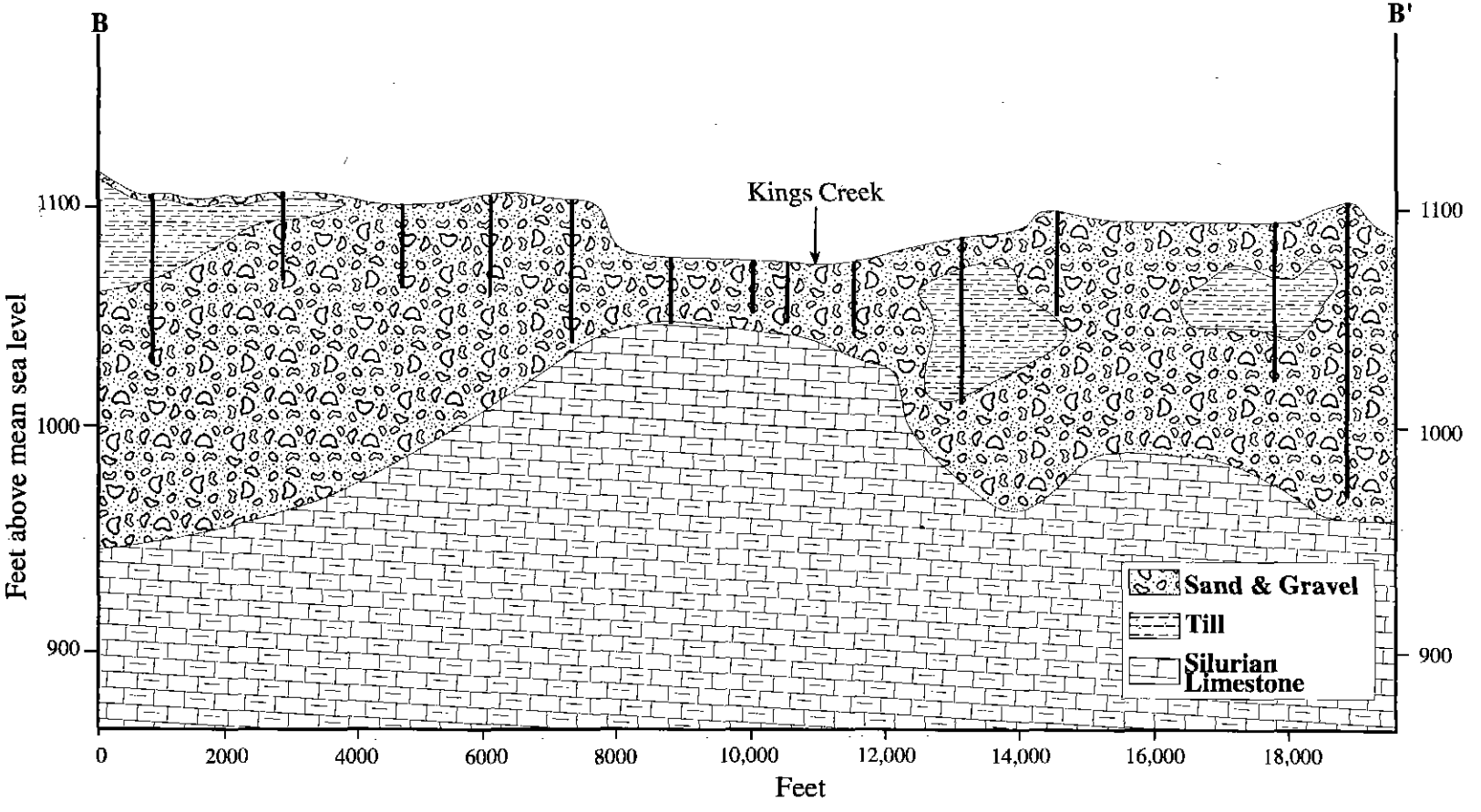


Figure 3.4. Cross-section of Kings Creek area

elevation of the water table, which were used to contour lines of equal elevation to determine ground water flow directions. Secondly, it was important to look for any large changes in water levels during the study, such as seasonal fluctuations, effects of major pumping, or effects from drought conditions (Kaser, 1962).

The well sites (Figure 2.2) chosen for water level measurements were based on water well logs on file at the Division of Water. Figure 2.2 shows a complete map with the location of all wells used in the study. A well log gives information on the well depth, formations encountered, and well construction details. Figure 4.1 is an example of a representative well log from the study area. Priority was given to wells constructed since 1980, as newer wells should have used better well construction techniques, allowing a clearer picture of aquifer problems versus problems caused by poorly constructed wells. Wells were also selected based on geographic location, aquifer material encountered, and permission of the landowners.

A representative of the Division of Water personally spoke to each property owner, asking permission to test the well and describing the data collection process. As promised, all water level and water quality results were given to each homeowner on a quarterly basis. In addition, a fact sheet published by Heidelberg College Water Quality Laboratory (WQL) that discussed water quality concentrations and what they might mean to the homeowner was also distributed with the results. A business card with the ODNR-DOW staff member's telephone number was also attached to provide a contact who could answer any questions the property owners might have. Full disclosure to all study participants was an important part of the outreach and educational component of the study. Several of the residents that participated in the study also became members of the Mad River Steering Committee, showing their interest in water quality issues in the Mad River Valley.

4.12 Collecting Static Water Level Data

The static water level in a well is the distance from a point on the ground surface to the non-pumping water level in a well. The static water level is measured by lowering an electronic probe into the well and reading the graduated tape after a beep indicates the top of the water table had been reached. After reading that number, the height of the measuring point above the land surface must be subtracted to determine the static water level. To determine the elevation of the water table, the recorded static water level value was subtracted from the surface elevation. The surface elevation was obtained from a USGS 7.5 minute topographic map.

4.13 Water Table Surface Map Construction

The main purpose of these measurements is to produce a water table map (Figure 4.2). Water level measurements for Figure 4.2 were collected in December 1993 (Appendix B). A water table map is used to determine the direction of shallow ground water flow. The static water level is subtracted from the surface elevation to give the elevation of the water table. When these elevations are plotted on a topographic base map, lines can be drawn contouring points of equal water elevation. These lines are referred to as equipotential lines or lines of equal hydraulic head. Since ground water moves from points of higher elevation to points of lower elevation, a line drawn perpendicular to an equipotential line defines the direction of ground water flow.

Ground water moves from recharge areas in the uplands and discharges in the Mad River Valley. In areas of sub-watersheds of the Mad River, ground water generally moves toward the tributaries, which in turn flow toward the Mad River (Figure 4.2). Ground water levels are their greatest in the uplands on the east and west sides of the valley, they decline steeply below the valley walls (as do the valley walls) and level off under the flat valley bottom.

The interaction between surface and ground water can greatly affect stream output. Most rivers receive a portion of their flow from ground water. A gaining stream means that ground water is being supplied to supplement the flow of the river. Conversely, a losing stream provides surface water to the ground water system. In a gaining stream (or reach of the stream), the equipotential lines form a V pointing upstream or the stream is gaining water from ground water; in losing streams the V points downstream or water is flowing from the stream to the aquifer. During the study, Mad River reaches were gaining. Seasonal fluctuations have little effect on ground water flow directions. A careful survey of water table maps compiled quarterly for the period from December 1993 to September 1994 confirm the lack of seasonal influence in the direction of ground water flow (Appendix B).

DNR 7802.92
TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

772986

Permit Number 120

COUNTY Champaign TOWNSHIP Concord SECTION/LOT No. _____ (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Hawkeye Realty PROPERTY ADDRESS 2895 Hanna Rd. (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY _____

CONSTRUCTION DETAILS

CASING Borehole Diameter 7 7/8 in.

[1] Diameter 5 in. Length 50 ft. Wall Thickness SDR21 in.

[2] Diameter _____ in. Length _____ ft. Wall Thickness _____ in.

Type: [1] Steel [2] [1] Galv. [2] [X] PVC [2] [1] [2] Other _____

Joints: [1] Threaded [2] [1] Welded [2] [X] Solvent [2] [1] [2] Other _____

Liner: Length _____ Type _____ Wall Thickness _____ in.

SCREEN

Type (wire wrapped, louvered, etc.) Slotted Material PVC

Length 2 ft. Diameter 5 in.

Set between 48 ft. and 50 ft. Slot _____

GROUT

Material Bentonite Volume used 150#

Method of installation pumped

Depth: placed from 40 ft. to top ft.

GRAVEL PACK (Filter Pack)

Material pea gravel Volume used 50#

Method of installation poured

Depth: placed from 48 ft. to 50 ft.

Pitless Device [X] Adapter ☐ Preassembled unit

Use of Well Domestic

☐ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other _____

Date of Completion 9-21-93

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Black Top Soil	0	5
Gravel & Sand	5	30
Sand	30	40
Water Bearing Gravel	40	50

*If additional space is needed to complete well log, use next consecutively numbered form.

WELL TEST

☐ Bailing ☐ Pumping* [X] Other Air

Test rate 20 gpm Duration of test 2 hrs.

Drawdown Bottom ft.

Measured from: [X] top of casing ☐ ground level ☐ Other _____

Static Level (depth to water) 5 ft. Date: 9-21-93

Quality (clear, cloudy, taste, odor) Clear

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

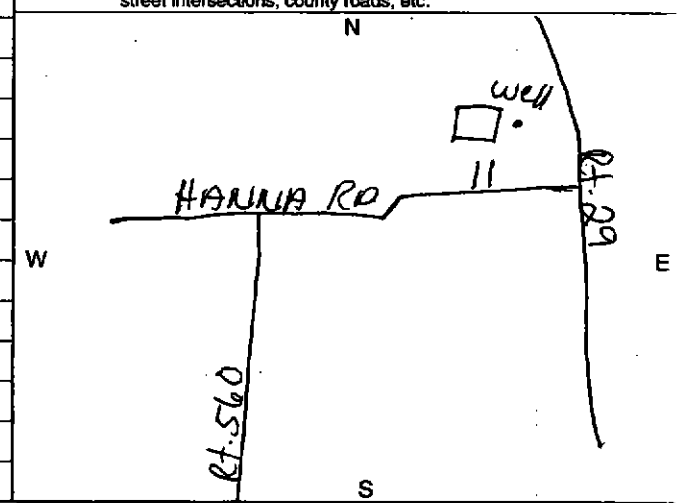
Type of pump _____ Capacity _____ gpm

Pump set at _____ ft.

Pump installed by _____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Crabtree Well & Pump

Address 2882 Snyder-Domer

City, State, Zip Spf 10. Oh. 45502

Signed Mark Crabtree

Date 9-22-93

ODH Registration Number 264

5127

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

Figure 4.1 Well log and drilling report

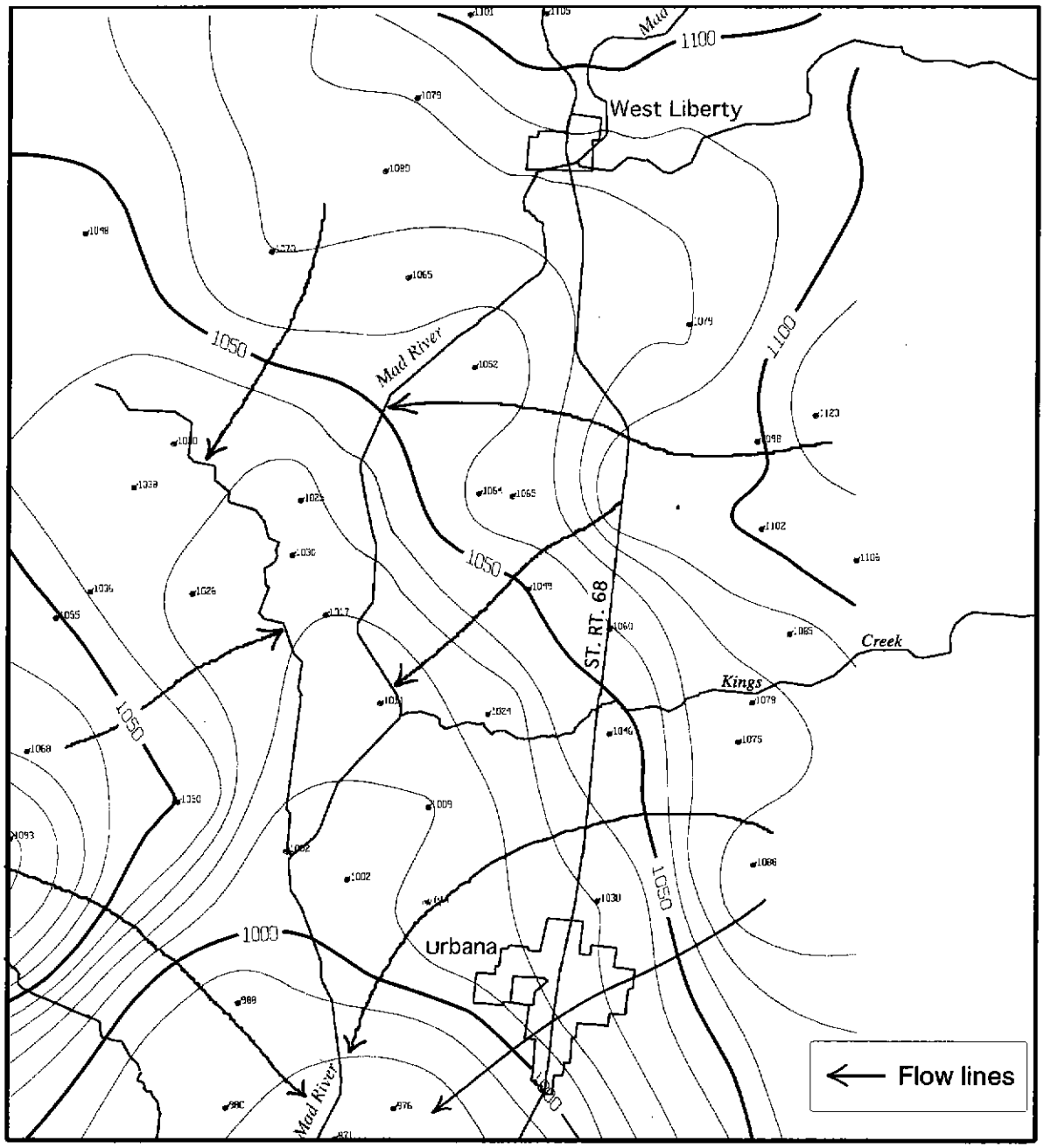


Figure 4.2 Mad River water table map December, 1993

4.14 Trends in the Data

Water level measurements are used to determine the seasonal fluctuation of the water table over the course of a year. Water levels tend to decline in late spring and summer, and increase in winter and early spring. The amount of these increases and declines tend to be relatively stable across the watershed, thereby having little or no effect on ground water flow direction.

What happens to precipitation falling upon the land surface depends on many variables. The soil moisture, soils temperature, land cover, slope, and season of the year are just some of the variables that may affect recharge to the aquifer by precipitation. Saturated soils, frozen soils, or excess slope cause precipitation to runoff on the surface instead of infiltrate. Evapotranspiration, the loss of water from a land area by transpiration of plants and evaporation of the soil, intercepts most of the rainfall during the summer that might recharge the aquifer; therefore, the heavy summer rainstorms provide little recharge for the ground water system. Without the presence of growing plants during the fall and winter, precipitation, minus direct evaporation, can infiltrate the ground surface and percolate downward, recharging the aquifer. When the ground is frozen during the winter, potential recharge waters runoff into surface water drainage and often fail to recharge local aquifer systems.

Any major fluctuation in precipitation patterns can also affect aquifer recharge. When a rainfall event occurs at a time when the soils are already saturated, runoff is higher than normal. Recharge is also affected by timing of the rainfall event. Slow-steady rainfall leads to better infiltration. If the soil moisture is adequate at the time of rainfall, recharge to the aquifer can occur even during the growing season.

4.15 Static Water Level Results

The largest fluctuations between the highest and lowest static water levels occurred in morainal areas where a thin veneer of glacial till overlays thicker deposits of outwash. Depth to water measurements in the morainal areas are usually deeper, as the depth to the aquifers are deeper and the vadose zone deposits are thicker than within the river valley. The static water level in these aquifers is slower to respond to fluctuations based on precipitation.

During the study period precipitation levels have been anything but normal. At Urbana for 1993, precipitation exceeded normal by 10.17 inches (Table 2.1). In 1994, precipitation was 9.69 inches below normal, and in 1995, precipitation was 10.82 inches above normal (Table 2.1). The lowest values recorded during the study period were recorded during December 1994 and March 1995. The highest ground water levels for the study period were recorded during December 1993, March 1994, June 1995, and September 1995. These four measuring periods accounted for more than 95% of the study-long water level highs recorded. Several wells exhibited their study-long high water levels during the June 1995 measurement. Precipitation levels for April and May of 1995 exceeded normal by 3.79 inches. Study-long highs were recorded in some wells in September 1995. This is normally a time when seasonal water levels are approaching their yearly lows. The answer again comes from excessive precipitation amounting to 9.26 inches above normal in the previous 2 months.

Only 5 wells showed a difference of greater than 5 feet between their lowest and highest ground water level. All these wells are located in the till-capped uplands of the end moraines. Twenty-three of the sixty-three wells measured showed less than 3 feet of difference between water level highs and lows. Thirty-five wells exhibited a water level change between 3 to 5 feet over the course of the study.

Seasonal water level fluctuations of 3 to 5 feet would be considered normal in sand and gravel aquifers in Ohio (Cashell, personal communication). A period of above normal or below normal precipitation for several years could show seasonal fluctuations of twice the normal amount (Cashell, personal communication). Considering the extreme precipitation events in the short study period of 3 years, the aquifer seems to behave as a typical sand and gravel aquifer would in Ohio.

CHAPTER 5 WATER QUALITY ANALYSIS

5.1 Methodology

Water quality data discussed in this report were collected within the watershed from both surface and ground water sources from December, 1993 to December, 1995. Sampling of both surface and ground water was performed on a quarterly basis at the same time that water level measurements were

taken. The first year of sampling included triazine and alachlor screens. After a year of sampling 41 wells and 4 surface water sites, no samples with concentrations approaching the safe drinking water standard were collected. Therefore, sampling focused on the cations and anions present in order to determine baseline water chemistries.

The 41 wells chosen for water quality sampling were selected on the basis of several factors. The geographic location was the first consideration. Wells were selected that provided an even geographic distribution across the study area. All wells initially chosen for sampling were selected based on the availability of a water well log so that well depth and formation of completion could be identified. When possible, preference was given to wells drilled since 1980. When problem areas were identified and wells were needed for further data collection, some of these preferences were disregarded.

The Water Quality Laboratory (WQL) at Heidelberg College in Tiffin, Ohio and Coshocton Environmental Testing Laboratory (CETL) in Coshocton, Ohio were selected to analyze all water samples. A subset of the 62 residential wells measured for water levels were sampled quarterly from December, 1993 to December, 1995. All samples were collected by ODNR personnel and sent to their respective laboratories. The WQL was sent 9 sets of samples one each quarter, but CETL was only used for 4 quarters from December, 1994 through September, 1995. Surface water samples were collected from 4 sites on the Mad River and analyzed for the same parameters as the ground water samples. Each surface water sample was analyzed by both labs. Because of the constituents analyzed by each lab there was little overlap of the analyses. The overlap of analyses that occurred provided a crude form of quality control between the 2 labs.

5.2 Ground Water Sampling Techniques

Samples analyzed by Heidelberg College's Water Quality Laboratory were collected in pre-packaged sample kits that contained three small vials in a mailable styrofoam container. A faucet or tap was allowed to run for several minutes prior to sampling to remove at least one volume of water from the well and to help purge the plumbing system. By eliminating influences of the well and plumbing system, a better picture of the ground water system is obtained. Care was also taken to insure that the tapped line did not pass through a water softener, conditioner, or filtration system. The three vials were rinsed with the tap water and then carefully filled, returned to their packages, and labeled.

The basic nutrient package from the WQL analyzes samples for nitrate (NO_3^-), nitrite (NO_2^-), ammonia (NH_3^-), chloride (Cl^-), sulfate (SO_4^-), silica (SiO_2), and phosphorous (as soluble reactive phosphorous, or SRP) calorimetrically by means of a TRAAC's 800 autoanalyzer system (Appendix C). The analysis is done by passing a beam of light from a photoelectric cell through the water sample. Each analyzed component is examined by a specific wavelength of light unique to that component.

Water samples were also screened for pesticides. The triazine screen defined the total concentration of the herbicides atrazine, cyanizene and symazine present but did not differentiate the specific triazine herbicides present. Similarly, the alachlor screen tested for the presence and total concentration of alachlor and metolachlor. Samples were analyzed using amino assay. The detection limit for this procedure is .1 part per billion (PPB). Negligible amounts of herbicide were present in any sample of ground water. This can be explained by the fact that herbicides readily bind to soil organic matter. Therefore, as they are applied and washed into the soil, herbicides become immobile and do not infiltrate the ground water. Much of the herbicide does wash away as overland flow and, as a result, surface water samples often have higher herbicide levels than ground water samples. Data for triazine and alachlor screens support this phenomenon.

A subset of the wells analyzed by the WQL were sent to CETL to obtain a major ion analyses. These samples were analyzed for pH, total alkalinity as $CaCo_3$, specific conductance, total dissolved solids, sulfate, chloride, calcium, magnesium, sodium, potassium, iron, manganese, aluminum, hardness, and nitrate.

Samples that were analyzed by Coshocton Environmental Testing were handled in adherence to U.S.EPA 600 sampling analytical protocol. Analysis on the samples was performed using a Perkin-Elmer 2380 atomic absorption spectrophotometer, Perkin-Elmer HGA 400 furnace, YSI Model 32 conductivity meter, Fisher 230A pH ion meter, Milton-Roy Spec 21 spectrophotometer, and a Mettler K-7 balance.

The collection process used the same criteria as for the WQL. All samples were collected in expandable 1 quart containers and 600 milliliter hard plastic bottles. The samples were stored in chilled coolers during collection and overnight transport to Coshocton Laboratories.

5.3 Surface Water Sampling Techniques

Water samples were collected from the Mad River using a bailer. A bailer is a tube that is lowered into the stream with a ball that covers the open end of the tube, allowing water to be collected. The four sites selected for river sampling were at bridged overpasses allowing samples to be collected from the center of the river. The Mad River is shallow therefore samples were collected in the upper 3 feet of the river. The bailers were rinsed after every use and reflushed with water at the next river sampling site to eliminate any chemical cross-contamination. The stream water had little turbidity so the bailed water was decanted directly into the vials with no filtration. The samples were subsequently shipped to Heidelberg College for analysis.

5.4 Natural Water Chemistry

The average dissolved chemical composition of ground water in the Mad River Valley is composed of 27.7% calcium and 20.4% magnesium (Figure 5.1). The average dissolved chemical composition of ground water in the study area for December, 1994, June, 1995, and September, 1995 can be found in Appendix D_1. The chemical make-up of the water within the Mad River study area is primarily influenced by the unconsolidated glacial material and underlying bedrock (Stein, 1974; and Feulner, 1960). The outwash is predominantly composed of eroded gravels from the carbonate bedrock at, and to the north of, the study area. Major ions such as calcium, magnesium, and bicarbonate are dissolved within ground water as it passes through the carbonate bedrock and glacial deposits.

Higher concentrations of sodium, chloride, and sulfates found in the ground water, are due in part to the dissolution of evaporite material such as halite, gypsum, and anhydride. Sodium and chloride can also indicate road salt contamination or connate waters in bedrock units. Sulfate can also be produced by the oxidation of the mineral pyrite. Minor constituents such as iron and manganese are often derived from the unconsolidated glacial material or bedrock. These constituents are converted into oxidized forms through biological activity.

By cation-anion analysis, the natural ground water chemistry can be classified as a calcium and bicarbonate-rich water. Because of the presence of excessive calcium, most local wells have hard water.

5.41 Chemical Parameters

The twenty chemical and physical parameters analyzed were used to illustrate the variability of water quality from well to well. The two most abundant cations (by concentration) were calcium (Ca^{2+}) and magnesium (Mg^{2+}). Together these two cations are the primary components of hardness and may have a profound influence on the quality of the water. Hardness was calculated in terms of the equivalent quantity of CaCO3. Water with a hardness ranging from 120-180 mg/L is generally considered hard, and needs to be softened. The mean (average) hardness value was 402 mg/L. Sodium (Na^+)and potassium (K^+) are also used to indicate the quality of water. The mean values for sodium and potassium are 6.68 mg/L and 2.38 mg/L respectively. Elevated levels of these two cations could lead to high blood pressure in some people who regularly drink the water. This type of water may also have a soda taste or, if substantial chloride (Cl^-) is present, may have a salty or brackish taste.

Dissolved iron (Fe^{2+}) is generally found in very low concentrations and, according to the U.S. Environmental Protection Agency (U.S.EPA), should not exceed the national secondary drinking water regulations standard of 0.3 mg/L. The mean value for iron in the study area was 0.249 mg/L. The secondary standards are recommended levels for aesthetics and taste, but are not federally enforceable. Substantial amounts of iron (>1 mg/L) may cause discoloration of water and stain appliance fixtures and laundry. Only 3 wells had a sample that exceeded 1 mg/L during the study.

Analysis was also run for the metals, manganese (Mn^{2+}) and aluminum (Al^{3+}). The national secondary drinking water standard for manganese is 0.05 mg/L and a mean value for the study area was 0.067 mg/L. The mean value of aluminum was 0.13 mg/L. The only standard for aluminum

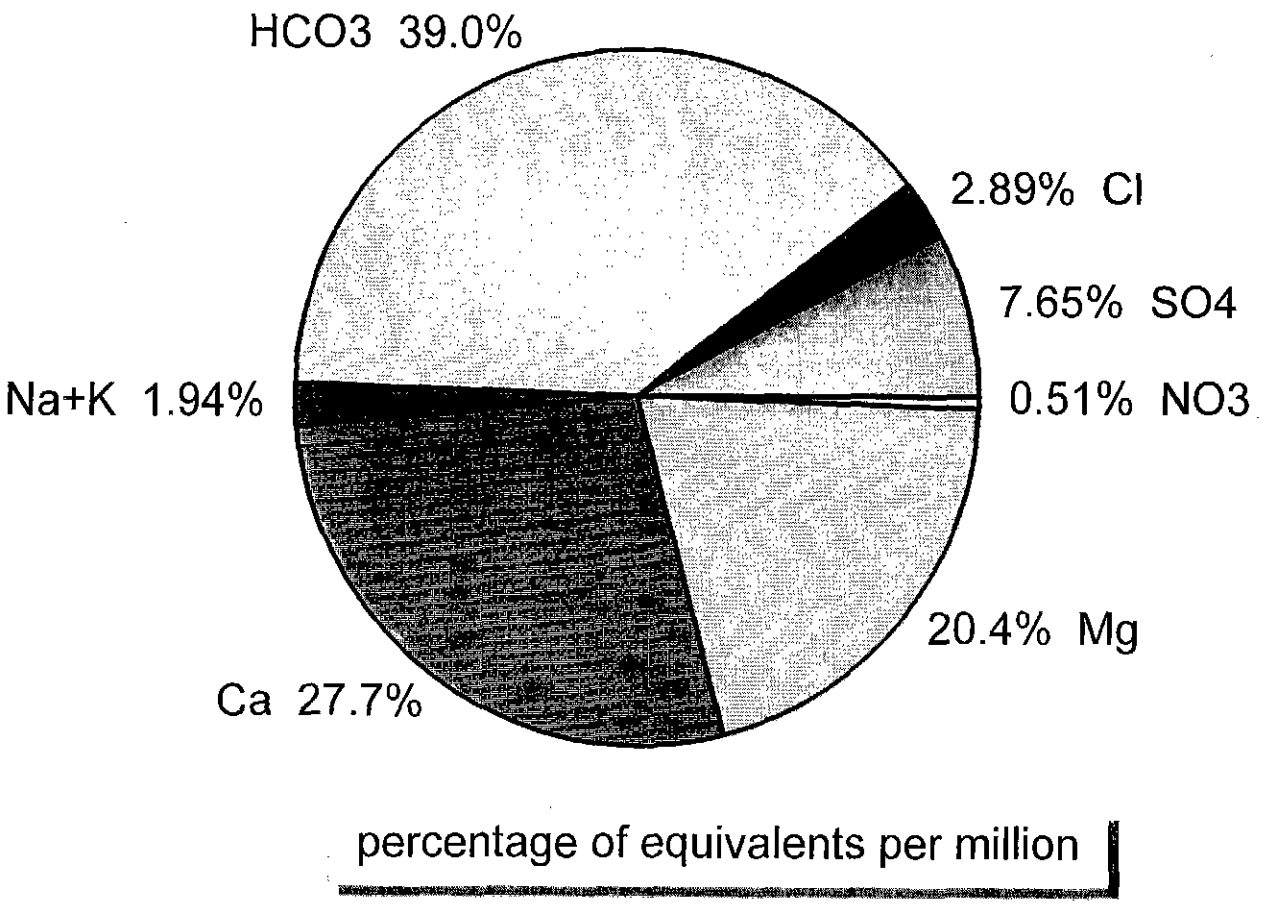


Figure 5.1 Average dissolved chemical composition of ground water

refers to irrigation water and that standard is 5.0 mg/L. Neither manganese or aluminum at these concentrations represent a health risk as these values affect only aesthetic and taste characteristics.

Sulfate (SO_4) was analyzed as a primary anion. The U.S.EPA has set a secondary recommended level at 250 mg/L. Sulfates can cause minor health problems if concentrations are too high (>250 mg/L). The mean value for sulfate was 59 mg/L within the Mad River NPS project area.

Physical characteristics such as pH, alkalinity, specific conductivity, and total dissolved solids (TDS) were analyzed in most of the NPS water samples. Ph measures the relative acidity of a given water sample. Natural rain waters are slightly acidic because of a hydrolysis reaction between water and carbon dioxide. Ground water in this area, however, is often slightly basic, or alkaline, due to the abundance of carbonate rock, which reacts with the acidic rain to release the bound carbon dioxide. The mean pH value was 7.28 with values ranging between 6.7 and 7.88.

Specific conductivity and total dissolved solids measure the amount of dissolved material within the water (Figures 5.2 and 5.3). Ground water typically has high concentrations of dissolved material. Specific conductivity is a general indicator of the relative concentration of ions within the water, while TDS measures dissolved solids concentration. The U.S.EPA has set a secondary MCL of 500 mg/L for TDS, whereas none is set for specific conductivity. Mean values for specific conductance were 738 micromhos (mhos) and 459 mg/L for total dissolved solids. High levels of TDS may cause pipe corrosion and damage plumbing.

Silica and phosphorous are generally analyzed for baseline water quality data. Silica (SiO_2) is derived from the bedrock and is not known to pose health risks at any level. Phosphorous may be present in bedrock, animal waste, and fertilizers. Phosphorus is an element that contributes to nutrient stream loading in areas where runoff is high. These parameters can often indicate physical changes within the water aerially and over time, much like TDS and specific conductivity. Mean concentrations of silica and phosphorous in the study area were 11.84 mg/L and .01 mg/L respectively.

5.42 Variations

Throughout the Mad River NPS study area the glacial material and the bedrock composition remain constant. Well log information along with field observation clearly shows the predominance of carbonate materials present. Therefore, major ions like calcium, magnesium, bicarbonate, and sulfate remain constant throughout the study area. Land use practices, however, varying from rural farmland to urban land, greatly influence the chemistry of ground water.

Constituents like sodium, chloride, nitrate, and ammonia may vary substantially depending on the type of land management practices occurring adjacent to the sample local. Sodium as well as chloride concentrations may greatly increase around a highly traveled roadway where road salt washes off and infiltrates the aquifer (Bair et al., 1989). For example, wells located adjacent to state routes exhibited the effects of road salting with an increase in sodium concentrations during the winter and spring analysis and a reduction in these values during the summer and fall.

5.5 Contaminant Water Chemistry

The primary ground water contaminants in this area are agriculturally derived. Nitrate and ammonia often come from livestock waste, which is rich in nitrogen compounds. Nitrogen is present in proteins within the waste and is converted to nitrate (NO_3^-) and ammonia (NH_3^-) by the process of mineralization.

5.51 Ammonia Contamination

Ammonia occurs as a gas under standard temperature and pressure conditions. In a liquid state ammonia has a high vapor pressure and is volatilized into the atmosphere. The impacts of elevated ammonia (NH_3^-) are dependent on the phase in which the cation is present. Provided it is in the gaseous phase, ammonia poses little health threat to humans and/or livestock although high concentrations of ammonia may be noxious to some people. Depending on the source or abundance, a strong odor may be associated with ammonia. Ammonia is the gas which gives manure its distinct smell.

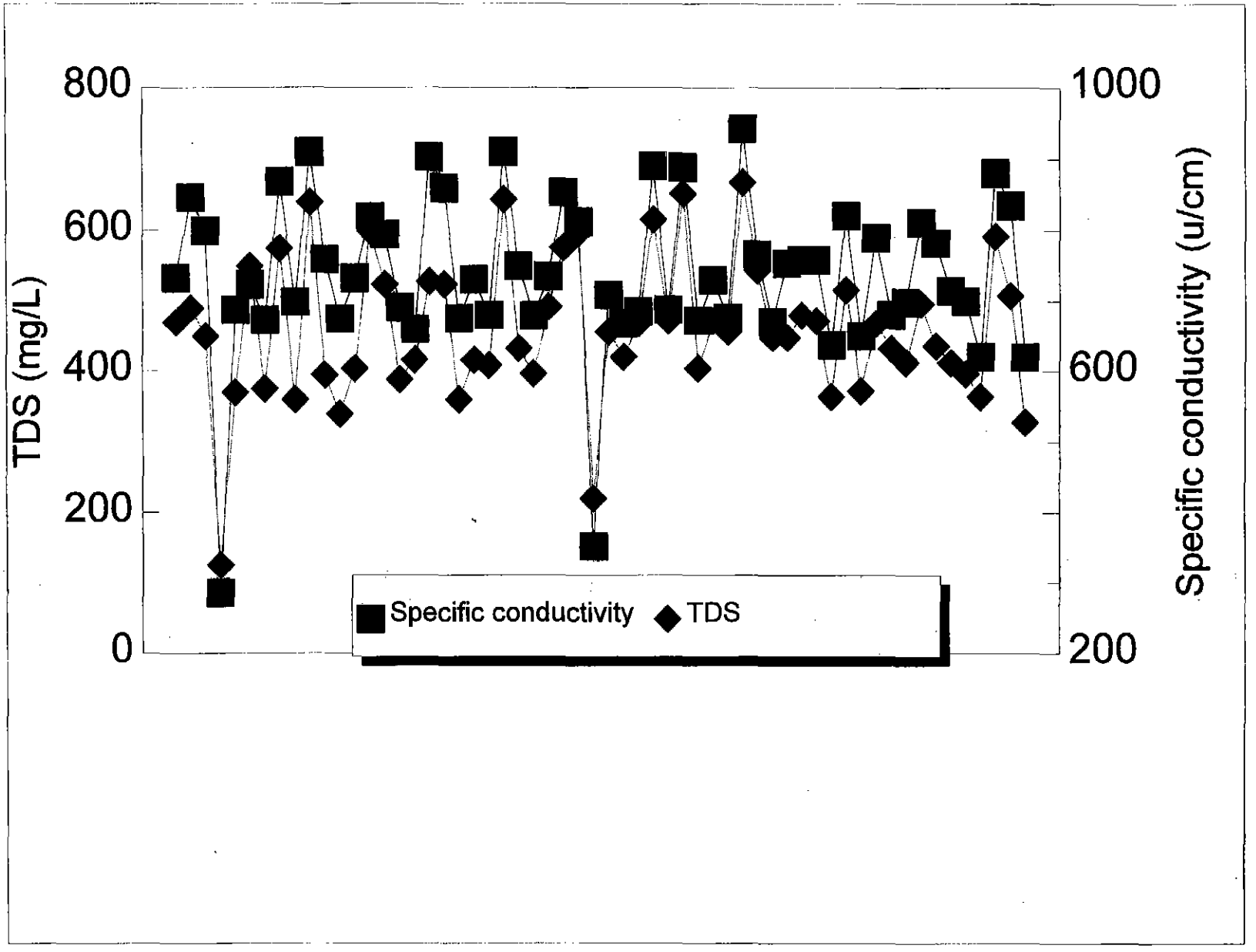


Figure 5.2 Specific Conductivity vs. TDS (mean values for all ground water data)

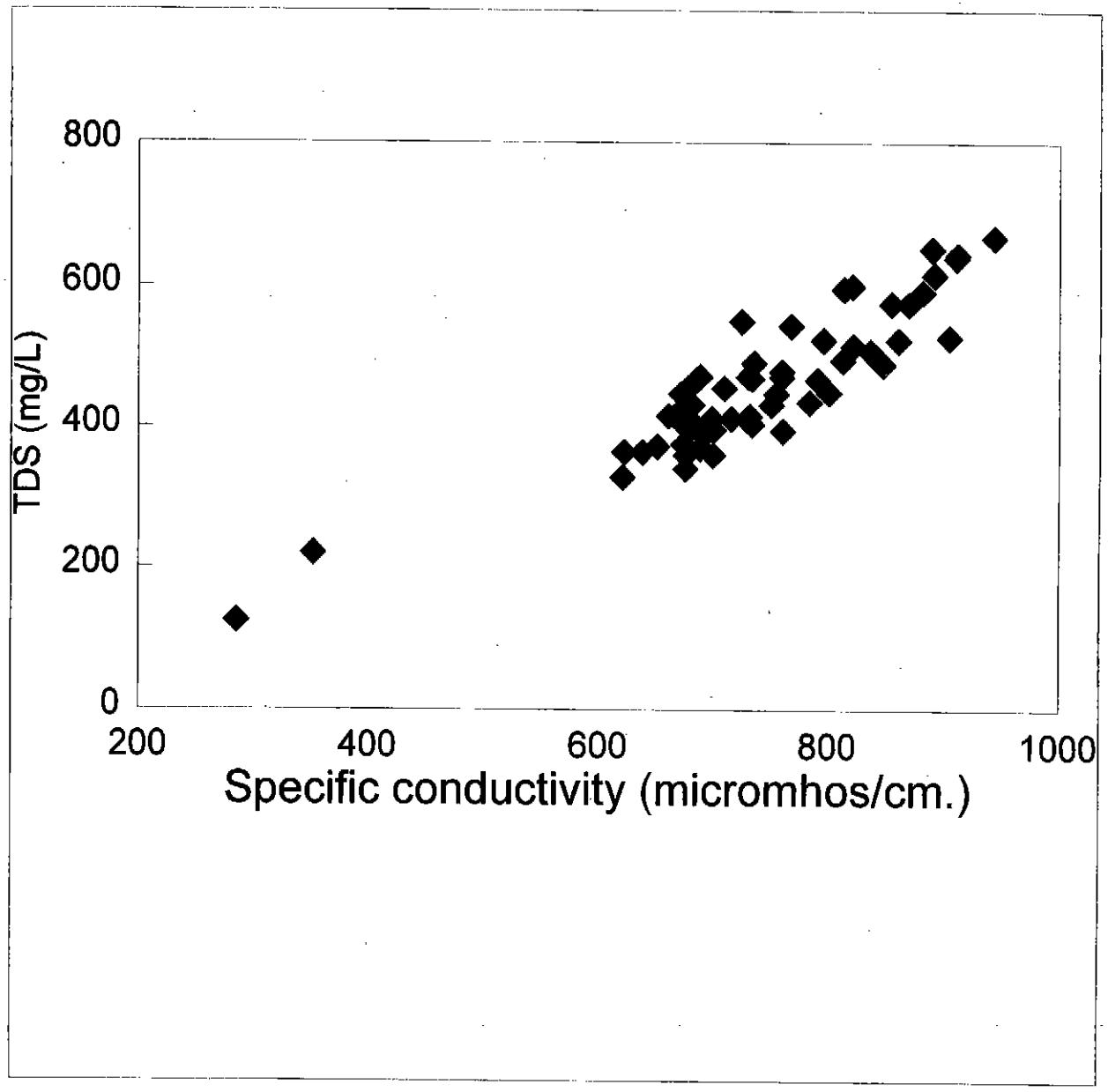


Figure 5.3 Specific Conductivity vs. TDS (mean values for all data)

Ammonia may be present in the aqueous phase when dissolved in water. Ammonia in the aqueous form tends to be much more toxic. Dissolved ammonia gas in water is lethal to many aquatic species at very low levels (i.e., 0.5 mg/L). A higher pH also results when ammonia is dissolved in water. Alkaline conditions in water pose another threat to aquatic animals, as well as animals that frequently utilize the contaminated water as a drinking supply.

Widespread ammonia contamination is not present in the study area, and is not expected to be a problem in the foreseeable future. The Heidelberg College voluntary well testing program gives some insight into the distribution of ammonia levels in Champaign County (Figure 5.4). The mean value for all samples collected was 0.14 mg/L. The United States EPA is planning to set a safe drinking water standard for ammonia at 35 mg/L. Values this high are almost never found in ground water. The highest values recorded were in well 21, which had values of 7.15 mg/L in March, 1994, 7.72 mg/L in June, 1995, 13.10 mg/L in September, 1995 and 7.23 mg/L in December, 1995. All other samples collected from well 21 were less than 1 mg/L. No other well showed a concentration above 0.56 mg/L. A concentration greater than 0.5 mg/L may indicate the presence of animal waste in which case a bacterial test should be performed (Pete Richards personal communication, 1996).

The anomalously high ammonia values in well 21 can be explained by localized environmental conditions and does not reflect a widespread contamination of the aquifer. The well is located between an agricultural field used for soybeans and upgradient of a feedlot for sheep. In addition, the well has a casing that is sheared below grade and has no well cap to protect the aquifer from surface contamination.

5.52 Nitrate Contamination

Of all the natural plant nutrients, nitrogen presents the greatest threat to water quality. The most common form of nitrogen in the soil is in the form of nitrate (NO_3^-), which is highly soluble. Nitrate can leach from the soil horizon becoming mobile (in solution) and moving as part of ground water flow. The concentration of nitrate in the soil is therefore the major problem.

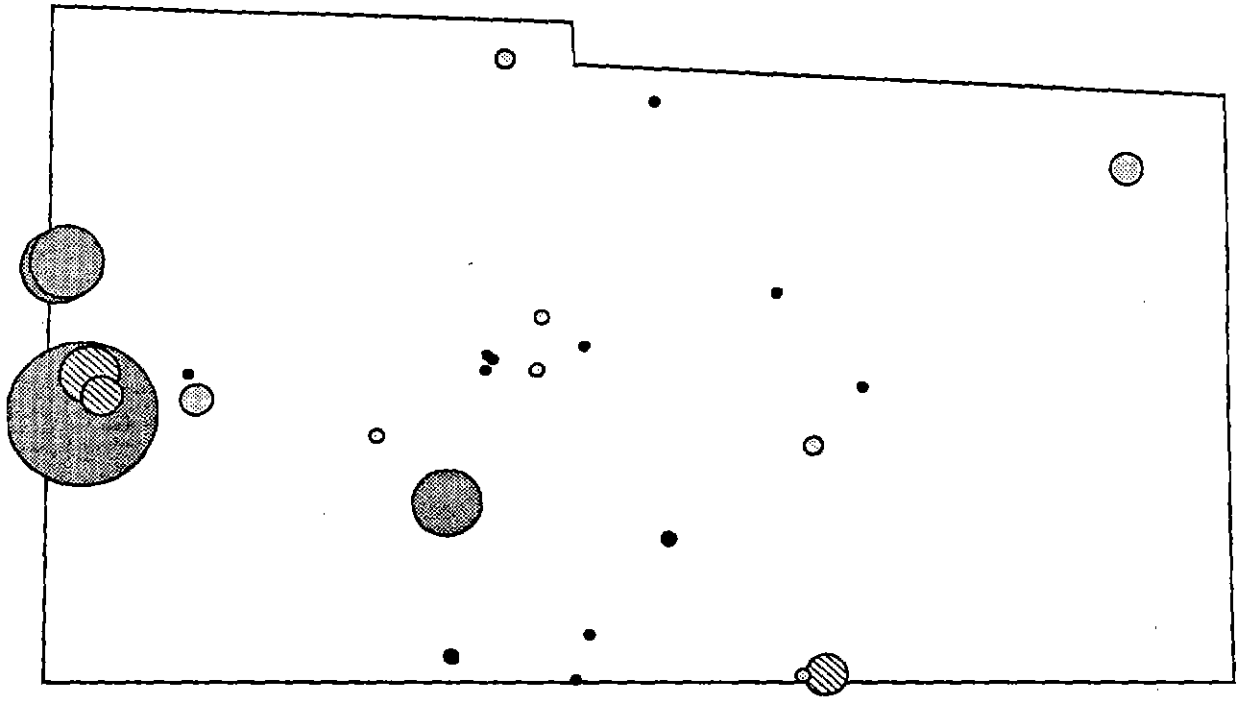
Baker (1990), in his voluntary well testing program for all of Ohio, found on average less than 3 percent of the wells sampled exceeded the safe drinking water standard of 10 milligrams per liter for nitrate. This study also looked at nitrate contamination related to the depth of the well and found that 7.2% of wells less than 50 feet deep exceed 10 Mg/L, while only 0.9% of wells over 100 feet deep exceeded the safe drinking water standard.

The negative impacts of nitrate can be strong if high levels are recognized. Nitrate may be toxic to infants younger than six months of age. Levels higher than 10 mg/L are considered dangerous. This is because a condition called methemoglobinemia may be induced. Methemoglobinemia is caused when nitrate is ingested and becomes converted to nitrite by bacteria in the stomach. Nitrite causes the blood to transmit oxygen inefficiently, ultimately reducing oxygen flow to the body. This condition may also occur in some ruminant livestock and adult horses.

Causes of nitrate contamination are generally limited to agriculture practices. The mean value for nitrate in the study area is 2.54 mg/L. Nitrate is commonly present at low levels in many wells within the study area (Appendix C). This suggests a widespread source, probably fertilizer application. Nitrate contamination within wells may fluctuate greatly due to varying infiltration rates, application times, and velocity rates of nitrate in ground water. Nitrate levels may increase by two orders of magnitude from an area with no nitrate fertilizer application to an area with large nitrate fertilizer application. Therefore, regular monitoring of the water should be done to prevent health problems.

Nitrate contaminated water directly correlates with fertilizer application. Should fertilizer application dramatically increase in part or all of the area, nitrate will be found in greater concentrations in the ground water. Therefore, future nitrate contamination problems may be reduced through knowledge of the best application times, which crops naturally produce nitrogen (e.g., legumes), and the agronomic rate for applying nitrogen to specific crops. By applying this knowledge, maximum crop yield may continue to be obtained, yet the probability of nitrate contamination will be reduced.

Well design plays an important role in the presence or absence of nitrate in a well. Plotted nitrate data in combination with historical well log information confirm this. Wells with greater than 100 feet of casing had less than 2 mg/L nitrate (Figure 5.5). Also, wells that were completed in aquifers greater than 50 feet below the surface showed less than 2 mg/L of nitrate (Figure 5.6). Wells that had less



From Heidelberg College Water Quality Laboratories

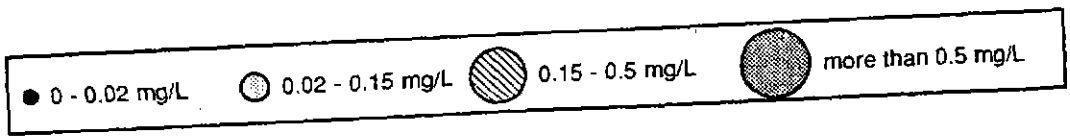


Figure 5.4 Ammonia as nitrogen for Champaign County, Ohio

than 100 feet of casing length and were less than 50 feet in depth to the top of the aquifer often showed somewhat higher nitrate levels. The highest nitrate values are found in some of the wells with less than 50 feet of casing and where the aquifer is within 25 feet of the surface. The highly permeable nature of the sandy soils and outwash deposits that cover a large part of the study area are a main reason nitrate is distributed in this fashion. These findings indicate that nitrate becomes increasingly dispersed or attenuated by aquifer material at greater depth.

Nitrogen is added to the soil horizon in five ways: from manufactured fertilizers; as organic wastes from animal manure; as the land application of septic sludge; from the uptake of nitrogen from legumes; or directly from the atmosphere (Ohio Cooperative Extension Service, 1991). Nitrogen from fertilizers, manure, and septic sludge are added to the soil horizon in the form of ammonia (NH_3^-) where it captures a loose H^+ ion to become ammonium (NH_4^+). However, soil microorganisms quickly convert the ammonium to nitrite (NO_2^-) by the process of nitrification and the nitrite to nitrate (NO_3^-). The nitrate moves into the ground water system unless it is intercepted. Field drain tiles can intercept this nitrate-laden water, eventually emptying it into surface water bodies.

Nitrate is retarded very little by organic soil matter. Nitrate often contaminates ground water below feed lots that have concentrated applications of manure. In this environment the anion generally takes substantial time to form because it must be oxidized from ammonia into nitrate.

Nitrate may bypass the slow oxidizing process by being applied to fields directly. Ammonium nitrate fertilizers dissolve in rain water. Ammonium (NH_4^+) and the very mobile nitrate dissociate and may infiltrate ground water.

Nitrate moves slowly through the soil horizon; therefore, nitrate that discharges through a field tile may be several years old. Vertical travel times for nitrate at the Piketon, Ohio Management Systems Evaluation Area (MESA) site (a similar hydrogeologic setting to the study area) were less than four feet per year (Martha Jagucki, U.S. Geologic Survey, personal communication, 1996).

Precipitation is the mechanism that drives nitrogen into the ground water system. The problem begins when more nitrogen-based fertilizers are applied to the land's surface than the crops can take up. Nitrogen that remains in the fall and winter usually infiltrates from rainfall and moves toward the water table as no plants are present to use the product. This nitrate is often below the root zone by spring when additional precipitation flushes it toward the water table.

The agricultural community uses crop variety, planting date, and nutrient status of the soil as the bases of nitrogen application decision making. Nitrogen may be removed from the soil in several different ways: denitrification, leaching, surface dissipation, and surface runoff. Denitrification is bacterial action removing part of the oxygen from the nitrate molecule and the volatilization of the remaining gases. Denitrification occurs in warm, wet, and oxygen-poor soils and in deep ground water systems when oxygen has been removed by organic matter. Leaching occurs when soil water content is higher than the capacity of plant roots to intercept the water and nitrogen. As water moves through the soil, nitrates move with the water. Surface dissipation occurs when fertilizers are spread on a field but not absorbed into the soils. The ammonia attaches to a water molecule and evaporates. Surface runoff occurs when major precipitation falls after application, creating a surface water problem.

A major nitrogen-based water problem occurs from the spreading of manure and sewage sludge. For example, manure from swine can contain 151 pounds per ton of nitrogen from dry waste (Ohio Cooperative Extension Service, 1991). Sludge, on the other hand, may contain 4.5% of its total mass as raw nitrogen or nitrogen-based compounds (Ohio Cooperative Extension Service, 1991). A series of Best Management Practices (BMPs) are available to help safely manage these substances to protect both surface and ground water supplies.

5.53 Nitrate in the Urbana Well Field

The ODNR Water Resources Section (WRS) was contacted in June of 1994 by the city of Urbana concerning elevated nitrate levels within the city's north well field (NWF) (Figure 2.2). Data the city obtained from sampling revealed that a one of their wells routinely had nitrate concentrations above 10 mg/L. This level is unacceptable according to the U.S.EPA, which sets the acceptable maximum contaminant level (MCL) for nitrate at 10 mg/L.

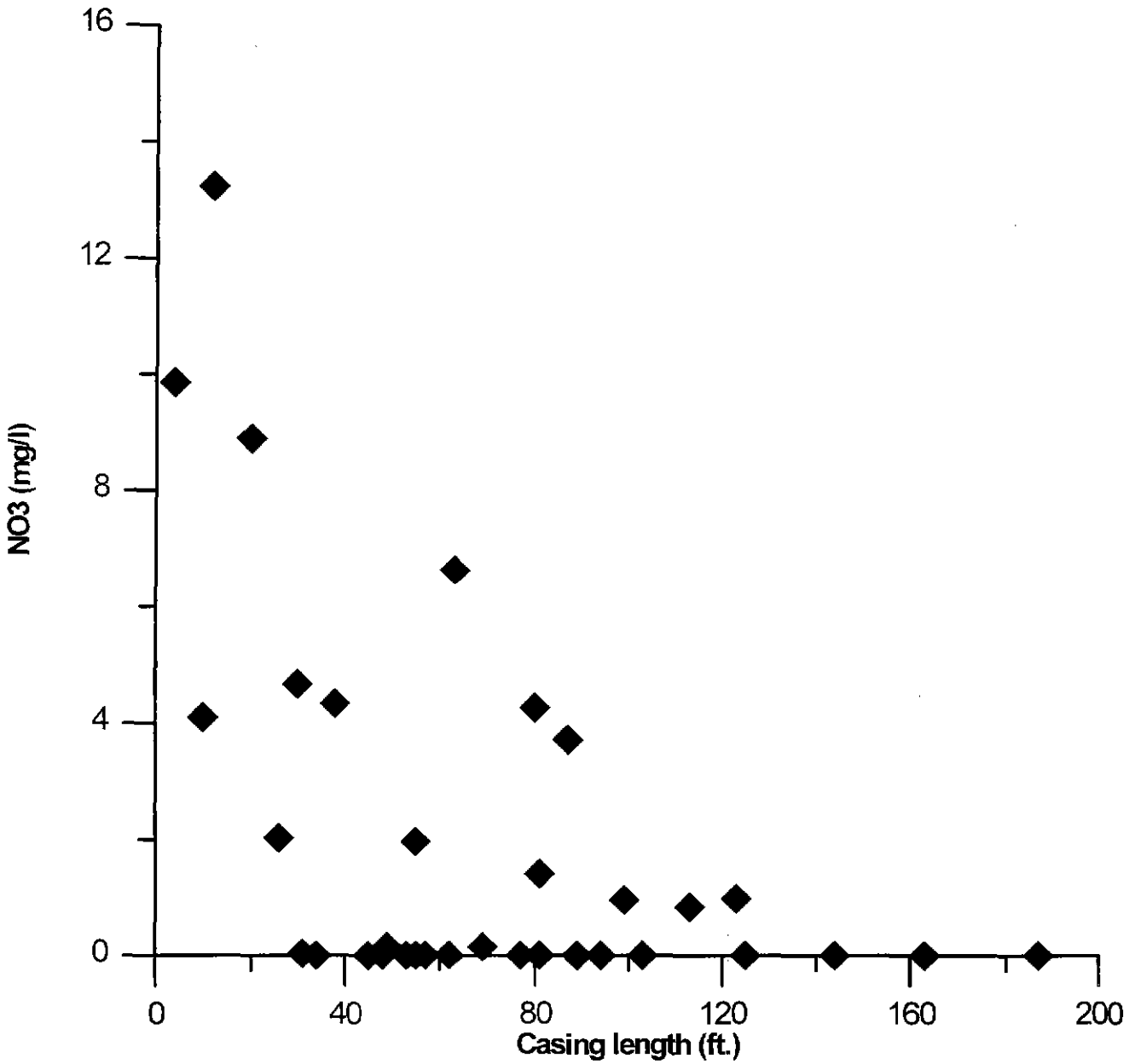


Figure 5.5 Casing length vs. NO3 for 3/95 ground water data

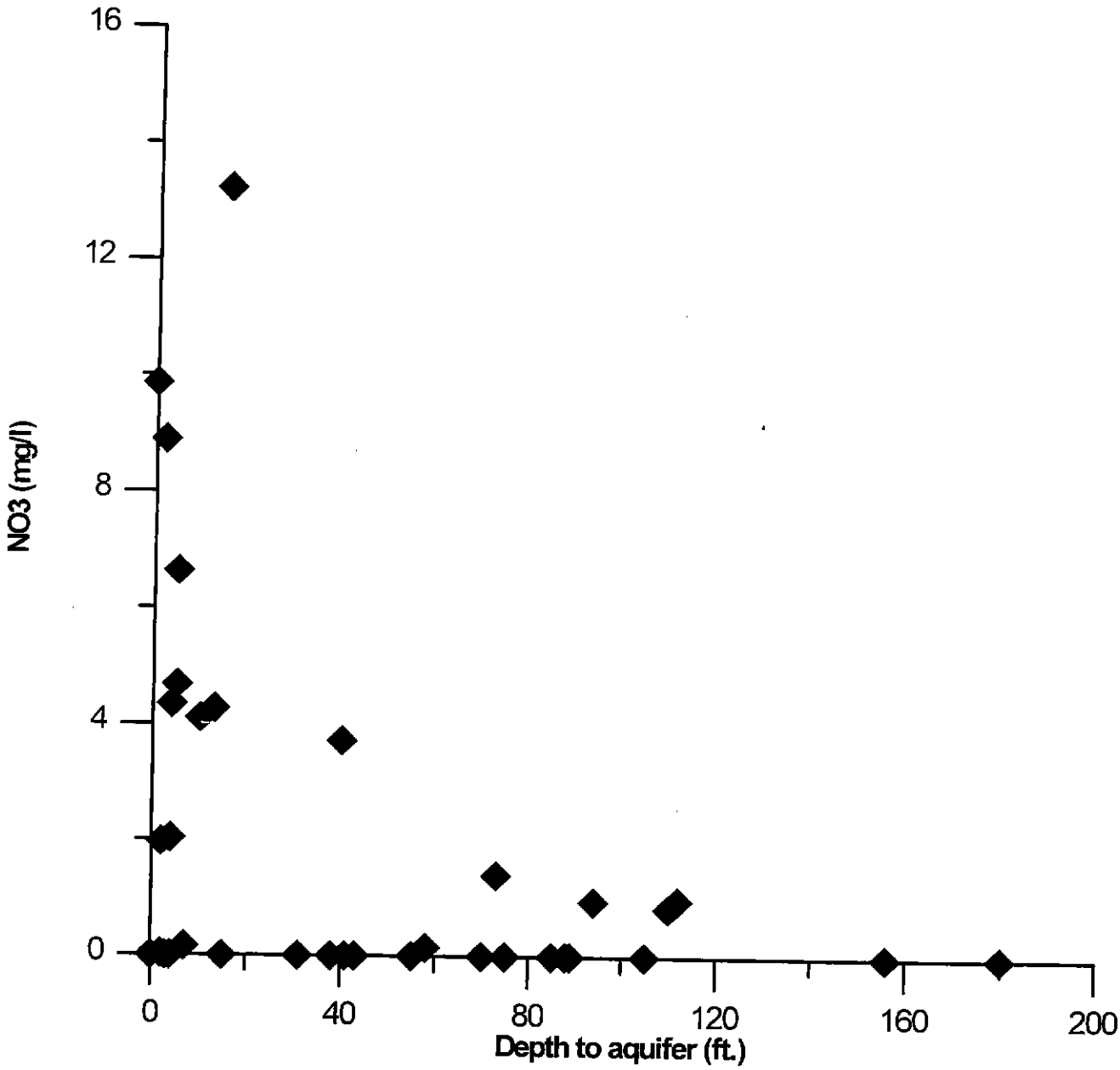


Figure 5.6 Depth to aquifer vs. nitrate for 3/95 ground water data

It was determined through construction of water table maps, precipitation data, and a limited survey of land use in the area that nitrate contamination was originating east of the NWF. The Springfield Moraine lies east of the NWF. This was determined to be the local recharge area for the aquifer in which the city's wells were completed. Abundant rainfall in combination with various agricultural practices could have led to the contamination of the NWF.

The Ohio EPA (OEPA) was notified of the nitrate contamination within the NWF. OEPA required quarterly testing of the water, as well as public notification of the contamination. The ODNR-WRS recommended that a private hydrogeologic consulting firm be brought in to further assess the problem and suggest any remedial measures.

5.54 Pesticide Contamination

Pesticides, a generalized classification which includes both pesticides and herbicides, are used to control animal pests and various weed problems that occur in agriculture. The sampling completed for this project focused on the presence of the herbicides atrazine, cyanazine, and simazine (collectively known as triazine), and alachlor, metolachlor or metalaxyl (collectively known as alachlor). The tests for these compounds were conducted at Heidelberg College Water Quality Lab in Tiffin, Ohio. Because of the nature of the screens, it was possible to determine the presence of these compounds, but not the concentrations. The screen used confirms the absence of pesticide in a water sample when the concentration is below the detection limit.

The U.S.EPA has set the safe drinking water standard for atrazine at 3.0 micrograms per liter (ug/L). Atrazine is considered a carcinogen and drinking water with concentrations below this level are considered safe for consumption over one's lifetime. Alachlor has a safe drinking water standard of 2.0 (ug/L). U.S.EPA considers alachlor to be a probable human carcinogen in concentrations above 2.0 ug/L. Theoretically, a person who consumed water at 2.0 ug/L over their complete lifetime would have no more that a five-in-a-million chance of developing cancer as a direct result of drinking water containing this pesticide (U.S.EPA, 1989).

Pesticide screens were run for the first year of the project. The screens were discontinued because of limited detection. The screens revealed the concentration (or lack thereof) of pesticide in the ground water. The lack of pesticide in the ground water indicates that the study area has a high content of organic soil matter. Organic soil matter provides sites for the pesticide to bind, thus retarding infiltration to the saturated zone.

Even though pesticides are nitrogen-based compounds like ammonia and nitrate, pesticides behave very differently in ground water. Pesticides tend not to be a major problem in ground water because of their tendency to adsorb to organic particles in the soil (Waldron, 1986). Because of runoff, surface water often has higher concentrations of pesticides than ground water (Appendix C).

Negligible amounts of herbicide were present in any sample of ground water. This can be explained by the fact that herbicides readily bind to soil organic matter. Therefore, as they are applied and washed into the soil, herbicides become immobile and do not infiltrate the ground water. Much of the herbicide does wash away as overland flow and, as a result, surface water samples often have higher herbicide levels than ground water samples. Data for triazine and alachlor screens support this phenomenon.

In a study completed by the U.S.EPA (Briskin, 1994), it was shown that of 102 pesticides and degradation products, less than 1% of all rural wells contained any pesticide contaminant. Conversely, nitrate was also analyzed and shown to be present in about 57% of rural wells. By observation, it is evident that nitrate has a far greater impact on ground water than pesticides.

5.6 Statistical Evaluation

5.61 Scatterplots

From the water quality samples collected a large accumulation of data were obtained. Statistical methods were needed to analyze the data on a large scale. Initially, simple comparisons were made between chemical and physical characteristics using elementary X-Y scatterplots. Using these scatterplots from individual sampling rounds, trends began to show up repeatedly.

The scatterplots confirmed that generally, in ground water nitrate and ammonia do not coexist (Figure 5.7). The process of nitrification converts ammonia, in the presence of oxygen, into nitrite and finally nitrate. Mineralization is the process that converts nitrogen in the soil to ammonia, while releasing carbon dioxide and water. Nitrate was plotted against other chemical constituents such as calcium, magnesium, sodium, etc. with no significant relationship present.

Scatterplots of other constituents were also plotted. Figures 5.8 and 5.9 reveal the relationship between calcium and hardness, and calcium and magnesium. Figure 5.8 shows that calcium levels are not the total controlling factor for hardness levels. The relationship between calcium and hardness is not a linear relationship because calcium and magnesium account for the hardness in a sample. A plot of chloride versus specific conductance shows a positive correlation (Figure 5.10). This relationship is logical because increasing ionic concentrations within a solution result in a higher electrical conductivity of the solution.

Other chemical relationships were explored looking for positive or inverse correlations. Chemical relationships that should exist, did. For example nitrate and ammonia are mutually exclusive. Many other chemical components were plotted and showed no relationships present.

5.62 Piper Trilinear and Stiff Diagrams

Trilinear diagrams are excellent for categorizing the quality of water through analysis of the major anions and cations. Plotting selected water samples from wells within the Mad River area, the fact that the water is rich in calcium and magnesium as well as in bicarbonates is illustrated in Figures 5.11, 5.12, and 5.13 (Appendix D_2). The example in Appendix D_2 shows that the same water type exists in both ground and surface waters in the study area. Calcium magnesium bicarbonate water type is found in nearly every sample collected. Waters with these characteristics are common in a carbonate bedrock terrain.

Stiff diagrams also graph the occurrence of major ionic constituents within the ground water. The shape of the polygon formed by the diagram will change as the composition of the water changes. As illustrated in Figure 5.14, the shapes of the polygons for each well did not radically change. The diagram clearly shows that the major cations and anions concentrations do not change appreciably from one geographic local to another.

5.63 Mean Values

Rigorous analysis of the data began with obtaining a single mean value for each constituent for each well. This eliminates the time variable and provides a constant water composition for a given well at any point in time. By utilizing this method, other more complex analyses such as probability plots can be conducted. The method employed for obtaining each mean was a simple arithmetic mean, (x)/n, where x is the concentration (mg/L) and n is the total number of values.

5.64 Normalization of Data

Once the means for each well were obtained, the data were analyzed. A determination of whether or not the data were normally distributed followed. Normal distribution of any set of data reveals a bell-shaped curve when graphically plotted. To employ many types of statistical tests, normalized data must be used. It was determined that for many constituents, the data were not normally distributed (Appendix D_3).

Nitrate levels required normalization because plots of the data showed a large number of samples near 0 mg/L, a smaller number of values near the calculated mean value of 2.54 mg/L, and a few extremely high values (Figure 5.15 and 5.16) (Appendix D_4).

5.65 Watershed Sub-Division

The Ohio EPA Nonpoint Source Assessment has documented historical water quality problems in the Mad River Watershed. Kings Creek sub-watershed was identified in the EPA assessment as having both ground water and surface water contamination. It was observed early in the study that the Kings Creek area was relatively higher in nitrate as compared to the rest of the project area. To see if this observation was statistically valid rather than a qualitative observation, the watershed had to be divided into sub-watersheds that could be compared quantitatively.

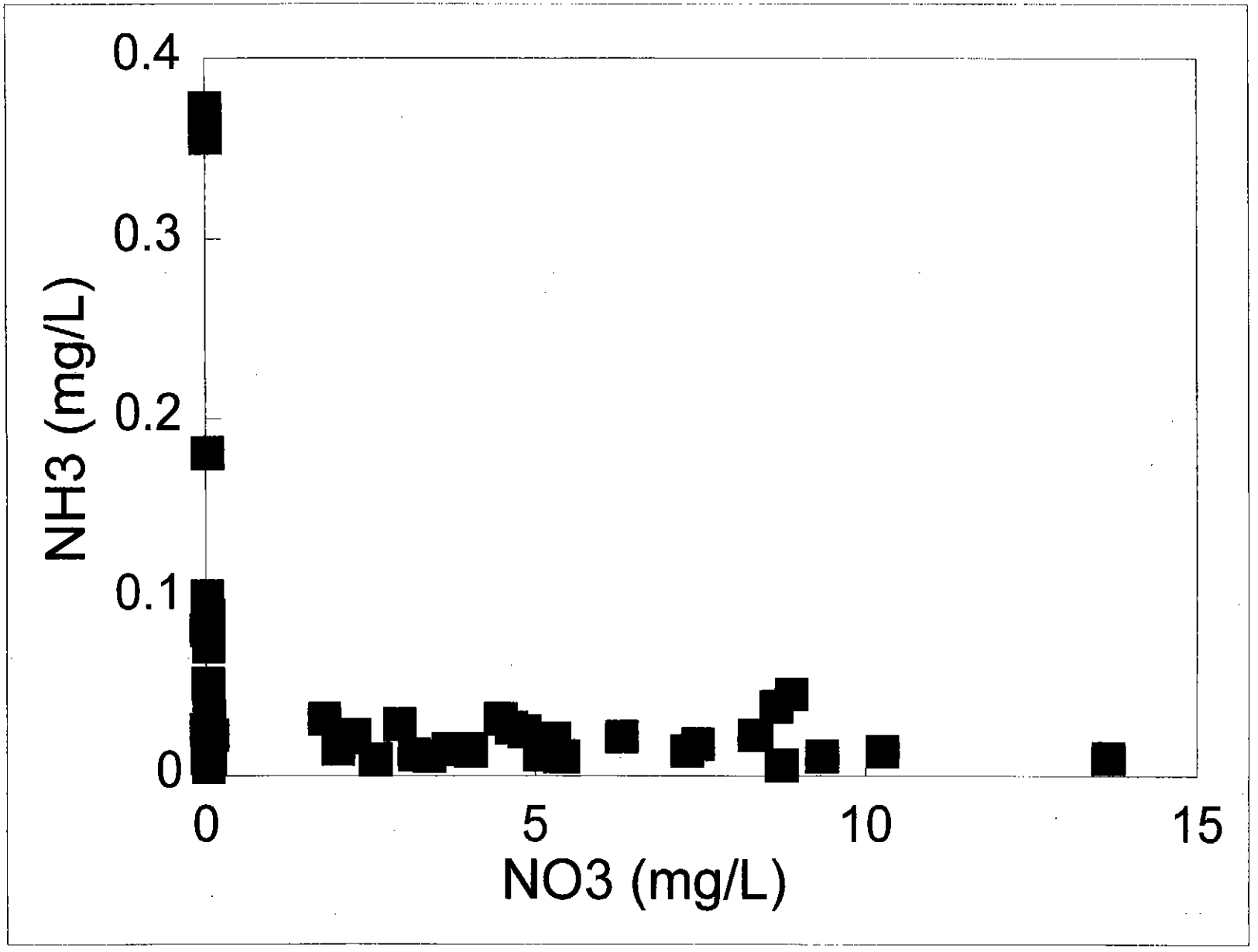


Figure 5.7 NO3 vs. NH3 for 6/95 ground water data

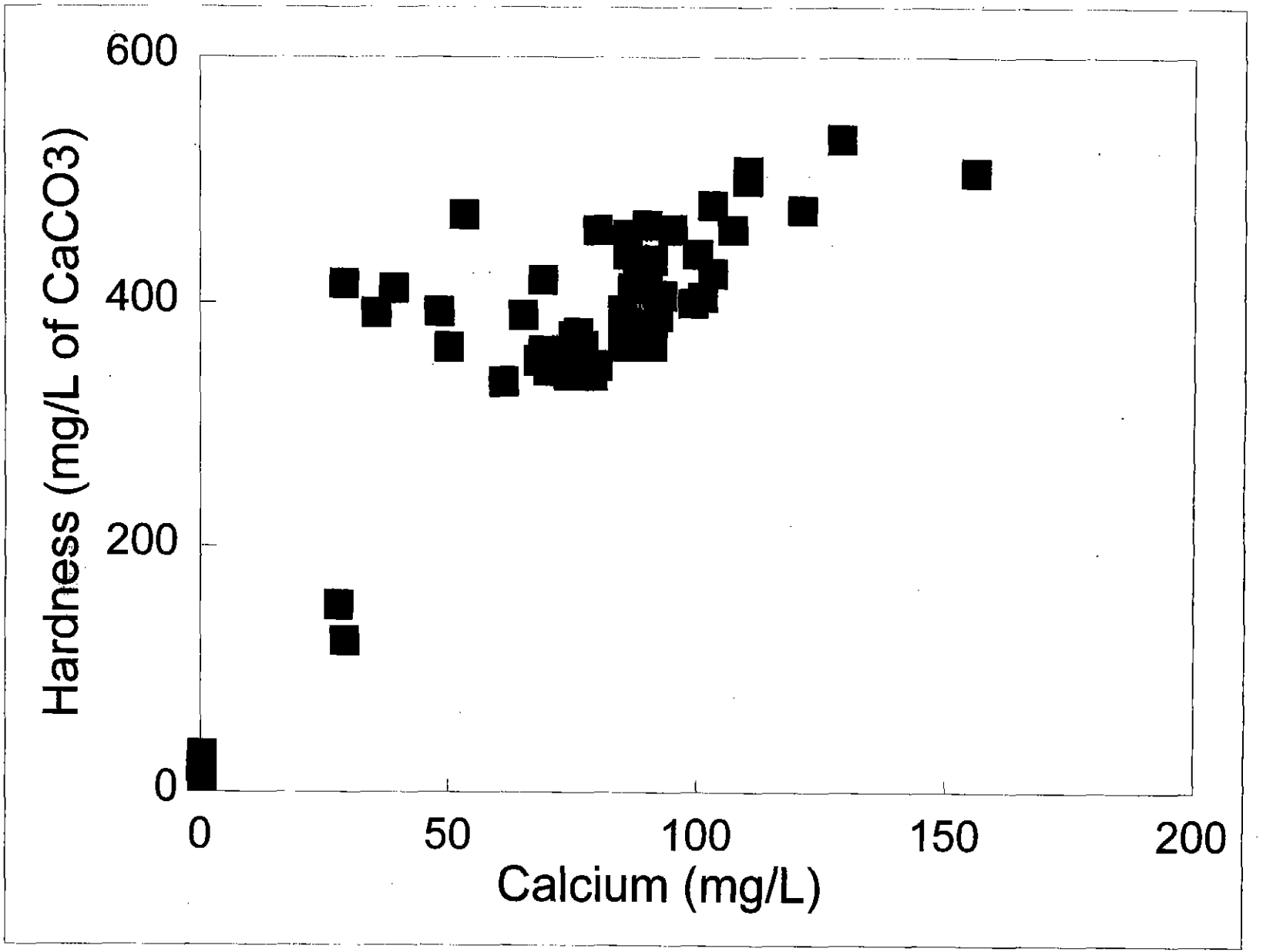


Figure 5.8 Calcium vs. hardness (mean values of all data)

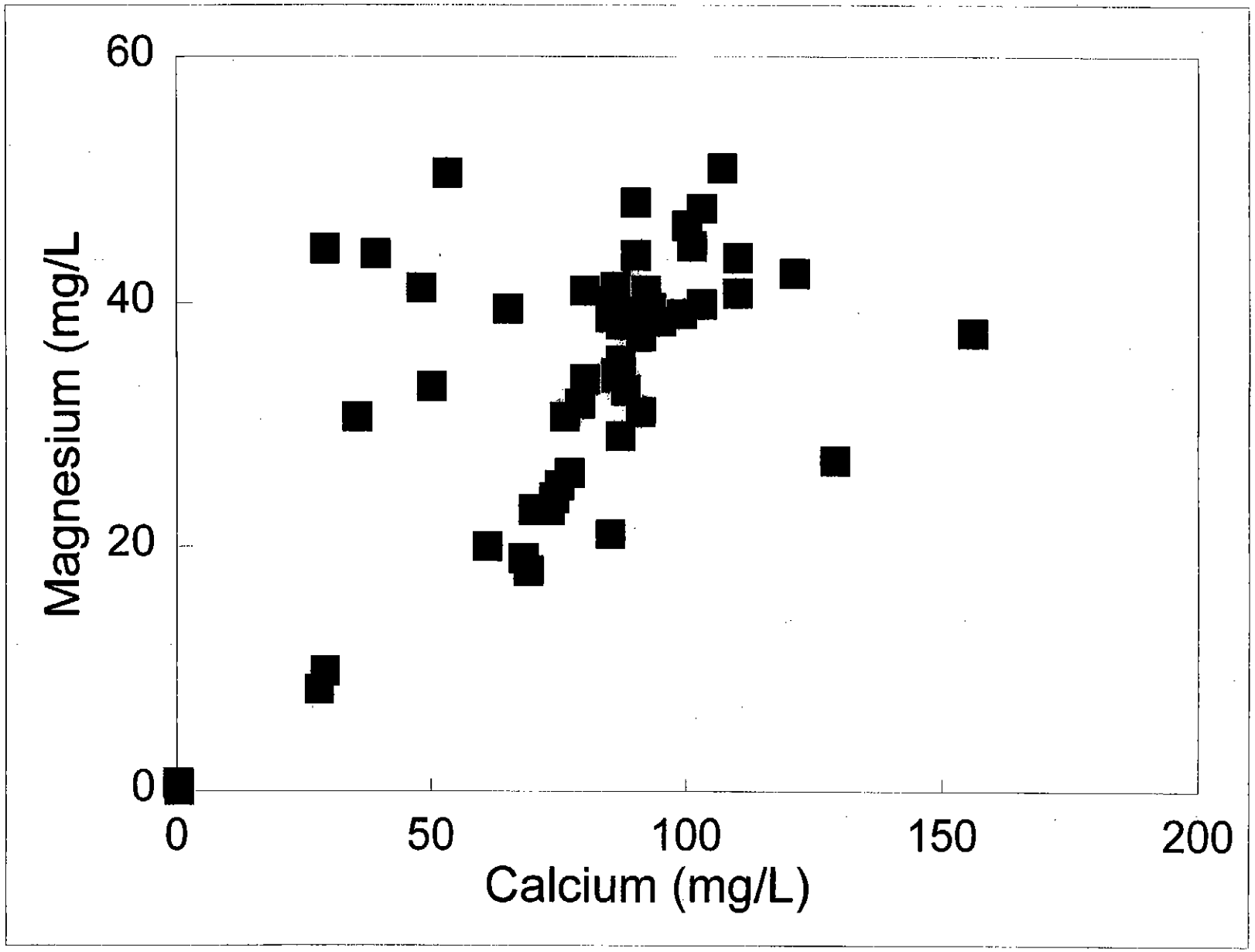


Figure 5.9 Calcium vs. magnesium (mean values for all data)

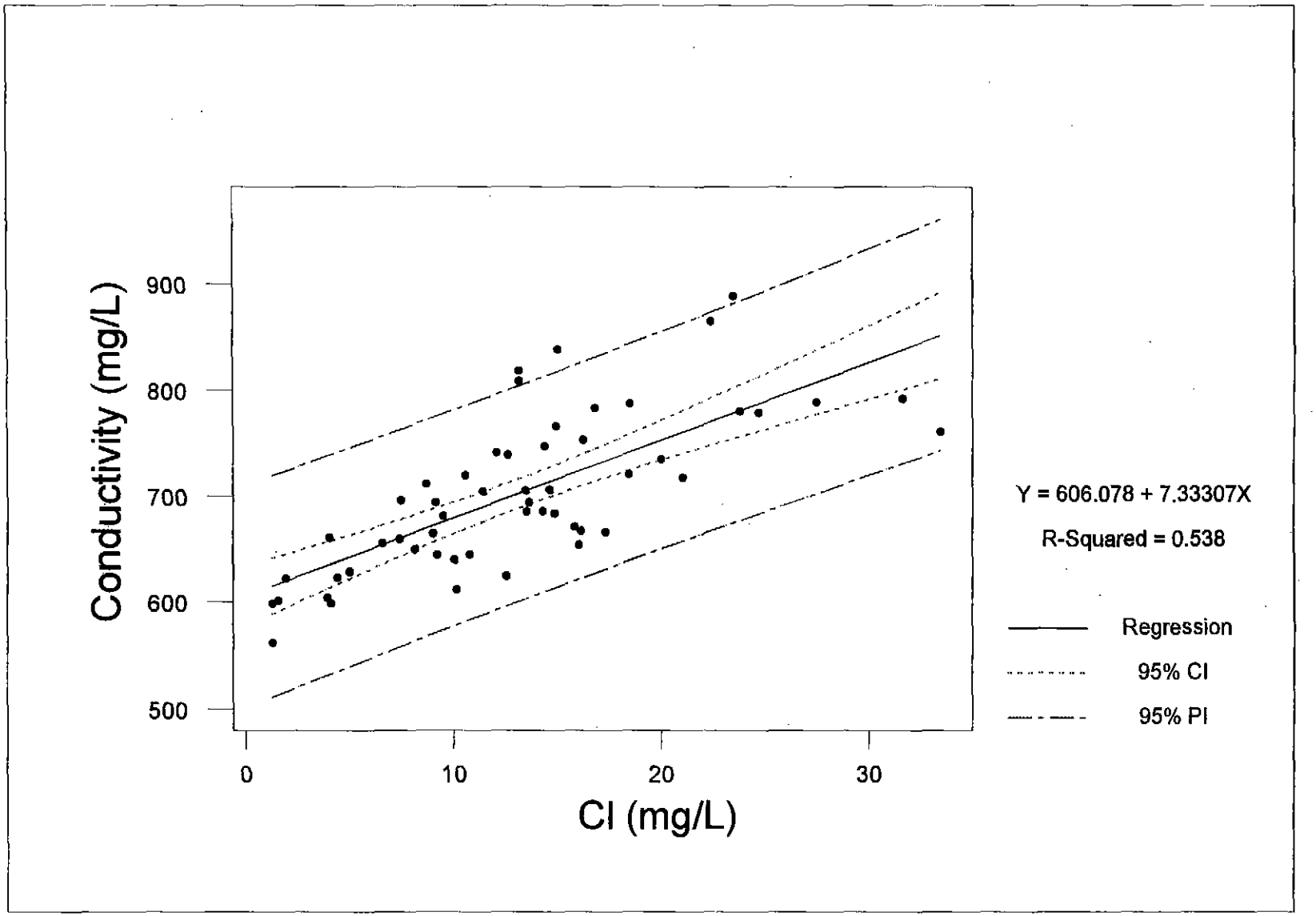


Figure 5.10 Regression plot for chloride vs. conductivity

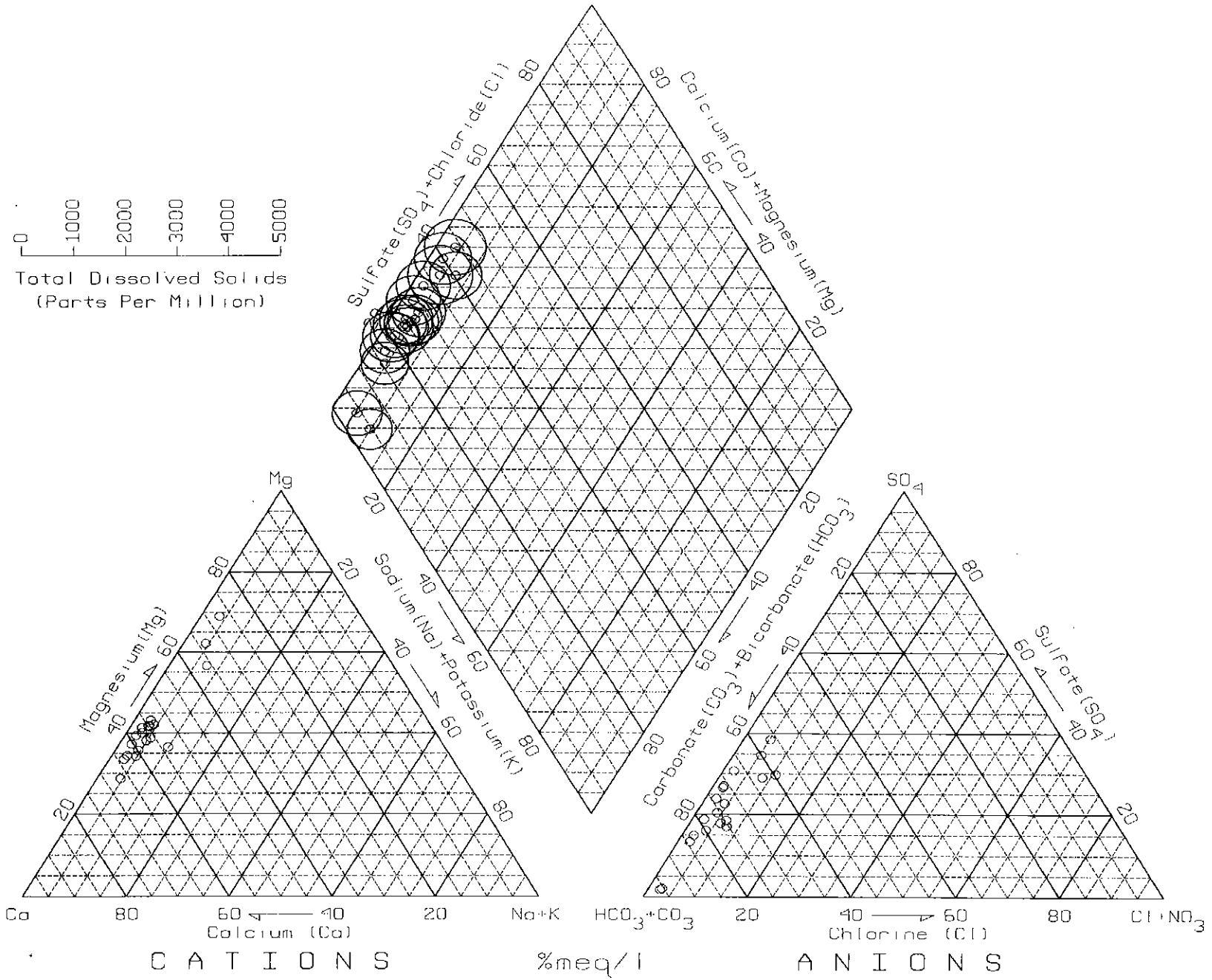


Figure 5.11 Piper diagram for North subwatershed

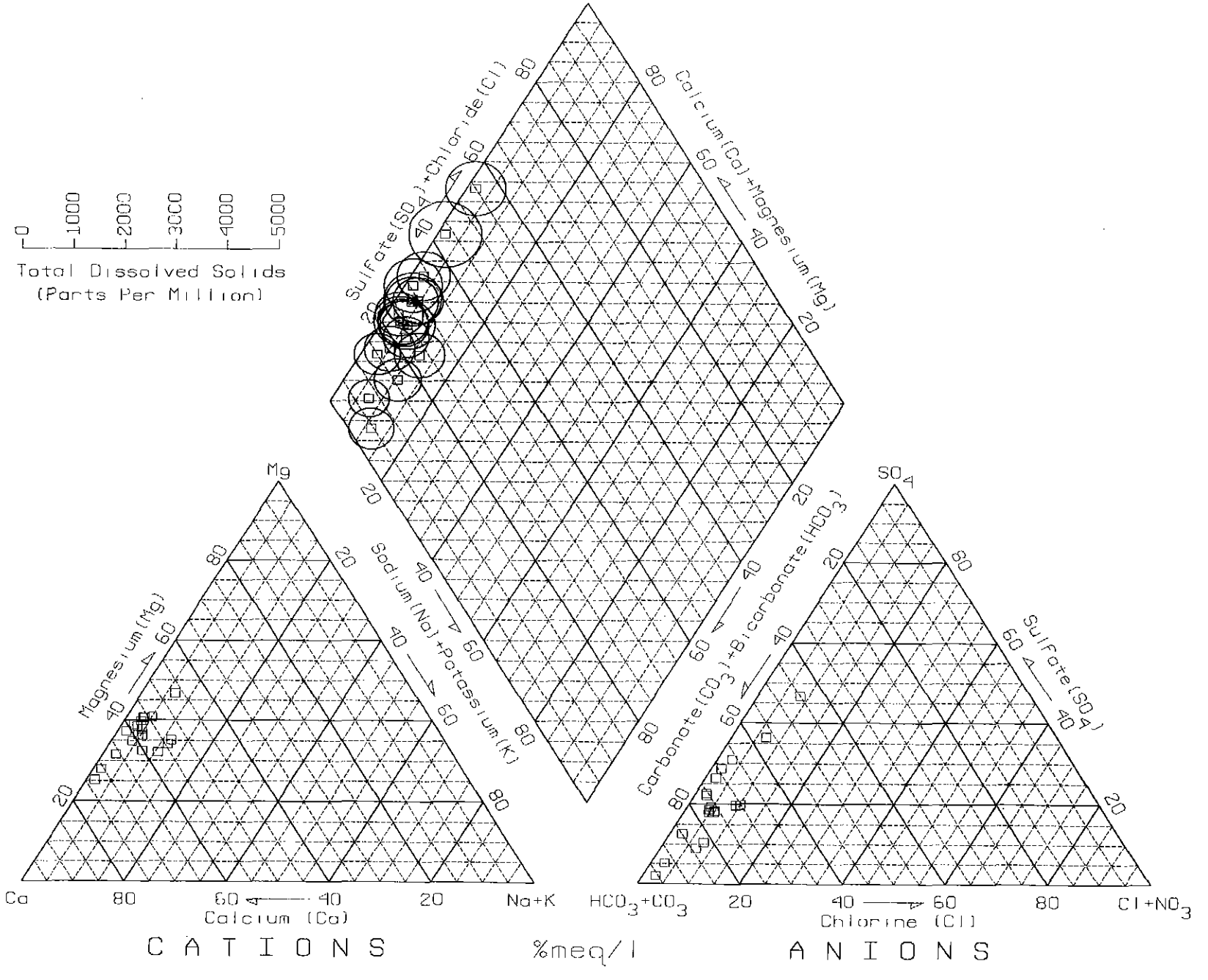


Figure 5.12 Piper diagram for South subwatershed

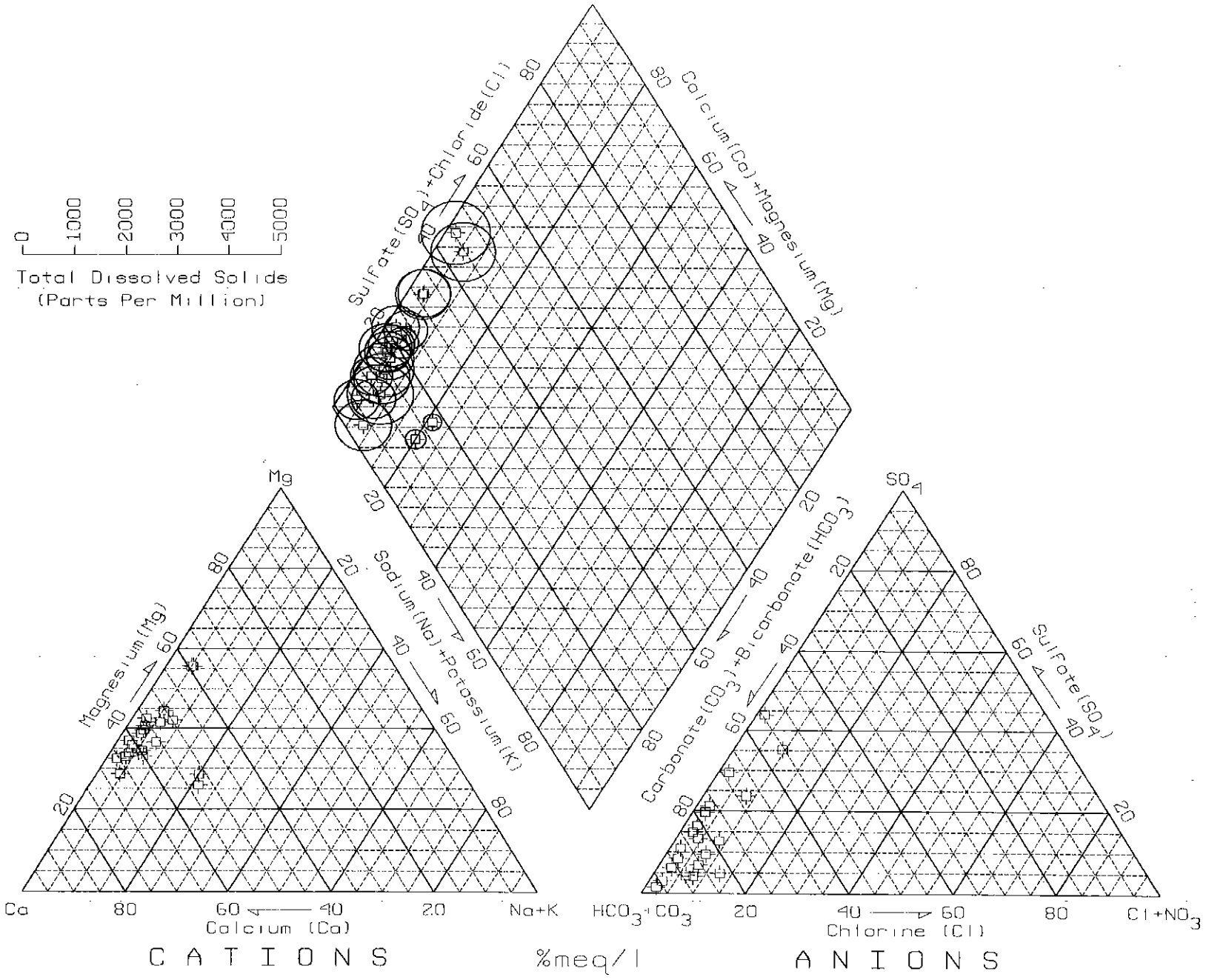


Figure 5.13 Piper diagram for Kings Creek subwatershed

The Mad River watershed was separated into three smaller sub-watersheds, one being the Kings Creek sub-watershed, another being the North Mad River sub-watershed, and last being the South Mad River sub-watershed. Kings Creek is by far the largest tributary to the Mad River in the study area. Wells in each sub-watershed are listed in table 5.1.

5.66 Probability Plots

Probability plots are graphs that are used to determine how well a set of data fits a certain distribution. The distribution type could be normal, log normal, or gamma. The analysis of normality can be attempted visually by comparing histograms, but human perception seems to respond better to the straight line of a probability plot (Hensel and Hirsch, 1995).

Probability plots can be constructed using 2 or 3 parameters. A probability plot can be used to determine the percent chance of exceeding a certain value, such as in streamflow data. For example, flows on a river are commonly plotted on a probability plot where a flow value can be found plotted against the percentage of time that flow value will be exceeded over the length of the study. For ground water quality during the study, these graphs reveal the probability percentage of wells having a certain value of a given constituent (nitrate) concentration. The higher the concentration of a constituent, the lower the number of wells that have that concentration (Figures 5.17, 5.18, and 5.19).

Probability plots clearly show the difference in nitrate concentrations within the 3 sub-watersheds. The probability plots provide a mechanism for defining a mean value and the probability of a certain concentration of nitrate within a limited geographic boundary.

CHAPTER 6-BASE FLOW STUDIES

6.1 Introduction

Determining the ground water contribution to surface water during low-flow conditions is an important portion of the project. The amount of ground water contribution to the Mad River and the location from which that ground water comes helps identify areas where certain land use activities may contaminate both ground water and surface water. USGS was subcontracted to perform this portion of the study and subsequently published "Determination of base-flow characteristics at selected streamflow-gaging stations on the Mad River, Ohio" by G. F. Koltun (1995). Information used in this study was compiled from streamflow gaging station records on the Mad River at Zanesfield, near Urbana; at St. Paris Pike, near Springfield; and near Dayton. Criteria for selection included at least 10 years of record for the gaging station, no low flow regulation (such as controlled release from a dam spillway), and inclusion of both wet and dry periods. The following is a synopsis of the U.S.G.S study.

6.2 Procedure

The program HYSEP (Sloto, 1988) was selected for the process of hydrograph separation. This program was used to estimate the daily mean base-flow at the above-mentioned stations. HYSEP uses algorithms originally developed by Pettyjohn and Henning (1979) in the publication Preliminary estimate of ground-water recharge rates, related streamflow and water quality in Ohio.

The most conservative method of estimating daily-mean base-flow was selected. The local-minimum method of hydrograph separation takes the lowest discharge value for a given time period. The center of that position is then advanced 1 day and a new local minimum value is calculated. The process is repeated until the analysis period is complete.

The time interval used in the HYSEP program is determined empirically by the equation I=2A0.2, where I is the time interval used in days, and A is the drainage in square miles. HYSEP computes annual mean base-flow, median annual base-flow, and the median percentage of total streamflow attributed to base-flow.

6.3 Gaging Station Record

The streamflow data from the gaging stations at Zanesfield and St. Paris Pike had substantially shorter records than the other three selected stations'. The variability in reporting records could skew the results if the reporting period was either wetter or dryer than normal in these two stations. Calibra-

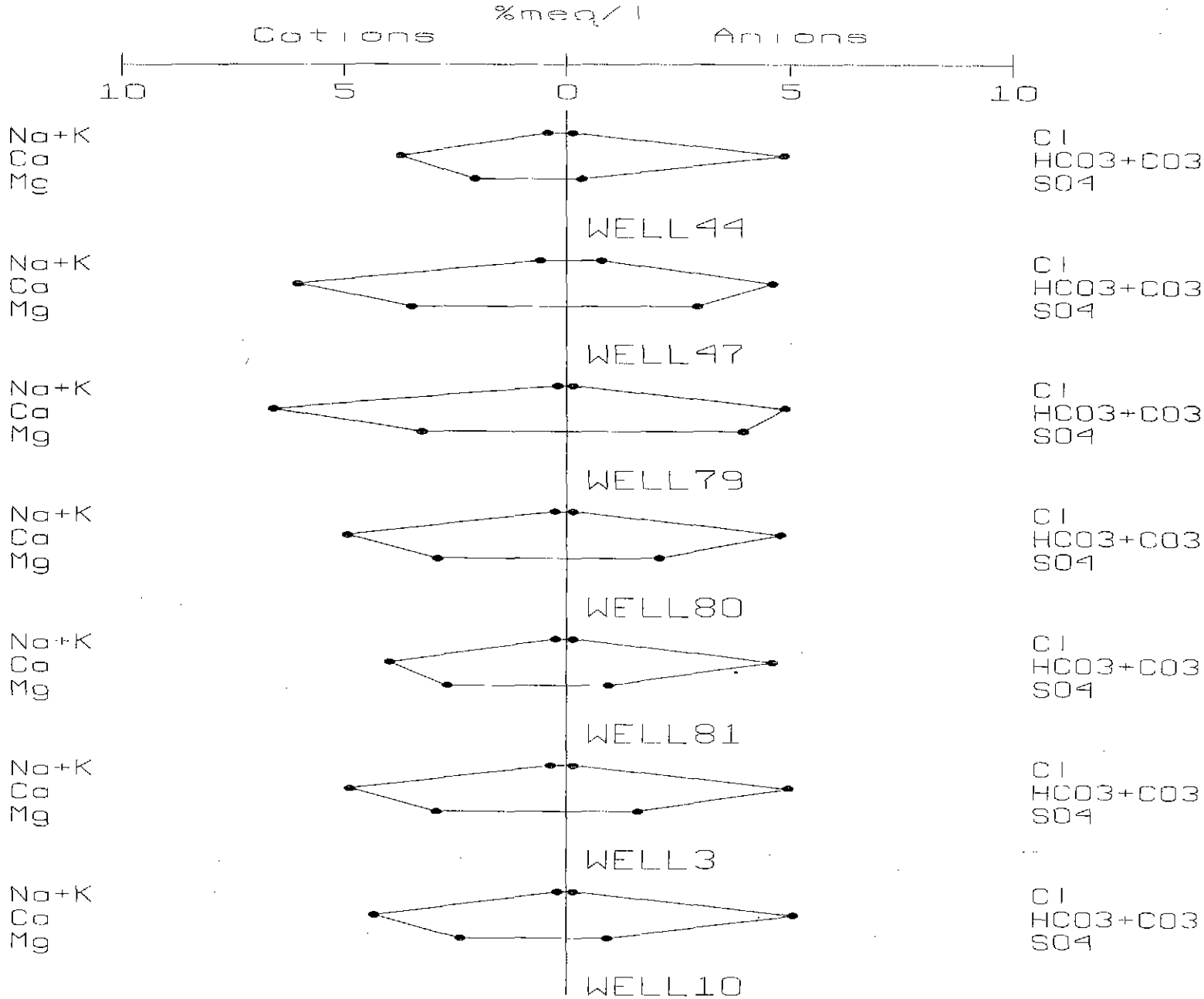
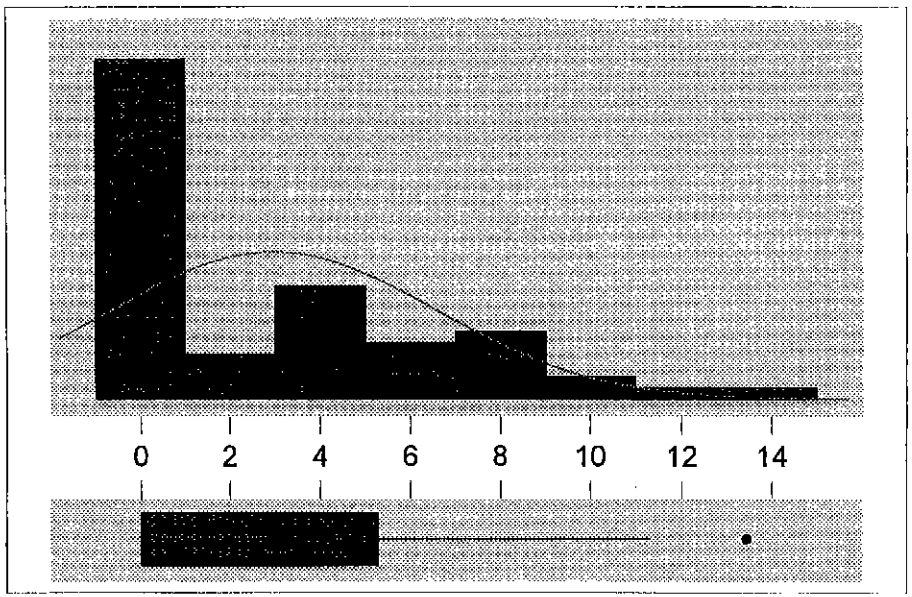
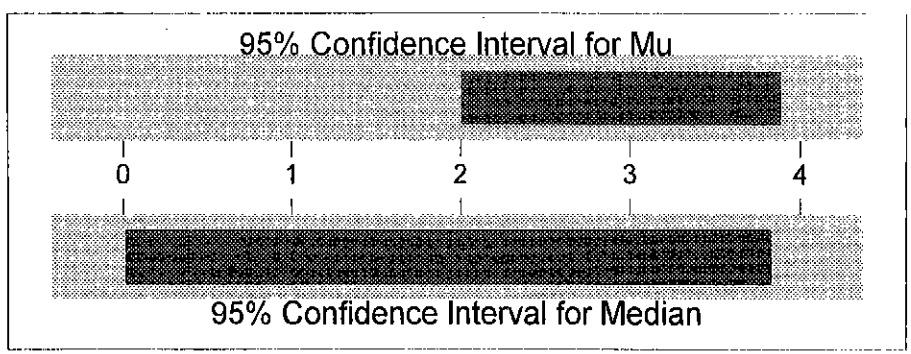


Figure 5.14 Stiff diagram for various wells





Raw Nitrate Data

Anderson-Darling Normality Test

A-Squared:	4.5142
p-value:	0.0000
Mean	2.9465
Std Dev	3.6095
Variance	13.0283
Skewness	0.9607
Kurtosis	-0.1378
n of data	59.0000
Minimum	0.0000
1st Quartile	0.0114
Median	0.3914
3rd Quartile	5.2800
Maximum	13.4450

95% Confidence Interval for Mu

2.0059	3.8872

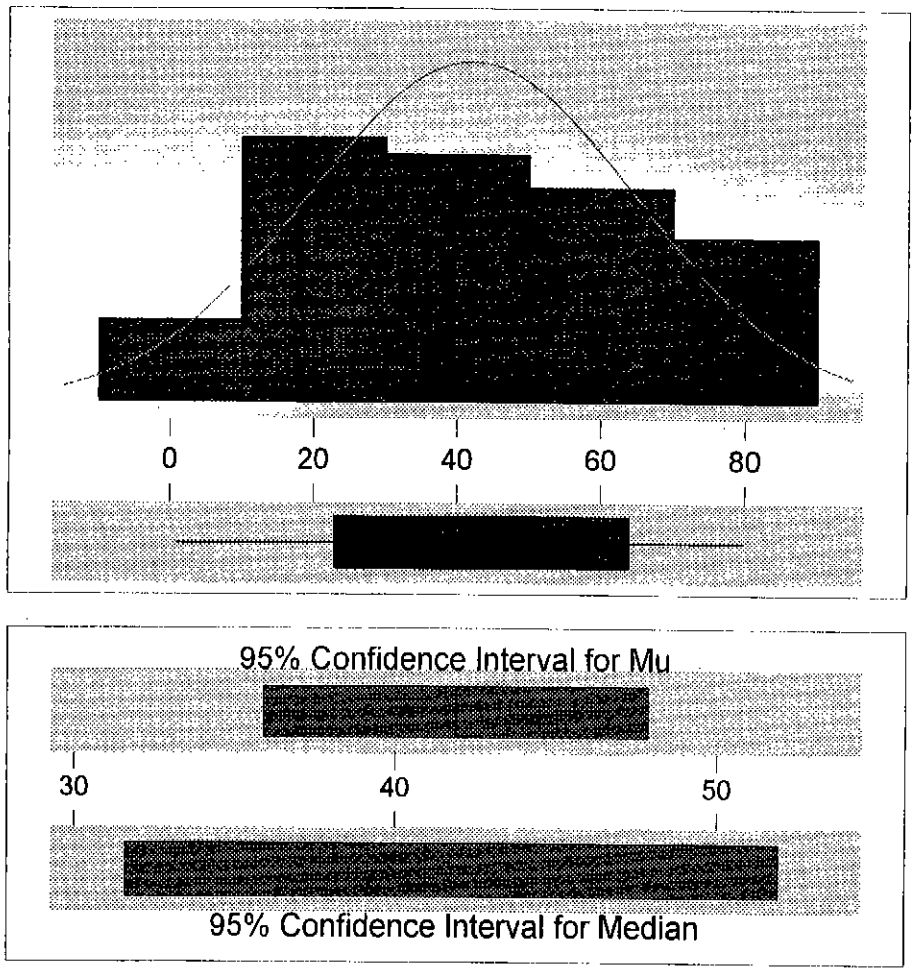
95% Confidence Interval for Sigma

3.0556	4.4106

95% Confidence Interval for Median

0.0191	3.8295

Figure 5.15 Statistical analysis of raw nitrate data



Normalized Nitrate Data

Anderson-Darling Normality Test

A-Squared:	0.610
p-value:	0.108
Mean	41.885
Std Dev	22.955
Variance	526.949
Skewness	0.030
Kurtosis	-1.215
n of data	59.000
Minimum	1.000
1st Quartile	23.000
Median	41.000
3rd Quartile	64.000
Maximum	80.000

95% Confidence Interval for Mu

35.903	47.867

95% Confidence Interval for Sigma

19.433	28.050

95% Confidence Interval for Median

31.616	51.922

Figure 5.16 Statistical analysis of normalized nitrate data

Table 5.1 Residential wells in each subbasin

Wells in Each Sub-basin*		
Kingscreek basin	**Southern basin**	**Northern basin**
8	34A	1
20	51	3
21	53	6
22	54	9
23	55	10
37	56	11
38	57	12
39	58	13
40	61	18
41	64	19
42	64A	24
43	65	25
44	66	26
45	67	27
46	70	28
77	71	29
78	72	30
79	74	33
80	75	34

* refer to figure 2.2 for spatial location of wells

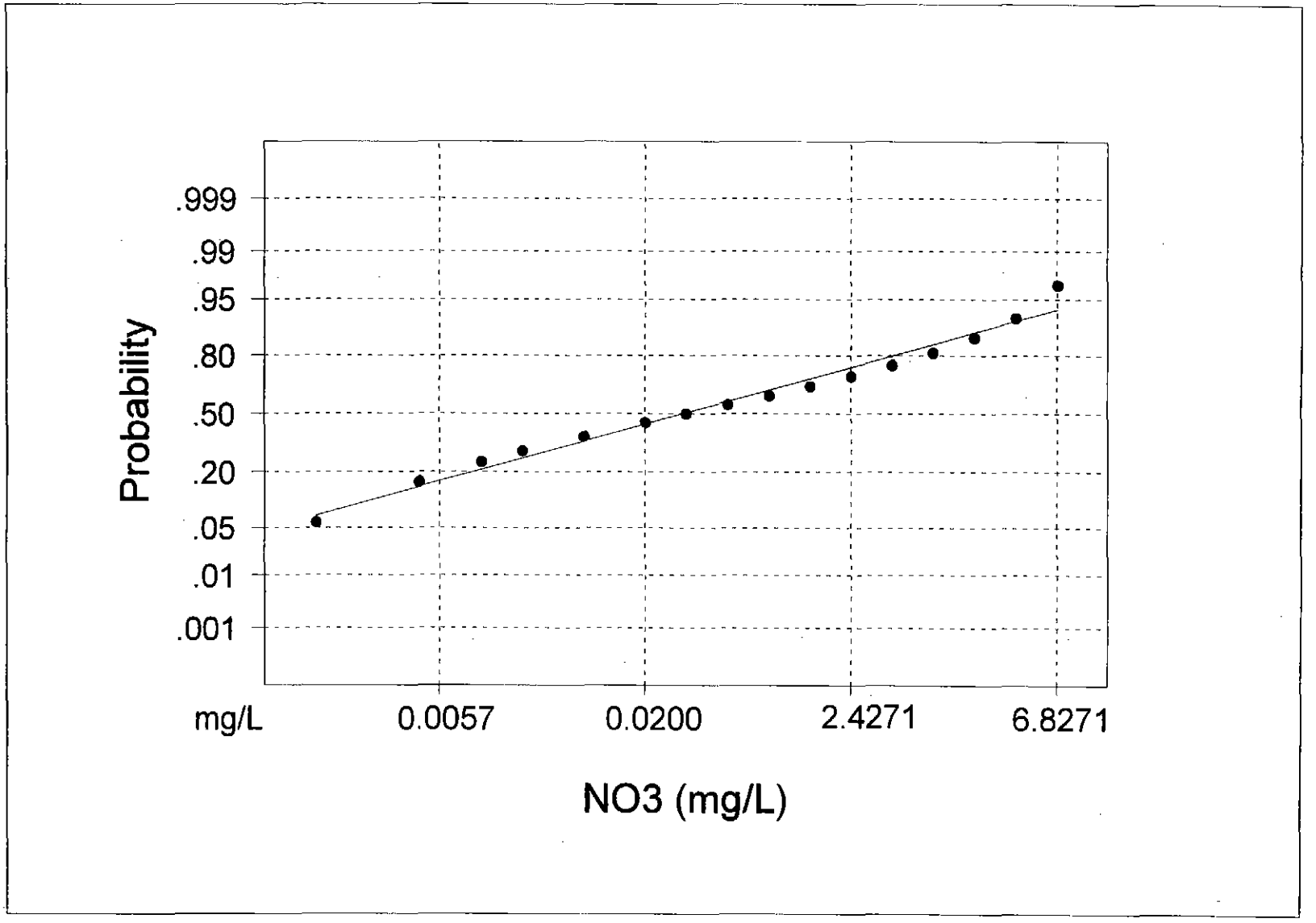


Figure 5.17 Probability of ground water having a minimum concentration of nitrate, North subwatershed (mean values of all data)

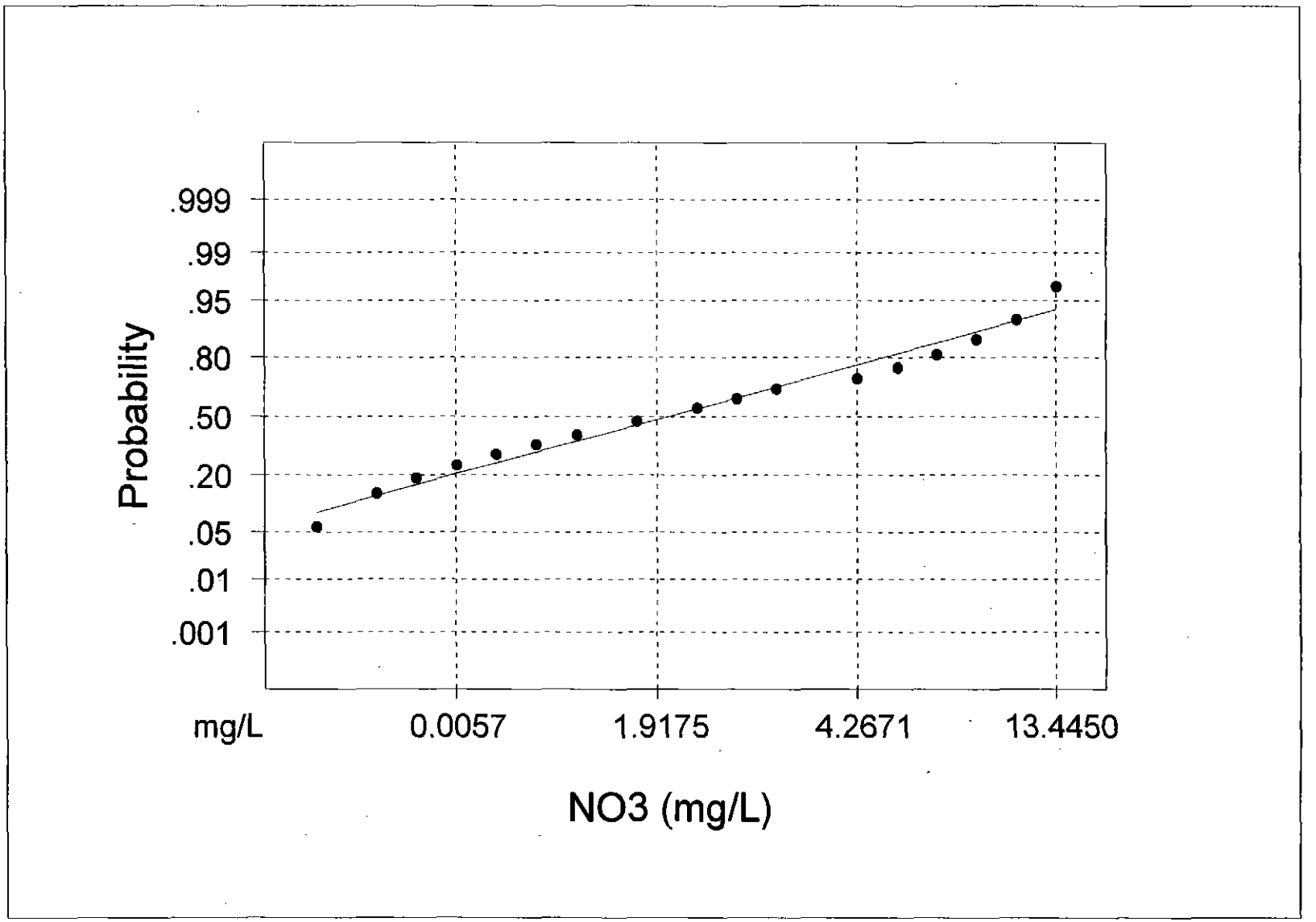


Figure 5.18 Probability of ground water having a minimum concentration of nitrate, Southern sub-watershed (mean values of all data)

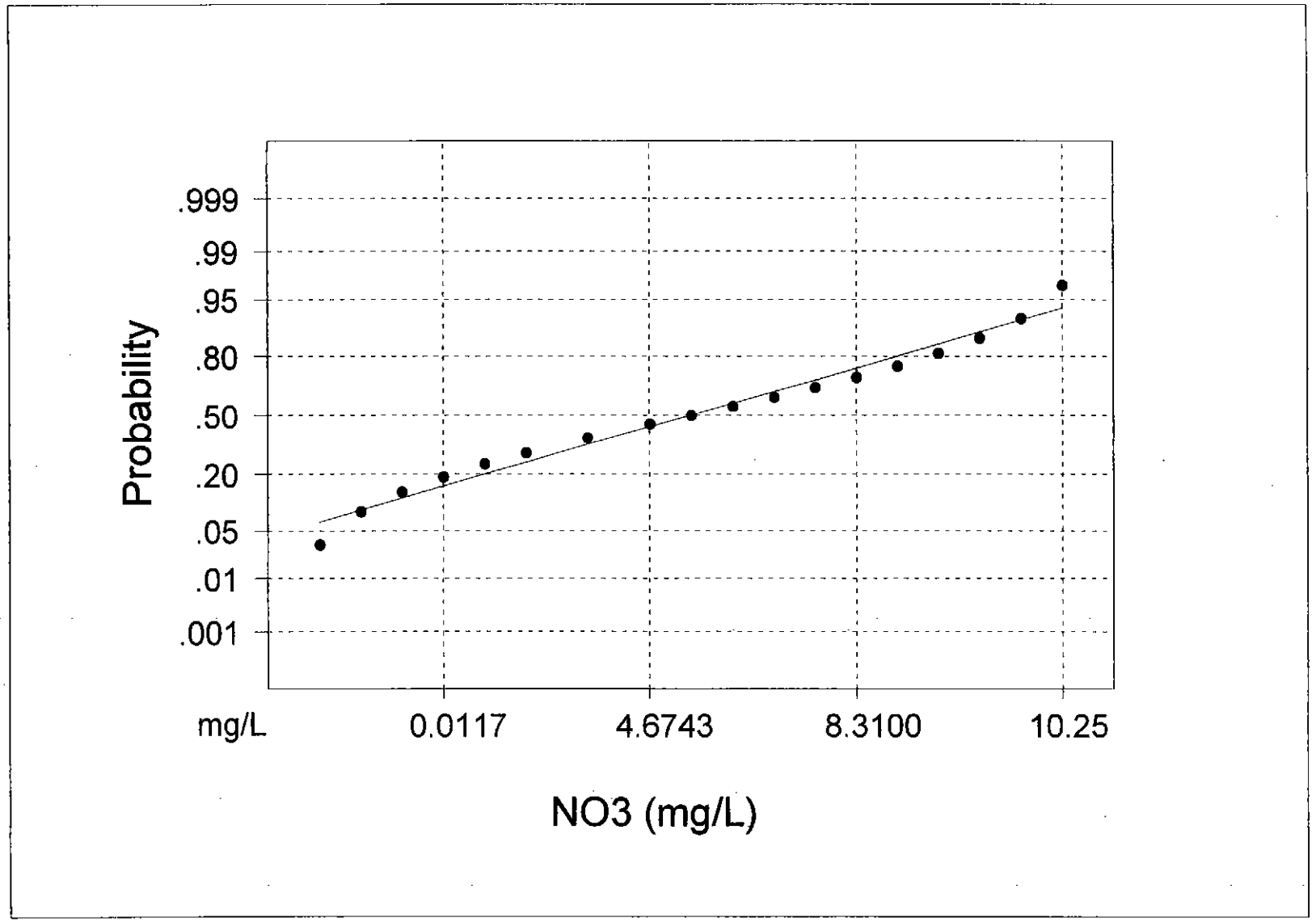


Figure 5.19 Probability of ground water having a minimum concentration of nitrate, Kings Creek subwatershed (mean values of all data)

tion of these stations with the Springfield station (the gaging station with the longest record) showed that while the Zanesfield data were normal for the reporting period of 1947-1979, the St. Paris Pike station was somewhat wetter than normal.

Flow duration curves were constructed and the St. Paris Pike station was calibrated to the index-station at Springfield to account for its wetter than normal results. The plots (Figures 6.1, 6.2, 6.3, 6.4, and 6.5) show that the base-flow and streamflow do not converge. This is caused by the presence of some surface runoff present in even these very low flows.

6.4 Analysis and Results

Eberts (personal communication, 1995) states that in general, the upper limb of the base-flow duration curve is composed of predominantly local ground water flow systems, whereas the lower limb is predominantly discharged from deep and intermediate flows. The break in slope on a base-flow duration curve between the lower limb and the upper limb is the sustained ground water discharge threshold (Figure 6.6). These values range from 91 to 98 percent.

Any values that exceeded the sustained ground-water discharge threshold were removed. The remaining values are considered to be composed of predominantly ground water discharge. The median values range from 0.11 (ft3/s) /mi2 at Zanesfield to 0.26 $(ft^3/s)/mi^2$ at St. Paris Pike. Expressed as a percentage of the median annual-mean base-flow, the median sustained ground water discharge ranged from 17.2 percent at Zanesfield to 38.6 percent near Springfield.

Even during very low flows, some surface runoff is present. A calculated value showed that 73 to 86 percent of the same-day streamflow values contained at least 10 percent sustained surface water discharge.

Some form of regulation affects 3 of the 5 gaging sites. Flows at St. Paris Pike may be affected by pumping at the Springfield city well field and C.J. Brown Reservoir, and the Dayton site may be affected by pumping at the Rohrers Island well field. A double-mass analysis was done to determine if the regulation affected base-flow. All effects were found to be either negligible or constant over the study period.

6.5 Final Summary

The median of the annual mean base-flows for the five stations ranged from 0.64 to 0.74 $(ft^3/s)/mi^2$. The median percentage of annual total streamflow attributed to base-flow ranged from 61.8 to 76.1 percent. The sustained ground water discharge values for the 5 gaging stations ranged from 0.9 to 175 ft3/s. This base-flow contribution is exceptionally high. The Mad River has the highest sustained dry-weather flow in Ohio (Cross and Feulner, 1964).

CHAPTER 7 RAINFALL-RUNOFF SIMULATION MODEL

7.1 Introduction

Rainfall-runoff simulation models are used by watershed hydrologists to gain understanding of the process whereby precipitation is dispersed to evapotranspiration, soil moisture storage, ground water recharge, and surface and subsurface movement to stream flow. Modeling difficulties arise from the large number of variables affecting the rainfall-runoff process, their varying levels of significance between watersheds, and inaccuracies of parameter estimates. Good simulation results, however, can often be obtained by calibrating a model to a specific watershed, that is, adjusting model parameters to obtain good fit of simulated hydrographs of flow to observed hydrographs of flow.

Geologic parameters affecting runoff can vary widely between and within watersheds. Differences in basin geology affect the runoff process via the interaction of surface and ground waters. Geology plays a very important role in this respect in the upper Mad River basin. Rainfall-runoff model calibration for the upper Mad River basin requires parameter adjustment to account for unusual amounts of runoff in the form of subsurface interflow and ground water discharge to streams.

The purpose of the modeling undertaken in this study is to develop a rainfall-runoff simulation model for the upper Mad River basin that is useful for understanding the surface-ground water relationships and evaluating the effects of existing or potential agricultural management practices on

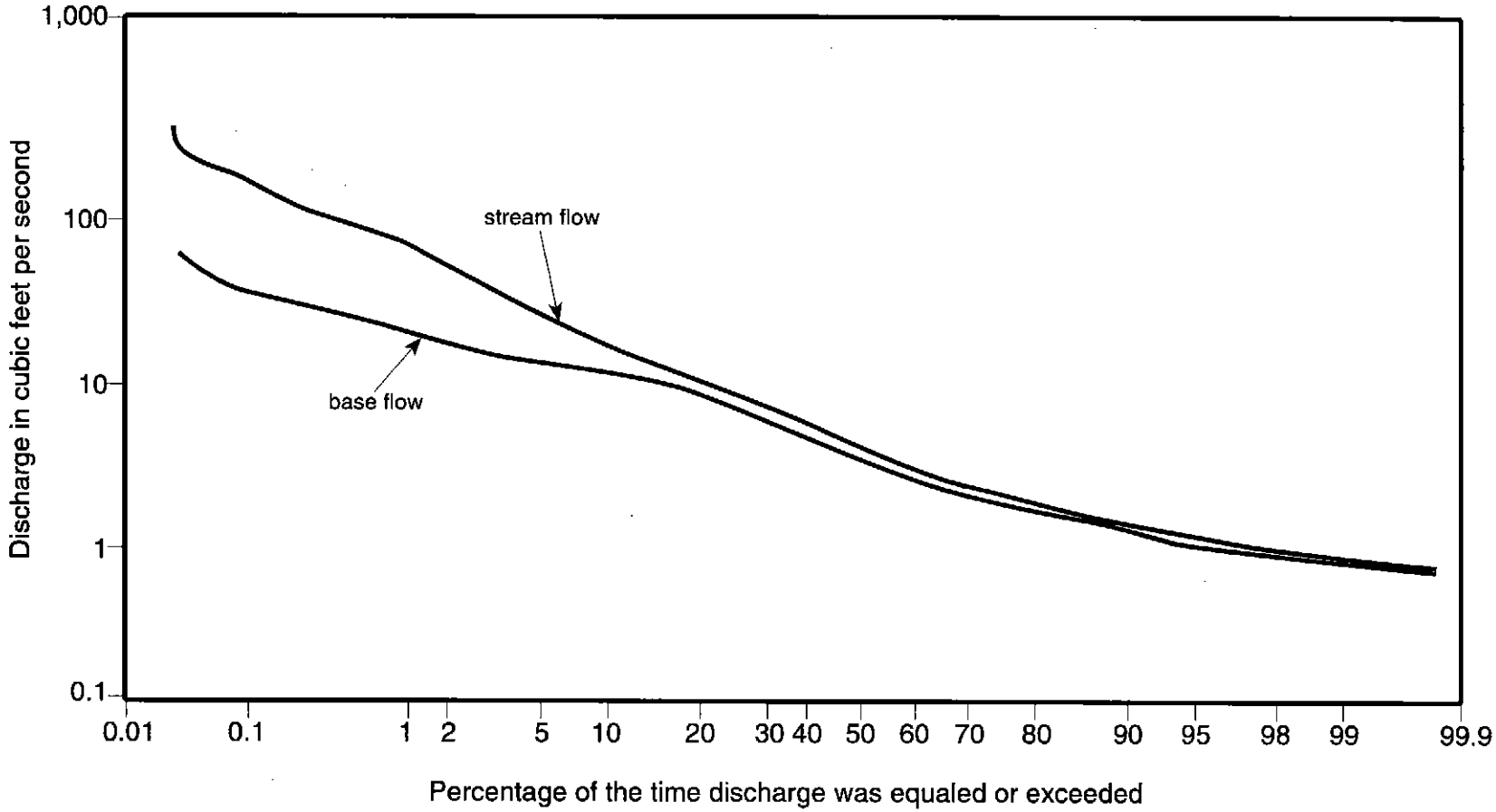


Figure 6.1 Streamflow and base flow duration curves for the Mad River near Zanesfield, Ohio

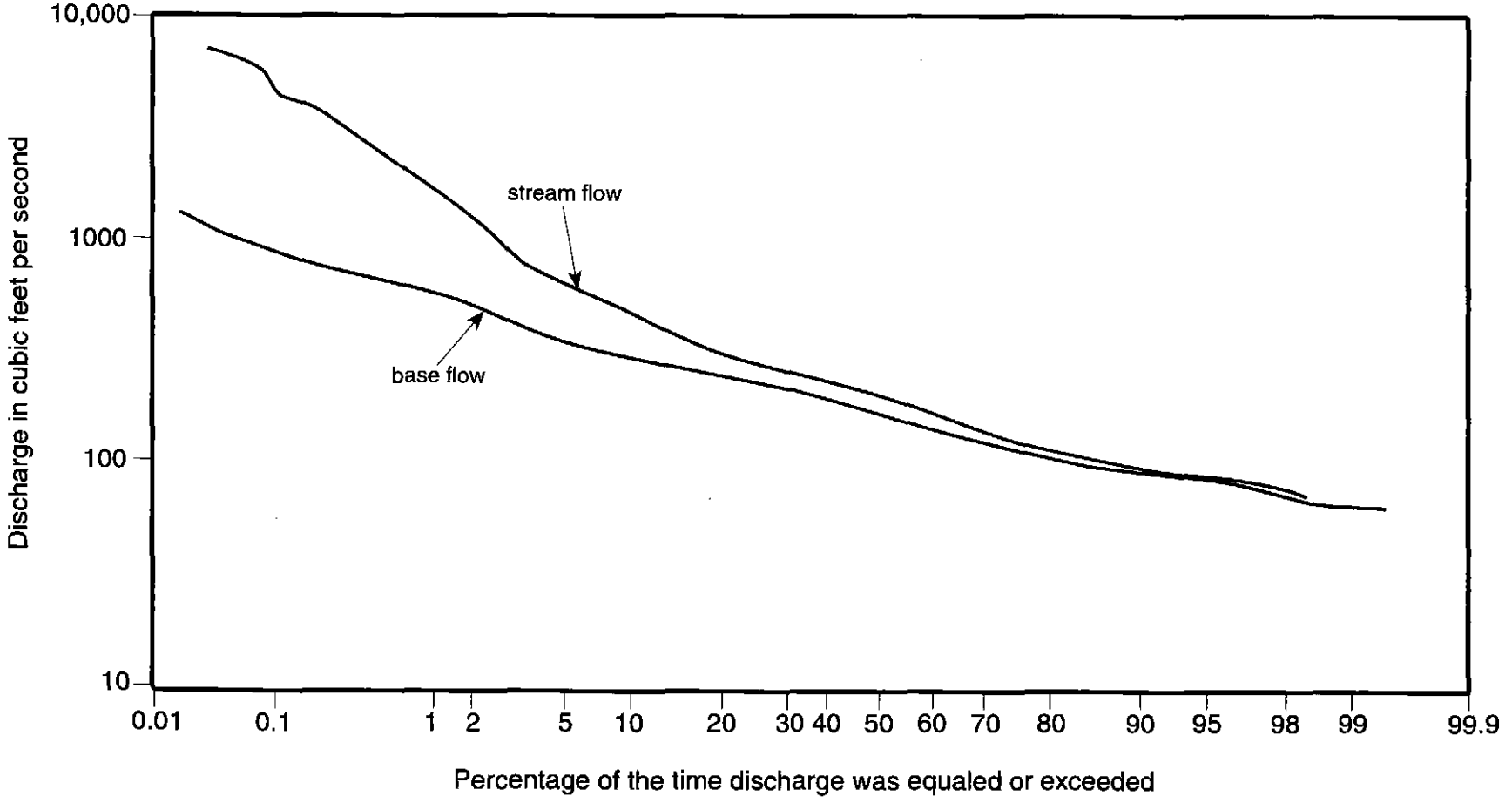


Figure 6.2 Streamflow and base flow curves for the Mad River near Urbana, Ohio

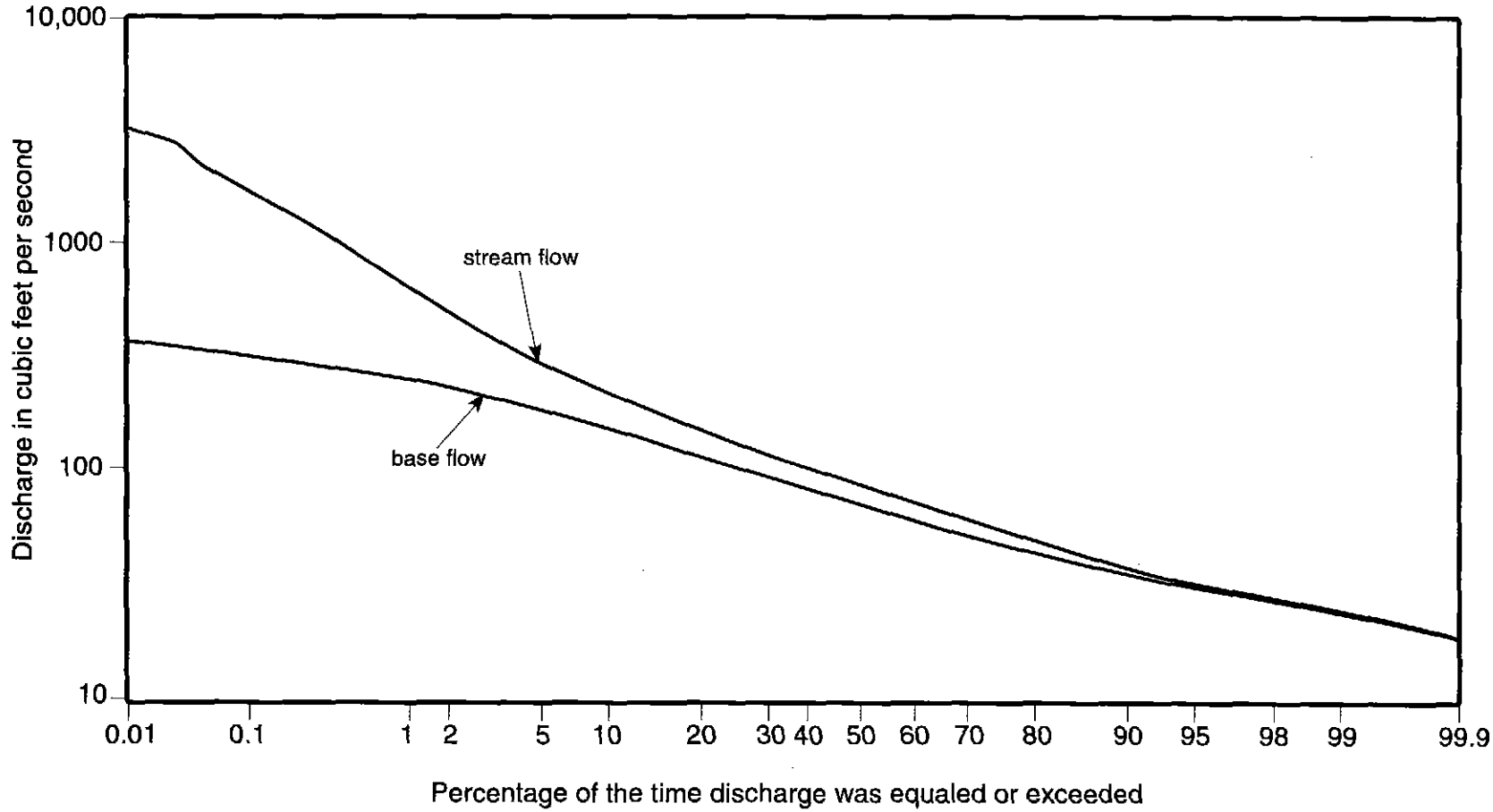


Figure 6.3 Streamflow and base flow duration curves for the Mad River near St. Paris Pike (at Eagle City), Ohio

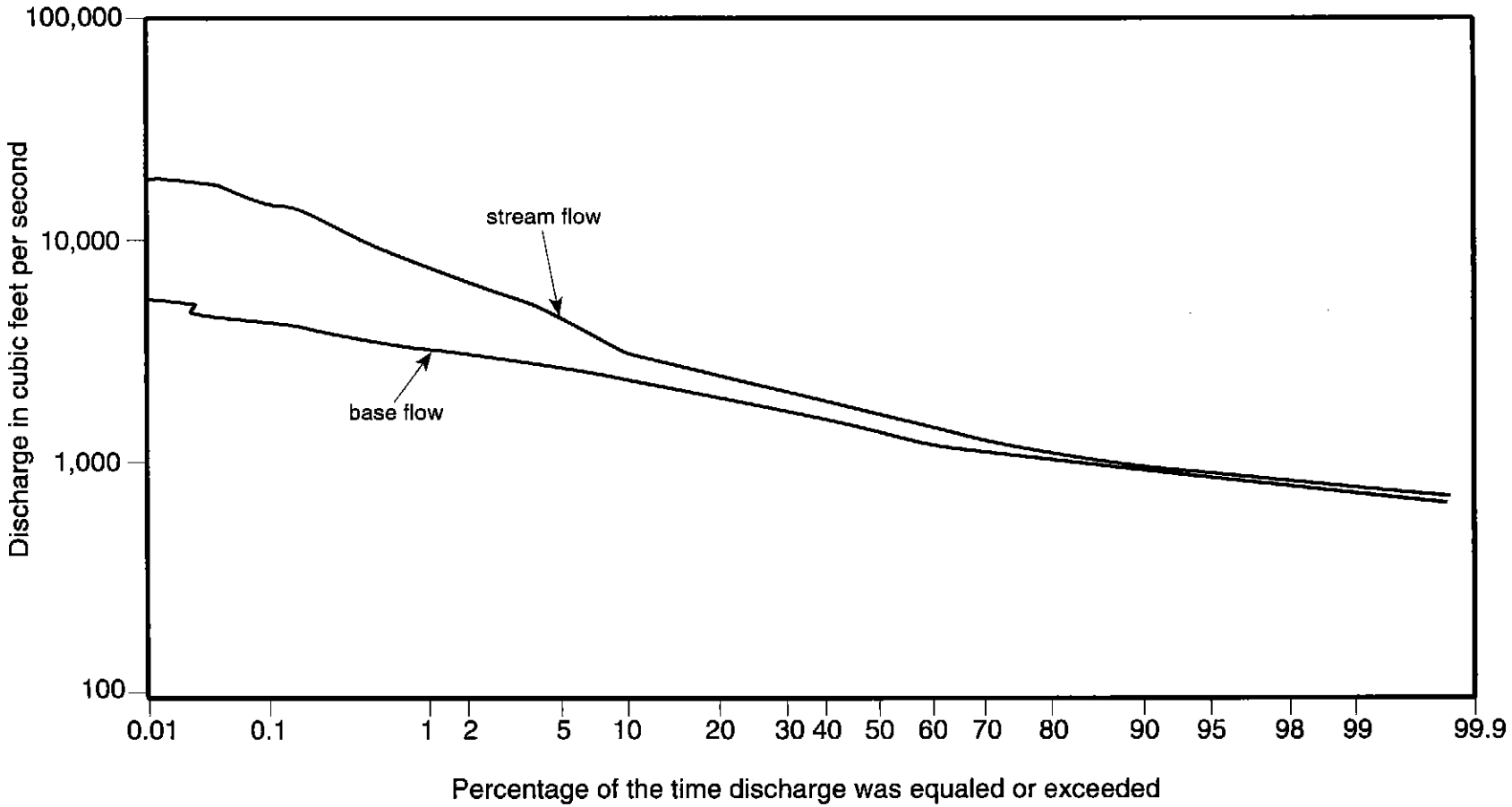


Figure 6.4 Streamflow and base flow duration curves for the Mad River near Springfield, Ohio

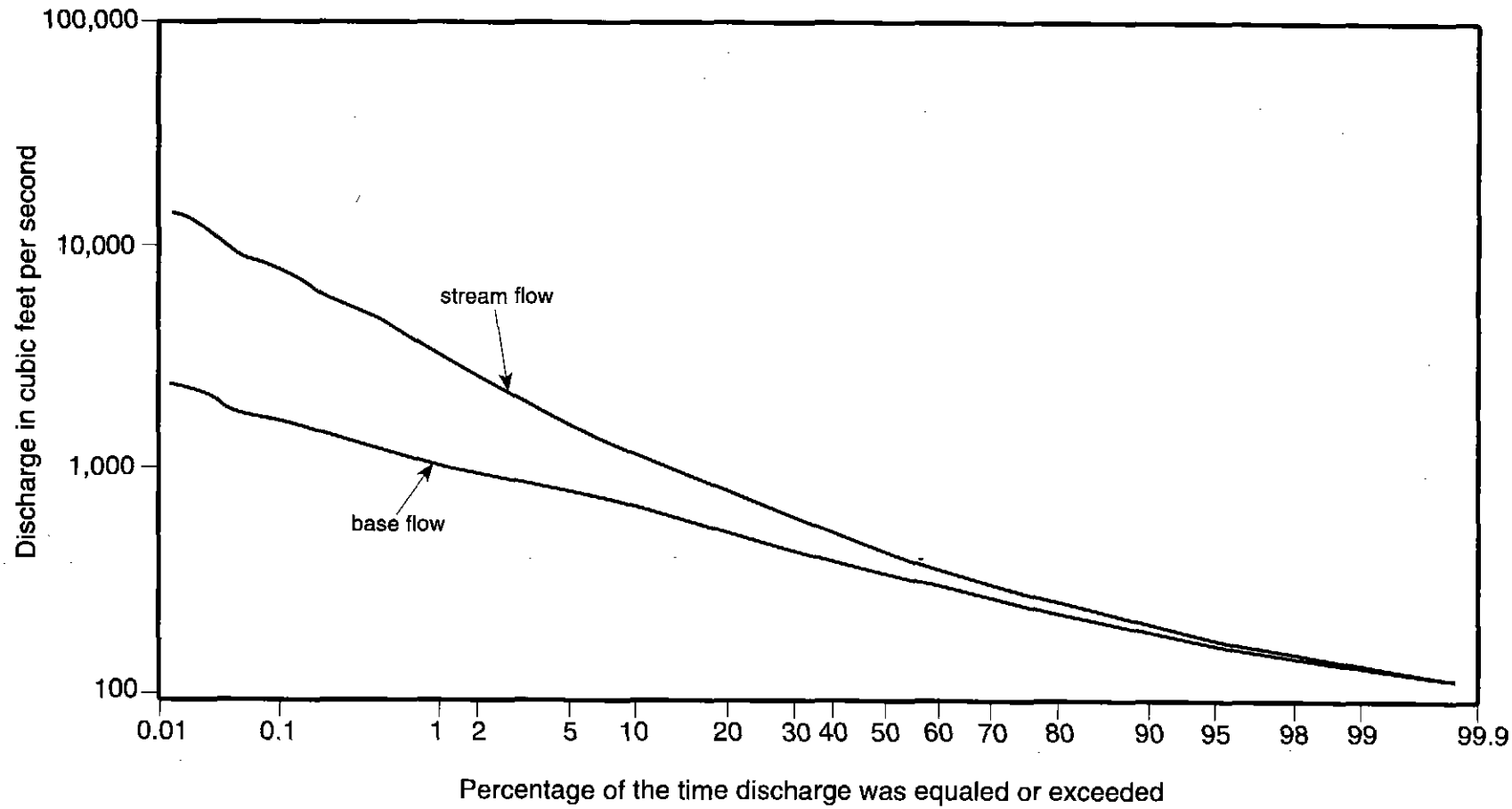


Figure 6.5 Streamflow and base flow duration curves for the Mad River near Dayton, Ohio

water resources. The objective is to effectively simulate hydrographs of flow resulting from rainfall events by calibrating a model with data from observations of historical rainfall-runoff events.

Because the upper Mad River basin is so heavily used for agriculture, propriety in the dispersion of applied fertilizers, herbicides and pesticides on farms is essential for protection of water quality. Good understanding of the surface-ground water relationships in the basin and particularly the ground water recharge process, is critical for determining best management practices to protect and utilize watershed resources.

Hydrometeorological data have been collected in the upper Mad River basin by: operation of weather observation stations, operation of continuous daily discharge stations, low-flow partial record measurements and systematic ground water level observations. Detailed soil surveys and mapping have also been completed. These data provide the basis for calibration of the rainfall-runoff simulation model developed as part of this study.

The rainfall-runoff simulation modeling as applied in this study primarily focuses on the interflow and base flow components of the runoff hydrograph. This is in sharp contrast to peak flow studies made by the Soil Conservation Service in 1979 to evaluate flood hazard along the upper Mad River. The calibrated model of this present study has application as a predictive tool to simulate potential stream flow recessions and quantify the timing and magnitude of ground water recharge throughout the basin.

7.2 Stream Hydrology

7.21 Basin Geomorphology

The upper Mad River basin encompasses approximately 162 square miles of land north of Urbana in parts of Champaign and Logan Counties. The basin is characterized by a land surface that is relatively youthful in its dissection with an incompletely developed drainage system (Ritchie et al., 1971). The Mad River, itself, originates in Logan County in a geologic formation known as the Bellefontaine outlier—a topographic high of Devonian Age rock that survived glaciation and other forces of geologic erosion. The river flows southward from the outlier through a trough-like valley of pre-glacial and interglacial origin flanked by morainal ridges of material deposited by the Scioto and Miami lobes of the Wisconsinan Glaciation. "The surface material in the interlobate area consists of extensive permeable drift such as kames, kame terraces and end moraines accompanied by high level outwash in the uplands and valley train in the main valleys." (Cross and Hedge, 1959)

Tributaries of the Mad River gather in the rolling-hilly morainal ridges flanking the basin and descend at rather steep gradient to the broad flat valley occupied by the river. The main stem has a low gradient averaging 5 to 6 feet per mile between Zanesfield and Urbana. Total stream length from the most distant point on the watershed divide to the outlet stream gage near Urbana is approximately 25.3 miles. The upper Mad River and its major tributaries are shown on the basin map in Figure 7.1.

7.22 Characteristics of Flow

The accumulation of permeable materials in the upper Mad River basin is extensive and ground water discharge from these glacial deposits give the river one of the highest indices of flow (7-day, 2-year low flow) of all streams in the state (Cross and Hedge, 1959). South of the study area in the lower Mad River basin, substantial base flow contribution is made from the Silurian and Devonian carbonate aquifer (Feulner and Hubble, 1960) (Sheets and Yost, 1994). The impact of the glacial geology on the stream flow is evidenced by the shape of the flow duration curve for the Mad River near Urbana as shown in Figure 7.2. From the duration curve, it can be seen that 90 percent of the time, flows in the Mad River near Urbana equal or exceed 48 cubic feet per second. The 90-percent duration flow is equivalent to about 0.3 cubic feet per second per square mile of drainage area and is comprised almost entirely of ground water discharging to the streams. Existing gage records for unregulated streams in the state show nearly all other streams with 90-percent index flows of less than 0.1 cubic feet per second per square mile of drainage area.

The relatively flat slope of the duration curve for the upper Mad River is characteristic of drainages with appreciable surface or ground water storage. Hydrographs of runoff events are characterized by relatively low peak rates of flow with extended recession limb sustained by subsurface interflow,

ground water and valley floodplain storage. Extreme floods in the basin are relatively rare and typically winter events resulting from heavy rainfall on saturated, frozen ground (USDA, 1979).

7.23 Land Use and Hydro-Modifications

The climax vegetation that evolved in the upper Mad River basin after retreat of the Late Wisconsinan Glaciation consisted of dense deciduous forest broken only in a few places by patches of wet and dry prairie. Swamp forests occupied the lower outwash terraces while oak-hickory and oak-maple forest occupied the higher level terraces and rolling uplands (Ritchie et al., 1971). Clearing of the land for agriculture has largely eliminated the woodland except for narrow riparian stream corridors and farm woodlots.

Conversion of valley bottom lands to agricultural use required artificial drainage. Most of the main stem of the Mad River between Zanesfield and Urbana has been altered by removal of bottom material and piling of spoil along the banks. These hydro-modifications have transformed the river into artificially straight segments of relatively uniform cross section. Existing stream bed materials for the most part, consists of coarse gravel and cobble.

The exact effects of past land use changes and hydro-modifications on the flow regimen of the Mad River have not been researched in detail. Nevertheless, channelization and conversion of forest land to agricultural land as has occurred in the upper Mad River basin generally accelerates runoff and lowers base flow of streams.

7.24 Relationship of Annual Precipitation and Runoff

The graph in Figure 7.3 contains data points for the upper Mad River basin that correspond to annual precipitation and annual runoff for the water years noted. Water years start October 1 and end September 30 of the following calendar year. Only part of the entire available record is plotted to simplify the diagram. A regression line has been fitted to the data by method of least squares. Statistical analysis of the data gives a coefficient of correlation, R, equal to 0.66. This correlation coefficient indicates a moderate correlation as reflected by the wide scatter of plotted points. The deviations of the annual data from the regression line are due in large measure to annual variations in two major components of the basin water balance equation—ground water storage and evapotranspiration.

When annual precipitation is deficient, ground water storage is generally reduced. Annual runoff following a year of deficient precipitation tends to be depressed despite return to normal precipitation because of the time and recharge required to replenish depleted ground water storage. Plotted points in Figure 7.3 exhibit this pattern for several drought year sequences. A typical sequence is 1944 and 1945. Precipitation in 1944 was extremely deficient leading to depletion of ground water storage. In 1945, precipitation was nearly normal in amount and seasonal distribution, but runoff was depressed apparently due to the time and recharge required to replenish depleted ground water storage.

Some of the deviations in the precipitation-runoff data in Figure 7.3 are quite large and are not explained by fluctuations in ground water storage. Distribution of annual precipitation is instrumental in explaining these large deviations.

Normally, precipitation in Ohio is fairly evenly distributed throughout the year, but occasionally it is not. Examination of the precipitation runoff records reveals that when most of the annual precipitation falls in winter, runoff is large relative to the amount of precipitation received due to lower rates of infiltration and evapotranspiration in winter than in summer. Conversely, when most of the annual precipitation occurs in summer, runoff is small relative to the amount of precipitation received due to higher rates of infiltration and evapotranspiration in summer than in winter. The years 1930 and 1931 are an extreme example as can be seen from the data in Figure 7.3.

In 1930, precipitation from November through March accounted for about 70 percent of annual precipitation, and runoff was excessive relative to the amount of precipitation received. In 1931 the reverse occurred, precipitation from April through September accounted for about 70 percent of annual precipitation, and runoff was very low relative to precipitation received. The primary factor causing extreme variation in the annual precipitation-runoff relationship is the difference between winter and summer rates of infiltration and evapotranspiration.

Soil moisture varies widely during the year. The recharge season is normally winter and nearly all soils are saturated by April (Ritchie et al., 1971). Soils that become saturated by winter rains tend to

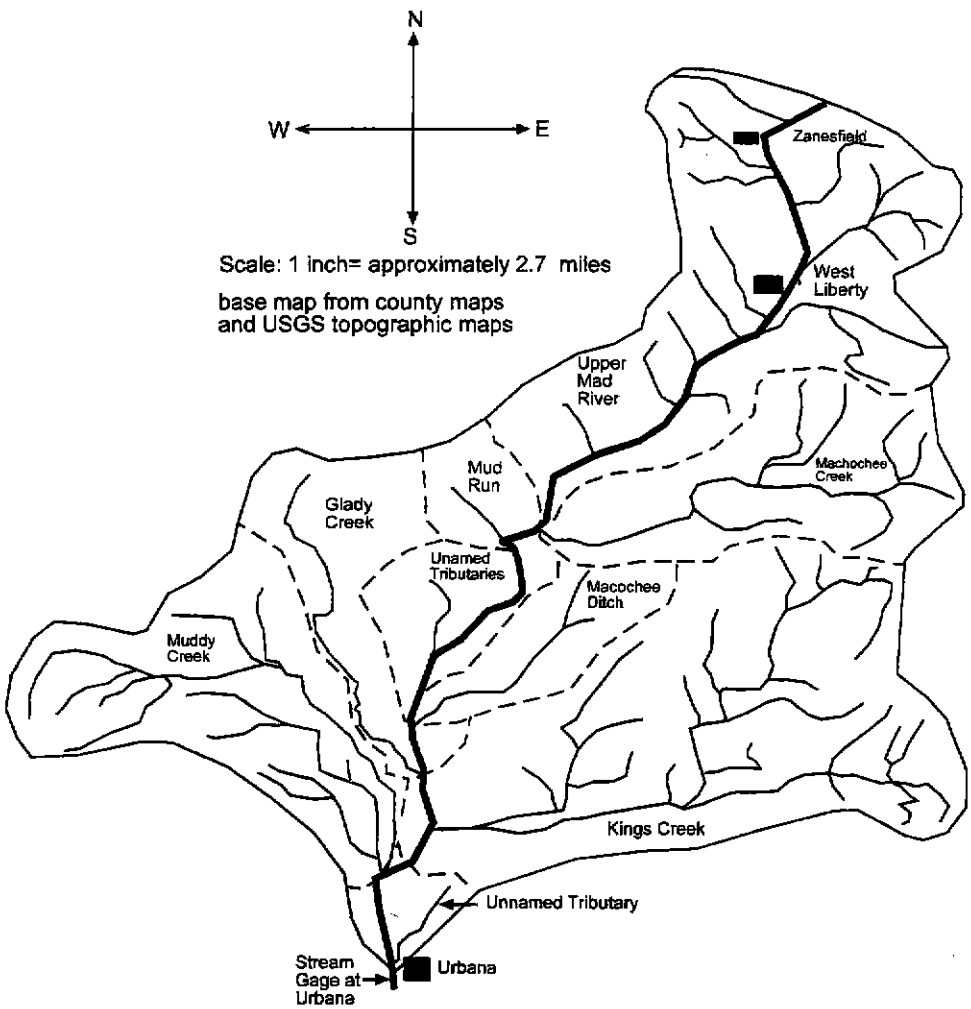


Figure 7.1 Upper Mad River subbasins

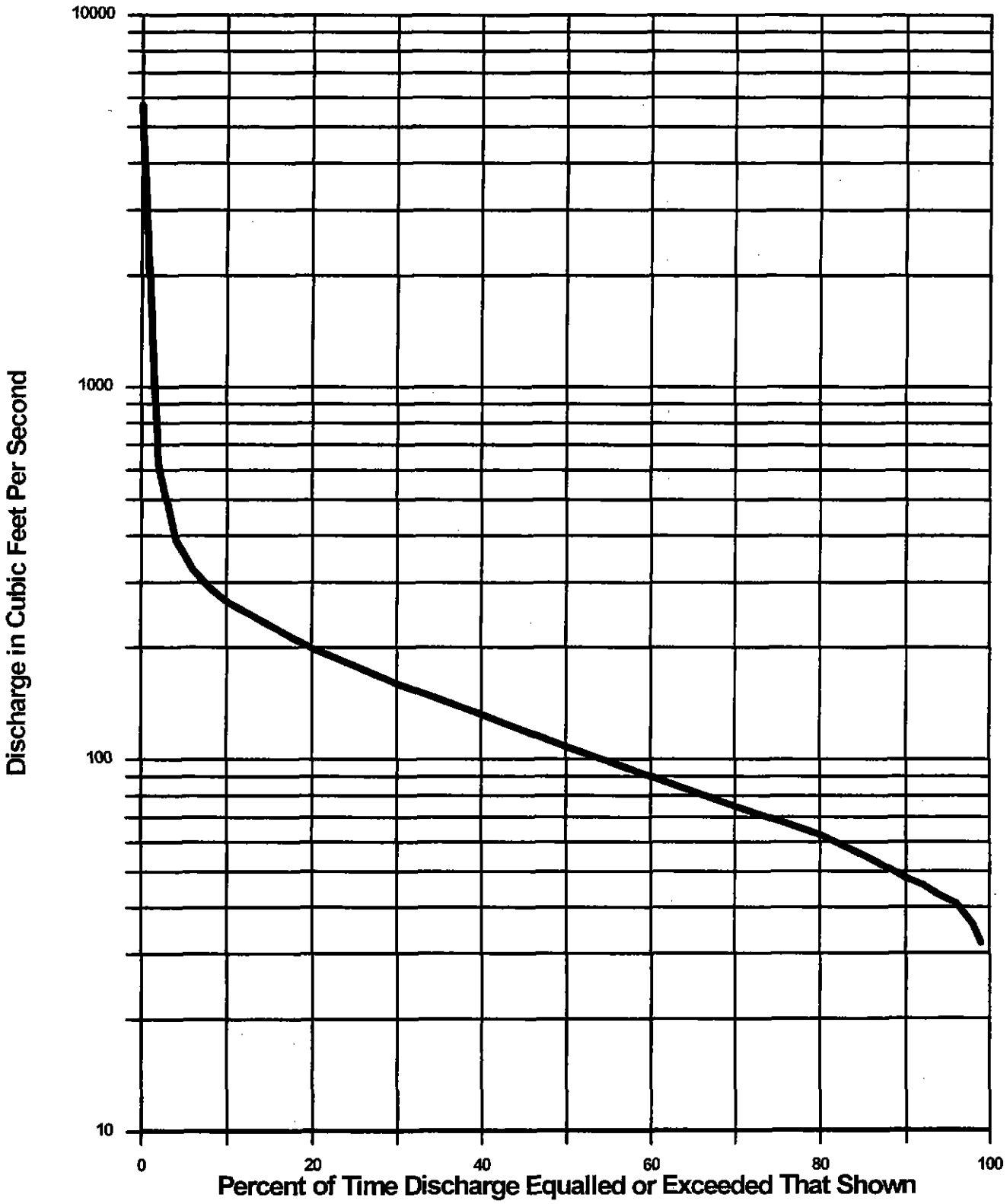


Figure 7.2 Daily flow-duration curve, Mad River near Urbana 1925-31, 1939-94

remain wet for extended periods due to minimal evapotranspiration. Initial abstraction from subsequent rains falling on wet or frozen soils is relatively low resulting in large runoff. A skewed distribution of annual precipitation toward winter months favors large runoff and rapid ground water recharge in winter; it also favors reduced evapotranspiration in summer as well.

Evapotranspiration is normally constrained by soil moisture depletion and even more so when summer precipitation is deficient. The process is described by Thornthwaithe and Mather as follows:

Evaporation from a moist soil begins immediately to lower the moisture content of soil. As the soil dries, the rate of evapotranspiration diminishes. Evapotranspiration at first goes on at nearly the maximum rate from all soils, but by the time 1 inch of water has been removed the rates from different soils begin to differ. When one-half of the water is gone, the rate of evapotranspiration falls to one-half of the potential rate, and plants begin to suffer from drought. With a constant rate of potential evapotranspiration of 0.2 in/day, the half-rate would be reached after 7 days in coarse sand but not until after 37 days in fine-textured soil. (Thornthwaithe and Mather, 1955)

If precipitation in the upper Mad River basin is normal in spring (about 1 inch per week), rainfall comes close to meeting crop water requirements. "In summer, crops use much more water than they do in spring, and all but 10 to 20 percent of the moisture available in the soil is exhausted by the end of August." (Ritchie et al., 1971) But, if soil moisture is kept near field capacity by frequent summer rains or irrigation, rates of evapotranspiration remain nearer to maximum potential amounts resulting in excessive water losses and reduced annual runoff.

Fluctuations in the amount of annual water loss to evapotranspiration are large and consistent with the magnitude of extreme deviations indicated in Figure 7.3. Careful consideration of water losses is necessary to determine the relative amounts of rainfall dispersed to soil moisture storage, ground water recharge and surface and subsurface movement to stream flow. Soil moisture depletion resulting from evapotranspiration establishes antecedent moisture condition, one of the key variables that must be accurately determined to use the rainfall-runoff simulation model developed in this study as a predictive tool.

7.3 Sources of Data

Several different types of data are used in development of the rainfall-runoff simulation model for the upper Mad River basin. These data include: basin parameters, stream flow, precipitation and antecedent moisture condition.

Data used in the modeling are from historical records, investigative reports, and field work conducted as part of this study. All data are from government sources.

7.31 Data for Watershed Parameters

Watershed parameters for the modeling were obtained from the following sources: U.S. Geological Survey (USGS) 7.5-minute quadrangle maps, soil survey investigation reports, aerial photographs contained in flood hazard reports, field survey measurements and other direct field observations.

Parameters determined from 7.5-minute quadrangle maps include: drainage basin area, stream channel length, valley cross section, and channel bed gradient. Channel dimensions for routing flow through stream reaches are from field measurements; Mannings roughness coefficients for routing flow are from field observations. Channel dimensions and roughness coefficients for estimating travel times are from field observation and aerial photography. Parameters for curve number estimates—soil type, land use and surface condition—are derived from soil investigation reports and field observations.

7.32 Stream Flow Data

Sources of stream flow data used for modeling purposes include historical published records for continuous daily mean discharge stations in the basin and low-flow partial record measurements—that is, instantaneous base flow measurements—taken at various points on streams in the basin.

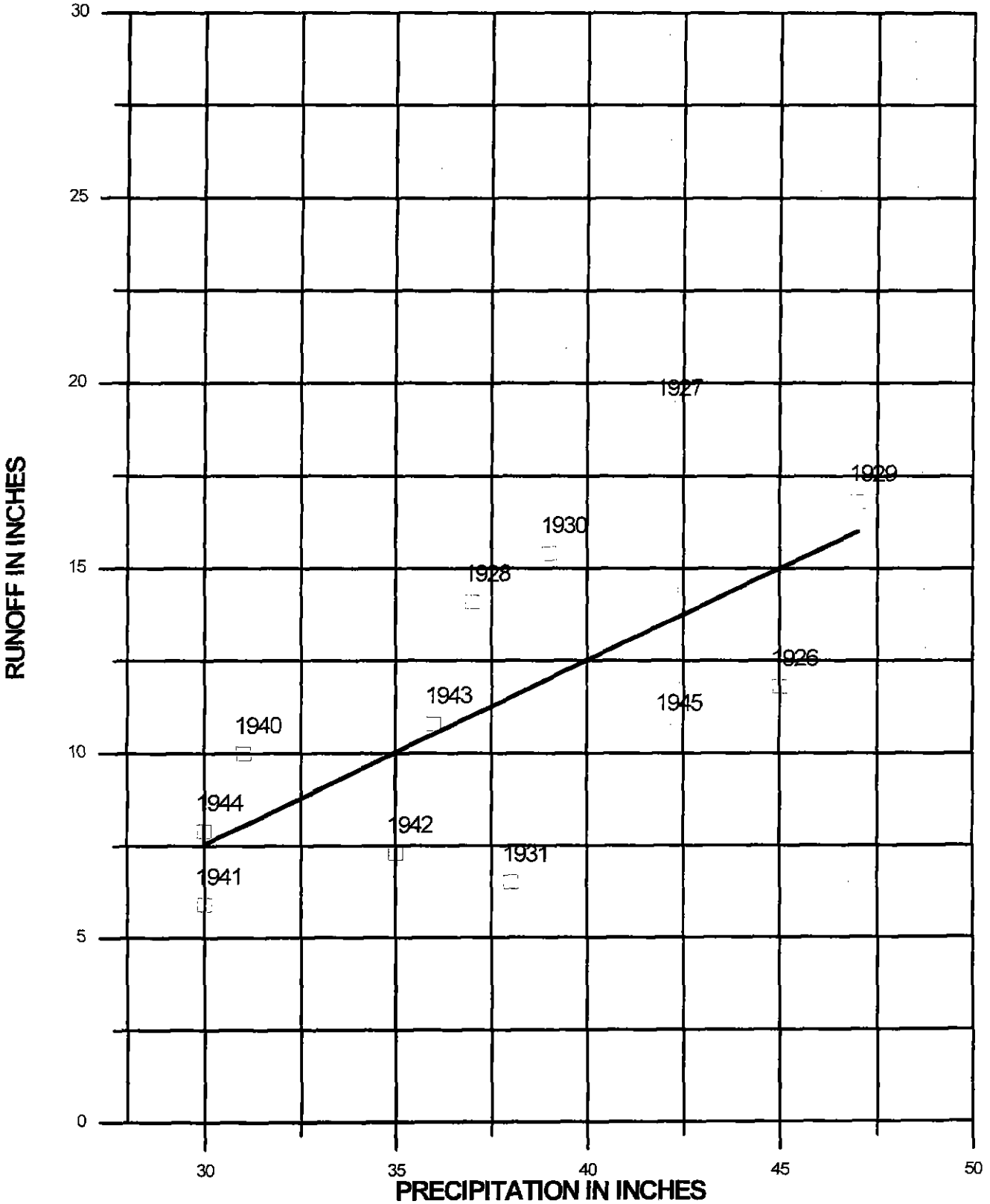


Figure 7.3 Annual precipitation vs. runoff, Mad River near Urbana 1925-31, 1939-45

Continuous daily mean discharge records of flow in the Mad River exist for stations near Urbana, at West Liberty and at Zanesfield. The record for the station near Urbana includes data for the water years 1925 to 1931 and 1939 to present. The station at West Liberty was established as part of this study and includes data for the water years 1994 to present. The Zanesfield station record covers the period 1946 to 1979. All of these data are compiled and published in annual data reports for Ohio by the U.S. Geological Survey.

Low-flow partial record measurements used in modeling include an historical record of measurements taken as part of a low-flow characteristics study by the U.S. Geological Survey in 1948, and a gain-loss study by the same agency in 1994 as part of this project. The table in Figure 7.4 summarizes results of the 1994 gain-loss study including additional low-flow measurements by the Division of Water in 1995 (USGS, 1995).

7.33 Climatological Data

Precipitation data used for modeling purposes were obtained from historical records for National Weather Service stations at Urbana and Bellefontaine. Data for these stations include temperature and precipitation records for the period 1925 to present. The precipitation records include both daily and hourly totals. Precipitation amounts for water years used in Figure 7.3 were obtained from isohyetal maps of annual precipitation derived from the observation records and published by the Division of Water in Bulletin 15, Climatic Factors of Ohio's Water Resources (Sanderson, 1950).

7.34 Data for Antecedent Moisture Condition

Sources of data for estimation of antecedent moisture condition used in modeling rainfall-runoff events include: estimates of available soil moisture capacity for various soil types as listed in soil survey investigation reports for Champaign and Logan Counties (Ritchie et al., 1971) (Waters and Siegenthaler, 1979), estimates of evapotranspiration rates for crops given in the Ohio Irrigation Guide (USDA et al., 1970) and weather observation records as previously noted.

7.4 Model Description

7.41 General Description of Model

The rainfall-runoff simulation model developed in this study is based on the U.S. Army Corps of Engineers' HEC-1 computer program. The model predicts basin runoff response to a precipitation event given starting base flow and antecedent soil moisture condition. The total runoff hydrograph is simulated including both direct surface runoff and base flow. The model does not automatically account for changes in soil moisture condition between storm events and is therefore a single event model. Singular events, however, can be complex storms.

7.42 Stream Network

For modeling purposes, the upper Mad River basin is divided into nine subbasins having relatively uniform hydrologic characteristics. Subbasins and their respective drainage areas in square miles are: Upper Mad River, 36.6; Macochee Creek 19.1; Mud Run 5.2; Unnamed Tributaries, 7.6; Macochee Ditch, 7.4; Glady Creek, 13.2; Kings Creek, 45.0; Muddy Creek, 22.9; and Unnamed Tributary, 4.2. Location of subbasins are shown in Figure 7.1.

Outflow hydrographs are computed separately for each subbasin for combination and routing along the main stem. Six routing reaches are defined along the main stem corresponding to channel segments between confluences with subbasin streams. The network scheme results in seven analysis and combination points as shown on the schematic diagram of Figure 7.5.

7.43 Subbasin Discharge Hydrographs

Total discharge hydrographs for subbasins are generated using the synthetic unit-hydrograph and base flow options in the HEC-1 program. The specific unit-hydrograph option used is the Soil Conservation Service (SCS) dimensionless unit-hydrograph as set forth in the SCS National Engineering Handbook, Section 4, Hydrology. The standard SCS dimensionless unit-hydrograph for average watersheds as incorporated in the HEC-1 program is replaced with and altered dimensionless unit-graph in the model to better simulate extended recession flows characteristic of the upper Mad River

LOCATION OF MEASUREMENT	DRAINAGE AREA IN SQUARE MILES	DISCHARGES IN CFS ON RESPECTIVE DATES		
		7/28/94	9/22/94	10/26/95
MAD RIVER NEAR URBANA	162.0	91.1 (95.8)	67.3 (73.1)	103.4
UNAMED TRIBUTARY	4.2	(2.9)	(2.2)	(3.2)
MUDDY CREEK NEAR CONFLUENCE WITH MAD RIVER	22.9	4.4	1.3 (3.4)	(4.7)
MAD RIVER ABOVE CONFLUENCE WITH MUDDY CREEK	134.9	(88.5)	(67.5)	*95.5
MAD RIVER CHANNEL GAIN BETWEEN S.R. 29 AND MUDDY CREEK CONFLUENCE		(6.8)	(5.2)	(7.4)
MAD RIVER AT S.R. 29	134.1	83.9 (81.7)	60.4 (62.3)	*88.1
MAD CHANNEL GAIN BETWEEN LIPPENCOTT RD. AND S.R. 29		(7.0)	(5.2)	(7.5)
KINGS CREEK ABOVE CONFLUENCE WITH MAD RIVER	45.0	21.6	16.1	(23.3)
GLADY CREEK AT LIPPENCOTT RD.	13.2	3.5	3.1 (2.7)	(3.8)
MACOCHEE DITCH AT LIPPENCOTT RD.	7.4	7.2	5.7	(7.8)
MAD RIVER AT LIPPENCOTT RD.	68.5	39.6 (42.4)	27.9 (32.6)	(45.7)
UNNAMED TRIBUTARIES	7.6	(13.5)	(10.7)	(14.5)
MAD RIVER AT PIMTOWN RD.	60.9	26.1 (28.9)	17.2 (21.9)	(31.2)
MUD RUN	5.2	(3.5)	(2.7)	(3.8)
MAD RIVER AT S.R. 68	55.7	22.6 (25.4)	14.7 (19.4)	*27.4
MACOCHEE CREEK	19.1	(6.4)	(4.9)	(6.9)
MAD RIVER AT WEST LIBERTY	36.6	19	14.5	*20.5

*ODNR, Division of Water base flow measurements
( ) adjusted or calculated discharges

Figure 7.4 Instantaneous discharge measurements for the Upper Mad River basin

basin. The altered unit-hydrograph is derived by lowering the peak rate factor in the peak flow rate equation and re-proportioning the volumes under the rising and falling limbs of the unit-hydrograph as described in the National Engineering Handbook (NEH-4) and Section 7.53 below.

Application of the SCS unit-hydrograph procedure requires determination of three parameters for each subbasin. They are: drainage area, curve number and lag time. NEH-4 gives detailed procedures for derivation of curve numbers and lag times. Curve numbers used in the model are average values for each subbasin; the curve number determines initial abstraction and uniform loss rates. Subbasin lag time is assumed constant for all runoff events and equal to 0.6 of time of concentration as per the empirical relation given in NEH-4 for general application. Duration of the unit-hydrograph is set equal to about one-quarter of the lag time as recommended in NEH-4.

Precipitation amounts applied in the unit-hydrograph procedure of the model are average subbasin amounts. Storm duration and temporal distribution of rainfall amounts are defined for each event using procedures given in the Rainfall Frequency Atlas for the Midwest (Huff and Angel, 1990). Observed hourly rainfall of events selected for model calibration were compared with and found to closely match the median time distribution for equivalent storm duration given in the Rainfall Frequency Atlas for the Midwest. Therefore, the observed rainfall amounts were given the applicable median time distribution for modeling purposes. Areal adjustment factors given in the Rainfall Frequency Atlas for the Midwest were applied to the average of point rainfall amounts recorded at the Urbana and Bellefontaine weather stations for each event.

In the HEC-1 program, the total stream flow hydrograph contains a direct runoff component and base flow component. The direct runoff component consists of precipitation in excess to initial abstraction and uniform loss rate. The base flow component consists of water releases from subsurface storage and provides the initial flow in the channel at beginning of the rainfall-runoff event being simulated. Use of the base flow option in the HEC-1 program requires: known or assumed starting base flow, recession constant and recession threshold. These subbasin parameters are determined for each runoff event. The recession constant is derived from the slope of the recession flow curve, and the recession threshold from the point where the linear portion of the recession curve as plotted on semilogarithmic paper diverges from the recession limb. The parameters are illustrated in the concept diagram from the HEC-1 manual as reproduced in Figure 7.6, and on the hydrograph analysis diagram of Figure 7.10.

Computed hydrographs for each subbasin are stored for later retrieval in the main program of the model by use of the HEC-1 data storage system. The data storage system package accepts data in standard time intervals such as 15 minute, 30 minute and 1 hour. The selected computation interval—that is, the duration of the unit-hydrograph—generally needs to conform to the standard time interval to avoid significant reduction in peak flow rates due to interpolation of data points by the program.

7.44 Hydrologic Routing of Stream Flow

Simulation of flow through the main channel reaches is based on Muskingum-Cung routing, a physical parameter based routing technique independent of computation interval used by the HEC-1 program in performing the routing. Parameters required for the modeling as specified by the HEC-1 program include: an eight point channel-valley cross section, reach length, bed slope, and Manning roughness coefficient.

Channel losses and gains along routing reaches are accounted for in the modeling using the channel infiltration option in the HEC-1 program. Simulation of channel gains is accomplished by entering a negative loss for the routing reach. Channel gains for routing reaches were determined from instantaneous base flow measurements tabulated in Figure 7.4 by summation of flows at the upstream end of main channel reaches and comparison with observed flow at downstream end of channel reaches.

7.45 Computer Model and Input Parameters

Input and output data files for one of the 12-day periods (7-22-76 to 8-2-76) used to calibrate the rainfall-runoff simulation model are contained in Appendix E of this report. Subbasin data for computation of runoff hydrographs are listed first followed by the main program that combines and routes subbasin hydrographs. Comment cards in the input data file identify the event specific parameters, that is, the variables.

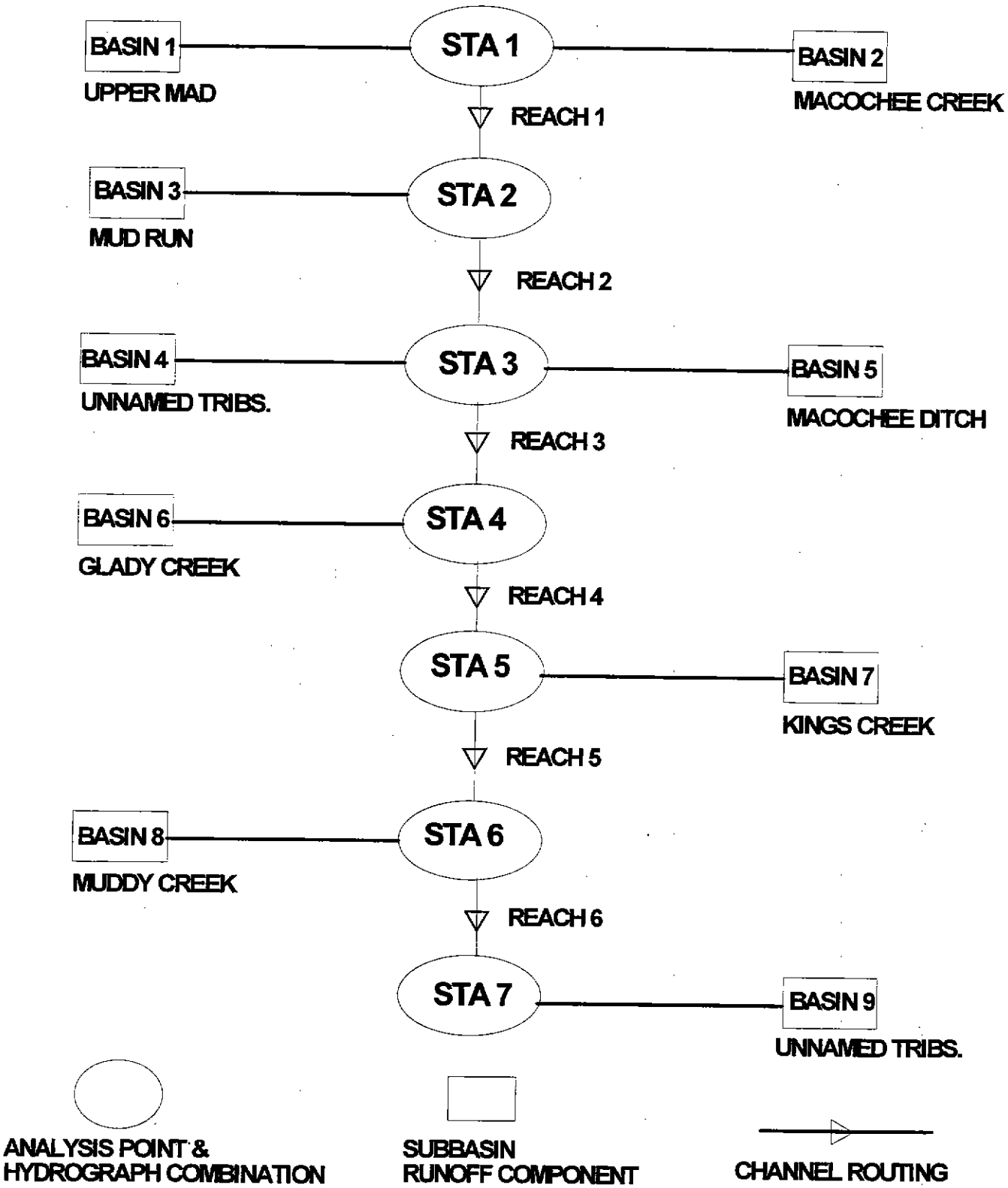


Figure 7.5 Stream network model schematic for the Upper Mad River basin

7.5 Methodology

7.51 General Approach to Modeling

In this study, the rainfall-runoff simulation model is constructed for the upper Mad River basin in accordance with guidelines in the U.S. Army Corps of Engineers' HEC-1 Users Manual, and then calibrated with selected historical rainfall-runoff events. Singular rainfall-runoff events causing isolated interruptions to base flow recessions are singled out for replication. Events are selected from both summer and winter seasons. Average daily mean stream flow, instantaneous peak flows, and time of occurrence of peak flows for the selected runoff events are part of the historical record for the Mad River near Urbana gaging station.

7.52 Estimation of Model Parameters

Parameters required to generate subbasin discharge hydrographs are: drainage area, lag time, curve number, starting base flow, recession constant, recession threshold and storm rainfall. The following procedures were used to obtain estimates of these parameters:

1. Drainage areas for subbasins are as planimetered from USGS 7.5-minute quadrangle maps.

2. Initial estimates of lag time are assumed equal to 0.6 of the time of concentration as determined by sum of travel time method. The 0.6 factor is based on the empirical formula given in NEH-4. Sum of travel time method as described in NEH-4 is the summation of time required for water to flow from the hydraulically most distant point on the basin divide, overland and through various channel reaches to the downstream end of the basin. Average channel velocities in travel time computations are Manning equation velocities for bank full flow. This is an average travel time for runoff events including the annual flood as explained in NEH-4.

3. Initial estimates of curve numbers for each subbasin are averages determined using data in SCS soil survey investigation reports for Champaign and Logan Counties and procedures outlined in NEH-4.

4. Starting base flow for each subbasin are estimates from the base flow correlation relations given in Figure 7.7. Development of the relations shown in Figure 7.7 are discussed below in Section 7.61.

5. The recession constant for recession flow is determined from hydrograph separation analysis described below in Sections 7.62 and 7.63 and illustrated in Figure 7.10.

6. Recession thresholds are determined by projection of known or estimated base flow backward in time to the end of direct surface runoff as shown in Figure 7.10 and described below in Sections 7.62 and 7.63.

7. Storm rainfall depth-duration data used in the modeling are from National Weather Service stations at Urbana and Bellefontaine. Observed hourly distribution of rainfall was matched with corresponding median time distribution in the Rainfall Frequency Atlas for the Midwest (Huff and Angle, 1992) as previously explained in Section 7.43.

Parameters required for hydrologic routing of main stem flows are: eight-point channel-valley cross sections, channel distance, bed slope, and Manning roughness coefficient. The following procedures were used to obtain estimates of these parameters:

1. Channel cross sections are as field measured; overbank sections are estimates from USGS 7.5-minute quadrangle maps.

2. Channel distance and bed slope are estimates from USGS 7.5- minute quadrangle maps.

3. Manning roughness coefficients are estimates from field observation and aerial photography.

4. Channel gains for various reaches are estimates from analysis of gain-loss study data as discussed in Section 7.44 and below in Section 7.61.

7.53 Calibration of the Rainfall-Runoff Model

Calibration of the rainfall-runoff model was accomplished using three separate observed rainfall-runoff events. Date of occurrence of these events were: November 16, 1955; June 25, 1971; and July 22, 1976. Respective storm durations were: 6-hour, 12-hour, and 24-hour. Each rainfall-runoff event was a singular event interrupting a period of recession base flow. Starting base flows in the Mad

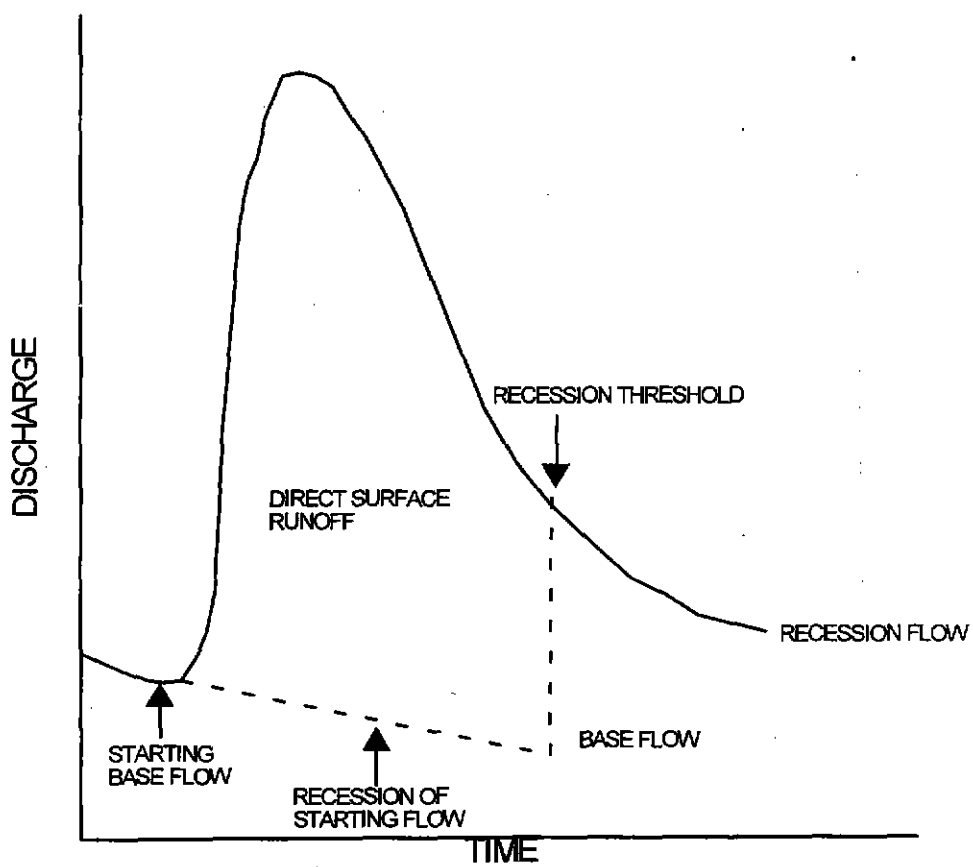


Figure 7.6 Base flow diagram illustrating HEC-1 parameters

River near Urbana for these events were: 48 cubic feet second (cfs), 64 cfs and 85 cfs respectively. Initial model runs were made using the estimated parameters as described in Section 7.52. Model parameters were then adjusted to improve the goodness of fit between the simulated hydrographs of flow and actual observed flows. The calibration was done by repeating the model runs after adjusting the parameters manually, rather than using the internal calibration option built into the HEC-1 program.

The process of improving the goodness of fit between simulated and observed runoff hydrographs involved adjustment of model parameters discussed in Section 7.52 and adjustment of the dimensionless unit-hydrograph shape to reflect unique basin characteristics. Adjustment of model parameters proceeded reshaping of the unit-hydrograph.

Calibration to achieve coincident time to peak between simulated and observed hydrographs was accomplished by adjustment of subbasin lag time estimates. Lag times were increased or decreased by reasonable adjustment of channel and overland velocities used in travel time computations. The magnitude of required adjustments was small. Final lag time estimates for each subbasin are given on the UD cards in the HEC-1 input data file in Appendix E.

Calibration to minimize differences between simulated and observed peak discharges and runoff volume was accomplished by adjustment of subbasin curve number estimates. Initial curve number estimates were increased or decreased to reflect soil moisture conditions deviating from the average condition termed antecedent moisture condition II in NEH-4.

Channel routing along the main stem affects both time to peak and peak rates of flow. Calibration involves adjustment of channel-valley cross section and roughness factors, parameters that were directly measured or observed in the field. No adjustment was considered necessary to any of these parameters in the modeling.

The recession limb of the simulated hydrograph was fitted to the observed hydrograph by adjustment of the dimensionless unit-hydrograph. The constant 484 in the peak flow equation, $q(p) = 484*A*Q/T(p)$, of the unit-hydrograph as set forth in NEH-4 was decreased to 258 to reflect basin conditions deviating from the average watershed. Procedures followed in adjusting the unit-hydrograph were as given in NEH-4 and Chapter II of the Bureau of Reclamation publication Design of Small Dams, 1965 edition. The procedure involved reshaping the unit-hydrograph so that a greater percentage of runoff volume is contained under the falling limb of the hydrograph as shown in Figure 7.12. The adjusted dimensionless unit-hydrograph and the revised peak flow equation were used to compute unit-hydrographs for each subbasin for direct input to the HEC-1 program. The unit-hydrograph discharge values for each subbasin are contained on the UI cards in the input data deck in Appendix E. Adjustment of the unit-hydrograph shape altered peak discharges, necessitating further adjustment of curve numbers.

7.6 Finding and Results

7.61 Findings from Analysis of Base Flow Measurements

Base flows of subbasin streams within the upper Mad River basin vary considerably in terms of discharge per square mile of drainage area. The base flows in cubic feet per second per square mile for all of the subbasin streams on July 28, 1994 as calculated from data in Figure 7.4 were: Upper Mad River, 0.67; Macochee Creek, 0.34; Mud Run, 0.67; Unnamed Tributaries, 1.78; Macochee Ditch, 0.97; Glady Creek, 0.26; Kings Creek, 0.49; Muddy Creek, 0.19; Unnamed Tributary, 0.69. From these data and the subbasin location map in Figure 7.1, it is apparent that base flows are greater on a per square mile basis for east tributary streams than west tributaries. This reflects ground water storage variability in the accumulated permeable drift. Kings Creek, Macochee Ditch and the Mad River north of West Liberty have relatively large base flows indicating large amounts of ground water storage, whereas, Glady Creek and Muddy Creek have relatively low base flows indicating lesser amounts of ground water storage.

Base flows of Mud Run, Macochee Creek and the Unnamed Tributaries are affected by unique factors that must be considered in making comparisons with the other subbasins. Base flows of Mud Run are affected by discharge from the West Liberty wastewater treatment plant while flows of Macochee Creek may be affected by the village well field and irrigation withdrawals. Base flows for

the Unnamed Tributaries are anomalies because they include channel gains along the main stem of the Mad River.

Analysis of the low-flow measurements tabulated in Figure 7.4 indicate that significant channel gains occur along Mad River main stem reaches 3, 4 and 5 as delineated in Figure 7.5. The relative amounts of gain in the respective reaches equates to 23, 27 and 50 percent of the total gain. Total channel gain for reaches 3 and 4 tabulated in Figure 7.4 was proportioned based on channel miles in each reach to obtain respective percentages. Significant influx of ground water to the main stem reaches identify the low terrace lands as important recharge areas.

The graph in Figure 7.7 is based on the data in Figure 7.4 and shows the relationship between base flows in the Mad River near Urbana and concurrent base flows in subbasin streams at their outlet confluence. Also shown on the graph, is the relationship for combined channel gains along reaches 3, 4 and 5 of the main stem.

7.62 Findings from Composite Recession Curve Analysis

Figure 7.8 contains a composite base flow recession flow curve for the upper Mad River near Urbana. The composite recession curve is constructed from segments of various base flow recessions from different water years using procedures described in hydrology textbooks (Butler, 1959) (Chow, 1964). Stream discharge indicated by the recession curve is representative of a long, rainless period during the growing season following a major storm. The curve closely mirrors the base flow recession of 1963 when virtually no rain fell for a period of eight months.

Recession flows recede or decay at an exponential rate that is defined by the slope of the base flow recession curve. In the HEC-1 model, the exponential decay rate used in the depletion equation is termed RTIOR and equals the ratio of the recession limb flow to the recession limb flow occurring one hour later. For the recession curve in Figure 7.8, the exponential decay rate equals 1.0005. This is the base flow recession constant for the upper Mad River basin.

The lower end of the recession curve in Figure 7.8 flattens off at a flow rate of 30 cubic feet per second. The gaging record contains two occasions when flow dipped to 24 cfs, but it appears that these were anomalies due to extreme cold temperatures. Base flow of 30 cfs was sustained for a period of about 4 months in 1963, indicating a threshold of minimum sustained base flow that is unaffected by seasonal fluctuations in precipitation and largely dependent on discharge from the extensive deep, permeable deposits in the upper basin.

The upper curvilinear portion of the recession curve in Figure 7.8 is greater than the projected base flow line because it includes interflow and direct runoff. Interflow is the horizontal movement of infiltrated water in the unsaturated zone (Fetter, 1988). The nature of interflow in the upper Mad River basin is investigated in this study by hydrograph separation analysis. No attempt is made to distinguish between interflow and bank storage, both affecting recession flow in similar manner (Squillance, 1996).

A ground water storage-discharge relation is derived for the basin by integration of the base flow recession curve (Johnston and Cross, 1949) (Butler, 1959) (Chow, 1964). Figure 7.9 shows the ground water storage-discharge relationship for the upper Mad River basin. The change in storage indicated is the average equivalent inches depth over the entire basin. Fluctuations in base flow from 30 cfs to 120 cfs involve no more than 2 inches of change in basin storage.

7.63 Findings from Hydrograph Separation Analysis

Figure 7.10 contains the results of a hydrograph separation analysis for a rainfall-runoff event recorded by the gage on the Mad River near Urbana. Flow components were separated by procedures proposed by Barnes as described in hydrology textbooks (Linsley, et al., 1982) (Chow, 1964). Hydrograph separation by this procedure was undertaken to gain better understanding of the magnitude of subsurface interflow since initial HEC-1 modeling using the base flow recession constant, RTIOR = 1.0005, did not produce accurate results as described below in Section 7.64. The hydrograph separation analysis revealed a protracted total recession flow limb extending for a period of about 10 days before becoming tangential with the base flow recession curve. The protracted recession flow is sustained by channel storage, interflow, bank storage and ground water discharge.

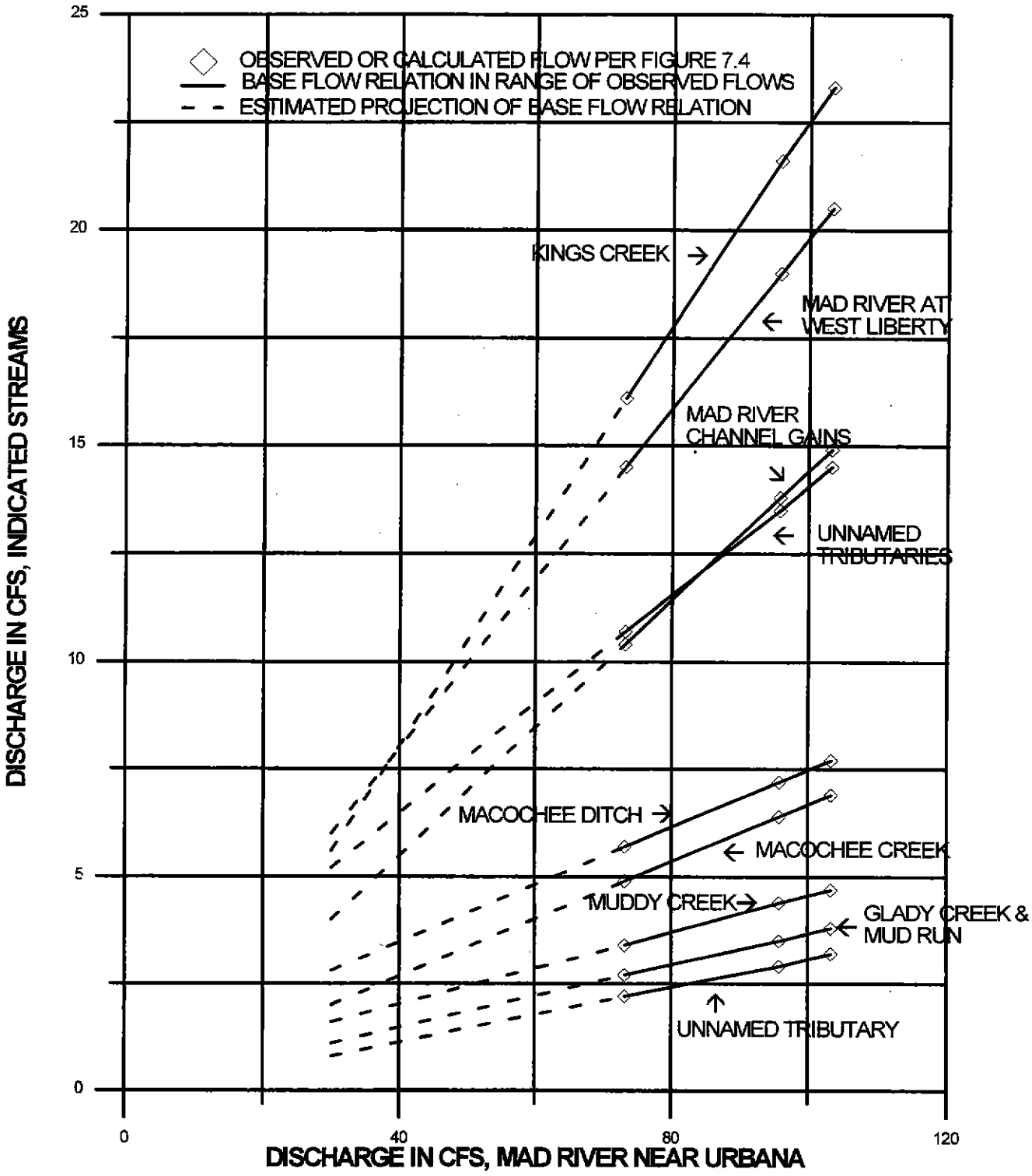


Figure 7.7 Relation of base flows for the Upper Mad River basin

A straight-line segment is fitted to the lower part of the recession limb of the hydrograph in Figure 7.10, a line segment approach to modeling the total recession flow (Butler, 1957) (Holtan and Lopez, 1971). The exponential decay rate for the straight-line segment equates to 1.0026. This recession constant, RTIOR = 1.0026, applies to the lower portion of the total recession curve where both interflow and ground water are sustaining the discharge.

The recession constant, RTIOR = 1.0026, was substituted for the base flow recession constant, RTIOR = 1.0005, in the rainfall-runoff simulation model to improve goodness of fit between observed and simulated recession flow. The recession threshold used in the modeling was determined by projecting the base flow at 10 days past the hydrograph peak backward in time along the straight-line segment to the end of surface runoff approximated by the equation N = A**0.2 where N is time in days past peak flow and A is basin area in square miles (Linsley et al., 1982). Projection of stream flow recession forward in time from the point of tangency with the base flow recession curve can be accomplished for rainless periods by use of the depletion equation and the base flow recession constant, RTIOR = 1.0005, given in Figure 7.8.

7.64 Findings Regarding Goodness of Fit of Hydrographs

Model simulations of observed rainfall-runoff events for the upper Mad River basin indicate that the time-to-peak flow for Kings Creek, the largest subbasin, nearly coincides with the time-to-peak flow for the Mad River main stem at their confluence. This coincidence of times to peak effectively establishes the timing of peak flows at the Urbana gage. Initial simulations produced reasonably good match between simulated and observed times to peak.

Simulations using initial estimates of curve numbers based on average soil moisture condition, AMC II, produced peak rates of flow that were much higher than observed peak rates of flow for the summer events modeled. Improved goodness of fit was accomplished by decreasing curve numbers to reflect the dry antecedent conditions. Improved goodness of fit for the modeling of the winter event was accomplished by increasing the curve number to reflect wetter antecedent conditions. A relationship was developed between final adjusted curve numbers and antecedent moisture condition for application of the model for predictive purposes. Little guidance exists on this type of curve number adjustment (Ponce and Hawkins, 1966). Methodology generally involves relating curve number to antecedent moisture condition by correlation with observed events (Steenhuis et al., 1995).

The final adjusted curve numbers for the three storm events modeled were correlated with antecedent soil moisture condition by application of the rainfall-runoff relations given in NEH-4 as follows: First, potential maximum retention, S, and initial abstraction, Ia, were determined by substituting final curve numbers (CNs) into the equations S = 1000/CN - 10 and Ia = 0.2S. Actual retention, F, was then determined from the equation F = (P -Ia) - Q where P = rainfall amount in inches and Q = runoff amount in inches as per the rainfall-runoff relation Q = (P - 0.2S)**2 / (P + 0.8S). Finally, ground water recharge in inches associated with each event was subtracted from the actual retention, F, to determine net retention, that is, initial soil moisture deficiency. Ground water recharge amounts were determined from the relation in Figure 7.9 using actual observed base flows at beginning and end of each rainfall-runoff event. Figure 7.11 shows the relation between soil moisture deficiency and curve number developed from the modeling.

Initial modeling produced simulated recession flows that receded much faster than observed recession flows. Reshaping of the dimensionless unit-hydrograph as previously described in Section 7.53 and illustrated in Figure 7.12 slowed the recession rate to improve goodness of fit. Downward adjustment of the constant in the peak rate of flow equation from 484 to 258 to account for a basin with large amounts of ground water storage and reshaping of the unit-hydrograph as needed produced the fit as shown in Figure 7.13.

7.65 Findings Regarding Rainfall-Runoff Events and Season of Year

Calibration of the rainfall-runoff model involved matching simulated flows to observed flows wherein both starting base flow and ending recession base flow were known. Recession thresholds used in the model were calculated by projection of ending base flow backward in time to the end of direct runoff as described in Section 7.63. When using the model for predictive purposes, ending base

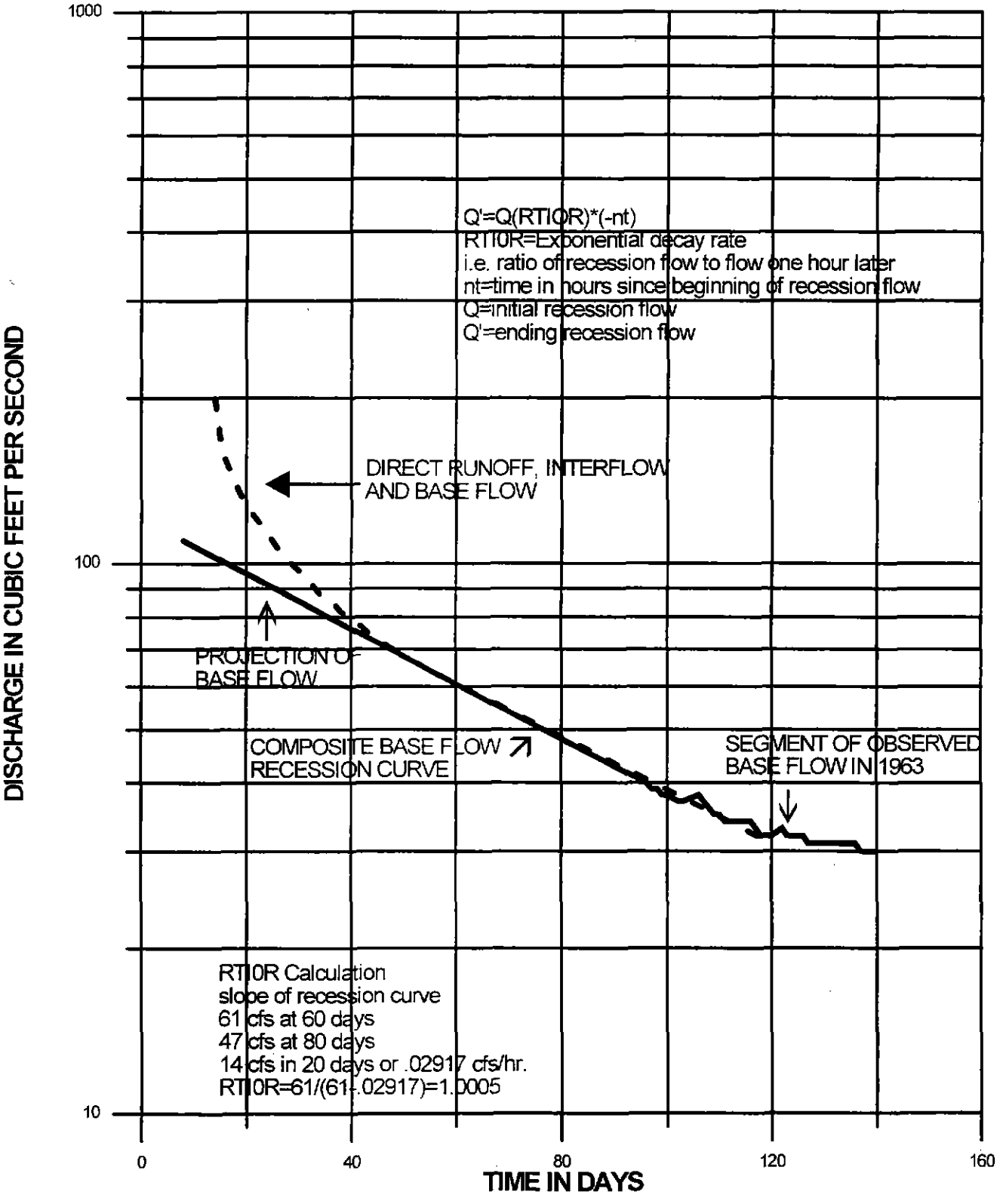


Figure 7.8 Composite base flow recession curve (ground water depletion curve), Mad River near Urbana

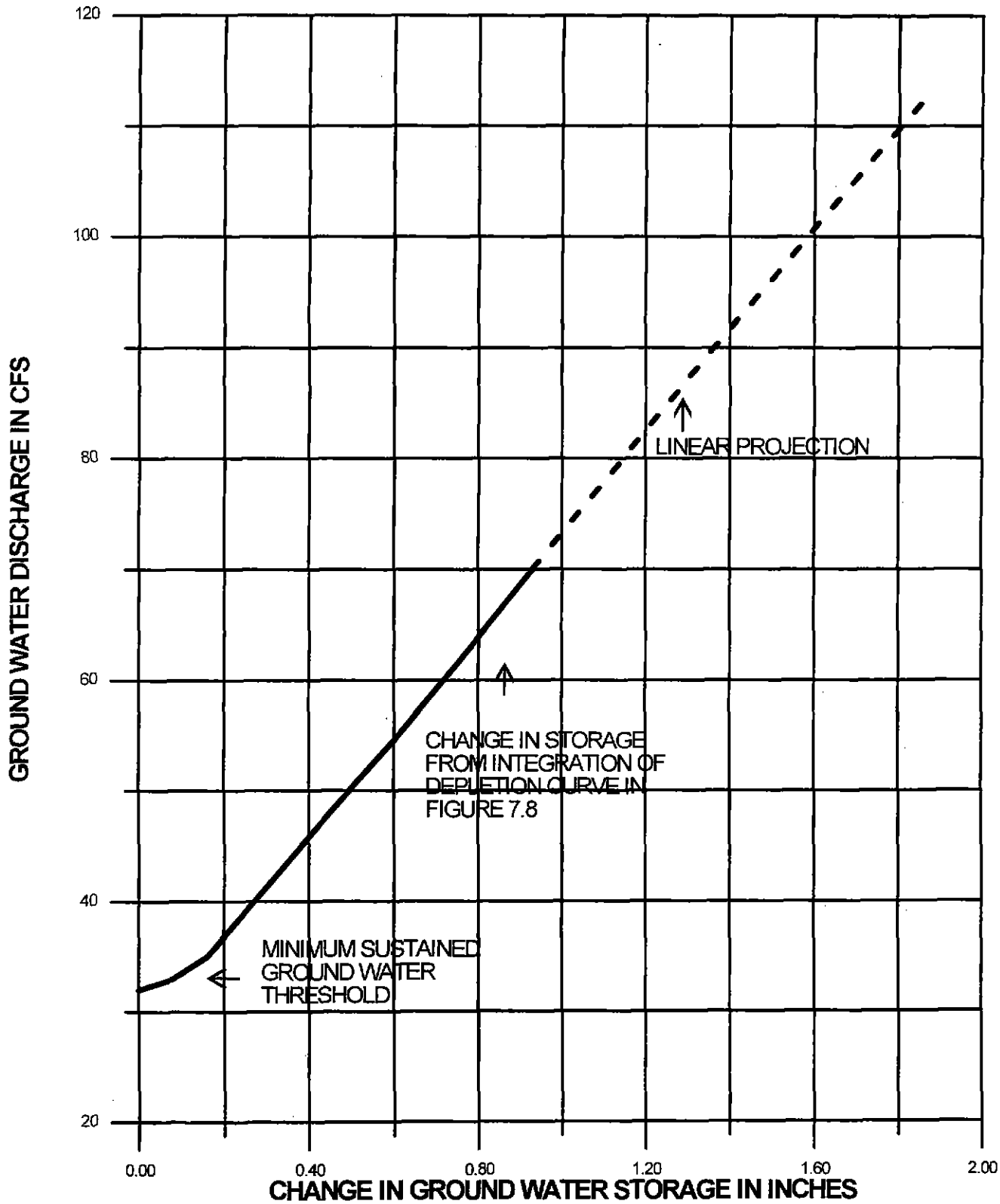


Figure 7.9 Ground water storage-discharge relationship, Mad River near Urbana

flow is not known and must be estimated based on expected amount of ground water recharge that varies seasonally.

The rainfall-runoff relations given in NEH-4 can be used to estimate the amount of ground water recharge as follows: First, soil moisture deficiency is field measured or estimated by the moisture accounting method, a simple bookkeeping procedure (USDA et al., 1970) (Thornthwaite and Mather, 1955). Moisture accounting is easiest if started when soil moisture is at field capacity following a heavy rain, that is, when soil contains no surplus of gravitational water and no deficit of capillary water. Daily evapotranspiration amounts less any rainfall are totaled to estimate soil moisture depletion. Potential maximum evapotranspiration rates for plants at various stages of growth must be adjusted for depletion of available soil moisture to obtain accurate estimates (Thornthwaite and Mather, 1955) The curve number corresponding to the estimated soil moisture deficiency is obtained from Figure 7.11 and substituted into the rainfall-runoff relations given in Section 7.64 to determine actual retention, F. Subtraction of the estimated soil moisture deficiency from the actual retention amount gives the estimated ground water recharge in inches. Conversion of ground water recharge to ending base flow is accomplished by using Figure 7.9 to step up the initial base flow. Application of the moisture accounting procedure and rainfall-runoff relations to storm events used in calibrating the model produced ending base flow estimates consistent with actual observed flows.

Figure 7.14 and 7.15 show runoff hydrographs recorded at the Urbana gage on the Mad River following similar rainfall events—one occurring in summer, the other in winter. These two figures illustrate the dramatic difference in ground water recharge that can occur between summer and winter seasons due primarily to water loss, that is, evapotranspiration. In spring and summer the step up in base flow is limited as rainfall tends to be trapped in soil moisture storage and dissipated by evapotranspiration. It is obvious from the figures that accurate modeling requires a good estimate of the expected amount of ground water recharge.

Also of note in Figures 7.14 and 7.15 is the double peaked hydrographs and the stair-step-like rise in ground water flow rates. The step up of flow rates is indicative of increases in ground water storage as given by the relation in Figure 7.9. This step up pattern is typical of the winter recharge season wherein ground water storage sequentially steps upward until the end of the normal recharge season in spring. The wide differences in seasonal recharge hold considerable significance for best management practices regarding timing of farm application of fertilizers and other agricultural chemicals. Nitrogen fertilizer applied in spring or summer, for example, should be less likely to contaminant ground water with nitrates than if applied in fall or winter, particularly if the latter is accompanied by fall plowing or other forms of tillage after crops have been harvested.

7.7 Application

7.71 Predictive and Interpretive Uses of the Model

The rainfall-runoff simulation model developed as part of this study can be used to estimate the hydrologic response of the upper Mad River basin to a particular rainfall event. Specifically, the model can estimate the total hydrographs of flow at the outlet confluence of each of the nine subbasins and at the upstream and downstream ends of the six channel routing reaches. The HEC-1 printout in Appendix E contains tables listing discharge as a function of time for all of the subbasins and channel routing reaches for the July 23, 1976 rainfall-runoff event that pertains to Figure 7.13.

Simulation of a particular rainfall-runoff event by use of the calibrated model inherently produces information regarding the relative amounts and timing of precipitation dispersed to evapotranspiration, soil moisture storage, ground water recharge and surface and subsurface movement to stream flow. For example, the runoff hydrograph resulting from the 2.6 inches of rainfall on July 26, 1976 as shown in Figure 7.13, indicates that base flow recession was interrupted for a period of about 10 days. Interruption of subbasin recession flows, as tabulated in the HEC-1 printout in Appendix E varies from 7 to 10 days. Had another significant rainfall event occurred during the period of interruption of recession flow, modeling would likely show significant step up in ground water recharge like the runoff event shown in Figure 7.14. Hence, the implication is that there is a 7 to 10 day recession period associated with a rainfall-runoff event of this nature when it would be advisable to defer application of agricultural chemicals to fields, if rain is in the forecast.

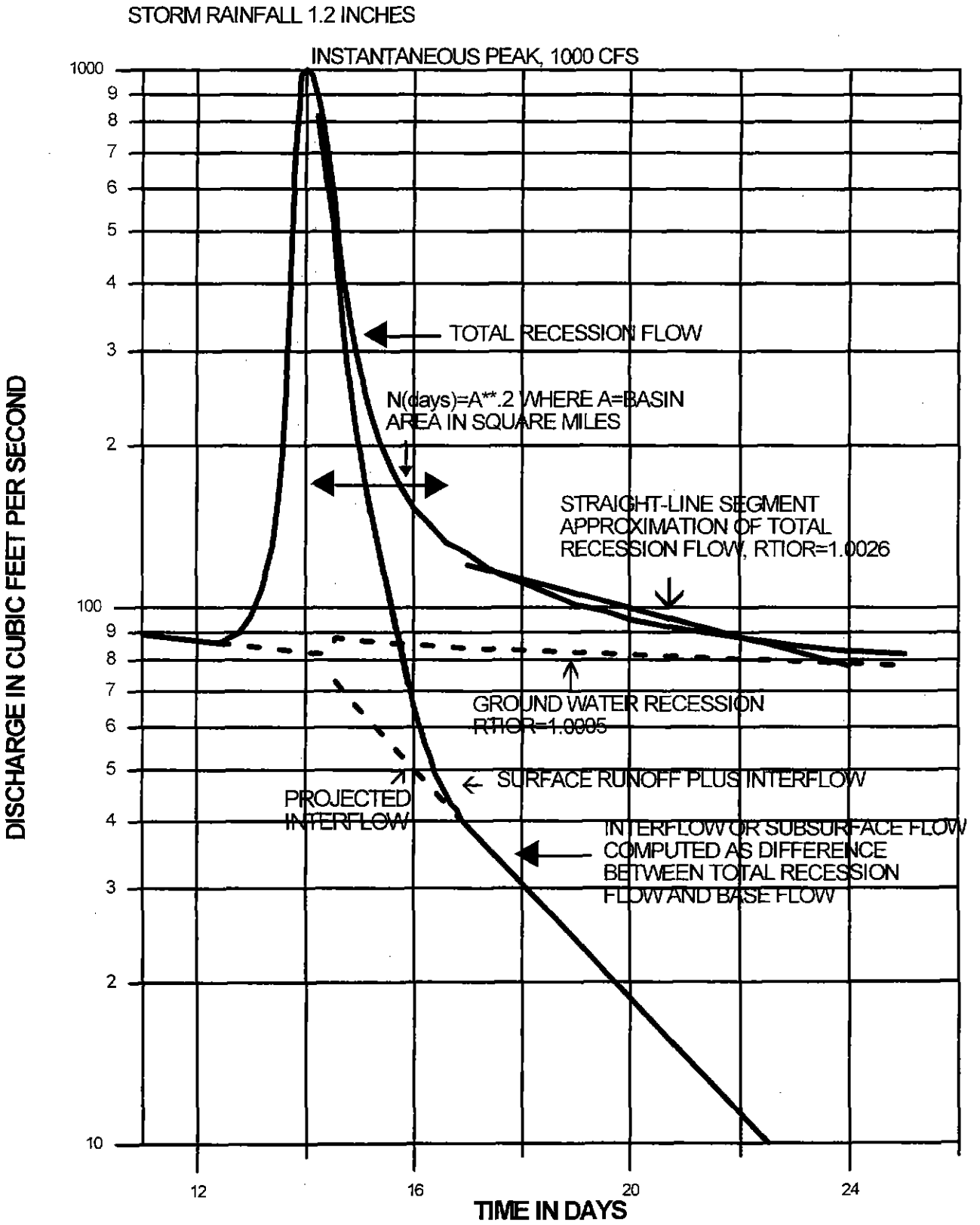


Figure 7.10 Hydrograph separation analysis Mad River near Urbana, June 11-24, 1944

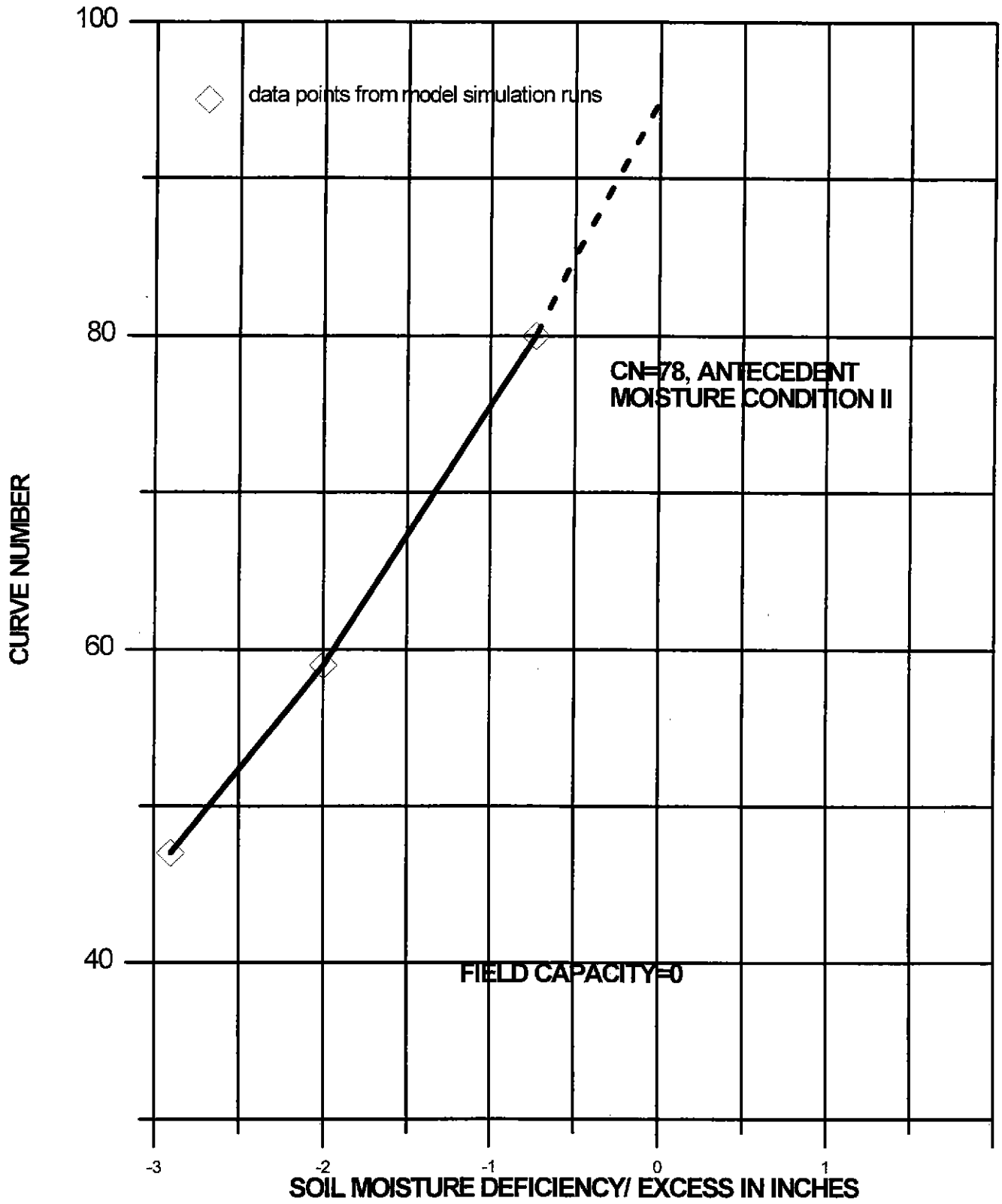


Figure 7.11 Relationship of curve number and soil moisture condition

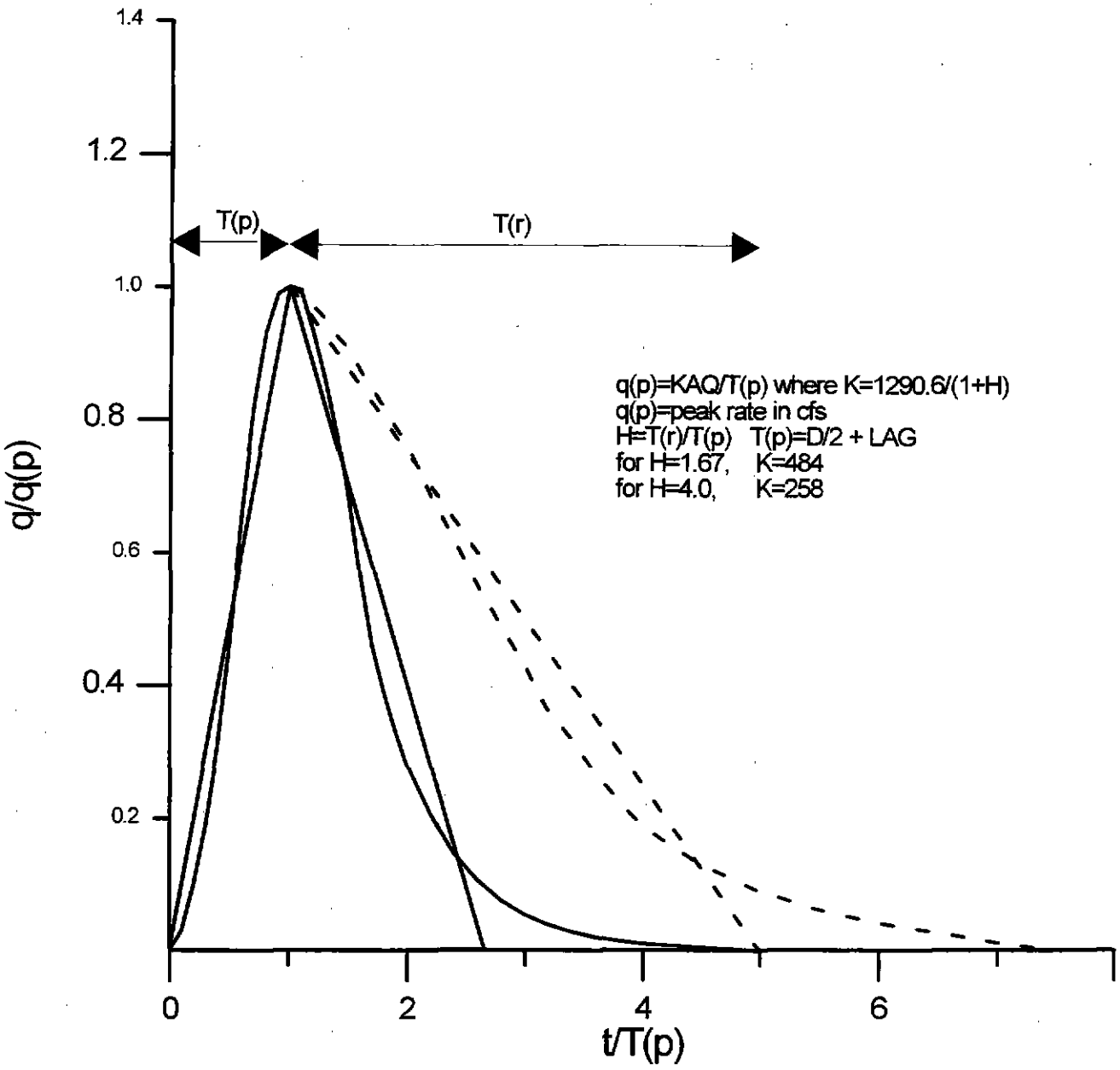


Figure 7.12 Dimensionless curvilinear unit hydrographs and equivalent triangular hydrographs

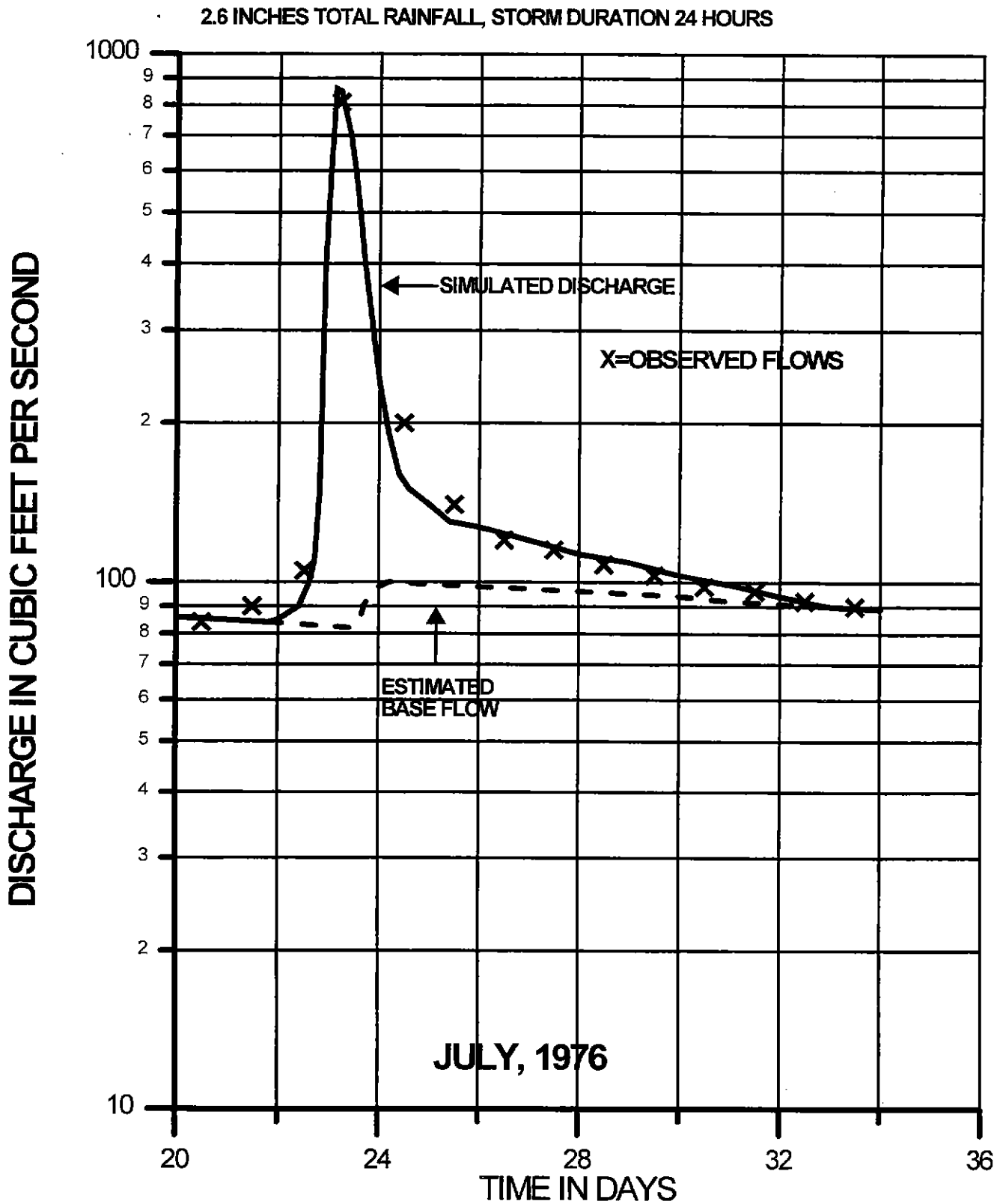


Figure 7.13 Simulated vs. observed runoff hydrographs for the Mad River near Urbana

The predictive information generated by the rainfall-runoff simulation model has utility for decision making about application of agricultural fertilizers and other chemicals to farm fields. The utility comes from being able to better assess the impact that management practices are likely to have on ground water and surface water, and being able to explain potential impacts based on a model of the upper Mad River basin. Application of rainfall-runoff model results for management decision making may be facilitated by preparation of nomographs or other similar charts of input-output parameters for a range of conditions and model runs.

7.72 Procedures for Applying the Model

Following is a step-by-step summary of procedures for application of the rainfall-runoff model for predictive purposes:

1. Base flow in the Mad River near Urbana and West Liberty is determined from the stream gages. Corresponding base flows for all subbasin streams are determined from the correlation relationship in Figure 7.7.

2. Soil moisture condition is assessed through direct field measurement or moisture accounting method as explained in Section 7.71. Curve numbers are assigned based on the relationship between soil moisture condition and curve number given in Figure 7.11.

3. The amount of ground water recharge expected from the precipitation event is calculated using rainfall-runoff relations as explained in Sections 7.64 and 7.71.

4. Rise in base flow due to ground water recharge is determined from the storage-discharge relationship given in Figure 7.9.

5. The recession threshold to be used in the model is computed from the depletion equation using RTIOR constant 1.0026 and the estimated base flow at the point of tangency on the recession curve as discussed in Section 7.63.

6. Total channel gains are estimated from the correlation relations in Figure 7.7 and distributed between reaches 3, 4 and 5 according to the respective percentages—23, 27 and 50—given in Section 7.61.

7. Areal adjustment is made to expected point rainfall depth and distributed according to appropriate median time distributions in the Rainfall Frequency Atlas for the Midwest (Huff and Angel, 1992) as discussed in Section 7.42.

8. Parameters for the rainfall-runoff simulation are entered in the computer data deck using the line editor and input to the HEC-1 program for execution.

7.8 Conclusions

The upper Mad River basin is not an average watershed because of its unique glacial geology. Ground water influx to streams from extensive permeable sand and gravel deposits give the Mad River exceptionally high base flow.

Permeable deposits in the upper Mad River basin are not uniformly distributed, giving rise to significant variation in base flow characteristics of subbasin streams. Kings Creek, Macochee Ditch and the Mad River north of West Liberty have the highest base flows per square mile of drainage area, while Glady Creek and Muddy Creek have the lowest.

Significant channel gains to base flow occur along the Mad River main stem between West Liberty and Urbana. The channel gains identify the low terrace lands bordering the stream as important ground water recharge areas.

Calibration of the rainfall-runoff model developed as part of this study required considerable adjustment of the standard SCS dimensionless unit-hydrograph in NEH-4 to improve goodness of fit between stimulated and observed recession flows. The adjustment was necessary because hydrographs of upper Mad River basin flows are characterized by protracted recession limbs sustained by unusual amounts of interflow, bank storage, and ground water discharge, a condition atypical of the average watershed applicable to the standard SCS unit-hydrograph.

Modeling of observed winter and summer rainfall-runoff events in the upper Mad River basin reveal dramatic differences in the amount of ground water recharge associated with the events. The amount of rainfall dispersed to ground water recharge in fall and winter is normally many times larger

24 JUL 0100	50	98.	*	26 JUL 2100	118	65.	*	28 JUL 1700	186	55.	*	1 AUG 1300	254	47.
24 JUL 0200	51	93.	*	26 JUL 2200	119	65.	*	29 JUL 1800	187	55.	*	1 AUG 1400	255	47.
24 JUL 0300	52	89.	*	26 JUL 2300	120	65.	*	29 JUL 1900	188	55.	*	1 AUG 1500	256	47.
24 JUL 0400	53	86.	*	27 JUL 0000	121	64.	*	29 JUL 2000	189	55.	*	1 AUG 1600	257	47.
24 JUL 0500	54	83.	*	27 JUL 0100	122	64.	*	29 JUL 2100	190	55.	*	1 AUG 1700	258	47.
24 JUL 0600	55	80.	*	27 JUL 0200	123	64.	*	29 JUL 2200	191	55.	*	1 AUG 1800	259	47.
24 JUL 0700	56	78.	*	27 JUL 0300	124	64.	*	29 JUL 2300	192	54.	*	1 AUG 1900	260	46.
24 JUL 0800	57	77.	*	27 JUL 0400	125	64.	*	30 JUL 0000	193	54.	*	1 AUG 2000	261	46.
24 JUL 0900	58	75.	*	27 JUL 0500	126	64.	*	30 JUL 0100	194	54.	*	1 AUG 2100	262	46.
24 JUL 1000	59	75.	*	27 JUL 0600	127	63.	*	30 JUL 0200	195	54.	*	1 AUG 2200	263	46.
24 JUL 1100	60	75.	*	27 JUL 0700	128	63.	*	30 JUL 0300	196	54.	*	1 AUG 2300	264	46.
24 JUL 1200	61	74.	*	27 JUL 0800	129	63.	*	30 JUL 0400	197	54.	*	2 AUG 0000	265	46.
24 JUL 1300	62	74.	*	27 JUL 0900	130	63.	*	30 JUL 0500	198	54.	*	2 AUG 0100	266	46.
24 JUL 1400	63	74.	*	27 JUL 1000	131	63.	*	30 JUL 0600	199	54.	*	2 AUG 0200	267	46.
24 JUL 1500	64	74.	*	27 JUL 1100	132	63.	*	30 JUL 0700	200	53.	*	2 AUG 0300	268	46.
24 JUL 1600	65	74.	*	27 JUL 1200	133	63.	*	30 JUL 0800	201	53.	*	2 AUG 0400	269	45.
24 JUL 1700	66	73.	*	27 JUL 1300	134	62.	*	30 JUL 0900	202	53.	*	2 AUG 0500	270	45.
24 JUL 1800	67	73.	*	27 JUL 1400	135	62.	*	30 JUL 1000	203	53.	*			
24 JUL 1900	68	73.	*	27 JUL 1500	136	62.	*	30 JUL 1100	204	53.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 435.	26.00		422.	294.	153.	82.
		(INCHES)	.052	.144	.225	.449
		(AC-FT)	209.	584.	909.	1818.

CUMULATIVE AREA = 75.90 SQ MI

*** ***

```
            **************
            *            *
  44 KK     *    BASIN6  *     GLADY CREEK SUBBASIN HYDROGRAPH
            *            *
            **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/GLADY/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/GLADY/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/GLADY/FLOW/01AUG1976/1HOUR/COMP/

              SUBBASIN RUNOFF DATA

  45 BA          SUBBASIN CHARACTERISTICS
                      TAREA       13.20  SUBBASIN AREA
```

***

****

HYDROGRAPH AT STATION BASIN6

****

* * *

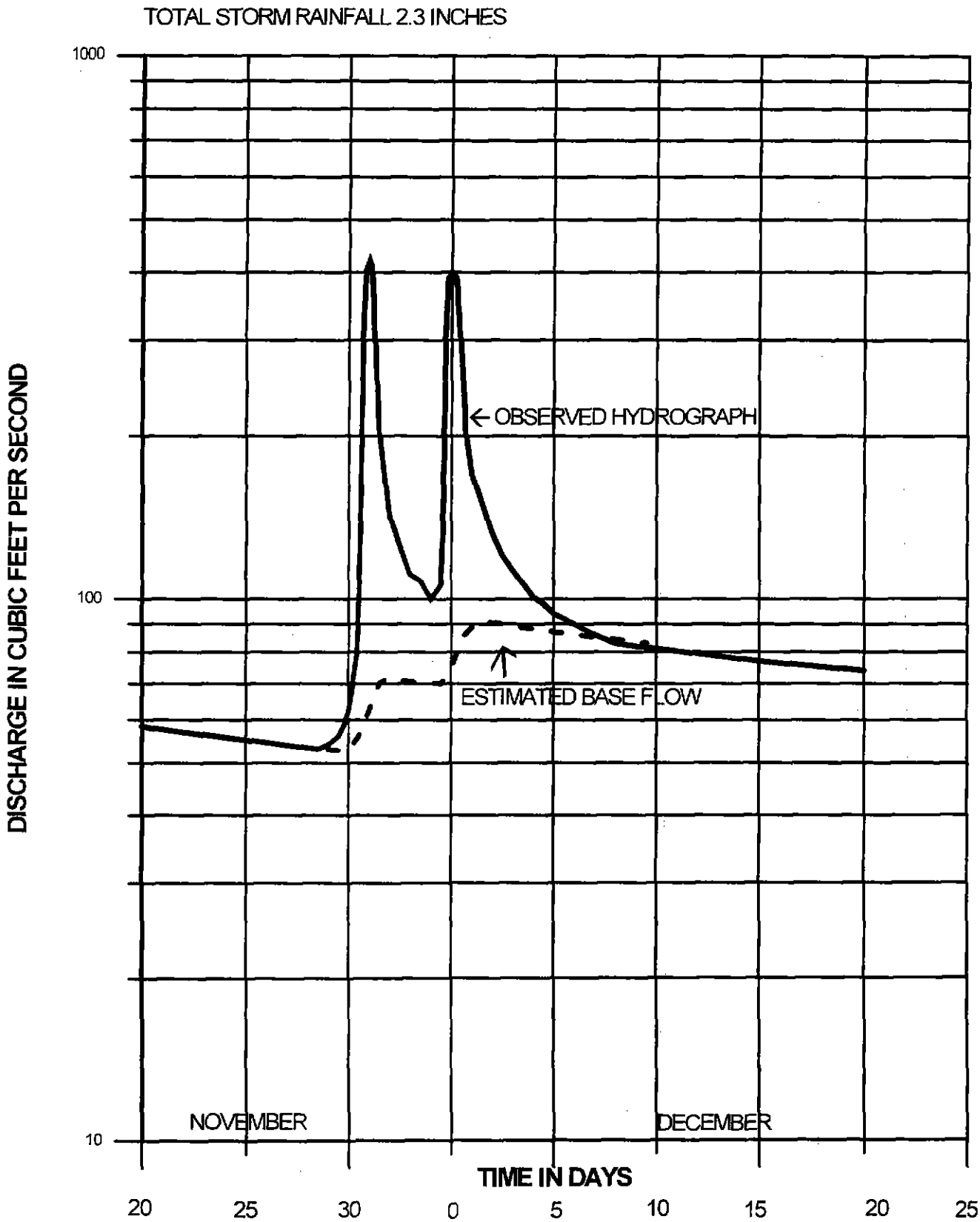


Figure 7.15 Runoff hydrograph for the Mad River near Urbana, Winter, 1977

than occurs in spring or summer. This is mostly due to higher rates of infiltration and evapotranspiration in spring and summer.

Because of the tendency for spring and summer rainfall to be retained in soil moisture storage and readily depleted by evapotranspiration, propriety in the dispersion of fertilizer and other agricultural chemicals points to timing coinciding with the growing season, particularly on the outwash terraces and valley-train land.

Use of the rainfall-runoff simulation model developed as part of this study as a predictive tool depends on accuracy in assessment of antecedent moisture condition. With careful attention given to this critical parameter, the model should be useful as both a predictive and interpretive tool for evaluation of hydrologic response to seasonal precipitation events and the effects that agricultural management practices may have on water quality in the basin.

CHAPTER 8 DRASTIC MAPPING FOR CHAMPAIGN AND LOGAN COUNTIES

8.1 Introduction

Ground Water Pollution Potential mapping was completed for both Champaign and Logan Counties (Jones, 1995a; and Sprowls, 1995). This mapping program, which is part of a state-wide effort, uses the DRASTIC system developed for U.S.EPA (Aller et al., 1987). DRASTIC maps are used to evaluate the potential impact of the release of a surface contaminate to an aquifer that provides drinking water.

DRASTIC mapping uses two major elements to indicate ground water pollution potential: a hydrogeologic setting and a numeric index. A hydrogeologic setting is the hydrogeologic environment that affects and controls ground water movement and occurrence. The numeric index is a number that identifies each hydrogeologic setting. DRASTIC is an acronym for Depth to water, Net recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone, and hydraulic Conductivity. The process of pollution potential mapping involves combining the seven parameters to produce a final numerical rating index. The hydrologic setting defines the aquifer material and the geologic environment with which the aquifer is associated (e.g., buried valley setting). The map and accompanying report are compiled using existing information such as reports, theses, and geologic maps. A more complete explanation can be found in Aller et al. (1987).

8.2 Uses for the Champaign and Logan County DRASTIC Maps

DRASTIC mapping for this project was designed to serve two purposes. The first purpose was to define the geologic setting within the study area (defining the sensitive hydrogeologic settings). The second purpose was to provide a document which could be used when land use decisions are made by planners and agency officials in the community.

The delineation of hydrogeologic settings for the study area helped to define the areal extent of the aquifer, the recharge for the aquifer, and soil type. In Logan County, the study area included West Liberty and a small area to the north. The DRASTIC map was used to define the extent of the outwash in the Mad River Valley. Because the bedrock is relatively shallow in this area, the hydrogeologic setting was classified as outwash. As the Mad River extends southward into Champaign County, the bedrock surface deepens and the hydrogeologic setting is classified as a buried valley.

During the review of streamflow information collected for Macochee Creek, the DRASTIC map was used to define the hydrologic extent of the outwash deposits in this tributary. Anomalous streamflow measurements indicated a weak hydraulic connection between the river and the outwash deposits. The aquifer was not recharging the surface water to the same degree that other tributaries in the north part of the study area were. The DRASTIC map and the bedrock topography map of Vormelker (1990b and 1992) clearly showed that the outwash deposits were thinner below Macochee Creek than in the Mad River and that the area was underlain with a non-water-producing bedrock. This information was helpful in understanding how important the thickness of the outwash aquifer is in relation to the amount of ground water discharge to surface water.

In Champaign County, the DRASTIC map was used to delineate the areas where the bedrock surface was deep or shallow. The depth to bedrock was very important in the Kings Creek area where the bedrock surface is only 20 feet below grade. The DRASTIC map was also used to define the extent of the ancient Teays River Valley. Research completed for the map was very helpful in this portion of this study.

The DRASTIC map was used to define the material beneath the end moraines in the valley. The Springfield and West Liberty end moraines are non-typical for end moraines in Ohio. Usually end moraines are composed of mostly glacial till with thin lenses of sand and gravel interbedded at depth. The DRASTIC map showed that below a thin veneer of glacial till these moraines were composed of a thick deposit of outwash. A review of the morainal settings reveals a higher than normal rating for the moraines because of this outwash. Without the DRASTIC map the true nature of these deposits would not have been revealed. The process of constructing a DRASTIC map requires a thorough understanding of the geology and hydrogeology of an area.

The second purpose of the DRASTIC maps in the study was to provide a planning tool to be used within both counties. Areas identified as sensitive by DRASTIC mapping can be appropriately developed to minimize the impacts on water quality. The information in a DRASTIC map helps local officials make better land-use-planning decisions to protect water quality. An NPS-funded project in the Mad River watershed is doing just that. This project, which is led by OSU Extension Champaign County, has been providing cost share money to landowners for the installation of BMPs. The DRASTIC information has been used to help with the selection process. Discussions have begun with the agricultural community on ways to improve water quality in the watershed and are continuing under the guidance of the Mad River Steering Committee.

Copies of the DRASTIC maps have been distributed to all of the agencies in Champaign and Logan Counties that deal with agricultural, health, and environmental issues. In addition, copies were distributed to the TOP of Ohio RC&D and Madmen Chapter of Trout Unlimited. These groups provided financial support for the printing of the DRASTIC maps and reports.

CHAPTER 9-FACTORS THAT AFFECT WATER QUALITY

9.1 Land Use

Land use in a sensitive area can greatly affect water quality. Extensive development concentrated in a small area or ill-advised land use planning are major contributors to the degradation of ground water quality. The study area is composed of agricultural lands with some centralized development. How land uses are distributed relative to hydrogeologically sensitive areas will influence surface and ground water quality.

An example of land use affecting water quality would be agricultural activity increasing the presence of nitrate in a ground water source. Rarely, if ever, do nitrate levels exceed the safe drinking water standard without the presence of sources generated by humans.

9.2 Feedlots

Feedlots are common in agricultural areas where livestock is a primary resource. Dairy and beef cattle, poultry, and swine operations are some examples of livestock that may produce a feedlot problem. When a large quantity of livestock is confined to a small area for feeding or milking, animal waste products are concentrated. Animal waste contains products that produce nitrate and bacteria that may infiltrate into the water supply.

The agricultural community has long recognized the problems associated with animal waste in feedlot environments. A portion of the Pollution Abatement Program run by the Ohio Department of Natural Resources, Division of Soil and Water handles water quality degradation caused by animal waste. This is a voluntary program unless water quality degradation caused by animal waste has been documented.

The amount of livestock wastes generated varies depending on the animal type, diet, age, and condition. A healthy hog can contribute 151 pounds of nitrogen for each ton of dry manure (Ohio Cooperative Extension Service, 1991). The way in which these wastes are managed is very important to water quality.

Manure presents three types of water pollution problems: nutrient enrichment, excessive free ammonia (NH_3^-), and oxygen depletion caused by bacterial breakdown (Ohio Cooperative Extension Service, 1991). Excessive nutrients and ammonia pose the greatest risk to ground water. Ammonia converts to nitrate, the component of manure breakdown that degrades ground water quality. Proper disposal and the use of BMPs such as the installation of filter strips and waste storage lagoons help to keep ground water safe from animal waste products.

9.3 Septic Systems

Faulty septic systems contaminate surface and ground water supplies world-wide. Local health departments inspect some wastewater systems regularly, but the majority of systems go unregulated unless someone complains of a public nuisance. Home sewage systems need to be pumped every other year and tested yearly to be sure the waste is being biodegraded. Many of these systems require more maintenance than the homeowner completes; consequently, the system ceases to properly filter the sewage.

A large percentage of human waste is managed by cities and municipalities through centralized sewer systems, but rural residents must provide their own on-site wastewater treatment system. Residential wastewater treatment systems are aerobically active. The addition of oxygen, which is digested by bacteria, helps decompose raw organic matter and kill pathogenic bacteria and viruses present in the sewage sludge (Ohio Cooperative Extension Service, 1991). Some chemicals added to the septic system can kill the bacteria cultures that break down the sewage in a septic tank. Residential and municipal sewage sludge are ultimately spread on agricultural fields across the state.

The major problem areas for individual on-site septic systems occur when density of homes exceeds the land's ability to process the waste. Subdivisions on individual septic and private water wells are especially susceptible. Fortunately this type of development is not common in the study area.

9.4 Crop Production

Corn and soybeans are the major cash crops in the Mad River watershed. In the Kings Creek sub-watershed where nitrate levels are highest, corn is the primary crop. To produce high-yielding corn acreage, a large amount of free nitrogen in necessary. An acre of land producing 180 bushels of corn requires 240 pounds of nitrogen (Hoyum et al., 1988). In 1986, Champaign County farmers applied 13,326,341 pounds of nitrogen fertilizer (Waldron, 1986). The most popular method for applying the nitrogen necessary for high yield corn production is the use of anhydrous ammonia (NH_3^+). Anhydrous ammonia combines with free hydrogen ions in the soil to produce ammonium (NH_4^+). Ammonium is fixed by the clay minerals in the soil, converting to nitrite (NO_2^-) and finally to nitrate (NO_3^-). This process is regulated by soil moisture, temperature, and pH.

A common practice in agriculture is to apply more fertilizer than necessary for that growing season to provide a soil residue for the next planting season. The problem with this method is that some of the excessive nitrogen leaches into the water table. A fall application of 200 pounds per acre may only yield 175 pounds of nitrogen per acre in the spring. The remaining nitrogen has leached through the unsaturated zone to the aquifer. The timing of the nitrogen application is also very important. Application of fertilizer just before a precipitation event increases the risk of surface runoff. The use of proper application amounts and correct timing can help maintain water quality (See Chapter 7).

9.5 Geology

Geologic conditions can greatly affect ground water quality. The study area consists of some vastly different geologic environments. The DRASTIC mapping process was very helpful in identifying unique hydrogeologic settings. The geology may or may not provide a natural protection barrier against aquifer contamination. Protection of the aquifer by natural means exists in areas where a thick layer of clay is present above the aquifer or where the depth to the water table is the greatest. Shallow

depth to water and coarse aquifer materials present the greatest risks to an aquifer from a surface contamination source.

The Kings Creek area is an example of less than ideal conditions for ground water protection. The depth to the water table and the bedrock surface are both extremely shallow. A thin soil layer overlies about 20 feet of coarse glacial outwash. Below the outwash is a fractured limestone bedrock surface. A contaminant such as nitrate that might be released at the surface in the Kings Creek area need only pass through the thin soil horizon and then move rapidly through the outwash aquifer. Once the contaminant reaches the upper surface of the bedrock, it would travel horizontally, through the fractured bedrock, and down drainage as a plume to be possibly intercepted by a domestic water well. Considering these conditions alone, it is not surprising that the Kings Creek sub-watershed contains many wells with elevated nitrate levels.

Elsewhere, water wells drilled into the clay-dominated upland areas on the Farmersville Moraine show little or no nitrate present. In this environment, the water table is deep and tens of feet of non-permeable clay overlie the aquifer to provide protection from surface contamination. For detailed information on the hydrogeology of Champaign and Logan Counties, please refer to Jones (1995a) and Sprowls (1995), respectively.

9.6 Well Construction

A properly constructed well will provide protection from surface contamination and mixing of aquifer waters. The infiltration of surface water can be controlled by sealing the area surrounding the well casing (annular space) with bentonite or neat cement. This process is referred to as grouting the surface casing of a well. Well grouting of this type prevents contaminated surface runoff from traveling down the outside of the casing directly into the aquifer. Wells that have tested positive for bacteria or have high nitrate values often result from poor well construction. Many wells constructed before 1980 have only cuttings from the well construction to fill the annular space. The disturbed earth materials near the well bore provide little protection from surface contaminants. Well construction using the proper sealing agents pumped into the annular space under pressure offer the greatest aquifer protection.

Sometimes a section of an aquifer is contaminated because an old unused well is left open at the surface. Unused wells should be properly sealed by grouting to prevent contamination.

Wells that are located next to agricultural fields or feedlots are especially susceptible to contamination from an improperly sealed annular space. The number of contaminants that may enter a well from the surface is almost unlimited. Fuel, fertilizer, solvents, sewage, animal waste, pesticides, and many other contaminants have been introduced into ground water from improperly sealed water wells (Sprowls, 1996).

The casing used in a well needs to be inspected periodically to ensure it has not been breached. Natural chemicals found in ground water are often corrosive to well casing and equipment. The casing may be used to block off water from an upper aquifer that may be of lower water quality. If the casing is breached, the waters will mix, degrading the water quality of the primary aquifer. Condition of the well cap should also be inspected. Missing or cracked caps must be replaced. There is no substitute for a properly installed well cap. A faulty well cap allows insects, rodents and surficial flow to enter the well.

CHAPTER 10-RESULTS AND DISCUSSION

10.1 Ground Water/Surface Water Interaction

Base-flow separation techniques (Koltun, 1995) have shown that the Mad River and its tributaries acquire a sizeable amount of their surface water flow from ground water contribution. Koltun (1995) states that the median percentage of annual total streamflow attributed to base-flow ranged from 61.8 to 76.1 percent. The Mad River has the highest sustained dry-weather flow in Ohio (Cross and Feulner, 1964).

A rainfall-runoff model (See Chapter 7) using the Corp of Engineers HEC-1 model clearly showed that the Upper Mad River is a highly unusual watershed. The unique glacial geology with extensive

deposits of sand and gravel give the Mad River an exceptionally high base-flow. Permeable deposits in the basin are not uniformly distributed, giving rise to significant variation in base-flow characteristics of sub-basin streams. Kings Creek, Macochee Ditch, and the Mad River north of West Liberty have the highest base-flows per square mile of drainage area, while Glady Creek and Muddy Creek have the lowest. Major base-flow gains occur along the channel between West Liberty and Urbana. The channel gains identify the low terrace lands bordering the stream as important ground water recharge areas. Appropriate land use management should be employed in these and other sensitive areas.

Modeling has shown that the amount of rainfall dispersed to ground water recharge in fall and winter is normally many times greater than occurs in spring and summer. Because of the tendency for rainfall to be trapped by soil moisture storage in spring and summer, the dispersion of fertilizer and other agricultural chemicals points to timing coinciding with the growing season, particularly on the outwash terraces and above the valley deposits. The practice of applying anhydrous ammonia or other types of fertilizer in the fall will lead to extensive leaching of the nitrogen and increased nitrate in private wells.

The nitrate level present in a water well is partly controlled by the depth to the water table and the amount of casing in the well. Examples of wells with low nitrate readings are wells 24 and 6, which are situated in the till uplands. They are topographically higher than the wells in the Mad River Valley, and the water table here is relatively deep. The till is extremely non-permeable and infiltration is limited. The water quality data (Appendix C), combined with the domestic water well logs (Appendix A), clearly show that nitrate contamination is absent due to the depth of the aquifer as well as the subsequent length of the well casings.

Conversely, wells 46 and 47 are situated within the valley and have mean nitrate concentrations of 5.99 mg/L and 2.12 mg/L respectively. In the valley the water table is shallow and infiltration rates are high. Because the depth to the aquifer is shallow, casing lengths are short and the chances of nitrate contamination are elevated.

Nitrate contamination is concentrated in the King Creek sub-watershed. Probability plots show a 50% probability for nitrate in the Kings Creek sub-watershed of 4.7 mg/L (Figure 5.19). This is compared the 50% probability of 0.02 mg/L of nitrate in the North sub-watershed (Figure 5.17) and 1.91 mg/L of nitrate in the South sub-watershed (Figure 5.18). Chapter five of this report gives a detailed discussion of this phenomenon.

CHAPTER 11-RECOMMENDATIONS AND FUTURE STUDIES

11.1 Suggestion for Planning and Future Studies in the Watershed

Future studies in the Mad River should include an in-depth study of the Kings Creek sub-watershed. Water quality in this area has shown anomalously high levels of nitrates. The nitrate problems appear in areas where the aquifer is affected by agricultural land use activities. Additional collection of data focusing on the sub-watershed should provide the necessary information to make informed land-use decisions.

Bacteria samples should be collected on private water wells across the entire study area. Bacteria sampling is straightforward and inexpensive, and could be conducted by the health departments of Champaign and Logan Counties in conjunction with the Mad River Steering Committee. In view of the sensitivity of the aquifer, the likelihood of some bacteria contamination is high. Where bacteria is detected, approved health department techniques should be employed to decontaminate the well.

Results of all water quality studies in the watershed should be used jointly by state and local officials, local planners, agricultural agencies, state agencies, local health departments, and concerned citizens to develop a long-range water quality plan for the watershed. This plan could include provisions for zoning, planning land use for productivity and improved water quality, and education about water availability and maintaining water quality.

Further development of the Mad River Steering Committee is very important to improving water quality in the watershed. The committee has served as a link between landowners, agencies, and the general public. More importantly, the committee has increased public awareness of the condition of

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

685541

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number _____

COUNTY CHAMPAIGN TOWNSHIP SALEM SECTION OF TOWNSHIP 25
OWNER DETWILER FARMS PROPERTY ADDRESS W. LIBERTY, OH.
LOCATION OF PROPERTY TOM'S 7419 UPPER VALLEY PK.

CONSTRUCTION DETAILS

CASING
Casing Diameter 8 in. Length of Casing 49 ft.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) SLOT Material PVC
Length 23 ft. Diameter 8 in.
Set between 26 ft. and 49 ft. Slot .085

GROUT
Material GRAVEL & CUTTINGS Volume used
Method of installation SHOVEL
Depth: placed from ft. to ft.
☐ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other

BAILING OR PUMPING TEST
(specify one by circling)

WELL TEST
Test rate 200+ gpm Duration of test 1½ hrs.
Drawdown (water level during pumping) 5 ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other
Static Level (depth to water) 12 ft. Date: 7-12-88
Quality (clear, cloudy, taste, odor) CLEAR

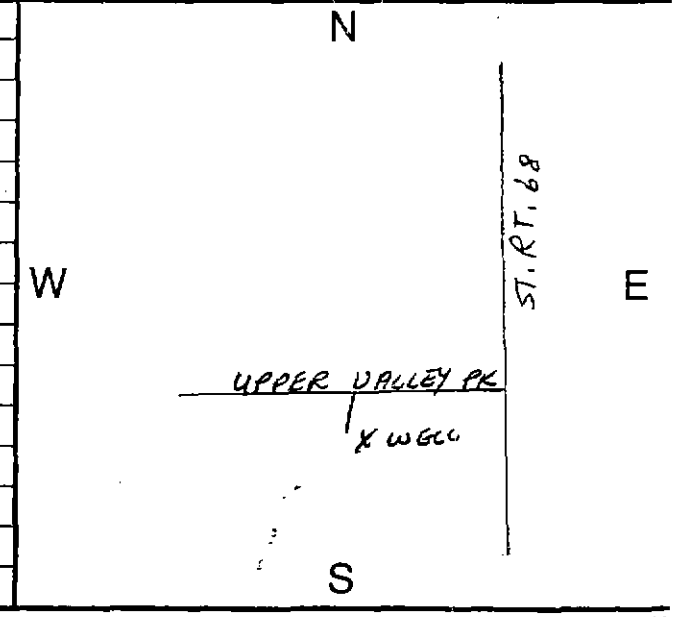
PUMP
Type of pump Capacity gpm
Pump set at ft.
Pump installed by
Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well IRRIGATION

WELL LOG*

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand	From	To
TOP SOIL	0 ft.	4 ft.
GRAVEL	4	49

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.88

DRILLING FIRM EATON WELL DRLG. SIGNED Marcella Eaton
ADDRESS 8401 N. Rt. 68 DATE 7-13-88
CITY, STATE, ZIP W. LIBERTY, OH. 43357 ODH REGISTRATION NUMBER 41

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE. COLS.. OHIO 43224

References

Aller, L., T. Bennett, J.H. Lehr, R.J Petty and G. Hackett, 1987. DRASTIC: A standardized system for evaluating ground water pollution potential using hydrologic settings. U.S. Environmental Protection Agency EPA/600/2-87-035, 622 p.

Bair, E.S., R.K. Diegel and M.S. Chapman, 1989. Ground water quality changes resulting from surface application of oil-field brine. Ohio Department of Natural Resources, Division of Oil and Gas, Brine Management Report.

Baker, D.B., 1990. Ground water quality assessment through cooperative well testing: An Ohio example. Journal of Soil and Water Conservation, vol. 45, pp. 230-235.

Briskin, J., 1994. National pesticide survey: methods, results, and policy implications. In Honeycutt, R.C. and D.J. Schabacker (eds.), Mechanisms of Pesticide Movement into Ground Water, Lewis Publishers, pp. 143-154.

Butler, S.S., 1957. Engineering hydrology. Prentice-Hall Inc., Englewood Cliffs, N.J. p. 356.

Chow, V.T., 1964. Section 14, Runoff. In Chow, V.T. (Ed.), Handbook of applied hydrology, McGraw-Hill, New York, N.Y., 54 p.

Cross, W.P. and A.J. Feulner, 1964, Anomalous stream-flow-ground-water regime in the Mad River Basin, near Springfield, Ohio. U.S. Geologic Survey Professional Paper, 475-D, p. D 198-D 201.

_____ and R.E. Hedge, 1959. Flow duration of Ohio streams. Ohio Department of Natural Resources, Division of Water, Bulletin 31, 152 p.

Dreimanis, A. and R.P. Goldthwait, 1973. Wisconsinan glaciation in the Huron, Erie and Ontario lobes. In Black, R. F., Goldthwait, R.P., and Willman, H.B., (eds.), The Wisconsinan Stage: Geological Society of America Memoir 136, p. 71-106.

Driscoll, F.G., 1986. Groundwater and wells. Johnson Filtration System, St. Paul, Minn., 1089 p.

Dumouchelle, D.H., C.W. Schalk, G.L. Rowe, and J.T. deRoche , 1993. Hydrogeology , simulated ground-water flow, and ground-water quality, Wright-Patterson Air Force Base, Ohio. United States Geologic Survey Water-Resources Investigations Report 93-4047, 152 p.

_____ and J.T. deRoche, 1991. Lithologic, natural-gamma, grain-size and well-construction data for Wright-Patterson Air Force Base, Ohio. United States Geologic Survey Water Resources Open-File Report 91-181, 94 p.

Fenneman, N.M., 1938. Physiography of the eastern United States. New York, McGraw-Hill Publishing Co., 714 p.

Fetter, C.W., 1988. Applied hydrogeology. New York, Macmillan Publishing Company, 592 p.

Feulner, A.J., 1960. Ground-water resources of Champaign County, Ohio. United States Geologic Survey unnumbered open-file, 110 p., 2 plates.

_____, 1961. Cyclic-fluctuation method for determining permeability to valley-train deposits in the Mad River Valley in Champaign County, Ohio. Ohio Journal of Science, v. 61, no. 2, p. 99-106.

_____ and H. Hubble, 1960. Occurrence of Strontium in surface and ground waters in Champaign County, Ohio. Economic Geology, v. 55, no. 1, p. 176-186.

Forsyth, J.L., 1956. The glacial geology of Logan and Shelby counties. The Ohio State University, Ph.D. dissertation (unpublished), 208 p.

Fuller, M.L. and F.G. Clapp, 1912. The underground water of southwestern Ohio. U.S. Geologic Survey, Water Supply Paper 259.

Goldthwait, R.P., 1952, The 1952 field conference of Friends of the Pleistocene, Guidebook, 14 p.

_____, G.W. White and J.L Forsyth, 1961. Glacial map of Ohio. U.S. Geological Survey, Misc. Geological Investigations Map I-316, 1 map with text.

Hansen, M.C., 1991. Campbell Hill-Ohio's Summit? In Ohio Geology, Winter 1991. Ohio Department of Natural Resources, Division of Geological Survey, 8 pp.

Harker, D.H. and R.J. Bernhagen, 1943. Water supply in Clark County. Ohio Water Supply Board, 45 pp.

Harstine, L.J., 1991. Hydrologic atlas for Ohio. Ohio Department of Natural Resources, Division of Water, Water Inventory Report no. 28, 13 p., 4 plates.

Hem, J.D., 1985. Study and interpretation of the chemical characteristics of natural water. U.S. Geological Survey, Water Supply Paper 2254, 263 pp., 4 plates.

Hensel, D.R. and R.M. Hirsch, 1995. Statistical methods in water resources. Studies in Environmental Science 49: New York, Elsevier Science, 529 p.

Hill, F. C., 1878. Report on the geology of Champaign County. Ohio Geological Survey, v. 3, pt. 1, p. 491-495.

Holtan, H.N. and N.C. Lopez, 1971. USDAHL-70 model of watershed hydrology. United States Department of Agriculture, Agricultural Research Service, Technical Bulletin No. 1435, p. 84.

Hoyum, R.A., J.F. Reed, P.J. Bergeaux, H.D. Morris, H.F. Reetz, and V. W. Case., 1988. Efficient fertilizer use. IMC Fertilizer, Inc., Mundelein, Illinois, p. 71-97.

Huff, F.A. and J.R. Angel, 1992, Rainfall frequency atlas of the Midwest. National Weather Service, Midwest Climate Center and Illinois State Water Survey, Bulletin 71, p. 141.

Janssens, A., 1964. A contribution to the Pleistocene geology of Champaign County, Ohio. unpublished M.S. thesis, The Ohio State University, Department of Geology, 96 p., 6 plates.

Jones, W., 1995a. Ground water pollution potential of Champaign County, Ohio. Ohio Department of Natural Resources, Division of Water GWPP Report no. 39, 109 p.

_____, 1995b. Ground water pollution potential of Greene County, Ohio. Ohio Department of Natural Resources, Division of Water GWPP Report no. 30, 122 p.

Johnstone, D. and W.P. Cross, 1949. Elements of applied hydrology. The Ronald Press Company, New York, N.Y., p. 276.

Kaser, P., 1962. Ground-water levels in the vicinity of Eagle City, Clark County, Ohio. Ohio Department of Natural Resources, Division of Water, 82 p.

Koltun, G. F., 1995. Determination of base-flow characteristics at selected streamflow gaging sites on the Mad River, Ohio. United States Geologic Survey, Water Resources Investigation Report 95-4037, 1995.

Kulibert, R.J., 1977. Delineation of the ancestral drainage paths of the Mad River, near Dayton, Ohio. unpublished M.S. thesis, Wright State University, Department of Geology, Dayton, Ohio, 64 p., 3 plates.

Leverett F., 1897. The water resources of Indiana and Ohio. U.S. Geologic Survey 18th Annual Report Pt. 4, p. 419-559.

Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus, 1982. Hydrology for engineers. McGraw-Hill, New York, N.Y., p. 340.

Norris, S.E. and H.B. Eagon, 1971. Recharge characteristics of a watercourse aquifer system at Springfield, Ohio. Groundwater 9: 30-41.

_____ and H.C. Spicer, 1958. Geological and geophysical study of the pre-glacial Teays Valley in west-central Ohio. United States Geologic Survey Water-Supply Paper 1460-E, p. 199-231.

_____, W.P. Cross, and R.P. Goldthwait, 1948. The water resources of Montgomery County, Ohio. Ohio Department of Public Works, Bulletin 12, 83 pp.

_____, _____, and _____, 1956. The water resources of Greene County, Ohio. Ohio Department of Natural Resources, Division of Water, Bulletin 19, 52 pp.

_____, _____, _____, and E.E. Sanderson, 1952. The Water Resources of Clark County, Ohio. Ohio Department of Natural Resources, Division of Water, Bulletin 22, 82 pp.

Ohio Cooperative Extension Service, 1991. Best management practices for preventing contamination of Ohio ground and surface waters. OCES Extension Bulletin 818, 43 pp.

Ohio Department of Natural Resources, 1988. Siegenthaler Esker State Nature Preserve, Division of Natural Areas and Preserves, 4 p.

Orton, E., 1874. Geology of Greene County. Report of the Geological Survey of Ohio, vol.II. pp. 659-696.

Pettyjohn, W.A. and R. Henning, 1979. Preliminary estimate of ground-water recharge rates, related streamflow and water quality in Ohio. The Ohio State University, Water Resources Center, 323 p.

Ponce, V.M. and R.H. Hawkins, 1996. Runoff curve numbers, has it reached maturity? in Journal of Hydrologic Engineering, vol. 1, No. 1, pp. 11-19.

Quinn, M.J., 1972. A glacial geology of Champaign County, Ohio. The Ohio State University, unpublished M.S. thesis, 94 pp.

_____ and R.P. Goldthwait, 1979. Glacial geology of Champaign County, Ohio. Ohio Department of Natural Resources, Division of Geological Survey, Report of Investigations, no. 111, 17 p., 1 map with text.

Richards, B.H., A. King and C. Contrino, 1973. Gravity anomalies as indicators of ground water reserves in glacial deposits. United States Army Engineer Topographic Laboratories, Fort Belvoid, Virginia, 73 p., 3 plates.

Ritchie, A., K. Powell, and V.L. Siegenthaler, 1971. Soil survey of Champaign County, Ohio. Ohio Department of Natural Resources, Division of Lands and Soil, and United States Department of Agriculture, 82 p.

Sanderson, E.E., 1950. The climatic factors of Ohio's water resources. Ohio Department of Natural Resources, Division of Water, Bulletin 15, 130 p.

Schmidt J.J., 1982. Ground water resources of Clark County, Ohio. Department of Natural Resources, Division of Water, 1 map with text.

_____, 1985. Ground water resources of Champaign County. Ohio Department of Natural Resources, Division of Water, 1 map with text.

_____, 1991. Ground water resources of Greene County, Ohio. Department of Natural Resources, Division of Water, 1 map with text.

Schumaker, G.A., 1991a. Reconnaissance bedrock geology of the Fletcher Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C5B1.

_____, 1991b. Reconnaissance bedrock geology of the Port Jefferson Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C5C1.

_____ and E.R. Slucher, 1994. Reconnaissance bedrock geology of the Christiansburg Quadrangle. Ohio Department of Natural Resources, Geological Survey Open-file Map BG-C5A1.

Sheets, R.R. and W.P. Yost, 1994. Ground water contribution from the Silurian/Devonian carbonate aquifer to the Mad River Valley, Southwestern Ohio. Ohio Journal of Science, v. 94, n. 5, p. 138-146.

Sloto, R.A., 1988, A computer method for estimating ground water contribution to streamflow using hydrograph-separation techniques. National computer Technology Meeting, Phoenix, Arizona.

Sprowls, K.M. , 1995. Ground water pollution potential of Logan County, Ohio. Ohio Department of Natural Resources, Division of Water GWPP Report no. 36, 105 p.

_____, (ed.) 1996. State of Ohio technical guidance for sealing unused wells. State Coordinating Committee on Ground Water, 44 pp.

Squillace, P.J., 1996. Observed and simulated movement of bank-storage water. in Ground Water Journal, vol. 43, no. 1, pp 121-134.

Steenhuis, T.S., M. Winchell, J. Rossing, J.A. Zollweg, and M.F. Walter, 1995. SCS runoff equation revisited for variable-source runoff areas. in Journal of Irrigation and Drainage Engineering, vol. 121, no. 3, pp. 234-238.

Stein, R., 1974. Ohio ground water quality primary monitoring network. Ohio Environmental Protection Agency, Division of Surveillance, 25 p.

Stout, W., K. Ver Steeg and G.F. Lamb, 1943. Geology of water in Ohio. Ohio Department of Natural Resources, Division of Geologic Survey, Bulletin 44, 694 p.

Struble, R.A., 1987a. Sand and gravel resources of Champaign County, Ohio. Ohio Department of Natural Resources, Division of Geologic Survey, Report of Investigations no. 136, 1 map with text.

_____, 1987b. Sand and gravel resources of Clark County, Ohio. Ohio Department of Natural Resources, Division of Geologic Survey, Report of Investigations no. 137, 1 map with text.

Swinford, E.M., 1991a. Reconnaissance bedrock geology of the St. Paris Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4B8.

_____, 1991b. Reconnaissance bedrock geology of the Thackery Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4A8.

_____, 1992a. Reconnaissance bedrock geology of the Bellefontaine Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4C7.

_____, 1992b. Reconnaissance bedrock geology of the DeGraff Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4C8.

_____, 1992c. Reconnaissance bedrock geology of the Kings Creek Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4B6.

_____, 1992d. Reconnaissance bedrock geology of the Mechanicsburg Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4A5.

_____, 1992e. Reconnaissance bedrock geology of the Milford Center Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4B4.

_____, 1992f. Reconnaissance bedrock geology of the North Lewisburg Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4B5.

_____, 1992g. Reconnaissance bedrock geology of the Northville Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4B7.

_____, 1992h. Reconnaissance bedrock geology of the Urbana West Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4A7.

_____, 1991a. Reconnaissance bedrock topography of the Thackery Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4A8.

_____ and E.R. Slucher, 1994. Reconnaissance bedrock geology of the Urbana East Quadrangle. Ohio Department of Natural Resources Division of Geological Survey Open-file Map BG-C4A6.

_____, 1991b. Reconnaissance bedrock topography of the Urbana East Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4A6.

_____, 1991c. Reconnaissance bedrock topography of the Urbana West Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4A7.

_____, 1992a. Reconnaissance bedrock topography of the Mechanicsburg Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4A5.

_____, 1992b. Reconnaissance bedrock topography of the St. Paris Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4B8.

_____ and E.R. Slucher, 1995. Regional bedrock geology of the Bellefontaine, Ohio, 30 x 60 minute quadrangle. Ohio Department of Natural Resources, Division of Geological Survey, Map No. 8.

Thornthwaite, C.W. and J.R. Mather, 1955. The water budget and its use in irrigation. in United States Department of Agriculture, Water-The Yearbook of Agriculture, 1955, pp. 346-358.

Walton, W.C. and G.D. Scudder, 1960. Ground water resources of the valley-train deposits in the Fairborn area, Ohio. Ohio Department of Natural Resources, Division of Water, Technical Report 3, 57 p.

United States Army Corps of Engineers, Hydrologic Engineering Center, 1990. HEC-1 Flood Hydrograph Package, Users Manual. Davis, California, 283 pp.

United States Department of Agriculture, Soil Conservation Service, 1979. Flood hazard Study, Upper Mad River, Logan County, Ohio, 17 p.

_____,1985. National engineering handbook. Section 4, Hydrology, 604 pp.

_____, 1970. Ohio Irrigation Guide, 54 p.

United States Department of Commerce, 1992. Monthly normals of temperature, precipitation and heating and cooling days 1961-1990, Ohio. National Oceanic and Atmospheric Administration, National Climatic Data Center, Climatography of the United States, no. 81, 30 p.

United States Department of Interior, Bureau of Reclamation, 1965. Design of small dams, 611 p.

United States Geologic Survey, 1991. Water resources data Ohio water year 1991. United States Geologic Survey Water-Data report OH-91-2, 430 p.

Vormelker, J.D., 1990a. Reconnaissance bedrock topography of the North Lewisburg Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4B5.

_____, 1990b. Reconnaissance bedrock topography of the Northville Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4B7.

_____, 1991a. Reconnaissance bedrock topography of the Christiansburg Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C5A1.

_____, 1991b. Reconnaissance bedrock topography of the Fletcher Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C5B1.

_____, 1991c. Reconnaissance bedrock topography of the Milford Center Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4B4.

_____, 1991d. Reconnaissance bedrock topography of the Port Jefferson Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C5C1.

_____, 1992. Reconnaissance bedrock topography of the Kings Creek Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BT-C4B6.

_____ and E.M. Swinford, 1992a. Reconnaissance bedrock topography of the DeGraff Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4C8.

_____ and _____, 1992b. Reconnaissance bedrock topography of the Bellefontaine Quadrangle. Ohio Department of Natural Resources, Division of Geological Survey Open-file Map BG-C4C7.

Waldron, A. C., 1986. Pesticide use on major crops in the Ohio River Basin of Ohio. Ohio Cooperative Extension Service. 267 pp.

Unpublished Data

Ohio Department of Natural Resources, Division of Water, Water Resources Section. Unpublished water well log reports for Champaign County.

Ohio Department of Natural Resources, Division of Water, Ground Water Province I, Upper Mad River.

United States Geological Survey, Water Resources Division, Unpublished gain/loss study for Champaign and Logan Counties, 1995.

WELL LOG AND DRILLING REPORT

737160

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 9

COUNTY Logan TOWNSHIP Monroe SECTION/LOT No. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Wenger's Produce Jerry Wenger PROPERTY ADDRESS 5025 Twp Rd. 166 West Liberty (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY N. E. of West Liberty 5 miles off C Rd. 5 to C Rd. 29 & Twp 166

CONSTRUCTION DETAILS

CASING

Borehole Diameter 8 3/4 in.

1 Diameter 6 in. Length 139 ft. Wall Thickness SDR17 in.

2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.

Type: 1 Steel 2 Galv. [X] PVC 1 2 Other ____

Joints: 1 Threaded 2 Welded [X] Solvent 1 2 Other ____

Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN

Type (wire wrapped, louvered, etc.) None Material ____

Length ____ ft. Diameter ____ in.

Set between ____ ft. and ____ ft. Slot ____

GROUT

Material Pole Clay & Cutting Volume used 200 lbs.

Method of installation pour in

Depth: placed from 139 ft. to ground ft.

GRAVEL PACK (Filter Pack)

Material None Volume used ____

Method of installation ____

Depth: placed from ____ ft. to ____ ft.

Pitless Device [X] Adapter ☐ Preassembled unit

Use of Well Domestic

[X] Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____

Date of Completion Feb. 28, 1992

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Yellow Clay	0	2
Gravel & Sand	2	33
Gray Clay & Gravel	33	139
Limestone	139	305
Water encountered at 180' & 299'		

WELL TEST

☐ Bailing ☐ Pumping* ☐ Other Air

Test rate 35 gpm Duration of test ____ hrs.

Drawdown 280 ft.

Measured from: [X] top of casing ☐ ground level ☐ Other ____

Static Level (depth to water) ground ft. Date: Feb. 28, 1992

Quality (clear, cloudy, taste, odor) Clear

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

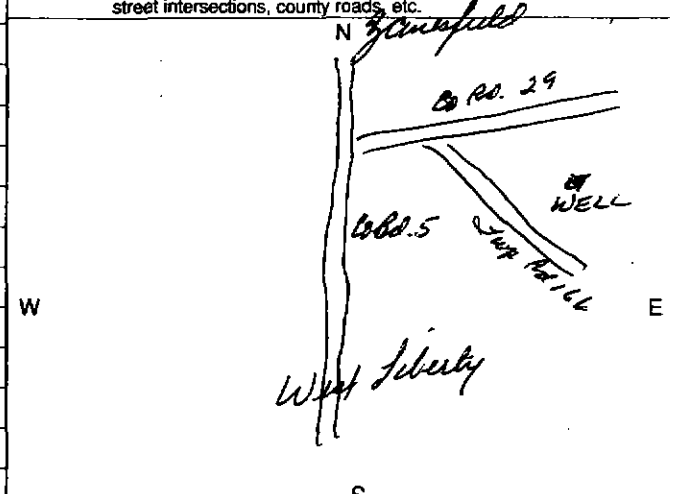
Type of pump Hand Capacity 20 gpm

Pump set at 120' ft.

Pump installed by W. D. Bill Harpest

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space needed to complete Well Log use next consecutively numbered form.

DNR 7802.90

Drilling Firm W. D. Bill Harpest

Address 205 Rd. 274

City, State, Zip Bellefontaine, Ohio 43311

Signed William D. Harpest

Date Feb. 28, 1992

ODH Registration Number 424

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

County Permit No. _____

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

568979

COUNTY Logan TOWNSHIP Liberty SECTION OF TOWNSHIP 34

OWNER Harold Yoder ADDRESS 883 St. Rt. 508, W. Liberty

LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 20

Type of screen — Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 25 gpm Duration of test 1 hrs

Drawdown 3 ft Date Oct. 1, 1980

Static level (depth to water) 36 ft

Quality (clear, cloudy, taste, odor) Clear

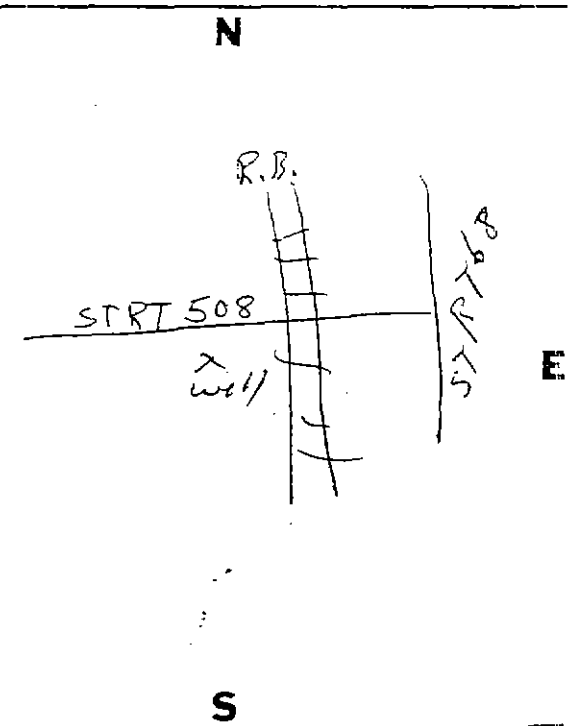
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Red clay	[illegible]	6 ft
gravel	6	54

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE Oct. 14, 1980

ADDRESS 8401 N. Rt. 68 West Liberty, Oh. SIGNED Jerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

652534

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY - SELF-TRANSCRIBING

Permit Number _____

COUNTY Logan TOWNSHIP Liberty SECTION OF TOWNSHIP 29

OWNER Littleton Funeral Home ADDRESS U.S. Rt. 68 S.

LOCATION OF PROPERTY Same 5591 Rt 68

CONSTRUCTION DETAILS

Casing diameter 5½ o.d. pvc Length of casing 69'

Type of screen .035 slot pvc Length of screen 2'

Type of pump —

Capacity of pump —

Depth of pump setting 60'

Date of completion 9-10-86

Rotary ☒ or Cable ☐

BAILING OR PUMPING TEST (specify one by circling) A/R

Test rate 25 gpm Duration of test 1 hrs

Drawdown — ft Date _____

Static level (depth to water) 43 ft

Quality (clear, cloudy, taste, odor) Clear

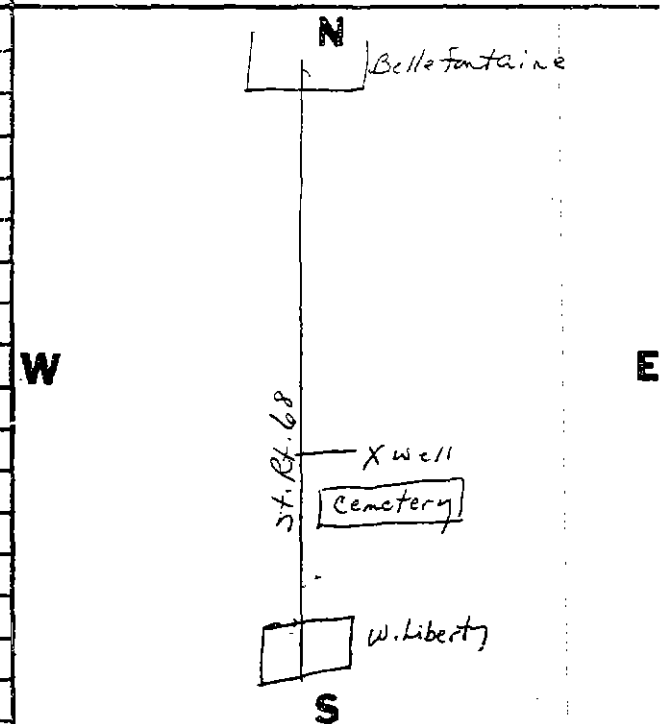
Pump installed by Wells Plumbing

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
gravel	0 ft	35 ft
clay	35	58
gravel	58	69

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802

DRILLING FIRM Eaton Well Drilling REGISTRATION NUMBER 43 DATE 9-10-86

ADDRESS 8401 N. Rt. 68, W. Liberty SIGNED Jerry Eaton

3

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer's Copy / Pink - Driller's Copy / Green - Local Health Dept. Copy

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

685541

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number _____

COUNTY CHAMPAIGN TOWNSHIP SALEM SECTION OF TOWNSHIP 25
OWNER DETWILER FARMS PROPERTY ADDRESS W. LIBERTY, OH.
LOCATION OF PROPERTY TOM'S 7419 UPPER VALLEY PK.

CONSTRUCTION DETAILS

CASING
Casing Diameter 8 in. Length of Casing 49 ft.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) SLOT Material PVC
Length 23 ft. Diameter 8 in.
Set between 26 ft. and 49 ft. Slot .085

GROUT
Material GRAVEL & CUTTINGS Volume used
Method of installation SHOVEL
Depth: placed from ft. to ft.
☐ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other

BAILING OR PUMPING TEST
(specify one by circling)

WELL TEST
Test rate 200+ gpm Duration of test 1½ hrs.
Drawdown (water level during pumping) 5 ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other
Static Level (depth to water) 12 ft. Date: 7-12-88
Quality (clear, cloudy, taste, odor) CLEAR

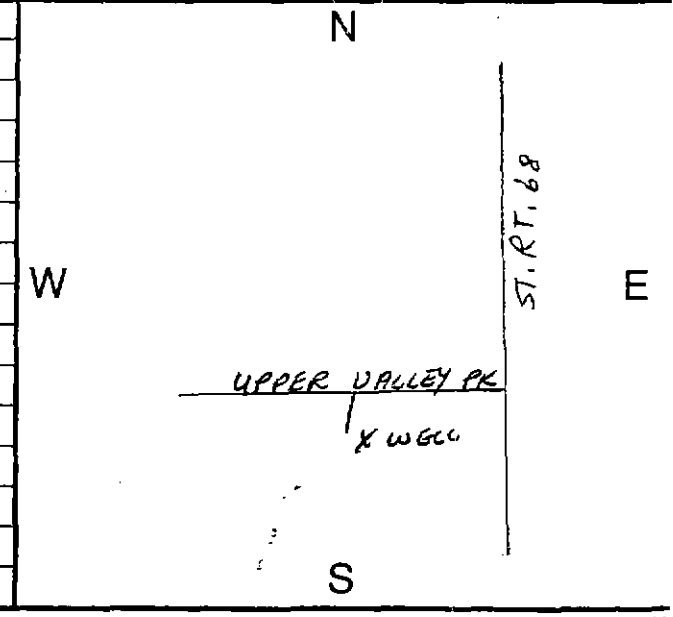
PUMP
Type of pump Capacity gpm
Pump set at ft.
Pump installed by
Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well IRRIGATION

WELL LOG*

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand	From	To
TOP SOIL	0 ft.	4 ft.
GRAVEL	4	49

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.88

DRILLING FIRM EATON WELL DRLG. SIGNED Marcella Eaton
ADDRESS 8401 N. Rt. 68 DATE 7-13-88
CITY, STATE, ZIP W. LIBERTY, OH. 43357 ODH REGISTRATION NUMBER 41

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE. COLS.. OHIO 43224

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

630456

COUNTY Champaign TOWNSHIP Harrison SECTION OF TOWNSHIP 3

OWNER Sam Plank ADDRESS 2395 Sinkhole Rd, West Liberty, O

LOCATION OF PROPERTY same

CONSTRUCTION DETAILS

Casing diameter 6" & PVC Length of casing 93'

Type of screen PVC .085 Slot Length of screen 2'

Type of pump —

Capacity of pump —

Depth of pump setting 75'

Date of completion —

BAILING OR PUMPING TEST (AIR)
(specify one by circling)

Test rate 25 gpm Duration of test 1 hrs

Drawdown — ft Date Aug 14, 1985

Static level (depth to water) 48 ft

Quality (clear, cloudy, taste, odor) clear

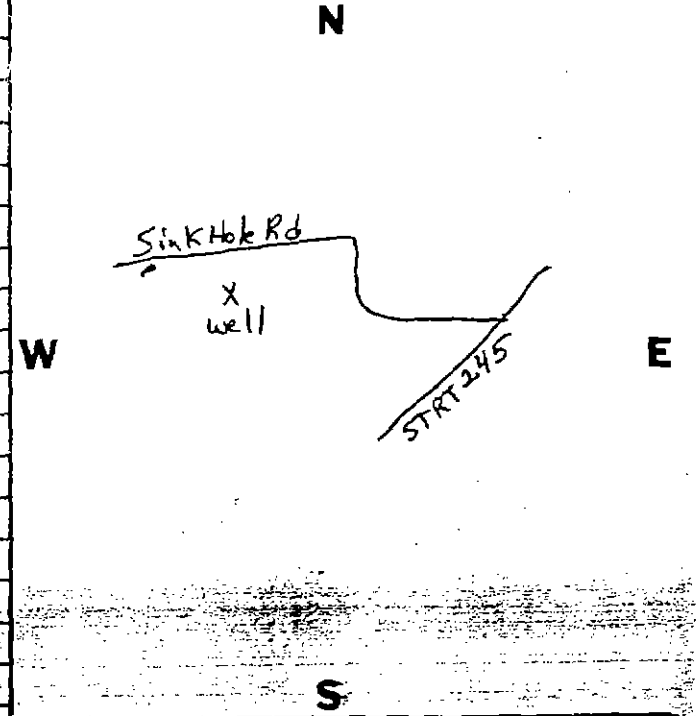
Pump installed by Lloyd Kells

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
clay	0 ft	45 ft
dry gravel	45	60
clay	60	85
gravel	85	91
clay	91	93

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE Aug 23, 1985

ADDRESS 8401 N. RT 68, West Liberty, O SIGNED Jerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

ONR 7302.93
TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Division of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

1/4/66

Permit Number 115

COUNTY Champaign TOWNSHIP Harrison SECTION/LOT No. 2 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Melvin Lattimer PROPERTY ADDRESS 2551 ST. RT. 245 (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY S.E. Corner of Hite Rd + St. Rt. 245 W.

CONSTRUCTION DETAILS

CASING
1 Diameter 5½ O.D. in. Length 57 ft. Borehole Diameter 7 7/8 in. Wall Thickness SDR-17 in.
2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: 1 2 Steel 1 2 Galv. X 2 PVC 1 2 Other ____
Joints: 1 2 Threaded 1 2 Welded X 2 Solvent 1 2 Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 2 ft. Diameter 5½ O.D. in.
Set between 48 ft. and 50 ft. Slot .085

GROUT
Material Benseal Volume used 100#
Method of installation Tremie
Depth: placed from 46 ft. to Surface ft.

GRAVEL PACK (Filter Pack)
Material Grit Sand Volume used 30 gal
Method of installation Poured
Depth: placed from 57 ft. to 46 ft.

Pitless Device X Adapter ☐ Preassembled unit
Use of Well Domestic
X Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion 8-9-93

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Red Clay	0	7
Gravely Red Clay	7	31
Gravel	31	50
Blue Clay	50	57

WELL TEST

☐ Bailing ☐ Pumping* X Other Air
Test rate 15 gpm Duration of test 1 hrs.
Drawdown ____ ft.
Measured from: ☐ top of casing X ground level ☐ Other ____
Static Level (depth to water) 42 ft Date: 8-9-93
Quality (clear, cloudy, taste, odor) Clear

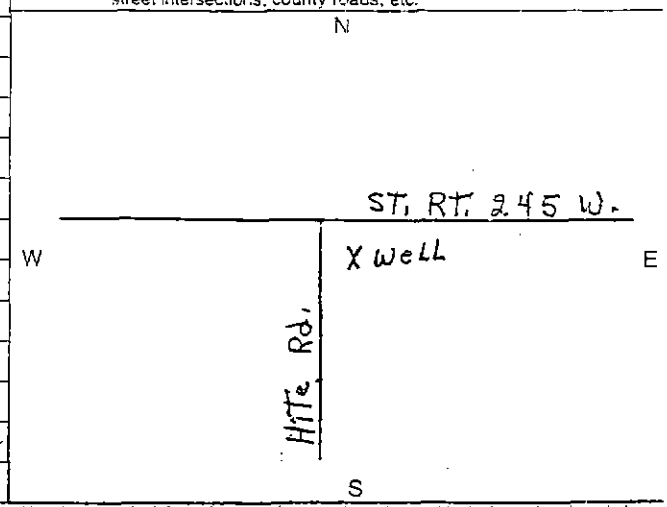
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 18 gpm
Pump set at 50 ft.
Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Eaton Well Drilling Signed Donald Eaton

Address 8800 N. Rt. 68 Date 8-10-93

City, State, Zip West Liberty, OH. 43357 ODH Registration Number 41

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

6

5173

120

WELL LOG AND DRILLING REPORT

696647

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-6739

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number 50

COUNTY Champaign TOWNSHIP Salem SECTION/LOT NO. 26

OWNER/BUILDER (CIRCLE ONE OR BOTH) Larry Thornburg PROPERTY ADDRESS 8966 N Rt 68 (CIRCLE ONE) (ADDRESS OF WELL LOCATION)

LOCATION OF PROPERTY 3/4 m S-W. Liberty on St Rt 68 (W. side)

CONSTRUCTION DETAILS

CASING
Diameter 5 1/2 OD in. Length 65 ft. Wall Thickness SDR 17 in.
Type: ☐ Steel ☐ Galv. ☑ PVC ☐ Other
Joints: ☐ Threaded ☐ Welded ☑ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) slot Material PVC
Length 10 ft. Diameter 5 1/2 OD in.
Set between 55 ft. and 65 ft. Slot .085
☑ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other
Date of completion 5-3-89

GROUT
Material cuttings - Bensseal Volume used 2 bgs.
Method of installation Tremie
Depth: placed from 0 ft. to 40 ft.

GRAVEL PACK
Material grit sand Volume used 60 gallon
Method of installation poured
Depth: placed from 60 ft. to 53 ft.

Pitless Device ☑ Adapter ☐ Preassembled unit
Use of Well domestic

PUMP

Type of pump
Capacity 10 gpm
Pump set at 40' ft.
Pump installed by

WELL TEST

Bailing ☐ or Pumping ☐ (air)
Test rate 20 gpm Duration of test 1 hrs
Drawdown 5 ft.
Measured from: ☐ top of casing ☑ ground level ☐ Other
Static Level (depth to water) 11 ft. Date 5-3-89
Quality (clear, cloudy, taste, odor) clear
(Attach a copy of the pumping test record, per 1521.05, ORC)

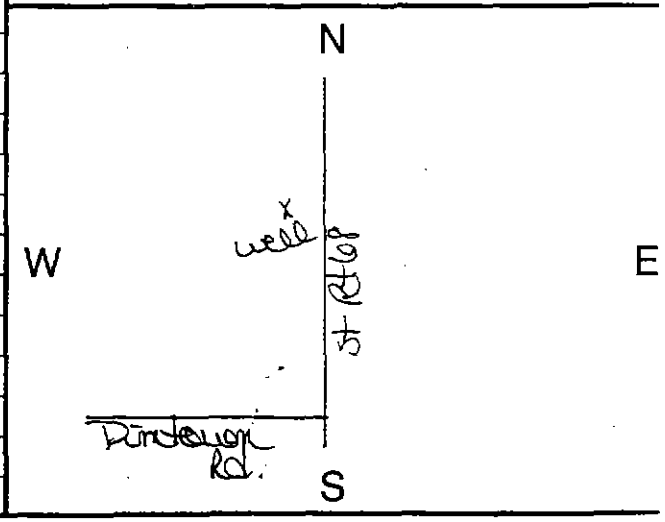
WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
brown clay	0 ft.	3 ft.
coarse gravel	3	65

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form

DNR 7802.88

DRILLING FIRM Cator Well Drilling SIGNED Chris Hamilton
ADDRESS 8401 N Rt 68 DATE 5-4-89
CITY, STATE, ZIP W. Liberty, OH 43357 ODH REGISTRATION NUMBER 41

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's Copy Pink - Driller's Copy Green - Local Health Dept. Copy

7

DNR 7802.92
TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

159428

Permit Number 135

COUNTY Champaign TOWNSHIP Salem SECTION/LOT No. _____ (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Brad Herron Const. PROPERTY ADDRESS 6764 Ludlow Rd. (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY _____

CONSTRUCTION DETAILS

CASING
Borehole Diameter 7 7/8 in.
X Diameter 5 in. Length 86 ft. Wall Thickness SDR21 in.
2 Diameter _____ in. Length _____ ft. Wall Thickness _____ in.
Type: 1 Steel 1 Galv. X PVC 1 2 Other _____
Joints: 1 Threaded 1 Welded X Solvent 1 2 Other _____
Liner: Length N A Type ——— Wall Thickness ——— in.

SCREEN
Type (wire wrapped, louvered, etc.) wire wrapped Material PVC
Length 10 ft. Diameter 5 in.
Set between 86 ft. and 96 ft. Slot _____

GROUT Granular
Material Bentonite Volume used 175 #
Method of installation Tremie Pipe
Depth: placed from 86 ft. to surface ft.

GRAVEL PACK (Filter Pack)
Material 5/12 GP Volume used 300 #
Method of installation _____
Depth: placed from 86 ft. to 96 ft

Pitless Device ☐ X Adapter ☐ Preassembled unit
Use of Well Domestic
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other _____
Date of Completion 9-23-92

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
C	0	8
S	8	20
S+G	20	51
C	51	53
C	53	63
S+G	63	96
First Well 9-22-92 (Dry)		
C	0	8
S	8	20
S+G	20	51
C	51	53

*If additional space is needed to complete well log, use next consecutively numbered form.

WELL TEST

☐ Bailing ☒ Pumping* ☐ Other _____
Test rate 15+ gpm Duration of test _____ hrs.
Drawdown _____ ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other _____
Static Level (depth to water) 65 ft. Date: 9-23-92
Quality (clear, cloudy, taste, odor) Clear

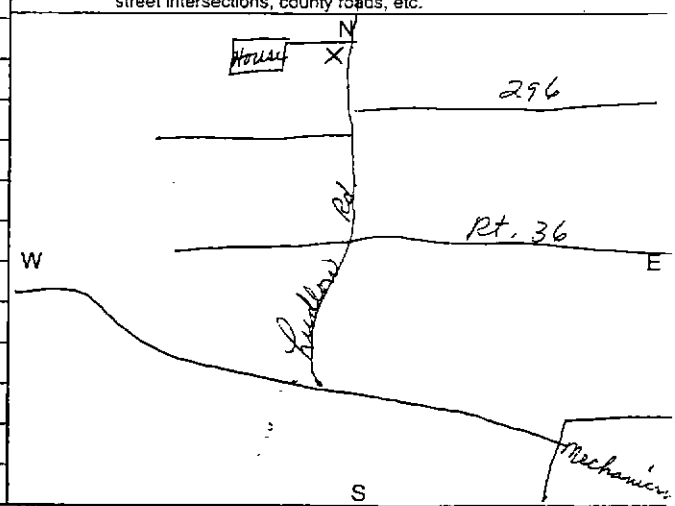
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 1/2 HP gpm
Pump set at 80' ft.
Pump installed by R.C. Barry Inc.

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



Drilling Firm R.C. Barry Inc.
Address 6767 W. Broad St.
City, State, Zip Galloway Ohio 43119

I hereby certify the information given is accurate and correct to the best of my knowledge.
Signed Perry Blankenship by H
Date 9-23-92
ODH Registration Number 368

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224
Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

8

WELL LOG AND DRILLING REPORT

736385

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 118

COUNTY Champaign TOWNSHIP Salem (SECTION) LOT No. 13 (CIRCLE ONE)

(OWNER) BUILDER (CIRCLE ONE OR BOTH) Stephen Lapp PROPERTY ADDRESS 7713 McClain Rd (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1/4 Mi N. of Mennonite Church Rd on McClain Rd (Eastside)

CONSTRUCTION DETAILS

CASING
1 Diameter 5½ O.D. in. Length 109 ft. Wall Thickness SDR 17 in.
2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: 1 Steel 1 Galv. ☒ PVC 1 2 2 2 Other ____
Joints: 1 Threaded 1 Welded ☒ Solvent 1 2 2 2 Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 10 ft. Diameter 5½ O.D. in.
Set between 99 ft. and 109 ft. Slot .085

Borehole Diameter 7 7/8 in.

GROUT
Material Benseal Volume used 150#
Method of installation Tremie
Depth: placed from 80 ft. to Surface ft.

GRAVEL PACK (Filter Pack)
Material grit Sand Volume used 150 gal
Method of installation Poured
Depth: placed from 109 ft. to 80 ft.

Pitless Device ☒ Adapter ☐ Preassembled unit
Use of Well Domestic / Farm
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion 8-30-91

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Red Clay	0	7
Gravely Clay	7	94
Gravel - Red	94	109

WELL TEST

☐ Bailing ☐ Pumping* ☒ Other Air
Test rate 30 gpm Duration of test 1 hrs.
Drawdown — ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other ____
Static Level (depth to water) 70 ft. Date: 8-30-91
Quality (clear, cloudy, taste, odor) Clear

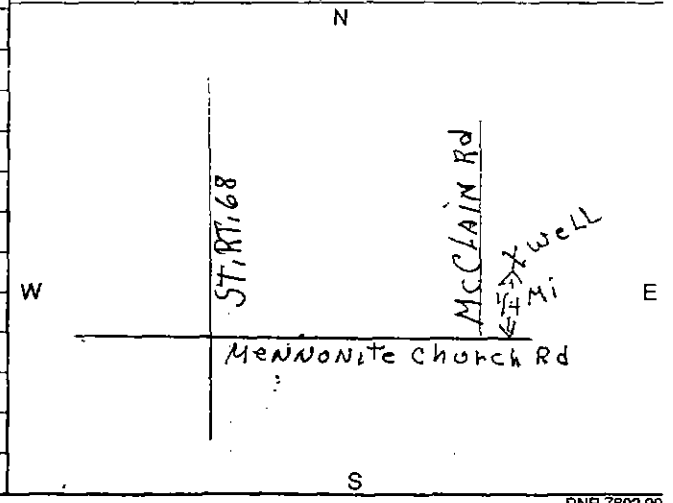
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 18 gpm
Pump set at 90 ft.
Pump installed by Eaton Well + Pump

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7602.90

Drilling Firm Eaton Well Drilling Signed Donald Eaton
Address 8800 N Rt 68 Date 9-4-91
City, State, Zip West Liberty OH 43357 ODH Registration Number 41

9

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

685542

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number _____

COUNTY CHAMPAIGN TOWNSHIP SALEM SECTION OF TOWNSHIP 20

OWNER DETWILER FARMS PROPERTY ADDRESS W. LIBERTY, OH.

LOCATION OF PROPERTY JOHN'S 259 ST. RT. 507

CONSTRUCTION DETAILS

CASING
Casing Diameter 8 in. Length of Casing 49 ft.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) SLOT Material PVC
Length 19 ft. Diameter 8 in.
Set between 32 ft. and 51 ft. Slot .085

GROUT
Material GRAVEL Volume used
Method of installation SHOVEL
Depth: placed from 0 ft. to 49 ft.
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other

BAILING OR PUMPING TEST
(specify one by circling)

AIR

WELL TEST
Test rate 700 gpm Duration of test 1½ hrs.
Drawdown (water level during pumping) 5 ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other
Static Level (depth to water) 7 ft. Date: 7-12-88
Quality (clear, cloudy, taste, odor) CLEAR

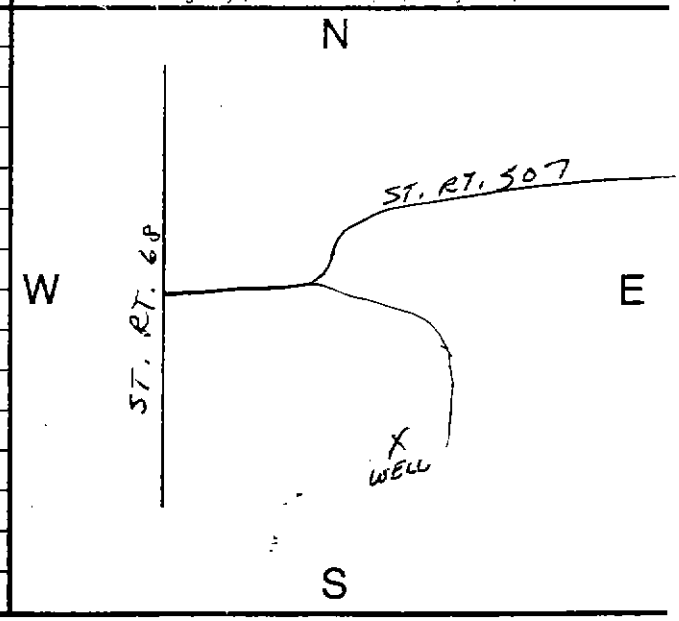
PUMP
Type of pump Capacity gpm
Pump set at ft.
Pump installed by
Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well IRRIGATION

WELL LOG*

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand	From	To
TOP SOIL	0 ft.	6 ft.
GRAVEL	6	51

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.88

DRILLING FIRM Eaton Well Drlg SIGNED
ADDRESS 8401 N. Rt-68 DATE 7-13-88
CITY, STATE, ZIP W. Liberty, OH 43357 ODH REGISTRATION NUMBER 41 10A

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

749317

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Permit Number 146

COUNTY Champaign TOWNSHIP Salem SECTION/LOT No. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) John L. DeTivoler PROPERTY ADDRESS 259 (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY St Rt 507 West Liberty O 43357

CONSTRUCTION DETAILS

CASING Borehole Diameter 5 7/8 in.

1 Diameter 6 in. Length ____ ft. Wall Thickness .142 in.

2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.

Type: 1 Steel 2 (Galv.) 1 PVC 2 1 2 Other ____

Joints: 1 Threaded 2 1 Welded 2 1 Solvent 2 1 2 Other ____

Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN

Type (wire wrapped, louvered, etc.) ____ Material ____

Length ____ ft. Diameter ____ in.

Set between ____ ft. and ____ ft. Slot ____

GROUT

Material Bentonite Volume used ____

Method of installation ____

Depth: placed from ____ ft. to ____ ft.

GRAVEL PACK (Filter Pack)

Material ____ Volume used ____

Method of installation ____

Depth: placed from ____ ft. to ____ ft.

Pitless Device ☐ Adapter ☐ Preassembled unit

Use of Well ____

☐ Rotary ☑ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____

Date of Completion 10/1/92

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Top Soil	0	2'
Gravel & Sand	2'	20'
Gravel & Water	20'	26'
26' Encountered water		

WELL TEST

☑ Bailing ☐ Pumping* ☐ Other ____

Test rate 10 gpm Duration of test 1 hr hrs

Drawdown 4 ft

Measured from: ☑ top of casing ☐ ground level ☐ Other ____

Static Level (depth to water) ____ ft. Date: ____

Quality (clear) cloudy, taste, odor) ____

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

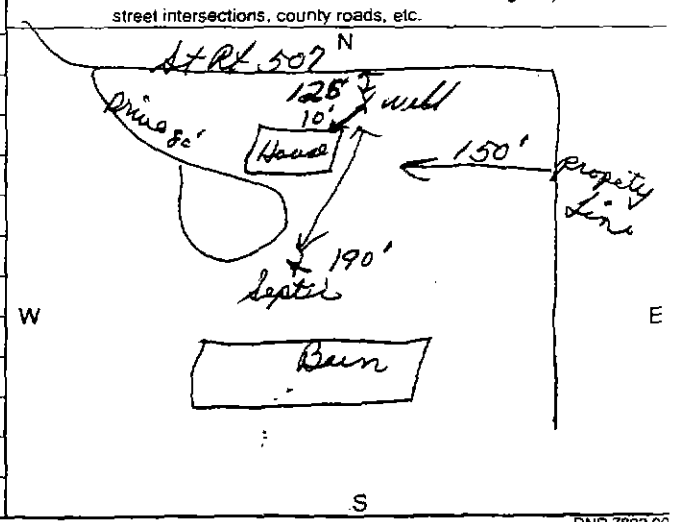
Type of pump ____ Capacity ____ gpm

Pump set at ____ ft.

Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Tri-County Drilling Inc

Address 2050 E. Kingscreek Rd

City, State, Zip Urbana O 43078

Signed Jerry Trout

Date 10/9/92

ODH Registration Number ____

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

10B

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

685541

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number _____

COUNTY CHAMPAIGN TOWNSHIP SALEM SECTION OF TOWNSHIP 25
OWNER DETWILER FARMS PROPERTY ADDRESS W. LIBERTY, OH.
LOCATION OF PROPERTY TOM'S 7419 UPPER VALLEY PK.

CONSTRUCTION DETAILS

CASING
Casing Diameter 8 in. Length of Casing 49 ft.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) SLOT Material PVC
Length 23 ft. Diameter 8 in.
Set between 26 ft. and 49 ft. Slot .085

GROUT
Material GRAVEL & CUTTINGS Volume used
Method of installation SHOVEL
Depth: placed from ft. to ft.
☐ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other

BAILING OR PUMPING TEST
(specify one by circling)

WELL TEST
Test rate 700+ gpm Duration of test 1½ hrs.
Drawdown (water level during pumping) 5 ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other
Static Level (depth to water) 12 ft. Date: 7-12-88
Quality (clear, cloudy, taste, odor) CLEAR

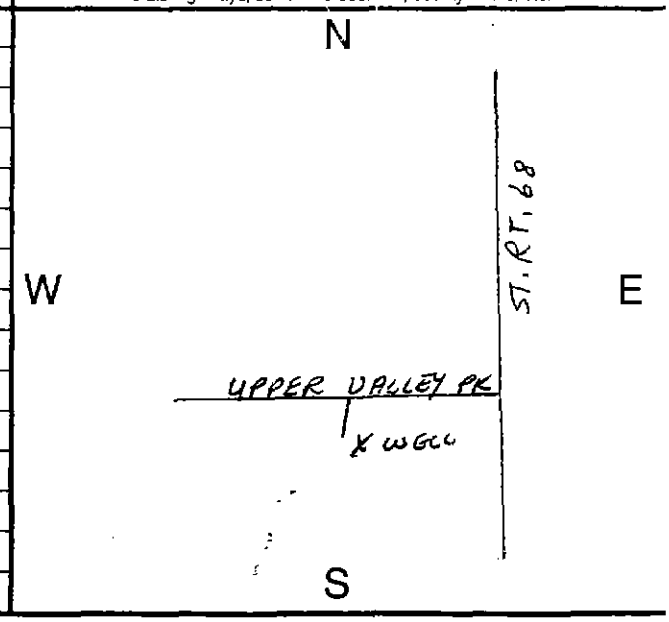
PUMP
Type of pump Capacity gpm
Pump set at ft.
Pump installed by
Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well IRRIGATION

WELL LOG*

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand	From	To
TOP SOIL	0 ft.	4 ft.
GRAVEL	4	49

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.88

DRILLING FIRM EATON WELL DRLG. SIGNED Marcella Eaton
ADDRESS 8401 N. RT. 68 DATE 7-13-88
CITY, STATE, ZIP W. LIBERTY, OH. 43357 ODH REGISTRATION NUMBER 41

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE. COLS.. OHIO 43224

County Permit No. _____

NO CARBON PAPER NECESSARY - SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

539388

COUNTY Champaign TOWNSHIP Harrison SECTION OF TOWNSHIP 35

OWNER Roseann Carney ADDRESS 2547 Couchman Rd.

LOCATION OF PROPERTY _____

CONSTRUCTION DETAILS

Casing diameter 5 3/8 Length of casing 87

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion _____

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 16 gpm Duration of test ½ hrs

Drawdown 25 ft Date 7/15/80

Static level (depth to water) 27 ft

Quality (clear, cloudy, taste, odor) clear

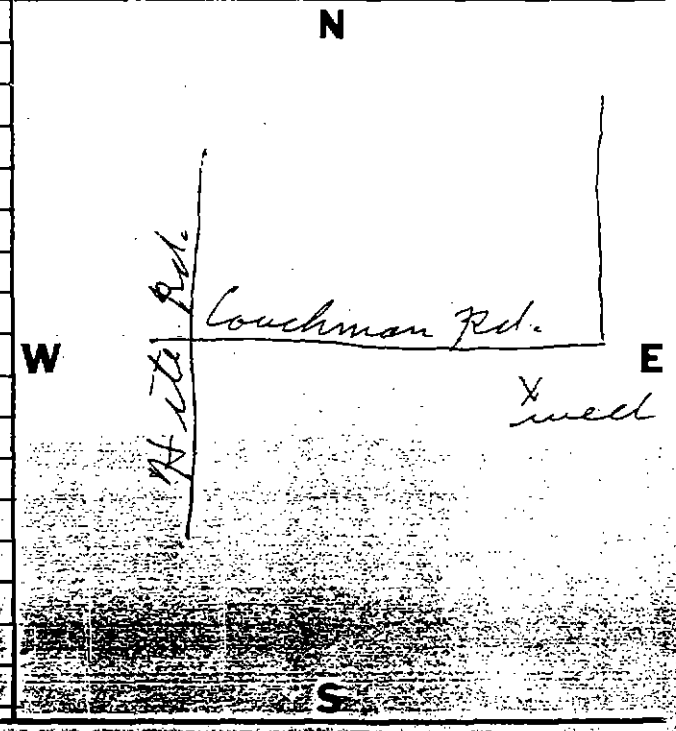
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
clay	0 ft	15 ft
hard pan	15	40
sand	40	87

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Rupert & Son DATE 7/15/80

ADDRESS 1600 W. Stokes Wilmington SIGNED Wm. Rupert

*If additional space is needed to complete well log, use next consecutive numbered form.

12

WELL LOG AND DRILLING REPORT

733074

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 79

COUNTY Champaign TOWNSHIP Harrison SECTION/LOT No. 8 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) John Murray PROPERTY ADDRESS Couchman Rd (ADDRESS OF WELL LOCATION)

LOCATION OF PROPERTY 100 yds W. of Wesley Chapel Rd. on Couchman Rd (North Side)

CONSTRUCTION DETAILS

CASING
1 Diameter 5½" in. Length 96 ft. Wall Thickness SDR17 in.
2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: 1 Steel 1 Galv. X PVC 1 2 Other ____
Joints: 1 Threaded 1 Welded X Solvent 1 2 Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 2' ft. Diameter 5½ O.D. in. Slot .085
Set between 94 ft. and 96 ft.

Borehole Diameter 7⅞ in.

GROUT
Material Bensed Volume used 150 lbs
Method of installation tremie
Depth: placed from 80 ft. to 0 ft.

GRAVEL PACK (Filter Pack)
Material Grit Sand Volume used 30 gal
Method of installation poured
Depth: placed from 76 ft. to 88 ft.

Pitless Device X Adapter ☐ Preassembled unit
Use of Well Domestic
X Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion July 5, 1991

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Red clay	0	17
Sand & Gravel	17	48
blue clay	48	88
Coarse Sand	88	96

If additional space is needed to complete well log, use next consecutively numbered form.

WELL TEST

☐ Bailing ☐ Pumping* X Other air
Test rate 15 gpm Duration of test 1 hr hrs.
Drawdown ____ ft.
Measured from: ☐ top of casing X ground level ☐ Other ____
Static Level (depth to water) 39 ft. Date: 7-5-91
Quality (clear, cloudy, taste, odor) Clear

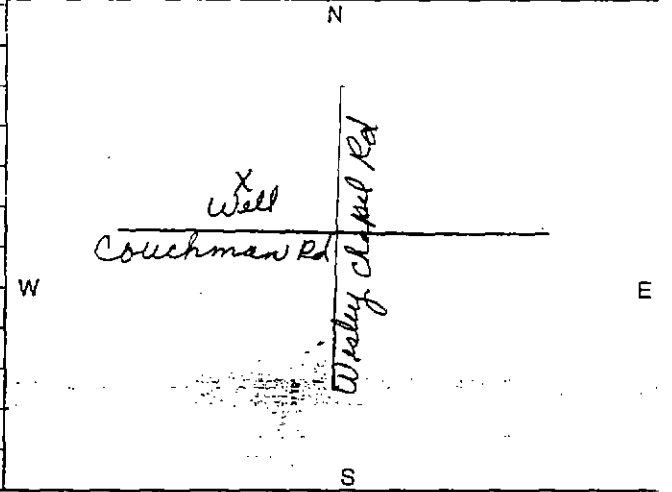
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 80 ft.
Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



DNR 7802.90

Drilling Firm Eaton Well Drilling Signed Lois Miller
Address 8401 Rt 68 N. Date 7-8-91
City, State, Zip West Liberty, Oh. 43357 ODH Registration Number #41

13

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

WELL LOG AND DRILLING REPORT

736423

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 106

COUNTY Champaign TOWNSHIP Harrison (SECTION) LOT No. 20 (CIRCLE ONE)

(OWNER) BUILDER (CIRCLE ONE OR BOTH) Jeff + Karen Armenthout PROPERTY ADDRESS 5812 Couchman Rd (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1/4 Mi. E. of Calland Rd on Couchman Rd. (Northside)

CONSTRUCTION DETAILS

CASING
[1] Diameter 5 1/2 O.D. in. Length 60 ft. Wall Thickness SDR17 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: [1] Steel [2] Galv. [X] PVC [1] [2] Other ____
Joints: [1] Threaded [2] Welded [X] Solvent [1] [2] Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter 7 7/8 in.

GROUT
Material Benseal Volume used 75 #
Method of installation Tremie
Depth: placed from ground ft. to 20 ft.

GRAVEL PACK (Filter Pack) 20-55 Native Cuttings
Material Grit Sand Volume used 30 gal
Method of installation Poured
Depth: placed from 55 ft. to 60 ft.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 2 1/2 ft. Diameter 5 1/2 O.D. in.
Set between 58 ft. and 60 ft. Slot .085

Pitless Device [X] Adapter [ ] Preassembled unit
Use of Well Domestic
[X] Rotary [ ] Cable [ ] Augered [ ] Driven [ ] Dug [ ] Other ____
Date of Completion 8-19-91

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Red Clay	0	5
Coarse Gravel	5	60

WELL TEST

[ ] Bailing [ ] Pumping* [X] Other Air
Test rate 15 gpm Duration of test 1 hrs.
Drawdown 0 ft.
Measured from: [ ] top of casing [X] ground level [ ] Other ____
Static Level (depth to water) 42 ft. Date: 8-19-91
Quality (clear, cloudy, taste, odor) Clear

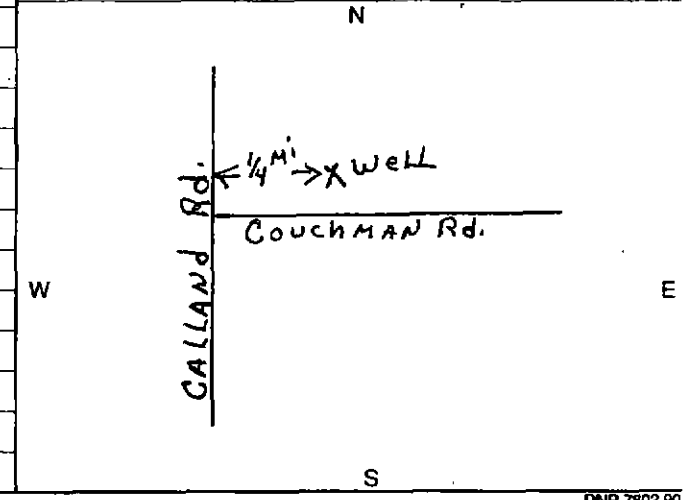
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 55 ft.
Pump installed by Homeowner

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Eaton Well Drilling
Address 8800 N. Rt. 68
City, State, Zip West Liberty OH 43357

Signed Donald Eaton
Date 8-20-91
ODH Registration Number 41

15

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

644028

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP 36

OWNER MacOChee Farms ADDRESS 6501 Upper Valley Pike, West Liberty, O

LOCATION OF PROPERTY same

CONSTRUCTION DETAILS

Casing diameter 6" ID - PVC Length of casing 45'

Type of screen PVC .085 slot Length of screen 2'

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST (specify one by circling) AIR

Test rate 35 gpm Duration of test 1 hr

Drawdown — ft Date May 10, 1984

Static level (depth to water) 8' ft

Quality (clear, cloudy, taste, odor) clear

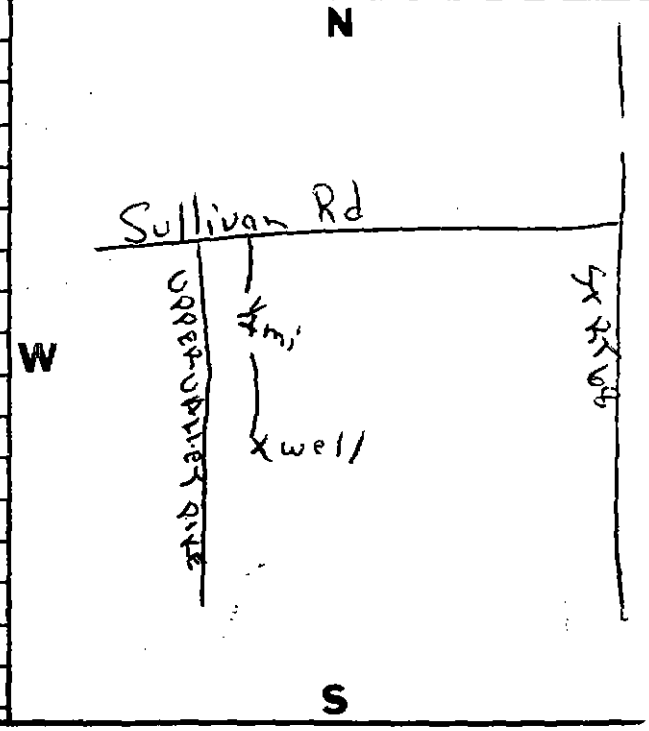
Pump installed by Well's Plumbing + Heating

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
gravel	0 ft	45 ft

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE May 14, 1984

ADDRESS 8401 N. RT. 68, W. Liberty, O SIGNED Jerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

18

ORIGINAL COPY – ODNR DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

690178

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number _____

COUNTY CHAMPAIGN TOWNSHIP SALEM SECTION OF TOWNSHIP 24
OWNER MARVIN WOOD CONST. PROPERTY ADDRESS URBANA
LOCATION OF PROPERTY 6709 W. KANAGY RD.

CONSTRUCTION DETAILS

CASING
Casing Diameter 5 1/2 in. Length of Casing 65 ft.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) SLOTTED Material PVC
Length 2 ft. Diameter 5 1/2" O.D. in.
Set between 63 ft. and 65 ft. Slot

GROUT
Material BENSEAL Volume used 100#
Method of installation TREMIE
Depth: placed from 0 ft. to 35 ft.
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other

BAILING OR PUMPING TEST
(specify one by circling)

AIR

WELL TEST
Test rate 12 gpm Duration of test 1 hrs.
Drawdown (water level during pumping) ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other
Static Level (depth to water) 41 ft. Date: 10-19-88
Quality (clear, cloudy, taste, odor) CLEAR

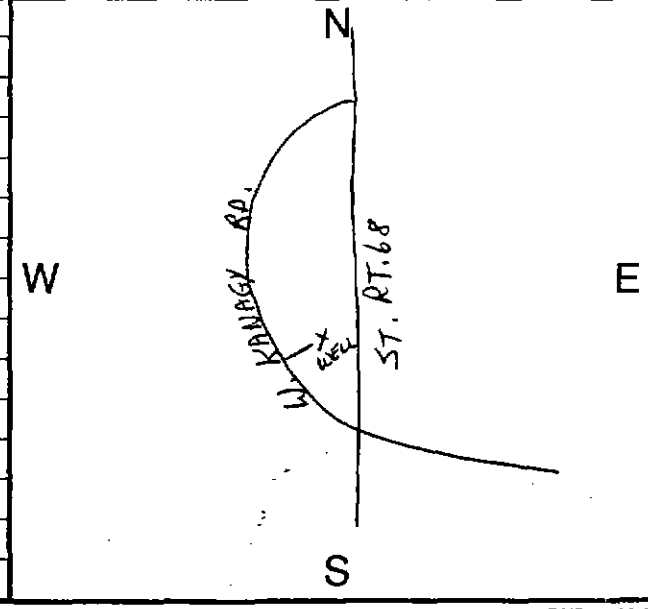
PUMP
Type of pump SUBMERSIBLE Capacity 18 gpm
Pump set at 60 ft.
Pump installed by EATON PUMP SRVC.
Pitless Device ☒ Adapter ☐ Preassembled unit
Use of Well DOMESTIC

WELL LOG*

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand	From	To
RED CLAY	0 ft.	5 ft.
SAND & GRAVEL	5	65

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7302.88

DRILLING FIRM EATON WELL DRLG.
ADDRESS 8401 N. Rt. 68
CITY, STATE, ZIP W. LIBERTY, OH. 43357

SIGNED Marcella Eaton
DATE 10-24-88
ODH REGISTRATION NUMBER 41

19

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO

WELL LOG AND DRILLING REPORT

742784

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 181

COUNTY Champaign TOWNSHIP Salem (SECTION) LOT No. 18 (CIRCLE ONE)

(OWNER) BUILDER (CIRCLE ONE OR BOTH) Rick + Gloria Davis PROPERTY ADDRESS 1409 E. Kanagy Rd. (ADDRESS OF WELL LOCATION)

LOCATION OF PROPERTY 1/2 Mi. W. of Game Farm Rd. on Kanagy Rd.

CONSTRUCTION DETAILS

CASING
1 Diameter 5 1/2 O.D. in. Length 93 ft. Wall Thickness SDR 17 in.
2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: 1 Steel 2 / 1 Galv. 2 / X PVC / 1 2 Other ____
Joints: 1 Threaded 2 / 1 Welded 2 / X Solvent / 1 2 Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter 7 7/8 in.

GROUT
Material Benseal Volume used 150 #
Method of installation Tremie
Depth: placed from 80 ft. to Sub Face ft.

GRAVEL PACK (Filter Pack)
Material Grit Sand Volume used 50 gal.
Method of installation Poured
Depth: placed from 93 ft. to 80 ft.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 2 ft. Diameter 5 1/2 O.D. in.
Set between 91 ft. and 93 ft. Slot .085

Pitless Device X Adapter ☐ Preassembled unit
Use of Well Domestic
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion 12-5-91

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Red clay	0	31
Sand + Gravel	31	65
Blue clay	65	80
Sand + Gravel	80	93

WELL TEST

☐ Bailing ☐ Pumping* ☒ Other Air
Test rate 15 gpm Duration of test 1 hrs.
Drawdown — ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other ____
Static Level (depth to water) 76 ft. Date: 12-5-91
Quality (clear, cloudy, taste, odor) Clear

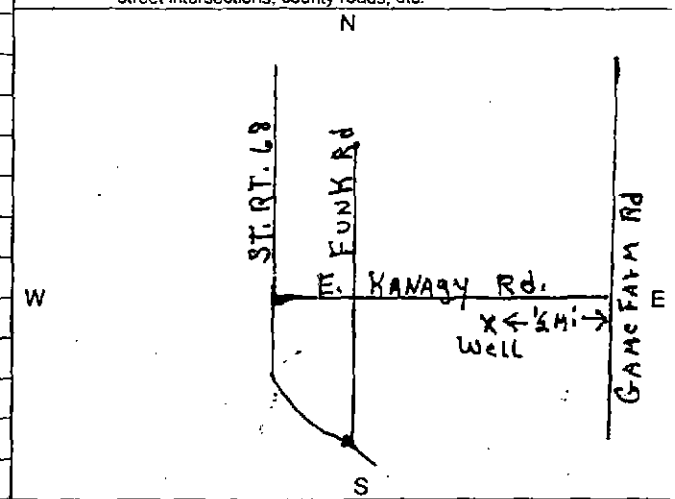
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 85 ft.
Pump installed by Eaton Well + Pump

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Eaton Well Drilling Signed Donald Eaton
Address 8800 N. Rt. 68 Date 12-5-91
City, State, Zip West Liberty, OH 43357 ODH Registration Number 41

20

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

WELL LOG AND DRILLING REPORT

670265

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

Job# Permit Number 87D-142

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP

OWNER Robert's Refuse ADDRESS 416 Taft Ave, Urbana, OH 43078

LOCATION OF PROPERTY John Nekh 2834 Kennard-Kingscreek Rd

CONSTRUCTION DETAILS

Casing diameter 5 1/2" O.D-PVC Length of casing 65

Type of screen — Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting 75

Date of completion 7/13/87

Rotary ☑ or Cable ☐

BAILING OR PUMPING TEST (AIR)

(specify one by circling)

Test rate 15 gpm Duration of test 1 hrs

Drawdown 30 ft Date 7/13/87

Static level (depth to water) 38 ft

Quality (clear, cloudy, taste, odor) Clear

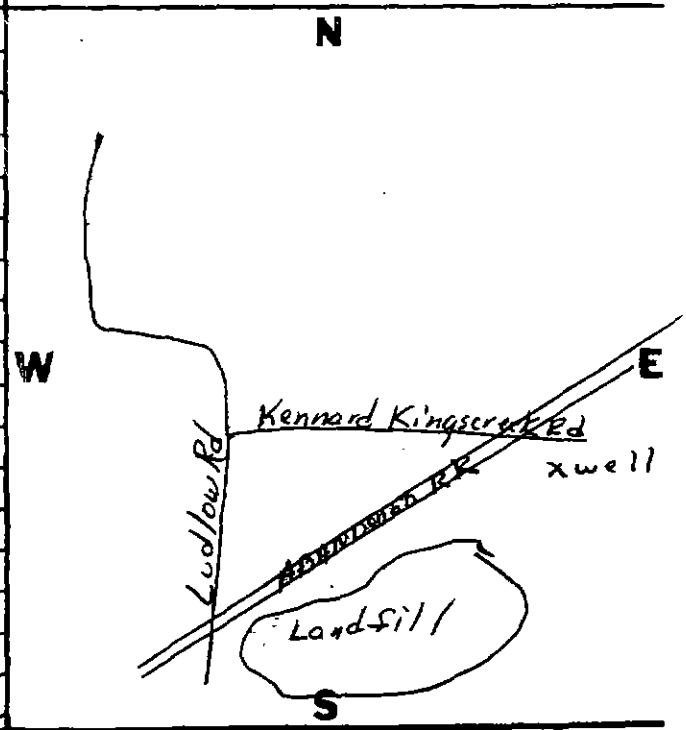
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
TopSoil	0 ft	1 ft
Gravel/boulders	1	47
clay	47	60
gravel	60	63
Limestone	63	100

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802

DRILLING FIRM Eaton Well Drilling Inc. REGISTRATION NUMBER 41 DATE 7/14/87

ADDRESS 8401 N. RT. 68, West Liberty, OH SIGNED Jerry Eaton

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer's Copy / Pink - Driller's Copy / Green - Local Health Dept. Copy

21A

WELL LOG AND DRILLING REPORT

714199

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 102

COUNTY CHAMPAIGN TOWNSHIP SALEM SECTION/LOT No. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) DANIEL SCHILLEGER PROPERTY ADDRESS 1660 SIBLEY Rd (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY INTERSECTION OF FARM Rd & SIBLEY Rd

CONSTRUCTION DETAILS

CASING

Borehole Diameter 7 7/8 in.

1 Diameter 5 in. Length 89 ft. Wall Thickness 265 in.

2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.

Type: 1 Steel 2 / 1 Galv. 2 / 1 ✓ PVC 2 / 1 2 Other ____

Joints: 1 Threaded 2 / 1 Welded 2 / 1 ✓ Solvent 2 / 1 2 Other ____

Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN

Type (wire wrapped, louvered, etc.) ____ Material ____

Length ____ ft. Diameter ____ in.

Set between ____ ft. and ____ ft. Slot ____

GROUT

Material BENONITE Volume used ____

Method of installation LIMESTONE CUTTINGS

Depth: placed from ____ ft. to ____ ft.

GRAVEL PACK (Filter Pack)

Material ____ Volume used ____

Method of installation ____

Depth: placed from ____ ft. to ____ ft.

Pitless Device ☐ Adapter ☐ Preassembled unit

Use of Well ____

☐ ✓ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____

Date of Completion 6-18-90

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
CLAY	0	35
GRAVEL	35	38
CLAY	38	60
CLAY GRAVEL	60	85
SAND GRAVEL	85	89

WELL IS 89' DEEP

WELL TEST

☐ Bailing ☐ Pumping* ☐ Other ____

Test rate 10 gpm Duration of test ____ hrs

Drawdown ____ ft.

Measured from: ☐ top of casing ☑ ✓ ground level ☐ Other ____

Static Level (depth to water) 64 ft. Date: 6-18-90

Quality (clear, cloudy, taste, odor) CLEAR

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

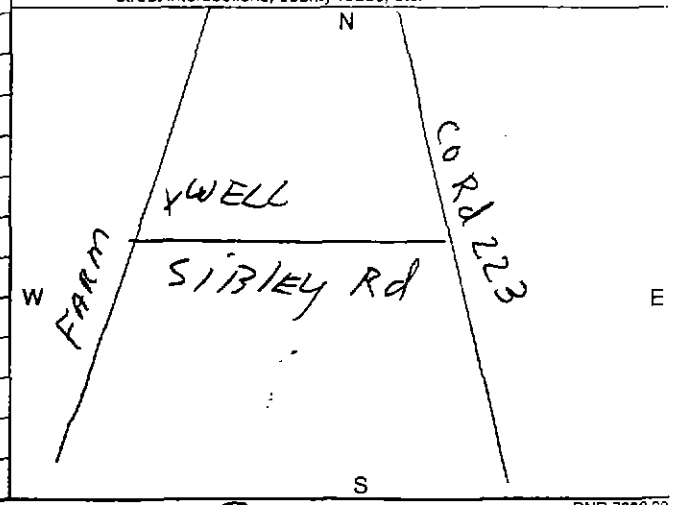
Type of pump ____ Capacity ____ gpm

Pump set at ____ ft.

Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Jeremie Rilz

Address 1215 N MAIN

City, State, Zip MARION O 43302

Signed W. Darell Rose

Date 6-21-90

ODH Registration Number 311

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

22

WELL LOG AND DRILLING REPORT

694474

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-6739

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number 169

COUNTY Champaign TOWNSHIP Salem SECTION/LOT NO. central (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Delia Lowe PROPERTY ADDRESS 126 Short Lime Farm Rd. (ADDRESS OF WELL LOCATION)

LOCATION OF PROPERTY

CONSTRUCTION DETAILS

CASING
Diameter 5 5/8 in. Length 53 ft. Wall Thickness ____ in.
Type: ☑ Steel ☑ Galv. ☐ PVC ☐ Other ____
Joints: ☐ Threaded ☑ Welded ☐ Solvent ☐ Other ____

SCREEN
Type (wire wrapped, louvered, etc.) ____ Material ____
Length ____ ft. Diameter ____ in.
Set between ____ ft. and ____ ft. Slot ____
☐ Rotary ☑ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of completion ____

GROUT
Material ____ Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

GRAVEL PACK
Material ____ Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well ____

PUMP
Type of pump ____ Capacity ____ gpm
Pump set at ____ ft.
Pump installed by ____

WELL TEST
Bailing ☑ or Pumping ☐
Test rate 10 gpm Duration of test ½ hrs.
Drawdown 3 ft.
Measured from: ☑ top of casing ☐ ground level ☐ Other ____
Static Level (depth to water) 27 ft. Date: 10/7/89
Quality (clear, cloudy, taste, odor) clear
(Attach a copy of the pumping test record, per 1521.05, ORC)

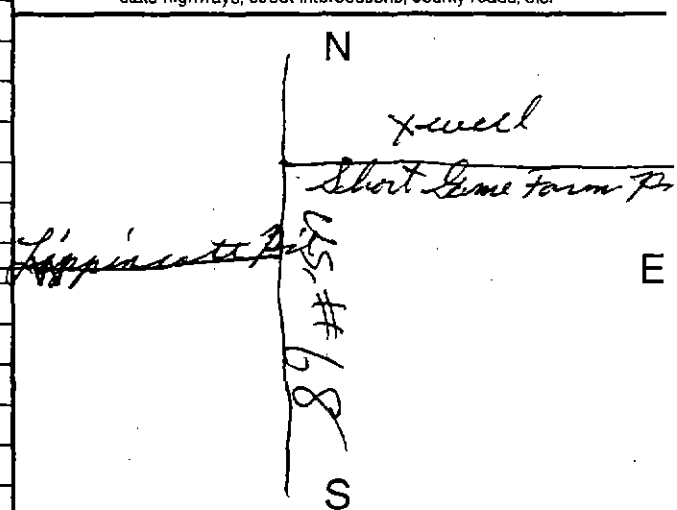
WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
clay	0 ft.	6 ft.
gravel	6	20
hardpan	20	41
sand	41	51
sand & gravel	51	53

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form

DNR 7802.88

DRILLING FIRM Rupert Well Drilling SIGNED Wm. Rupert
ADDRESS 1690 Mt. Rt. #29 DATE 10/7/89
CITY, STATE, ZIP Urbana, O. 43078 ODH REGISTRATION NUMBER 1300

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

703920

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-6739

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number 32

COUNTY Champaign TOWNSHIP Salem SECTION/LOT NO. 29 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Kenneth Goings PROPERTY ADDRESS 850 Lippencott Rd (ADDRESS OF WELL LOCATION ±)

LOCATION OF PROPERTY Corner of Lippencott + Rd 235

CONSTRUCTION DETAILS

CASING
Diameter 5½ O.D. in. Length 126 ft. Wall Thickness SdR 17 in.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) Slot Material PVC
Length 3 ft. Diameter 5½ O.D. in.
Set between 123 ft. and 126 ft. Slot .085
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other
Date of completion 3-8-90

GROUT
Material G.R. PK cuttings Benseal Volume used 2 bgs 100 Lb
Method of installation Tremie
Depth: placed from 0 ft. to 40 ft.

GRAVEL PACK
Material Grit sand Volume used 30 gal.
Method of installation Poured
Depth: placed from 120 ft. to 126 ft.

Pitless Device ☒ Adapter ☐ Preassembled unit
Use of Well Domestic

PUMP

Type of pump _____ Capacity _____ gpm
Pump set at 120' ft.
Pump installed by Eaton Pump Service

WELL TEST

Bailing ☐ or Pumping ☐ (Air)
Test rate 15 gpm Duration of test 1 hrs
Drawdown 15 ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other
Static Level (depth to water) 98 ft. Date: 3-8-90
Quality (clear, cloudy, taste, odor) Clear
(Attach a copy of the pumping test record, per 1521.05, ORC)

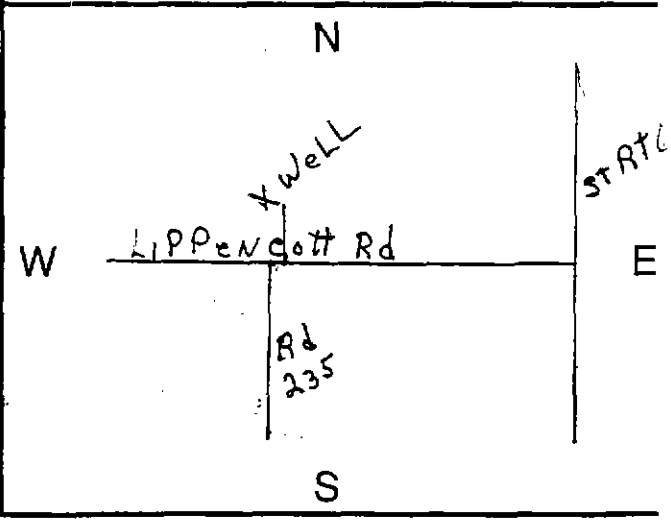
WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Brown Clay	0 ft.	13 ft.
Gravely Clay	13	67
Red Gravely Clay	67	78
Gray Clay	78	112
Gravel	112	126

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form

DNR 7802.88

DRILLING FIRM Eaton Well Drilling SIGNED Donald Eaton
ADDRESS 8401 N RT 68 DATE 3-8-90
CITY, STATE, ZIP West Liberty Oh 43357 ODH REGISTRATION NUMBER 41

24

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's Copy Pink - Driller's Copy Green - Local Health Dept. Copy

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER
DO NOT USE INK.

№ 357672

County CHAMPAIGN Township SALEM Section of Township 35

Owner WAYNE TUBBIS Address URBANA RR#3

Location of property well EAST edge of LIPPINCOTT

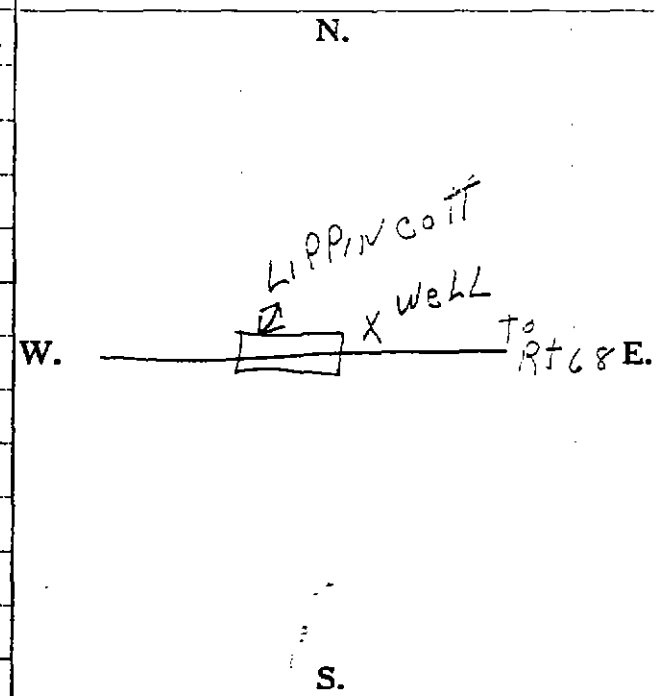
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 5 5/8" Length of casing 62'	Pumping Rate 25 G.P.M. Duration of test 2 hrs.
Type of screen — Length of screen —	Drawdown NONE ft. Date JAN 23, 1967
Type of pump —	Static level-depth to water 25 ft.
Capacity of pump —	Quality (clear, cloudy, taste, odor) CLEAR
Depth of pump setting —	
Date of completion —	Pump installed by —

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Red clay	0 Feet	8 Ft.
Muddy gravel	8	30
Blue clay	30	55
gravel	55	62

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm —

Address Box 75 Rosewood, O

Date JAN 23, 1967

Signed Donald Eaton

25

*If additional space is needed to complete well log, use next consecutive numbered form.

27

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

686969

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number _____

COUNTY Champaign TOWNSHIP ~~Concord~~ (Salem) SECTION OF TOWNSHIP 5

OWNER John Fairchild PROPERTY ADDRESS 2273 Lippincott Rd. W.L. 4335

LOCATION OF PROPERTY N.W. corner of house

CONSTRUCTION DETAILS

CASING
Casing Diameter 5 in. Length of Casing 116 ft.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other _____
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other _____

SCREEN
Type (wire wrapped, louvered, etc.) _____ Material _____
Length _____ ft. Diameter _____ in.
Set between _____ ft. and _____ ft. Slot _____

GROUT
Material native cutting Volume used a lot
Method of installation shovel
Depth: placed from 0 ft. to 116 ft.
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other _____

BAILING OR PUMPING TEST
(specify one by circling)

WELL TEST
Test rate 15 gpm Duration of test 1 hrs.
Drawdown (water level during pumping) 80 ft.
Measured from: ☒ top of casing ☐ ground level ☐ Other _____
Static Level (depth to water) 7 ft. Date: 8-8-88
Quality (clear, cloudy, taste, odor) clear

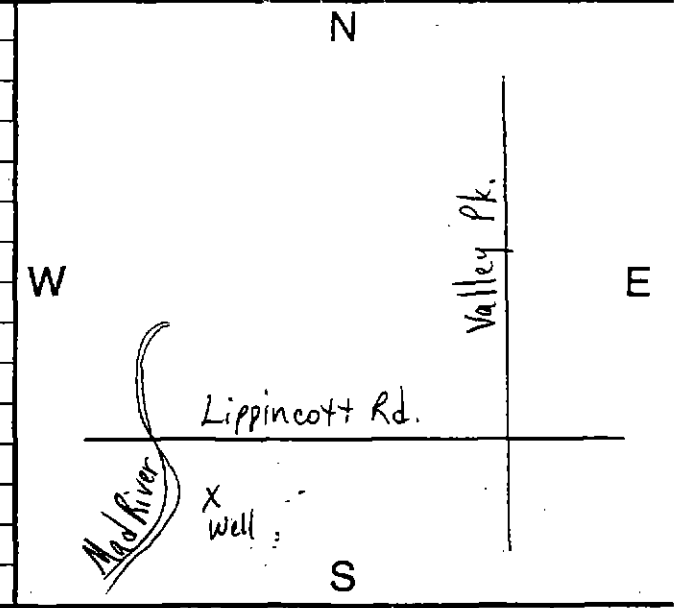
PUMP
Type of pump _____ Capacity _____ gpm
Pump set at 100 ft.
Pump installed by _____
Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well Domestic

WELL LOG*

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand	From	To
Red clay	0 ft.	5 ft.
Coarse gravel	5	28
Blue clay	28	30
Sand	30	76
Gravely blue clay	76	114
Limestone	114	160

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.88

DRILLING FIRM Eaton Well Drilling SIGNED Donna Hix
ADDRESS 8401 North Rt. 68 DATE 8-9-88
CITY, STATE, ZIP West Liberty, OH 43357 ODH REGISTRATION NUMBER 41

26

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

738395

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 101

COUNTY Champaign TOWNSHIP Concord SECTION/LOT No. _____ (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Roy Morrow PROPERTY ADDRESS 2977 Lippencott Rd (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY _____

CONSTRUCTION DETAILS

CASING
[1] Diameter 5 5/8 in. Length 56 ft. Wall Thickness 1/4 in.
[2] Diameter _____ in. Length _____ ft. Wall Thickness _____ in.
Type: [1] Steel [2] [1] Galv. [2] [1] PVC [2] [1] [2] Other _____
Joints: [1] Threaded [2] [1] Welded [2] [1] Solvent [2] [1] [2] Other _____
Liner: Length _____ Type _____ Wall Thickness _____ in.

Borehole Diameter 5 5/8 in.

GROUT
Material Dry Driven Volume used 100 #
Method of installation Bentonite
Depth: placed from 40 ft. to 0 ft.

GRAVEL PACK (Filter Pack)
Material — Volume used —
Method of installation —
Depth: placed from — ft. to — ft.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material Steel
Length 2 ft. Diameter 5 5/8 in.
Set between 54 ft. and 56 ft. Slot Torch

Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well Domestic
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other _____
Date of Completion 8-12-91

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc	From	To
Brown Clay	0	4
Brown Clay + Gravel	4	15
Brown Gravel	15	54
Water Gravel	54	56

WELL TEST

☐ Bailing ☐ Pumping* ☐ Other Air
Test rate 10 gpm Duration of test 2 hrs.
Drawdown Bottom ft.
Measured from: ☒ top of casing ☐ ground level ☐ Other _____
Static Level (depth to water) 27 ft. Date: 8-12-91
Quality (clear, cloudy, taste, odor) clear

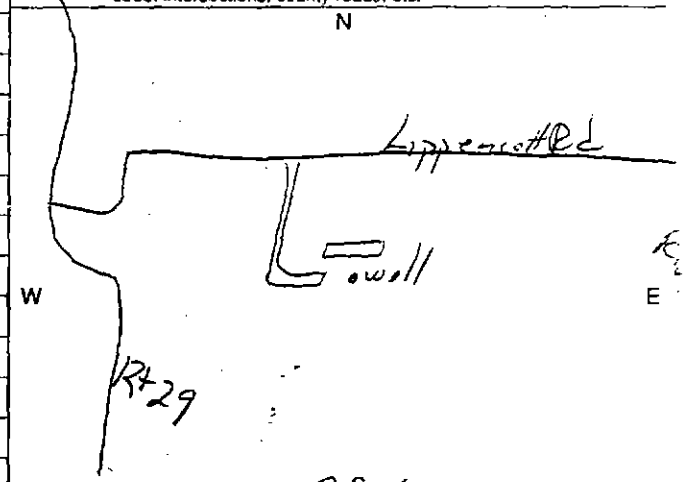
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump _____ Capacity _____ gpm
Pump set at _____ ft.
Pump installed by _____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Green Valley Well + Pump
Address 3802 Snyder-Donner Rd
City, State, Zip Springfield Ohio

Signed Mark Pratt
Date 12-5-91
ODH Registration Number 264

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

27

WELL LOG AND DRILLING REPORT

678714

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

Permit Number 46

COUNTY CHAMPAIGN TOWNSHIP CONCORD SECTION OF TOWNSHIP 17

OWNER STEVE LININGER ADDRESS 3601 CHURCH RD. URBANA

LOCATION OF PROPERTY SAME

CONSTRUCTION DETAILS

Casing diameter 5⅝" o.d. pvc Length of casing 94

Type of screen .085 slotted pvc Length of screen 2½

Type of pump SUBMERSIBLE

Capacity of pump 10 g.p.m.

Depth of pump setting 70'

Date of completion 4-19-88

Rotary ☒ or Cable ☐

BAILING OR PUMPING TEST

AIR (specify one by circling)

Test rate 15 gpm Duration of test 1 hrs

Drawdown 15 ft Date 4-19-88

Static level (depth to water) 19 ft

Quality (clear, cloudy, taste, odor) CLEAR

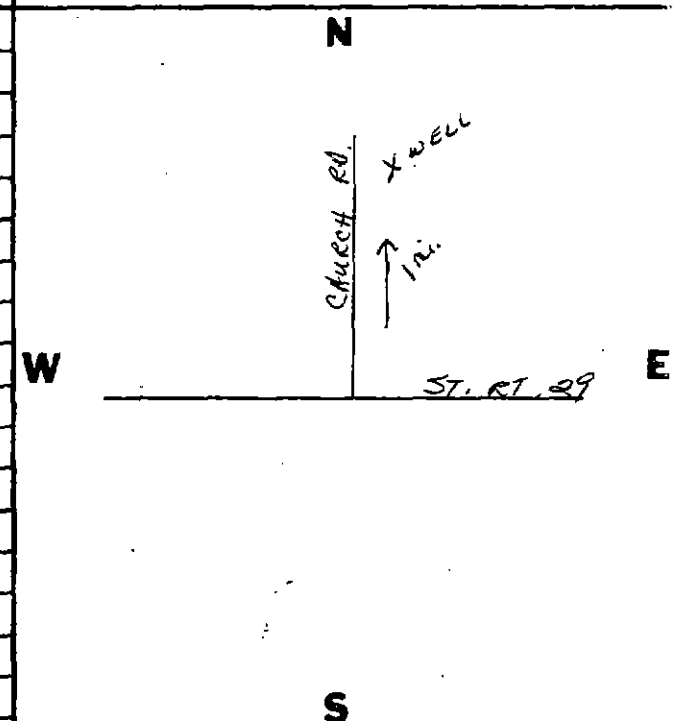
Pump installed by HOME OWNER

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
BROWN CLAY	0 ft	12 ft
GRAVELY GRAY CLAY	12	89
BR. UNIFORM GRAVEL	89	94

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802

DRILLING FIRM EATON WELL DRLG. REGISTRATION NUMBER 41 DATE 4-20-88

ADDRESS 8401 N. Rt. 68 W. LIBERTY SIGNED Marcella Eaton

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer's Copy / Pink - Driller's Copy / Green - Local Health Dept. Copy

28

WELL LOG AND DRILLING REPORT

ORIGINAL

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

456618

County Champaign Township Concord Section of Township 31

Owner Richard Irwin Address 4561 W. Rt. #29

Location of property Cross Road from sugar camp

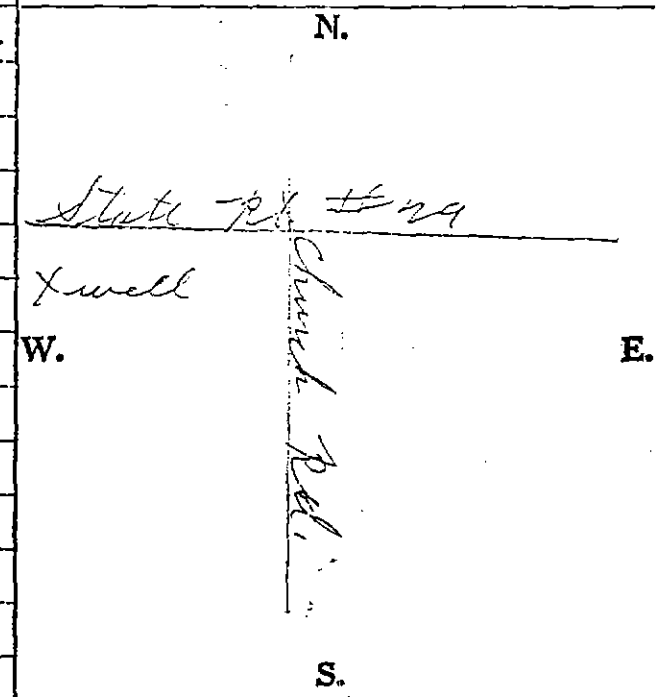
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST (Specify one by circling)
Casing diameter 5" Length of casing 144'	Test Rate 6 G.P.M. Duration of test 24 hrs.
Type of screen Length of screen	Drawdown 8 ft. Date 7/31/73
Type of pump	Static level-depth to water 22 ft.
Capacity of pump	Quality (clear, cloudy, taste, odor) clear
Depth of pump setting	
Date of completion	Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
clay	0 Feet	10 Ft.
gravel	10	20
clay	20	70
sand	70	142
gravel	142	144

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm Rupert & Son Date 7/31/73

Address 637 Miami St. Urbana Signed Bill Rupert

29

*If additional space is needed to complete well log, use next consecutive numbered form.

212

WELL LOG AND DRILLING REPORT

705952

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-6739

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number 47

COUNTY Champaign TOWNSHIP Concord SECTION/LOT NO. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) James Cauchman PROPERTY ADDRESS 5965 Calland Rd. West Liberty (ADDRESS OF WELL LOCATION ⊥)

LOCATION OF PROPERTY 1/2 mile North of ST. RT. 29 on the ☒ EAST SIDE OF CALLAND RD.

CONSTRUCTION DETAILS

CASING
Diameter 6 in. Length 72 ft. Wall Thickness 142 in
Type: ☐ Steel ☑ Galv. ☐ PVC ☐ Other
Joints: ☐ Threaded ☑ Welded ☐ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) Material
Length ft. Diameter in.
Set between ft. and ft. Slot
☐ Rotary ☑ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other
Date of completion

GROUT
Material Drill Cuttings Volume used
Method of installation
Depth: placed from ft. to ft.

GRAVEL PACK
Material Volume used
Method of installation
Depth: placed from ft. to ft.

Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well residential

PUMP
Type of pump Capacity gpm
Pump set at ft.
Pump installed by

WELL TEST
Bailing ☑ or Pumping ☐
Test rate 15 gpm Duration of test hrs.
Drawdown 5 ft.
Measured from: ☑ top of casing ☐ ground level ☐ Other
Static Level (depth to water) 28 ft. Date:
Quality (clear, cloudy, taste, odor) Clear
(Attach a copy of the pumping test record, per 1521.05, ORC)

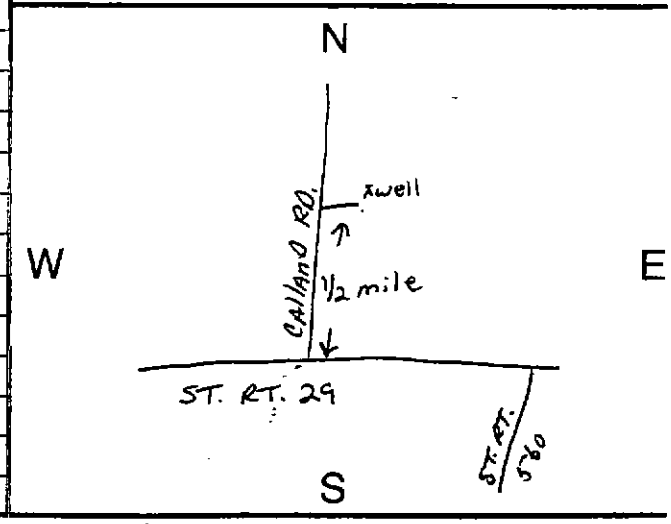
WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Topsoil	0 ft.	1 ft.
Yellow Clay	1	15
Gray Clay	15	25
Gravel	25	65
Gray Clay	65	69
Sand, gravel, water	69	72

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form

DNR 7802.88

DRILLING FIRM Knicely's Well Drilling
ADDRESS 4734 Roselawn-Quincy Rd.
CITY, STATE, ZIP Quincy, Oh. 43343

SIGNED Lloyd Knicely
DATE 5-4-90
ODH REGISTRATION NUMBER 1383

30

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's Copy Pink - Driller's Copy Green - Local Health Dept. Copy

WELL LOG AND DRILLING REPORT

697663

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-6739

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number 86

COUNTY Champaign TOWNSHIP Concord SECTION/LOT NO. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Jeff Kitchen PROPERTY ADDRESS 5185 Woodville Pk (ADDRESS OF WELL LOCATION)

LOCATION OF PROPERTY Approx ½ mile E. of 560

CONSTRUCTION DETAILS

CASING
Diameter 6 in. Length 85 ft. Wall Thickness ____ in.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other ____
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other ____

SCREEN
Type (wire wrapped, louvered, etc.) slotted Material PVC
Length 7 ft. Diameter 6 in.
Set between 85 ft. and 92 ft. Slot 30
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of completion 6-16-89

GROUT
Material Bentonite Volume used 100#
Method of installation pour from top
Depth: placed from 50 ft. to Surface f

GRAVEL PACK
Material Pea Gravel Volume used ____
Method of installation pour from top
Depth: placed from 85 ft. to 92 f
Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well ____

PUMP

Type of pump submersible Capacity 10 gpm
Pump set at 80' ft.
Pump installed by Crabtree

WELL TEST

Bailing ☐ or Pumping ☐
Test rate 10 gpm Duration of test 2 hrs
Drawdown 5 ft
Measured from: ☒ top of casing ☐ ground level ☐ Other ____
Static Level (depth to water) 65 ft. Date: 6-16-89
Quality (clear, cloudy, taste, odor) clear
(Attach a copy of the pumping test record, per 1521.05, ORC)

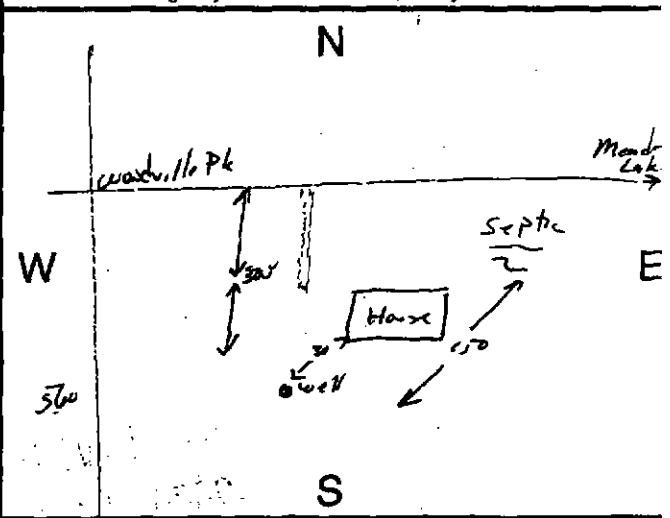
WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Clay	0 ft.	6 ft.
clay + gravel	6	20
clay	20	35
clay + gravel	35	80
sand + gravel	80	92

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form

DNR 7802.88

DRILLING FIRM Crabtree Well & Pump
ADDRESS 3882 Snyder-Donnor Rd
CITY, STATE, ZIP Spfld-Ohio

SIGNED Mark Kelt
DATE 6-28-89
ODH REGISTRATION NUMBER 264

31

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's Copy Pink - Driller's Copy Green - Local Health Dept. Copy

166

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

753623

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Permit Number 301

COUNTY CHAMPAIGN TOWNSHIP CONCORD SECTION/LOT No. 40 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) RONALD HAGANS PROPERTY ADDRESS 3974 WOODVILLE PIKE (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY CORNER OF WOODVILLE PIKE & KISER RD.

CONSTRUCTION DETAILS

CASING
[1] Diameter 5½ in. Length ____ ft. Wall Thickness SDR17 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: [1] Steel [1] Galv. [■] PVC [1] [2] Other ____
Joints: [1] Threaded [1] Welded [■] Solvent [1] [2] Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter 7⅞ in.

SCREEN
Type (wire wrapped, louvered, etc.) SLOTTED Material PVC
Length 2 ft. Diameter 5½ OD in.
Set between 74 ft. and 76 ft. Slot .085

GROUT
Material BENSEAL Volume used 100#
Method of installation TREMMIE
Depth: placed from 70 ft. to SURFACE ft.

GRAVEL PACK (Filter Pack)
Material GRIT SAND Volume used 30 GAL.
Method of installation POURED
Depth: placed from 76 ft. to 70 ft.

Pitless Device ■ Adapter ☐ Preassembled unit
Use of Well DOMESTIC
■ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion 12-11-92

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
RED CLAY	0	6
SAND & GRAVEL	6	45
RED CLAY	45	68
GRAVEL	68	76

WELL TEST

☐ Bailing ☐ Pumping* ■ Other AIR
Test rate 20 gpm Duration of test 1 hrs.
Drawdown 15' ft.
Measured from: ☐ top of casing ■ ground level ☐ Other ____
Static Level (depth to water) 25 ft. Date: ____
Quality (clear, cloudy, taste, odor) CLEAR

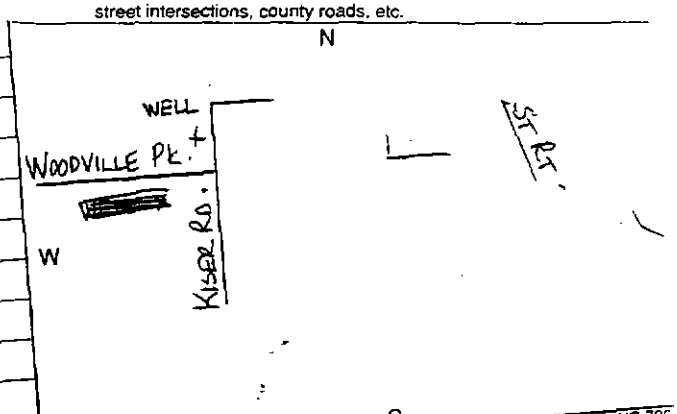
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump SUBMERSIBLE Capacity 10 gpm
Pump set at 70' ft.
Pump installed by ST. PARIS PLUMBING

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



DNR 780

*If additional space is needed to complete well log, use next consecutively numbered form.

Signed Esther M. Neer
Date 12-15-92
Drilling Firm EATON WELL DRILLING
Address 8401 N. RT 68
City, State, Zip WEST LIBERTY OH 43357
ODH Registration Number 41

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224
Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

37

WELL LOG AND DRILLING REPORT

654936

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY - SELF-TRANSCRIBING

Permit Number _____

COUNTY Champaign TOWNSHIP Concord SECTION OF TOWNSHIP 4

~~OWNER~~ Elder. Mike Love ADDRESS 5165 Catawba - Mech. Rd. Urba

LOCATION OF PROPERTY 3024 W. St. Rt. 29, Urbana

CONSTRUCTION DETAILS

Casing diameter 5½ o.d. pvc Length of casing 49'

Type of screen .085 slot Length of screen 2'

Type of pump _____

Capacity of pump ——

Depth of pump setting 40'

Date of completion 6-13-86

Rotary ☒ or Cable ☐

BAILING OR PUMPING TEST (specify one by circling) AIR

Test rate 20 gpm Duration of test ½ hr.

Drawdown 35 ft Date _____

Static level (depth to water) 25 ft

Quality (clear, cloudy, taste, odor) Clear

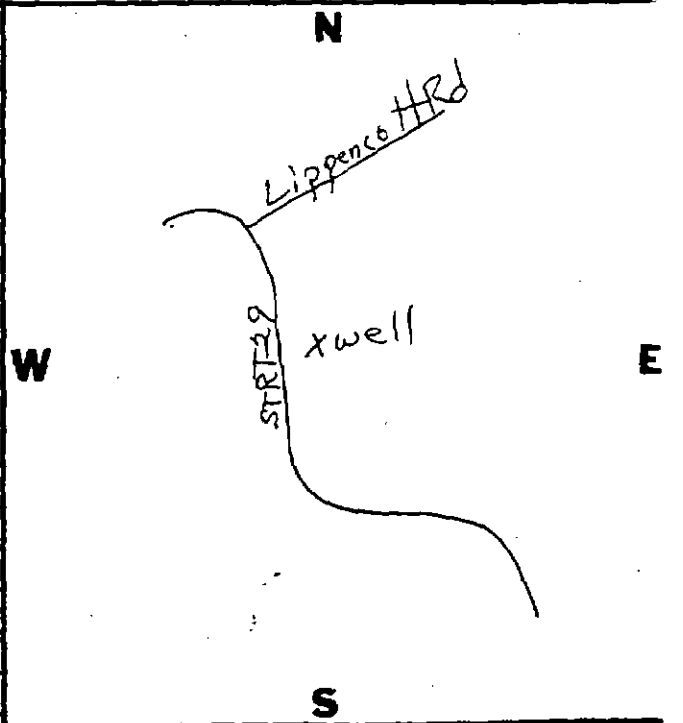
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Clay	0 ft	7 ft
Sand	7	21
Sand + gravel	21	49

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802

DRILLING FIRM Eaton Well Drilling REGISTRATION NUMBER 43 DATE 6-13-86

ADDRESS 8401 N. Rt. 68 W. Liberty SIGNED Jerry Eaton

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer's Copy / Pink - Driller's Copy / Green - Local Health Dept. Copy

33

WELL LOG AND DRILLING REPORT

700056

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-6739

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number 22

COUNTY Champaign TOWNSHIP Concord SECTION/LOT NO. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Leo Rousch PROPERTY ADDRESS 2559 Concord Pk. Urbana (ADDRESS OF WELL LOCATION)

LOCATION OF PROPERTY 1/4 mile EAST OF ST. RT 29 ON The South Side OF Concord Pk.

CONSTRUCTION DETAILS

CASING
Diameter 6 in. Length 45 ft. Wall Thickness .142 in.
Type: ☐ Steel ☑ Galv. ☐ PVC ☐ Other
Joints: ☐ Threaded ☑ Welded ☐ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) Material
Length ft. Diameter in.
Set between ft. and ft. Slot
☐ Rotary ☑ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other
Date of completion

GROUT
Material drill cutting Volume used
Method of installation
Depth: placed from ft. to ft.

GRAVEL PACK
Material Volume used
Method of installation
Depth: placed from ft. to ft.

Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well residence

PUMP
Type of pump Capacity gpm
Pump set at ft.
Pump installed by

WELL TEST
Bailing ☑ or Pumping ☐
Test rate 15 gpm Duration of test hrs.
Drawdown 2 ft.
Measured from: ☐ top of casing ☐ ground level ☐ Other
Static Level (depth to water) 22 ft. Date:
Quality (clear, cloudy, taste, odor) Clear
(Attach a copy of the pumping test record, per 1521.05, ORC)

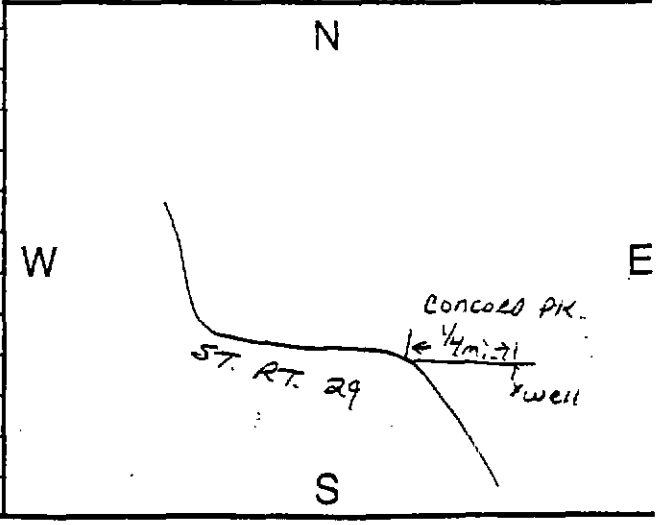
WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Topsoil	0 ft.	1 ft.
Yellow clay	1	5
gravel	5	37
gray clay	37	38
Sand, gravel, water	38	45

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form

DNR 7802.88

DRILLING FIRM Knicely's Well Drilling SIGNED Lloyd Knicely
ADDRESS 9724 Rosewood - Quincy Rd. DATE 7/17/89
CITY, STATE, ZIP Quincy, Oh 43343 ODH REGISTRATION NUMBER 1383

34

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's Copy Pink - Driller's Copy Green - Local Health Dept. Copy

WELL LOG AND DRILLING REPORT

136362

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 141

COUNTY Champaign TOWNSHIP Salem (SECTION) LOT No. 28 (CIRCLE ONE)

(OWNER) BUILDER (CIRCLE ONE OR BOTH) Gene Anderson PROPERTY ADDRESS 4756 Ridge Rd (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1 Mi. S. of Lippincott Rd on Ridge Rd. (West side)

CONSTRUCTION DETAILS

CASING
[1] Diameter 5 1/2" O.D. in. Length 142 ft. Wall Thickness SDR 17 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: [1] Steel [2] Galv. [X] PVC [2] Other ____
Joints: [1] Threaded [2] Welded [X] Solvent [2] Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter 7 7/8 in.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 2 ft. Diameter 5 1/2 O.D. in.
Set between 140 ft. and 142 ft. Slot .085

GROUT
Material Benseal Volume used 150#
Method of installation Tremie
Depth: placed from 100 ft. to Surface ft.

GRAVEL PACK (Filter Pack) 135-100 Native Cuttings
Material Grit Sand Volume used 30 gal
Method of installation Poured
Depth: placed from 142 ft. to 135 ft.

Pitless Device [X] Adapter [ ] Preassembled unit
Use of Well Domestic
[X] Rotary [ ] Cable [ ] Augered [ ] Driven [ ] Dug [ ] Other ____
Date of Completion 10-3-91

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Red Clay	0	17
Gravely Blue Clay	17	135
Tight Packed Gravel	135	142

WELL TEST

[ ] Bailing [ ] Pumping* [X] Other Air
Test rate 20 gpm Duration of test 1 hrs.
Drawdown 0 ft.
Measured from: [ ] top of casing [X] ground level [ ] Other ____
Static Level (depth to water) 101 ft. Date: 10-3-91
Quality (clear, cloudy, taste, odor) Clear

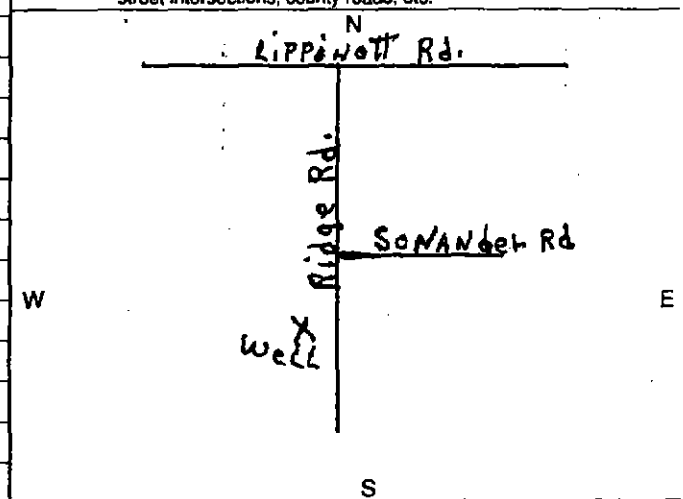
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 120 ft.
Pump installed by Eaton Well + Pump

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Eaton Well Drilling
Address 8800 N. Rt. 68
City, State, Zip West Liberty OH. 43357

Signed Donald Eaton
Date 10-3-91
ODH Registration Number 41

36

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

36

County Permit No. _____

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

568958

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP 28

OWNER Martha Englehart ADDRESS 4497 Ridge Rd. Urbana

LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 125'

Type of screen — Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 15 gpm Duration of test 1 hrs

Drawdown _____ ft Date May 2, 1980

Static level (depth to water) 73 ft

Quality (clear, cloudy, taste, odor) Clear

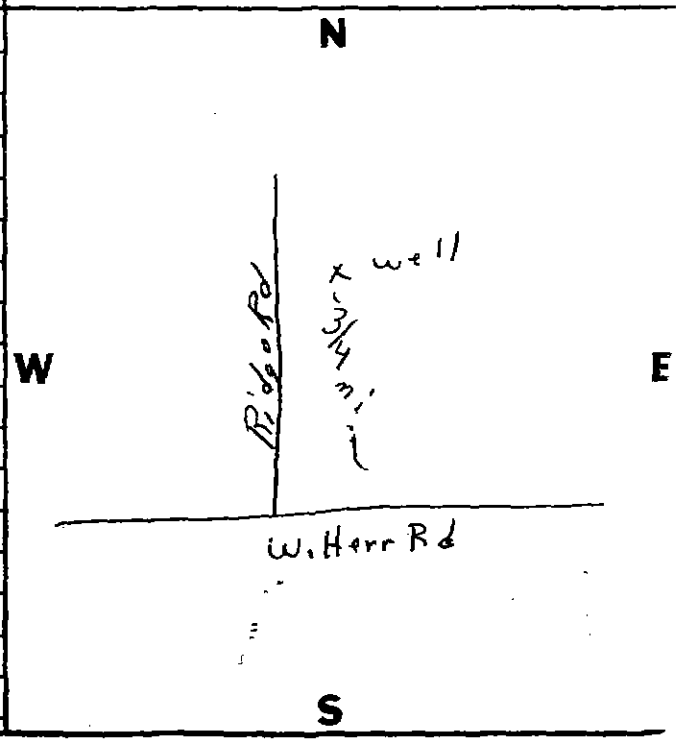
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
red Clay	0 ft	15 ft
blue Clay	15	90
red Clay	90	105
muddy sand	105	122
sand & gravel	122	125

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE June 14, 1980

ADDRESS 840 N. Rt. 68 West Liberty, Oh. SIGNED Gerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

37

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

640224

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP 22

OWNER Donald Barger ADDRESS 4121 N. RT 68, Urbana

LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS

Casing diameter 6" I.D. PVC Length of casing 55

Type of screen PVC .085 Length of screen 21

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST AIR
(specify one by circling)

Test rate 40 gpm Duration of test 1 hr

Drawdown — ft Date Dec 7, 1982

Static level (depth to water) 28

Quality (clear, cloudy, taste, odor) clear

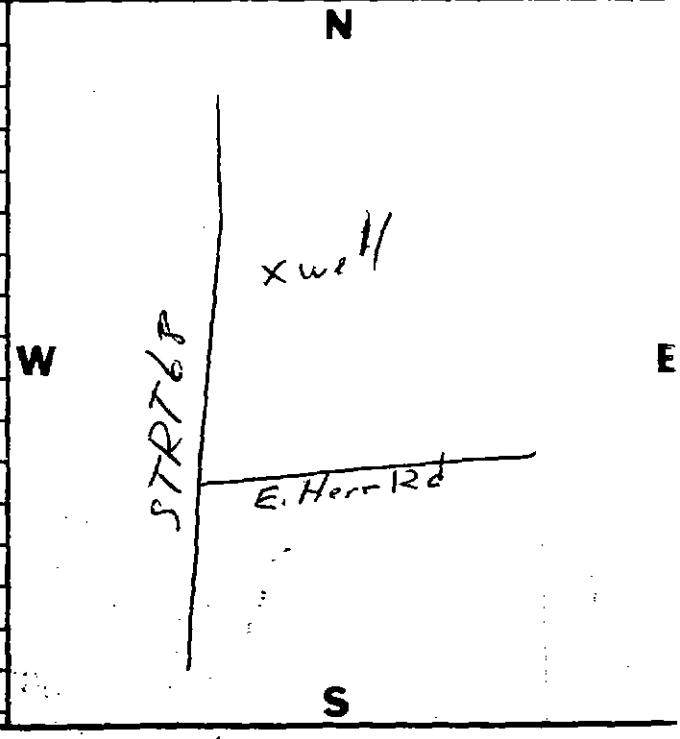
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
clay	0 ft	15 ft
gravel	15	55

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE Feb 4, 1983

ADDRESS 840 N. RT 68, W. Liberty, O SIGNED Gary Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

38

ORIGINAL COPY - ODNR DIVISION OF WATER FOUNTAIN SQ. COLS. OHIO 43224

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

689826

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number 197

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP

OWNER Adolph Murray PROPERTY ADDRESS 1992 Kennard-Kingscreek Rd.

LOCATION OF PROPERTY off Ludlow Rd. 1 2 Miles West on Kennard-Kingscreek Rd.

CONSTRUCTION DETAILS

CASING
Casing Diameter 6" in. Length of Casing 70' ft.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other

SCREEN
Type (wire wrapped, louvered, etc.) 53 slot Material P.V.C.
Length 34" ft. Diameter 6" in.
Set between 68-70 ft. and 70 ft. Slot 53

GROUT
Material Bentonite Volume used 150 lbs
Method of installation Tremie pipe
Depth: placed from 30' ft. to surface ft.
☐ Rotary ☒ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other

BAILING OR PUMPING TEST
(specify one by circling)

WELL TEST
Test rate 50 gpm Duration of test ½ hrs.
Drawdown (water level during pumping) — ft.
Measured from: ☐ top of casing ☐ ground level ☐ Other
Static Level (depth to water) 45 ft. Date Nov. 24, 1988
Quality (clear, cloudy, taste, odor) clear

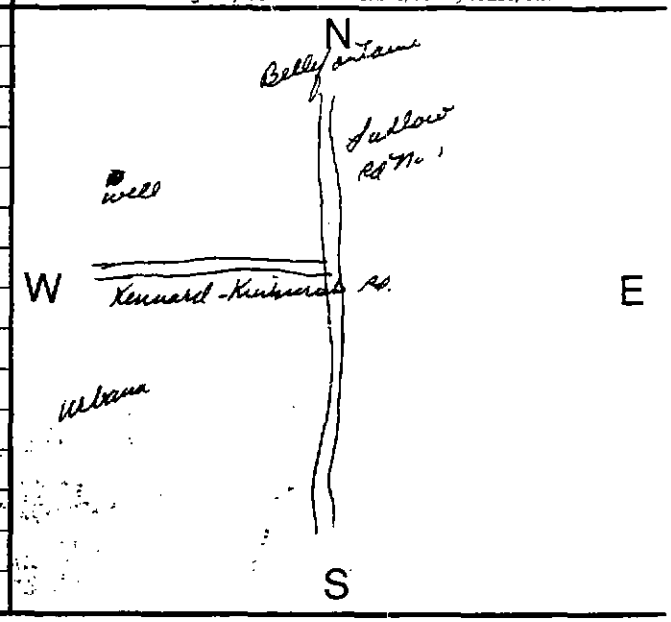
PUMP
Type of pump ½ Houlde Capacity 10 gpm
Pump set at 58' ft.
Pump installed by W.D. Bill Harpest
Pitless Device ☒ Adapter ☐ Preassembled unit
Use of Well Home

WELL LOG*

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand	From	To
Top Soil	0 ft.	2 ft.
Yellow clay	2	10
Gravel Dry	10	48
Sand & Gravel	48	72

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.88

DRILLING FIRM W.D. Bill Harpest SIGNED William D. Harpest
ADDRESS 2059 Rd. 179 DATE Nov. 24, 1988
CITY, STATE, ZIP Bellefontaine, Ohio 43311 ODH REGISTRATION NUMBER # 434

39

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

150

County Permit No. _____

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

568972

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP 9

OWNER Phil Crabtree ADDRESS 2250 E. Kingscreek Rd. Urb

LOCATION OF PROPERTY 1768 E. Kingscreek Rd.

CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 43

Type of screen — Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 15 gpm Duration of test 1 hrs

Drawdown _____ ft Date Aug. 12, 1980

Static level (depth to water) 23 ft

Quality (clear, cloudy, taste, odor) Clear

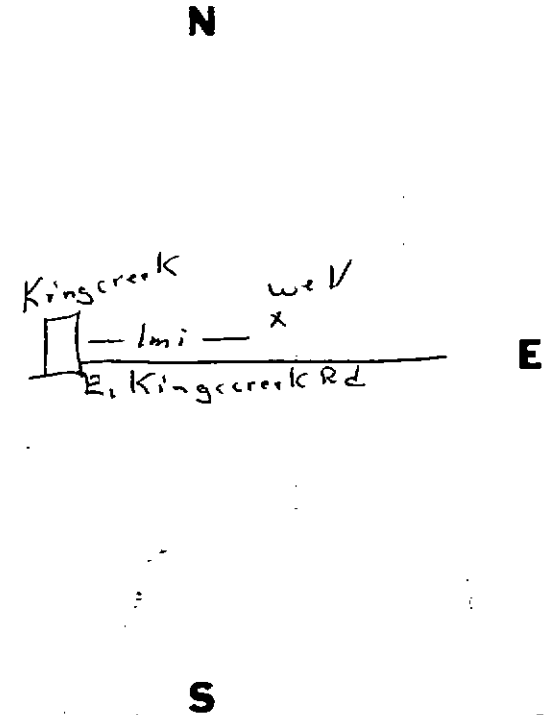
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Gravel	0 ft	43 ft

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE Sept. 9, 1980

ADDRESS 8401 Rt. 68 West Liberty SIGNED Jerry Eaton

40

*If additional space is needed to complete well log, use next consecutive numbered form.

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

153580

Permit Number 157

COUNTY Champaign TOWNSHIP Salem (SECTION) LOT No. 20 (CIRCLE ONE)

(OWNER) BUILDER (CIRCLE ONE OR BOTH) Donald Fraley PROPERTY ADDRESS 141 E. ST. RT. 296 (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 500 ft. E. of ST. RT. 68 on ST. RT. 296 (Southside)

CONSTRUCTION DETAILS

CASING
1 Diameter 5½ O.D. in. Length 59 ft. Wall Thickness SDR-17 in.
2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Borehole Diameter 7⅞ in.
Type: 1 Steel 2 Galv. 2 PVC 2 Other ____
Joints: 1 Threaded 2 Welded 2 Solvent 2 Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

GROUT
Material Benseal Volume used 100#
Method of installation Tremie 56-40 Native cuttings
Depth: placed from ground ft. to 40 ft.

GRAVEL PACK (Filter Pack)
Material Grit Sand Volume used 25 gal.
Method of installation Poured
Depth: placed from 59 ft. to 56 ft.

SCREEN
Type (wire wrapped, louvered, etc.) Sloted Material PVC
Length 2 ft. Diameter 5½ O.D. in.
Set between 57 ft. and 59 ft. Slot .085

Pitless Device ☒ Adapter ☐ Preassembled unit
Use of Well Domestic
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion 9-15-92

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Top Soil	0	4
Gravel	4	59

WELL TEST

☐ Bailing ☐ Pumping* ☒ Other Air
Test rate 20 gpm Duration of test 1 hrs.
Drawdown 0 ft.
Measured from: ☐ top of casing ☒ ground level ☐ Other ____
Static Level (depth to water) 15 ft. Date: 9-15-92
Quality (clear, cloudy, taste, odor) Clear

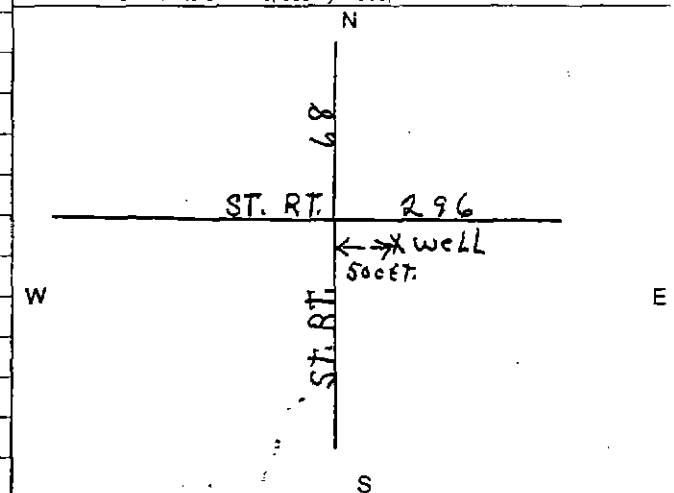
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 40 ft.
Pump installed by —

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use reverse side or attach numbered form.

DNR 7802.90

Drilling Firm Eaton Drilling
Address 8800 N. RT. 68
City, State, Zip West Liberty, OH 43357

Signed Donald Eaton
Date 9-16-92
ODH Registration Number 41

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

43

WELL LOG AND DRILLING REPORT

ORIGIN.

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Geological Survey
Fountain Square
Columbus, Ohio 43224 Phone (614) 466-5344

488985

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP OR LOT NUMBER 120

OWNER Hanel Construction Co. ADDRESS 2989 Rt 296

LOCATION OF PROPERTY Corner of US #68 + Rte #296

CONSTRUCTION DETAILS

Casing diameter 5⅝ Length of casing 38

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion _____

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 16 gpm Duration of test ½

Drawdown 4 ft Date 5/28/76

Static level (depth to water) 17

Quality (clear, cloudy, taste, odor) clear

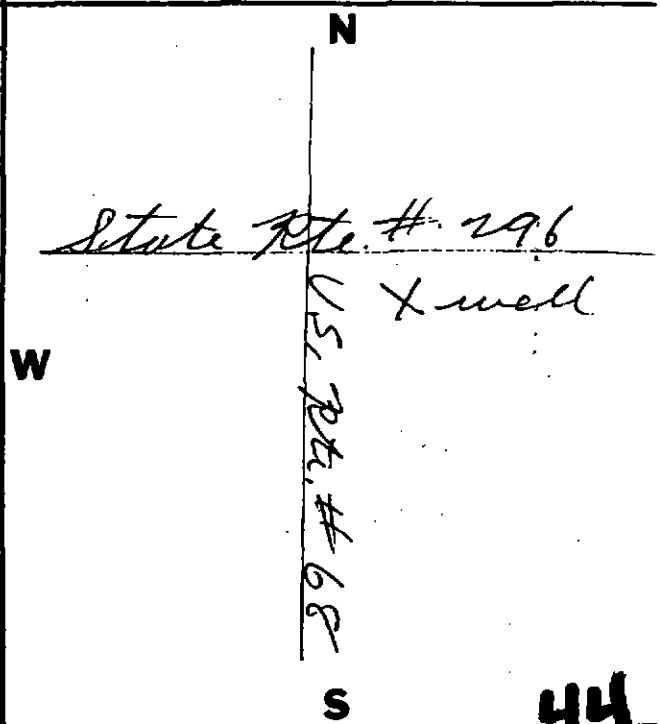
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
clay	0 ft	7 ft
clay + gravel	7	35
sand + gravel	35	38

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



44

DRILLING FIRM Rupert + Son DATE 5/28/76

ADDRESS 1690 W. Rte #29 SIGNED Wm. Rupert

*If additional space is needed to complete well log, use next consecutive numbered form.

45

WELL LOG AND DRILLING REPORT

732284

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 49

COUNTY Champaign TOWNSHIP Salem SECTION LOT No. 27 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Fairchild Const. PROPERTY ADDRESS 1074 W. Rt. 296 (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1 Mi. W. of St Rt 68 on St. Rt. 296 (Northside)

CONSTRUCTION DETAILS

CASING
[1] Diameter 5 1/2 O.D. in. Borehole Diameter 7 7/8 in.
[1] Diameter 5 1/2 O.D. in. Length 81 ft. Wall Thickness SDR 17 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.

Type: [1] [2] Steel [1] [2] Galv. [X] PVC [1] [2] Other ____

Joints: [1] [2] Threaded [1] [2] Welded [X] Solvent [1] [2] Other ____

Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 2 ft. Diameter 5 1/2 O.D. in.
Set between 81 ft. and 83 ft. Slot .085

GROUT
Material Benseal Volume used 150#
Method of installation Tremie
Depth: placed from 0 ft. to 76 ft.

GRAVEL PACK (Filter Pack)
Material grift sand Volume used 30 gal
Method of installation Poured
Depth: placed from 83 ft. to 76 ft.

Pitless Device [X] Adapter [ ] Preassembled unit
Use of Well Domestic
[X] Rotary [ ] Cable [ ] Augered [ ] Driven [ ] Dug [ ] Other ____
Date of Completion 5/21/91

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Top Soil	0	3
Sand + gravel	3	31
blue clay	31	50
Muddy sand	50	76
gravel (Coarse)	76	83

WELL TEST

[ ] Bailing [ ] Pumping* [X] Other Air
Test rate 30 gpm Duration of test 1 hrs.
Drawdown — ft.
Measured from: [ ] top of casing [X] ground level [ ] Other ____
Static Level (depth to water) 11 ft. Date: 5/21/91
Quality (clear, cloudy, taste, odor) Cleah

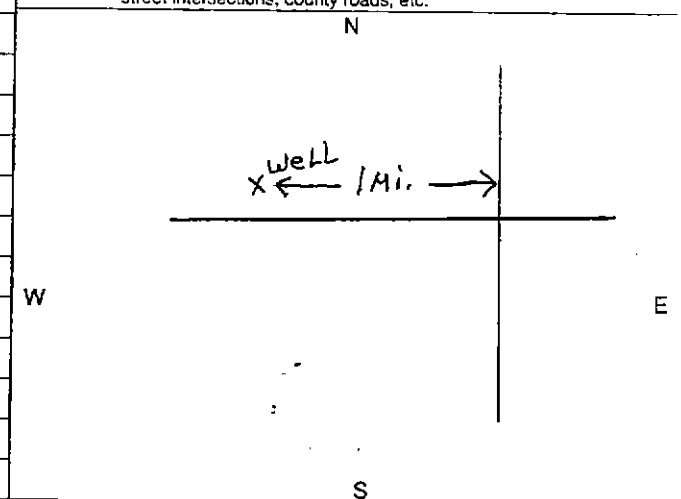
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 60' ft.
Pump installed by Tony Malkin

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Eaton Well Drilling Signed Donald Eaton
Address 8800 N. Rt. 68 Date 5-22-91
City, State, Zip West Liberty OH 43357 ODH Registration Number 41

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224
Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

45

WELL LOG AND DRILLING REPORT

732285

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 50

COUNTY Champaign TOWNSHIP Salem SECTION LOT No. 27 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Fairchild Const. PROPERTY ADDRESS 1522 W. Rt. 296 (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1mi W. of St. Rt. 68 on St. Rt. 296 (Northside)

CONSTRUCTION DETAILS

CASING
[1] Diameter 5½ O.D. in. Length 82 ft. Wall Thickness ____ in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: [1] Steel [1] Galv. [X] PVC [1] [2] Other ____
Joints: [1] Threaded [1] Welded [X] Solvent [1] [2] Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter 7⅞ in.

GROUT
Material Benseal Volume used 150#
Method of installation Tremie
Depth: placed from 0 ft. to 76 ft.

GRAVEL PACK (Filter Pack)
Material Grift Sand Volume used 30 gal
Method of installation Poured
Depth: placed from 83 ft. to 76 ft.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 2 ft. Diameter 5½ O.D. in.
Set between 80 ft. and 82 ft. Slot .085

Pitless Device [X] Adapter [ ] Preassembled unit
Use of Well Domestic
[X] Rotary [ ] Cable [ ] Augered [ ] Driven [ ] Dug [ ] Other ____
Date of Completion 5-21-91

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Top Soil	0	3
Sand + gravel	3	32
blue clay	32	56
Muddy Sand	56	76
gravel (coarse)	76	82

WELL TEST

[ ] Bailing [ ] Pumping* [X] Other Air
Test rate 30 gpm Duration of test 1 hrs
Drawdown — ft.
Measured from: [ ] top of casing [X] ground level [ ] Other ____
Static Level (depth to water) 11 ft. Date: 5-21-91
Quality (clear, cloudy, taste, odor) Clear

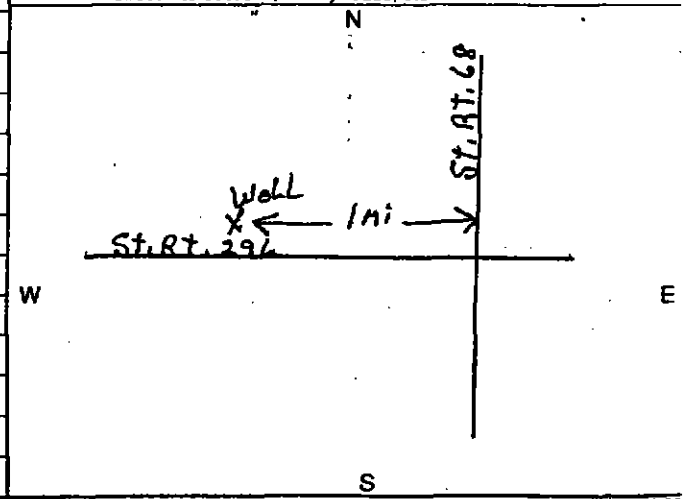
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 60 ft.
Pump Installed by Malkin Pump Service

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Eaton Well Drilling Signed Donald Eaton
Address 8800 N. Rt. 68 Date 5-22-91
City, State, Zip West Liberty OH 43357 ODH Registration Number 41

46

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224 66

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

597256

COUNTY Champaign TOWNSHIP Concord SECTION OF TOWNSHIP 2

OWNER John Sommers ADDRESS 2299 W. Rt. 29, Urbana

LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 30'

Type of screen .050 stainless Length of screen 5'

Type of pump

Capacity of pump

Depth of pump setting

Date of completion

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 40 gpm Duration of test 2 hrs

Drawdown — ft Date July 9, 1981

Static level (depth to water) 14 ft

Quality (clear, cloudy, taste, odor) Clear

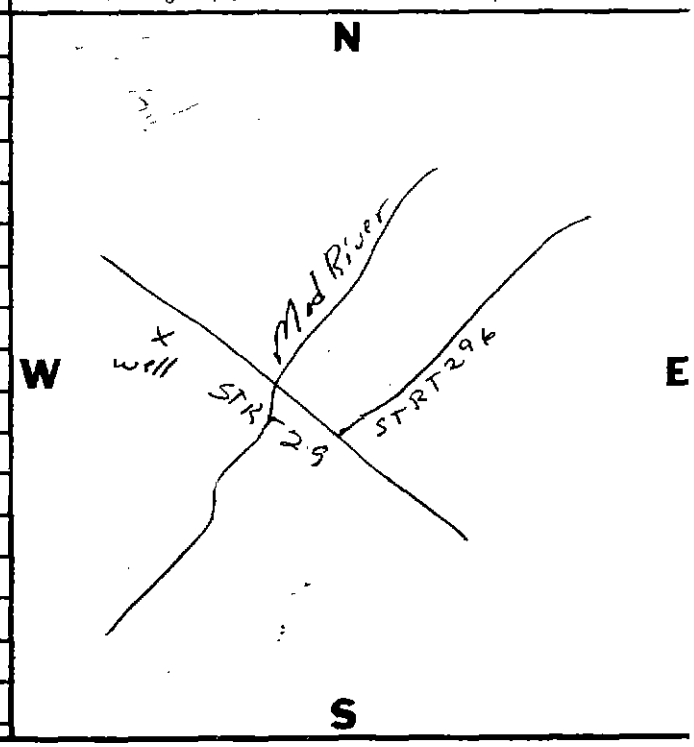
Pump installed by

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
red clay	0 ft	5 ft
Sand & gravel	5	35

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE July 21, 1981

ADDRESS 8401 N. Rt. 68, W. Liberty SIGNED Gerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

47e

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

692896

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number _____

COUNTY Champaign TOWNSHIP Concord SECTION OF TOWNSHIP _____
OWNER Chet Pilcher PROPERTY ADDRESS 2677 Hanna Rd.
LOCATION OF PROPERTY Between 560 + 29

CONSTRUCTION DETAILS

CASING
Casing Diameter 6 in. Length of Casing _____ ft.
Type: ☐ Steel ☒ Galv. ☐ PVC ☐ Other _____
Joints: ☐ Threaded ☒ Welded ☐ Solvent ☐ Other _____

SCREEN
Type (wire wrapped, louvered, etc.) _____ Material _____
Length _____ ft. Diameter _____ in.
Set between _____ ft. and _____ ft. Slot _____

GROUT
Material Bentonite Volume used 10 lbs
Method of installation Gravity
Depth: placed from _____ ft. to _____ ft.
☐ Rotary ☒ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other _____

BAILING OR PUMPING TEST
(specify one by circling)

WELL TEST
Test rate 50 gpm Duration of test 1 hrs
Drawdown (water level during pumping) 3 ft.
Measured from: ☒ top of casing ☐ ground level ☐ Other _____
Static Level (depth to water) 10 ft. Date: 3-16-89
Quality (clear, cloudy, taste, odor) Clear

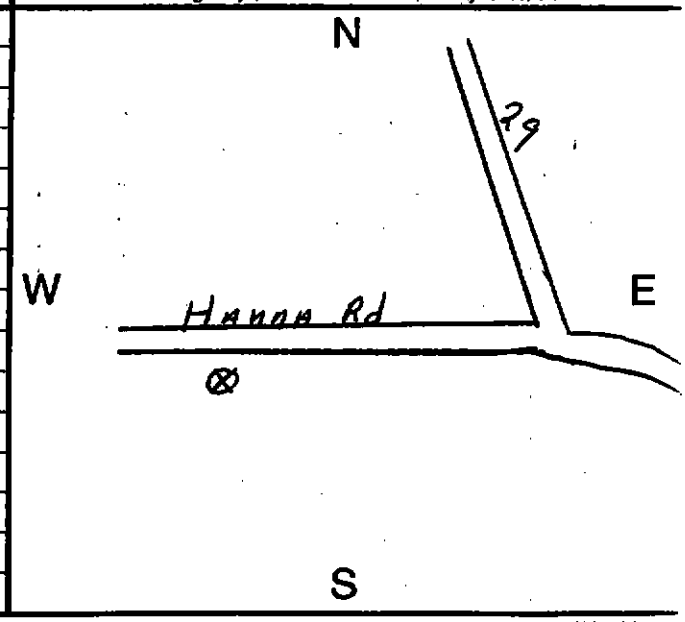
PUMP
Type of pump _____ Capacity _____ gpm
Pump set at 20 ft.
Pump installed by _____
Pitless Device ☒ Adapter ☐ Preassembled unit
Use of Well Single Dwelling

WELL LOG*

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand	From	To
Brown clay	0 ft.	8 ft.
Brown Gravel	8	20
Gray Gravel	20	27
H2O water 27		

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.88

DRILLING FIRM Lower Well Drilling SIGNED David V. Lower
ADDRESS 2542 S. limestone DATE 3-16-89
CITY, STATE, ZIP Spfld, Ohio 45505 ODH REGISTRATION NUMBER 204

48

174

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

668887

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY - SELF-TRANSCRIBING

Permit Number 87J-114

COUNTY Champaign TOWNSHIP Concord SECTION OF TOWNSHIP 19

OWNER Marion Bailey ADDRESS 2070 Barger Rd, Urbana, OH 43078

LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS

Casing diameter 5½" OD-PVC Length of casing 113'

Type of screen PVC, .085 S/OT Length of screen 2'

Type of pump —

Capacity of pump —

Depth of pump setting 100'

Date of completion 6/15/87

Rotary ☑ or Cable ☐

BAILING OR PUMPING TEST (AIR)
(specify one by circling)

Test rate 10 gpm Duration of test 1 hrs

Drawdown 25 ft Date 6/15/87

Static level (depth to water) 65' ft

Quality (clear, cloudy, taste, odor) clear

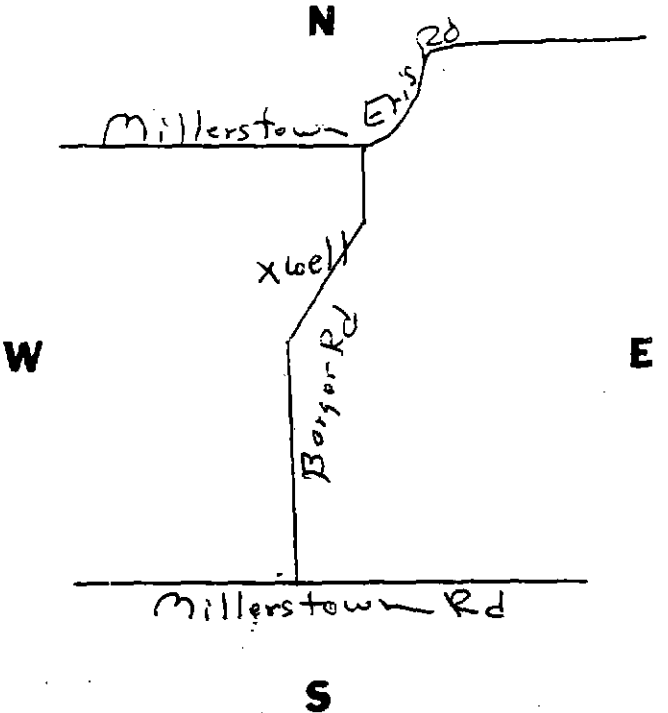
Pump installed by Ireland Plumbing

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Red Clay	0 ft	5 ft
Clay & Gravel	5	30
Sand & Gravel	30	45
Blue Clay	45	77
Hardpan	77	85
Blue Clay	85	110
Sand & Gravel	110	113

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802

DRILLING FIRM Eaton Well Drilling Inc REGISTRATION NUMBER 41 DATE June 29, 198

ADDRESS 8401 N. RT. 68, West Liberty, OH SIGNED Jerry Eaton

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer's Copy / Pink - Driller's Copy / Green - Local Health Dept. Copy

51

WELL LOG AND DRILLING REPORT

662615

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

Permit Number _____

COUNTY Champaign TOWNSHIP Concord SECTION OF TOWNSHIP _____

OWNER Dave Thomas ADDRESS 119 Lincoln Place Urbana, Ohio 43078

LOCATION OF PROPERTY On Millerstown West of 560 approx 1 1/2 mile on North side of road 5730 Millerstown

CONSTRUCTION DETAILS

Casing diameter 5 1/2 O.D. Length of casing 78

Type of screen slot .052 Length of screen 10

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion _____
Rotary ☐ or Cable ☐

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 50 gpm Duration of test 1 hrs

Drawdown 10 ft Date February 10,1987

Static level (depth to water) 54 ft

Quality (clear, cloudy, taste, odor) Clear

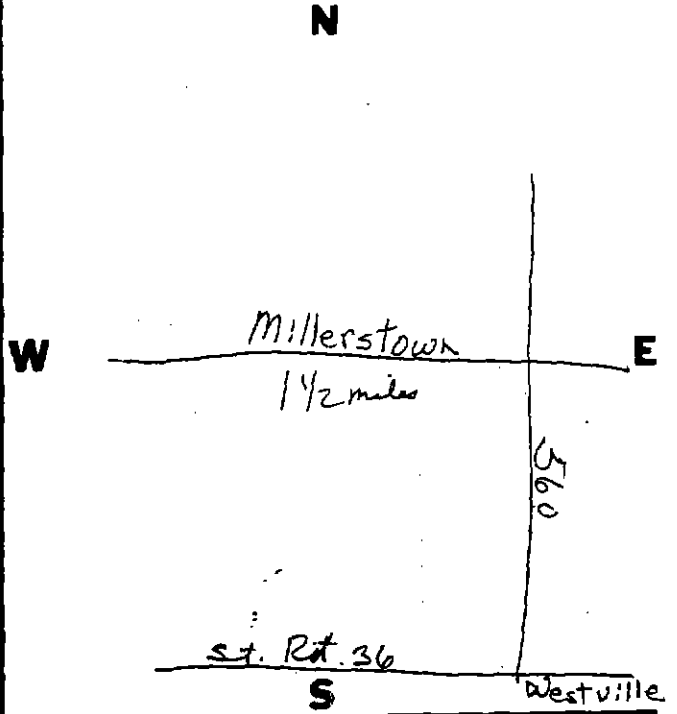
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Clay	0 ft	24 ft
Gravel	24	28
Clay	28	75
Gravel	75	38

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802

DRILLING FIRM Wiley Well Drilling, Inc. REGISTRATION NUMBER 164 DATE 2/10/87

ADDRESS R. 4 Box 273 Union CIty, Indiana 47390 SIGNED Larry J. Wiley (Caw)

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer's Copy / Pink - Driller's Copy / Green - Local Health Dept. Copy

52

WELL LOG AND DRILLING REPORT

136343

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 164

COUNTY Champaign TOWNSHIP Concord SECTION/LOT No. 7 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Charles Stadler PROPERTY ADDRESS 1755 N. RT. 560 (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1mi N. of Millerstown Rd on St. RT. 560 (Eastside)

CONSTRUCTION DETAILS

CASING
[1] Diameter 5½ O.D. in. Length 103 ft. Wall Thickness SDR 17 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: [1] [2] Steel [1] [2] Galv. [X] [2] PVC [1] [2] Other ____
Joints: [1] [2] Threaded [1] [2] Welded [X] [2] Solvent [1] [2] Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN
Type (wire wrapped, louvered, etc.) Slotted Material PVC
Length 5' ft. Diameter 5½ in.
Set between 103 ft. and 98 ft. Slot .085

Borehole Diameter 7⅞ in.

GROUT
Material Benseal Volume used 150#
Method of installation Tremie
Depth: placed from 80 ft. to Surface ft.

GRAVEL PACK (Filter Pack)
Material grit Sand Volume used 80 gal.
Method of installation Poured
Depth: placed from 103 ft. to 90 ft.

Pitless Device [X] Adapter [ ] Preassembled unit
Use of Well Domestic
[X] Rotary [ ] Cable [ ] Augered [ ] Driven [ ] Dug [ ] Other ____
Date of Completion 11-8-91

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Red clay	0	43
Sand + Gravel	43	60
Sandy Blue clay	60	80
Gravel	80	103

WELL TEST

[ ] Bailing [ ] Pumping* [X] Other Air
Test rate 50' gpm Duration of test 1 hrs.
Drawdown ____ ft.
Measured from: [ ] top of casing [X] ground level [ ] Other ____
Static Level (depth to water) 38 ft. Date: 11-8-91
Quality (clear, cloudy, taste, odor) Clear

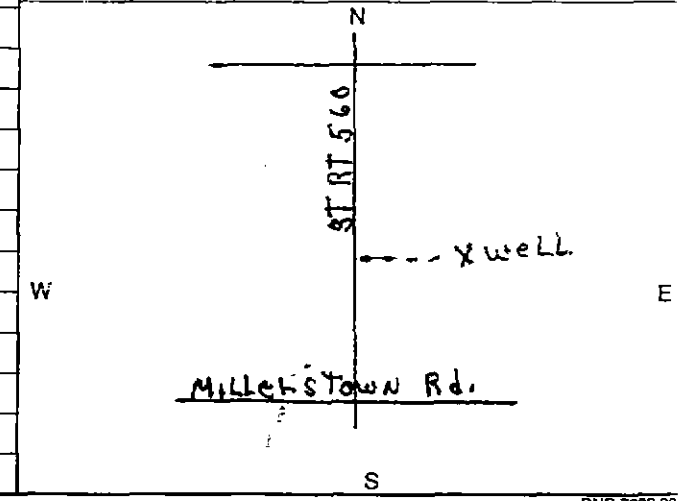
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 18 gpm
Pump set at 80 ft.
Pump installed by Eaton Well + Pump

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Eaton Well Drilling Signed Donald Eaton
Address 8800 N. RT. 68 Date 11-11-91
City, State, Zip West Liberty OH 43357 ODH Registration Number 41

53

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224
Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

652357

COUNTY Champaign TOWNSHIP Concord SECTION OF TOWNSHIP 1

OWNER Roger Tullis ADDRESS 2850 Millerstown Rd, Urbana, 43078

LOCATION OF PROPERTY 1456 River Rd

CONSTRUCTION DETAILS

Casing diameter 6" ID-PVC Length of casing 79'

Type of screen PVC, 085 Length of screen 2'

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST (specify one by circling) AIR

Test rate 35 gpm Duration of test 1 hr

Drawdown ft Date May 24, 1984

Static level (depth to water) 8'

Quality (clear, cloudy, taste, odor) clear

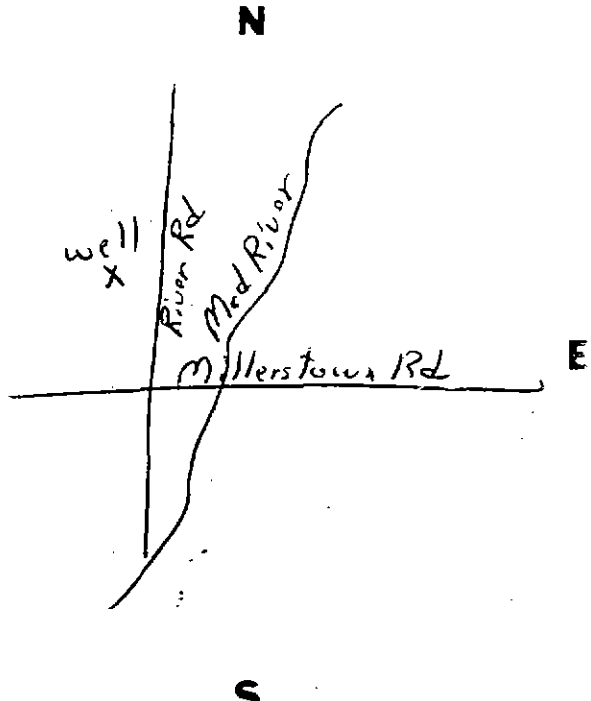
Pump installed by Lloyd Kells

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
gravel	0 ft	77 ft
clay	77	79

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE July 2, 1984

ADDRESS 8401 N. RT 68, W. Liberty, OH SIGNED Jerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

54

ORIGINAL COPY - ODNR, DIVISION OF WATER FOUNTAIN SQ COLS OHIO 43224

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY - SELF-TRANSCRIBING

634626

COUNTY Champaign TOWNSHIP Urbana SECTION OF TOWNSHIP 36

OWNER Jerry Stickley ADDRESS 2241 Millerstown Rd, Urbana, OH 43078

LOCATION OF PROPERTY same

CONSTRUCTION DETAILS

Casing diameter 5½" cu-pvc Length of casing 81

Type of screen PVC 0.35 slot Length of screen 4'

Type of pump —

Capacity of pump —

Depth of pump setting 50

Date of completion 4/12/86

BAILING OR PUMPING TEST (AIR)
(specify one by circling)

Test rate 50 gpm Duration of test 1 hrs

Drawdown 20 ft Date 4/12/86

Static level (depth to water) 6 ft

Quality (clear, cloudy, taste, odor) clear

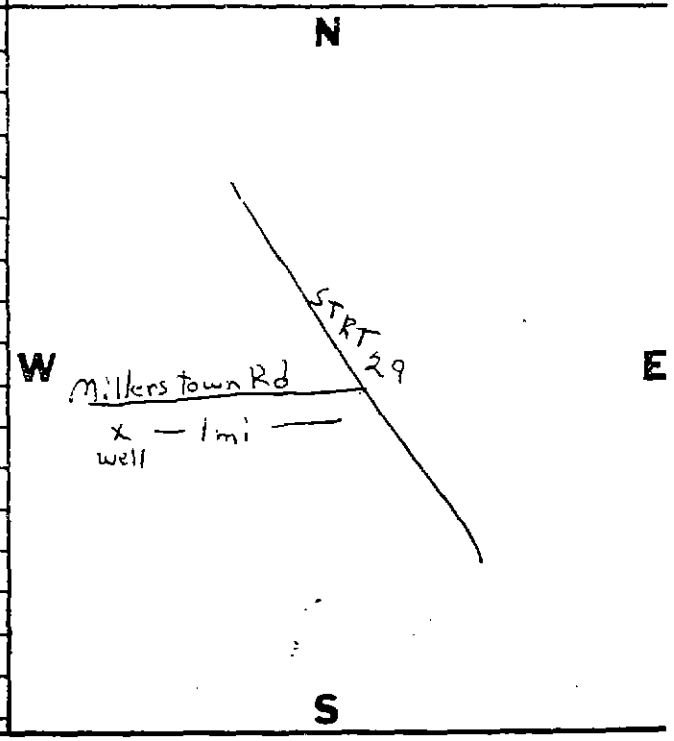
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
gravel	0 ft	14 ft
blue clay	14	20
sand & gravel	20	32
clay	32	73
gravel	73	81

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE 4/14/86

ADDRESS 8401 N. RT. 68, West Liberty, OH SIGNED Jerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

55

ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

640435

COUNTY Champaign TOWNSHIP Urbana SECTION OF TOWNSHIP 36

OWNER George Craig ADDRESS 1539 Millerstown Rd, Urbana

LOCATION OF PROPERTY same

CONSTRUCTION DETAILS

Casing diameter 6" I.D. - PVC Length of casing 81

Type of screen PVC .055 slot Length of screen 2

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST (AIR)
(specify one by circling)

Test rate 30 gpm Duration of test 1 hrs

Drawdown 5 ft Date Oct. 10, 1983

Static level (depth to water) 53 ft

Quality (clear, cloudy, taste, odor) Clear

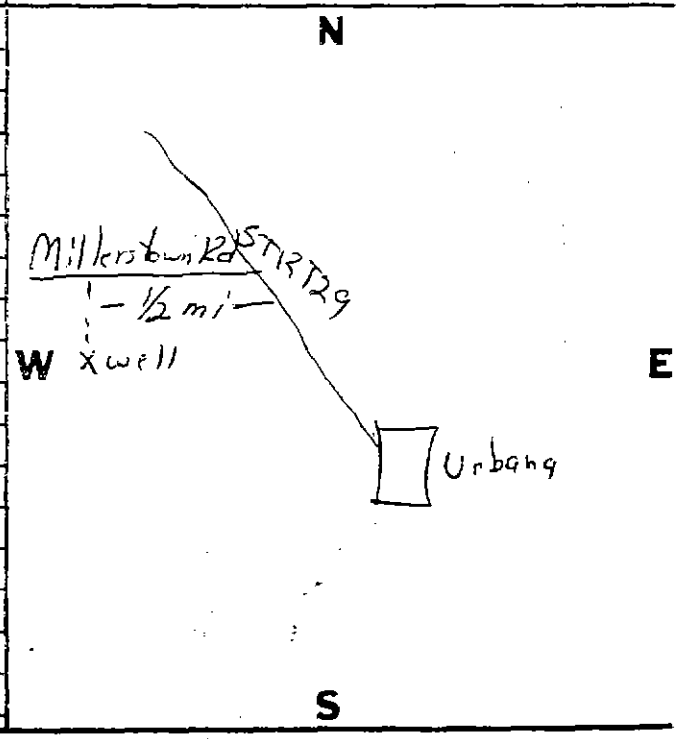
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
clay	0 ft	10 ft
gravel	10	55
clay	55	75
gravel	75	78
clay	78	81

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE Oct. 18, 1983

ADDRESS W. Liberty, Ohio SIGNED Jerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

56

ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

County Permit No. _____

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

539389

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP 459

OWNER Bill Henry ADDRESS 1843 W. Rte. #29

LOCATION OF PROPERTY _____

CONSTRUCTION DETAILS

Casing diameter 5 5/8 Length of casing 187

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion _____

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 16 gpm Duration of test 1 hrs

Drawdown 12 ft Date 8/25/80

Static level (depth to water) 96 ft

Quality (clear, cloudy, taste, odor) clear

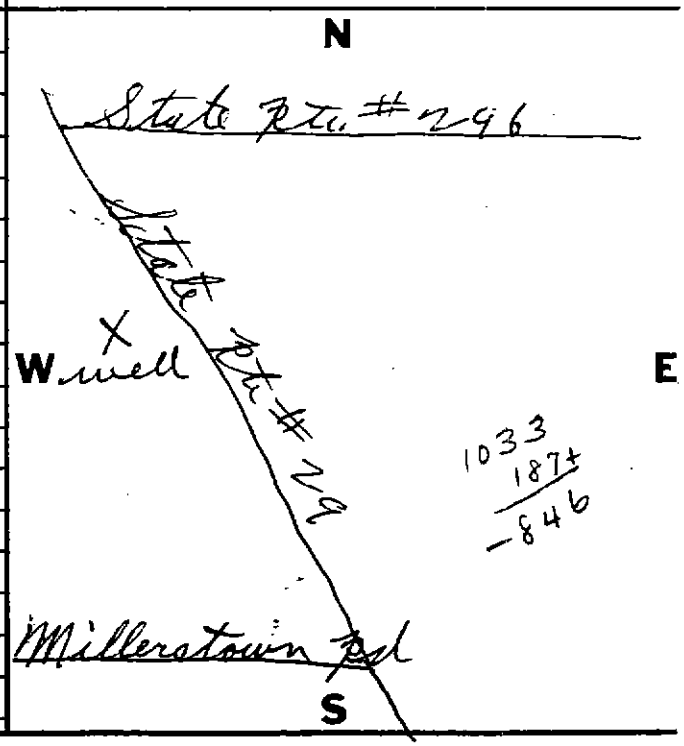
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
clay	0 ft	97 ft
sand	97	99
clay	99	180
sand	180	187

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Rupert & Son DATE 8/25/80

ADDRESS 1640 W. Rte #29 SIGNED Wm Rupert

57

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

ORIGINAL

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2546
Columbus, Ohio 43215

No. 419315

County Champaign Township Urbana Section of Township 30

Owner Fred Garvey Address 201 Fulton St Urbana, O

Location of property 250 Ft west of Railroad st on Fulton St

CONSTRUCTION DETAILS

Casing diameter [illegible] Length of casing 34'

Type of screen — Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST
(Specify one by circling)

Test Rate 16 G.P.M. Duration of test 2 hrs.

Drawdown [illegible] ft. Date MAY 24, 1971

Static level-depth to water 15 ft.

Quality (clear, cloudy, taste, odor) Clear

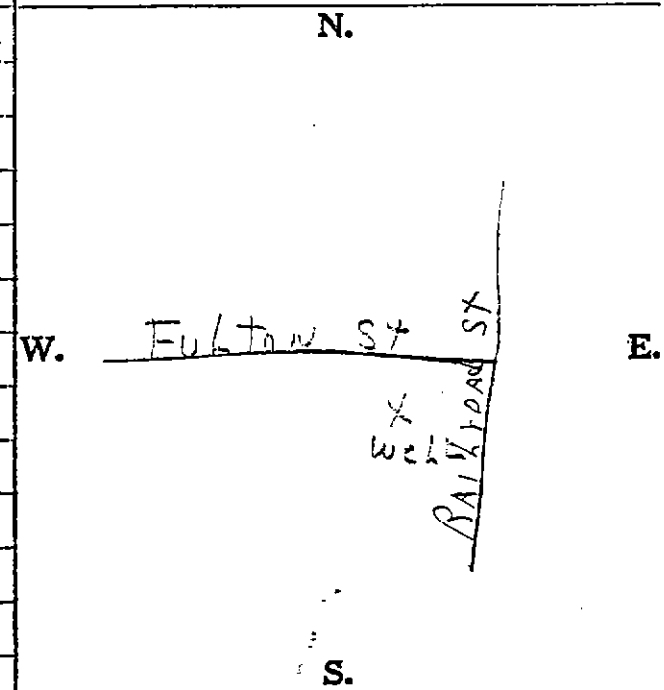
Pump installed by —

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Red clay	0 Feet	3 Ft.
gravel	3	34

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm Donald Eaton & Son Date MAY 24, 1971

Address Box 75 Rosewood, O Signed Donald Eaton

58

*If additional space is needed to complete well log, use next consecutive numbered form.

281

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

591420

COUNTY Champ. TOWNSHIP Salem SECTION OF TOWNSHIP South

OWNER McCullough Bros. ADDRESS 1304 K. Kingsreed Rd

LOCATION OF PROPERTY North Edge of Urbana on Dellinger Rd

CONSTRUCTION DETAILS

Casing diameter 6in Length of casing 76.9

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting 70 ft

Date of completion _____

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 20 gpm Duration of test 1 hrs

Drawdown None ft Date 10-11-83

Static level (depth to water) 36 ft

Quality (clear, cloudy, taste, odor) _____

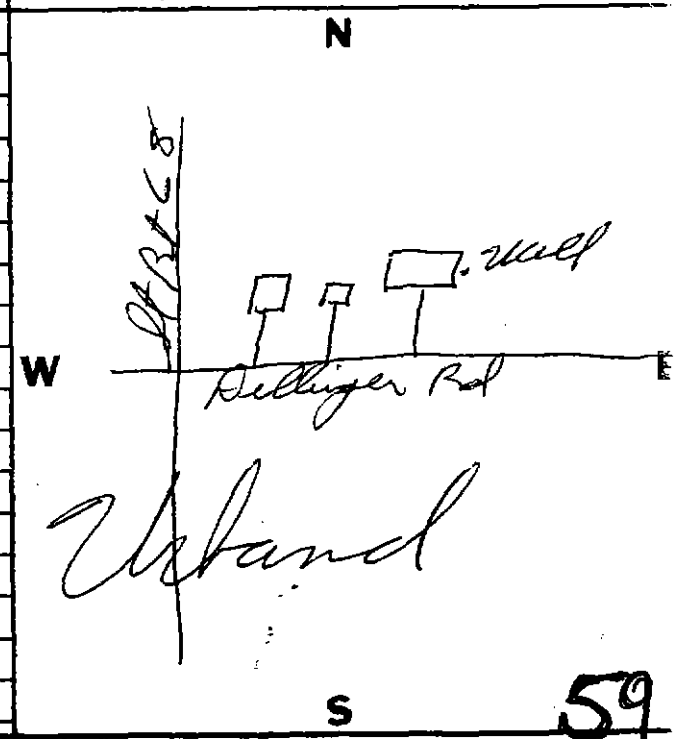
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
	~~0 ft~~	ft
Clay	0	10
Gravel	10	60
Clay	60	75
Water at	76	

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



59

DRILLING FIRM DeLaney Well Drilling DATE 10-11-83

ADDRESS 1412 K. Kingsreed Rd SIGNED Floyd DeLaney

*If additional space is needed to complete well log, use next consecutive numbered form.

ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

718706

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 91

COUNTY Champaign TOWNSHIP Salem (SECTION) LOT No. 13 (CIRCLE ONE)

(OWNER) BUILDER (CIRCLE ONE OR BOTH) Warren Haney PROPERTY ADDRESS 661 Jackson Hill Rd (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1/4 Mi E. of Clark Rd on Jackson Hill Rd (S. Side back Lane)

CONSTRUCTION DETAILS

CASING
1 Diameter 5 1/2 O.D. in. Length 93 ft. Wall Thickness SDR 17 in.
2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: 1 Steel 2 Galv. X PVC 2 1 2 Other ____
Joints: 1 Threaded 2 1 Welded 2 X Solvent 2 1 2 Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN
Type (wire wrapped, louvered, etc.) Slot Material PVC
Length 2 1/2 ft. Diameter 5 1/2 O.D. in.
Set between 91 ft. and 93 ft. Slot .085

Borehole Diameter 7 7/8 in.

GROUT
Material Bensal Volume used 4 bags 200#
Method of installation Tremie
Depth: placed from ground ft. to 75 ft.

GRAVEL PACK (Filter Pack)
Material Grit Sand Volume used 30 gal
Method of installation Poured
Depth: placed from 75 ft. to 93 ft.

Pitless Device X Adapter ☐ Preassembled unit
Use of Well Domestic
X Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion 8-27-90

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Brown Clay	0	5
Gravel	5	12
Gray Clay	12	17
Gravel	17	35
Gray Clay	35	86
Gravel	86	93

WELL TEST

☐ Bailing ☐ Pumping* X Other Air
Test rate 20 gpm Duration of test 1 hrs
Drawdown 20 ft.
Measured from: ☐ top of casing X ground level ☐ Other ____
Static Level (depth to water) 14 ft. Date: 8-27-90
Quality (clear, cloudy, taste, odor) Clear

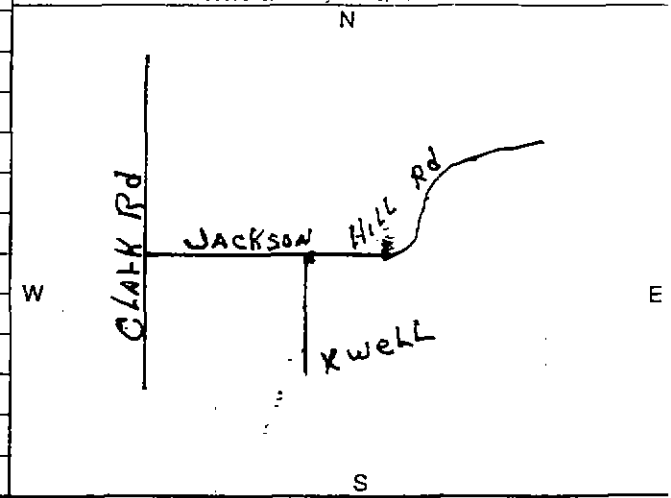
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 40 ft.
Pump installed by Eaton Well + Pump

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Eaton Well Drilling Signed Donald Eaton
Address 8800 N. RT. 68 Date 8-27-90
City, State, Zip West Liberty OH 43357 ODH Registration Number 41

60

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224
Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

WELL LOG AND DRILLING REPORT

659754

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

Permit Number _____

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP 7

OWNER Cokin Co. ADDRESS 1881 N. Dugan Rd, Urbana

LOCATION OF PROPERTY same

CONSTRUCTION DETAILS

Casing diameter 5½" o.d. pvc Length of casing 163'

Type of screen .085 pvc slot Length of screen 5'

Type of pump —

Capacity of pump —

Depth of pump setting 100'

Date of completion 8-17-86

Rotary ☒ or Cable ☐

BAILING OR PUMPING TEST (specify one by circling) Air

Test rate 70 gpm Duration of test 1 hrs

Drawdown 20 ft Date _____

Static level (depth to water) 50 ft

Quality (clear, cloudy, taste, odor) Clear

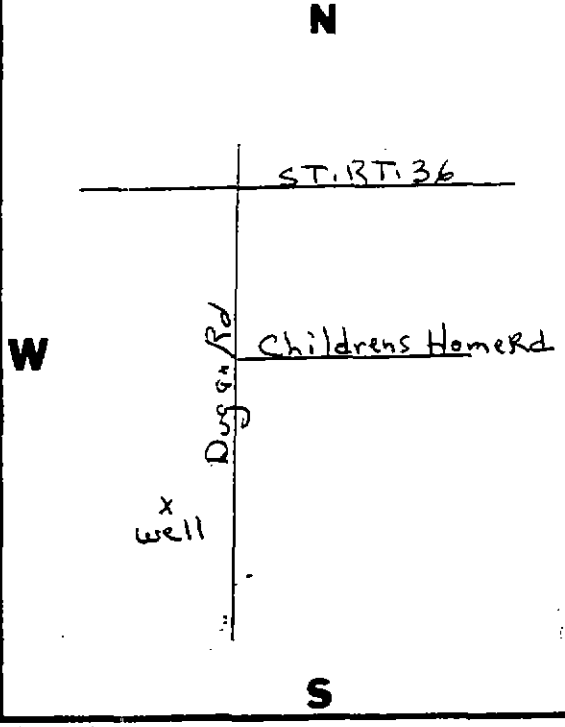
Pump installed by Tony Markin

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
sand & gravel/clay	0 ft	45 ft
clay	45	100
sand & gravel	100	110
clay	110	156
sand & gravel	156	163

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 78

DRILLING FIRM Eaton Well Drilling REGISTRATION NUMBER 41 DATE 10-17-86

ADDRESS 840 N. Rt. 68, W. Liberty SIGNED Jerry Eaton

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer's Copy / Pink - Driller's Copy / Green - Local Health Dept. Copy

61

WEL LOG AND DRILLING REP^RT

ORIGINAL

NO CARBON PAPER NECESSARY-SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Geological Survey
Fountain Square
Columbus, Ohio 43224 Phone (614) 466-5344

479384

COUNTY Champaign TOWNSHIP Urbana SECTION OF TOWNSHIP ~~OR LOT NUMBER~~ 12

OWNER John Zugaro ADDRESS 317 W. Reynolds Urbana,

LOCATION OF PROPERTY 1/4 Mile North of RT 36 on Dugan Rd

CONSTRUCTION DETAILS

Casing diameter 5 5/8" Length of casing 87'

Type of screen — Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST (specify one by circling)

Test rate 16 gpm Duration of test 2 hrs

Drawdown None ft Date July 3, 1975

Static level (depth to water) 61 ft

Quality (clear, cloudy, taste, odor) clear

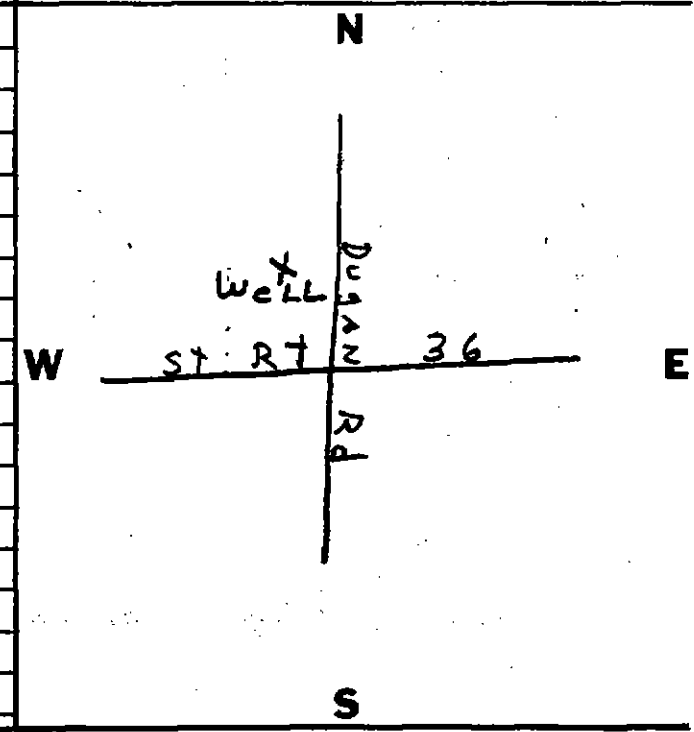
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Red clay	0 ft	10 ft
gravel	10	87

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Donald E. Eaton Well Drlg DATE July 3, 1975

ADDRESS Box 75 Rosewood, O SIGNED Donald Eaton

62

(72)

*If additional space is needed to complete well log, use next consecutive numbered form.

295

WELL LOG AND DRILLING REPORT

ORIGINAL

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK.

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

№ 288378

County Champaign Township Urbana Section of Township

Owner Wilbur Phelps Address RR2 Urbana

Location of property Rt 36 out of Urbana about 1 mile west

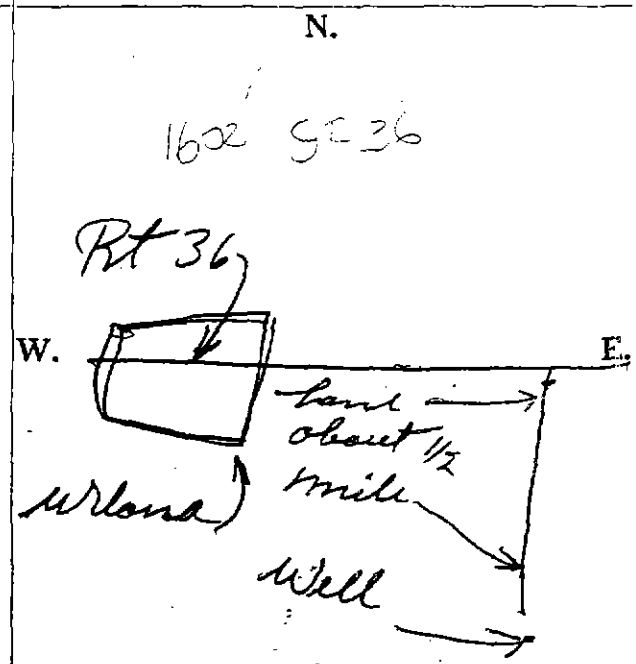
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 4 1/4" Length of casing 57'	Pumping Rate G.P.M. Duration of test hrs.
Type of screen Length of screen	Drawdown ft. Date
Type of pump	Static level-depth to water ft.
Capacity of pump	~~Quality (clear~~, cloudy, taste, ~~odor~~) good
Depth of pump setting 44	
Date of completion	Pump installed by

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
yellow Clay	0 Feet	8 Ft.
yellow Gravel	8	40
Water Gravel	40	49
T.D. 49'		

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm T. J. FYFFE
Water Wells & Pumps
Address R.F.D. No. 3 FA 2-3627
SPRINGFIELD, OHIO

Date July 22-63
Signed T. J. Fyffe

63

WELL LOG AND DRILLING REPORT

719784

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 143

COUNTY Champaign TOWNSHIP Mad River SECTION/LOT No. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Chuck Bair PROPERTY ADDRESS 3215 W. Rt 36 Urbana (ADDRESS OF WELL LOCATION #)

LOCATION OF PROPERTY 3/4 mile east of Westville on the South side of Road

CONSTRUCTION DETAILS

CASING
1 Diameter 6 in. Length 31 ft. Wall Thickness .142 in.
2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: 1 Steel 2 Galv. 1 PVC 2 1 2 Other ____
Joints: 1 Threaded 2 Welded 1 Solvent 2 1 2 Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter ____ in.

SCREEN
Type (wire wrapped, louvered, etc.) ____ Material ____
Length ____ ft. Diameter ____ in.
Set between ____ ft. and ____ ft. Slot ____

GROUT
Material Drillcuttings Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

GRAVEL PACK (Filter Pack)
Material ____ Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well residential
☐ Rotary ☑ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion 9-8-90

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Topsoil	0	2
Sand & gravel	2	28
Gravel Water	28	31

WELL TEST

☑ Bailing ☐ Pumping* ☐ Other ____
Test rate 40 gpm Duration of test ____ hrs.
Drawdown 2' ft.
Measured from: ☑ top of casing ☐ ground level ☐ Other ____
Static Level (depth to water) 7 ft. Date: ____
Quality (clear, cloudy, taste, odor) Clear

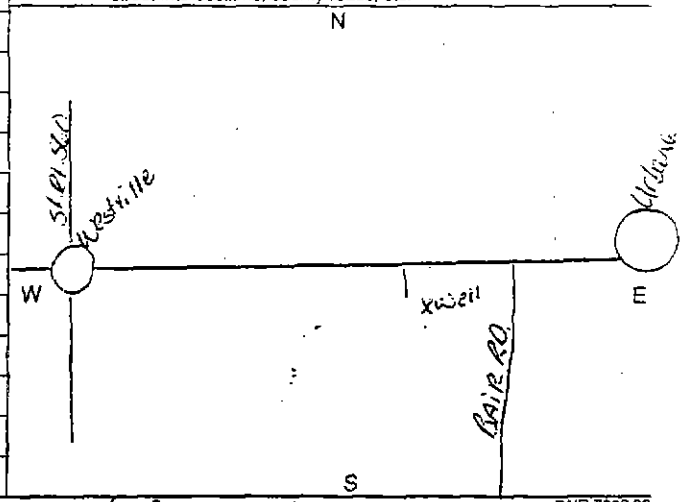
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump ____ Capacity ____ gpm
Pump set at ____ ft.
Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Kinsley Well Drilling
Address 9734 Rodewood-Quincy Rd.
City, State, Zip Quincy Oh. 43343

Signed Lloyd Kinsley
Date 9-8-90
ODH Registration Number 1383

64

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

County Permit No. _____

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

539391

COUNTY Champaign TOWNSHIP Mad River SECTION OF TOWNSHIP 8 9

OWNER Junior Mayer ADDRESS [illegible]

LOCATION OF PROPERTY 1.2 mi. south of U.S. #36 on Bair Rd.

CONSTRUCTION DETAILS

Casing diameter 5 5/8 Length of casing 38

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion _____

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 16 gpm Duration of test ½ hrs

Drawdown 4 ft Date 9/6/80

Static level (depth to water) 15 ft

Quality (clear, cloudy, taste, odor) clear

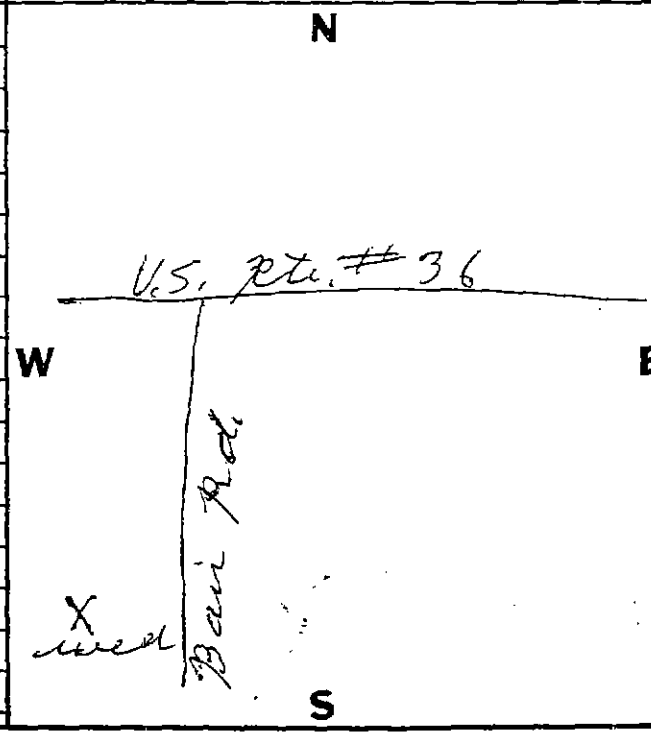
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
clay	0 ft	4 ft
sand & gravel	4	38

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Rupert & Son DATE 9/6/80

ADDRESS 1690 W. Rte. #29 Urbana SIGNED Wm. Rupert

*If additional space is needed to complete well log, use next consecutive numbered form.

-65

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

749310

Permit Number 58

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

COUNTY Champaign TOWNSHIP Urbana SECTION/LOT No. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Rural Theobey PROPERTY ADDRESS 1855 St Rt 55 (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY Urbana, O 43078

CONSTRUCTION DETAILS

CASING Borehole Diameter 5 7/8 in.

1 Diameter 6 in. Length 10 ft. Wall Thickness .142 in.

2 Diameter ____ in. Length ____ ft. Wall Thickness ____ in.

Type: 1 Steel 2 (Galv) 1 PVC 2 1 2 Other ____

Joints: 1 Threaded 2 (Welded) 1 Solvent 2 1 2 Other ____

Liner: Length ____ Type ____ Wall Thickness ____ in.

GROUT Material Grout Volume used ____

Method of installation ____

Depth: placed from ____ ft. to ____ ft.

GRAVEL PACK (Filter Pack)

Material ____ Volume used ____

Method of installation ____

Depth: placed from ____ ft. to ____ ft.

SCREEN

Type (wire wrapped, louvered, etc.) ____ Material ____

Length ____ ft. Diameter ____ in.

Set between ____ ft. and ____ Slot ____

Pitless Device ☒ Adapter ☐ Preassembled unit

Use of Well Home

☐ Rotary ☒ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____

Date of Completion 5/30/92

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc	From	To
Clay	0	10
Clay & Gravel	10	15
Clay & Gravel & Sand	15	20
Water Gravel	20	93

20' water

*If additional space is needed to complete well log, use next consecutively numbered form.

WELL TEST

☒ Bailing ☐ Pumping* ☐ Other ____

Test rate 20 gpm Duration of test 1 hr.

Drawdown 0 ft.

Measured from: ☒ top of casing ☐ ground level ☐ Other ____

Static Level (depth to water) 13 ft. Date: 5/30/92

Quality (clear, cloudy, taste, odor) ____

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

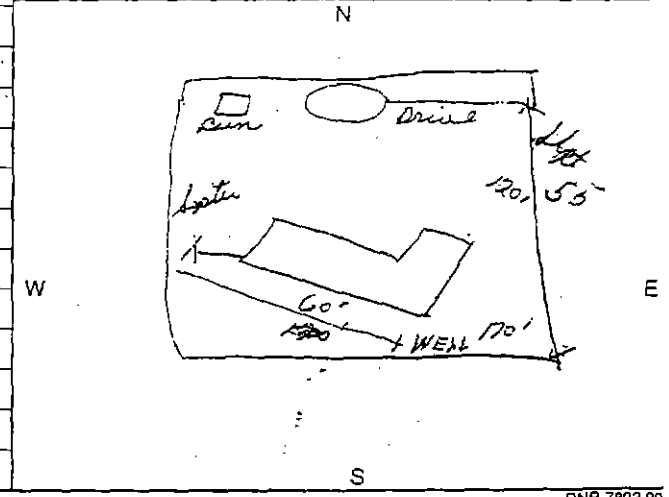
Type of pump ____ Capacity ____ gpm

Pump set at ____ ft.

Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



DNR 7802.90

Drilling Firm T.R. Stone Inc Signed Jerry Trent

Address 2030 E Kingsview Rd Date 6/30/92

City, State, Zip Urbana, O 43078 ODH Registration Number 2007

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

66

WELL LOG AND DRILLING REPORT

668890

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

Permit Number 87D-117

COUNTY Champaign TOWNSHIP Urbana SECTION OF TOWNSHIP 34

~~OWNER~~ Builder Ron Furrow Construction ADDRESS 2290 Rd 34, Quincy, OH 43343

LOCATION OF PROPERTY 1510 ST RT 55, Urbana

CONSTRUCTION DETAILS

Casing diameter 5½" OD-PVC Length of casing 80'

Type of screen PVC .085 Slot Length of screen 2'

Type of pump —

Capacity of pump —

Depth of pump setting 75

Date of completion 6/16/87

Rotary ☒ or Cable ☐

BAILING OR PUMPING TEST (Air)

(specify one by circling)

Test rate 15 gpm Duration of test 1 hrs

Drawdown 15 ft Date 6/16/87

Static level (depth to water) 58 ft

Quality (clear, cloudy, taste, odor) clear

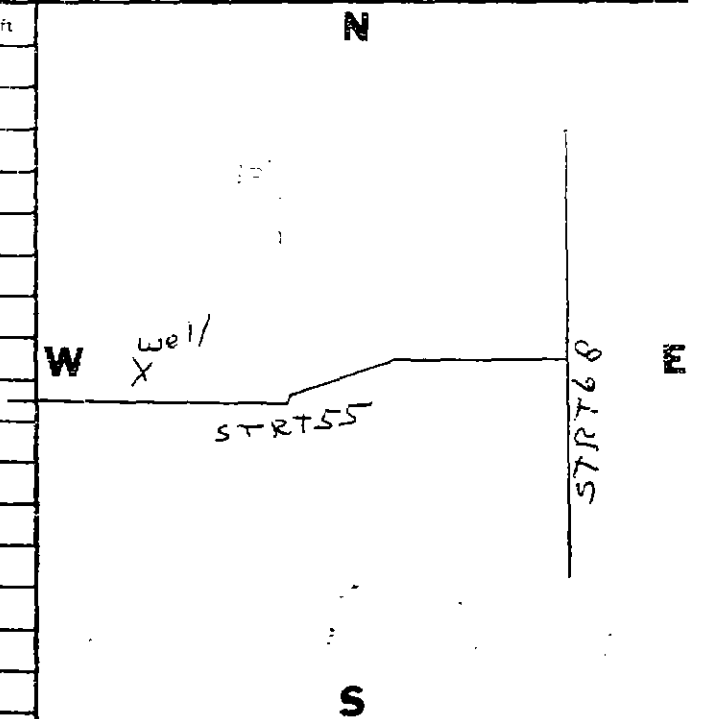
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Red Clay	0 ft	13 ft
Gravel & Sand	13	65
Gravel	65	80

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802

DRILLING FIRM Eaton Well Drilling Inc REGISTRATION NUMBER 41 DATE 6/29/87

ADDRESS 8401 N. RT 168, West Liberty, OH SIGNED Jerry Eaton

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer's Copy / Pink - Driller's Copy / Green - Local Health Dept. Copy

67

WEI' LOG AND DRILLING RE'ORT

ORIGINAL

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 · Phone (614) 469-2646
Columbus, Ohio 43215

436608

County Champaign Township Urbana Section of Township acreage

Owner Gerald Roskew Address Urbana

Location of property 2 miles West Urbana on left

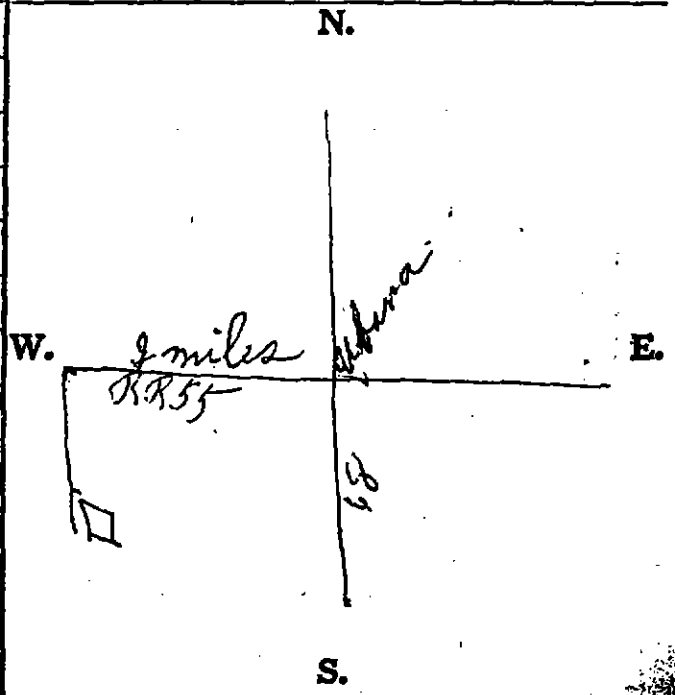
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST (Specify one by circling)
Casing diameter 5 3/8 Length of casing	Test Rate 12 G.P.M. Duration of test 1 hrs
Type of screen Length of screen	Drawdown 4 ft. Date April 26, 1972
Type of pump	Static level-depth to water 19 ft Water ft.
Capacity of pump	Quality (clear, cloudy, taste, odor) Clear
Depth of pump setting 76 ft	
Date of completion April 26 1972	Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
top soil	0 Feet	10 Ft.
Blue mud	10	20
Gravel	20	75
Gravel & sand	75	81
Gravel	81	

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm G. R. Fletcher Date April 26, 1972

Address 1105 Warnock St. Signed G. R. Fletcher

*If additional space is needed to complete well log, use next consecutive numbered form.

323

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY - SELF-TRANSCRIBING

640293

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP 13

OWNER Clarence Tallman ADDRESS 589 Jackson Hill Rd, Urbana

LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS

Casing diameter 6" ID PVC Length of casing 50'

Type of screen PVC, .085 slot Length of screen 2'

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST (AIR)
(specify one by circling)

Test rate 20 gpm Duration of test 1 hr

Drawdown — ft Date Aug. 8, 1983

Static level (depth to water) 28 ft

Quality (clear, cloudy, taste, odor) Clear

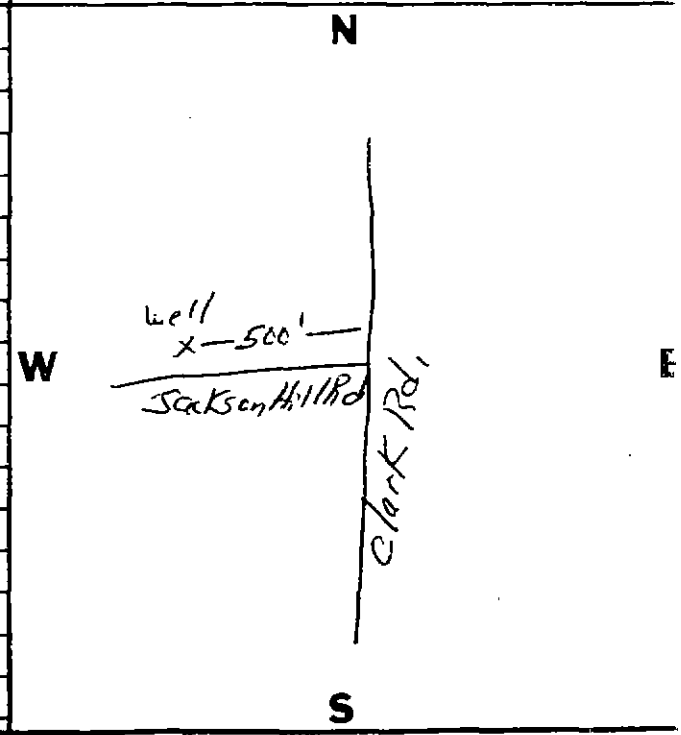
Pump installed by Fetz Plumbing

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
clay	0 ft	15 ft
gravel	15	48
clay	48	50

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE Aug. 12, 1983

ADDRESS 8401 N. RT 168, W. Liberty, O SIGNED Jerry Eaton

70

*If additional space is needed to complete well log, use next consecutive numbered form.

75

ORIGINAL COPY - ODNR. DIVISION OF WATER. FOUNTAIN SQ. COLS. OHIO 43224

WELL LOG AND DRILLING REPORT

718706

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 91

COUNTY Champaign TOWNSHIP Salem SECTION/LOT No. 13 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Warren Haney PROPERTY ADDRESS 661 Jackson Hill Rd (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1/4 Mi E. of Clark Rd on Jackson Hill Rd (S. Side back lane)

CONSTRUCTION DETAILS

CASING
[1] Diameter 5 1/2 O.D. in. Length 93 ft. Wall Thickness SDR 17 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: [1] Steel [2] Galv. [X] PVC [2] Other ____
Joints: [1] Threaded [2] Welded [X] Solvent [2] Other ____
Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter 7 7/8 in.

SCREEN
Type (wire wrapped, louvered, etc.) Slot Material PVC
Length 2 1/2 ft. Diameter 5 1/2 O.D. in.
Set between 91 ft. and 93 ft. Slot .085

GROUT
Material Benseal Volume used 4 bags 200#
Method of installation Tremie
Depth: placed from ground ft. to 75 ft.

GRAVEL PACK (Filter Pack)
Material Grit Sand Volume used 30 gal
Method of installation Poured
Depth: placed from 75 ft. to 93 ft.

Pitless Device [X] Adapter [ ] Preassembled unit
Use of Well Domestic
[X] Rotary [ ] Cable [ ] Augered [ ] Driven [ ] Dug [ ] Other ____
Date of Completion 8-27-90

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Brown Clay	0	5
Gravel	5	12
Gray Clay	12	17
Gravel	17	35
Gray Clay	35	86
Gravel	86	93

WELL TEST

[ ] Bailing [ ] Pumping* [X] Other Air
Test rate 20 gpm Duration of test 1 hrs
Drawdown 20 ft.
Measured from: [ ] top of casing [X] ground level [ ] Other ____
Static Level (depth to water) 14 ft. Date: 8-27-90
Quality (clear, cloudy, taste, odor) Clear

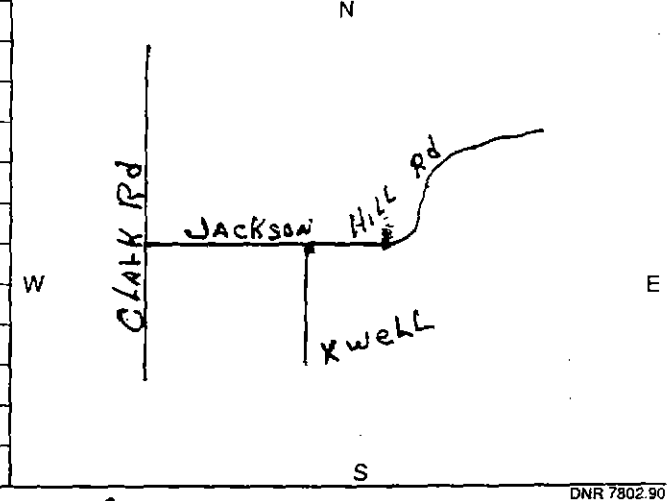
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 40 ft.
Pump installed by Eaton Well + Pump

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Eaton Well Drilling Signed Donald Eaton
Address 8800 N. RT. 68 Date 8-27-90
City, State, Zip West Liberty OH 43357 ODH Registration Number 41

71

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224 76

Blue - Customer's copy, Pink - Driller's copy, Green - Local Health Dept. copy

WELL LOG AND DRILLING REPORT

738383

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 152

COUNTY Champaign Co. TOWNSHIP Salem SECTION/LOT No. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Daniel Roberts PROPERTY ADDRESS 681 Jackson Hill Rd (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY

CONSTRUCTION DETAILS

CASING Borehole Diameter 5 7/8 in.

[1] Diameter 5 5/8 in. Length 55 ft. Wall Thickness .20 or .21 in.

[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.

Type: [1] Steel [X] Galv. [1] PVC [1] [2] [2] [2] Other ____

Joints: [1] Threaded [X] Welded [1] Solvent [1] [2] [2] [2] Other ____

Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN

Type (wire wrapped, louvered, etc.) — Material —

Length — ft. Diameter ____ in.

Set between ____ ft. and ____ ft. Slot open hole

GROUT

Material bentonite Volume used 100 lbs

Method of installation dry driven

Depth: placed from 45 ft. to 0 ft.

GRAVEL PACK (Filter Pack)

Material ____ Volume used —

Method of installation —

Depth: placed from — ft. to — ft.

Pitless Device ☐ Adapter ☐ Preassembled unit

Use of Well Domestic

☐ Rotary [X] Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____

Date of Completion ____

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Clay	0	2
brown gravel	2	50
water gravel	50	55

WELL TEST

[X] Bailing ☐ Pumping* ☐ Other ____

Test rate 15 gpm Duration of test 2 hrs.

Drawdown 4' ft.

Measured from: [X] top of casing ☐ ground level ☐ Other ____

Static Level (depth to water) 40' ft. Date: 11-11-91

Quality (clear, cloudy, taste, odor) clear

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

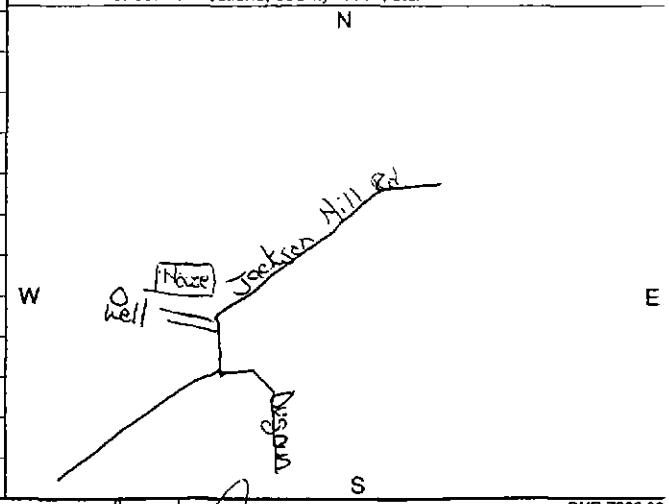
Type of pump ____ Capacity ____ gpm

Pump set at ____ ft.

Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Crabtree Well + Pump Signed Mark Crabtree

Address 3882 Snyder Domer Rd. Date 11-13-91

City, State, Zip Springfield, OH 45502 ODH Registration Number 2604

72

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

712336

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-6739

TYPE OR USE PEN
SELF-TRANSCRIBING
PRESS HARD!

Permit Number _____

COUNTY CHAMPAIGN TOWNSHIP Salem SECTION/LOT NO. _____ (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Martin Shaffer PROPERTY ADDRESS Jackson Hill Rd. #1767 (ADDRESS OF WELL LOCATION)

LOCATION OF PROPERTY S. R. 36E to Dugan Rd. North on Dugan to end of road- runs into Jackson Hill a new bridge- turn right- straight si

CONSTRUCTION DETAILS

CASING
Diameter 5½ in. Length 120 ft. Wall Thickness SDR21 in.
Type: ☐ Steel ☐ Galv. ☒ PVC ☐ Other _____
Joints: ☐ Threaded ☐ Welded ☒ Solvent ☐ Other _____

SCREEN
Type (wire wrapped, louvered, etc.) slotted Material PVC
Length 5 ft. Diameter 5½ in.
Set between 120 ft. and 125 ft. Slot .051
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other _____
Date of completion 7/2/90

GROUT
Material Benseal & native clay / Volume used 40 gallons
Method of installation Pumped & gravity
Depth: placed from 25 ft. to 0 ft.

GRAVEL PACK
Material Pea gravel Volume used 40 gallons
Method of installation Gravity
Depth: placed from 120 ft. to 125 ft.

Pitless Device ☐ Adapter ☐ Preassembled unit
Use of Well Home

PUMP
Type of pump _____ Capacity _____ gpm
Pump set at _____ ft.
Pump installed by _____

WELL TEST
Bailing ☐ or Pumping ☐ AIR X
Test rate 30+ gpm Duration of test 1 hrs.
Drawdown 25 ft.
Measured from: ☒ top of casing ☐ ground level ☐ Other _____
Static Level (depth to water) 83 ft. Date: 7/2/90
Quality (clear, cloudy, taste, odor) Clear
(Attach a copy of the pumping test record, per 1521.05, ORC)

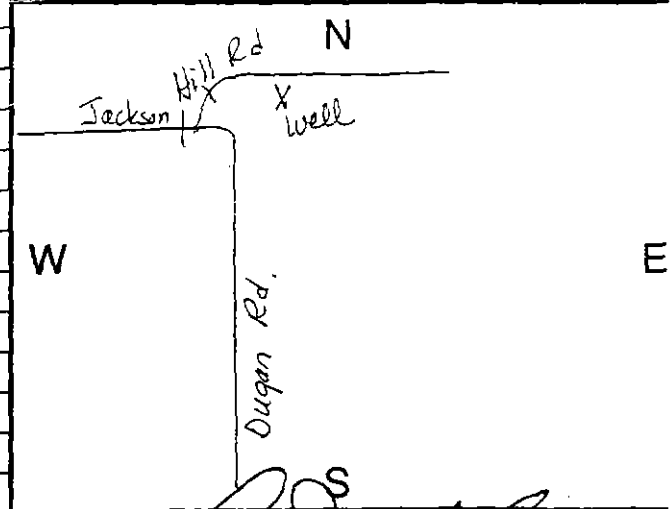
WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Clay	0 ft.	15 ft.
Sand & yellow gravel	15'	105'
Gravel & sand	105'	130'
Total Depth	125'	

SKETCH SHOWING LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



* If additional space is needed to complete well log, use next consecutively numbered form

DNR 7802.88

DRILLING FIRM Wiley Well Drilling, Inc.
ADDRESS R. R. 4 Box 273
CITY, STATE, ZIP Union City, IN 47390

SIGNED _____
DATE 7/10/90
ODH REGISTRATION NUMBER 164

74

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Blue - Customer's Copy Pink - Driller's Copy Green - Local Health Dept. Copy

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER
DO NOT USE INK.

№ 327300

County CHAMPAIGN Township SALEM Section of Township 11

Owner LeGRAND FARM MANGMT Address West Liberty, O

Location of property 2 Mile west of Kenand on Ludlow Rd

CONSTRUCTION DETAILS

Casing diameter 4¼" Length of casing 61'

Type of screen — Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST

Pumping Rate 12 G.P.M. Duration of test 2 hrs.

Drawdown None ft. Date APR 8, 1965

Static level-depth to water 42 ft.

Quality (clear, cloudy, taste, odor) clear

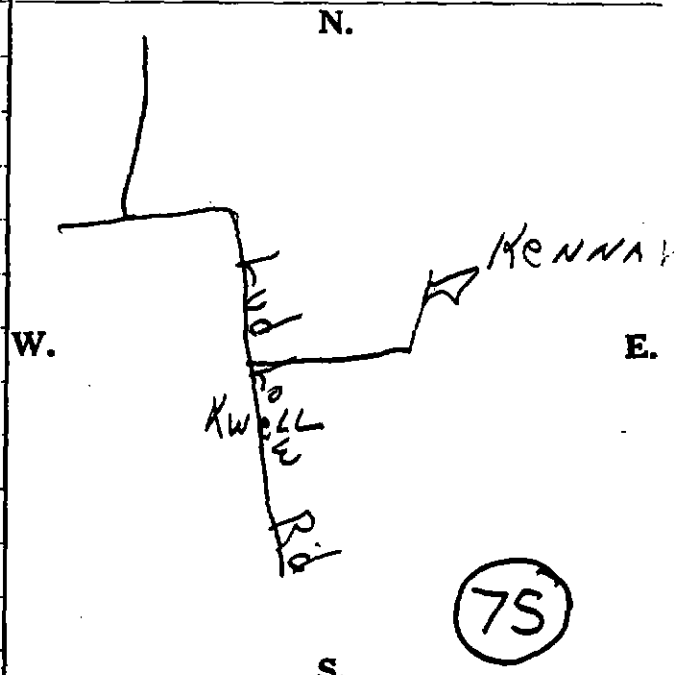
Pump installed by —

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Red clay	0 Feet	5 Ft.
gravel	5	40
Blue clay	40	48
gravel	48	61

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm —

Address Box 75 Rosewood, O

Date APR 8, 1965

Signed Donald Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

68

WELL LOG AND DRILLING REPORT

742149

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 38

COUNTY Champaign TOWNSHIP Salem SECTION/LOT No. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Raymond Green PROPERTY ADDRESS 4131 N. Ludlow Rd. Urbana (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 1 mile north of St. Rt. 296 on the East side of Ludlow Rd.

CONSTRUCTION DETAILS

CASING

[1] Diameter 6 in. Length 92 ft. Wall Thickness .142 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.

Type: [1] [2] Steel [1] [2] Galv. [1] [2] PVC [1] [2] Other ____

Joints: [1] [2] Threaded [1] [2] Welded [1] [2] Solvent [1] [2] Other ____

Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter ____ in.

SCREEN

Type (wire wrapped, louvered, etc.) ____ Material ____
Length ____ ft. Diameter ____ in.
Set between ____ ft. and ____ ft. Slot ____

GROUT

Material Drill cuttings Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

GRAVEL PACK (Filter Pack)

Material ____ Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

Pitless Device ☐ Adapter ☐ Preassembled unit

Use of Well residential

☐ Rotary ☑ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____

Date of Completion 3/28/92

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

	From	To
Topsoil	0	2
gravely yellow clay	2	6
gravel	6	45
gravel gray clay	45	67
sand water	67	88
sand & gravel water	88	92

RECEIVED
APR 1 1992 OHIO DIV. OF WATER

WELL TEST

☑ Bailing ☐ Pumping* ☐ Other ____
Test rate 20 gpm Duration of test 2 hrs.
Drawdown 3 ft.
Measured from: ☑ top of casing ☐ ground level ☐ Other ____
Static Level (depth to water) 35 ft. Date: ____
Quality (clear, cloudy, taste, odor) Clear

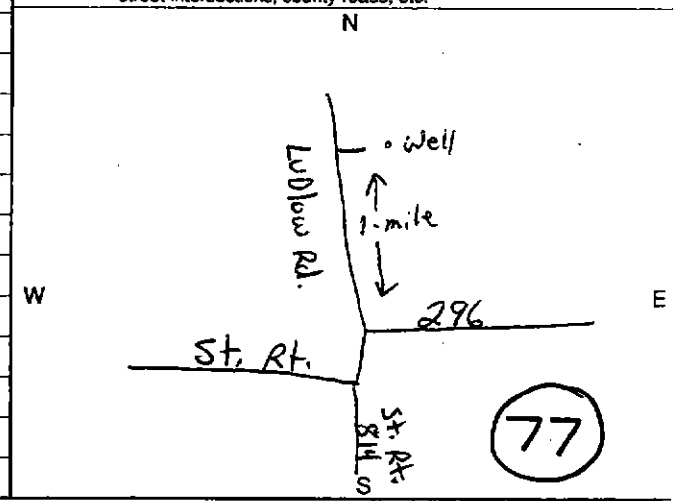
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump ____ Capacity ____ gpm
Pump set at ____ ft.
Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm Knisley Well Drilling
Address 9734 Rosewood-Quincy Rd.
City, State, Zip Quincy OH. 43343

Signed Floyd Knisley
Date 4/2/92
ODH Registration Number 1383

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

Pink - Driller's copy Green - Local Health Dept. copy

16

County Permit No. _____

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

576462

COUNTY Champaign TOWNSHIP Salem SECTION OF TOWNSHIP 9

OWNER Jim Popp ADDRESS 1587 E. Kingscreek Rd.

LOCATION OF PROPERTY same

CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 42'

Type of screen — Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 20 gpm Duration of test 1 hr

Drawdown — ft Date Nov. 5, 1980

Static level (depth to water) 25 f

Quality (clear, cloudy, taste, odor) Clear

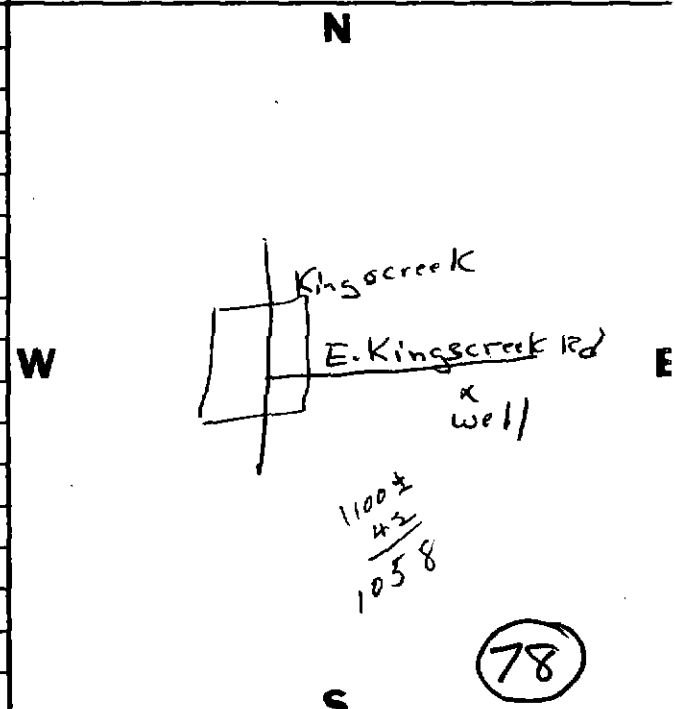
Pump installed by —

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
top soil	0 ft	4 ft
dry gravel	4	42
limestone	42	53

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Eaton Well Drilling DATE Dec. 26, 1980

ADDRESS 8401 N. St. 68 West Liberty SIGNED Jerry Eaton

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER
DO NOT USE INK.

№ 371271

County Champaign Township Salem Section of Township 15

Owner Marvin Wood (Contractor) Address Urbana, O

Location of property In Kingscreek

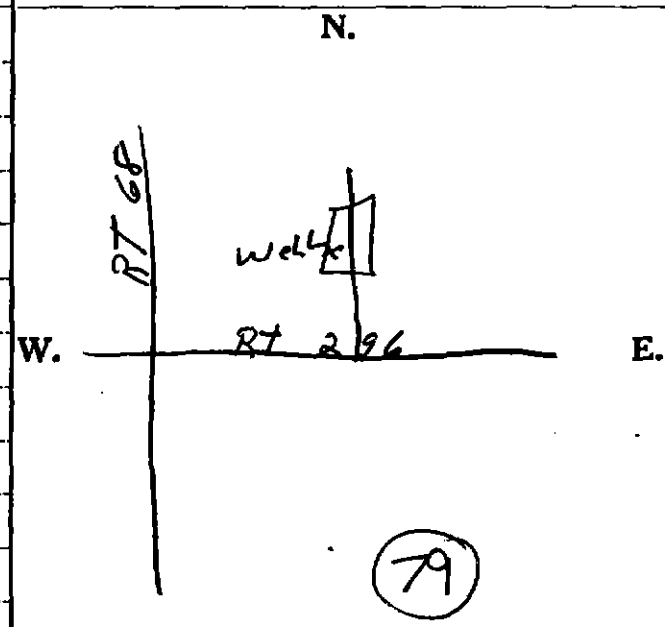
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 4¼" Length of casing 39'	Pumping Rate 10 G.P.M. Duration of test 2 hrs.
Type of screen — Length of screen —	Drawdown 35 ft. Date July 26, 1967
Type of pump —	Static level-depth to water 36 ft.
Capacity of pump —	Quality (clear, cloudy, taste, odor) Clear, odor + taste
Depth of pump setting —	
Date of completion —	Pump installed by —

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Top Soil	0 Feet	2 Ft.
gravel	2	25
Brown Clay	25	39
Limestone	39	121

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm —

Address Box 75, Rosewood, O

Date July 26, 1967

Signed Donald Estes

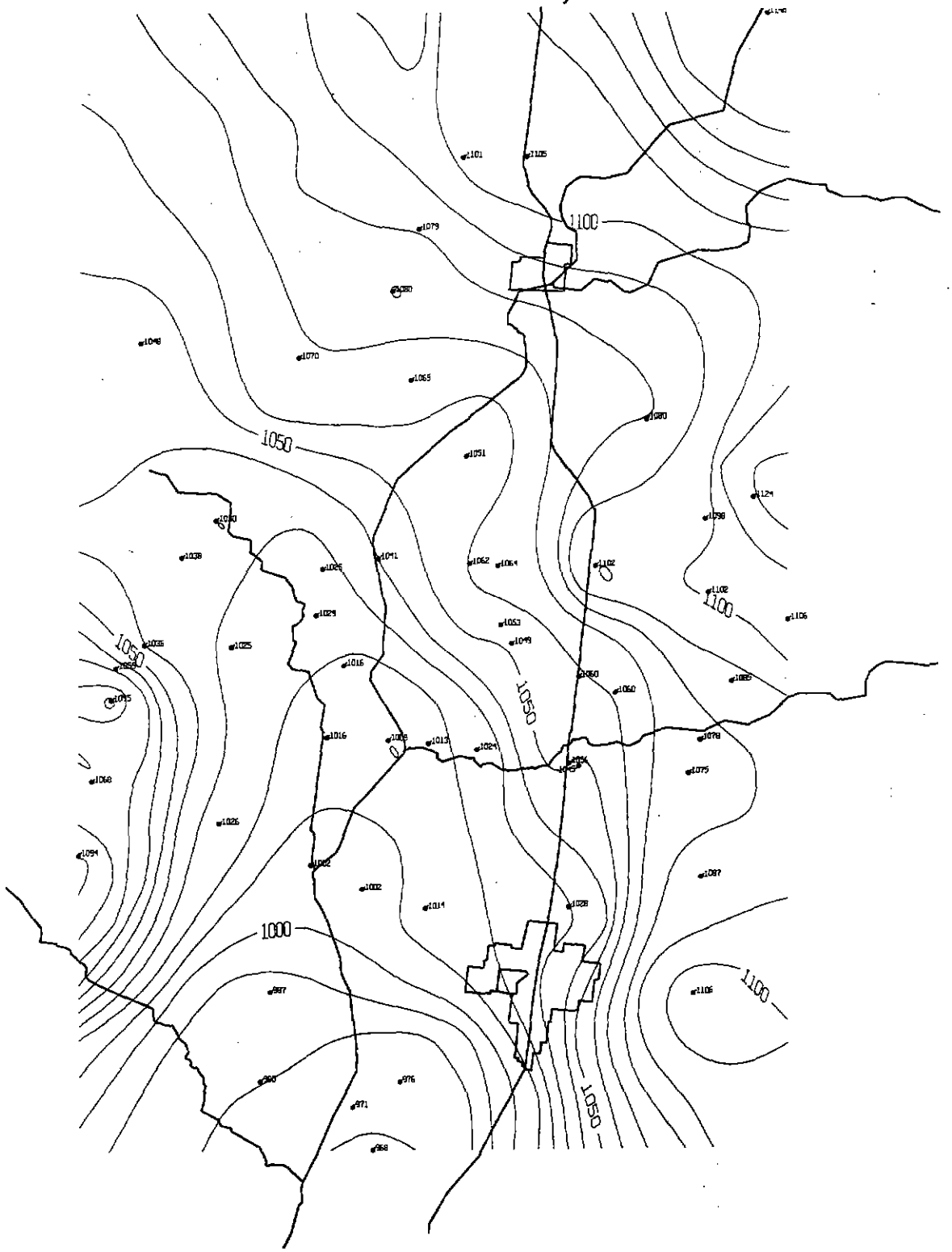
60

*If additional space is needed to complete well log, use next consecutive numbered form.

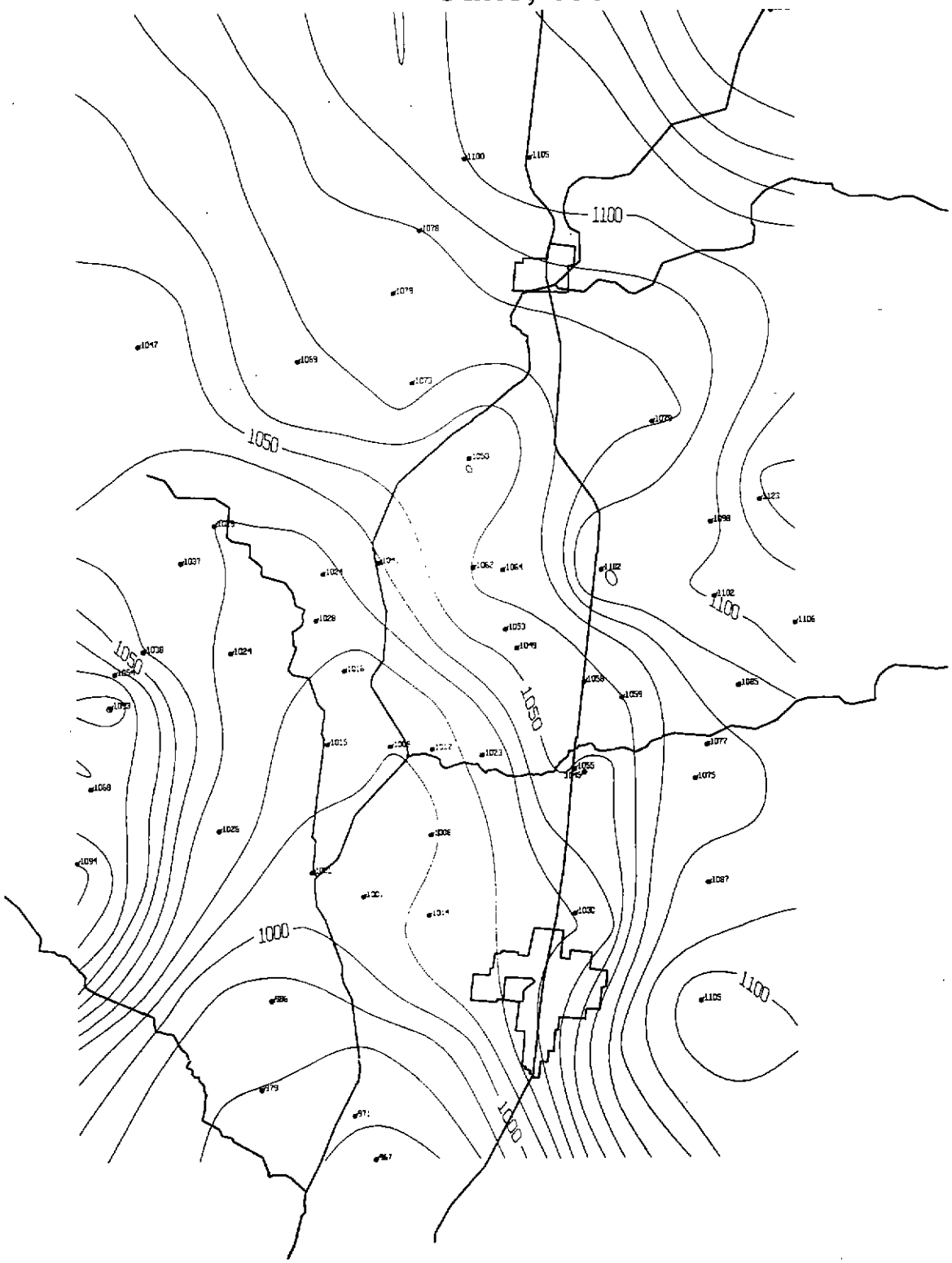
MAD RIVER WATERSHED
STATIC WATER LEVEL

WELL ID NUMBER	ADDRESS	CASING HEIGHT	12/93	3/94	6/94	9/94	12/94	3/95	6/95	9/95	12/95
1	5025 ST. RT. 166	1.25	1.00	+ 1.25	1.52	3.50	2.15	n/a	n/a	3.10	1.00
2	883 ST. RT. 508	1.08	32.78	32.60	33.75	35.78	37.17	38.20	34.87	32.50	35.29
3	5591 ST. RT. 68	0.33	39.63	39.33	40.15	42.57	44.10	45.40	42.75	40.95	n/a
5	2395 SINKHOLE RD.	0.80	44.98	45.22	46.20	47.68	48.68	49.41	46.88	45.15	46.80
6	2451 ST. RT. 245	1.00	44.48	43.63	44.66	45.31	45.96	46.45	45.60	43.10	44.80
7	8966 N. ST. RT. 68	0.75	9.73	11.20	12.30	13.40	14.00	12.82	11.05	11.80	13.05
8	6764 LUDLOW RD.	0.83	55.85	55.15	56.07	58.12	59.85	61.70	61.15	57.80	58.30
9	7713 McCLAIN RD.	0.50	70.00	69.98	70.56	n/a	72.25	73.00	71.80	70.90	72.35
10	259 ST. RT. 507	0.00	10.69	12.20	13.30	12.88	15.20	14.10	12.05	12.90	14.15
11	7419 UPPER VALLEY PIKE	0.83	10.12	11.78	12.55	12.90	13.30	12.05	11.40	12.00	12.70
12	2547 COUCHMAN RD.	1.00	28.70	29.43	21.50	28.00	31.81	31.50	30.20	30.10	30.90
13	3562 COUCHMAN RD.	0.00	39.58	40.00	40.58	42.00	43.00	42.72	40.90	39.82	41.25
15	5812 COUCHMAN RD.	0.75	40.88	41.08	42.00	42.80	44.71	44.65	41.22	39.00	42.40
18	6501 UPPER VALLEY PIKE	2.50	10.38	11.92	12.96	12.95	13.10	12.80	11.60	12.10	12.75
19	6709 WEST KANAGY RD.	1.00	n/a	n/a	n/a	40.50	41.45	41.60	40.20	39.10	40.60
20	1409 E. KANAGY RD.	0.75	76.11	76.00	76.36	77.20	77.97	79.18	80.00	78.07	77.90
21	2834 KENNARD-K.C.	0.00	43.68	43.60	43.75	n/a	46.60	n/a	n/a	n/a	n/a
22	1660 SIBLEY RD.	1.50	66.75	66.63	66.75	67.58	67.97	68.70	68.60	67.75	67.90
23	126 SHORT G. F. RD.	1.92	26.61	26.78	27.60	29.05	30.20	30.90	29.00	27.20	29.15
24	850 LIPPENCOTT RD.	1.50	98.60	99.40	99.80	100.30	100.51	100.66	99.70	99.20	100.60
25	1272 LIPPENCOTT RD	1.50	24.50	26.88	26.80	26.90	27.11	26.26	25.80	26.30	26.60
26	2273 LIPPENCOTT RD.	1.00	2.10	2.72	3.15	3.50	4.25	3.53	2.50	2.55	3.65
27	2977 LIPPENCOTT RD.	1.68	22.84	23.50	23.95	23.42	24.55	23.60	22.50	24.82	25.30
28	5601 CHURCH RD.	1.00	18.71	19.28	20.00	n/a	20.75	19.55	18.60	20.00	20.35
29	4861 W ST. RT. 29	0.75	25.97	26.45	27.25	27.84	29.33	28.10	25.35	26.50	27.75
31	5185 WOODVILLE PK.	2.17	62.12	61.92	60.00	62.60	63.70	63.75	62.30	61.85	62.20
32	3974 WOODVILLE PK.	0.75	25.50	26.03	27.40	28.75	29.45	26.60	24.95	26.90	28.70
33	3024 W. ST. RT. 29	1.00	24.15	25.25	25.95	26.85	27.35	26.20	23.85	24.82	26.25
34	2559 CONCORD PK.	1.00	21.74	22.62	23.22	24.80	24.25	22.96	21.60	22.50	24.40
34A	683 RIVER ROAD	4.61	6.34	6.93	n/a	n/a	n/a	n/a	n/a	n/a	n/a
36	4634 RIDGE RD.	0.00	n/a	91.75	92.10	93.15	93.65	94.04	n/a	92.03	92.78
37	4497 RIDGE RD.	1.35	74.21	74.69	74.80	76.34	76.95	77.23	75.76	74.95	75.95
38	4121 N. ST. RT. 68	1.40	23.80	23.80	25.43	26.32	n/a	27.92	25.23	23.78	25.95
39	1992 KENNARD K.C.	1.60	37.94	38.36	38.69	39.08	39.73	39.86	39.04	38.31	37.99
40	1708 E. KINGSCREEK	0.70	21.21	21.75	22.21	22.88	23.28	23.10	22.02	21.82	22.50
41	3881 CLARK RD.	0.90	n/a	34.20	35.04	36.80	38.08	38.74	35.79	34.15	36.39
42	1638 E ST. RT. 296	1.50	83.10	83.20	83.73	85.42	86.40	86.70	83.72	83.37	64.98
43	141 E. ST. RT 296	0.65	14.81	15.02	15.77	17.28	18.33	18.71	15.94	14.79	16.73
44	2989 RT. 68	-4.50	n/a	9.00	9.74	n/a	12.18	12.47	9.84	8.77	n/a
45	1074 W. ST. RT. 296	1.20	14.34	15.05	15.56	16.19	16.48	15.82	14.75	14.79	14.98
46	1522 ST. RT. 296	1.00	n/a	16.50	17.00	17.75	18.06	17.00	16.14	16.53	17.12
47	2299 W. ST. RT. 29	1.30	13.59	15.25	15.60	16.11	16.31	14.86	14.10	15.19	15.66
48	2677 HANNA RD.	0.80	n/a	8.35	9.27	10.03	10.28	8.42	7.58	8.67	9.18
49	3594 N. ST. RT. 560	1.80	73.16	73.41	74.12	75.65	76.40	75.72	73.16	73.66	74.56
50	3164 LANTZ	1.40	n/a	18.18	20.89	22.36	24.03	n/a	16.86	19.37	20.50
51	2070 BARGER RD.	1.00	65.84	65.96	66.08	67.72	68.92	69.64	66.25	66.06	66.88
52	5730 MILLERSTOWN	2.20	54.72	53.98	53.61	56.43	57.55	57.49	54.58	53.94	55.10
53	1755 N. ST. RT. 560	0.50	n/a	38.07	38.78	40.21	41.03	39.90	37.80	37.83	38.93
54	1456 RIVER ROAD	0.90	9.85	10.07	10.88	11.67	11.41	10.28	9.86	10.60	10.85
55	2241 MILLERSTOWN RD.	1.30	6.46	6.65	7.46	8.27	7.92	6.84	6.46	7.18	7.40
56	1539 MILLERSTOWN RD	1.25	49.74	49.52	49.79	51.45	52.39	52.78	50.42	n/a	50.25
57	1843 W. RT. 29	1.30	93.64	n/a	94.77	n/a	95.72	95.25	94.22	94.12	94.68
59	166 DELLINGER	1.30	33.79	36.00	34.18	36.00	37.12	37.74	34.79	32.89	34.90
61	1881 DUGGAN RD.	1.80	53.51	50.93	51.47	n/a	n/a	n/a	53.20	52.60	53.48
62	370 DUGGAN RD.	1.00	n/a	63.36	63.58	65.00	66.38	n/a	66.93	64.98	65.60
64	3315 W. ST. RT. 36	1.50	5.72	6.45	7.22	8.89	9.56	8.11	5.48	5.33	7.18
65	1900 BAIR RD.	1.40	13.32	13.70	14.20	15.39	15.78	14.80	12.95	12.42	13.94
66	1855 ST. RT. 55	2.70	9.80	9.98	10.54	11.05	11.68	11.38	9.85	9.96	11.00
67	1510 ST. RT. 55	1.20	58.25	58.27	n/a	59.42	60.55	60.88	58.75	58.58	59.30
68	1238 HICKORY GROVE RD.	1.45	n/a	17.53	18.21	19.40	19.66	19.38	17.59	17.64	19.32
70	589 JACKSON HILL RD.	1.00	n/a	n/a	n/a	27.83	28.91	29.32	26.19	24.71	26.97
71	661 JACKSON HILL RD.	1.00	n/a	n/a	n/a	17.43	18.41	18.24	15.81	14.44	16.23
72	681 JACKSON HILL RD.	1.00	n/a	n/a	n/a	42.28	43.44	n/a	40.70	39.04	41.38
74	1763 JACKSON HILL RD.	1.00	n/a	n/a	n/a	79.85	80.57	n/a	82.00	81.58	n/a
RS1	W.L. WATER PLANT										
RS2	LIPPENCOTT ROAD										
RS3	ABOVE KINGSCREEK										
RS4	AT URBANA G.S.										

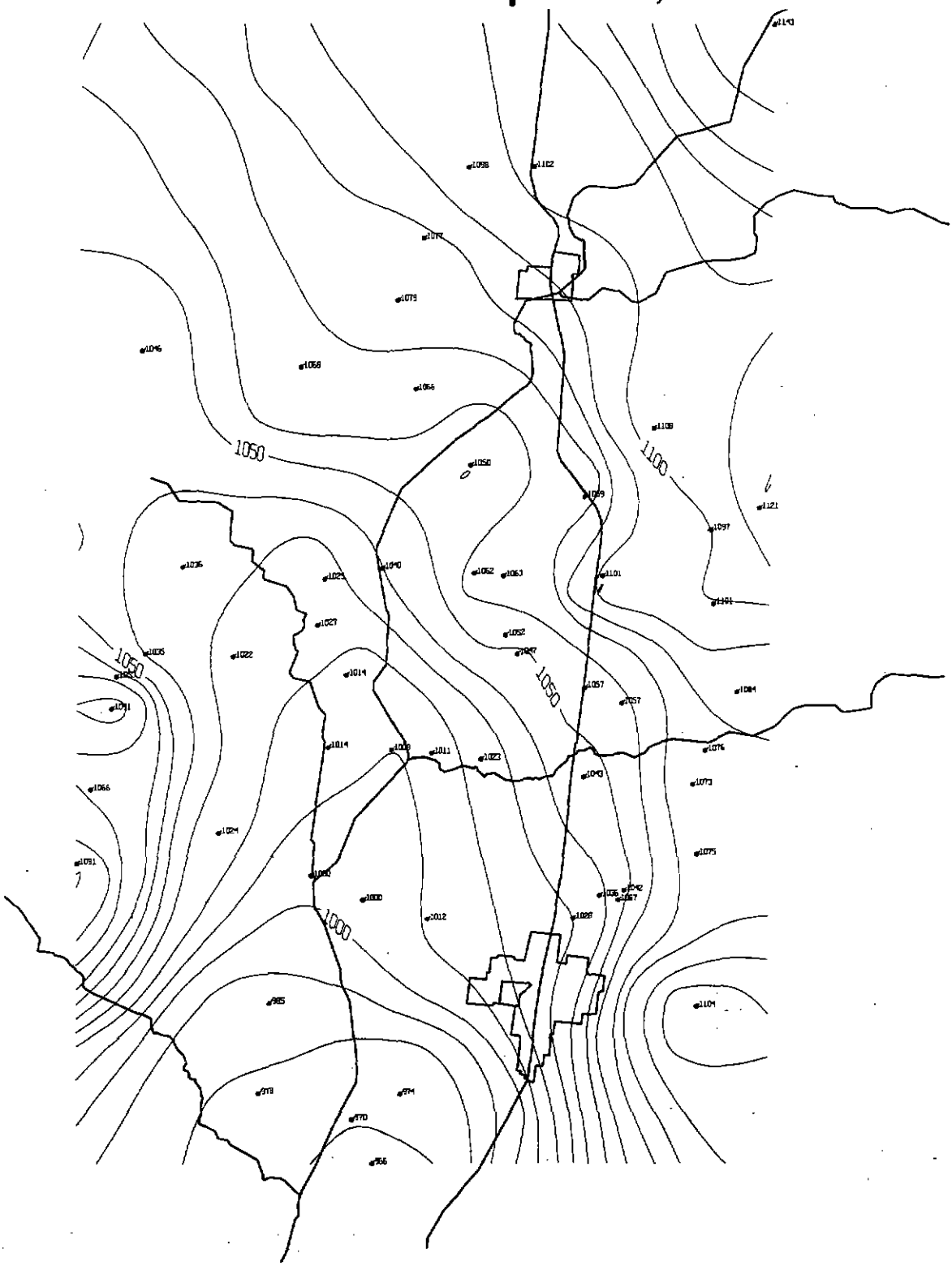
Mad River Water Table Map
March, 1994



Mad River Water Table Map
June, 1994



Mad River Water Table Map
September, 1994



Date 12/94 Coshocton

NPS #	ADDRESS	Ph	Alk	Sc	TDS	SO4	CL	CA	MG	NA	K	FE	MN	AL	HARDNESS	NO3
RS1	River Sample	7.50	270	671	400	30.0	14.5	76.0	30.6	7.9	2.10	0.05	0.01	0.10	376	3.50
RS2	River Sample	7.35	270	687	405	61.0	18.7	87.0	35.2	8.4	2.07	0.01	0.01	0.10	412	3.60
RS3	River Sample	7.51	199	716	290	75.0	17.0	50.0	33.1	6.7	2.40	0.02	0.07	0.10	364	4.40
RS4	River Sample	7.49	229	693	395	90.0	17.5	86.0	33.9	7.6	1.95	0.01	0.01	0.10	440	3.90
8	6764 Ludlow Rd.	6.90	290	728	510	30.0	8.7	0.4	0.6	180.0	0.49	0.02	0.03	0.10	30	9.20
10	259 St. Rt. 507	6.99	261	733	470	46.5	15.1	39.0	44.0	4.8	1.67	0.01	0.01	0.10	412	11.30
11	7419 Upper Valley Pike	6.95	260	847	490	102.0	26.8	53.1	50.6	11.0	2.47	0.03	0.04	0.10	472	1.40
19	6709 W. Kanagy Rd.	6.80	299	800	450	73.0	10.3	95.0	38.5	7.7	2.74	0.02	0.10	0.10	460	7.00
21	2834 Kennard-Kingscreek	6.70	108	285	125	5.0	9.6	27.9	8.3	5.0	13.40	0.03	0.02	0.10	152	2.15
25	1272 Lippencott Rd.	7.00	272	688	370	58.0	8.4	29.0	44.4	3.7	1.28	0.02	0.10	0.10	416	0.21
33	3024 W. St. Rt. 29	6.75	275	724	550	148.0	14.8	103.0	47.7	7.1	1.77	0.01	0.19	0.10	480	0.90
40	1708 E. Kingscreek Rd.	7.02	219	673	375	28.0	13.8	35.4	30.6	4.2	2.29	0.01	0.01	0.10	392	8.40
47	2299 W. St. Rt. 29	6.72	280	869	575	140.0	27.7	121.0	42.4	12.1	2.64	0.01	0.01	0.10	476	1.30
53	1755 N. Rt. 560	7.09	299	699	360	60.0	10.6	86.0	34.2	7.1	1.10	0.01	0.05	0.10	384	0.10
55	2241 Millerstown Rd.	6.99	224	910	640	183.0	23.9	110.0	40.8	2.9	1.23	0.02	0.34	0.10	508	0.10
56	1539 Millerstown Rd.	7.31	280	760	395	62.0	23.4	88.0	32.8	6.8	1.58	0.02	0.01	0.10	424	4.00
65	1900 Bair Rd.	7.10	273	675	340	50.0	10.0	65.0	39.5	9.6	1.82	0.01	0.01	0.10	390	5.20

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 3/95 Coshocton

NPS #	ADDRESS	Ph	Alk	Sc	TDS	SO4	CL	CA	MG	NA	K	FE	MN	AL	HARDNESS	NO3
RS1	River Sample	7.41	296	689	412	68.0	17.0	87.0	38.2	7.3	1.97	0.04	0.04	0.1	377	3.7
RS2	River Sample	7.49	297	721	408	76.0	18.0	99.0	39.1	7.2	1.92	0.02	0.03	0.1	400	4.5
RS3	River Sample	7.60	298	739	432	90.0	18.0	103.0	39.9	6.5	1.85	0.04	0.04	0.1	424	5.7
RS4	River Sample	7.60	321	820	600	117.0	25.0	107.0	51.0	8.8	1.83	0.02	0.01	0.1	460	2.8
8	6764 Ludlow Rd.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10	259 St. Rt. 507	7.41	307	733	404	60.0	16.0	90.0	43.9	5.3	1.40	0.03	0.01	0.1	417	13.3
11	7419 Upper Valley Pike	7.60	321	820	600	117.0	25.0	107.0	51.0	8.8	1.83	0.02	0.01	0.1	460	2.8
19	6709 Kanagy Rd.	7.42	352	795	524	65.0	16.0	100.0	46.3	5.7	2.59	0.01	0.01	0.1	440	8.7
25	1272 Lippencott Rd.	7.41	341	691	388	54.0	10.0	92.0	41.0	3.7	1.14	0.04	0.09	0.1	389	0.1
38	4121 N. St. Rt. 68	7.55	285	660	416	78.0	20.0	89.0	39.3	5.2	1.73	0.24	0.4	0.1	377	0.1
39	*1992 Kennard Kingscreek*	*7.25*	*436*	*904*	*528*	*17.0*	*18.0*	*110.0*	*43.7*	*14.0*	*5.50*	*0.01*	*0.01*	*0.1*	*500*	*8.7*
40	1708 E. Kingscreek Rd.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
41	3881 Clark Rd.	7.41	391	860	524	25.0	20.0	90.0	48.2	9.3	2.27	0.02	0.01	0.1	464	14.2
42	1638 E. St. Rt. 296	7.69	331	675	360	42.0	10.0	85.0	40.1	4.0	1.50	0.85	0.07	0.1	380	0.1
44	2989 St.Rt. 68	7.61	319	731	416	29.0	17.0	48.0	41.2	6.2	1.23	0.01	0.01	0.1	393	12.0
47	2299 W. St. Rt. 29	7.65	349	956	576	125.0	28.0	0.5	0.1	245.0	0.59	0.01	0.01	0.1	12	1.4
53	1755 N. St. Rt. 560	7.85	317	680	408	59.0	14.0	92.0	40.8	6.2	1.01	0.12	0.03	0.1	393	0.2
55	2241 Millerstown Rd.	7.51	327	911	644	165.0	23.0	156.0	37.5	3.3	1.07	0.33	0.35	0.1	507	0.3
56	1539 Millerstown Rd.	7.58	320	750	432	70.0	24.0	101.0	44.6	5.9	1.55	0.01	0.01	0.1	405	3.6
65	1900 Bair Rd.	7.52	315	679	396	32.0	17.0	85.0	38.8	8.0	1.59	0.02	0.01	0.1	365	6.6

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 6/95 Coshocton

NPS #	ADDRESS	Ph	Alk	Sc	TDS	SO4	CL	CA	MG	NA	K	FE	MN	AL	HARDNESS	NO3
RS1	River Sample	7.60	279	661	444	34.0	5.0	74.0	24	5.8	2.77	0.44	0.01	0.62	341	0.0
RS2	River Sample	7.70	287	693	480	42.0	5.0	68.0	19	5.6	2.39	0.06	0.01	0.1	353	0.0
RS3	River Sample	7.80	266	735	588	57.0	5.0	77.0	26	5.6	1.10	0.05	0.01	0.1	365	0.0
RS4	River Sample	7.50	285	738	492	63.0	5.0	85.0	21	5.1	1.80	0.12	0.01	0.1	394	0.0
10	259 St. Rt. 507	7.25	310	735	492	44.0	5.0	87.0	29	3.9	1.52	0.05	0.03	0.1	382	0.0
11	7419 Upper Valley Pike	7.25	300	854	576	88.0	5.0	91.0	31	7.0	1.91	0.01	0.01	0.1	435	0.0
19	6709 Kanagy Rd.	7.10	320	813	596	40.0	5.0	69.0	18	4.0	2.35	0.01	0.01	0.1	419	0.0
21	2834 Kennard-Kingscreek	7.05	134	352	220	5.0	7.0	29.1	9.8	4.0	15.30	0.29	0.07	0.1	123	0.0
25	1272 Lippencott Rd.	7.30	301	709	456	90.0	5.0	91.0	37.2	3.3	1.14	0.1	0.09	0.1	365	0.0
26	2273 Lippencott Rd.	7.25	347	668	420	5.0	5.0	80.0	33.7	8.2	1.15	0.8	0.03	0.1	349	0.0
28	5601 Church Rd.	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
38	4121 N. St. Rt. 68	7.25	269	685	468	59.0	5.0	69.0	18	4.4	1.70	0.29	0.35	0.1	361	0.0
39	1992 Kennard-Kingscreek	7.00	396	891	616	5.0	5.0	80.0	41	11.8	5.50	0.02	0.01	0.1	460	0.0
40	1708 E. Kingscreek Rd.	7.23	277	688	472	21.0	5.0	73.0	23	3.5	1.98	0.03	0.01	0.1	361	0.0
41	3881 Clark Rd.	7.00	363	889	652	36.0	5.0	86.0	41.3	9.7	2.42	0.01	0.01	0.1	456	0.0
42	1638 E. St. Rt. 296	7.30	320	673	404	8.0	5.0	70.0	23	3.8	1.58	1.35	0.08	0.1	345	0.0
44	2989 St. Rt. 68	7.35	296	730	472	16.0	5.0	75.0	25	9.1	1.21	0.04	0.01	0.1	373	0.0
47	2299 W. St. Rt. 29	7.80	330	1012	624	115.0	5.0	0.2	0.68	220.0	0.68	0.02	0.01	0.1	20	0.0
53	1755 N. Rt. 560	7.20	300	677	456	35.0	5.0	79.0	31.7	4.5	1.03	0.62	0.03	0.1	341	0.0
55	2241 Millerstown Rd.	7.05	306	943	668	100.0	5.0	129.0	27	2.7	1.08	1.12	0.36	0.1	534	0.0
56	1539 Millerstown Rd.	7.13	293	767	544	85.0	5.0	93.0	39.6	5.4	1.62	0.01	0.01	0.1	406	0.0
65	1900 Bair Rd.	7.28	293	671	448	13.0	5.0	61.0	20	7.4	1.82	0.01	0.01	0.1	336	0.0

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 9/95 Coshocton

NPS #	ADDRESS	Ph	Alk	Sc	TDS	SO4	CL	CA	MG	NA	K	FE	MN	AL	HARDNESS	NO3
RS1	River Sample	7.88	290	678	396	50.0	6.0	88.0	30.0	6.70	2.59	0.17	0.02	0.1	362	1.89
RS2	River Sample	7.91	259	727	440	75.0	9.0	85.0	33.7	6.10	2.24	0.04	0.01	0.1	392	2.28
RS3	River Sample	7.88	271	726	468	70.0	7.0	84.0	34.3	5.60	2.30	0.17	0.03	0.4	396	2.44
RS4	River Sample	7.95	264	734	460	95.0	7.0	98.0	32.9	5.40	3.20	0.26	0.03	0.3	392	2.4
3	5591 St. Rt. 68	7.50	303	754	448	77.0	5.0	98.0	35.5	7.50	1.49	0.02	0.02	0.2	412	1.6
12	2547 Couchman Rd.	7.25	293	759	480	55.0	5.0	84.0	35.9	3.88	2.10	0.02	0.01	0.1	424	2.22
13	3562 Couchman Rd.	7.35	278	759	472	100.0	5.0	100.0	37.4	3.58	1.59	1.01	0.06	0.1	428	0.1
29	4861 W. St. Rt. 29	7.50	309	637	364	5.0	5.0	69.0	28.5	13.60	1.60	2.08	0.04	0.1	328	0.1
33	3024 W. St. Rt. 29	7.28	269	821	516	122.0	14.0	108.0	34.4	4.54	1.60	0.01	0.2	0.1	460	0.11
51	2070 Barger Rd.	7.60	317	650	372	5.0	5.0	71.0	27.0	16.00	1.90	0.51	0.06	0.2	344	0.21
54	1456 River Rd.	7.23	318	790	468	75.0	5.0	95.0	35.8	4.92	8.70	0.01	0.01	0.1	440	2.44
57	1843 W. St. Rt. 29	7.30	278	681	432	64.0	5.0	85.0	34.0	3.50	1.00	0.71	0.15	0.1	390	0.09
64	3315 W. Rt. 36	7.23	271	698	412	100.0	7.0	106.0	30.9	3.93	1.30	2.09	0.16	1.9	424	0.08
66	1855 St. Rt. 55	7.20	288	812	496	55.0	10.0	84.0	33.6	19.30	3.10	0.12	0.03	0.2	404	2.4
67	1510 St. Rt. 55	7.48	3	783	436	23.0	13.0	97.0	33.0	18.70	3.00	0.04	0.01	0.1	378	2.24
75	5439 N. Ludlow Rd.	7.28	290	715	412	55.0	13.0	93.0	32.3	6.30	1.40	0.25	0.01	0.1	388	2.3
77	4855 N. Ludlow Rd.	7.68	281	700	396	56.0	5.0	87.0	32.1	2.97	0.97	0.21	0.03	0.1	383	2.32
78	1587 E. Kingscreek Rd.	7.53	283	621	364	40.0	5.0	77.0	32.6	4.75	1.51	0.27	0.03	0.1	348	0.1
79	1309 Kennard-Kingscreek	7.41	298	881	592	189.0	5.0	132.0	39.7	3.69	1.86	0.09	0.02	0.1	508	0.17
80	1220 Kingscreek Rd.	7.63	292	836	508	99.0	5.0	99.0	35.4	5.00	2.06	0.01	0.01	0.1	462	2.06
81	2624 N. St. Rt. 68	7.88	281	620	328	45.0	5.0	80.0	32.6	5.10	1.20	0.36	0.04	0.1	337	0.14

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 12/93 Heidelberg

NPS #	ADDRESS	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SIO2	TRIAZINE	ALACHLOR
RS1	River Sample	1.26	0.000	0.014	5.1	19.2	252	-0.002	3.88	0.02	0.07
RS2	River Sample	1.23	0.000	0.019	4.5	19.5	249	-0.004	3.86	0.01	0.07
RS3	River Sample	4.02	0.004	0.002	12.7	57.1	591	0.000	7.60	0.02	0.20
RS4	River Sample	4.09	0.003	0.000	14.5	73.8	761	0.001	8.73	0.01	0.20
3	5591 St. Rt. 68	0.05	0.000	0.000	14.5	62.4	750	-0.002	12.16	0.00	0.01
6	2451 St. Rt. 245	0.01	0.000	0.006	11.4	70.4	708	-0.002	12.56	0.00	0.01
8	6764 Ludlow Rd.	9.97	0.000	0.105	15.5	34.0	798	0.015	9.63	0.01	0.02
9	7713 McClain Rd.	3.32	0.003	0.006	24.8	78.2	788	0.002	11.99	0.00	0.01
10	259 St. Rt. 507	0.13	0.000	0.418	13.6	52.4	715	-0.001	5.84	0.00	0.02
11	7419 Upper Valley Pike	5.07	0.000	0.009	27.6	84.0	604	-0.004	6.78	0.01	0.24
12	2547 Couchman Rd.	5.65	0.000	0.002	18.7	42.5	791	-0.002	13.25	0.00	0.01
13	3562 Couchman Rd.	0.00	0.000	0.009	3.2	25.4	245	0.002	3.84	0.01	0.01
18	6501 Upper Valley Pike	2.48	0.000	0.006	5.2	24.9	231	0.001	2.77	0.00	0.03
19	6709 Kanagy Rd.	9.52	0.000	0.013	15.7	55.1	800	-0.002	11.48	0.01	0.05
21	2834 Kennard-Kingscreek	7.83	0.000	0.005	14.3	35.7	424	0.007	5.20	0.01	0.02
22	1660 Sibley Rd.	0.02	0.000	0.044	4.8	27.5	406	-0.004	13.78	0.00	0.01
24	850 Lippencott Rd.	0.19	0.000	0.006	2.3	12.9	356	-0.005	5.86	0.00	0.01
25	1272 Lippencott Rd.	0.00	0.000	0.020	9.3	49.3	684	-0.002	14.15	0.00	0.01
26	2273 Lippencott Rd.	0.00	0.000	0.184	2.2	12.8	666	0.008	16.13	0.00	0.01
27	2977 Lippencott Rd.	0.00	0.000	0.017	10.1	59.8	750	-0.003	13.88	0.00	0.01
30	5965 Calland Rd.	0.00	0.000	0.112	4.0	30.0	661	-0.001	17.36	0.00	0.01
33	3024 W. St. Rt. 29	0.00	0.000	0.015	14.7	139.1	846	0.005	9.97	0.01	0.03
34A	683 River Rd.	4.99	0.011	0.000	15.0	62.9	730	-0.004	9.10	0.00	0.01
34	2559 Concord Pk.	0.00	0.000	0.099	19.5	124.6	849	0.001	13.88	0.01	0.02
37	4497 Ridge Rd.	0.00	0.000	0.027	6.7	37.2	642	-0.003	12.56	0.00	0.01
42	1638 E. St. Rt. 296	0.00	0.000	0.010	17.6	35.6	688	0.000	13.24	0.00	0.01
43	141 E. St. Rt. 296	6.78	0.001	0.000	9.9	27.6	643	-0.004	8.28	0.00	0.01
45	1074 W. St. Rt. 296	4.30	0.001	0.000	15.4	53.1	724	-0.002	11.60	0.00	0.01
47	2299 W. St. Rt. 29	1.34	0.000	0.009	8.7	40.7	379	-0.004	3.21	0.00	0.02
51	2070 Barger Rd.	0.00	0.000	0.255	1.3	4.3	256	0.002	10.54	0.00	0.01
53	1755 N. Rt. 560	0.00	0.000	0.041	8.4	55.6	688	-0.001	14.09	0.01	0.01
55	2241 Millerstown Rd.	0.00	0.000	0.047	22.8	152.3	933	-0.001	14.45	0.01	0.39
56	1539 Millerstown Rd.	9.31	0.000	0.000	21.2	39.7	728	0.000	10.06	0.01	0.02
57	1843 W. St. Rt. 29	0.02	0.000	0.088	7.4	55.1	706	0.001	14.25	0.01	0.01
58	201 Fulton St.	11.30	0.002	0.000	16.8	52.4	783	-0.003	9.31	0.00	0.01
61	1881 N. Duggan Rd.	0.00	0.000	0.243	5.2	35.0	621	-0.003	13.34	0.00	0.01
64	3315 W. Rt. 36	0.00	0.000	0.050	10.6	77.1	720	-0.004	6.95	0.00	0.20
64A	3154 Rt. 36	0.00	0.000	0.032	22.4	96.8	865	-0.003	8.87	0.00	0.41
65	1990 Bair Rd.	6.38	0.000	0.002	9.4	34.2	698	-0.004	11.85	0.00	0.01
66	1855 St. Rt. 55	4.85	0.000	0.008	32.4	35.8	792	-0.003	11.75	0.00	0.01
67	1510 St. Rt. 55	3.70	0.000	0.000	31.0	37.3	776	-0.004	12.54	0.00	0.01

All concentrations are recorded in milligrams per liter *=not analyzed

Date 3/94 Heidelberg

NFS #	ADDRESS	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SiO2	TRIAZINE	ALACHLOR
RS1	River Sample	3.11	0.033	0.080	12.9	48.7	582	-0.004	6.65	0.02	0.02
RS2	River Sample	3.67	0.036	0.083	13.7	61.5	587	-0.007	7.03	0.03	0.18
RS3	River Sample	4.83	0.032	0.079	13.9	65.4	595	-0.007	7.89	0.03	0.21
RS4	River Sample	3.88	0.000	0.086	14.2	77.7	591	-0.002	7.36	0.03	0.23
3	5591 St. Rt. 68	0.00	0.000	0.087	14.0	67.5	700	-0.005	12.39	0.04	0.02
6	2451 St. Rt. 245	0.00	0.024	0.078	11.2	78.9	652	-0.005	12.82	0.01	0.03
8	6764 Ludlow Rd.	10.32	0.026	0.087	15.6	39.5	771	0.019	9.80	0.03	0.03
9	7713 McClain Rd.	3.53	0.026	0.079	25.6	87.1	743	-0.005	12.04	0.01	0.02
10	259 St. Rt. 507	4.88	0.069	0.564	12.5	58.7	684	-0.004	6.63	0.01	0.03
11	.7419 Upper Valley Pike	5.62	0.025	0.086	25.7	77.4	733	-0.004	8.14	0.03	0.45
12	2547 Couchman Rd.	4.77	0.025	0.083	18.2	51.0	705	-0.005	13.35	0.02	0.03
13	3562 Couchman Rd.	0.00	0.024	0.091	10.2	91.0	624	-0.005	10.83	0.01	0.02
18	6501 Upper Valley Pike	*	*	*	*	*	*	*	*	*	*
19	6709 Kanagy Rd.	10.86	0.027	0.084	16.9	54.9	742	-0.003	12.02	0.01	0.08
21	2834 Kennard-Kingscreek	0.07	0.041	7.152	3.7	15.6	220	0.829	4.59	0.06	0.04
22	1660 Sibley Rd.	0.05	0.025	0.071	4.2	39.2	506	-0.004	17.91	0.01	0.03
23	126 Short Game Farm Rd.	0.00	0.025	0.087	8.9	69.5	638	-0.003	12.08	0.01	0.02
24	850 Lippencott Rd.	0.63	0.027	0.081	4.3	33.3	611	-0.003	14.10	0.01	0.02
25	1272 Lippencott Rd.	0.04	0.024	0.086	8.3	54.7	623	-0.007	14.42	0.02	0.03
26	2273 Lippencott Rd.	0.00	0.024	0.117	2.8	14.2	495	-0.004	16.07	0.02	0.02
27	2977 Lippencott Rd.	0.04	0.023	0.114	4.7	40.5	570	0.001	13.45	0.02	0.04
28	5601 Church Rd.	0.04	0.025	0.079	7.2	60.4	829	0.019	18.53	0.01	0.02
29	4861 W. St. Rt. 29	0.00	0.027	0.228	1.4	18.1	568	-0.002	12.17	0.03	0.03
30	5965 Calland Rd.	*	*	*	*	*	*	*	*	*	*
33	3024 W. St. Rt. 29	0.00	0.024	0.074	13.1	149.2	777	-0.004	9.85	0.01	0.05
34A	683 River Rd.	5.20	0.043	0.081	15.9	70.1	674	-0.004	9.25	0.01	0.04
34	2559 Concord Pk.	0.05	0.025	0.094	19.7	127.5	790	-0.003	13.95	0.01	0.03
37	4497 Ridge Rd.	0.00	0.024	0.090	6.2	43.9	593	-0.007	13.14	0.02	0.02
38	4121 N. St. Rt. 68	0.04	0.023	0.091	12.2	68.7	639	-0.007	9.91	0.02	0.04
42	1638 E. St. Rt. 296	0.04	0.024	0.085	7.4	41.9	635	-0.007	13.69	0.02	0.02
43	141 E. St. Rt. 296	9.18	0.032	0.079	12.9	43.9	793	-0.005	11.82	0.02	0.02
45	1074 W. St. Rt. 296	4.98	0.025	0.078	14.9	54.2	590	-0.003	11.50	0.01	0.03
47	2299 W. St. Rt. 296	3.39	0.027	0.085	26.6	114.1	796	-0.004	7.46	0.01	0.05
51	2070 Barger Rd.	*	*	*	*	*	*	*	*	*	*
53	1755 N. Rt. 560	0.04	0.024	0.074	8.2	52.8	634	-0.004	14.41	0.01	0.03
54	1456 River Rd.	4.33	0.024	0.088	11.2	75.0	682	-0.003	9.64	0.01	0.02
55	2241 Millerstown Rd.	0.00	0.024	0.085	22.6	167.7	841	-0.003	14.52	0.01	0.52
56	1539 Millerstown Rd.	7.23	0.026	0.082	20.2	51.6	633	-0.004	10.22	0.01	0.02
57	1843 W. St. Rt. 29	0.00	0.024	0.098	7.0	62.9	650	-0.006	14.30	0.02	0.02
58	201 Fulton St.	*	*	*	*	*	*	*	*	*	*
61	1881 N. Duggan Rd.	0.04	0.023	0.114	4.7	40.5	570	0.001	13.45	0.02	0.04
64	3315 W. Rt. 36	0.00	0.025	0.082	8.3	78.4	632	-0.004	7.46	0.03	0.31
65	1900 Bair Rd.	5.61	0.024	0.083	8.2	38.7	571	-0.006	12.03	0.02	0.04
66	1855 St. Rt. 55	4.81	0.025	0.081	31.8	39.2	741	-0.006	11.98	0.01	0.03
67	1510 St. Rt. 55	3.69	0.025	0.090	33.6	42.4	731	-0.007	12.69	0.02	0.03

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 6/94 Heidelberg

NPS #	ADDRESS	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SIO2	TRIAZINE	ALACHLOR
RS1	River Sample	3.64	0.039	0.013	12.7	44.1	758	0.002	9.09	0.03	0.13
RS2	River Sample	3.97	0.024	0.020	14.5	58.2	790	0.002	9.16	0.09	0.34
RS3	River Sample	5.06	0.012	0.001	14.0	58.2	792	0.001	8.85	0.05	0.33
RS4	River Sample	4.04	0.012	0.016	14.2	66.4	761	0.001	8.83	0.07	0.32
1	5025 Rt. 166	0.00	0.000	0.137	1.2	23.4	554	0.002	11.03	0.01	0.08
3	5591 St. Rt. 68	0.00	0.000	0.025	14.9	64.0	816	0.002	12.31	0.01	0.06
6	2451 St. Rt. 245	0.00	0.000	0.000	11.0	75.2	770	0.001	12.79	0.01	0.06
8	6764 Ludlow Rd.	0.00	0.000	0.000	14.3	54.6	909	0.004	9.45	0.30	0.28
9	7713 McClain Rd.	3.48	0.000	0.000	25.1	81.6	736	0.000	11.71	0.01	0.06
10	259 St. Rt. 507	7.68	0.158	0.021	11.8	55.3	819	0.001	9.35	0.01	0.06
11	7419 Upper Valley Pike	4.26	0.000	0.000	28.1	93.3	931	0.000	8.62	0.01	0.85
12	2547 Couchman Rd	4.79	0.000	0.000	17.8	45.2	686	0.001	12.81	0.02	0.09
13	3562 Couchman Rd	0.00	0.000	0.022	11.6	81.9	834	0.002	11.19	0.01	0.05
18	6501 Upper Valley Pike	*	*	*	*	*	*	*	*	*	*
19	6709 Kanagy Rd	8.73	0.122	0.000	15.3	54.3	839	0.001	11.27	0.03	0.38
21	2834 Kennard Kingscreek	*	*	*	*	*	*	*	*	*	*
22	1660 Sibley Rd	0.00	0.000	0.000	3.9	34.7	743	0.002	16.09	0.03	0.07
23	126 Short Game Farm Rd	0.00	0.000	0.000	9.6	66.6	589	0.001	12.59	0.01	0.06
24	850 Lippencott Rd	0.00	0.000	0.000	4.3	29.8	710	0.003	13.93	0.20	0.22
25	1272 Lippencott Rd	0.00	0.000	0.017	8.7	48.6	750	0.001	14.07	0.01	0.04
26	2273 Lippencott Rd	0.00	0.000	0.088	1.8	11.0	727	0.003	15.61	0.01	0.08
27	2977 Lippencott Rd	*	*	*	*	*	*	*	*	*	*
28	5601 Church Rd.	0.00	0.000	0.007	4.1	53.4	952	0.001	18.18	0.01	0.04
29	4861 W. St. Rt. 29	0.00	0.000	0.306	1.7	16.6	676	0.002	14.91	0.02	0.12
33	3024 W. St. Rt. 29	0.53	0.000	0.000	12.6	124.6	923	0.001	9.82	0.01	0.11
34A	683 River Rd.	*	*	*	*	*	*	*	*	*	*
34	2559 Concord Pk.	0.00	0.000	0.098	20.8	122.0	910	0.003	13.56	0.01	0.06
37	4497 Ridge Rd.	0.00	0.000	0.020	6.3	37.5	711	0.001	12.75	0.01	0.07
38	4121 N. St. Rt. 68	0.00	0.000	0.008	11.9	66.4	758	0.002	9.63	0.01	0.09
40	1708 E. Kingscreek Rd.	8.09	0.000	0.003	10.5	34.2	763	0.002	9.71	0.01	0.05
42	1638 E. St. Rt. 296	0.00	0.000	0.002	8.1	37.1	759	0.002	13.09	0.01	0.05
43	141 E. St. Rt. 296	9.14	0.000	0.000	13.8	40.6	917	0.000	11.04	0.02	0.08
45	1074 W. St. Rt. 296	4.58	0.001	0.005	15.0	55.0	799	0.002	11.46	0.01	0.05
47	2299 W. St. Rt. 29	3.40	0.000	0.002	26.8	119.0	1061	0.184	7.40	0.01	0.08
51	2070 Barger Rd.	0.00	0.000	0.433	1.3	6.0	725	0.006	16.37	0.01	0.05
53	1755 N. Rt. 560	0.00	0.000	0.030	8.7	59.0	745	0.005	13.96	0.01	0.07
54	1456 River Rd.	2.94	0.000	0.000	11.8	78.3	855	0.001	9.68	0.01	0.07
55	2241 Millerstown Rd.	0.00	0.000	0.036	23.8	157.5	1024	0.004	14.31	0.01	0.65
56	1539 Millerstown Rd.	7.22	0.000	0.000	19.7	44.5	766	0.001	9.88	0.01	0.15
57	1843 W. St. Rt. 29	0.00	0.000	0.088	7.1	55.6	756	0.001	13.41	0.01	0.07
58	201 Fulton St.	*	*	*	*	*	*	*	*	*	*
61	1881 N. Duggan Rd.	0.00	0.000	0.000	4.7	43.1	761	0.001	13.68	0.01	0.06
64	3315 W. Rt. 36	0.00	0.000	0.047	8.1	73.8	798	0.002	6.97	0.01	0.57
65	1900 Bair Rd.	5.75	0.000	0.000	9.3	34.6	774	0.001	11.39	0.01	0.05
66	1855 St. Rt. 55	4.98	0.000	0.000	32.1	37.0	893	0.002	11.65	0.01	0.05
67	1510 St. Rt. 55	3.85	0.000	0.000	34.1	39.0	880	0.001	12.36	0.01	0.05

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 9/94 Heidelberg

NPS #	ADDRESS	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SIO2	TRIAZINE	ALACHLOR
RS1	River Sample	3.38	0.000	0.037	12.1	37.6	625	0.001	8.17	0.01	0.07
RS2	River Sample	3.88	0.000	0.023	15.2	55.6	723	0.003	9.26	0.02	0.35
RS3	River Sample	4.57	0.013	0.050	15.2	60.2	808	0.009	9.25	0.02	0.25
RS4	River Sample	4.09	0.000	0.013	15.4	62.4	728	0.000	9.16	0.01	0.23
1	5025 Rt. 166	0.00	0.000	0.033	1.3	5.6	672	0.003	10.75	0.21	0.20
3	5591 St. Rt. 68	0.00	0.000	0.025	14.6	58.9	676	0.002	12.44	0.01	0.03
6	2451 St. Rt. 245	0.00	0.000	0.024	10.9	65.6	794	0.002	12.38	0.03	0.06
8	6764 Ludlow Rd.	9.51	0.000	0.023	15.0	26.3	918	0.008	9.62	0.01	0.05
9	7713 McClain Rd.	2.49	0.000	0.019	24.5	76.2	796	0.002	11.69	0.01	0.03
10	259 St. Rt. 507	0.00	0.000	0.024	12.2	49.9	802	0.002	9.24	0.23	0.07
11	7419 Upper Valley Pike	0.22	0.091	0.018	29.8	96.6	930	0.001	9.54	0.28	0.64
12	2547 Couchman Rd.	4.80	0.000	0.024	19.0	36.7	748	0.002	12.55	0.01	0.03
13	3562 Couchman Rd.	0.00	0.000	0.020	11.2	76.4	693	0.002	11.10	0.01	0.02
18	6501 Upper Valley Pike	9.57	0.000	0.027	18.8	73.7	904	0.011	10.04	0.09	0.45
19	6709 Kanagy Rd.	0.00	0.000	0.025	16.3	49.5	874	0.004	11.37	0.03	0.11
20	1409 E. Kanagy Rd.	0.06	0.000	0.022	12.5	63.6	625	0.001	10.27	0.01	0.03
21	2834 Kennard-Kingscreek	7.72	1.259	0.021	5.4	5.1	338	0.000	6.21	0.02	0.06
22	1660 Sibley Rd.	0.00	0.000	0.024	4.1	28.0	727	0.003	17.07	0.17	0.13
23	126 Short Game Farm Rd	0.00	0.000	0.022	9.2	57.1	600	0.005	12.37	0.01	0.03
24	850 Lippencott Rd.	0.05	0.000	0.021	4.1	19.2	726	0.001	13.62	0.11	0.25
25	1272 Lippencott Rd.	0.00	0.000	0.027	8.8	42.6	720	0.002	13.79	0.01	0.03
26	2273 Lippencott Rd	0.00	0.000	0.125	1.7	0.8	687	0.007	15.78	0.01	0.04
27	2977 Lippencott Rd.	*	*	*	*	*	*	*	*	*	*
28	5601 Church Rd.	*	*	*	*	*	*	*	*	*	*
29	4861 W. St. Rt. 29	0.00	0.000	0.340	1.5	5.2	671	0.001	14.88	0.01	0.02
33	3024 W. St. Rt. 29	0.67	0.000	0.023	12.7	149.3	903	0.001	9.55	0.01	0.05
34	2559 Concord Pk.	0.00	0.000	0.029	21.3	116.1	752	0.001	13.39	0.09	0.09
34A	683 River Rd.	3.13	0.015	0.021	15.6	64.7	803	0.002	8.81	0.01	0.04
37	4497 Ridge Rd.	0.00	0.000	0.020	6.6	29.7	729	0.001	12.63	0.01	0.02
38	4121 N. St. Rt. 68	0.00	0.000	0.037	12.3	58.9	774	0.003	9.73	0.01	0.05
40	1708 E. Kingscreek Rd.	7.68	0.000	0.020	9.8	133.1	754	0.001	13.62	0.11	0.25
42	1638 E. St. Rt. 296	0.00	0.000	0.031	8.1	30.7	743	0.003	13.35	0.02	0.02
43	141 E. St. Rt. 296	9.25	0.000	0.013	14.0	27.8	905	0.001	11.05	0.01	0.04
45	1074 W. St. Rt. 296	4.86	0.000	0.016	14.2	46.1	641	0.001	11.56	0.01	0.04
47	2299 W. St. Rt. 29	1.82	0.000	0.020	26.5	26.4	960	0.000	7.59	0.01	0.04
51	2070 Barger Rd.	0.07	0.093	0.306	1.2	3.5	731	0.011	16.02	0.02	0.03
53	1755 N. Rt. 560	0.00	0.000	0.037	8.5	50.7	632	0.002	13.87	0.02	0.02
54	1456 River Rd.	*	*	*	*	*	*	*	*	*	*
55	2241 Millerstown Rd.	0.00	0.000	0.034	23.7	156.2	1007	0.002	14.15	0.02	0.51
56	1539 Millerstown Rd.	5.48	0.000	0.013	19.9	49.2	827	0.000	10.14	0.02	0.03
57	1843 W. St. Rt. 29	0.00	0.000	0.068	7.0	49.1	774	0.001	13.57	0.02	0.02
58	201 Fulton St.	*	*	*	*	*	*	*	*	*	*
61	1881 N. Duggan Rd.	0.00	0.000	0.088	4.8	28.1	692	0.001	13.05	0.02	0.03
64	3315 W. Rt. 36	0.00	0.000	0.304	10.1	68.5	812	0.001	6.95	0.01	0.43
65	1900 Bair Rd.	5.19	0.000	0.018	8.7	26.3	623	0.001	11.77	0.01	0.04
66	1855 St. Rt. 55	4.50	0.000	0.020	32.1	29.3	880	0.001	11.46	0.01	0.04
67	1510 St. Rt. 55	3.80	0.000	0.022	34.5	33.1	803	0.000	12.28	0.01	0.03
70	589 Jackson Hill Rd.	3.04	0.000	0.016	13.5	43.3	776	0.001	12.00	0.02	0.03
71	661 Jackson Hill Rd.	0.00	0.000	0.024	23.8	30.1	780	0.001	14.37	0.06	0.13
72	681 Jackson Hill Rd.	2.18	0.000	0.021	13.1	40.4	819	0.000	12.08	0.02	0.02

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 12/94 Heidelberg

NPS #	ADDRESS	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SIO2	TRIAZINE	ALACHLOR
RS1	River Sample	3.25	0.000	0.020	11.4	39.0	664	-0.002	8.42	*	*
RS2	River Sample	3.74	0.095	0.022	14.0	62.3	737	0.042	9.71	*	*
RS3	River Sample	*	*	*	*	*	*	*	*	*	*
RS4	River Sample	*	*	*	*	*	*	*	*	*	*
1	5025 Rt. 166	0.00	0.000	0.103	1.2	22.6	586	0.001	10.90	*	*
3	5591 St. Rt. 68	0.00	0.000	0.014	13.8	69.4	693	-0.002	12.25	*	*
6	2451 St. Rt. 245	0.00	0.000	0.016	11.2	76.5	639	-0.002	12.76	*	*
8	6764 Ludlow Rd.	9.01	0.000	0.012	15.3	21.0	814	-0.002	8.38	*	*
9	7713 McClain Rd.	1.41	0.000	0.015	24.4	85.7	818	-0.002	11.29	*	*
10	259 St. Rt. 507	9.21	0.000	0.011	11.9	63.5	726	-0.002	9.48	*	*
11	7419 Upper Valley Pike	1.32	0.000	0.057	26.5	120.6	843	0.001	9.52	*	*
12	2547 Couchman Rd.	4.15	0.000	0.009	18.3	40.8	774	-0.002	12.87	*	*
13	3562 Couchman Rd.	0.00	0.000	0.049	10.7	87.3	756	0.001	11.17	*	*
18	6501 Upper Valley Pike	0.00	0.000	0.192	16.7	72.9	716	0.116	9.52	*	*
19	6709 Kanagy Rd.	6.63	0.000	0.015	17.2	60.2	686	-0.002	11.59	*	*
20	1409 E. Kanagy Rd.	*	*	*	*	*	*	*	*	*	*
21	2834 Kennard-Kingscreek	6.57	3.631	0.232	5.4	7.5	310	1.244	6.39	*	*
22	1660 Sibley Rd.	0.00	0.000	0.044	4.0	31.5	664	-0.002	17.20	*	*
23	126 Short Game Farm Rd	0.00	0.000	0.031	10.0	66.1	555	0.001	12.23	*	*
24	850 Lippencott Rd.	0.87	0.000	0.017	3.8	23.9	659	-0.002	13.86	*	*
25	1272 Lippencott Rd.	0.00	0.000	0.024	8.8	43.7	644	-0.002	14.23	*	*
26	2273 Lippencott Rd.	0.00	0.000	0.144	1.2	7.3	573	0.019	16.13	*	*
27	2977 Lippencott Rd.	*	*	*	*	*	*	*	*	*	*
28	5601 Church Rd.	0.00	0.000	0.014	3.7	46.3	848	0.002	18.04	*	*
29	4861 W. St. Rt. 29	0.00	0.000	0.446	1.3	13.9	551	0.000	15.37	*	*
33	3024 W. St. Rt. 29	0.72	0.000	0.010	12.5	111.2	759	-0.002	9.69	*	*
34	2559 Concord Pk.	0.00	0.000	0.091	20.0	125.5	842	0.003	12.86	*	*
34A	683 River Rd.	*	*	*	*	*	*	*	*	*	*
37	4497 Ridge Rd.	0.00	0.000	0.023	6.6	8.4	643	-0.001	12.54	*	*
38	4121 N. St. Rt. 68	0.00	0.000	0.029	13.6	65.1	675	0.003	9.87	*	*
40	1708 E. Kingscreek Rd.	8.86	0.000	0.017	10.9	18.5	685	0.004	9.98	*	*
42	1638 E. St. Rt. 296	0.00	0.000	0.017	8.1	36.1	683	0.000	13.25	*	*
43	141 E. St. Rt. 296	9.05	0.000	0.018	13.3	19.1	820	0.002	11.37	*	*
45	1074 W. St. Rt. 296	4.85	0.000	0.021	13.9	47.4	714	-0.001	11.50	*	*
47	2299 W. St. Rt. 29	1.05	0.000	0.014	27.4	119.0	775	-0.002	7.63	*	*
51	2070 Barger Rd.	0.00	0.000	0.420	0.8	2.0	659	0.020	16.31	*	*
53	1755 N. Rt. 560	0.00	0.000	0.028	24.5	57.6	647	0.001	14.06	*	*
54	1456 River Rd.	*	*	*	*	*	*	*	*	*	*
55	2241 Millerstown Rd.	0.00	0.000	0.102	23.9	111.2	911	-0.002	14.30	*	*
56	1539 Millerstown Rd.	3.74	0.000	0.015	21.0	63.7	719	-0.002	10.21	*	*
57	1843 W. St. Rt. 29	0.00	0.000	0.067	7.5	65.2	675	0.000	13.76	*	*
58	201 Fulton St.	*	*	*	*	*	*	*	*	*	*
61	1881 N. Duggan Rd.	*	*	*	*	*	*	*	*	*	*
64	3315 W. Rt. 36	0.00	0.000	0.049	7.2	75.4	681	-0.001	7.03	*	*
65	1900 Bair Rd.	5.10	0.000	0.015	8.7	4.6	680	-0.002	11.83	*	*
66	1855 St. Rt. 55	2.67	0.000	0.148	26.6	14.8	673	0.001	10.30	*	*
67	1510 St. Rt. 55	4.02	0.000	0.027	34.1	25.0	781	0.000	12.38	*	*
70	589 Jackson Hill Rd.	2.49	0.000	0.023	12.6	35.7	640	-0.002	12.24	*	*
71	661 Jackson Hill Rd.	*	*	*	*	*	*	*	*	*	*
72	681 Jackson Hill Rd.	1.26	0.000	0.030	11.6	34.7	666	-0.002	10.94	*	*

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 3/95 Heidelberg

NPS #	ADDRESS	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SIO2	TRIAZINE	ALACHLOR
RS1	River Sample	3.13	0.003	0.012	15.6	66.1	631	0.000	7.69	*	*
RS2	River Sample	3.68	0.001	0.014	16.8	76.4	676	0.000	7.84	*	*
RS3	River Sample	4.34	0.000	0.007	16.4	84.3	643	0.000	7.85	*	*
RS4	River Sample	4.34	0.002	0.012	17.7	94.1	694	0.000	7.74	*	*
1	5025 Rt. 166	0.00	0.000	0.128	1.6	27.5	436	0.000	10.82	*	*
3	5591 St. Rt. 68	0.15	0.000	0.027	16.0	66.4	849	0.000	12.14	*	*
6	2451 St. Rt. 245	0.00	0.000	0.000	11.8	78.2	636	0.000	12.68	*	*
8	6764 Ludlow Rd.	*	*	*	*	*	*	*	*	*	*
9	7713 McClain Rd.	0.96	0.000	0.013	23.8	87.2	723	0.000	11.33	*	*
10	259 St. Rt. 507	8.89	0.058	0.027	13.3	60.5	713	0.000	8.52	*	*
11	7419 Upper Valley Pike	2.03	0.000	0.018	23.9	134.2	642	0.000	8.64	*	*
12	2547 Couchman Rd.	3.72	0.000	0.025	18.0	55.6	649	0.000	12.78	*	*
13	3562 Couchman Rd.	0.00	0.000	0.015	11.6	86.5	640	0.000	10.98	*	*
18	6501 Upper Valley Pike	9.86	0.000	0.020	19.1	81.7	733	0.000	10.24	*	*
19	6709 Kanagy Rd.	6.63	0.000	0.016	16.7	67.0	585	0.000	11.88	*	*
20	1409 E. Kanagy Rd.	*	*	*	*	*	*	*	*	*	*
21	2834 Kennard-Kingscreek	*	*	*	*	*	*	*	*	*	*
22	1660 Sibley Rd.	0.00	0.000	0.015	4.9	40.1	659	0.000	23.55	*	*
23	126 Short Game Farm Rd	0.00	0.000	0.022	11.8	73.7	665	0.000	11.8	*	*
24	850 Lippencott Rd.	0.98	0.000	0.031	4.3	38.2	581	0.000	13.48	*	*
25	1272 Lippencott Rd.	0.00	0.000	0.016	10.4	57.0	582	0.000	13.8	*	*
26	2273 Lippencott Rd.	0.00	0.000	0.188	2.0	15.4	585	0.001	15.81	*	*
27	2977 Lippencott Rd.	*	*	*	*	*	*	*	*	*	*
28	5601 Church Rd.	0.00	0.000	0.010	8.5	63.6	893	0.002	17.35	*	*
29	4861 W. St. Rt. 29	0.00	0.000	0.493	1.9	21.1	601	0.000	15.4	*	*
33	3024 W. St. Rt. 29	0.16	0.000	0.016	13.0	110.6	733	0.000	9.66	*	*
34	2559 Concord Pike	0.00	0.000	0.111	20.5	137.3	755	0.000	12.77	*	*
34A	683 River Rd.	0.10	0.000	0.024	12.6	67.7	702	0.000	9.22	*	*
37	4497 Ridge Rd.	0.00	0.000	0.021	7.1	45.3	616	0.000	12.31	*	*
38	4121 N. St. Rt. 68	0.00	0.000	0.029	17.2	68.1	613	0.000	9.31	*	*
40	1708 E. Kingscreek Rd.	*	*	*	*	*	*	*	*	*	*
42	1638 E. St. Rt. 296	0.00	0.000	0.005	8.9	43.9	601	0.005	13.15	*	*
43	141 E. St. Rt. 296	*	*	*	*	*	*	*	*	*	*
45	1074 W. St. Rt. 296	4.67	0.000	0.032	15.0	56.5	664	0.000	11.27	*	*
47	2299 W. St. Rt. 29	0.84	0.000	0.013	28.4	143.8	1023	0.132	7.430	*	*
51	2070 Barger Rd.	0.00	0.000	0.394	1.7	15.0	595	0.007	16.17	*	*
53	1755 N. Rt. 560	0.00	0.000	0.034	8.7	61.2	583	0.000	13.56	*	*
54	1456 River Rd.	1.41	0.000	0.012	13.6	138.5	660	0.000	9.76	*	*
55	2241 Millerstown Rd.	0.00	0.000	0.034	22.9	190.6	658	0.000	14.02	*	*
56	1539 Millerstown Rd.	2.47	0.000	0.005	22.4	71.2	629	0.000	10.15	*	*
57	1843 W. St. Rt. 29	0.00	0.000	0.058	8.4	64.6	643	0.000	13.31	*	*
58	201 Fulton St.	*	*	*	*	*	*	*	*	*	*
61	1881 N. Duggan Rd.	0.00	0.000	0.093	5.2	42.8	567	0.000	12.91	*	*
64	3315 W. Rt. 36	0.03	0.000	0.009	8.6	74.4	649	0.000	6.75	*	*
65	1900 Bair Rd.	4.34	0.000	0.008	9.3	46.9	634	0.000	11.43	*	*
66	1855 St. Rt. 55	4.10	0.000	0.020	32.5	46.5	773	0.000	11.82	*	*
67	1510 St. Rt. 55	4.27	0.000	0.007	32.7	41.3	602	0.000	12.06	*	*
70	589 Jackson Hill Rd.	1.69	0.000	0.007	13.5	51.8	609	0.000	12.13	*	*
71	661 Jackson Hill Rd.	*	*	*	*	*	*	*	*	*	*
72	681 Jackson Hill Rd.	1.97	0.000	0.014	14.0	53.2	629	0.000	11.89	*	*
74	1763 Jackson Hill Rd.	13.23	0.000	0.025	8.3	37.7	631	0.000	11.32	*	*

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 6/95 Heidelberg

NPS #	ADDRESS	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SIO2	TRIAZINE	ALACHLOR
RS1	River Sample	3.17	0.007	0.012	13.9	45.4	648	-0.001	8.13	*	*
RS2	River Sample	3.69	0.003	0.015	14.8	56.4	667	-0.001	8.36	*	*
RS3	River Sample	6.30	0.012	0.022	15.4	65.8	684	-0.003	8.03	*	*
RS4	River Sample	4.03	0.006	0.014	15.4	80.3	700	-0.002	8.03	*	*
1	5025 Rt. 166	0.00	0.028	0.082	1.0	27.8	564	-0.003	10.97	*	*
3	5591 St. Rt 68	*	*	*	*	*	*	*	*	*	*
6	2451 St. Rt. 245	0.04	0.030	0.051	12.4	80.2	732	0.008	12.31	*	*
8	6764 Ludlow Rd.	8.73	0.002	0.006	14.4	41.4	821	-0.002	9.65	*	*
9	7713 McClain Rd.	1.80	0.002	0.032	24.6	93.5	848	0	11.56	*	*
10	259 St. Rt. 507	0.04	0.002	0.005	12.8	64.7	713	-0.002	9.27	*	*
11	7419 Upper Valley Pike	7.29	0.003	0.014	30.6	99.2	838	-0.001	8.77	*	*
12	2547 Couchman Rd.	3.40	0.002	0.011	19.1	52.9	691	-0.001	12.37	*	*
13	3562 Couchman Rd.	0.04	0.002	0.011	11.7	91.7	690	-0.002	11.14	*	*
18	6501 Upper Valley Pike	9.34	0.002	0.011	20.7	88.0	752	-0.002	10.26	*	*
19	6709 Kanagy Rd.	5.42	0.125	0.011	15.4	70.2	745	-0.002	11.64	*	*
20	1409 E. Kanagy Rd.	*	*	*	*	*	*	*	*	*	*
21	2834 Kennard-Kingscreek	1.19	1.193	7.723	7.4	0.2	135	9999	6.45	*	*
22	1660 Sibley Rd.	0.03	0.002	0.011	4.8	40.6	659	-0.002	17.26	*	*
23	126 Short Game Farm Rd.	0.04	0.003	0.014	11.2	80.5	626	-0.002	12.29	*	*
24	850 Lippencott Rd.	0.02	0.002	0.017	4.2	36.9	588	-0.002	13.78	*	*
25	1272 Lippencott Rd.	0.10	0.002	0.023	10.2	53.8	509	-0.002	13.95	*	*
26	2273 Lippencott Rd	0.03	0.001	0.181	1.6	18.2	628	-0.002	16.12	*	*
27	2977 Lippencott Rd.	*	*	*	*	*	*	*	*	*	*
28	5601 Church Rd.	0.05	0.011	0.032	5.1	65.1	882	-0.003	17.94	*	*
29	4861 W. St. Rt. 29	0.01	0.003	0.372	1.5	20.1	543	-0.002	13.95	*	*
33	3024 W. St. Rt. 29	0.02	0.004	0.018	13.3	238	719	-0.002	9.67	*	*
34	2559 Concord Pike	0.06	0.003	0.010	20.6	148.7	795	-0.001	13.15	*	*
34A	683 River Rd.	2.01	0.006	0.015	14.0	87.2	622	-0.002	9.1	*	*
37	4497 Ridge Rd.	*	*	*	*	*	*	*	*	*	*
38	4121 N. St. Rt. 68	0.03	0.002	0.052	18.4	81.3	656	-0.002	9.72	*	*
39	1992 Kennard-Kingscreek	7.46	0.005	0.018	18.5	43.4	787	-0.002	12.58	*	*
40	1708 E. Kingscreek Rd.	8.88	0.016	0.046	11.0	45.7	676	0	9.75	*	*
41	3881 Clark Rd.	10.25	0.008	0.014	20.0	40.5	735	0.004	11.36	*	*
42	1638 E. St. Rt 296	0.04	0.001	0.020	8.2	42.2	660	-0.002	13.16	*	*
43	141 E. St. Rt. 296	8.65	0.013	0.039	14.7	48.5	833	0	11.39	*	*
44	2989 St. Rt. 296	8.35	0.002	0.023	17.3	43.0	666	0	10.7	*	*
45	1074 W. St. Rt. 296	4.48	0.003	0.032	15.3	64.2	655	-0.001	11.48	*	*
46	1522 W. St. Rt. 296	5.28	0.002	0.021	15.8	53.1	671	-0.001	11.55	*	*
47	2299 W. St. Rt. 29	2.10	0.000	0.021	29.1	118.6	1009	0.427	7.85	*	*
51	2070 Barger Rd.	0.01	0.002	0.356	1.2	10.6	627	0.001	16.32	*	*
53	1755 N. Rt. 560	0.03	0.002	0.026	8.3	63.5	587	-0.002	13.68	*	*
54	1456 River Rd.	5.06	0.001	0.012	11.6	101.9	768	-0.003	10.17	*	*
55	2241 Millerstown Rd.	0.04	0.009	0.073	24.6	258.3	850	0.012	13.86	*	*
56	1539 Millerstown Rd.	2.95	0.011	0.029	23.1	61.3	722	0.006	10.1	*	*
57	1843 W. St Rt. 29	0.02	0.004	0.101	7.8	65.0	670	-0.001	13.57	*	*
58	201 Fulton St.	*	*	*	*	*	*	*	*	*	*
61	1881 N. Duggan Rd.	0.04	0.003	0.090	5.2	44.2	563	-0.002	12.95	*	*
64	3315 W. Rt. 36	0.05	0.003	0.034	8.0	83.6	689	-0.002	6.87	*	*
65	1900 Bair Rd.	5.36	0.003	0.011	9.4	42.1	674	-0.002	11.17	*	*
66	1855 St. Rt. 55	3.96	0.001	0.015	33.9	47.5	794	-0.003	11.51	*	*
67	1510 St. Rt. 55	4.64	0.001	0.027	34.0	42.6	754	-0.002	12.24	*	*
70	589 Jackson Hill Rd.	2.58	0.003	0.009	14.3	54.8	716	-0.002	12.03	*	*
71	661 Jackson Hill Rd.	*	*	*	*	*	*	*	*	*	*
72	681 Jackson Hill Rd.	2.26	0.000	0.023	15.1	50.1	707	0.004	12.27	*	*
74	1763 Jackson Hill Rd.	13.66	0.002	0.010	8.0	38.9	669	-0.002	11.25	*	*
75	5439 N. Ludlow Rd.	4.83	0.016	0.025	13.6	50.2	694	-0.002	9.57	*	*
76	4855 N. Ludlow Rd.	0.00	0.003	0.026	11.1	60.4	666	0.002	13.09	*	*
77	4131 N. Ludlow Rd.	9.15	0.549	0.342	9.1	51.2	694	-0.003	9.58	*	*
78	1587 E. Kingscreek Rd.	0.02	0.002	0.010	4.1	29.0	599	-0.002	10.34	*	*
79	1309 Kennard-Kingscreek	0.06	0.003	0.011	14.9	167.4	756	-0.002	8.16	*	*
80	1220 Kingscreek Rd.	8.31	0.001	0.023	16.0	85.8	654	-0.003	8.05	*	*

All concentrations are recorded in milligrams per liter

*=not analyzed

Date 9/95 Heidelberg

NPS #	ADDRESS	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SIO2	TRIAZINE	ALACHLOR
1	5025 Rt. 166	0.04	0.120	0.021	1.3	27.4	584	0.000	11.45	*	*
6	2451 St. Rt. 245	0.03	0.011	0.021	13.8	80.6	652	0.001	11.45	*	*
8	6764 Ludlow Rd.	8.81	0.010	0.018	15.2	4.0	806	0.002	9.93	*	*
9	7713 McClain Rd.	2.90	0.001	0.035	23.5	90.0	712	0.001	12.58	*	*
10	259 St. Rt. 507	0.10	0.010	0.020	12.4	62.6	665	0.001	9.58	*	*
11	7419 Upper Valley Pike	8.93	0.010	0.020	41.6	95.9	850	0.001	10.58	*	*
18	6501 Upper Valley Pike	8.87	0.011	0.017	20.6	88.0	628	0.001	10.68	*	*
19	6709 Kanagy Rd.	8.20	0.011	0.020	27.7	61.6	683	0.000	12.02	*	*
21	2834 Kennard-Kingscreek	0.17	0.133	13.101	8.0	19.3	471	0.000	11.28	*	*
22	1660 Sibley Rd.	0.04	0.011	0.025	4.7	48.6	640	0.001	17.85	*	*
23	126 Short Game Farm Rd.	0.04	0.011	0.022	8.5	74.7	647	0.001	12.68	*	*
24	850 Lippencott Rd.	0.02	0.012	0.039	4.6	35.8	616	0.000	14.59	*	*
25	1272 Lippencott Rd.	0.00	0.011	0.016	9.4	55.1	569	0.001	14.16	*	*
26	2273 Lippencott Rd.	0.01	0.000	0.153	2.1	14.9	501	0.005	17.38	*	*
28	5601 Church Rd.	0.04	0.011	0.021	5.5	60.1	875	0.001	19.28	*	*
34	2559 Concord Pike	0.03	0.011	0.146	21.6	138.1	712	0.000	13.83	*	*
34A	683 River Rd.	2.60	0.004	0.018	13.1	72.1	639	0.001	9.30	*	*
38	4121 N. St. Rt. 68	0.01	0.010	0.084	17.8	77.4	618	0.001	10.57	*	*
39	1992 Kennard-Kingscreek	8.57	0.006	0.034	21.3	45.7	683	0.001	13.48	*	*
40	1708 E. Kingscreek Rd.	9.81	0.011	0.046	12.8	38.5	611	0.001	10.61	*	*
41	3881 Clark Rd.	9.57	0.010	0.030	15.7	38.2	598	0.004	12.00	*	*
42	1638 E. St. Rt. 296	0.02	0.010	0.029	8.7	40.4	507	0.001	13.68	*	*
43	141 E. St. Rt. 296	9.15	0.011	0.017	16.2	40.9	863	0.000	11.67	*	*
44	2989 St. Rt. 296	9.30	0.011	0.032	14.8	41.5	792	0.012	12.25	*	*
45	1074 W. St. Rt. 296	4.36	0.009	0.019	15.2	69.5	562	0.001	11.86	*	*
46	1522 St. Rt. 296	5.76	0.011	0.036	16.3	59.2	651	0.007	12.20	*	*
47	2299 W. St. Rt. 29	3.26	0.009	0.051	26.1	99.3	671	0.010	8.19	*	*
53	1755 N. Rt. 560	0.02	0.011	0.050	5.6	46.9	464	0.002	14.89	*	*
55	2241 Millerstown Rd.	0.04	0.011	0.040	23.7	167.0	806	0.001	14.91	*	*
56	1539 Millerstown Rd.	8.47	0.011	0.019	24.5	61.7	729	0.000	10.55	*	*
61	1881 N. Duggan Rd.	1.59	0.012	0.030	5.6	46.9	522	0.004	14.73	*	*
65	1900 Bair Rd.	10.48	0.009	0.074	12.9	35.1	586	0.018	12.32	*	*
70	589 Jackson Hill Rd.	2.93	0.011	0.036	14.6	54.2	600	0.000	13.20	*	*
71	661 Jackson Hill Rd.	0.02	0.011	0.122	8.5	49.2	521	0.001	14.78	*	*
72	681 Jackson Hill Rd.	2.55	0.012	0.024	15.0	50.4	617	0.003	12.70	*	*
74	1763 Jackson Hill Rd.	13.92	0.003	0.017	7.6	38.4	575	0.001	11.75	*	*

All concentrations are recorded in milligrams per liter

*=not analyzed

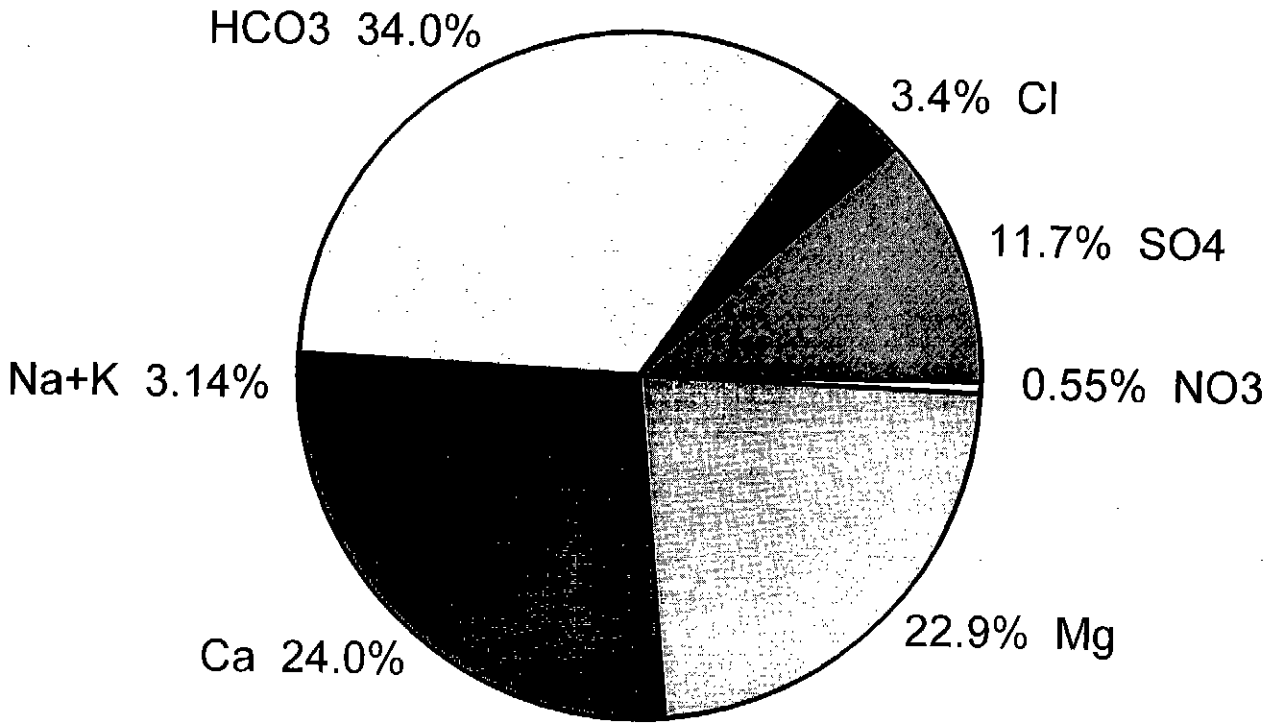
Date 12/95 Heidelberg

NPS #	ID	NAME	NO3	NO2	NH3	CL	SO4	CONDUCTIVITY	PHOSPHORUS	SIO2	TRIAZINE	ALACHLOR
1		5025 Rt. 166	0.03	0.016	0.105	1.50	15.10	546	0.010	10.43	0.04	0.02
6		2451 St. Rt. 245	0.03	0.019	0.032	11.00	66.50	629	0.006	11.97	0.05	0.02
8		6764 Ludlow Rd.	6.92	0.020	0.039	15.10	37.90	832	0.010	8.83	0.05	0.03
9		7713 McClain Rd.	2.55	0.012	0.040	23.30	67.60	721	0.010	11.72	0.05	0.02
10		259 St. Rt. 507	*	*	*	*	*	*	*	*	*	*
11		7419 Upper Valley Pike	4.61	0.016	0.053	35.80	92.20	772	0.009	9.01	0.07	0.39
18		6501 Upper Valley Pike	8.78	0.018	0.040	20.00	81.30	658	0.006	9.92	0.04	0.11
19		6709 Kanagy Rd.	8.96	0.007	0.082	17.80	31.60	558	0.010	5.27	0.06	0.06
21		2834 Kennard-Kingscreek	0.30	0.051	7.239	14.60	18.90	570	0.000	8.88	0.08	0.05
22		1660 Sibley Rd.	0.01	0.018	0.077	5.20	22.60	633	0.005	16.87	0.04	0.02
23		126 Short Game Farm Rd.	0.04	0.019	0.045	8.50	41.90	551	0.012	11.60	0.04	0.02
24		850 Lippencott Rd.	1.03	0.017	0.039	4.50	21.40	596	0.004	13.02	0.05	0.02
25		1272 Lippencott Rd.	0.04	0.020	0.041	9.90	41.30	494	0.012	13.31	0.08	0.03
26		2273 Lippencott Rd	0.04	0.018	0.168	2.10	2.90	560	0.004	14.93	0.04	0.02
28		5601 Church Rd.	0.04	0.019	0.041	5.40	51.10	883	0.005	16.80	0.04	0.03
34		2559 Concord Pike	0.06	0.017	0.102	21.10	193.20	821	0.003	12.72	0.07	0.04
34A		683 River Rd.	7.95	0.008	0.035	15.30	47.20	663	0.010	8.59	0.08	0.04
38		4121 N. St. Rt. 68	0.02	0.017	0.082	17.30	65.60	558	0.000	9.21	0.06	0.03
39		1992 Kennard-Kingscreek	7.28	0.017	0.081	31.40	19.80	805	0.012	12.22	0.58	0.09
40		1708 E. Kingscreek Rd.	9.34	0.018	0.040	11.10	24.90	587	0.007	9.69	0.09	0.04
41		3881 Clark Rd.	8.47	0.018	0.042	14.20	20.70	666	0.002	10.66	0.06	0.03
42		1638 E. St. Rt. 296	0.03	0.017	0.046	8.90	29.00	576	0.005	12.55	0.05	0.02
43		141 E. St. Rt. 296	9.67	0.017	0.041	17.50	36.40	894	0.001	10.89	0.06	0.03
44		2989 St. Rt. 296	9.69	0.018	0.036	14.50	17.90	715	0.011	10.90	0.07	0.04
45		1074 W. St. Rt. 296	4.18	0.044	0.035	15.40	40.60	639	0.005	10.64	0.06	0.03
46		1522 W. St. Rt. 296	6.92	0.016	0.040	18.20	31.00	599	0.008	11.07	0.07	0.04
47		2299 W. St. Rt. 29	1.85	0.018	0.036	26.90	212.20	983	0.002	7.35	0.03	0.05
53		1755 N. Rt. 560	0.04	0.019	0.048	7.40	38.70	562	0.006	13.27	0.04	0.02
54		1456 River Rd.	3.57	0.018	0.036	11.70	66.40	712	0.004	10.13	0.04	0.03
55		2241 Millerstown Rd.	0.01	0.018	0.055	23.90	241.50	866	0.005	13.47	0.04	0.04
56		1539 Millerstown Rd.	8.22	0.018	0.044	18.50	34.30	702	0.004	9.54	0.06	0.03
61		1881 N. Duggan Rd.	0.03	0.019	0.259	5.40	28.20	572	0.005	12.36	0.04	0.02
65		1900 Bair Rd.	8.75	0.018	0.039	13.20	16.80	604	0.007	11.37	0.07	0.03
70		589 Jackson Hill Rd.	2.47	0.016	0.039	14.90	38.40	611	0.007	11.49	0.06	0.02
71		661 Jackson Hill Rd.	0.05	0.011	0.117	8.60	25.80	609	0.011	13.35	0.06	0.03
72		681 Jackson Hill Rd.	2.06	0.018	0.034	15.00	30.40	610	0.012	11.89	0.09	0.04
74		1763 Jackson Hill Rd.	13.90	0.018	0.041	7.80	22.60	634	0.006	10.76	0.05	0.04
RS1		River Sample	3.35	0.003	0.117	15.00	37.40	648	0.012	6.62	0.06	0.05
RS2		River Sample	3.81	0.009	0.036	18.40	49.00	637	0.011	6.21	0.06	0.16
RS3		River Sample	4.77	0.034	0.047	17.00	56.90	620	0.000	6.85	0.06	0.14
RS4		River Sample	4.06	0.008	0.041	15.30	65.90	584	0.003	6.94	0.08	0.14

All concentrations are recorded in milligrams per liter

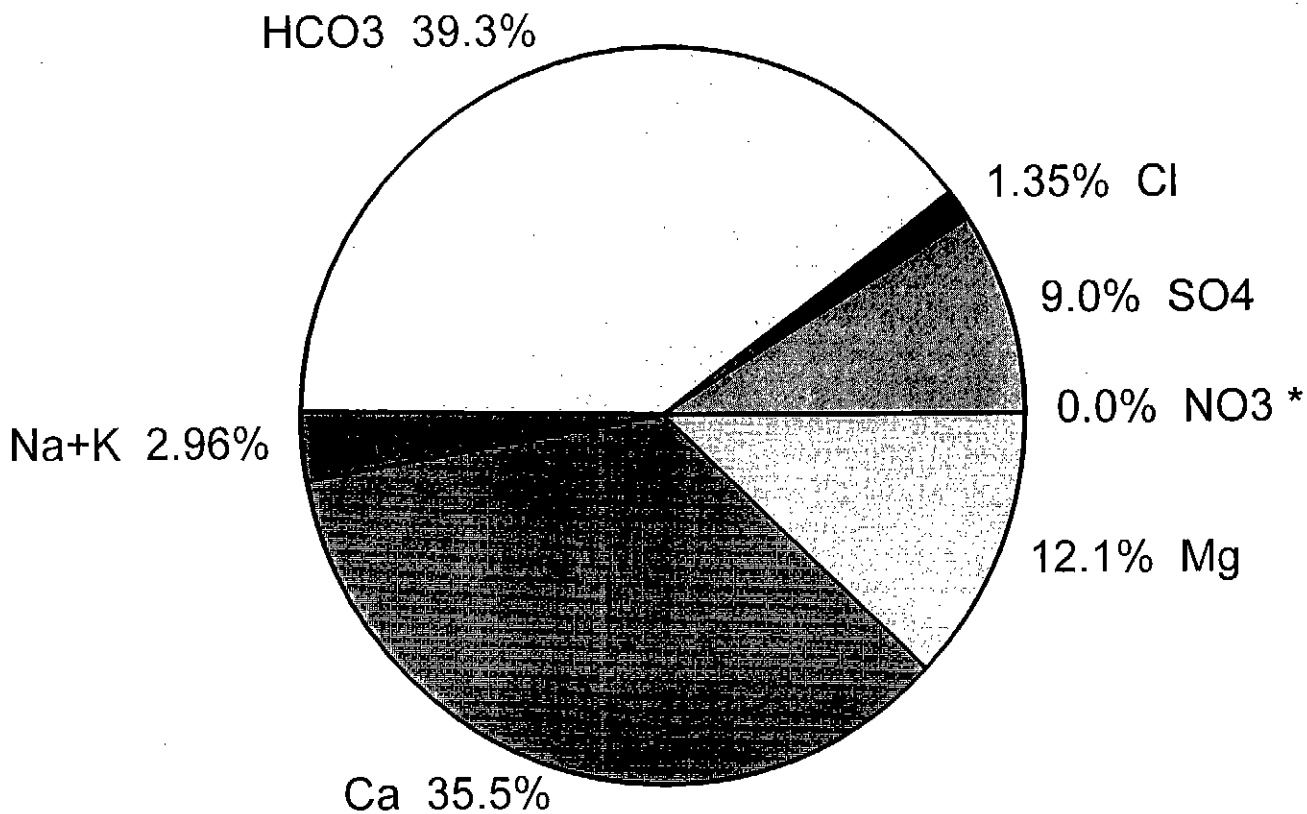
*=not analyzed

Ave. Dissolved Chemical Composition of Ground Water for 12/94 Data



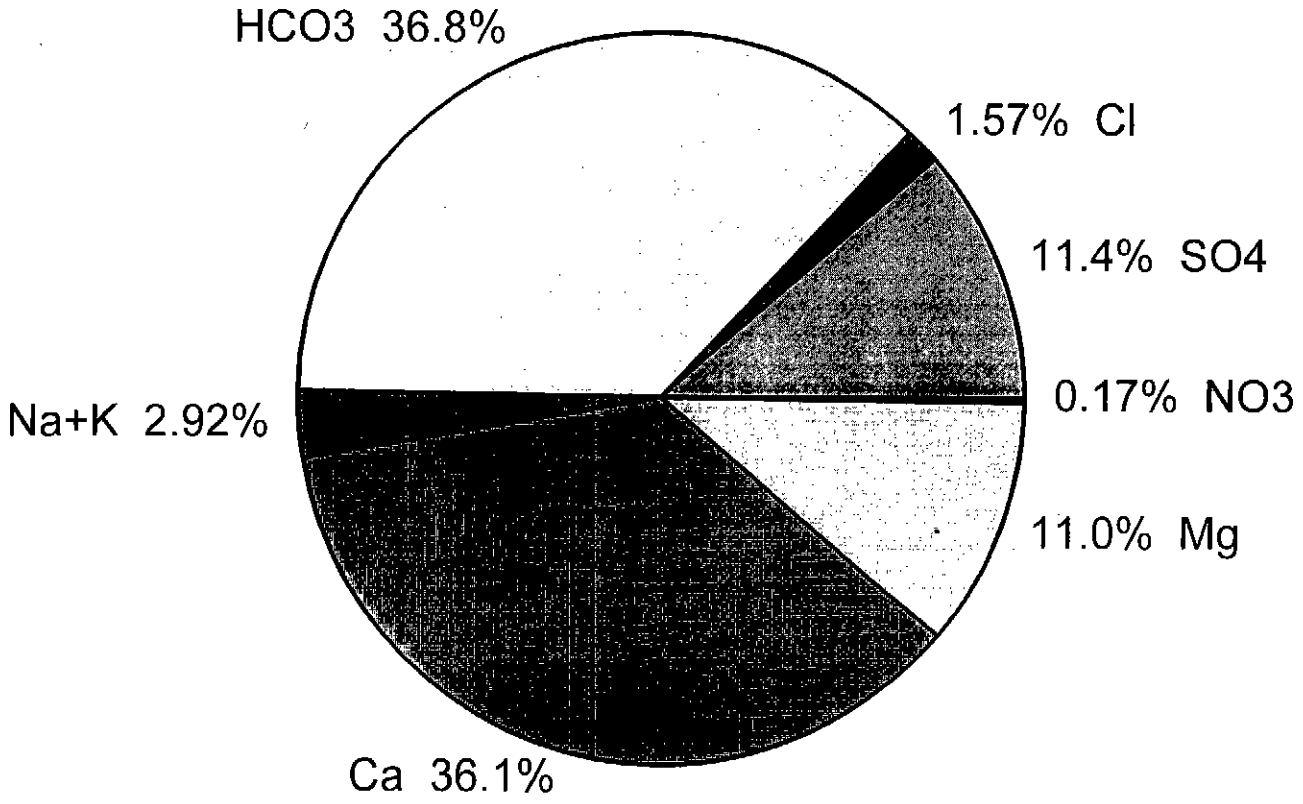
percentage of equivalents per million

Average Dissolved Chemical Composition of Ground Water for 6/95 Data

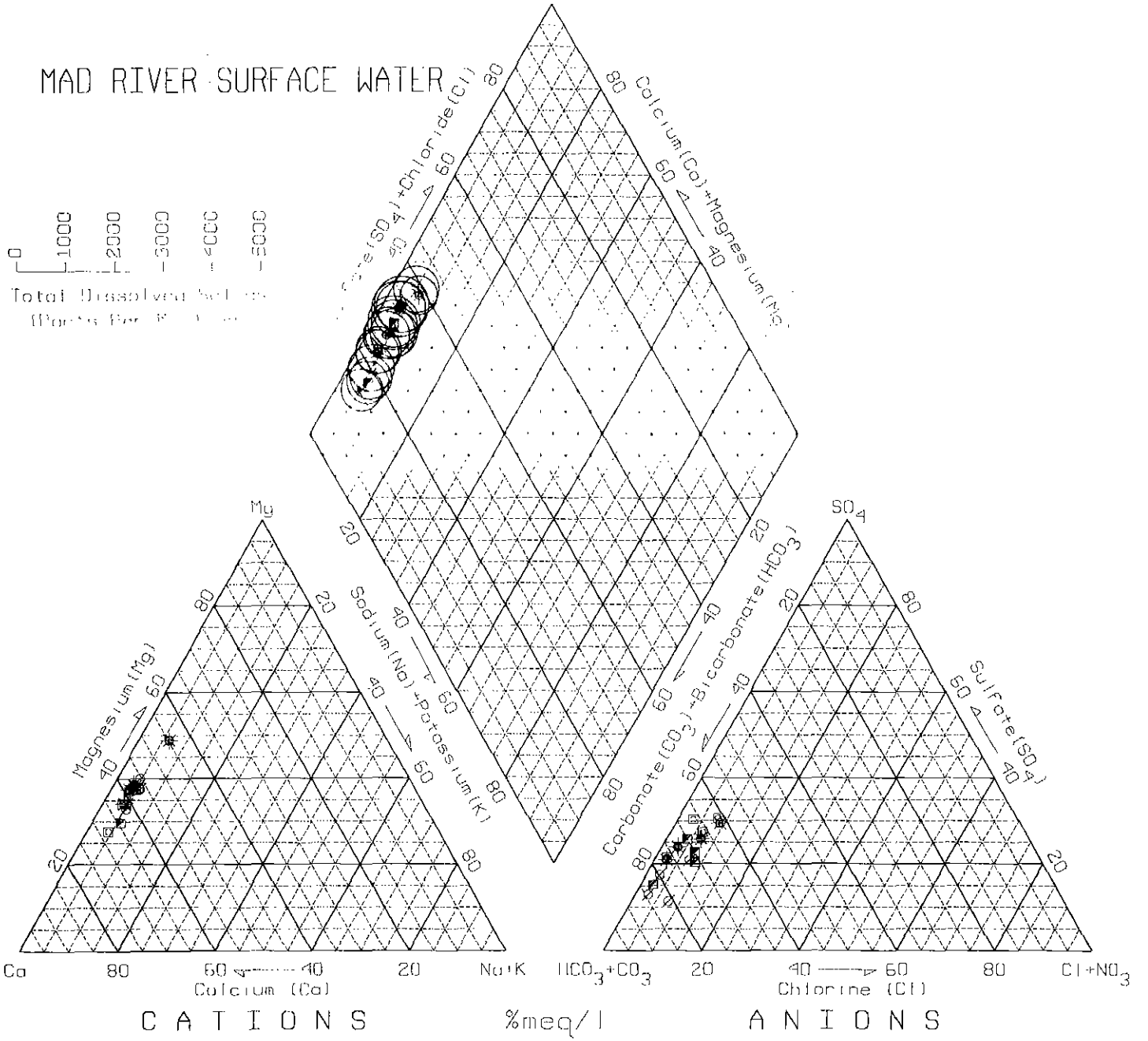


percent of equivalents per million

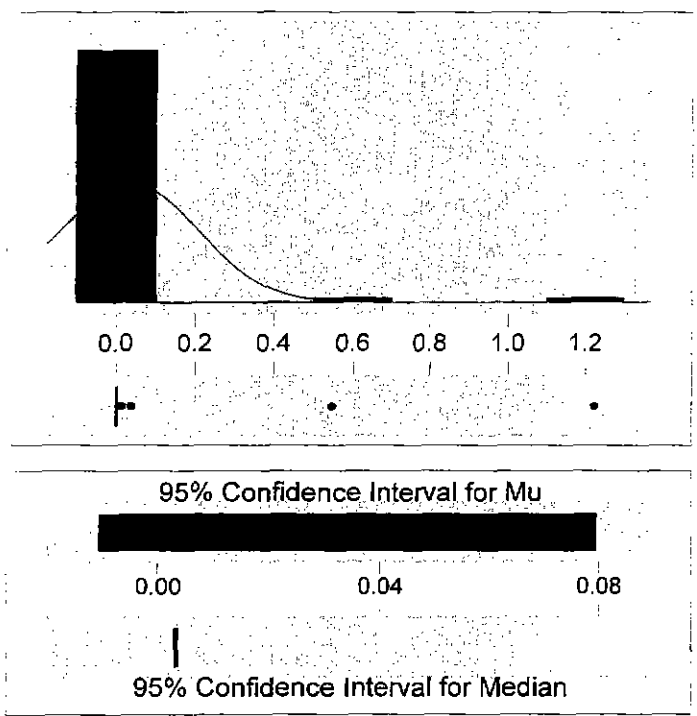
Average Dissolved Chemical Composition of Ground Water for 9/95 Data



percentage of equivalents per million


MAD RIVER SURFACE WATER
0
1000
2000
3000
4000
5000
Total Dissolved Solids
(Parts Per Million)
Sulfate(SO4)+Chloride(Cl)
Calcium(Ca)+Magnesium(Mg)
Sodium(Na)+Potassium(K)
Carbonate(CO3)+Bicarbonate(HCO3)
Mg
Magnesium(Mg)
Ca
Calcium (Ca)
Na+K
CATIONS
%meq/l
SO4
Sulfate(SO4)
HCO3+CO3
Chlorine (Cl)
Cl+NO3
ANIONS

Descriptive Statistics



Variable: NO2

Anderson-Darling Normality Test

A-Squared:	19.3164
p-value:	0.0000
Mean	0.0344
Std Dev	0.1730
Variance	0.0299
Skewness	5.9591
Kurtosis	36.2967
n of data	59.0000
Minimum	-0.0040
1st Quartile	0.0000
Median	0.0033
3rd Quartile	0.0043
Maximum	1.2248

95% Confidence Interval for Mu

-0.0106	0.0795

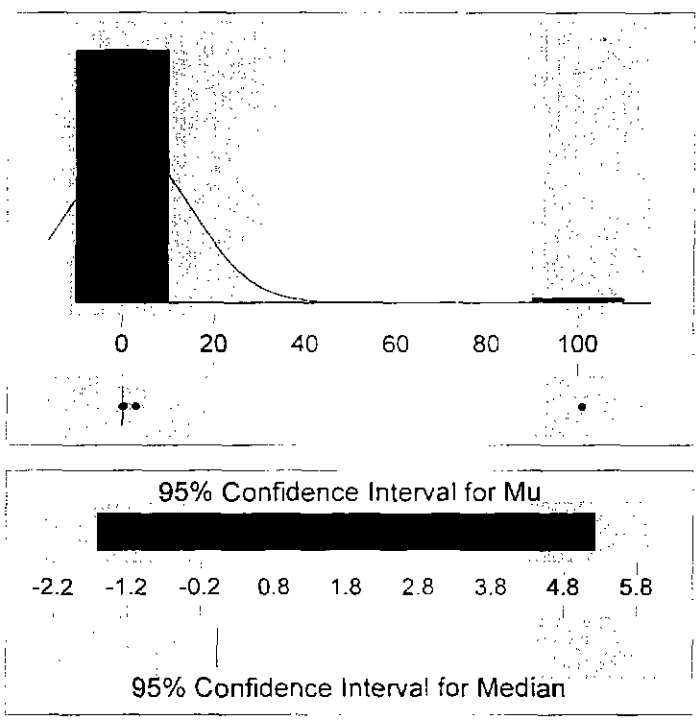
95% Confidence Interval for Sigma

0.1465	0.2114

95% Confidence Interval for Median

0.0029	0.0036

Descriptive Statistics



Variable: NH3

Anderson-Darling Normality Test

A-Squared:	21.316
p-value:	0.000
Mean	1.815
Std Dev	13.133
Variance	172.469
Skewness	7.285
Kurtosis	52.002
n of data	59.000
Minimum	0.000
1st Quartile	0.022
Median	0.028
3rd Quartile	0.059
Maximum	100.936

95% Confidence Interval for Mu

-1.607	5.238

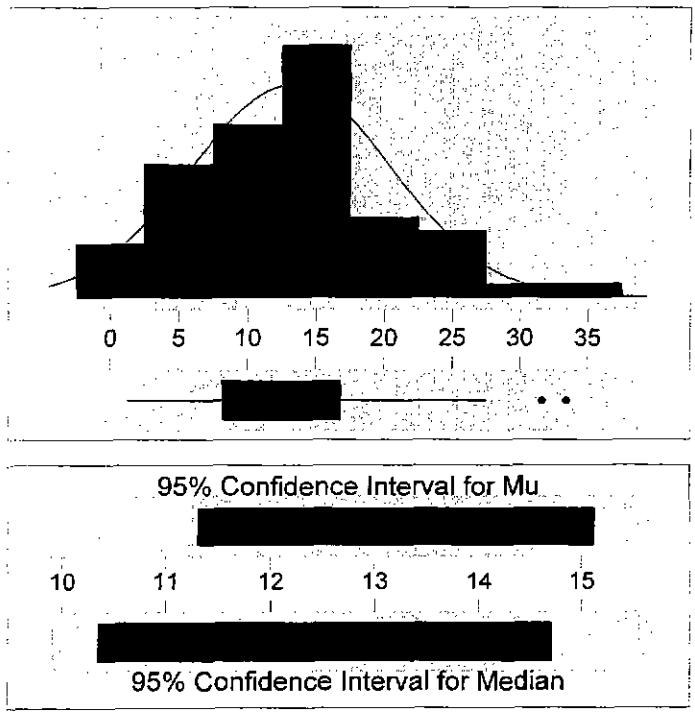
95% Confidence Interval for Sigma

11.117	16.048

95% Confidence Interval for Median

0.025	0.031

Descriptive Statistics



Variable: cl

Anderson-Darling Normality Test

A-Squared:	0.4211
p-value:	0.3136
Mean	13.2106
Std Dev	7.3265
Variance	53.6774
Skewness	0.5706
Kurtosis	0.0545
n of data	59.0000
Minimum	1.2500
1st Quartile	8.1500
Median	13.1000
3rd Quartile	16.8000
Maximum	33.4286

95% Confidence Interval for Mu

11.3013	15.1199

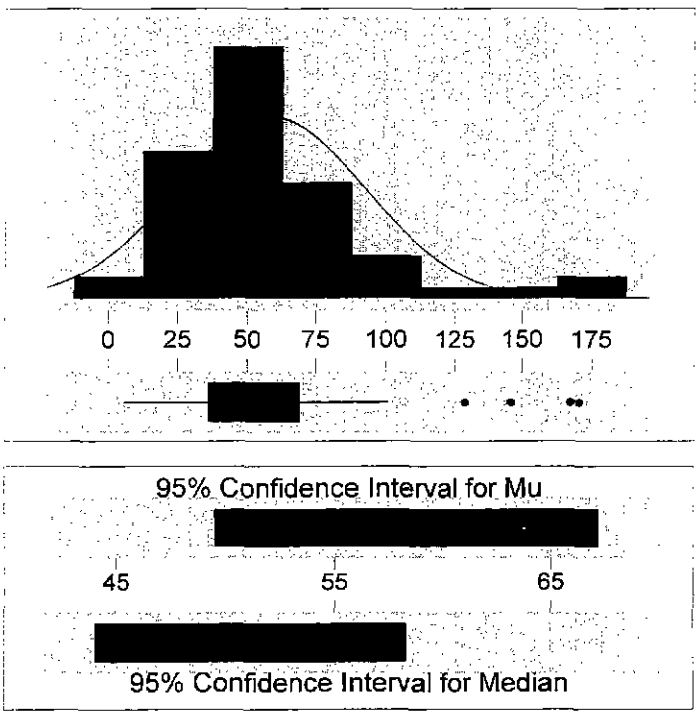
95% Confidence Interval for Sigma

6.2021	8.9526

95% Confidence Interval for Median

10.3501	14.7096

Descriptive Statistics



Variable: so4

Anderson-Darling Normality Test

A-Squared:	2.08
p-value:	0.00
Mean	58.32
Std Dev	33.91
Variance	1149.97
Skewness	1.46
Kurtosis	2.43
n of data	59.00
Minimum	5.73
1st Quartile	36.13
Median	52.40
3rd Quartile	68.92
Maximum	170.54

95% Confidence Interval for Mu

49.49	67.16

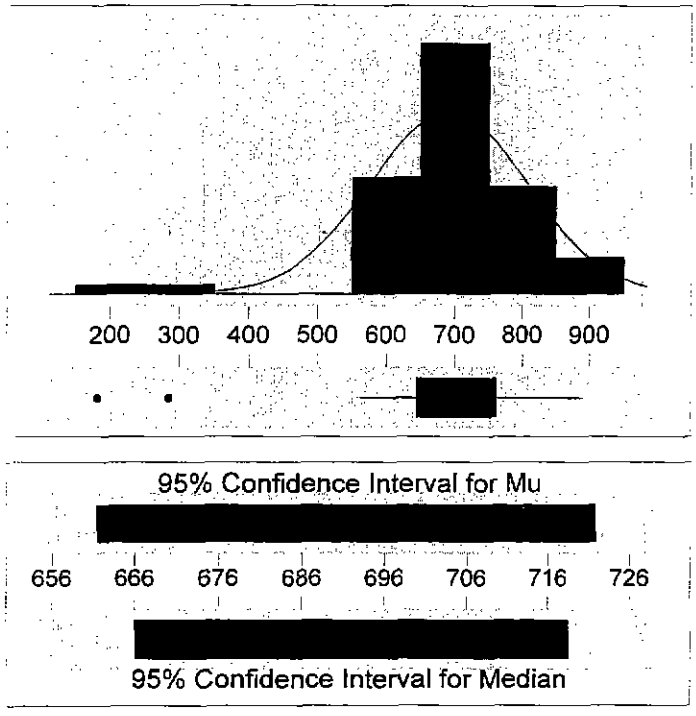
95% Confidence Interval for Sigma

28.71	41.44

95% Confidence Interval for Median

44.05	58.28

Descriptive Statistics



Variable: cond

Anderson-Darling Normality Test

A-Squared:	1.9
p-value:	0.0
Mean	691.7
Std Dev	115.8
Variance	13417.3
Skewness	-1.8
Kurtosis	6.5
n of data	59.0
Minimum	182.1
1st Quartile	645.1
Median	694.0
3rd Quartile	761.0
Maximum	889.1

95% Confidence Interval for Mu

661.5	721.9

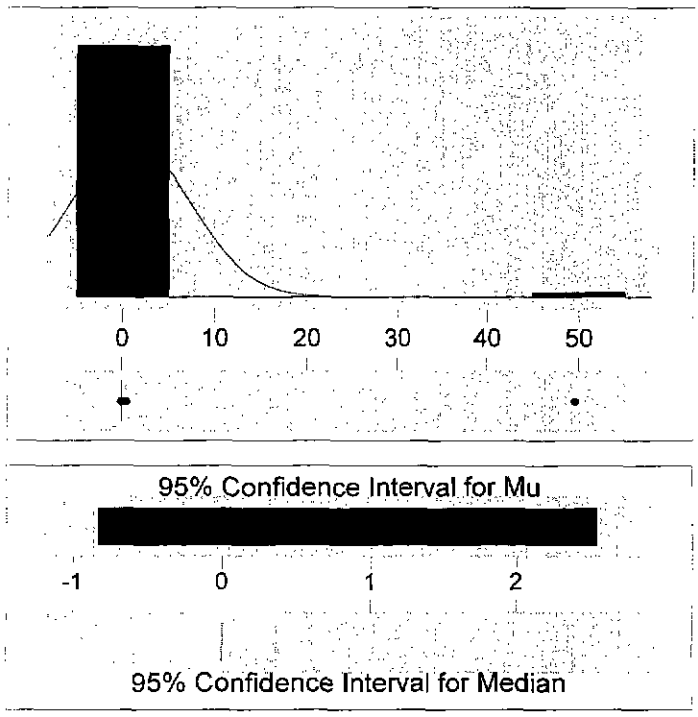
95% Confidence Interval for Sigma

98.1	141.5

95% Confidence Interval for Median

666.0	718.5

Descriptive Statistics



Variable: srp

Anderson-Darling Normality Test

A-Squared:	21.6628
p-value:	0.0000
Mean	0.8526
Std Dev	6.4638
Variance	41.7812
Skewness	7.2937
Kurtosis	52.0883
n of data	59.0000
Minimum	-0.0030
1st Quartile	-0.0011
Median	-0.0006
3rd Quartile	0.0010
Maximum	49.6579

95% Confidence Interval for Mu

-0.8319	2.5370

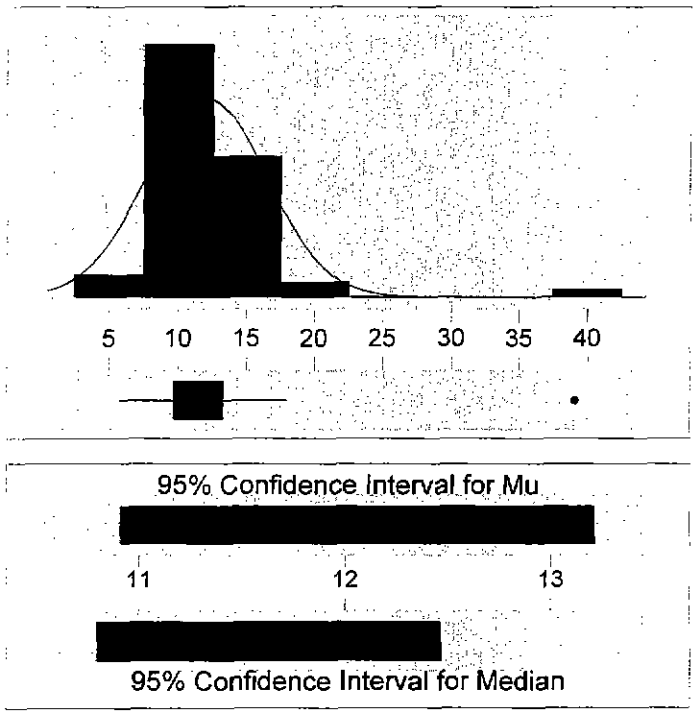
95% Confidence Interval for Sigma

5.4719	7.8985

95% Confidence Interval for Median

-0.0010	0.0001

Descriptive Statistics



Variable: sio2

Anderson-Darling Normality Test

A-Squared:	3.1197
p-value:	0.0000
Mean	12.0605
Std Dev	4.4096
Variance	19.4442
Skewness	3.8565
Kurtosis	21.3429
n of data	59.0000
Minimum	5.7680
1st Quartile	9.6950
Median	11.6071
3rd Quartile	13.2757
Maximum	39.1083

95% Confidence Interval for Mu

10.9114	13.2097

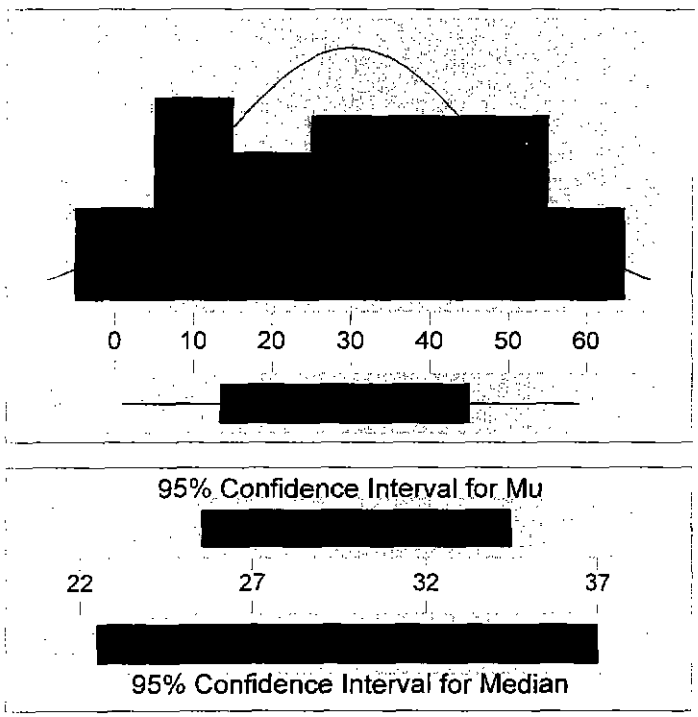
95% Confidence Interval for Sigma

3.7329	5.3883

95% Confidence Interval for Median

10.7973	12.4638

Descriptive Statistics



Variable: NO2 norm

Anderson-Darling Normality Test

A-Squared:	0.695
p-value:	0.066
Mean	30.000
Std Dev	17.157
Variance	294.379
Skewness	0.003
Kurtosis	-1.261
n of data	59.000
Minimum	1.000
1st Quartile	13.500
Median	30.000
3rd Quartile	45.000
Maximum	59.000

95% Confidence Interval for Mu

25.529	34.471

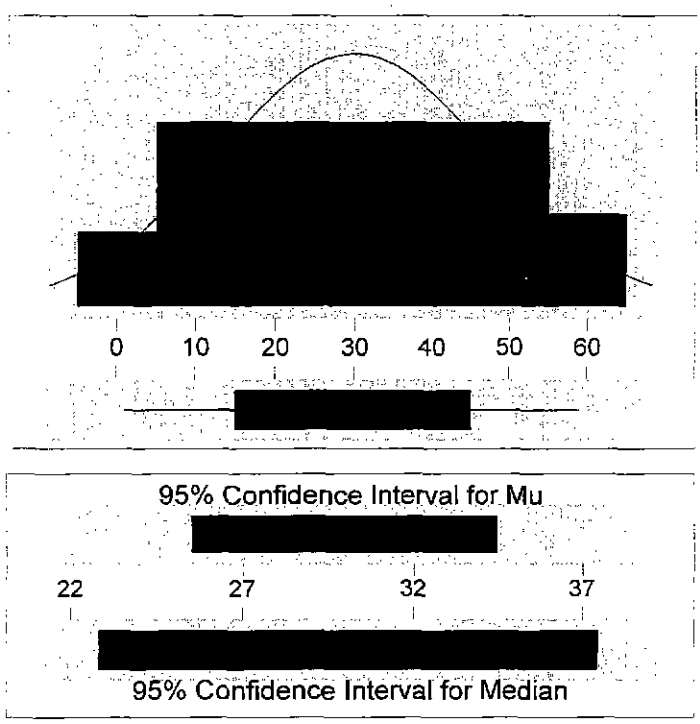
95% Confidence Interval for Sigma

14.524	20.966

95% Confidence Interval for Median

22.500	37.000

Descriptive Statistics



Variable: NH3 norm

Anderson-Darling Normality Test

A-Squared:	0.642
p-value:	0.090
Mean	30.000
Std Dev	17.173
Variance	294.905
Skewness	0.001
Kurtosis	-1.261
n of data	59.000
Minimum	1.000
1st Quartile	15.000
Median	30.000
3rd Quartile	45.000
Maximum	59.000

95% Confidence Interval for Mu

25.525	34.475

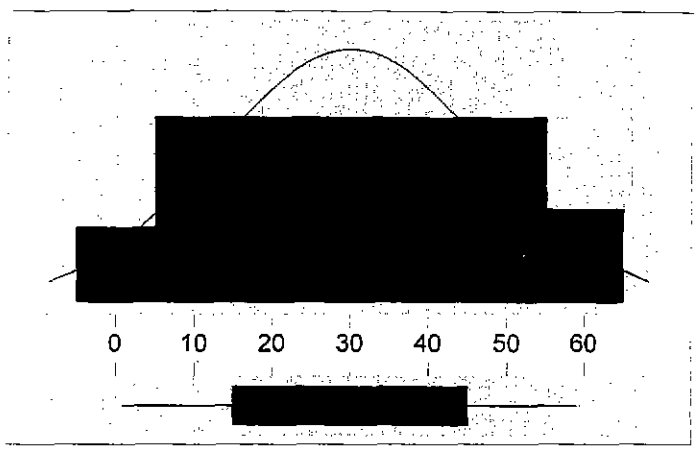
95% Confidence Interval for Sigma

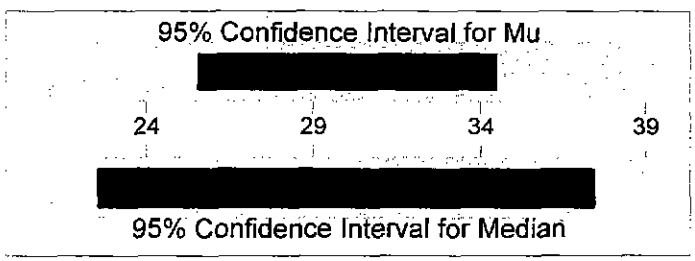
14.537	20.984

95% Confidence Interval for Median

22.808	37.461

Descriptive Statistics





Variable: CI norm

Anderson-Darling Normality Test

A-Squared:	0.633
p-value:	0.095
Mean	30.000
Std Dev	17.176
Variance	295.000
Skewness	0.000
Kurtosis	-1.261
n of data	59.000
Minimum	1.000
1st Quartile	15.000
Median	30.000
3rd Quartile	45.000
Maximum	59.000

95% Confidence Interval for Mu

25.524	34.476

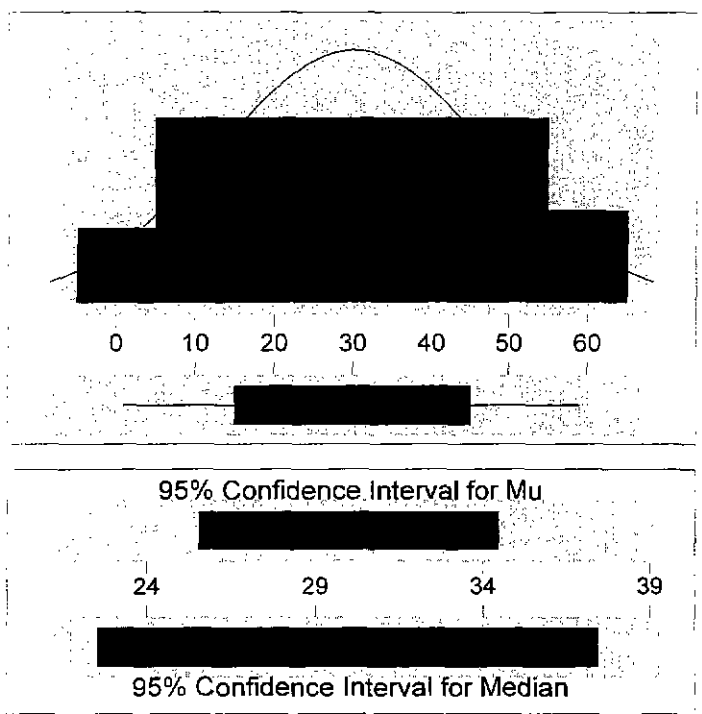
95% Confidence Interval for Sigma

14.540	20.988

95% Confidence Interval for Median

22.539	37.461

Descriptive Statistics



Variable: SO4 norm

Anderson-Darling Normality Test

A-Squared:	0.633
p-value:	0.095
Mean	30.000
Std Dev	17.176
Variance	295.000
Skewness	0.000
Kurtosis	-1.261
n of data	59.000
Minimum	1.000
1st Quartile	15.000
Median	30.000
3rd Quartile	45.000
Maximum	59.000

95% Confidence Interval for Mu

25.524	34.476

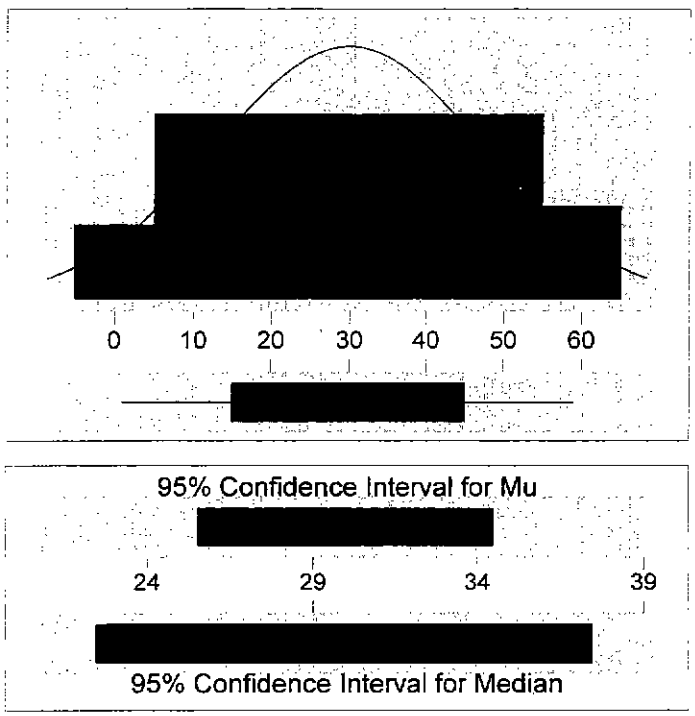
95% Confidence Interval for Sigma

14.540	20.988

95% Confidence Interval for Median

22.539	37.461

Descriptive Statistics



Variable: Cond nor

Anderson-Darling Normality Test

A-Squared:	0.634
p-value:	0.094
Mean	30.000
Std Dev	17.175
Variance	294.983
Skewness	0.000
Kurtosis	-1.261
n of data	59.000
Minimum	1.000
1st Quartile	15.000
Median	30.500
3rd Quartile	45.000
Maximum	59.000

95% Confidence Interval for Mu

25.524	34.476

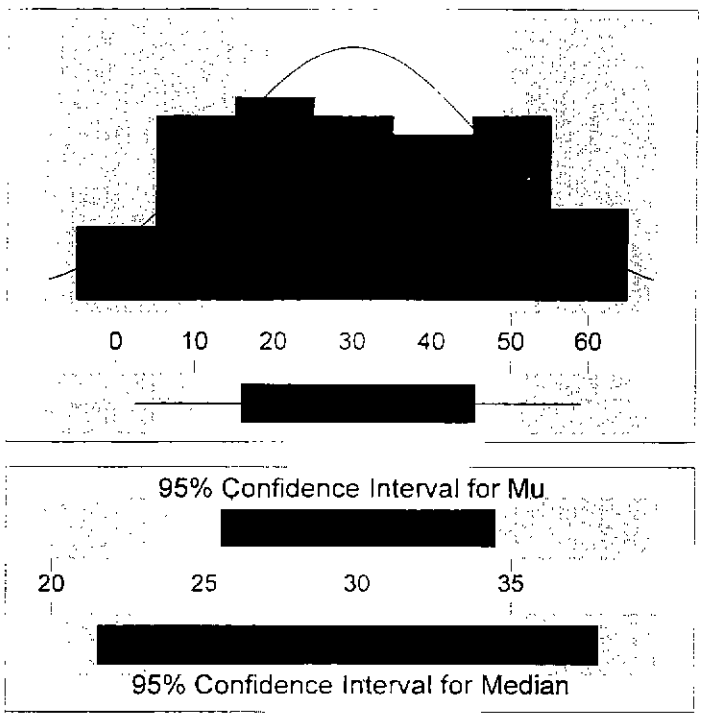
95% Confidence Interval for Sigma

14.539	20.987

95% Confidence Interval for Median

22.500	37.461

Descriptive Statistics



Variable: SRP norm

Anderson-Darling Normality Test

A-Squared:	0.734
p-value:	0.053
Mean	30.000
Std Dev	17.146
Variance	293.974
Skewness	0.006
Kurtosis	-1.261
n of data	59.000
Minimum	2.500
1st Quartile	16.000
Median	30.000
3rd Quartile	45.500
Maximum	59.000

95% Confidence Interval for Mu

25.532	34.468

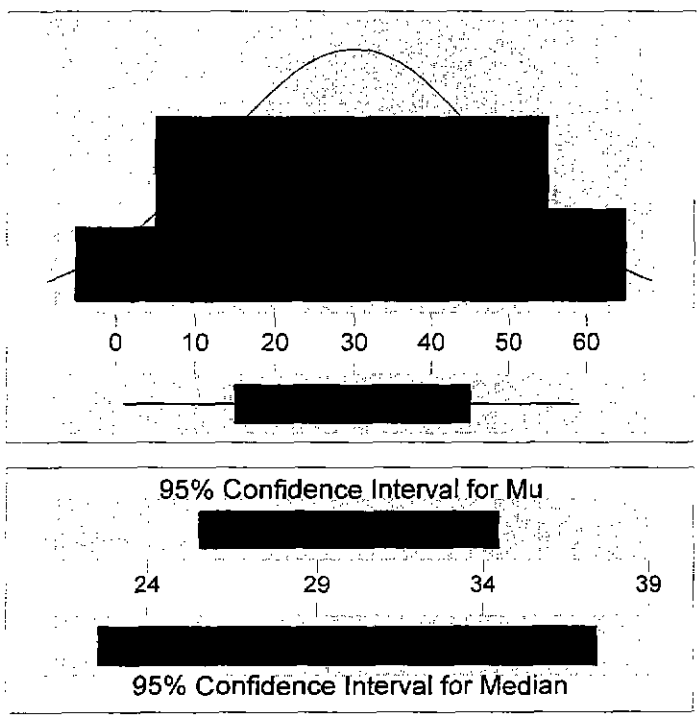
95% Confidence Interval for Sigma

14.514	20.951

95% Confidence Interval for Median

21.500	37.922

Descriptive Statistics



Variable: SiO2 nor

Anderson-Darling Normality Test

A-Squared:	0.633
p-value:	0.095
Mean	30.000
Std Dev	17.176
Variance	295.000
Skewness	0.000
Kurtosis	-1.261
n of data	59.000
Minimum	1.000
1st Quartile	15.000
Median	30.000
3rd Quartile	45.000
Maximum	59.000

95% Confidence Interval for Mu

25.524	34.476

95% Confidence Interval for Sigma

14.540	20.988

95% Confidence Interval for Median

22.539	37.461

```
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            SEPTEMBER 1990            *
*             VERSION 4.0              *
*                                      *
*  RUN DATE  07/09/1996  TIME  14:13:13 *
*                                      *
****************************************
```

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

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

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

```
1                                        HEC-1 INPUT                                        PAGE  1

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

            1          ID   MAD RIVER RAINFALL-RUNOFF MODEL
            2          ID   UPPER MAD RIVER SUBBASIN
            3          ID   RUNOFF SUBROUTINE
*** FREE ***
            4          IT      60 22JUL76       0     270
            5          IN      72
            6          IO       4       0

            7          KK  BASIN1UPPER MAD RIVER SUBBASIN HYDROGRAPH
            8          BA    36.6
            9          KM   STARTING BASE FLOW = 16.9 CFS
           10          BF    16.9    28.1  1.0026
           11          KM   PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
           12          PB   2.430
           13          PC   0.000   0.049   0.097   0.170   0.243   0.292   0.340   0.389   0.462   0.535
           14          PC   0.705   0.948   1.312   1.652   1.920   2.114   2.236   2.308   2.357   2.406
           15          PC   2.430
           16          KM   ANTECEDENT MOISTURE CONDITION II, CN = 59
           17          LS       0      59
           18          IN      60
           19          UI     120     360     800    1300    1540    1617    1580    1520    1450    1370
```

```
          20          UI    1290    1200    1110    1010     920     825     730     645     585     495
          21          UI     430     370     310     270     240     205     180     160     150     135
          22          UI     122     108      95      82      72      62      52      42      32      22
          23          UI      15      10       5
          24          ZW   A=MAD B=UPPER C=FLOW F=COMP
          25          ZZ
1****************************************                                    ****************************************
*                                      *                                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY CORPS OF ENGINEERS       *
*            SEPTEMBER 1990            *                                    *   HYDROLOGIC ENGINEERING CENTER      *
*             VERSION 4.0              *                                    *         609 SECOND STREET            *
*                                      *                                    *      DAVIS, CALIFORNIA 95616         *
* RUN DATE  07/09/1996  TIME  14:13:13 *                                    *          (916) 756-1104              *
*                                      *                                    *                                      *
****************************************                                    ****************************************


                        MAD RIVER RAINFALL-RUNOFF MODEL
                        UPPER MAD RIVER SUBBASIN
                        RUNOFF SUBROUTINE

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

    IT          HYDROGRAPH TIME DATA
                       NMIN         60  MINUTES IN COMPUTATION INTERVAL
                      IDATE     22JUL76  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        270  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2AUG76  ENDING DATE
                     NDTIME       0500  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL    1.00 HOURS
                      TOTAL TIME BASE  269.00 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


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


          **************
          *            *
  7 KK    *   BASIN1   *     UPPER MAD RIVER SUBBASIN HYDROGRAPH
          *            *
          **************
```

```
                    STARTING BASE FLOW = 16.9 CFS
                    PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS

  5 IN        TIME DATA FOR INPUT TIME SERIES
                  JXMIN          72  TIME INTERVAL IN MINUTES
                 JXDATE     22JUL76  STARTING DATE
                 JXTIME           0  STARTING TIME
                    ANTECEDENT MOISTURE CONDITION II, CN = 59

            SUBBASIN RUNOFF DATA

  8 BA        SUBBASIN CHARACTERISTICS
                  TAREA       36.60  SUBBASIN AREA

 10 BF        BASE FLOW CHARACTERISTICS
                  STRTQ       16.90  INITIAL FLOW
                  QRCSN       28.10  BEGIN BASE FLOW RECESSION
                  RTIOR     1.00260  RECESSION CONSTANT

              PRECIPITATION DATA

 12 PB            STORM        2.43  BASIN TOTAL PRECIPITATION

 13 PI          INCREMENTAL PRECIPITATION PATTERN
                  .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                  .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                  .05       .04       .04       .02

 17 LS        SCS LOSS RATE
                  STRTL        1.39  INITIAL ABSTRACTION
                 CRVNBR       59.00  CURVE NUMBER
                  RTIMP         .00  PERCENT IMPERVIOUS AREA

 19 UI        INPUT UNITGRAPH,  43 ORDINATES,  VOLUME = 1.00
                 120.0     360.0     800.0    1300.0    1540.0    1617.0    1580.0    1520.0    1450.0    1370.0
                1290.0    1200.0    1110.0    1010.0     920.0     825.0     730.0     645.0     585.0     495.0
                 430.0     370.0     310.0     270.0     240.0     205.0     180.0     160.0     150.0     135.0
                 122.0     108.0      95.0      82.0      72.0      62.0      52.0      42.0      32.0      22.0
                  15.0      10.0       5.0

                                                    ***
  -----DSS---ZOPEN:  Version: 6-EA;  Existing File Opened
                     Unit:  71,  File: H1DSS.DSS
-----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/UPPER/FLOW/01JUL1976/1HOUR/COMP/
-----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/UPPER/FLOW/01AUG1976/1HOUR/COMP/
1
                                          RUNOFF SUMMARY
                                     FLOW IN CUBIC FEET PER SECOND
                                   TIME IN HOURS,  AREA IN SQUARE MILES

                                 PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION  FLOW    PEAK                                            AREA      STAGE     MAX STAGE
+                                                    6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                       BASIN1    209.   26.00        201.        137.         65.     36.60
1                                                 HEC-1 INPUT                                                PAGE  1

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

```
            1          ID   MAD RIVER RAINFALL-RUNOFF MODEL
            2          ID   MACOCHEE CREEK SUBBASIN
            3          ID   RUNOFF SUBROUTINE
*** FREE ***
            4          IT      60 22JUL76       0     270
            5          IN      72
            6          IO       4       0

            7          KK  BASIN2MACOCHEE CREEK SUBBASIN HYDROGRAPH
            8          BA    19.1
            9          KM   STARTING BASE FLOW = 5.7 CFS
           10          BF     5.7     9.5  1.0026
           11          KM   PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
           12          PB   2.430
           13          PC   0.000   0.049   0.097   0.170   0.243   0.292   0.340   0.389   0.462   0.535
           14          PC   0.705   0.948   1.312   1.652   1.920   2.114   2.236   2.308   2.357   2.406
           15          PC   2.430
           16          KM   ANTECEDENT MOISTURE CONDITION II, CN = 59
           17          LS       0      59
           18          IN      60
           19          UI     120     360     740    1000    1044    1000     950     890     825     750
           20          UI     670     600     525     460     400     330     280     230     190     160
           21          UI     140     120     105      90      80      65      55      45      40      35
           22          UI      30      25      15      10       5
           23          ZW   A=MAD B=MACCK C=FLOW F=COMP
           24          ZZ
1*************************************                    *************************************
*                                   *                    *                                   *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                *   U.S. ARMY CORPS OF ENGINEERS    *
*            SEPTEMBER 1990           *                *   HYDROLOGIC ENGINEERING CENTER   *
*             VERSION 4.0             *                *         609 SECOND STREET         *
*                                     *                *      DAVIS, CALIFORNIA 95616      *
*  RUN DATE  07/09/1996  TIME  14:13:13 *              *          (916) 756-1104           *
*                                     *                *                                   *
*************************************                    *************************************


                        MAD RIVER RAINFALL-RUNOFF MODEL
                        MACOCHEE CREEK SUBBASIN
                        RUNOFF SUBROUTINE

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

    IT          HYDROGRAPH TIME DATA
                       NMIN         60  MINUTES IN COMPUTATION INTERVAL
                      IDATE     22JUL76  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        270  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2AUG76  ENDING DATE
                     NDTIME        0500  ENDING TIME
                      ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL    1.00 HOURS
                      TOTAL TIME BASE  269.00 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


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


          **************
          *            *
   7 KK   *   BASIN2   *     MACOCHEE CREEK SUBBASIN HYDROGRAPH
          *            *
          **************
                         STARTING BASE FLOW = 5.7 CFS
                         PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
                         ANTECEDENT MOISTURE CONDITION II, CN = 59

             SUBBASIN RUNOFF DATA

   8 BA         SUBBASIN CHARACTERISTICS
                     TAREA       19.10  SUBBASIN AREA

  10 BF         BASE FLOW CHARACTERISTICS
                     STRTQ        5.70  INITIAL FLOW
                     QRCSN        9.50  BEGIN BASE FLOW RECESSION
                     RTIOR     1.00260  RECESSION CONSTANT

                PRECIPITATION DATA

  12 PB              STORM        2.43  BASIN TOTAL PRECIPITATION

  13 PI           INCREMENTAL PRECIPITATION PATTERN
                     .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                     .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                     .05       .04       .04       .02

  17 LS         SCS LOSS RATE
                     STRTL        1.39  INITIAL ABSTRACTION
                    CRVNBR       59.00  CURVE NUMBER
                     RTIMP         .00  PERCENT IMPERVIOUS AREA

  19 UI         INPUT UNITGRAPH,  35 ORDINATES,  VOLUME = 1.00
                    120.0     360.0     740.0    1000.0    1044.0    1000.0     950.0     890.0     825.0     750.0
                    670.0     600.0     525.0     460.0     400.0     330.0     280.0     230.0     190.0     160.0
                    140.0     120.0     105.0      90.0      80.0      65.0      55.0      45.0      40.0      35.0
                     30.0      25.0      15.0      10.0       5.0

                                                   ***
-----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/MACCK/FLOW/01JUL1976/1HOUR/COMP/
-----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/MACCK/FLOW/01AUG1976/1HOUR/COMP/
1
                                                RUNOFF SUMMARY
                                          FLOW IN CUBIC FEET PER SECOND
```

```
                                        TIME IN HOURS,  AREA IN SQUARE MILES

                                   PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION    FLOW    PEAK                                           AREA      STAGE     MAX STAGE
+                                                       6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                        BASIN2     123.   25.00         117.         72.         30.      19.10
1                                                     HEC-1 INPUT                                          PAGE  1

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

           1            ID   MAD RIVER RAINFALL-RUNOFF MODEL
           2            ID   MUD RUN SUBBASIN
           3            ID   RUNOFF SUBROUTINE
 *** FREE ***
           4            IT      60 22JUL76       0     270
           5            IN      72
           6            IO       4       0

           7            KK  BASIN3MUD RUN SUBBASIN HYDROGRAPH
           8            BA     5.2
           9            KM   STARTING BASE FLOW = 3.1 CFS
          10            BF     3.1     5.2  1.0026
          11            KM   PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
          12            PB   2.430
          13            PC   0.000   0.049   0.097   0.170   0.243   0.292   0.340   0.389   0.462   0.535
          14            PC   0.705   0.948   1.312   1.652   1.920   2.114   2.236   2.308   2.357   2.406
          15            PC   2.430
          16            KM   ANTECEDENT MOISTURE CONDITION II, CN = 59
          17            LS       0      59
          18            UD    2.54
          19            ZW   A=MAD B=MUD C=FLOW F=COMP
          20            ZZ
1*****************************************                                  *****************************************
*                                       *                                  *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                  *    U.S. ARMY CORPS OF ENGINEERS       *
*            SEPTEMBER 1990             *                                  *    HYDROLOGIC ENGINEERING CENTER      *
*             VERSION 4.0               *                                  *          609 SECOND STREET            *
*                                       *                                  *       DAVIS, CALIFORNIA 95616         *
*  RUN DATE  07/09/1996  TIME  14:13:13 *                                  *           (916) 756-1104              *
*                                       *                                  *                                       *
*****************************************                                  *****************************************


                        MAD RIVER RAINFALL-RUNOFF MODEL
                        MUD RUN SUBBASIN
                        RUNOFF SUBROUTINE

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

    IT           HYDROGRAPH TIME DATA
                        NMIN         60  MINUTES IN COMPUTATION INTERVAL
                       IDATE     22JUL76  STARTING DATE
```

```
                ITIME        0000  STARTING TIME
                   NQ         270  NUMBER OF HYDROGRAPH ORDINATES
              NDDATE      2AUG76  ENDING DATE
              NDTIME        0500  ENDING TIME
               ICENT          19  CENTURY MARK

          COMPUTATION INTERVAL    1.00 HOURS
               TOTAL TIME BASE  269.00 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


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


          **************
          *            *
  7 KK    *   BASIN3   *     MUD RUN SUBBASIN HYDROGRAPH
          *            *
          **************
                       STARTING BASE FLOW = 3.1 CFS
                       PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
                       ANTECEDENT MOISTURE CONDITION II, CN = 59

            SUBBASIN RUNOFF DATA

  8 BA        SUBBASIN CHARACTERISTICS
                 TAREA        5.20  SUBBASIN AREA

 10 BF        BASE FLOW CHARACTERISTICS
                 STRTQ        3.10  INITIAL FLOW
                 QRCSN        5.20  BEGIN BASE FLOW RECESSION
                 RTIOR     1.00260  RECESSION CONSTANT

              PRECIPITATION DATA

 12 PB           STORM        2.43  BASIN TOTAL PRECIPITATION

 13 PI          INCREMENTAL PRECIPITATION PATTERN
                 .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                 .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                 .05       .04       .04       .02

 17 LS        SCS LOSS RATE
                 STRTL        1.39  INITIAL ABSTRACTION
                CRVNBR       59.00  CURVE NUMBER
                 RTIMP         .00  PERCENT IMPERVIOUS AREA

 18 UD        SCS DIMENSIONLESS UNITGRAPH
                  TLAG        2.54  LAG

                                                    ***
```

```
                                        UNIT HYDROGRAPH
                                     15 END-OF-PERIOD ORDINATES
            186.      624.      828.      702.      427.      243.      146.      85.       49.       29.
             17.       10.        6.        3.        1.
 -----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/MUD/FLOW/01JUL1976/1HOUR/COMP/
 -----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/MUD/FLOW/01AUG1976/1HOUR/COMP/
1
                                        RUNOFF SUMMARY
                                   FLOW IN CUBIC FEET PER SECOND
                                 TIME IN HOURS,  AREA IN SQUARE MILES

                                     PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION      FLOW     PEAK                                          AREA      STAGE     MAX STAGE
+                                                          6-HOUR      24-HOUR      72-HOUR

        HYDROGRAPH AT
+                        BASIN3       64.   20.00          55.          22.          11.       5.20
1                                                     HEC-1 INPUT                                          PAGE  1

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

           1            ID   MAD RIVER RAINFALL-RUNOFF MODEL
           2            ID   UNNAMED TRIBUTARIES SUBBASIN
           3            ID   RUNOFF SUBROUTINE
 *** FREE ***
           4            IT      60 22JUL76       0     270
           5            IN      72
           6            IO       4       0

           7            KK  BASIN4UNNAMED TRIBUTARIES SUBBASIN HYDROGRAPH
           8            BA     7.6
           9            KM   STARTING BASE FLOW = 12.2 CFS
          10            BF    12.2    19.3  1.0026
          11            KM   PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
          12            PB   2.430
          13            PC   0.000   0.049   0.097   0.170   0.243   0.292   0.340   0.389   0.462   0.535
          14            PC   0.705   0.948   1.312   1.652   1.920   2.114   2.236   2.308   2.357   2.406
          15            PC   2.430
          16            KM   ANTECEDENT MOISTURE CONDITION II, CN = 59
          17            LS       0      59
          18            UD    1.25
          19            ZW   A=MAD B=TRIBS C=FLOW F=COMP
          20            ZZ
1****************************************                                  ****************************************
 *                                      *                                  *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                  *    U.S. ARMY CORPS OF ENGINEERS      *
 *            SEPTEMBER 1990            *                                  *    HYDROLOGIC ENGINEERING CENTER     *
 *             VERSION 4.0              *                                  *          609 SECOND STREET           *
 *                                      *                                  *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE  07/09/1996  TIME  14:13:13 *                                  *           (916) 756-1104             *
 *                                      *                                  *                                      *
 ****************************************                                  ****************************************
```

MAD RIVER RAINFALL-RUNOFF MODEL
UNNAMED TRIBUTARIES SUBBASIN

```
                    RUNOFF SUBROUTINE

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

 IT           HYDROGRAPH TIME DATA
                  NMIN         60  MINUTES IN COMPUTATION INTERVAL
                 IDATE     22JUL76  STARTING DATE
                 ITIME        0000  STARTING TIME
                    NQ         270  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE      2AUG76  ENDING DATE
                NDTIME        0500  ENDING TIME
                 ICENT          19  CENTURY MARK

             COMPUTATION INTERVAL    1.00 HOURS
                  TOTAL TIME BASE  269.00 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


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


          **************
          *            *
  7 KK    *   BASIN4   *     UNNAMED TRIBUTARIES SUBBASIN HYDROGRAPH
          *            *
          **************
                     STARTING BASE FLOW = 12.2 CFS
                     PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
                     ANTECEDENT MOISTURE CONDITION II, CN = 59

            SUBBASIN RUNOFF DATA

  8 BA        SUBBASIN CHARACTERISTICS
                  TAREA        7.60  SUBBASIN AREA

 10 BF        BASE FLOW CHARACTERISTICS
                  STRTQ       12.20  INITIAL FLOW
                  QRCSN       19.30  BEGIN BASE FLOW RECESSION
                  RTIOR     1.00260  RECESSION CONSTANT

            PRECIPITATION DATA

 12 PB            STORM        2.43  BASIN TOTAL PRECIPITATION

 13 PI         INCREMENTAL PRECIPITATION PATTERN
                  .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                  .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                  .05       .04       .04       .02
```



```
                    ANTECEDENT MOISTURE CONDITION II, CN = 59

            SUBBASIN RUNOFF DATA

  8 BA        SUBBASIN CHARACTERISTICS
                  TAREA        7.40  SUBBASIN AREA

 10 BF        BASE FLOW CHARACTERISTICS
```

```
 17 LS          SCS LOSS RATE
                      STRTL        1.39  INITIAL ABSTRACTION
                     CRVNBR       59.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

 18 UD          SCS DIMENSIONLESS UNITGRAPH
                       TLAG        1.25  LAG
```

```
                      STRTQ        6.40  INITIAL FLOW
                      QRCSN       10.30  BEGIN BASE FLOW RECESSION
                      RTIOR     1.00260  RECESSION CONSTANT

                PRECIPITATION DATA

 12 PB                STORM        2.43  BASIN TOTAL PRECIPITATION

 13 PI            INCREMENTAL PRECIPITATION PATTERN
                      .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                      .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                      .05       .04       .04       .02

 17 LS          SCS LOSS RATE
                      STRTL        1.39  INITIAL ABSTRACTION
                     CRVNBR       59.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

 19 UI          INPUT UNITGRAPH,  27 ORDINATES,  VOLUME = 1.01
                     85.0     340.0     545.0     530.0     500.0     460.0     415.0     360.0     305.0     250.0
                    210.0     170.0     135.0     105.0      82.0      68.0      55.0      45.0      38.0      30.0
                     25.0      20.0      15.0      11.0       8.0       5.0       2.0

                                                   ***
-----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/MACD/FLOW/01JUL1976/1HOUR/COMP/
-----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/MACD/FLOW/01AUG1976/1HOUR/COMP/
1
                                                RUNOFF SUMMARY
                                          FLOW IN CUBIC FEET PER SECOND
                                       TIME IN HOURS,  AREA IN SQUARE MILES

                                  PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION   FLOW    PEAK                                            AREA      STAGE     MAX STAGE
+                                                      6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                       BASIN5     62.   23.00          58.         33.         17.       7.40
1                                                   HEC-1 INPUT                                                PAGE  1

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

           1            ID   MAD RIVER RAINFALL-RUNOFF MODEL
           2            ID   GLADY CREEK SUBBASIN
           3            ID   RUNOFF SUBROUTINE
*** FREE ***
           4            IT      60 22JUL76        0      270
           5            IN      72
           6            IO       4        0

           7            KK  BASIN6GLADY CREEK SUBBASIN HYDROGRAPH
           8            BA    13.2
           9            KM   STARTING BASE FLOW = 3.1 CFS
          10            BF     3.1      5.2  1.0026
          11            KM   PRECIPIATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
          12            PB   2.430
          13            PC   0.000   0.049   0.097   0.170   0.243   0.292   0.340   0.389   0.462   0.535
          14            PC   0.705   0.948   1.312   1.652   1.920   2.114   2.236   2.308   2.357   2.406
          15            PC   2.430
          16            KM   ANTECEDENT MOISTURE CONDITION II, CN = 59
          17            LS       0      59
```

```
18          IN      60
19          UI      30      80     140     230     380     440     464     460     445     435
20          UI     420     405     385     365     345     320     295     275     255     235
21          UI     215     195     175     160     145     130     115     105      95      80
22          UI      75      65      60      52      48      42      39      37      33      30
23          UI      28      24      22      20      18      16      13      11       9       7
24          UI       6       5       4       3       2
25          ZW   A=MAD B=GLADY C=FLOW F=COMP
26          ZZ
1*****************************************                    *****************************************
*                                       *                    *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *   U.S. ARMY CORPS OF ENGINEERS        *
*            SEPTEMBER 1990             *                    *   HYDROLOGIC ENGINEERING CENTER       *
*             VERSION 4.0               *                    *          609 SECOND STREET            *
*                                       *                    *        DAVIS, CALIFORNIA 95616        *
*  RUN DATE  07/09/1996  TIME  14:13:13 *                    *           (916) 756-1104              *
*                                       *                    *                                       *
*****************************************                    *****************************************


                    MAD RIVER RAINFALL-RUNOFF MODEL
                    GLADY CREEK SUBBASIN
                    RUNOFF SUBROUTINE

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

   IT         HYDROGRAPH TIME DATA
                   NMIN         60  MINUTES IN COMPUTATION INTERVAL
                  IDATE     22JUL76  STARTING DATE
                  ITIME       0000  STARTING TIME
                     NQ        270  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     2AUG76  ENDING DATE
                 NDTIME       0500  ENDING TIME
                  ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL    1.00 HOURS
                  TOTAL TIME BASE  269.00 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


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


          **************
          *            *
```

```
 7 KK     *    BASIN6  *     GLADY CREEK SUBBASIN HYDROGRAPH
          *            *
          **************
                         STARTING BASE FLOW = 3.1 CFS
                         PRECIPIATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
                         ANTECEDENT MOISTURE CONDITION II, CN = 59

             SUBBASIN RUNOFF DATA

 8 BA          SUBBASIN CHARACTERISTICS
                    TAREA       13.20  SUBBASIN AREA

10 BF          BASE FLOW CHARACTERISTICS
                    STRTQ        3.10  INITIAL FLOW
                    QRCSN        5.20  BEGIN BASE FLOW RECESSION
                    RTIOR     1.00260  RECESSION CONSTANT

               PRECIPITATION DATA

12 PB               STORM        2.43  BASIN TOTAL PRECIPITATION

13 PI            INCREMENTAL PRECIPITATION PATTERN
                     .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                     .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                     .05       .04       .04       .02

17 LS          SCS LOSS RATE
                    STRTL        1.39  INITIAL ABSTRACTION
                   CRVNBR       59.00  CURVE NUMBER
                    RTIMP         .00  PERCENT IMPERVIOUS AREA

19 UI          INPUT UNITGRAPH,  55 ORDINATES,  VOLUME = 1.00
                    30.0      80.0     140.0     230.0     380.0     440.0     464.0     460.0     445.0     435.0
                   420.0     405.0     385.0     365.0     345.0     320.0     295.0     275.0     255.0     235.0
                   215.0     195.0     175.0     160.0     145.0     130.0     115.0     105.0      95.0      80.0
                    75.0      65.0      60.0      52.0      48.0      42.0      39.0      37.0      33.0      30.0
                    28.0      24.0      22.0      20.0      18.0      16.0      13.0      11.0       9.0       7.0
                     6.0       5.0       4.0       3.0       2.0

                                                   ***
 -----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/GLADY/FLOW/01JUL1976/1HOUR/COMP/
 -----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/GLADY/FLOW/01AUG1976/1HOUR/COMP/
1
                                                RUNOFF SUMMARY
                                          FLOW IN CUBIC FEET PER SECOND
                                        TIME IN HOURS,  AREA IN SQUARE MILES

                                  PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION   FLOW     PEAK                                          AREA      STAGE     MAX STAGE
+                                                     6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                        BASIN6     60.   27.00          58.         43.         19.      13.20
1                                                   HEC-1 INPUT                                              PAGE  1

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

           1            ID   MAD RIVER RAINFALL-RUNOFF MODEL
           2            ID   KINGS CREEK SUBBASIN
           3            ID   RUNOFF SUBROUTINE
```

```
*** FREE ***
          4          IT      60 22JUL76       0     270
          5          IN      72
          6          IO       4       0

          7          KK  BASIN7KINGS CREEK SUBBASIN HYDROGRAPH
          8          BA    45.0
          9          KM   STARTING BASE FLOW = 19.0 CFS
         10          BF    19.0    32.5  1.0026
         11          KM   PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
         12          PB   2.430
         13          PC   0.000   0.049   0.097   0.170   0.243   0.292   0.340   0.389   0.462   0.535
         14          PC   0.705   0.948   1.312   1.652   1.920   2.114   2.236   2.308   2.357   2.406
         15          PC   2.430
         16          KM   ANTECEDENT MOISTURE CONDITION II, CN = 59
         17          LS       0      59
         18          IN      60
         19          UI     120     700    1460    2070    2276    2240    2140    2020    1880    1740
         20          UI    1600    1440    1300    1150    1020     880     760     650     545     460
         21          UI     385     330     290     255     225     200     180     160     140     120
         22          UI     100      85      75      60      45      30      20      10
         23          ZW   A=MAD B=KINGS C=FLOW F=COMP
         24          ZZ
1*************************************                    *************************************
*                                   *                    *                                   *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                 *   U.S. ARMY CORPS OF ENGINEERS    *
*          SEPTEMBER 1990           *                    *   HYDROLOGIC ENGINEERING CENTER   *
*           VERSION 4.0             *                    *        609 SECOND STREET          *
*                                   *                    *      DAVIS, CALIFORNIA 95616      *
* RUN DATE  07/09/1996  TIME  14:13:13 *                 *         (916) 756-1104            *
*                                   *                    *                                   *
*************************************                    *************************************


                        MAD RIVER RAINFALL-RUNOFF MODEL
                        KINGS CREEK SUBBASIN
                        RUNOFF SUBROUTINE

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

   IT           HYDROGRAPH TIME DATA
                       NMIN          60  MINUTES IN COMPUTATION INTERVAL
                      IDATE     22JUL76  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         270  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2AUG76  ENDING DATE
                     NDTIME        0500  ENDING TIME
                      ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL    1.00 HOURS
                      TOTAL TIME BASE  269.00 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


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


          **************
          *            *
   7 KK   *   BASIN7   *     KINGS CREEK SUBBASIN HYDROGRAPH
          *            *
          **************
                        STARTING BASE FLOW = 19.0 CFS
                        PRECIPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
                        ANTECEDENT MOISTURE CONDITION II. CN = 59

            SUBBASIN RUNOFF DATA

   8 BA       SUBBASIN CHARACTERISTICS
                  TAREA       45.00  SUBBASIN AREA

  10 BF       BASE FLOW CHARACTERISTICS
                  STRTQ       19.00  INITIAL FLOW
                  QRCSN       32.50  BEGIN BASE FLOW RECESSION
                  RTIOR     1.00260  RECESSION CONSTANT

              PRECIPITATION DATA

  12 PB           STORM        2.43  BASIN TOTAL PRECIPITATION

  13 PI         INCREMENTAL PRECIPITATION PATTERN
                  .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                  .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                  .05       .04       .04       .02

  17 LS       SCS LOSS RATE
                  STRTL        1.39  INITIAL ABSTRACTION
                 CRVNBR       59.00  CURVE NUMBER
                  RTIMP         .00  PERCENT IMPERVIOUS AREA

  19 UI       INPUT UNITGRAPH,  38 ORDINATES,  VOLUME = 1.00
                 120.0     700.0    1460.0    2070.0    2276.0    2240.0    2140.0    2020.0    1880.0    1740.0
                1600.0    1440.0    1300.0    1150.0    1020.0     880.0     760.0     650.0     545.0     460.0
                 385.0     330.0     290.0     255.0     225.0     200.0     180.0     160.0     140.0     120.0
                 100.0      85.0      75.0      60.0      45.0      30.0      20.0      10.0

                                                          ***
-----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/KINGS/FLOW/01JUL1976/1HOUR/COMP/
-----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/KINGS/FLOW/01AUG1976/1HOUR/COMP/
1
                                          RUNOFF SUMMARY
                                     FLOW IN CUBIC FEET PER SECOND
                                   TIME IN HOURS,  AREA IN SQUARE MILES

                              PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
```

```
        OPERATION       STATION      FLOW     PEAK                                          AREA      STAGE     MAX STAGE
+                                                        6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                        BASIN7       280.   25.00         267.        171.         79.      45.00
1                                                     HEC-1 INPUT                                                  PAGE  1

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

            1           ID   MAD RIVER RAINFALL-RUNOFF MODEL
            2           ID   MUDDY CREEK SUBBASIN
            3           ID   RUNOFF SUBROUTINE
 *** FREE ***
            4           IT      60 22JUL76       0     270
            5           IN      72
            6           IO       4       0

            7           KK  BASIN8MUDDY CREEK SUBBASIN HYDROGRAPH
            8           BA    22.9
            9           KM   STARTING BASE FLOW = 3.9 CFS
           10           BF     3.9     6.4  1.0026
           11           KM   PRECIPITATION DEPTH = 2.430  STORM DURATION = 24 HOURS
           12           PB   2.430
           13           PC   0.000   0.049   0.097   0.170   0.243   0.292   0.340   0.389   0.462   0.535
           14           PC   0.705   0.948   1.312   1.652   1.920   2.114   2.236   2.308   2.357   2.406
           15           PC   2.430
           16           KM   ANTECEDENT MOISTURE CONDITION II, CN = 59
           17           LS       0      59
           18           IN      60
           19           UI      50     120     240     460     650     750     805     800     785     760
           20           UI     735     705     665     640     600     560     525     480     450     410
           21           UI     375     340     310     275     250     225     205     185     165     150
           22           UI     130     115     105      95      85      78      70      65      58      52
           23           UI      48      42      38      34      30      27      23      19      15      11
           24           UI       8       5       3
           25           ZW   A=MAD B=MUDDY C=FLOW F=COMP
           26           ZZ
1*************************************                                    *************************************
*                                   *                                    *                                   *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                 *   U.S. ARMY CORPS OF ENGINEERS    *
*          SEPTEMBER 1990           *                                   *   HYDROLOGIC ENGINEERING CENTER   *
*           VERSION 4.0             *                                   *        609 SECOND STREET          *
*                                   *                                   *      DAVIS, CALIFORNIA 95616      *
* RUN DATE  07/09/1996  TIME  14:13:13 *                                *          (916) 756-1104           *
*                                   *                                   *                                   *
*************************************                                    *************************************


                        MAD RIVER RAINFALL-RUNOFF MODEL
                        MUDDY CREEK SUBBASIN
                        RUNOFF SUBROUTINE

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

```
 IT          HYDROGRAPH TIME DATA
                  NMIN          60  MINUTES IN COMPUTATION INTERVAL
                 IDATE     22JUL76  STARTING DATE
                 ITIME        0000  STARTING TIME
                    NQ         270  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE      2AUG76  ENDING DATE
                NDTIME        0500  ENDING TIME
                 ICENT          19  CENTURY MARK

            COMPUTATION INTERVAL    1.00 HOURS
                 TOTAL TIME BASE  269.00 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


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


          **************
          *            *
  7 KK    *    BASIN8  *     MUDDY CREEK SUBBASIN HYDROGRAPH
          *            *
          **************
                         STARTING BASE FLOW = 3.9 CFS
                         PRECIPITATION DEPTH = 2.430  STORM DURATION = 24 HOURS
                         ANTECEDENT MOISTURE CONDITION II, CN = 59

            SUBBASIN RUNOFF DATA

  8 BA        SUBBASIN CHARACTERISTICS
                 TAREA       22.90  SUBBASIN AREA

 10 BF        BASE FLOW CHARACTERISTICS
                 STRTQ        3.90  INITIAL FLOW
                 QRCSN        6.40  BEGIN BASE FLOW RECESSION
                 RTIOR     1.00260  RECESSION CONSTANT

              PRECIPITATION DATA

 12 PB           STORM        2.43  BASIN TOTAL PRECIPITATION

 13 PI          INCREMENTAL PRECIPITATION PATTERN
                  .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                  .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                  .05       .04       .04       .02

 17 LS        SCS LOSS RATE
                 STRTL        1.39  INITIAL ABSTRACTION
                CRVNBR       59.00  CURVE NUMBER
                 RTIMP         .00  PERCENT IMPERVIOUS AREA

 19 UI        INPUT UNITGRAPH,  53 ORDINATES,  VOLUME = 1.00
```

```
                50.0    120.0    240.0    460.0    650.0    750.0    805.0    800.0    785.0    760.0
               735.0    705.0    665.0    640.0    600.0    560.0    525.0    480.0    450.0    410.0
               375.0    340.0    310.0    275.0    250.0    225.0    205.0    185.0    165.0    150.0
               130.0    115.0    105.0     95.0     85.0     78.0     70.0     65.0     58.0     52.0
                48.0     42.0     38.0     34.0     30.0     27.0     23.0     19.0     15.0     11.0
                 8.0      5.0      3.0

                                                  ***
 -----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/MUDDY/FLOW/01JUL1976/1HOUR/COMP/
 -----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/MUDDY/FLOW/01AUG1976/1HOUR/COMP/
1
                                          RUNOFF SUMMARY
                                     FLOW IN CUBIC FEET PER SECOND
                                   TIME IN HOURS,  AREA IN SQUARE MILES

                                 PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION  FLOW     PEAK                                          AREA      STAGE     MAX STAGE
+                                                     6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                        BASIN8    104.   27.00        101.         74.         32.      22.90
1                                                HEC-1 INPUT                                          PAGE  1

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

           1           ID   MAD RIVER RAINFALL-RUNOFF MODEL
           2           ID   UNNAMED TRIBUTARY
           3           ID   RUNOFF SUBROUTINE
 *** FREE ***
           4           IT      60 22JUL76       0     270
           5           IN      72
           6           IO       4       0

           7           KK  BASIN9UNNAMED TRIBUTARY SUBBASIN HYDROGRAPH
           8           BA     4.2
           9           KM   STARTING BASE FLOW = 2.6 CFS
          10           BF     2.6     4.4  1.0026
          11           KM   PRECEPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
          12           PB   2.430
          13           PC   0.000   0.049   0.097   0.170   0.243   0.292   0.340   0.389   0.462   0.535
          14           PC   0.705   0.948   1.312   1.652   1.920   2.114   2.236   2.308   2.357   2.406
          15           PC   2.430
          16           KM   ANTECEDENT MOISTURE CONDITION II, CN = 59
          17           LS       0      59
          18           UD    2.03
          19           ZW   A=MAD B=TRIB C=FLOW F=COMP
          20           ZZ
1*************************************                    *************************************
*                                   *                    *                                   *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                 *   U.S. ARMY CORPS OF ENGINEERS    *
*          SEPTEMBER 1990           *                    *   HYDROLOGIC ENGINEERING CENTER   *
*           VERSION 4.0             *                    *        609 SECOND STREET          *
*                                   *                    *      DAVIS, CALIFORNIA 95616      *
*  RUN DATE  07/09/1996  TIME  14:13:13 *                *          (916) 756-1104           *
*                                   *                    *                                   *
*************************************                    *************************************
```

```
                    MAD RIVER RAINFALL-RUNOFF MODEL
                    UNNAMED TRIBUTARY
                    RUNOFF SUBROUTINE

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

   IT        HYDROGRAPH TIME DATA
                 NMIN         60  MINUTES IN COMPUTATION INTERVAL
                IDATE     22JUL76  STARTING DATE
                ITIME        0000  STARTING TIME
                   NQ         270  NUMBER OF HYDROGRAPH ORDINATES
               NDDATE      2AUG76  ENDING DATE
               NDTIME        0500  ENDING TIME
               ICENT           19  CENTURY MARK

             COMPUTATION INTERVAL    1.00 HOURS
                  TOTAL TIME BASE  269.00 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


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


          **************
          *            *
 7 KK     *    BASIN9  *     UNNAMED TRIBUTARY SUBBASIN HYDROGRAPH
          *            *
          **************
                    STARTING BASE FLOW = 2.6 CFS
                    PRECEPITATION DEPTH = 2.430 INCHES, STORM DURATION = 24 HOURS
                    ANTECEDENT MOISTURE CONDITION II, CN = 59

             SUBBASIN RUNOFF DATA

 8 BA        SUBBASIN CHARACTERISTICS
                TAREA        4.20  SUBBASIN AREA

10 BF        BASE FLOW CHARACTERISTICS
                STRTQ        2.60  INITIAL FLOW
                QRCSN        4.40  BEGIN BASE FLOW RECESSION
                RTIOR     1.00260  RECESSION CONSTANT

             PRECIPITATION DATA

12 PB           STORM        2.43  BASIN TOTAL PRECIPITATION

13 PI          INCREMENTAL PRECIPITATION PATTERN
```

```
                    .04       .04       .05       .06       .06       .04       .04       .04       .05       .06
                    .08       .14       .20       .28       .29       .26       .21       .16       .10       .07
                    .05       .04       .04       .02

  17 LS          SCS LOSS RATE
                      STRTL        1.39  INITIAL ABSTRACTION
                     CRVNBR       59.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

  18 UD          SCS DIMENSIONLESS UNITGRAPH
                       TLAG        2.03  LAG

                                                    ***

                                                UNIT HYDROGRAPH
                                            12 END-OF-PERIOD ORDINATES
              245.      741.      757.      470.      235.      125.       66.       35.       18.       10.
                6.        2.
 -----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/TRIB/FLOW/01JUL1976/1HOUR/COMP/
 -----DSS---ZWRITE Unit  71; Vers.    1:  /MAD/TRIB/FLOW/01AUG1976/1HOUR/COMP/
1
                                                RUNOFF SUMMARY
                                        FLOW IN CUBIC FEET PER SECOND
                                      TIME IN HOURS,  AREA IN SQUARE MILES

                                     PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION      FLOW    PEAK                                           AREA      STAGE     MAX STAGE
+                                                          6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                        BASIN9        56    [illegible]        46.         18.          9.       4.20
1                                                      HEC-1 INPUT                                          PAGE  1

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

           1            ID   MAD RIVER RAINFALL-RUNOFF MODEL
           2            ID   CHAMPAIGN AND LOGAN COUNTIES
           3            ID   MAIN PROGRAM
*** FREE ***
                        *DIAGRAM
           4            IT      60 22JUL76        [illegible]      270
           5            IN      72
           6            IO       0        [illegible]

           7            KK  BASIN1UPPER MAD RIVER SUBBASIN HYDROGRAPH
           8            BA    36.6
           9            ZR  =QI A=MAD B=UPPER C=FLOW E=1HOUR F=COMP

          10            KK  BASIN2MACOCHEE CREEK SUBBASIN HYDROGRAPH
          11            BA    19.1
          12            ZR  =QI A=MAD B=MACOC C=FLOW E=1HOUR F=COMP

          13            KK    STA1COMBINED HYDROGRAPH FOR UPPER MAD RIVER AND MACOCHEE CREEK
          14            HC       2

          15            KK  REACH1OUTFLOW HYDROGRAPH FOR CHANNEL REACH1
          16            RD
          17            RC      .1      .06       .1     5000     .002     1082
          18            RX       0        1       50       55       85       90      140      141
          19            RY    1082     1080     1079     1075     1075     1079     1080     1082
```

```
 20          KK  BASIN3MUD RUN SUBBASIN HYDROGRAPH
 21          BA     5.2
 22          ZR  =QI A=MAD B=MUD C=FLOW E=1HOUR F=COMP

 23          KK    STA2COMBINED HYDROGRAPH FOR CHANNEL REACH1 AND MUD RUN
 24          HC       2

 25          KK  REACH2OUTFLOW HYDROGRAPH FOR CHANNEL REACH2
 26          RD
 27          RC      .1      .06       .1   25000   .0017    1058
 28          RX       0        1       50      55      80      85     135     136
 29          RY    1058     1056     1055    1050    1050    1055    1056    1058

 30          KK  BASIN4UNNAMED TRIBUTARIES SUBBASIN HYDROGRAPH
 31          BA     7.6
 32          ZR  =QI A=MAD B=TRIBS C=FLOW E=1HOUR F=COMP

 33          KK  BASIN5MACOCHEE DITCH SUBBASIN HYDROGRAPH
 34          BA     7.4
 35          ZR  =QI A=MAD B=MACD C=FLOW E=1HOUR F=COMP

 36          KK    STA3COMBINED HYDROGRAPH FOR CHANNEL REACH2, UNNAMED TRIBS, AND MACOCHEE DITC
 37          HC       3
1                                          HEC-1 INPUT                                          PAGE  2

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


 38          KK  REACH3OUTFLOW HYDROGRAPH FOR CHANNEL REACH3
 39          RD
 40          RL    -4.8
 41          RC      .1      .06       .1    5600   .0012    1035
 42          RX       0        1       50      55      90      95     145     146
 43          RY    1035     1034     1033    1025    1025    1033    1034    1035

 44          KK  BASIN6GLADY CREEK SUBBASIN HYDROGRAPH
 45          BA    13.2
 46          ZR  =QI A=MAD B=GLADY C=FLOW E=1HOUR F=COMP

 47          KK    STA4COMBINED HYDROGRAPH FOR CHANNEL REACH3 AND GLADY CREEK
 48          HC       2

 49          KK  REACH4OUTFLOW HYDROGRAPH FOR CHANNEL REACH4
 50          RD
 51          RL    -5.6
 52          RC      .1      .06       .1    6800    .001    1028
 53          RX       0        1       50      55     100     105     155     156
 54          RY    1028     1026     1025    1018    1018    1025    1026    1028

 55          KK  BASIN7KINGS CREEK SUBBASIN HYDROGRAPH
 56          BA    45.0
 57          ZR  =QI A=MAD B=KINGS C=FLOW E=1HOUR F=COMP

 58          KK    STA5COMBINED HYDROGRAPH FOR CHANNEL REACH4 AND KINGS CREEK
 59          HC       2

 60          KK  REACH5OUTFLOW HYDROGRAPH FOR CHANNEL REACH5
 61          RD
 62          RL   -10.3
```

```
 63          RC      .1     .06      .1   11200   .0013    1015
 64          RX       0       1      50      55     115     120     170     171
 65          RY    1015    1013    1012    1005    1005    1012    1013    1015

 66          KK  BASIN8MUDDY CREEK SUBBASIN HYDROGRAPH
 67          BA    22.9
 68          ZR  =QI A=MAD B=MUDDY C=FLOW E=1HOUR F=COMP

 69          KK    STA6COMBINED HYDROGRAPH FOR CHANNEL REACH5 AND MUDDY CREEK
 70          HC       2

 71          KK  REACH6OUTFLOW HYDROGRAPH FOR CHANNEL REACH6
 72          RD
 73          RC      .1     .06      .1    9800   .0012    1005
 74          RX       0       1      50      55     125     130     180     181
 75          RY    1005    1003    1002     995     995    1002    1003    1005

 76          KK  BASIN9UNNAMED TRIBUTARY SUBBASIN HYDROGRAPH
 77          BA     4.2
 78          ZR  =QI A=MAD B=TRIB C=FLOW E=1HOUR F=COMP
1                                                HEC-1 INPUT                                                    PAGE  3

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


 79          KK    STA7COMBINED HYDROGRAPH FOR CHANNEL REACH6 AND UNNAMED TRIBUTARY
 80          KO       0       2
 81          HC       2
 82          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

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

     7     BASIN1
                .
                .
    10          .      BASIN2
                .           .
                .           .
    13       STA1............
                V
                V
    15     REACH1
                .
                .
    20          .      BASIN3
                .           .
                .           .
    23       STA2............
                V
                V
    25     REACH2
                .
                .
    30          .      BASIN4
                .           .
                .           .
```

```
33          .           .      BASIN5
            .           .
            .           .
36       STA3.......................
            V
            V
38     REACH3
            .
            .
44          .      BASIN6
            .           .
            .           .
47       STA4............
            V
            V
49     REACH4
            .
            .
55          .      BASIN7
            .           .
            .           .
58       STA5............
            V
            V
60     REACH5
            .
            .
66          .      BASIN8
            .           .
            .           .
69       STA6............
            V
            V
71     REACH6
            .
            .
76          .      BASIN9
            .           .
            .           .
79       STA7............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *            SEPTEMBER 1990            *
 *             VERSION 4.0              *
 *                                      *
 *  RUN DATE  07/09/1996  TIME  14:13:13 *
 *                                      *
 ****************************************

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

MAD RIVER RAINFALL-RUNOFF MODEL
CHAMPAIGN AND LOGAN COUNTIES
MAIN PROGRAM

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

    IT          HYDROGRAPH TIME DATA
                       NMIN          60  MINUTES IN COMPUTATION INTERVAL
                      IDATE     22JUL76  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         270  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2AUG76  ENDING DATE
                     NDTIME        0500  ENDING TIME
                      ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL    1.00 HOURS
                      TOTAL TIME BASE  269.00 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


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


          **************
          *            *
  7 KK    *    BASIN1  *     UPPER MAD RIVER SUBBASIN HYDROGRAPH
          *            *
          **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/UPPER/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/UPPER/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/UPPER/FLOW/01AUG1976/1HOUR/COMP/

             SUBBASIN RUNOFF DATA

  8 BA          SUBBASIN CHARACTERISTICS
                      TAREA       36.60  SUBBASIN AREA

                                                                  ***

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

                                                HYDROGRAPH AT STATION   BASIN1

*****************************************************************************************************************************
                                  *                                 *                                 *
  DA MON HRMN  ORD      FLOW      *  DA MON HRMN  ORD      FLOW    *  DA MON HRMN  ORD      FLOW    *  DA MON HRMN  ORD      FLOW
                                  *                                 *                                 *
  22 JUL 0000    1       17.      *  24 JUL 2000   69       27.    *  27 JUL 1600  137       23.    *  30 JUL 1200  205       19.
  22 JUL 0100    2       17.      *  24 JUL 2100   70       27.    *  27 JUL 1700  138       22.    *  30 JUL 1300  206       19.
  22 JUL 0200    3       17.      *  24 JUL 2200   71       27.    *  27 JUL 1800  139       22.    *  30 JUL 1400  207       19.
  22 JUL 0300    4       17.      *  24 JUL 2300   72       27.    *  27 JUL 1900  140       22.    *  30 JUL 1500  208       19.
  22 JUL 0400    5       17.      *  25 JUL 0000   73       27.    *  27 JUL 2000  141       22.    *  30 JUL 1600  209       19.
```

22 JUL 0500	6	17.	*	25 JUL 0100	74	27.	*	27 JUL 2100	142	22.	*	30 JUL 1700	210	19.
22 JUL 0600	7	17.	*	25 JUL 0200	75	26.	*	27 JUL 2200	143	22.	*	30 JUL 1800	211	19.
22 JUL 0700	8	17.	*	25 JUL 0300	76	26.	*	27 JUL 2300	144	22.	*	30 JUL 1900	212	19.
22 JUL 0800	9	17.	*	25 JUL 0400	77	26.	*	28 JUL 0000	145	22.	*	30 JUL 2000	213	18.
22 JUL 0900	10	17.	*	25 JUL 0500	78	26.	*	28 JUL 0100	146	22.	*	30 JUL 2100	214	18.
22 JUL 1000	11	16.	*	25 JUL 0600	79	26.	*	28 JUL 0200	147	22.	*	30 JUL 2200	215	18.
22 JUL 1100	12	16.	*	25 JUL 0700	80	26.	*	28 JUL 0300	148	22.	*	30 JUL 2300	216	18.
22 JUL 1200	13	16.	*	25 JUL 0800	81	26.	*	28 JUL 0400	149	22.	*	31 JUL 0000	217	18.
22 JUL 1300	14	16.	*	25 JUL 0900	82	26.	*	28 JUL 0500	150	22.	*	31 JUL 0100	218	18.
22 JUL 1400	15	16.	*	25 JUL 1000	83	26.	*	28 JUL 0600	151	22.	*	31 JUL 0200	219	18.
22 JUL 1500	16	16.	*	25 JUL 1100	84	26.	*	28 JUL 0700	152	22.	*	31 JUL 0300	220	18.
22 JUL 1600	17	19.	*	25 JUL 1200	85	26.	*	28 JUL 0800	153	22.	*	31 JUL 0400	221	18.
22 JUL 1700	18	26.	*	25 JUL 1300	86	26.	*	28 JUL 0900	154	22.	*	31 JUL 0500	222	18.
22 JUL 1800	19	42.	*	25 JUL 1400	87	26.	*	28 JUL 1000	155	21.	*	31 JUL 0600	223	18.
22 JUL 1900	20	70.	*	25 JUL 1500	88	26.	*	28 JUL 1100	156	21.	*	31 JUL 0700	224	18.
22 JUL 2000	21	105.	*	25 JUL 1600	89	26.	*	28 JUL 1200	157	21.	*	31 JUL 0800	225	18.
22 JUL 2100	22	138.	*	25 JUL 1700	90	25.	*	28 JUL 1300	158	21.	*	31 JUL 0900	226	18.
22 JUL 2200	23	165.	*	25 JUL 1800	91	25.	*	28 JUL 1400	159	21.	*	31 JUL 1000	227	18.
22 JUL 2300	24	185.	*	25 JUL 1900	92	25.	*	28 JUL 1500	160	21.	*	31 JUL 1100	228	18.
23 JUL 0000	25	198.	*	25 JUL 2000	93	25.	*	28 JUL 1600	161	21.	*	31 JUL 1200	229	18.
23 JUL 0100	26	206.	*	25 JUL 2100	94	25.	*	28 JUL 1700	162	21.	*	31 JUL 1300	230	18.
23 JUL 0200	27	209.	*	25 JUL 2200	95	25.	*	28 JUL 1800	163	21.	*	31 JUL 1400	231	18.
23 JUL 0300	28	206.	*	25 JUL 2300	96	25.	*	28 JUL 1900	164	21.	*	31 JUL 1500	232	18.
23 JUL 0400	29	198.	*	26 JUL 0000	97	25.	*	28 JUL 2000	165	21.	*	31 JUL 1600	233	18.
23 JUL 0500	30	188.	*	26 JUL 0100	98	25.	*	28 JUL 2100	166	21.	*	31 JUL 1700	234	18.
23 JUL 0600	31	176.	*	26 JUL 0200	99	25.	*	28 JUL 2200	167	21.	*	31 JUL 1800	235	17.
23 JUL 0700	32	164.	*	26 JUL 0300	100	25.	*	28 JUL 2300	168	21.	*	31 JUL 1900	236	17.
23 JUL 0800	33	152.	*	26 JUL 0400	101	25.	*	29 JUL 0000	169	21.	*	31 JUL 2000	237	17.
23 JUL 0900	34	139.	*	26 JUL 0500	102	25.	*	29 JUL 0100	170	21.	*	31 JUL 2100	238	17.
23 JUL 1000	35	127.	*	26 JUL 0600	103	25.	*	29 JUL 0200	171	21.	*	31 JUL 2200	239	17.
23 JUL 1100	36	116.	*	26 JUL 0700	104	25.	*	29 JUL 0300	172	21.	*	31 JUL 2300	240	17.
23 JUL 1200	37	105.	*	26 JUL 0800	105	24.	*	29 JUL 0400	173	21.	*	1 AUG 0000	241	17.
23 JUL 1300	38	94.	*	26 JUL 0900	106	24.	*	29 JUL 0500	174	20.	*	1 AUG 0100	242	17.
23 JUL 1400	39	84.	*	26 JUL 1000	107	24.	*	29 JUL 0600	175	20.	*	1 AUG 0200	243	17.
23 JUL 1500	40	75.	*	26 JUL 1100	108	24.	*	29 JUL 0700	176	20.	*	1 AUG 0300	244	17.
23 JUL 1600	41	67.	*	26 JUL 1200	109	24.	*	29 JUL 0800	177	20.	*	1 AUG 0400	245	17.
23 JUL 1700	42	60.	*	26 JUL 1300	110	24.	*	29 JUL 0900	178	20.	*	1 AUG 0500	246	17.
23 JUL 1800	43	54.	*	26 JUL 1400	111	24.	*	29 JUL 1000	179	20.	*	1 AUG 0600	247	17.
23 JUL 1900	44	49.	*	26 JUL 1500	112	24.	*	29 JUL 1100	180	20.	*	1 AUG 0700	248	17.
23 JUL 2000	45	45.	*	26 JUL 1600	113	24.	*	29 JUL 1200	181	20.	*	1 AUG 0800	249	17.
23 JUL 2100	46	41.	*	26 JUL 1700	114	24.	*	29 JUL 1300	182	20.	*	1 AUG 0900	250	17.
23 JUL 2200	47	38.	*	26 JUL 1800	115	24.	*	29 JUL 1400	183	20.	*	1 AUG 1000	251	17.
23 JUL 2300	48	36.	*	26 JUL 1900	116	24.	*	29 JUL 1500	184	20.	*	1 AUG 1100	252	17.
24 JUL 0000	49	34.	*	26 JUL 2000	117	24.	*	29 JUL 1600	185	20.	*	1 AUG 1200	253	17.
24 JUL 0100	50	31.	*	26 JUL 2100	118	24.	*	29 JUL 1700	186	20.	*	1 AUG 1300	254	17.
24 JUL 0200	51	30.	*	26 JUL 2200	119	24.	*	29 JUL 1800	187	20.	*	1 AUG 1400	255	17.
24 JUL 0300	52	28.	*	26 JUL 2300	120	24.	*	29 JUL 1900	188	20.	*	1 AUG 1500	256	17.
24 JUL 0400	53	28.	*	27 JUL 0000	121	23.	*	29 JUL 2000	189	20.	*	1 AUG 1600	257	16.
24 JUL 0500	54	28.	*	27 JUL 0100	122	23.	*	29 JUL 2100	190	20.	*	1 AUG 1700	258	16.
24 JUL 0600	55	28.	*	27 JUL 0200	123	23.	*	29 JUL 2200	191	20.	*	1 AUG 1800	259	16.
24 JUL 0700	56	28.	*	27 JUL 0300	124	23.	*	29 JUL 2300	192	20.	*	1 AUG 1900	260	16.
24 JUL 0800	57	28.	*	27 JUL 0400	125	23.	*	30 JUL 0000	193	19.	*	1 AUG 2000	261	16.
24 JUL 0900	58	28.	*	27 JUL 0500	126	23.	*	30 JUL 0100	194	19.	*	1 AUG 2100	262	16.
24 JUL 1000	59	28.	*	27 JUL 0600	127	23.	*	30 JUL 0200	195	19.	*	1 AUG 2200	263	16.
24 JUL 1100	60	28.	*	27 JUL 0700	128	23.	*	30 JUL 0300	196	19.	*	1 AUG 2300	264	16.
24 JUL 1200	61	27.	*	27 JUL 0800	129	23.	*	30 JUL 0400	197	19.	*	2 AUG 0000	265	16.
24 JUL 1300	62	27.	*	27 JUL 0900	130	23.	*	30 JUL 0500	198	19.	*	2 AUG 0100	266	16.
24 JUL 1400	63	27.	*	27 JUL 1000	131	23.	*	30 JUL 0600	199	19.	*	2 AUG 0200	267	16.
24 JUL 1500	64	27.	*	27 JUL 1100	132	23.	*	30 JUL 0700	200	19.	*	2 AUG 0300	268	16.
24 JUL 1600	65	27.	*	27 JUL 1200	133	23.	*	30 JUL 0800	201	19.	*	2 AUG 0400	269	16.

24 JUL 1700	66	27.	*	27 JUL 1300	134	23.	*	30 JUL 0900	202	19.	*	2 AUG 0500	270	16.
24 JUL 1800	67	27.	*	27 JUL 1400	135	23.	*	30 JUL 1000	203	19.	*			
24 JUL 1900	68	27.	*	27 JUL 1500	136	23.	*	30 JUL 1100	204	19.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 209.	26.00		201.	137.	65.	32.
		(INCHES)	.051	.139	.198	.365
		(AC-FT)	99.	271.	386.	712.

CUMULATIVE AREA = 36.60 SQ MI

*** ***

```
            **************
            *            *
  10 KK     *    BASIN2  *     MACOCHEE CREEK SUBBASIN HYDROGRAPH
            *            *
            **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MACCK/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MACCK/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MACCK/FLOW/01AUG1976/1HOUR/COMP/
```

SUBBASIN RUNOFF DATA

```
  11 BA          SUBBASIN CHARACTERISTICS
                       TAREA       19.10  SUBBASIN AREA
```

***

****

HYDROGRAPH AT STATION BASIN2

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	6.	*	24 JUL 2000	69	9.	*	27 JUL 1600	137	8.	*	30 JUL 1200	205	6.
22 JUL 0100	2	6.	*	24 JUL 2100	70	9.	*	27 JUL 1700	138	8.	*	30 JUL 1300	206	6.
22 JUL 0200	3	6.	*	24 JUL 2200	71	9.	*	27 JUL 1800	139	8.	*	30 JUL 1400	207	6.
22 JUL 0300	4	6.	*	24 JUL 2300	72	9.	*	27 JUL 1900	140	8.	*	30 JUL 1500	208	6.
22 JUL 0400	5	6.	*	25 JUL 0000	73	9.	*	27 JUL 2000	141	7.	*	30 JUL 1600	209	6.
22 JUL 0500	6	6.	*	25 JUL 0100	74	9.	*	27 JUL 2100	142	7.	*	30 JUL 1700	210	6.
22 JUL 0600	7	6.	*	25 JUL 0200	75	9.	*	27 JUL 2200	143	7.	*	30 JUL 1800	211	6.
22 JUL 0700	8	6.	*	25 JUL 0300	76	9.	*	27 JUL 2300	144	7.	*	30 JUL 1900	212	6.
22 JUL 0800	9	6.	*	25 JUL 0400	77	9.	*	28 JUL 0000	145	7.	*	30 JUL 2000	213	6.
22 JUL 0900	10	6.	*	25 JUL 0500	78	9.	*	28 JUL 0100	146	7.	*	30 JUL 2100	214	6.
22 JUL 1000	11	6.	*	25 JUL 0600	79	9.	*	28 JUL 0200	147	7.	*	30 JUL 2200	215	6.
22 JUL 1100	12	6.	*	25 JUL 0700	80	9.	*	28 JUL 0300	148	7.	*	30 JUL 2300	216	6.
22 JUL 1200	13	6.	*	25 JUL 0800	81	9.	*	28 JUL 0400	149	7.	*	31 JUL 0000	217	6.
22 JUL 1300	14	6.	*	25 JUL 0900	82	9.	*	28 JUL 0500	150	7.	*	31 JUL 0100	218	6.

22 JUL 1400	15	5.	*	25 JUL 1000	83	9.	*	28 JUL 0600	151	7.	*	31 JUL 0200	219	6.
22 JUL 1500	16	6.	*	25 JUL 1100	84	9.	*	28 JUL 0700	152	7.	*	31 JUL 0300	220	6.
22 JUL 1600	17	8.	*	25 JUL 1200	85	9.	*	28 JUL 0800	153	7.	*	31 JUL 0400	221	6.
22 JUL 1700	18	15.	*	25 JUL 1300	86	9.	*	28 JUL 0900	154	7.	*	31 JUL 0500	222	6.
22 JUL 1800	19	30.	*	25 JUL 1400	87	9.	*	28 JUL 1000	155	7.	*	31 JUL 0600	223	6.
22 JUL 1900	20	53.	*	25 JUL 1500	88	9.	*	28 JUL 1100	156	7.	*	31 JUL 0700	224	6.
22 JUL 2000	21	76.	*	25 JUL 1600	89	9.	*	28 JUL 1200	157	7.	*	31 JUL 0800	225	6.
22 JUL 2100	22	96.	*	25 JUL 1700	90	9.	*	28 JUL 1300	158	7.	*	31 JUL 0900	226	6.
22 JUL 2200	23	109.	*	25 JUL 1800	91	9.	*	28 JUL 1400	159	7.	*	31 JUL 1000	227	6.
22 JUL 2300	24	117.	*	25 JUL 1900	92	9.	*	28 JUL 1500	160	7.	*	31 JUL 1100	228	6.
23 JUL 0000	25	122.	*	25 JUL 2000	93	8.	*	28 JUL 1600	161	7.	*	31 JUL 1200	229	6.
23 JUL 0100	26	123.	*	25 JUL 2100	94	8.	*	28 JUL 1700	162	7.	*	31 JUL 1300	230	6.
23 JUL 0200	27	121.	*	25 JUL 2200	95	8.	*	28 JUL 1800	163	7.	*	31 JUL 1400	231	6.
23 JUL 0300	28	114.	*	25 JUL 2300	96	8.	*	28 JUL 1900	164	7.	*	31 JUL 1500	232	6.
23 JUL 0400	29	105.	*	26 JUL 0000	97	8.	*	28 JUL 2000	165	7.	*	31 JUL 1600	233	6.
23 JUL 0500	30	96.	*	26 JUL 0100	98	8.	*	28 JUL 2100	166	7.	*	31 JUL 1700	234	6.
23 JUL 0600	31	86.	*	26 JUL 0200	99	8.	*	28 JUL 2200	167	7.	*	31 JUL 1800	235	6.
23 JUL 0700	32	77.	*	26 JUL 0300	100	8.	*	28 JUL 2300	168	7.	*	31 JUL 1900	236	6.
23 JUL 0800	33	68.	*	26 JUL 0400	101	8.	*	29 JUL 0000	169	7.	*	31 JUL 2000	237	6.
23 JUL 0900	34	60.	*	26 JUL 0500	102	8.	*	29 JUL 0100	170	7.	*	31 JUL 2100	238	6.
23 JUL 1000	35	52.	*	26 JUL 0600	103	8.	*	29 JUL 0200	171	7.	*	31 JUL 2200	239	6.
23 JUL 1100	36	45.	*	26 JUL 0700	104	8.	*	29 JUL 0300	172	7.	*	31 JUL 2300	240	6.
23 JUL 1200	37	39.	*	26 JUL 0800	105	8.	*	29 JUL 0400	173	7.	*	1 AUG 0000	241	6.
23 JUL 1300	38	34.	*	26 JUL 0900	106	8.	*	29 JUL 0500	174	7.	*	1 AUG 0100	242	6.
23 JUL 1400	39	29.	*	26 JUL 1000	107	8.	*	29 JUL 0600	175	7.	*	1 AUG 0200	243	6.
23 JUL 1500	40	26.	*	26 JUL 1100	108	8.	*	29 JUL 0700	176	7.	*	1 AUG 0300	244	6.
23 JUL 1600	41	23.	*	26 JUL 1200	109	8.	*	29 JUL 0800	177	7.	*	1 AUG 0400	245	6.
23 JUL 1700	42	20.	*	26 JUL 1300	110	8.	*	29 JUL 0900	178	7.	*	1 AUG 0500	246	6.
23 JUL 1800	43	18.	*	26 JUL 1400	111	8.	*	29 JUL 1000	179	7.	*	1 AUG 0600	247	6.
23 JUL 1900	44	16.	*	26 JUL 1500	112	8.	*	29 JUL 1100	180	7.	*	1 AUG 0700	248	6.
23 JUL 2000	45	14.	*	26 JUL 1600	113	8.	*	29 JUL 1200	181	7.	*	1 AUG 0800	249	6.
23 JUL 2100	46	13.	*	26 JUL 1700	114	8.	*	29 JUL 1300	182	7.	*	1 AUG 0900	250	6.
23 JUL 2200	47	12.	*	26 JUL 1800	115	8.	*	29 JUL 1400	183	7.	*	1 AUG 1000	251	6.
23 JUL 2300	48	11.	*	26 JUL 1900	116	8.	*	29 JUL 1500	184	7.	*	1 AUG 1100	252	6.
24 JUL 0000	49	10.	*	26 JUL 2000	117	8.	*	29 JUL 1600	185	7.	*	1 AUG 1200	253	6.
24 JUL 0100	50	9.	*	26 JUL 2100	118	8.	*	29 JUL 1700	186	7.	*	1 AUG 1300	254	6.
24 JUL 0200	51	9.	*	26 JUL 2200	119	8.	*	29 JUL 1800	187	7.	*	1 AUG 1400	255	6.
24 JUL 0300	52	9.	*	26 JUL 2300	120	8.	*	29 JUL 1900	188	7.	*	1 AUG 1500	256	6.
24 JUL 0400	53	9.	*	27 JUL 0000	121	8.	*	29 JUL 2000	189	7.	*	1 AUG 1600	257	6.
24 JUL 0500	54	9.	*	27 JUL 0100	122	8.	*	29 JUL 2100	190	7.	*	1 AUG 1700	258	6.
24 JUL 0600	55	9.	*	27 JUL 0200	123	8.	*	29 JUL 2200	191	7.	*	1 AUG 1800	259	6.
24 JUL 0700	56	9.	*	27 JUL 0300	124	8.	*	29 JUL 2300	192	7.	*	1 AUG 1900	260	5.
24 JUL 0800	57	9.	*	27 JUL 0400	125	8.	*	30 JUL 0000	193	7.	*	1 AUG 2000	261	5.
24 JUL 0900	58	9.	*	27 JUL 0500	126	8.	*	30 JUL 0100	194	7.	*	1 AUG 2100	262	5.
24 JUL 1000	59	9.	*	27 JUL 0600	127	8.	*	30 JUL 0200	195	7.	*	1 AUG 2200	263	5.
24 JUL 1100	60	9.	*	27 JUL 0700	128	8.	*	30 JUL 0300	196	6.	*	1 AUG 2300	264	5.
24 JUL 1200	61	9.	*	27 JUL 0800	129	8.	*	30 JUL 0400	197	6.	*	2 AUG 0000	265	5.
24 JUL 1300	62	9.	*	27 JUL 0900	130	8.	*	30 JUL 0500	198	6.	*	2 AUG 0100	266	5.
24 JUL 1400	63	9.	*	27 JUL 1000	131	8.	*	30 JUL 0600	199	6.	*	2 AUG 0200	267	5.
24 JUL 1500	64	9.	*	27 JUL 1100	132	8.	*	30 JUL 0700	200	6.	*	2 AUG 0300	268	5.
24 JUL 1600	65	9.	*	27 JUL 1200	133	8.	*	30 JUL 0800	201	6.	*	2 AUG 0400	269	5.
24 JUL 1700	66	9.	*	27 JUL 1300	134	8.	*	30 JUL 0900	202	6.	*	2 AUG 0500	270	5.
24 JUL 1800	67	9.	*	27 JUL 1400	135	8.	*	30 JUL 1000	203	6.	*			
24 JUL 1900	68	9.	*	27 JUL 1500	136	8.	*	30 JUL 1100	204	6.	*			
			*				*				*			

****

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)				

```
                        (CFS)
+    123.     25.00                117.        72.        30.        13.
                      (INCHES)     .057       .139       .178       .285
                       (AC-FT)      58.       142.       181.       291.

                      CUMULATIVE AREA =   19.10 SQ MI


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


          **************
          *            *
 13 KK    *     STA1   *    COMBINED HYDROGRAPH FOR UPPER MAD RIVER AND MACOCHEE CREEK
          *            *
          **************

 14 HC          HYDROGRAPH COMBINATION
                     ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                    ***

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

                                        HYDROGRAPH AT STATION     STA1
                                            SUM OF  2 HYDROGRAPHS

*****************************************************************************************************************************
```

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	23.	24 JUL 2000	69	36.	27 JUL 1600	137	30.	30 JUL 1200	205	25.
22 JUL 0100	2	23.	24 JUL 2100	70	36.	27 JUL 1700	138	30.	30 JUL 1300	206	25.
22 JUL 0200	3	22.	24 JUL 2200	71	36.	27 JUL 1800	139	30.	30 JUL 1400	207	25.
22 JUL 0300	4	22.	24 JUL 2300	72	36.	27 JUL 1900	140	30.	30 JUL 1500	208	25.
22 JUL 0400	5	22.	25 JUL 0000	73	36.	27 JUL 2000	141	30.	30 JUL 1600	209	25.
22 JUL 0500	6	22.	25 JUL 0100	74	35.	27 JUL 2100	142	30.	30 JUL 1700	210	25.
22 JUL 0600	7	22.	25 JUL 0200	75	35.	27 JUL 2200	143	30.	30 JUL 1800	211	25.
22 JUL 0700	8	22.	25 JUL 0300	76	35.	27 JUL 2300	144	30.	30 JUL 1900	212	25.
22 JUL 0800	9	22.	25 JUL 0400	77	35.	28 JUL 0000	145	29.	30 JUL 2000	213	25.
22 JUL 0900	10	22.	25 JUL 0500	78	35.	28 JUL 0100	146	29.	30 JUL 2100	214	25.
22 JUL 1000	11	22.	25 JUL 0600	79	35.	28 JUL 0200	147	29.	30 JUL 2200	215	25.
22 JUL 1100	12	22.	25 JUL 0700	80	35.	28 JUL 0300	148	29.	30 JUL 2300	216	25.
22 JUL 1200	13	22.	25 JUL 0800	81	35.	28 JUL 0400	149	29.	31 JUL 0000	217	24.
22 JUL 1300	14	22.	25 JUL 0900	82	35.	28 JUL 0500	150	29.	31 JUL 0100	218	24.
22 JUL 1400	15	22.	25 JUL 1000	83	35.	28 JUL 0600	151	29.	31 JUL 0200	219	24.
22 JUL 1500	16	22.	25 JUL 1100	84	35.	28 JUL 0700	152	29.	31 JUL 0300	220	24.
22 JUL 1600	17	26.	25 JUL 1200	85	34.	28 JUL 0800	153	29.	31 JUL 0400	221	24.
22 JUL 1700	18	41.	25 JUL 1300	86	34.	28 JUL 0900	154	29.	31 JUL 0500	222	24.
22 JUL 1800	19	73.	25 JUL 1400	87	34.	28 JUL 1000	155	29.	31 JUL 0600	223	24.
22 JUL 1900	20	123.	25 JUL 1500	88	34.	28 JUL 1100	156	29.	31 JUL 0700	224	24.
22 JUL 2000	21	181.	25 JUL 1600	89	34.	28 JUL 1200	157	29.	31 JUL 0800	225	24.
22 JUL 2100	22	234.	25 JUL 1700	90	34.	28 JUL 1300	158	28.	31 JUL 0900	226	24.
22 JUL 2200	23	274.	25 JUL 1800	91	34.	28 JUL 1400	159	28.	31 JUL 1000	227	24.
22 JUL 2300	24	302.	25 JUL 1900	92	34.	28 JUL 1500	160	28.	31 JUL 1100	228	24.
23 JUL 0000	25	320.	25 JUL 2000	93	34.	28 JUL 1600	161	28.	31 JUL 1200	229	24.
23 JUL 0100	26	329.	25 JUL 2100	94	34.	28 JUL 1700	162	28.	31 JUL 1300	230	24.
23 JUL 0200	27	329.	25 JUL 2200	95	34.	28 JUL 1800	163	28.	31 JUL 1400	231	24.

23 JUL 0300	28	320.	*	25 JUL 2300	96	33.	*	28 JUL 1900	164	28.	*	31 JUL 1500	232	24.
23 JUL 0400	29	303.	*	26 JUL 0000	97	33.	*	28 JUL 2000	165	28.	*	31 JUL 1600	233	23.
23 JUL 0500	30	283.	*	26 JUL 0100	98	33.	*	28 JUL 2100	166	28.	*	31 JUL 1700	234	23.
23 JUL 0600	31	263.	*	26 JUL 0200	99	33.	*	28 JUL 2200	167	28.	*	31 JUL 1800	235	23.
23 JUL 0700	32	241.	*	26 JUL 0300	100	33.	*	28 JUL 2300	168	28.	*	31 JUL 1900	236	23.
23 JUL 0800	33	220.	*	26 JUL 0400	101	33.	*	29 JUL 0000	169	28.	*	31 JUL 2000	237	23.
23 JUL 0900	34	199.	*	26 JUL 0500	102	33.	*	29 JUL 0100	170	28.	*	31 JUL 2100	238	23.
23 JUL 1000	35	179.	*	26 JUL 0600	103	33.	*	29 JUL 0200	171	28.	*	31 JUL 2200	239	23.
23 JUL 1100	36	161.	*	26 JUL 0700	104	33.	*	29 JUL 0300	172	27.	*	31 JUL 2300	240	23.
23 JUL 1200	37	144.	*	26 JUL 0800	105	33.	*	29 JUL 0400	173	27.	*	1 AUG 0000	241	23.
23 JUL 1300	38	128.	*	26 JUL 0900	106	33.	*	29 JUL 0500	174	27.	*	1 AUG 0100	242	23.
23 JUL 1400	39	114.	*	26 JUL 1000	107	33.	*	29 JUL 0600	175	27.	*	1 AUG 0200	243	23.
23 JUL 1500	40	101.	*	26 JUL 1100	108	32.	*	29 JUL 0700	176	27.	*	1 AUG 0300	244	23.
23 JUL 1600	41	90.	*	26 JUL 1200	109	32.	*	29 JUL 0800	177	27.	*	1 AUG 0400	245	23.
23 JUL 1700	42	80.	*	26 JUL 1300	110	32.	*	29 JUL 0900	178	27.	*	1 AUG 0500	246	23.
23 JUL 1800	43	72.	*	26 JUL 1400	111	32.	*	29 JUL 1000	179	27.	*	1 AUG 0600	247	23.
23 JUL 1900	44	65.	*	26 JUL 1500	112	32.	*	29 JUL 1100	180	27.	*	1 AUG 0700	248	23.
23 JUL 2000	45	59.	*	26 JUL 1600	113	32.	*	29 JUL 1200	181	27.	*	1 AUG 0800	249	22.
23 JUL 2100	46	54.	*	26 JUL 1700	114	32.	*	29 JUL 1300	182	27.	*	1 AUG 0900	250	22.
23 JUL 2200	47	50.	*	26 JUL 1800	115	32.	*	29 JUL 1400	183	27.	*	1 AUG 1000	251	22.
23 JUL 2300	48	47.	*	26 JUL 1900	116	32.	*	29 JUL 1500	184	27.	*	1 AUG 1100	252	22.
24 JUL 0000	49	43.	*	26 JUL 2000	117	32.	*	29 JUL 1600	185	27.	*	1 AUG 1200	253	22.
24 JUL 0100	50	41.	*	26 JUL 2100	118	32.	*	29 JUL 1700	186	26.	*	1 AUG 1300	254	22.
24 JUL 0200	51	39.	*	26 JUL 2200	119	32.	*	29 JUL 1800	187	26.	*	1 AUG 1400	255	22.
24 JUL 0300	52	38.	*	26 JUL 2300	120	31.	*	29 JUL 1900	188	26.	*	1 AUG 1500	256	22.
24 JUL 0400	53	37.	*	27 JUL 0000	121	31.	*	29 JUL 2000	189	26.	*	1 AUG 1600	257	22.
24 JUL 0500	54	37.	*	27 JUL 0100	122	31.	*	29 JUL 2100	190	26.	*	1 AUG 1700	258	22.
24 JUL 0600	55	37.	*	27 JUL 0200	123	31.	*	29 JUL 2200	191	26.	*	1 AUG 1800	259	22.
24 JUL 0700	56	37.	*	27 JUL 0300	124	31.	*	29 JUL 2300	192	26.	*	1 AUG 1900	260	22.
24 JUL 0800	57	37.	*	27 JUL 0400	125	31.	*	30 JUL 0000	193	26.	*	1 AUG 2000	261	22.
24 JUL 0900	58	37.	*	27 JUL 0500	126	31.	*	30 JUL 0100	194	26.	*	1 AUG 2100	262	22.
24 JUL 1000	59	37.	*	27 JUL 0600	127	31.	*	30 JUL 0200	195	26.	*	1 AUG 2200	263	22.
24 JUL 1100	60	37.	*	27 JUL 0700	128	31.	*	30 JUL 0300	196	26.	*	1 AUG 2300	264	22.
24 JUL 1200	61	37.	*	27 JUL 0800	129	31.	*	30 JUL 0400	197	26.	*	2 AUG 0000	265	22.
24 JUL 1300	62	37.	*	27 JUL 0900	130	31.	*	30 JUL 0500	198	26.	*	2 AUG 0100	266	22.
24 JUL 1400	63	36.	*	27 JUL 1000	131	31.	*	30 JUL 0600	199	26.	*	2 AUG 0200	267	21.
24 JUL 1500	64	36.	*	27 JUL 1100	132	30.	*	30 JUL 0700	200	26.	*	2 AUG 0300	268	21.
24 JUL 1600	65	36.	*	27 JUL 1200	133	30.	*	30 JUL 0800	201	25.	*	2 AUG 0400	269	21.
24 JUL 1700	66	36.	*	27 JUL 1300	134	30.	*	30 JUL 0900	202	25.	*	2 AUG 0500	270	21.
24 JUL 1800	67	36.	*	27 JUL 1400	135	30.	*	30 JUL 1000	203	25.	*			
24 JUL 1900	68	36.	*	27 JUL 1500	136	30.	*	30 JUL 1100	204	25.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 329.	25.00		316.	208.	95.	45.
		(INCHES)	.053	.139	.191	.338
		(AC-FT)	157.	412.	567.	1003.

CUMULATIVE AREA = 55.70 SQ MI

*** ***

```
          **************
          *            *
15 KK     *   REACH1   *     OUTFLOW HYDROGRAPH FOR CHANNEL REACH1
          *            *
          **************

            HYDROGRAPH ROUTING DATA

16 RD         MUSKINGUM-CUNGE CHANNEL ROUTING

17 RC         NORMAL DEPTH CHANNEL
                    ANL        .100  LEFT OVERBANK N-VALUE
                   ANCH        .060  MAIN CHANNEL N-VALUE
                    ANR        .100  RIGHT OVERBANK N-VALUE
                  RLNTH       5000.  REACH LENGTH
                    SEL       .0020  ENERGY SLOPE
                  ELMAX      1082.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                   CROSS-SECTION DATA
                      --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
19 RY       ELEVATION  1082.00   1080.00   1079.00   1075.00   1075.00   1079.00   1080.00   1082.00
18 RX       DISTANCE        .00      1.00     50.00     55.00     85.00     90.00    140.00    141.00

                                                  ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

        STORAGE        .00      1.29      2.62      3.98      5.39      6.83      8.31      9.83     11.40     12.99
        OUTFLOW        .00      6.31     20.03     39.39     63.70     92.56    125.68    162.88    204.03    249.03
      ELEVATION    1075.00   1075.37   1075.74   1076.11   1076.47   1076.84   1077.21   1077.58   1077.95   1078.32

        STORAGE      14.63     16.33     19.01     23.23     28.86     34.75     40.66     46.58     52.52     58.48
        OUTFLOW     297.80    351.19    416.02    491.85    584.31    694.65    818.37    954.35   1101.78   1260.05
      ELEVATION    1078.68   1079.05   1079.42   1079.79   1080.16   1080.53   1080.89   1081.26   1081.63   1082.00

                          COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                COMPUTATION TIME STEP
              ELEMENT    ALPHA       M        DT        DX      PEAK   TIME TO    VOLUME   MAXIMUM
                                                                         PEAK              CELERITY
                                          (MIN)      (FT)     (CFS)    (MIN)      (IN)     (FPS)

                MAIN                       28.97   2500.00    329.43  1564.39       .34      2.88


                                INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                MAIN                       60.00              329.39  1560.00       .34

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1004E+04 EXCESS= .0000E+00 OUTFLOW= .1004E+04 BASIN STORAGE=-.8812E-01 PERCENT ERROR=    .0


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

                                HYDROGRAPH AT STATION   REACH1

*****************************************************************************************************************************
                        *                        *                        *
```

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
			*				*				*			
22 JUL 0000	1	23.	*	24 JUL 2000	69	36.	*	27 JUL 1600	137	30.	*	30 JUL 1200	205	25.
22 JUL 0100	2	23.	*	24 JUL 2100	70	36.	*	27 JUL 1700	138	30.	*	30 JUL 1300	206	25.
22 JUL 0200	3	23.	*	24 JUL 2200	71	36.	*	27 JUL 1800	139	30.	*	30 JUL 1400	207	25.
22 JUL 0300	4	22.	*	24 JUL 2300	72	36.	*	27 JUL 1900	140	30.	*	30 JUL 1500	208	25.
22 JUL 0400	5	22.	*	25 JUL 0000	73	36.	*	27 JUL 2000	141	30.	*	30 JUL 1600	209	25.
22 JUL 0500	6	22.	*	25 JUL 0100	74	36.	*	27 JUL 2100	142	30.	*	30 JUL 1700	210	25.
22 JUL 0600	7	22.	*	25 JUL 0200	75	35.	*	27 JUL 2200	143	30.	*	30 JUL 1800	211	25.
22 JUL 0700	8	22.	*	25 JUL 0300	76	35.	*	27 JUL 2300	144	30.	*	30 JUL 1900	212	25.
22 JUL 0800	9	22.	*	25 JUL 0400	77	35.	*	28 JUL 0000	145	30.	*	30 JUL 2000	213	25.
22 JUL 0900	10	22.	*	25 JUL 0500	78	35.	*	28 JUL 0100	146	29.	*	30 JUL 2100	214	25.
22 JUL 1000	11	22.	*	25 JUL 0600	79	35.	*	28 JUL 0200	147	29.	*	30 JUL 2200	215	25.
22 JUL 1100	12	22.	*	25 JUL 0700	80	35.	*	28 JUL 0300	148	29.	*	30 JUL 2300	216	25.
22 JUL 1200	13	22.	*	25 JUL 0800	81	35.	*	28 JUL 0400	149	29.	*	31 JUL 0000	217	25.
22 JUL 1300	14	22.	*	25 JUL 0900	82	35.	*	28 JUL 0500	150	29.	*	31 JUL 0100	218	24.
22 JUL 1400	15	22.	*	25 JUL 1000	83	35.	*	28 JUL 0600	151	29.	*	31 JUL 0200	219	24.
22 JUL 1500	16	22.	*	25 JUL 1100	84	35.	*	28 JUL 0700	152	29.	*	31 JUL 0300	220	24.
22 JUL 1600	17	22.	*	25 JUL 1200	85	35.	*	28 JUL 0800	153	29.	*	31 JUL 0400	221	24.
22 JUL 1700	18	27.	*	25 JUL 1300	86	34.	*	28 JUL 0900	154	29.	*	31 JUL 0500	222	24.
22 JUL 1800	19	48.	*	25 JUL 1400	87	34.	*	28 JUL 1000	155	29.	*	31 JUL 0600	223	24.
22 JUL 1900	20	93.	*	25 JUL 1500	88	34.	*	28 JUL 1100	156	29.	*	31 JUL 0700	224	24.
22 JUL 2000	21	151.	*	25 JUL 1600	89	34.	*	28 JUL 1200	157	29.	*	31 JUL 0800	225	24.
22 JUL 2100	22	209.	*	25 JUL 1700	90	34.	*	28 JUL 1300	158	29.	*	31 JUL 0900	226	24.
22 JUL 2200	23	257.	*	25 JUL 1800	91	34.	*	28 JUL 1400	159	28.	*	31 JUL 1000	227	24.
22 JUL 2300	24	291.	*	25 JUL 1900	92	34.	*	28 JUL 1500	160	28.	*	31 JUL 1100	228	24.
23 JUL 0000	25	313.	*	25 JUL 2000	93	34.	*	28 JUL 1600	161	28.	*	31 JUL 1200	229	24.
23 JUL 0100	26	326.	*	25 JUL 2100	94	34.	*	28 JUL 1700	162	28.	*	31 JUL 1300	230	24.
23 JUL 0200	27	329.	*	25 JUL 2200	95	34.	*	28 JUL 1800	163	28.	*	31 JUL 1400	231	24.
23 JUL 0300	28	324.	*	25 JUL 2300	96	34.	*	28 JUL 1900	164	28.	*	31 JUL 1500	232	24.
23 JUL 0400	29	310.	*	26 JUL 0000	97	33.	*	28 JUL 2000	165	28.	*	31 JUL 1600	233	24.
23 JUL 0500	30	292.	*	26 JUL 0100	98	33.	*	28 JUL 2100	166	28.	*	31 JUL 1700	234	23.
23 JUL 0600	31	271.	*	26 JUL 0200	99	33.	*	28 JUL 2200	167	28.	*	31 JUL 1800	235	23.
23 JUL 0700	32	250.	*	26 JUL 0300	100	33.	*	28 JUL 2300	168	28.	*	31 JUL 1900	236	23.
23 JUL 0800	33	229.	*	26 JUL 0400	101	33.	*	29 JUL 0000	169	28.	*	31 JUL 2000	237	23.
23 JUL 0900	34	209.	*	26 JUL 0500	102	33.	*	29 JUL 0100	170	28.	*	31 JUL 2100	238	23.
23 JUL 1000	35	189.	*	26 JUL 0600	103	33.	*	29 JUL 0200	171	28.	*	31 JUL 2200	239	23.
23 JUL 1100	36	170.	*	26 JUL 0700	104	33.	*	29 JUL 0300	172	28.	*	31 JUL 2300	240	23.
23 JUL 1200	37	152.	*	26 JUL 0800	105	33.	*	29 JUL 0400	173	27.	*	1 AUG 0000	241	23.
23 JUL 1300	38	136.	*	26 JUL 0900	106	33.	*	29 JUL 0500	174	27.	*	1 AUG 0100	242	23.
23 JUL 1400	39	121.	*	26 JUL 1000	107	33.	*	29 JUL 0600	175	27.	*	1 AUG 0200	243	23.
23 JUL 1500	40	108.	*	26 JUL 1100	108	33.	*	29 JUL 0700	176	27.	*	1 AUG 0300	244	23.
23 JUL 1600	41	96.	*	26 JUL 1200	109	32.	*	29 JUL 0800	177	27.	*	1 AUG 0400	245	23.
23 JUL 1700	42	86.	*	26 JUL 1300	110	32.	*	29 JUL 0900	178	27.	*	1 AUG 0500	246	23.
23 JUL 1800	43	78.	*	26 JUL 1400	111	32.	*	29 JUL 1000	179	27.	*	1 AUG 0600	247	23.
23 JUL 1900	44	70.	*	26 JUL 1500	112	32.	*	29 JUL 1100	180	27.	*	1 AUG 0700	248	23.
23 JUL 2000	45	63.	*	26 JUL 1600	113	32.	*	29 JUL 1200	181	27.	*	1 AUG 0800	249	23.
23 JUL 2100	46	58.	*	26 JUL 1700	114	32.	*	29 JUL 1300	182	27.	*	1 AUG 0900	250	23.
23 JUL 2200	47	53.	*	26 JUL 1800	115	32.	*	29 JUL 1400	183	27.	*	1 AUG 1000	251	22.
23 JUL 2300	48	49.	*	26 JUL 1900	116	32.	*	29 JUL 1500	184	27.	*	1 AUG 1100	252	22.
24 JUL 0000	49	46.	*	26 JUL 2000	117	32.	*	29 JUL 1600	185	27.	*	1 AUG 1200	253	22.
24 JUL 0100	50	43.	*	26 JUL 2100	118	32.	*	29 JUL 1700	186	27.	*	1 AUG 1300	254	22.
24 JUL 0200	51	41.	*	26 JUL 2200	119	32.	*	29 JUL 1800	187	27.	*	1 AUG 1400	255	22.
24 JUL 0300	52	39.	*	26 JUL 2300	120	32.	*	29 JUL 1900	188	26.	*	1 AUG 1500	256	22.
24 JUL 0400	53	38.	*	27 JUL 0000	121	31.	*	29 JUL 2000	189	26.	*	1 AUG 1600	257	22.
24 JUL 0500	54	37.	*	27 JUL 0100	122	31.	*	29 JUL 2100	190	26.	*	1 AUG 1700	258	22.
24 JUL 0600	55	37.	*	27 JUL 0200	123	31.	*	29 JUL 2200	191	26.	*	1 AUG 1800	259	22.
24 JUL 0700	56	37.	*	27 JUL 0300	124	31.	*	29 JUL 2300	192	26.	*	1 AUG 1900	260	22.
24 JUL 0800	57	37.	*	27 JUL 0400	125	31.	*	30 JUL 0000	193	26.	*	1 AUG 2000	261	22.
24 JUL 0900	58	37.	*	27 JUL 0500	126	31.	*	30 JUL 0100	194	26.	*	1 AUG 2100	262	22.

24 JUL 1000	59	37.	*	27 JUL 0600	127	31.	*	30 JUL 0200	195	26.	*	1 AUG 2200	263	22.
24 JUL 1100	60	37.	*	27 JUL 0700	128	31.	*	30 JUL 0300	196	26.	*	1 AUG 2300	264	22.
24 JUL 1200	61	37.	*	27 JUL 0800	129	31.	*	30 JUL 0400	197	26.	*	2 AUG 0000	265	22.
24 JUL 1300	62	37.	*	27 JUL 0900	130	31.	*	30 JUL 0500	198	26.	*	2 AUG 0100	266	22.
24 JUL 1400	63	37.	*	27 JUL 1000	131	31.	*	30 JUL 0600	199	26.	*	2 AUG 0200	267	22.
24 JUL 1500	64	36.	*	27 JUL 1100	132	31.	*	30 JUL 0700	200	26.	*	2 AUG 0300	268	21.
24 JUL 1600	65	36.	*	27 JUL 1200	133	30.	*	30 JUL 0800	201	26.	*	2 AUG 0400	269	21.
24 JUL 1700	66	36.	*	27 JUL 1300	134	30.	*	30 JUL 0900	202	25.	*	2 AUG 0500	270	21.
24 JUL 1800	67	36.	*	27 JUL 1400	135	30.	*	30 JUL 1000	203	25.	*			
24 JUL 1900	68	36.	*	27 JUL 1500	136	30.	*	30 JUL 1100	204	25.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 329.	26.00		315.	207.	95.	45.
		(INCHES)	.053	.139	.191	.338
		(AC-FT)	156.	411.	567.	1003.

CUMULATIVE AREA = 65.70 SQ MI

*** ***

```
            **************
            *            *
  20 KK     *   BASIN3   *     MUD RUN SUBBASIN HYDROGRAPH
            *            *
            **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAP MUD FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAP MUD FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAP MUD FLOW/01AUG1976/1HOUR/COMP/

              SUBBASIN RUNOFF DATA

  21 BA          SUBBASIN CHARACTERISTICS
                      TAREA        5.20  SUBBASIN AREA
```

***

****

HYDROGRAPH AT STATION BASIN3

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	3.	*	24 JUL 2000	69	5.	*	27 JUL 1600	137	4.	*	30 JUL 1200	205	3.
22 JUL 0100	2	3.	*	24 JUL 2100	70	5.	*	27 JUL 1700	138	4.	*	30 JUL 1300	206	3.
22 JUL 0200	3	3.	*	24 JUL 2200	71	5.	*	27 JUL 1800	139	4.	*	30 JUL 1400	207	3.
22 JUL 0300	4	3.	*	24 JUL 2300	72	5.	*	27 JUL 1900	140	4.	*	30 JUL 1500	208	3.
22 JUL 0400	5	3.	*	25 JUL 0000	73	5.	*	27 JUL 2000	141	4.	*	30 JUL 1600	209	3.
22 JUL 0500	6	3.	*	25 JUL 0100	74	5.	*	27 JUL 2100	142	4.	*	30 JUL 1700	210	3.
22 JUL 0600	7	3.	*	25 JUL 0200	75	5.	*	27 JUL 2200	143	4.	*	30 JUL 1800	211	3.

22 JUL 0700	8	3.	*	25 JUL 0300	76	5.	*	27 JUL 2300	144	4.	*	30 JUL 1900	212	3.
22 JUL 0800	9	3.	*	25 JUL 0400	77	5.	*	28 JUL 0000	145	4.	*	30 JUL 2000	213	3.
22 JUL 0900	10	3.	*	25 JUL 0500	78	5.	*	28 JUL 0100	146	4.	*	30 JUL 2100	214	3.
22 JUL 1000	11	3.	*	25 JUL 0600	79	5.	*	28 JUL 0200	147	4.	*	30 JUL 2200	215	3.
22 JUL 1100	12	3.	*	25 JUL 0700	80	5.	*	28 JUL 0300	148	4.	*	30 JUL 2300	216	3.
22 JUL 1200	13	3.	*	25 JUL 0800	81	5.	*	28 JUL 0400	149	4.	*	31 JUL 0000	217	3.
22 JUL 1300	14	3.	*	25 JUL 0900	82	5.	*	28 JUL 0500	150	4.	*	31 JUL 0100	218	3.
22 JUL 1400	15	3.	*	25 JUL 1000	83	5.	*	28 JUL 0600	151	4.	*	31 JUL 0200	219	3.
22 JUL 1500	16	3.	*	25 JUL 1100	84	5.	*	28 JUL 0700	152	4.	*	31 JUL 0300	220	3.
22 JUL 1600	17	7.	*	25 JUL 1200	85	5.	*	28 JUL 0800	153	4.	*	31 JUL 0400	221	3.
22 JUL 1700	18	18.	*	25 JUL 1300	86	5.	*	28 JUL 0900	154	4.	*	31 JUL 0500	222	3.
22 JUL 1800	19	37.	*	25 JUL 1400	87	5.	*	28 JUL 1000	155	4.	*	31 JUL 0600	223	3.
22 JUL 1900	20	55.	*	25 JUL 1500	88	4.	*	28 JUL 1100	156	4.	*	31 JUL 0700	224	3.
22 JUL 2000	21	64.	*	25 JUL 1600	89	4.	*	28 JUL 1200	157	4.	*	31 JUL 0800	225	3.
22 JUL 2100	22	63.	*	25 JUL 1700	90	4.	*	28 JUL 1300	158	4.	*	31 JUL 0900	226	3.
22 JUL 2200	23	56.	*	25 JUL 1800	91	4.	*	28 JUL 1400	159	4.	*	31 JUL 1000	227	3.
22 JUL 2300	24	49.	*	25 JUL 1900	92	4.	*	28 JUL 1500	160	4.	*	31 JUL 1100	228	3.
23 JUL 0000	25	42.	*	25 JUL 2000	93	4.	*	28 JUL 1600	161	4.	*	31 JUL 1200	229	3.
23 JUL 0100	26	34.	*	25 JUL 2100	94	4.	*	28 JUL 1700	162	4.	*	31 JUL 1300	230	3.
23 JUL 0200	27	26.	*	25 JUL 2200	95	4.	*	28 JUL 1800	163	4.	*	31 JUL 1400	231	3.
23 JUL 0300	28	17.	*	25 JUL 2300	96	4.	*	28 JUL 1900	164	4.	*	31 JUL 1500	232	3.
23 JUL 0400	29	11.	*	26 JUL 0000	97	4.	*	28 JUL 2000	165	4.	*	31 JUL 1600	233	3.
23 JUL 0500	30	8.	*	26 JUL 0100	98	4.	*	28 JUL 2100	166	4.	*	31 JUL 1700	234	3.
23 JUL 0600	31	6.	*	26 JUL 0200	99	4.	*	28 JUL 2200	167	4.	*	31 JUL 1800	235	3.
23 JUL 0700	32	5.	*	26 JUL 0300	100	4.	*	28 JUL 2300	168	4.	*	31 JUL 1900	236	3.
23 JUL 0800	33	5.	*	26 JUL 0400	101	4.	*	29 JUL 0000	169	4.	*	31 JUL 2000	237	3.
23 JUL 0900	34	5.	*	26 JUL 0500	102	4.	*	29 JUL 0100	170	4.	*	31 JUL 2100	238	3.
23 JUL 1000	35	5.	*	26 JUL 0600	103	4.	*	29 JUL 0200	171	4.	*	31 JUL 2200	239	3.
23 JUL 1100	36	5.	*	26 JUL 0700	104	4.	*	29 JUL 0300	172	4.	*	31 JUL 2300	240	3.
23 JUL 1200	37	5.	*	26 JUL 0800	105	4.	*	29 JUL 0400	173	4.	*	1 AUG 0000	241	3.
23 JUL 1300	38	5.	*	26 JUL 0900	106	4.	*	29 JUL 0500	174	4.	*	1 AUG 0100	242	3.
23 JUL 1400	39	5.	*	26 JUL 1000	107	4.	*	29 JUL 0600	175	4.	*	1 AUG 0200	243	3.
23 JUL 1500	40	5.	*	26 JUL 1100	108	4.	*	29 JUL 0700	176	4.	*	1 AUG 0300	244	3.
23 JUL 1600	41	5.	*	26 JUL 1200	109	4.	*	29 JUL 0800	177	4.	*	1 AUG 0400	245	3.
23 JUL 1700	42	5.	*	26 JUL 1300	110	4.	*	29 JUL 0900	178	4.	*	1 AUG 0500	246	3.
23 JUL 1800	43	5.	*	26 JUL 1400	111	4.	*	29 JUL 1000	179	4.	*	1 AUG 0600	247	3.
23 JUL 1900	44	5.	*	26 JUL 1500	112	4.	*	29 JUL 1100	180	4.	*	1 AUG 0700	248	3.
23 JUL 2000	45	5.	*	26 JUL 1600	113	4.	*	29 JUL 1200	181	4.	*	1 AUG 0800	249	3.
23 JUL 2100	46	5.	*	26 JUL 1700	114	4.	*	29 JUL 1300	182	4.	*	1 AUG 0900	250	3.
23 JUL 2200	47	5.	*	26 JUL 1800	115	4.	*	29 JUL 1400	183	4.	*	1 AUG 1000	251	3.
23 JUL 2300	48	5.	*	26 JUL 1900	116	4.	*	29 JUL 1500	184	3.	*	1 AUG 1100	252	3.
24 JUL 0000	49	5.	*	26 JUL 2000	117	4.	*	29 JUL 1600	185	3.	*	1 AUG 1200	253	3.
24 JUL 0100	50	5.	*	26 JUL 2100	118	4.	*	29 JUL 1700	186	3.	*	1 AUG 1300	254	3.
24 JUL 0200	51	5.	*	26 JUL 2200	119	4.	*	29 JUL 1800	187	3.	*	1 AUG 1400	255	3.
24 JUL 0300	52	5.	*	26 JUL 2300	120	4.	*	29 JUL 1900	188	3.	*	1 AUG 1500	256	3.
24 JUL 0400	53	5.	*	27 JUL 0000	121	4.	*	29 JUL 2000	189	3.	*	1 AUG 1600	257	3.
24 JUL 0500	54	5.	*	27 JUL 0100	122	4.	*	29 JUL 2100	190	3.	*	1 AUG 1700	258	3.
24 JUL 0600	55	5.	*	27 JUL 0200	123	4.	*	29 JUL 2200	191	3.	*	1 AUG 1800	259	3.
24 JUL 0700	56	5.	*	27 JUL 0300	124	4.	*	29 JUL 2300	192	3.	*	1 AUG 1900	260	3.
24 JUL 0800	57	5.	*	27 JUL 0400	125	4.	*	30 JUL 0000	193	3.	*	1 AUG 2000	261	3.
24 JUL 0900	58	5.	*	27 JUL 0500	126	4.	*	30 JUL 0100	194	3.	*	1 AUG 2100	262	3.
24 JUL 1000	59	5.	*	27 JUL 0600	127	4.	*	30 JUL 0200	195	3.	*	1 AUG 2200	263	3.
24 JUL 1100	60	5.	*	27 JUL 0700	128	4.	*	30 JUL 0300	196	3.	*	1 AUG 2300	264	3.
24 JUL 1200	61	5.	*	27 JUL 0800	129	4.	*	30 JUL 0400	197	3.	*	2 AUG 0000	265	3.
24 JUL 1300	62	5.	*	27 JUL 0900	130	4.	*	30 JUL 0500	198	3.	*	2 AUG 0100	266	3.
24 JUL 1400	63	5.	*	27 JUL 1000	131	4.	*	30 JUL 0600	199	3.	*	2 AUG 0200	267	3.
24 JUL 1500	64	5.	*	27 JUL 1100	132	4.	*	30 JUL 0700	200	3.	*	2 AUG 0300	268	3.
24 JUL 1600	65	5.	*	27 JUL 1200	133	4.	*	30 JUL 0800	201	3.	*	2 AUG 0400	269	3.
24 JUL 1700	66	5.	*	27 JUL 1300	134	4.	*	30 JUL 0900	202	3.	*	2 AUG 0500	270	3.
24 JUL 1800	67	5.	*	27 JUL 1400	135	4.	*	30 JUL 1000	203	3.	*			

24 JUL 1900	68	5.	*	27 JUL 1500	136	4.	*	30 JUL 1100	204	3.	*

****

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	269.00-HR
+		(CFS)				
+ 64.	20.00		55.	22.	11.	5.
		(INCHES)	.098	.161	.229	.437
		(AC-FT)	27.	45.	64.	121.

CUMULATIVE AREA = 5.20 SQ MI

*** ***

```
            **************
            *            *
 23 KK      *     STA2   *     COMBINED HYDROGRAPH FOR CHANNEL REACH1 AND MUD RUN
            *            *
            **************
```

24 HC HYDROGRAPH COMBINATION

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

****

HYDROGRAPH AT STATION STA2

SUM OF 2 HYDROGRAPHS

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	26.	*	24 JUL 2000	69	41.	*	27 JUL 1600	137	34.	*	30 JUL 1200	205	29.
22 JUL 0100	2	26.	*	24 JUL 2100	70	41.	*	27 JUL 1700	138	34.	*	30 JUL 1300	206	29.
22 JUL 0200	3	26.	*	24 JUL 2200	71	40.	*	27 JUL 1800	139	34.	*	30 JUL 1400	207	28.
22 JUL 0300	4	26.	*	24 JUL 2300	72	40.	*	27 JUL 1900	140	34.	*	30 JUL 1500	208	28.
22 JUL 0400	5	25.	*	25 JUL 0000	73	40.	*	27 JUL 2000	141	34.	*	30 JUL 1600	209	28.
22 JUL 0500	6	25.	*	25 JUL 0100	74	40.	*	27 JUL 2100	142	34.	*	30 JUL 1700	210	28.
22 JUL 0600	7	25.	*	25 JUL 0200	75	40.	*	27 JUL 2200	143	34.	*	30 JUL 1800	211	28.
22 JUL 0700	8	25.	*	25 JUL 0300	76	40.	*	27 JUL 2300	144	34.	*	30 JUL 1900	212	28.
22 JUL 0800	9	25.	*	25 JUL 0400	77	40.	*	28 JUL 0000	145	33.	*	30 JUL 2000	213	28.
22 JUL 0900	10	25.	*	25 JUL 0500	78	40.	*	28 JUL 0100	146	33.	*	30 JUL 2100	214	28.
22 JUL 1000	11	25.	*	25 JUL 0600	79	40.	*	28 JUL 0200	147	33.	*	30 JUL 2200	215	28.
22 JUL 1100	12	25.	*	25 JUL 0700	80	40.	*	28 JUL 0300	148	33.	*	30 JUL 2300	216	28.
22 JUL 1200	13	25.	*	25 JUL 0800	81	39.	*	28 JUL 0400	149	33.	*	31 JUL 0000	217	28.
22 JUL 1300	14	25.	*	25 JUL 0900	82	39.	*	28 JUL 0500	150	33.	*	31 JUL 0100	218	28.
22 JUL 1400	15	25.	*	25 JUL 1000	83	39.	*	28 JUL 0600	151	33.	*	31 JUL 0200	219	28.
22 JUL 1500	16	25.	*	25 JUL 1100	84	39.	*	28 JUL 0700	152	33.	*	31 JUL 0300	220	28.
22 JUL 1600	17	29.	*	25 JUL 1200	85	39.	*	28 JUL 0800	153	33.	*	31 JUL 0400	221	27.
22 JUL 1700	18	46.	*	25 JUL 1300	86	39.	*	28 JUL 0900	154	33.	*	31 JUL 0500	222	27.
22 JUL 1800	19	86.	*	25 JUL 1400	87	39.	*	28 JUL 1000	155	33.	*	31 JUL 0600	223	27.
22 JUL 1900	20	148.	*	25 JUL 1500	88	39.	*	28 JUL 1100	156	32.	*	31 JUL 0700	224	27.

22 JUL 2000	21	215.	*	25 JUL 1600	89	39.	*	28 JUL 1200	157	32.	*	31 JUL 0800	225	27.
22 JUL 2100	22	272.	*	25 JUL 1700	90	39.	*	28 JUL 1300	158	32.	*	31 JUL 0900	226	27.
22 JUL 2200	23	313.	*	25 JUL 1800	91	38.	*	28 JUL 1400	159	32.	*	31 JUL 1000	227	27.
22 JUL 2300	24	339.	*	25 JUL 1900	92	38.	*	28 JUL 1500	160	32.	*	31 JUL 1100	228	27.
23 JUL 0000	25	355.	*	25 JUL 2000	93	38.	*	28 JUL 1600	161	32.	*	31 JUL 1200	229	27.
23 JUL 0100	26	360.	*	25 JUL 2100	94	38.	*	28 JUL 1700	162	32.	*	31 JUL 1300	230	27.
23 JUL 0200	27	355.	*	25 JUL 2200	95	38.	*	28 JUL 1800	163	32.	*	31 JUL 1400	231	27.
23 JUL 0300	28	341.	*	25 JUL 2300	96	38.	*	28 JUL 1900	164	32.	*	31 JUL 1500	232	27.
23 JUL 0400	29	321.	*	26 JUL 0000	97	38.	*	28 JUL 2000	165	32.	*	31 JUL 1600	233	27.
23 JUL 0500	30	300.	*	26 JUL 0100	98	38.	*	28 JUL 2100	166	32.	*	31 JUL 1700	234	27.
23 JUL 0600	31	277.	*	26 JUL 0200	99	38.	*	28 JUL 2200	167	32.	*	31 JUL 1800	235	26.
23 JUL 0700	32	256.	*	26 JUL 0300	100	38.	*	28 JUL 2300	168	31.	*	31 JUL 1900	236	26.
23 JUL 0800	33	235.	*	26 JUL 0400	101	37.	*	29 JUL 0000	169	31.	*	31 JUL 2000	237	26.
23 JUL 0900	34	214.	*	26 JUL 0500	102	37.	*	29 JUL 0100	170	31.	*	31 JUL 2100	238	26.
23 JUL 1000	35	194.	*	26 JUL 0600	103	37.	*	29 JUL 0200	171	31.	*	31 JUL 2200	239	26.
23 JUL 1100	36	175.	*	26 JUL 0700	104	37.	*	29 JUL 0300	172	31.	*	31 JUL 2300	240	26.
23 JUL 1200	37	157.	*	26 JUL 0800	105	37.	*	29 JUL 0400	173	31.	*	1 AUG 0000	241	26.
23 JUL 1300	38	141.	*	26 JUL 0900	106	37.	*	29 JUL 0500	174	31.	*	1 AUG 0100	242	26.
23 JUL 1400	39	126.	*	26 JUL 1000	107	37.	*	29 JUL 0600	175	31.	*	1 AUG 0200	243	26.
23 JUL 1500	40	113.	*	26 JUL 1100	108	37.	*	29 JUL 0700	176	31.	*	1 AUG 0300	244	26.
23 JUL 1600	41	102.	*	26 JUL 1200	109	37.	*	29 JUL 0800	177	31.	*	1 AUG 0400	245	26.
23 JUL 1700	42	91.	*	26 JUL 1300	110	37.	*	29 JUL 0900	178	31.	*	1 AUG 0500	246	26.
23 JUL 1800	43	83.	*	26 JUL 1400	111	37.	*	29 JUL 1000	179	31.	*	1 AUG 0600	247	26.
23 JUL 1900	44	75.	*	26 JUL 1500	112	36.	*	29 JUL 1100	180	31.	*	1 AUG 0700	248	26.
23 JUL 2000	45	68.	*	26 JUL 1600	113	36.	*	29 JUL 1200	181	30.	*	1 AUG 0800	249	26.
23 JUL 2100	46	63.	*	26 JUL 1700	114	36.	*	29 JUL 1300	182	30.	*	1 AUG 0900	250	25.
23 JUL 2200	47	58.	*	26 JUL 1800	115	36.	*	29 JUL 1400	183	30.	*	1 AUG 1000	251	25.
23 JUL 2300	48	54.	*	26 JUL 1900	116	36.	*	29 JUL 1500	184	30.	*	1 AUG 1100	252	25.
24 JUL 0000	49	51.	*	26 JUL 2000	117	36.	*	29 JUL 1600	185	30.	*	1 AUG 1200	253	25.
24 JUL 0100	50	48.	*	26 JUL 2100	118	36.	*	29 JUL 1700	186	30.	*	1 AUG 1300	254	25.
24 JUL 0200	51	46.	*	26 JUL 2200	119	36.	*	29 JUL 1800	187	30.	*	1 AUG 1400	255	25.
24 JUL 0300	52	44.	*	26 JUL 2300	120	36.	*	29 JUL 1900	188	30.	*	1 AUG 1500	256	25.
24 JUL 0400	53	43.	*	27 JUL 0000	121	36.	*	29 JUL 2000	189	30.	*	1 AUG 1600	257	25.
24 JUL 0500	54	42.	*	27 JUL 0100	122	35.	*	29 JUL 2100	190	30.	*	1 AUG 1700	258	25.
24 JUL 0600	55	42.	*	27 JUL 0200	123	35.	*	29 JUL 2200	191	30.	*	1 AUG 1800	259	25.
24 JUL 0700	56	42.	*	27 JUL 0300	124	35.	*	29 JUL 2300	192	30.	*	1 AUG 1900	260	25.
24 JUL 0800	57	42.	*	27 JUL 0400	125	35.	*	30 JUL 0000	193	30.	*	1 AUG 2000	261	25.
24 JUL 0900	58	42.	*	27 JUL 0500	126	35.	*	30 JUL 0100	194	29.	*	1 AUG 2100	262	25.
24 JUL 1000	59	42.	*	27 JUL 0600	127	35.	*	30 JUL 0200	195	29.	*	1 AUG 2200	263	25.
24 JUL 1100	60	42.	*	27 JUL 0700	128	35.	*	30 JUL 0300	196	29.	*	1 AUG 2300	264	25.
24 JUL 1200	61	42.	*	27 JUL 0800	129	35.	*	30 JUL 0400	197	29.	*	2 AUG 0000	265	24.
24 JUL 1300	62	41.	*	27 JUL 0900	130	35.	*	30 JUL 0500	198	29.	*	2 AUG 0100	266	24.
24 JUL 1400	63	41.	*	27 JUL 1000	131	35.	*	30 JUL 0600	199	29.	*	2 AUG 0200	267	24.
24 JUL 1500	64	41.	*	27 JUL 1100	132	35.	*	30 JUL 0700	200	29.	*	2 AUG 0300	268	24.
24 JUL 1600	65	41.	*	27 JUL 1200	133	34.	*	30 JUL 0800	201	29.	*	2 AUG 0400	269	24.
24 JUL 1700	66	41.	*	27 JUL 1300	134	34.	*	30 JUL 0900	202	29.	*	2 AUG 0500	270	24.
24 JUL 1800	67	41.	*	27 JUL 1400	135	34.	*	30 JUL 1000	203	29.	*			
24 JUL 1900	68	41.	*	27 JUL 1500	136	34.	*	30 JUL 1100	204	29.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 360.	25.00		345.	229.	106.	51.
		(INCHES)	.053	.140	.194	.346
		(AC-FT)	171.	453.	630.	1124.

CUMULATIVE AREA = 60.90 SQ MI

*** ***

```
          **************
          *            *
 25 KK    *   REACH2   *     OUTFLOW HYDROGRAPH FOR CHANNEL REACH2
          *            *
          **************

            HYDROGRAPH ROUTING DATA

 26 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

 27 RC        NORMAL DEPTH CHANNEL
                     ANL        .100  LEFT OVERBANK N-VALUE
                    ANCH        .060  MAIN CHANNEL N-VALUE
                     ANR        .100  RIGHT OVERBANK N-VALUE
                   RLNTH      25000.  REACH LENGTH
                     SEL       .0017  ENERGY SLOPE
                   ELMAX      1058.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                  CROSS-SECTION DATA
                        --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 29 RY       ELEVATION   1058.00   1056.00   1055.00   1050.00   1050.00   1055.00   1056.00   1058.00
 28 RX       DISTANCE        .00      1.00     50.00     55.00     80.00     85.00    135.00    136.00

                                                  ***

                                  COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

        STORAGE        .00      6.14     12.49     19.04     25.79     32.75     39.91     47.27     54.84     62.61
        OUTFLOW        .00      6.03     19.12     37.52     60.56     87.83    119.08    154.13    192.84    235.12
      ELEVATION    1050.00   1050.42   1050.84   1051.26   1051.68   1052.11   1052.53   1052.95   1053.37   1053.79

        STORAGE      70.58     78.76     87.22    101.96    126.77    158.86    191.37    223.98    256.68    289.50
        OUTFLOW     280.91    330.16    383.79    450.46    530.03    630.67    748.98    881.73   1027.73   1186.09
      ELEVATION    1054.21   1054.63   1055.05   1055.47   1055.89   1056.32   1056.74   1057.16   1057.58   1058.00

                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                    COMPUTATION TIME STEP
              ELEMENT    ALPHA      M        DT        DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                          PEAK                CELERITY
                                          (MIN)      (FT)      (CFS)    (MIN)       (IN)      (FPS)

                MAIN                       30.00   3125.00     358.32   1620.00       .35       2.94


                                   INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                MAIN                       60.00               358.32   1620.00       .35
```

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1125E+04 EXCESS= .0000E+00 OUTFLOW= .1126E+04 BASIN STORAGE=-.4871E+00 PERCENT ERROR= .0

HYDROGRAPH AT STATION REACH2

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	26.	24 JUL 2000	69	41.	27 JUL 1600	137	35.	30 JUL 1200	205	29.
22 JUL 0100	2	26.	24 JUL 2100	70	41.	27 JUL 1700	138	34.	30 JUL 1300	206	29.
22 JUL 0200	3	26.	24 JUL 2200	71	41.	27 JUL 1800	139	34.	30 JUL 1400	207	29.
22 JUL 0300	4	26.	24 JUL 2300	72	41.	27 JUL 1900	140	34.	30 JUL 1500	208	29.
22 JUL 0400	5	26.	25 JUL 0000	73	41.	27 JUL 2000	141	34.	30 JUL 1600	209	29.
22 JUL 0500	6	26.	25 JUL 0100	74	41.	27 JUL 2100	142	34.	30 JUL 1700	210	29.
22 JUL 0600	7	26.	25 JUL 0200	75	41.	27 JUL 2200	143	34.	30 JUL 1800	211	29.
22 JUL 0700	8	26.	25 JUL 0300	76	40.	27 JUL 2300	144	34.	30 JUL 1900	212	28.
22 JUL 0800	9	26.	25 JUL 0400	77	40.	28 JUL 0000	145	34.	30 JUL 2000	213	28.
22 JUL 0900	10	25.	25 JUL 0500	78	40.	28 JUL 0100	146	34.	30 JUL 2100	214	28.
22 JUL 1000	11	25.	25 JUL 0600	79	40.	28 JUL 0200	147	34.	30 JUL 2200	215	28.
22 JUL 1100	12	25.	25 JUL 0700	80	40.	28 JUL 0300	148	34.	30 JUL 2300	216	28.
22 JUL 1200	13	25.	25 JUL 0800	81	40.	28 JUL 0400	149	33.	31 JUL 0000	217	28.
22 JUL 1300	14	25.	25 JUL 0900	82	40.	28 JUL 0500	150	33.	31 JUL 0100	218	28.
22 JUL 1400	15	25.	25 JUL 1000	83	40.	28 JUL 0600	151	33.	31 JUL 0200	219	28.
22 JUL 1500	16	25.	25 JUL 1100	84	40.	28 JUL 0700	152	33.	31 JUL 0300	220	28.
22 JUL 1600	17	25.	25 JUL 1200	85	39.	28 JUL 0800	153	33.	31 JUL 0400	221	28.
22 JUL 1700	18	25.	25 JUL 1300	86	39.	28 JUL 0900	154	33.	31 JUL 0500	222	28.
22 JUL 1800	19	25.	25 JUL 1400	87	39.	28 JUL 1000	155	33.	31 JUL 0600	223	28.
22 JUL 1900	20	25.	25 JUL 1500	88	39.	28 JUL 1100	156	33.	31 JUL 0700	224	28.
22 JUL 2000	21	27.	25 JUL 1600	89	39.	28 JUL 1200	157	33.	31 JUL 0800	225	27.
22 JUL 2100	22	77.	25 JUL 1700	90	39.	28 JUL 1300	158	33.	31 JUL 0900	226	27.
22 JUL 2200	23	186.	25 JUL 1800	91	39.	28 JUL 1400	159	33.	31 JUL 1000	227	27.
22 JUL 2300	24	260.	25 JUL 1900	92	39.	28 JUL 1500	160	33.	31 JUL 1100	228	27.
23 JUL 0000	25	308.	25 JUL 2000	93	39.	28 JUL 1600	161	32.	31 JUL 1200	229	27.
23 JUL 0100	26	337.	25 JUL 2100	94	39.	28 JUL 1700	162	32.	31 JUL 1300	230	27.
23 JUL 0200	27	353.	25 JUL 2200	95	38.	28 JUL 1800	163	32.	31 JUL 1400	231	27.
23 JUL 0300	28	358.	25 JUL 2300	96	38.	28 JUL 1900	164	32.	31 JUL 1500	232	27.
23 JUL 0400	29	353.	26 JUL 0000	97	38.	28 JUL 2000	165	32.	31 JUL 1600	233	27.
23 JUL 0500	30	340.	26 JUL 0100	98	38.	28 JUL 2100	166	32.	31 JUL 1700	234	27.
23 JUL 0600	31	321.	26 JUL 0200	99	38.	28 JUL 2200	167	32.	31 JUL 1800	235	27.
23 JUL 0700	32	301.	26 JUL 0300	100	38.	28 JUL 2300	168	32.	31 JUL 1900	236	27.
23 JUL 0800	33	280.	26 JUL 0400	101	38.	29 JUL 0000	169	32.	31 JUL 2000	237	27.
23 JUL 0900	34	259.	26 JUL 0500	102	38.	29 JUL 0100	170	32.	31 JUL 2100	238	27.
23 JUL 1000	35	239.	26 JUL 0600	103	38.	29 JUL 0200	171	32.	31 JUL 2200	239	27.
23 JUL 1100	36	220.	26 JUL 0700	104	38.	29 JUL 0300	172	32.	31 JUL 2300	240	26.
23 JUL 1200	37	201.	26 JUL 0800	105	37.	29 JUL 0400	173	31.	1 AUG 0000	241	26.
23 JUL 1300	38	183.	26 JUL 0900	106	37.	29 JUL 0500	174	31.	1 AUG 0100	242	26.
23 JUL 1400	39	166.	26 JUL 1000	107	37.	29 JUL 0600	175	31.	1 AUG 0200	243	26.
23 JUL 1500	40	150.	26 JUL 1100	108	37.	29 JUL 0700	176	31.	1 AUG 0300	244	26.
23 JUL 1600	41	136.	26 JUL 1200	109	37.	29 JUL 0800	177	31.	1 AUG 0400	245	26.
23 JUL 1700	42	123.	26 JUL 1300	110	37.	29 JUL 0900	178	31.	1 AUG 0500	246	26.
23 JUL 1800	43	112.	26 JUL 1400	111	37.	29 JUL 1000	179	31.	1 AUG 0600	247	26.
23 JUL 1900	44	101.	26 JUL 1500	112	37.	29 JUL 1100	180	31.	1 AUG 0700	248	26.
23 JUL 2000	45	92.	26 JUL 1600	113	37.	29 JUL 1200	181	31.	1 AUG 0800	249	26.
23 JUL 2100	46	84.	26 JUL 1700	114	37.	29 JUL 1300	182	31.	1 AUG 0900	250	26.
23 JUL 2200	47	77.	26 JUL 1800	115	37.	29 JUL 1400	183	31.	1 AUG 1000	251	26.
23 JUL 2300	48	71.	26 JUL 1900	116	36.	29 JUL 1500	184	31.	1 AUG 1100	252	26.
24 JUL 0000	49	65.	26 JUL 2000	117	36.	29 JUL 1600	185	30.	1 AUG 1200	253	26.
24 JUL 0100	50	61.	26 JUL 2100	118	36.	29 JUL 1700	186	30.	1 AUG 1300	254	26.
24 JUL 0200	51	57.	26 JUL 2200	119	36.	29 JUL 1800	187	30.	1 AUG 1400	255	25.

24 JUL 0300	52	54.	*	26 JUL 2300	120	36.	*	29 JUL 1900	188	30.	*	1 AUG 1500	256	25.
24 JUL 0400	53	51.	*	27 JUL 0000	121	36.	*	29 JUL 2000	189	30.	*	1 AUG 1600	257	25.
24 JUL 0500	54	48.	*	27 JUL 0100	122	36.	*	29 JUL 2100	190	30.	*	1 AUG 1700	258	25.
24 JUL 0600	55	46.	*	27 JUL 0200	123	36.	*	29 JUL 2200	191	30.	*	1 AUG 1800	259	25.
24 JUL 0700	56	44.	*	27 JUL 0300	124	36.	*	29 JUL 2300	192	30.	*	1 AUG 1900	260	25.
24 JUL 0800	57	43.	*	27 JUL 0400	125	36.	*	30 JUL 0000	193	30.	*	1 AUG 2000	261	25.
24 JUL 0900	58	42.	*	27 JUL 0500	126	36.	*	30 JUL 0100	194	30.	*	1 AUG 2100	262	25.
24 JUL 1000	59	42.	*	27 JUL 0600	127	35.	*	30 JUL 0200	195	30.	*	1 AUG 2200	263	25.
24 JUL 1100	60	42.	*	27 JUL 0700	128	35.	*	30 JUL 0300	196	30.	*	1 AUG 2300	264	25.
24 JUL 1200	61	42.	*	27 JUL 0800	129	35.	*	30 JUL 0400	197	30.	*	2 AUG 0000	265	25.
24 JUL 1300	62	42.	*	27 JUL 0900	130	35.	*	30 JUL 0500	198	29.	*	2 AUG 0100	266	25.
24 JUL 1400	63	42.	*	27 JUL 1000	131	35.	*	30 JUL 0600	199	29.	*	2 AUG 0200	267	25.
24 JUL 1500	64	42.	*	27 JUL 1100	132	35.	*	30 JUL 0700	200	29.	*	2 AUG 0300	268	25.
24 JUL 1600	65	42.	*	27 JUL 1200	133	35.	*	30 JUL 0800	201	29.	*	2 AUG 0400	269	25.
24 JUL 1700	66	41.	*	27 JUL 1300	134	35.	*	30 JUL 0900	202	29.	*	2 AUG 0500	270	24.
24 JUL 1800	67	41.	*	27 JUL 1400	135	35.	*	30 JUL 1000	203	29.	*			
24 JUL 1900	68	41.	*	27 JUL 1500	136	35.	*	30 JUL 1100	204	29.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR.	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 358.	27.00		343.	228.	106.	51.
		(INCHES)	.052	.139	.194	.346
		(AC-FT)	170.	451.	629.	1125.

CUMULATIVE AREA = 60.90 SQ MI

*** ***

```
            **************
            *            *
  30 KK     *    BASIN4  *     UNNAMED TRIBUTARIES SUBBASIN HYDROGRAPH
            *            *
            **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/TRIBS/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/TRIBS/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/TRIBS/FLOW/01AUG1976/1HOUR/COMP/

              SUBBASIN RUNOFF DATA

  31 BA          SUBBASIN CHARACTERISTICS
                       TAREA        7.60  SUBBASIN AREA
```

***

****

HYDROGRAPH AT STATION BASIN4

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
			*				*				*			

22 JUL 0000	1	12.	*	24 JUL 2000	69	17.	*	27 JUL 1600	137	15.	*	30 JUL 1200	205	12.
22 JUL 0100	2	12.	*	24 JUL 2100	70	17.	*	27 JUL 1700	138	14.	*	30 JUL 1300	206	12.
22 JUL 0200	3	12.	*	24 JUL 2200	71	17.	*	27 JUL 1800	139	14.	*	30 JUL 1400	207	12.
22 JUL 0300	4	12.	*	24 JUL 2300	72	17.	*	27 JUL 1900	140	14.	*	30 JUL 1500	208	12.
22 JUL 0400	5	12.	*	25 JUL 0000	73	17.	*	27 JUL 2000	141	14.	*	30 JUL 1600	209	12.
22 JUL 0500	6	12.	*	25 JUL 0100	74	17.	*	27 JUL 2100	142	14.	*	30 JUL 1700	210	12.
22 JUL 0600	7	12.	*	25 JUL 0200	75	17.	*	27 JUL 2200	143	14.	*	30 JUL 1800	211	12.
22 JUL 0700	8	12.	*	25 JUL 0300	76	17.	*	27 JUL 2300	144	14.	*	30 JUL 1900	212	12.
22 JUL 0800	9	12.	*	25 JUL 0400	77	17.	*	28 JUL 0000	145	14.	*	30 JUL 2000	213	12.
22 JUL 0900	10	12.	*	25 JUL 0500	78	17.	*	28 JUL 0100	146	14.	*	30 JUL 2100	214	12.
22 JUL 1000	11	12.	*	25 JUL 0600	79	17.	*	28 JUL 0200	147	14.	*	30 JUL 2200	215	12.
22 JUL 1100	12	12.	*	25 JUL 0700	80	17.	*	28 JUL 0300	148	14.	*	30 JUL 2300	216	12.
22 JUL 1200	13	12.	*	25 JUL 0800	81	17.	*	28 JUL 0400	149	14.	*	31 JUL 0000	217	12.
22 JUL 1300	14	12.	*	25 JUL 0900	82	17.	*	28 JUL 0500	150	14.	*	31 JUL 0100	218	12.
22 JUL 1400	15	12.	*	25 JUL 1000	83	17.	*	28 JUL 0600	151	14.	*	31 JUL 0200	219	12.
22 JUL 1500	16	13.	*	25 JUL 1100	84	17.	*	28 JUL 0700	152	14.	*	31 JUL 0300	220	12.
22 JUL 1600	17	34.	*	25 JUL 1200	85	17.	*	28 JUL 0800	153	14.	*	31 JUL 0400	221	12.
22 JUL 1700	18	77.	*	25 JUL 1300	86	17.	*	28 JUL 0900	154	14.	*	31 JUL 0500	222	12.
22 JUL 1800	19	112.	*	25 JUL 1400	87	17.	*	28 JUL 1000	155	14.	*	31 JUL 0600	223	12.
22 JUL 1900	20	120.	*	25 JUL 1500	88	16.	*	28 JUL 1100	156	14.	*	31 JUL 0700	224	12.
22 JUL 2000	21	107.	*	25 JUL 1600	89	16.	*	28 JUL 1200	157	14.	*	31 JUL 0800	225	12.
22 JUL 2100	22	88.	*	25 JUL 1700	90	16.	*	28 JUL 1300	158	14.	*	31 JUL 0900	226	12.
22 JUL 2200	23	72.	*	25 JUL 1800	91	16.	*	28 JUL 1400	159	14.	*	31 JUL 1000	227	11.
22 JUL 2300	24	62.	*	25 JUL 1900	92	16.	*	28 JUL 1500	160	14.	*	31 JUL 1100	228	11.
23 JUL 0000	25	52.	*	25 JUL 2000	93	16.	*	28 JUL 1600	161	14.	*	31 JUL 1200	229	11.
23 JUL 0100	26	36.	*	25 JUL 2100	94	16.	*	28 JUL 1700	162	14.	*	31 JUL 1300	230	11.
23 JUL 0200	27	22.	*	25 JUL 2200	95	16.	*	28 JUL 1800	163	14.	*	31 JUL 1400	231	11.
23 JUL 0300	28	19.	*	25 JUL 2300	96	16.	*	28 JUL 1900	164	14.	*	31 JUL 1500	232	11.
23 JUL 0400	29	19.	*	26 JUL 0000	97	16.	*	28 JUL 2000	165	14.	*	31 JUL 1600	233	11.
23 JUL 0500	30	19.	*	26 JUL 0100	98	16.	*	28 JUL 2100	166	13.	*	31 JUL 1700	234	11.
23 JUL 0600	31	19.	*	26 JUL 0200	99	16.	*	28 JUL 2200	167	13.	*	31 JUL 1800	235	11.
23 JUL 0700	32	19.	*	26 JUL 0300	100	16.	*	28 JUL 2300	168	13.	*	31 JUL 1900	236	11.
23 JUL 0800	33	19.	*	26 JUL 0400	101	16.	*	29 JUL 0000	169	13.	*	31 JUL 2000	237	11.
23 JUL 0900	34	19.	*	26 JUL 0500	102	16.	*	29 JUL 0100	170	13.	*	31 JUL 2100	238	11.
23 JUL 1000	35	19.	*	26 JUL 0600	103	16.	*	29 JUL 0200	171	13.	*	31 JUL 2200	239	11.
23 JUL 1100	36	19.	*	26 JUL 0700	104	16.	*	29 JUL 0300	172	13.	*	31 JUL 2300	240	11.
23 JUL 1200	37	19.	*	26 JUL 0800	105	16.	*	29 JUL 0400	173	13.	*	1 AUG 0000	241	11.
23 JUL 1300	38	19.	*	26 JUL 0900	106	16.	*	29 JUL 0500	174	13.	*	1 AUG 0100	242	11.
23 JUL 1400	39	19.	*	26 JUL 1000	107	16.	*	29 JUL 0600	175	13.	*	1 AUG 0200	243	11.
23 JUL 1500	40	19.	*	26 JUL 1100	108	16.	*	29 JUL 0700	176	13.	*	1 AUG 0300	244	11.
23 JUL 1600	41	19.	*	26 JUL 1200	109	16.	*	29 JUL 0800	177	13.	*	1 AUG 0400	245	11.
23 JUL 1700	42	19.	*	26 JUL 1300	110	16.	*	29 JUL 0900	178	13.	*	1 AUG 0500	246	11.
23 JUL 1800	43	19.	*	26 JUL 1400	111	16.	*	29 JUL 1000	179	13.	*	1 AUG 0600	247	11.
23 JUL 1900	44	18.	*	26 JUL 1500	112	15.	*	29 JUL 1100	180	13.	*	1 AUG 0700	248	11.
23 JUL 2000	45	18.	*	26 JUL 1600	113	15.	*	29 JUL 1200	181	13.	*	1 AUG 0800	249	11.
23 JUL 2100	46	18.	*	26 JUL 1700	114	15.	*	29 JUL 1300	182	13.	*	1 AUG 0900	250	11.
23 JUL 2200	47	18.	*	26 JUL 1800	115	15.	*	29 JUL 1400	183	13.	*	1 AUG 1000	251	11.
23 JUL 2300	48	18.	*	26 JUL 1900	116	15.	*	29 JUL 1500	184	13.	*	1 AUG 1100	252	11.
24 JUL 0000	49	18.	*	26 JUL 2000	117	15.	*	29 JUL 1600	185	13.	*	1 AUG 1200	253	11.
24 JUL 0100	50	18.	*	26 JUL 2100	118	15.	*	29 JUL 1700	186	13.	*	1 AUG 1300	254	11.
24 JUL 0200	51	18.	*	26 JUL 2200	119	15.	*	29 JUL 1800	187	13.	*	1 AUG 1400	255	11.
24 JUL 0300	52	18.	*	26 JUL 2300	120	15.	*	29 JUL 1900	188	13.	*	1 AUG 1500	256	11.
24 JUL 0400	53	18.	*	27 JUL 0000	121	15.	*	29 JUL 2000	189	13.	*	1 AUG 1600	257	11.
24 JUL 0500	54	18.	*	27 JUL 0100	122	15.	*	29 JUL 2100	190	13.	*	1 AUG 1700	258	11.
24 JUL 0600	55	18.	*	27 JUL 0200	123	15.	*	29 JUL 2200	191	13.	*	1 AUG 1800	259	11.
24 JUL 0700	56	18.	*	27 JUL 0300	124	15.	*	29 JUL 2300	192	13.	*	1 AUG 1900	260	11.
24 JUL 0800	57	18.	*	27 JUL 0400	125	15.	*	30 JUL 0000	193	13.	*	1 AUG 2000	261	11.
24 JUL 0900	58	18.	*	27 JUL 0500	126	15.	*	30 JUL 0100	194	13.	*	1 AUG 2100	262	10.
24 JUL 1000	59	18.	*	27 JUL 0600	127	15.	*	30 JUL 0200	195	12.	*	1 AUG 2200	263	10.
24 JUL 1100	60	18.	*	27 JUL 0700	128	15.	*	30 JUL 0300	196	12.	*	1 AUG 2300	264	10.

24 JUL 1200	61	18.	*	27 JUL 0800	129	15.	*	30 JUL 0400	197	12.	*	2 AUG 0000	265	10.
24 JUL 1300	62	18.	*	27 JUL 0900	130	15.	*	30 JUL 0500	198	12.	*	2 AUG 0100	266	10.
24 JUL 1400	63	18.	*	27 JUL 1000	131	15.	*	30 JUL 0600	199	12.	*	2 AUG 0200	267	10.
24 JUL 1500	64	18.	*	27 JUL 1100	132	15.	*	30 JUL 0700	200	12.	*	2 AUG 0300	268	10.
24 JUL 1600	65	18.	*	27 JUL 1200	133	15.	*	30 JUL 0800	201	12.	*	2 AUG 0400	269	10.
24 JUL 1700	66	17.	*	27 JUL 1300	134	15.	*	30 JUL 0900	202	12.	*	2 AUG 0500	270	10.
24 JUL 1800	67	17.	*	27 JUL 1400	135	15.	*	30 JUL 1000	203	12.	*			
24 JUL 1900	68	17.	*	27 JUL 1500	136	15.	*	30 JUL 1100	204	12.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 120.	19.00		95.	43.	26.	17.
		(INCHES)	.116	.209	.381	.906
		(AC-FT)	47.	85.	155.	367.

CUMULATIVE AREA = 7.60 SQ MI

*** ***

```
            **************
            *            *
  33 KK     *    BASIN5  *     MACOCHEE DITCH SUBBASIN HYDROGRAPH
            *            *
            **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MACD/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MACD/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MACD/FLOW/01AUG1976/1HOUR/COMP/
```

SUBBASIN RUNOFF DATA

34 BA SUBBASIN CHARACTERISTICS

TAREA 7.40 SUBBASIN AREA

***

****

HYDROGRAPH AT STATION BASIN5

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	6.	*	24 JUL 2000	69	10.	*	27 JUL 1600	137	8.	*	30 JUL 1200	205	7.
22 JUL 0100	2	6.	*	24 JUL 2100	70	10.	*	27 JUL 1700	138	8.	*	30 JUL 1300	206	7.
22 JUL 0200	3	6.	*	24 JUL 2200	71	9.	*	27 JUL 1800	139	8.	*	30 JUL 1400	207	7.
22 JUL 0300	4	6.	*	24 JUL 2300	72	9.	*	27 JUL 1900	140	8.	*	30 JUL 1500	208	7.
22 JUL 0400	5	6.	*	25 JUL 0000	73	9.	*	27 JUL 2000	141	8.	*	30 JUL 1600	209	7.
22 JUL 0500	6	6.	*	25 JUL 0100	74	9.	*	27 JUL 2100	142	8.	*	30 JUL 1700	210	7.
22 JUL 0600	7	6.	*	25 JUL 0200	75	9.	*	27 JUL 2200	143	8.	*	30 JUL 1800	211	7.
22 JUL 0700	8	6.	*	25 JUL 0300	76	9.	*	27 JUL 2300	144	8.	*	30 JUL 1900	212	7.
22 JUL 0800	9	6.	*	25 JUL 0400	77	9.	*	28 JUL 0000	145	8.	*	30 JUL 2000	213	7.

22 JUL 0900	10	6.	*	25 JUL 0500	78	9.	*	28 JUL 0100	146	8.	*	30 JUL 2100	214	7.
22 JUL 1000	11	6.	*	25 JUL 0600	79	9.	*	28 JUL 0200	147	8.	*	30 JUL 2200	215	7.
22 JUL 1100	12	6.	*	25 JUL 0700	80	9.	*	28 JUL 0300	148	8.	*	30 JUL 2300	216	7.
22 JUL 1200	13	6.	*	25 JUL 0800	81	9.	*	28 JUL 0400	149	8.	*	31 JUL 0000	217	6.
22 JUL 1300	14	6.	*	25 JUL 0900	82	9.	*	28 JUL 0500	150	8.	*	31 JUL 0100	218	6.
22 JUL 1400	15	6.	*	25 JUL 1000	83	9.	*	28 JUL 0600	151	8.	*	31 JUL 0200	219	6.
22 JUL 1500	16	6.	*	25 JUL 1100	84	9.	*	28 JUL 0700	152	8.	*	31 JUL 0300	220	6.
22 JUL 1600	17	8.	*	25 JUL 1200	85	9.	*	28 JUL 0800	153	8.	*	31 JUL 0400	221	6.
22 JUL 1700	18	14.	*	25 JUL 1300	86	9.	*	28 JUL 0900	154	8.	*	31 JUL 0500	222	6.
22 JUL 1800	19	26.	*	25 JUL 1400	87	9.	*	28 JUL 1000	155	8.	*	31 JUL 0600	223	6.
22 JUL 1900	20	39.	*	25 JUL 1500	88	9.	*	28 JUL 1100	156	8.	*	31 JUL 0700	224	6.
22 JUL 2000	21	50.	*	25 JUL 1600	89	9.	*	28 JUL 1200	157	8.	*	31 JUL 0800	225	6.
22 JUL 2100	22	57.	*	25 JUL 1700	90	9.	*	28 JUL 1300	158	8.	*	31 JUL 0900	226	6.
22 JUL 2200	23	60.	*	25 JUL 1800	91	9.	*	28 JUL 1400	159	8.	*	31 JUL 1000	227	6.
22 JUL 2300	24	62.	*	25 JUL 1900	92	9.	*	28 JUL 1500	160	8.	*	31 JUL 1100	228	6.
23 JUL 0000	25	61.	*	25 JUL 2000	93	9.	*	28 JUL 1600	161	8.	*	31 JUL 1200	229	6.
23 JUL 0100	26	59.	*	25 JUL 2100	94	9.	*	28 JUL 1700	162	7.	*	31 JUL 1300	230	6.
23 JUL 0200	27	53.	*	25 JUL 2200	95	9.	*	28 JUL 1800	163	7.	*	31 JUL 1400	231	6.
23 JUL 0300	28	47.	*	25 JUL 2300	96	9.	*	28 JUL 1900	164	7.	*	31 JUL 1500	232	6.
23 JUL 0400	29	41.	*	26 JUL 0000	97	9.	*	28 JUL 2000	165	7.	*	31 JUL 1600	233	6.
23 JUL 0500	30	36.	*	26 JUL 0100	98	9.	*	28 JUL 2100	166	7.	*	31 JUL 1700	234	6.
23 JUL 0600	31	30.	*	26 JUL 0200	99	9.	*	28 JUL 2200	167	7.	*	31 JUL 1800	235	6.
23 JUL 0700	32	26.	*	26 JUL 0300	100	9.	*	28 JUL 2300	168	7.	*	31 JUL 1900	236	6.
23 JUL 0800	33	22.	*	26 JUL 0400	101	9.	*	29 JUL 0000	169	7.	*	31 JUL 2000	237	6.
23 JUL 0900	34	19.	*	26 JUL 0500	102	9.	*	29 JUL 0100	170	7.	*	31 JUL 2100	238	6.
23 JUL 1000	35	16.	*	26 JUL 0600	103	9.	*	29 JUL 0200	171	7.	*	31 JUL 2200	239	6.
23 JUL 1100	36	14.	*	26 JUL 0700	104	9.	*	29 JUL 0300	172	7.	*	31 JUL 2300	240	6.
23 JUL 1200	37	13.	*	26 JUL 0800	105	9.	*	29 JUL 0400	173	7.	*	1 AUG 0000	241	6.
23 JUL 1300	38	11.	*	26 JUL 0900	106	9.	*	29 JUL 0500	174	7.	*	1 AUG 0100	242	6.
23 JUL 1400	39	10.	*	26 JUL 1000	107	9.	*	29 JUL 0600	175	7.	*	1 AUG 0200	243	6.
23 JUL 1500	40	10.	*	26 JUL 1100	108	9.	*	29 JUL 0700	176	7.	*	1 AUG 0300	244	6.
23 JUL 1600	41	10.	*	26 JUL 1200	109	9.	*	29 JUL 0800	177	7.	*	1 AUG 0400	245	6.
23 JUL 1700	42	10.	*	26 JUL 1300	110	9.	*	29 JUL 0900	178	7.	*	1 AUG 0500	246	6.
23 JUL 1800	43	10.	*	26 JUL 1400	111	9.	*	29 JUL 1000	179	7.	*	1 AUG 0600	247	6.
23 JUL 1900	44	10.	*	26 JUL 1500	112	9.	*	29 JUL 1100	180	7.	*	1 AUG 0700	248	6.
23 JUL 2000	45	10.	*	26 JUL 1600	113	8.	*	29 JUL 1200	181	7.	*	1 AUG 0800	249	6.
23 JUL 2100	46	10.	*	26 JUL 1700	114	8.	*	29 JUL 1300	182	7.	*	1 AUG 0900	250	6.
23 JUL 2200	47	10.	*	26 JUL 1800	115	8.	*	29 JUL 1400	183	7.	*	1 AUG 1000	251	6.
23 JUL 2300	48	10.	*	26 JUL 1900	116	8.	*	29 JUL 1500	184	7.	*	1 AUG 1100	252	6.
24 JUL 0000	49	10.	*	26 JUL 2000	117	8.	*	29 JUL 1600	185	7.	*	1 AUG 1200	253	6.
24 JUL 0100	50	10.	*	26 JUL 2100	118	8.	*	29 JUL 1700	186	7.	*	1 AUG 1300	254	6.
24 JUL 0200	51	10.	*	26 JUL 2200	119	8.	*	29 JUL 1800	187	7.	*	1 AUG 1400	255	6.
24 JUL 0300	52	10.	*	26 JUL 2300	120	8.	*	29 JUL 1900	188	7.	*	1 AUG 1500	256	6.
24 JUL 0400	53	10.	*	27 JUL 0000	121	8.	*	29 JUL 2000	189	7.	*	1 AUG 1600	257	6.
24 JUL 0500	54	10.	*	27 JUL 0100	122	8.	*	29 JUL 2100	190	7.	*	1 AUG 1700	258	6.
24 JUL 0600	55	10.	*	27 JUL 0200	123	8.	*	29 JUL 2200	191	7.	*	1 AUG 1800	259	6.
24 JUL 0700	56	10.	*	27 JUL 0300	124	8.	*	29 JUL 2300	192	7.	*	1 AUG 1900	260	6.
24 JUL 0800	57	10.	*	27 JUL 0400	125	8.	*	30 JUL 0000	193	7.	*	1 AUG 2000	261	6.
24 JUL 0900	58	10.	*	27 JUL 0500	126	8.	*	30 JUL 0100	194	7.	*	1 AUG 2100	262	6.
24 JUL 1000	59	10.	*	27 JUL 0600	127	8.	*	30 JUL 0200	195	7.	*	1 AUG 2200	263	6.
24 JUL 1100	60	10.	*	27 JUL 0700	128	8.	*	30 JUL 0300	196	7.	*	1 AUG 2300	264	6.
24 JUL 1200	61	10.	*	27 JUL 0800	129	8.	*	30 JUL 0400	197	7.	*	2 AUG 0000	265	6.
24 JUL 1300	62	10.	*	27 JUL 0900	130	8.	*	30 JUL 0500	198	7.	*	2 AUG 0100	266	6.
24 JUL 1400	63	10.	*	27 JUL 1000	131	8.	*	30 JUL 0600	199	7.	*	2 AUG 0200	267	6.
24 JUL 1500	64	10.	*	27 JUL 1100	132	8.	*	30 JUL 0700	200	7.	*	2 AUG 0300	268	6.
24 JUL 1600	65	10.	*	27 JUL 1200	133	8.	*	30 JUL 0800	201	7.	*	2 AUG 0400	269	6.
24 JUL 1700	66	10.	*	27 JUL 1300	134	8.	*	30 JUL 0900	202	7.	*	2 AUG 0500	270	6.
24 JUL 1800	67	10.	*	27 JUL 1400	135	8.	*	30 JUL 1000	203	7.	*			
24 JUL 1900	68	10.	*	27 JUL 1500	136	8.	*	30 JUL 1100	204	7.	*			
			*				*				*			

```
*****************************************************************************************************************************

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    269.00-HR
+   (CFS)       (HR)
                            (CFS)
+     62.     23.00                 58.         33.         17.          10.
                          (INCHES)  .073        .165        .262         .556
                           (AC-FT)  29.         65.         103.         220.

                          CUMULATIVE AREA =    7.40 SQ MI


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


            **************
            *            *
 36 KK      *     STA3   *     COMBINED HYDROGRAPH FOR CHANNEL REACH2, UNNAMED TRIBS, AND MACOCHEE DITC
            *            *
            **************

 37 HC          HYDROGRAPH COMBINATION
                     ICOMP          3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                  ***

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

                                    HYDROGRAPH AT STATION     STA3
                                        SUM OF  3 HYDROGRAPHS

*****************************************************************************************************************************
```

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	44.	24 JUL 2000	69	68.	27 JUL 1600	137	57.	30 JUL 1200	205	48.
22 JUL 0100	2	44.	24 JUL 2100	70	68.	27 JUL 1700	138	57.	30 JUL 1300	206	48.
22 JUL 0200	3	44.	24 JUL 2200	71	68.	27 JUL 1800	139	57.	30 JUL 1400	207	48.
22 JUL 0300	4	44.	24 JUL 2300	72	67.	27 JUL 1900	140	57.	30 JUL 1500	208	47.
22 JUL 0400	5	44.	25 JUL 0000	73	67.	27 JUL 2000	141	56.	30 JUL 1600	209	47.
22 JUL 0500	6	44.	25 JUL 0100	74	67.	27 JUL 2100	142	56.	30 JUL 1700	210	47.
22 JUL 0600	7	44.	25 JUL 0200	75	67.	27 JUL 2200	143	56.	30 JUL 1800	211	47.
22 JUL 0700	8	44.	25 JUL 0300	76	67.	27 JUL 2300	144	56.	30 JUL 1900	212	47.
22 JUL 0800	9	44.	25 JUL 0400	77	67.	28 JUL 0000	145	56.	30 JUL 2000	213	47.
22 JUL 0900	10	44.	25 JUL 0500	78	66.	28 JUL 0100	146	56.	30 JUL 2100	214	47.
22 JUL 1000	11	44.	25 JUL 0600	79	66.	28 JUL 0200	147	56.	30 JUL 2200	215	47.
22 JUL 1100	12	43.	25 JUL 0700	80	66.	28 JUL 0300	148	55.	30 JUL 2300	216	46.
22 JUL 1200	13	43.	25 JUL 0800	81	66.	28 JUL 0400	149	55.	31 JUL 0000	217	46.
22 JUL 1300	14	43.	25 JUL 0900	82	66.	28 JUL 0500	150	55.	31 JUL 0100	218	46.
22 JUL 1400	15	43.	25 JUL 1000	83	66.	28 JUL 0600	151	55.	31 JUL 0200	219	46.
22 JUL 1500	16	45.	25 JUL 1100	84	65.	28 JUL 0700	152	55.	31 JUL 0300	220	46.
22 JUL 1600	17	67.	25 JUL 1200	85	65.	28 JUL 0800	153	55.	31 JUL 0400	221	46.
22 JUL 1700	18	116.	25 JUL 1300	86	65.	28 JUL 0900	154	55.	31 JUL 0500	222	46.
22 JUL 1800	19	163.	25 JUL 1400	87	65.	28 JUL 1000	155	54.	31 JUL 0600	223	46.
22 JUL 1900	20	185.	25 JUL 1500	88	65.	28 JUL 1100	156	54.	31 JUL 0700	224	46.
22 JUL 2000	21	183.	25 JUL 1600	89	65.	28 JUL 1200	157	54.	31 JUL 0800	225	45.
22 JUL 2100	22	221.	25 JUL 1700	90	64.	28 JUL 1300	158	54.	31 JUL 0900	226	45.

22 JUL 2200	23	318.	*	25 JUL 1800	91	64.	*	28 JUL 1400	159	54.	*	31 JUL 1000	227	45.
22 JUL 2300	24	384.	*	25 JUL 1900	92	64.	*	28 JUL 1500	160	54.	*	31 JUL 1100	228	45.
23 JUL 0000	25	422.	*	25 JUL 2000	93	64.	*	28 JUL 1600	161	54.	*	31 JUL 1200	229	45.
23 JUL 0100	26	432.	*	25 JUL 2100	94	64.	*	28 JUL 1700	162	53.	*	31 JUL 1300	230	45.
23 JUL 0200	27	429.	*	25 JUL 2200	95	64.	*	28 JUL 1800	163	53.	*	31 JUL 1400	231	45.
23 JUL 0300	28	425.	*	25 JUL 2300	96	63.	*	28 JUL 1900	164	53.	*	31 JUL 1500	232	45.
23 JUL 0400	29	414.	*	26 JUL 0000	97	63.	*	28 JUL 2000	165	53.	*	31 JUL 1600	233	44.
23 JUL 0500	30	395.	*	26 JUL 0100	98	63.	*	28 JUL 2100	166	53.	*	31 JUL 1700	234	44.
23 JUL 0600	31	371.	*	26 JUL 0200	99	63.	*	28 JUL 2200	167	53.	*	31 JUL 1800	235	44.
23 JUL 0700	32	346.	*	26 JUL 0300	100	63.	*	28 JUL 2300	168	53.	*	31 JUL 1900	236	44.
23 JUL 0800	33	321.	*	26 JUL 0400	101	63.	*	29 JUL 0000	169	53.	*	31 JUL 2000	237	44.
23 JUL 0900	34	297.	*	26 JUL 0500	102	62.	*	29 JUL 0100	170	52.	*	31 JUL 2100	238	44.
23 JUL 1000	35	274.	*	26 JUL 0600	103	62.	*	29 JUL 0200	171	52.	*	31 JUL 2200	239	44.
23 JUL 1100	36	253.	*	26 JUL 0700	104	62.	*	29 JUL 0300	172	52.	*	31 JUL 2300	240	44.
23 JUL 1200	37	232.	*	26 JUL 0800	105	62.	*	29 JUL 0400	173	52.	*	1 AUG 0000	241	44.
23 JUL 1300	38	213.	*	26 JUL 0900	106	62.	*	29 JUL 0500	174	52.	*	1 AUG 0100	242	43.
23 JUL 1400	39	195.	*	26 JUL 1000	107	62.	*	29 JUL 0600	175	52.	*	1 AUG 0200	243	43.
23 JUL 1500	40	179.	*	26 JUL 1100	108	61.	*	29 JUL 0700	176	52.	*	1 AUG 0300	244	43.
23 JUL 1600	41	165.	*	26 JUL 1200	109	61.	*	29 JUL 0800	177	51.	*	1 AUG 0400	245	43.
23 JUL 1700	42	152.	*	26 JUL 1300	110	61.	*	29 JUL 0900	178	51.	*	1 AUG 0500	246	43.
23 JUL 1800	43	140.	*	26 JUL 1400	111	61.	*	29 JUL 1000	179	51.	*	1 AUG 0600	247	43.
23 JUL 1900	44	130.	*	26 JUL 1500	112	61.	*	29 JUL 1100	180	51.	*	1 AUG 0700	248	43.
23 JUL 2000	45	121.	*	26 JUL 1600	113	61.	*	29 JUL 1200	181	51.	*	1 AUG 0800	249	43.
23 JUL 2100	46	112.	*	26 JUL 1700	114	61.	*	29 JUL 1300	182	51.	*	1 AUG 0900	250	43.
23 JUL 2200	47	105.	*	26 JUL 1800	115	60.	*	29 JUL 1400	183	51.	*	1 AUG 1000	251	42.
23 JUL 2300	48	99.	*	26 JUL 1900	116	60.	*	29 JUL 1500	184	50.	*	1 AUG 1100	252	42.
24 JUL 0000	49	94.	*	26 JUL 2000	117	60.	*	29 JUL 1600	185	50.	*	1 AUG 1200	253	42.
24 JUL 0100	50	89.	*	26 JUL 2100	118	60.	*	29 JUL 1700	186	50.	*	1 AUG 1300	254	42.
24 JUL 0200	51	85.	*	26 JUL 2200	119	60.	*	29 JUL 1800	187	50.	*	1 AUG 1400	255	42.
24 JUL 0300	52	82.	*	26 JUL 2300	120	60.	*	29 JUL 1900	188	50.	*	1 AUG 1500	256	42.
24 JUL 0400	53	79.	*	27 JUL 0000	121	59.	*	29 JUL 2000	189	50.	*	1 AUG 1600	257	42.
24 JUL 0500	54	76.	*	27 JUL 0100	122	59.	*	29 JUL 2100	190	50.	*	1 AUG 1700	258	42.
24 JUL 0600	55	74.	*	27 JUL 0200	123	59.	*	29 JUL 2200	191	50.	*	1 AUG 1800	259	42.
24 JUL 0700	56	72.	*	27 JUL 0300	124	59.	*	29 JUL 2300	192	49.	*	1 AUG 1900	260	41.
24 JUL 0800	57	71.	*	27 JUL 0400	125	59.	*	30 JUL 0000	193	49.	*	1 AUG 2000	261	41.
24 JUL 0900	58	70.	*	27 JUL 0500	126	59.	*	30 JUL 0100	194	49.	*	1 AUG 2100	262	41.
24 JUL 1000	59	70.	*	27 JUL 0600	127	59.	*	30 JUL 0200	195	49.	*	1 AUG 2200	263	41.
24 JUL 1100	60	70.	*	27 JUL 0700	128	58.	*	30 JUL 0300	196	49.	*	1 AUG 2300	264	41.
24 JUL 1200	61	69.	*	27 JUL 0800	129	58.	*	30 JUL 0400	197	49.	*	2 AUG 0000	265	41.
24 JUL 1300	62	69.	*	27 JUL 0900	130	58.	*	30 JUL 0500	198	49.	*	2 AUG 0100	266	41.
24 JUL 1400	63	69.	*	27 JUL 1000	131	58.	*	30 JUL 0600	199	49.	*	2 AUG 0200	267	41.
24 JUL 1500	64	69.	*	27 JUL 1100	132	58.	*	30 JUL 0700	200	48.	*	2 AUG 0300	268	41.
24 JUL 1600	65	69.	*	27 JUL 1200	133	58.	*	30 JUL 0800	201	48.	*	2 AUG 0400	269	41.
24 JUL 1700	66	69.	*	27 JUL 1300	134	57.	*	30 JUL 0900	202	48.	*	2 AUG 0500	270	40.
24 JUL 1800	67	68.	*	27 JUL 1400	135	57.	*	30 JUL 1000	203	48.	*			
24 JUL 1900	68	68.	*	27 JUL 1500	136	57.	*	30 JUL 1100	204	48.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 432.	25.00		418.	290.	148.	77.
		(INCHES)	.051	.142	.218	.423
		(AC-FT)	207.	575.	881.	1711.

CUMULATIVE AREA = 75.90 SQ MI

*** ***

```
          **************
          *            *
 38 KK    *   REACH3   *     OUTFLOW HYDROGRAPH FOR CHANNEL REACH3
          *            *
          **************

            HYDROGRAPH ROUTING DATA

 40 RL        ROUTING LOSSES
                    QLOSS       -4.80  INITIAL LOSS
                    CLOSS         .00  ADDITIONAL FRACTION LOST

 39 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

 41 RC        NORMAL DEPTH CHANNEL
                     ANL        .100  LEFT OVERBANK N-VALUE
                    ANCH        .060  MAIN CHANNEL N-VALUE
                     ANR        .100  RIGHT OVERBANK N-VALUE
                   RLNTH       5600.  REACH LENGTH
                     SEL       .0012  ENERGY SLOPE
                   ELMAX      1035.0  MAX  ELEV  FOR STORAGE/OUTFLOW CALCULATION

                                   CROSS-SECTION DATA
                        --- LEFT OVERBANK --- + ------- MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 43 RY       ELEVATION   1035.00   1034.00   1033.00   1025.00   1025.00   1033.00   1034.00   1035.00
 42 RX       DISTANCE        .00      1.00      50.00     55.00     90.00     95.00    145.00    146.00

                                                  ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00      2.39      4.83      7.31      9.83     12.40     15.01     17.67     20.37     23.12
          OUTFLOW        .00     10.25     32.32     63.13    101.37    146.25    197.22    253.85    315.85    382.95
        ELEVATION    1025.00   1025.53   1026.05   1026.58   1027.11   1027.63   1028.16   1028.68   1029.21   1029.74

          STORAGE      25.91     28.75     31.63     34.55     37.52     40.54     44.71     52.35     62.10     71.95
          OUTFLOW     454.96    531.70    613.05    698.88    789.11    883.66    995.58   1126.36   1284.80   1464.74
        ELEVATION    1030.26   1030.79   1031.32   1031.84   1032.37   1032.90   1033.42   1033.95   1034.47   1035.00

                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                   COMPUTATION TIME STEP
              ELEMENT    ALPHA        M         DT        DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                          PEAK,                 CELERITY
                                                (MIN      (FT)     (CFS)    (MIN)       (IN)      (FPS)

                 MAIN                           30.00   2800.00    430.65   1530.00       .42       2.68


                                   INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                 MAIN                           60.00              430.51   1560.00       .42


CONTINUITY SUMMARY (AC-FT) - INFLOW= .1713E+04 EXCESS= .0000E+00 OUTFLOW= .1713E+04 BASIN STORAGE=-.3066E+00 PERCENT ERROR=    .0
```

HYDROGRAPH AT STATION REACH3

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	49.	24 JUL 2000	69	73.	27 JUL 1600	137	62.	30 JUL 1200	205	53.
22 JUL 0100	2	49.	24 JUL 2100	70	73.	27 JUL 1700	138	62.	30 JUL 1300	206	53.
22 JUL 0200	3	49.	24 JUL 2200	71	73.	27 JUL 1800	139	62.	30 JUL 1400	207	53.
22 JUL 0300	4	49.	24 JUL 2300	72	72.	27 JUL 1900	140	62.	30 JUL 1500	208	52.
22 JUL 0400	5	49.	25 JUL 0000	73	72.	27 JUL 2000	141	61.	30 JUL 1600	209	52.
22 JUL 0500	6	49.	25 JUL 0100	74	72.	27 JUL 2100	142	61.	30 JUL 1700	210	52.
22 JUL 0600	7	49.	25 JUL 0200	75	72.	27 JUL 2200	143	61.	30 JUL 1800	211	52.
22 JUL 0700	8	49.	25 JUL 0300	76	72.	27 JUL 2300	144	61.	30 JUL 1900	212	52.
22 JUL 0800	9	49.	25 JUL 0400	77	72.	28 JUL 0000	145	61.	30 JUL 2000	213	52.
22 JUL 0900	10	49.	25 JUL 0500	78	71.	28 JUL 0100	146	61.	30 JUL 2100	214	52.
22 JUL 1000	11	48.	25 JUL 0600	79	71.	28 JUL 0200	147	61.	30 JUL 2200	215	52.
22 JUL 1100	12	48.	25 JUL 0700	80	71.	28 JUL 0300	148	60.	30 JUL 2300	216	51.
22 JUL 1200	13	48.	25 JUL 0800	81	71.	28 JUL 0400	149	60.	31 JUL 0000	217	51.
22 JUL 1300	14	48.	25 JUL 0900	82	71.	28 JUL 0500	150	60.	31 JUL 0100	218	51.
22 JUL 1400	15	48.	25 JUL 1000	83	71.	28 JUL 0600	151	60.	31 JUL 0200	219	51.
22 JUL 1500	16	48.	25 JUL 1100	84	70.	28 JUL 0700	152	60.	31 JUL 0300	220	51.
22 JUL 1600	17	51.	25 JUL 1200	85	70.	28 JUL 0800	153	60.	31 JUL 0400	221	51.
22 JUL 1700	18	78.	25 JUL 1300	86	70.	28 JUL 0900	154	60.	31 JUL 0500	222	51.
22 JUL 1800	19	133.	25 JUL 1400	87	70.	28 JUL 1000	155	59.	31 JUL 0600	223	51.
22 JUL 1900	20	175.	25 JUL 1500	88	70.	28 JUL 1100	156	59.	31 JUL 0700	224	50.
22 JUL 2000	21	189.	25 JUL 1600	89	70.	28 JUL 1200	157	59.	31 JUL 0800	225	50.
22 JUL 2100	22	202.	25 JUL 1700	90	69.	28 JUL 1300	158	59.	31 JUL 0900	226	50.
22 JUL 2200	23	267.	25 JUL 1800	91	69.	28 JUL 1400	159	59.	31 JUL 1000	227	50.
22 JUL 2300	24	355.	25 JUL 1900	92	69.	28 JUL 1500	160	59.	31 JUL 1100	228	50.
23 JUL 0000	25	409.	25 JUL 2000	93	69.	28 JUL 1600	161	59.	31 JUL 1200	229	50.
23 JUL 0100	26	432.	25 JUL 2100	94	69.	28 JUL 1700	162	58.	31 JUL 1300	230	50.
23 JUL 0200	27	435.	25 JUL 2200	95	69.	28 JUL 1800	163	58.	31 JUL 1400	231	50.
23 JUL 0300	28	432.	25 JUL 2300	96	68.	28 JUL 1900	164	58.	31 JUL 1500	232	50.
23 JUL 0400	29	424.	26 JUL 0000	97	68.	28 JUL 2000	165	58.	31 JUL 1600	233	49.
23 JUL 0500	30	409.	26 JUL 0100	98	68.	28 JUL 2100	166	58.	31 JUL 1700	234	49.
23 JUL 0600	31	387.	26 JUL 0200	99	68.	28 JUL 2200	167	58.	31 JUL 1800	235	49.
23 JUL 0700	32	363.	26 JUL 0300	100	68.	28 JUL 2300	168	58.	31 JUL 1900	236	49.
23 JUL 0800	33	338.	26 JUL 0400	101	68.	29 JUL 0000	169	57.	31 JUL 2000	237	49.
23 JUL 0900	34	314.	26 JUL 0500	102	67.	29 JUL 0100	170	57.	31 JUL 2100	238	49.
23 JUL 1000	35	292.	26 JUL 0600	103	67.	29 JUL 0200	171	57.	31 JUL 2200	239	49.
23 JUL 1100	36	270.	26 JUL 0700	104	67.	29 JUL 0300	172	57.	31 JUL 2300	240	49.
23 JUL 1200	37	249.	26 JUL 0800	105	67.	29 JUL 0400	173	57.	1 AUG 0000	241	48.
23 JUL 1300	38	229.	26 JUL 0900	106	67.	29 JUL 0500	174	57.	1 AUG 0100	242	48.
23 JUL 1400	39	211.	26 JUL 1000	107	67.	29 JUL 0600	175	57.	1 AUG 0200	243	48.
23 JUL 1500	40	194.	26 JUL 1100	108	66.	29 JUL 0700	176	57.	1 AUG 0300	244	48.
23 JUL 1600	41	179.	26 JUL 1200	109	66.	29 JUL 0800	177	56.	1 AUG 0400	245	48.
23 JUL 1700	42	166.	26 JUL 1300	110	66.	29 JUL 0900	178	56.	1 AUG 0500	246	48.
23 JUL 1800	43	153.	26 JUL 1400	111	66.	29 JUL 1000	179	56.	1 AUG 0600	247	48.
23 JUL 1900	44	142.	26 JUL 1500	112	66.	29 JUL 1100	180	56.	1 AUG 0700	248	48.
23 JUL 2000	45	132.	26 JUL 1600	113	66.	29 JUL 1200	181	56.	1 AUG 0800	249	48.
23 JUL 2100	46	123.	26 JUL 1700	114	65.	29 JUL 1300	182	56.	1 AUG 0900	250	47.
23 JUL 2200	47	116.	26 JUL 1800	115	65.	29 JUL 1400	183	56.	1 AUG 1000	251	47.
23 JUL 2300	48	109.	26 JUL 1900	116	65.	29 JUL 1500	184	55.	1 AUG 1100	252	47.
24 JUL 0000	49	103.	26 JUL 2000	117	65.	29 JUL 1600	185	55.	1 AUG 1200	253	47.

24 JUL 0100	50	98.	*	26 JUL 2100	118	65.	*	28 JUL 1700	186	55.	*	1 AUG 1300	254	47.
24 JUL 0200	51	93.	*	26 JUL 2200	119	65.	*	29 JUL 1800	187	55.	*	1 AUG 1400	255	47.
24 JUL 0300	52	89.	*	26 JUL 2300	120	65.	*	29 JUL 1900	188	55.	*	1 AUG 1500	256	47.
24 JUL 0400	53	86.	*	27 JUL 0000	121	64.	*	29 JUL 2000	189	55.	*	1 AUG 1600	257	47.
24 JUL 0500	54	83.	*	27 JUL 0100	122	64.	*	29 JUL 2100	190	55.	*	1 AUG 1700	258	47.
24 JUL 0600	55	80.	*	27 JUL 0200	123	64.	*	29 JUL 2200	191	55.	*	1 AUG 1800	259	47.
24 JUL 0700	56	78.	*	27 JUL 0300	124	64.	*	29 JUL 2300	192	54.	*	1 AUG 1900	260	46.
24 JUL 0800	57	77.	*	27 JUL 0400	125	64.	*	30 JUL 0000	193	54.	*	1 AUG 2000	261	46.
24 JUL 0900	58	75.	*	27 JUL 0500	126	64.	*	30 JUL 0100	194	54.	*	1 AUG 2100	262	46.
24 JUL 1000	59	75.	*	27 JUL 0600	127	63.	*	30 JUL 0200	195	54.	*	1 AUG 2200	263	46.
24 JUL 1100	60	75.	*	27 JUL 0700	128	63.	*	30 JUL 0300	196	54.	*	1 AUG 2300	264	46.
24 JUL 1200	61	74.	*	27 JUL 0800	129	63.	*	30 JUL 0400	197	54.	*	2 AUG 0000	265	46.
24 JUL 1300	62	74.	*	27 JUL 0900	130	63.	*	30 JUL 0500	198	54.	*	2 AUG 0100	266	46.
24 JUL 1400	63	74.	*	27 JUL 1000	131	63.	*	30 JUL 0600	199	54.	*	2 AUG 0200	267	46.
24 JUL 1500	64	74.	*	27 JUL 1100	132	63.	*	30 JUL 0700	200	53.	*	2 AUG 0300	268	46.
24 JUL 1600	65	74.	*	27 JUL 1200	133	63.	*	30 JUL 0800	201	53.	*	2 AUG 0400	269	45.
24 JUL 1700	66	73.	*	27 JUL 1300	134	62.	*	30 JUL 0900	202	53.	*	2 AUG 0500	270	45.
24 JUL 1800	67	73.	*	27 JUL 1400	135	62.	*	30 JUL 1000	203	53.	*			
24 JUL 1900	68	73.	*	27 JUL 1500	136	62.	*	30 JUL 1100	204	53.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 435.	26.00		422.	294.	153.	82.
		(INCHES)	.052	.144	.225	.449
		(AC-FT)	209.	584.	909.	1818.

CUMULATIVE AREA = 75.90 SQ MI

*** ***

```
            **************
            *            *
  44 KK     *    BASIN6  *     GLADY CREEK SUBBASIN HYDROGRAPH
            *            *
            **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/GLADY/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/GLADY/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/GLADY/FLOW/01AUG1976/1HOUR/COMP/

              SUBBASIN RUNOFF DATA

  45 BA          SUBBASIN CHARACTERISTICS
                      TAREA       13.20  SUBBASIN AREA
```

***

****

HYDROGRAPH AT STATION BASIN6

****

* * *

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
			*				*				*			
22 JUL 0000	1	3.	*	24 JUL 2000	69	5.	*	27 JUL 1600	137	4.	*	30 JUL 1200	205	4.
22 JUL 0100	2	3.	*	24 JUL 2100	70	5.	*	27 JUL 1700	138	4.	*	30 JUL 1300	206	4.
22 JUL 0200	3	3.	*	24 JUL 2200	71	5.	*	27 JUL 1800	139	4.	*	30 JUL 1400	207	4.
22 JUL 0300	4	3.	*	24 JUL 2300	72	5.	*	27 JUL 1900	140	4.	*	30 JUL 1500	208	4.
22 JUL 0400	5	3.	*	25 JUL 0000	73	5.	*	27 JUL 2000	141	4.	*	30 JUL 1600	209	4.
22 JUL 0500	6	3.	*	25 JUL 0100	74	5.	*	27 JUL 2100	142	4.	*	30 JUL 1700	210	4.
22 JUL 0600	7	3.	*	25 JUL 0200	75	5.	*	27 JUL 2200	143	4.	*	30 JUL 1800	211	4.
22 JUL 0700	8	3.	*	25 JUL 0300	76	5.	*	27 JUL 2300	144	4.	*	30 JUL 1900	212	4.
22 JUL 0800	9	3.	*	25 JUL 0400	77	5.	*	28 JUL 0000	145	4.	*	30 JUL 2000	213	4.
22 JUL 0900	10	3.	*	25 JUL 0500	78	5.	*	28 JUL 0100	146	4.	*	30 JUL 2100	214	4.
22 JUL 1000	11	3.	*	25 JUL 0600	79	5.	*	28 JUL 0200	147	4.	*	30 JUL 2200	215	4.
22 JUL 1100	12	3.	*	25 JUL 0700	80	5.	*	28 JUL 0300	148	4.	*	30 JUL 2300	216	3.
22 JUL 1200	13	3.	*	25 JUL 0800	81	5.	*	28 JUL 0400	149	4.	*	31 JUL 0000	217	3.
22 JUL 1300	14	3.	*	25 JUL 0900	82	5.	*	28 JUL 0500	150	4.	*	31 JUL 0100	218	3.
22 JUL 1400	15	3.	*	25 JUL 1000	83	5.	*	28 JUL 0600	151	4.	*	31 JUL 0200	219	3.
22 JUL 1500	16	3.	*	25 JUL 1100	84	5.	*	28 JUL 0700	152	4.	*	31 JUL 0300	220	3.
22 JUL 1600	17	4.	*	25 JUL 1200	85	5.	*	28 JUL 0800	153	4.	*	31 JUL 0400	221	3.
22 JUL 1700	18	5.	*	25 JUL 1300	86	5.	*	28 JUL 0900	154	4.	*	31 JUL 0500	222	3.
22 JUL 1800	19	8.	*	25 JUL 1400	87	5.	*	28 JUL 1000	155	4.	*	31 JUL 0600	223	3.
22 JUL 1900	20	13.	*	25 JUL 1500	88	5.	*	28 JUL 1100	156	4.	*	31 JUL 0700	224	3.
22 JUL 2000	21	21.	*	25 JUL 1600	89	5.	*	28 JUL 1200	157	4.	*	31 JUL 0800	225	3.
22 JUL 2100	22	30.	*	25 JUL 1700	90	5.	*	28 JUL 1300	158	4.	*	31 JUL 0900	226	3.
22 JUL 2200	23	39.	*	25 JUL 1800	91	5.	*	28 JUL 1400	159	4.	*	31 JUL 1000	227	3.
22 JUL 2300	24	47.	*	25 JUL 1900	92	5.	*	28 JUL 1500	160	4.	*	31 JUL 1100	228	3.
23 JUL 0000	25	53.	*	25 JUL 2000	93	5.	*	28 JUL 1600	161	4.	*	31 JUL 1200	229	3.
23 JUL 0100	26	57.	*	25 JUL 2100	94	5.	*	28 JUL 1700	162	4.	*	31 JUL 1300	230	3.
23 JUL 0200	27	59.	*	25 JUL 2200	95	5.	*	28 JUL 1800	163	4.	*	31 JUL 1400	231	3.
23 JUL 0300	28	60.	*	25 JUL 2300	96	5.	*	28 JUL 1900	164	4.	*	31 JUL 1500	232	3.
23 JUL 0400	29	60.	*	26 JUL 0000	97	5.	*	28 JUL 2000	165	4.	*	31 JUL 1600	233	3.
23 JUL 0500	30	59.	*	26 JUL 0100	98	5.	*	28 JUL 2100	166	4.	*	31 JUL 1700	234	3.
23 JUL 0600	31	57.	*	26 JUL 0200	99	5.	*	28 JUL 2200	167	4.	*	31 JUL 1800	235	3.
23 JUL 0700	32	54.	*	26 JUL 0300	100	5.	*	28 JUL 2300	168	4.	*	31 JUL 1900	236	3.
23 JUL 0800	33	52.	*	26 JUL 0400	101	5.	*	29 JUL 0000	169	4.	*	31 JUL 2000	237	3.
23 JUL 0900	34	49.	*	26 JUL 0500	102	5.	*	29 JUL 0100	170	4.	*	31 JUL 2100	238	3.
23 JUL 1000	35	46.	*	26 JUL 0600	103	5.	*	29 JUL 0200	171	4.	*	31 JUL 2200	239	3.
23 JUL 1100	36	43.	*	26 JUL 0700	104	5.	*	29 JUL 0300	172	4.	*	31 JUL 2300	240	3.
23 JUL 1200	37	40.	*	26 JUL 0800	105	5.	*	29 JUL 0400	173	4.	*	1 AUG 0000	241	3.
23 JUL 1300	38	37.	*	26 JUL 0900	106	5.	*	29 JUL 0500	174	4.	*	1 AUG 0100	242	3.
23 JUL 1400	39	35.	*	26 JUL 1000	107	5.	*	29 JUL 0600	175	4.	*	1 AUG 0200	243	3.
23 JUL 1500	40	32.	*	26 JUL 1100	108	5.	*	29 JUL 0700	176	4.	*	1 AUG 0300	244	3.
23 JUL 1600	41	29.	*	26 JUL 1200	109	5.	*	29 JUL 0800	177	4.	*	1 AUG 0400	245	3.
23 JUL 1700	42	27.	*	26 JUL 1300	110	5.	*	29 JUL 0900	178	4.	*	1 AUG 0500	246	3.
23 JUL 1800	43	25.	*	26 JUL 1400	111	5.	*	29 JUL 1000	179	4.	*	1 AUG 0600	247	3.
23 JUL 1900	44	23.	*	26 JUL 1500	112	5.	*	29 JUL 1100	180	4.	*	1 AUG 0700	248	3.
23 JUL 2000	45	21.	*	26 JUL 1600	113	5.	*	29 JUL 1200	181	4.	*	1 AUG 0800	249	3.
23 JUL 2100	46	19.	*	26 JUL 1700	114	5.	*	29 JUL 1300	182	4.	*	1 AUG 0900	250	3.
23 JUL 2200	47	17.	*	26 JUL 1800	115	5.	*	29 JUL 1400	183	4.	*	1 AUG 1000	251	3.
23 JUL 2300	48	16.	*	26 JUL 1900	116	5.	*	29 JUL 1500	184	4.	*	1 AUG 1100	252	3.
24 JUL 0000	49	14.	*	26 JUL 2000	117	5.	*	29 JUL 1600	185	4.	*	1 AUG 1200	253	3.
24 JUL 0100	50	13.	*	26 JUL 2100	118	5.	*	29 JUL 1700	186	4.	*	1 AUG 1300	254	3.
24 JUL 0200	51	12.	*	26 JUL 2200	119	5.	*	29 JUL 1800	187	4.	*	1 AUG 1400	255	3.
24 JUL 0300	52	11.	*	26 JUL 2300	120	4.	*	29 JUL 1900	188	4.	*	1 AUG 1500	256	3.
24 JUL 0400	53	10.	*	27 JUL 0000	121	4.	*	29 JUL 2000	189	4.	*	1 AUG 1600	257	3.
24 JUL 0500	54	9.	*	27 JUL 0100	122	4.	*	29 JUL 2100	190	4.	*	1 AUG 1700	258	3.
24 JUL 0600	55	9.	*	27 JUL 0200	123	4.	*	29 JUL 2200	191	4.	*	1 AUG 1800	259	3.
24 JUL 0700	56	8.	*	27 JUL 0300	124	4.	*	29 JUL 2300	192	4.	*	1 AUG 1900	260	3.
24 JUL 0800	57	8.	*	27 JUL 0400	125	4.	*	30 JUL 0000	193	4.	*	1 AUG 2000	261	3.
24 JUL 0900	58	7.	*	27 JUL 0500	126	4.	*	30 JUL 0100	194	4.	*	1 AUG 2100	262	3.

24 JUL 1000	59	7.	*	27 JUL 0600	127	4.	*	30 JUL 0200	195	4.	*	1 AUG 2200	263	3.
24 JUL 1100	60	6.	*	27 JUL 0700	128	4.	*	30 JUL 0300	196	4.	*	1 AUG 2300	264	3.
24 JUL 1200	61	6.	*	27 JUL 0800	129	4.	*	30 JUL 0400	197	4.	*	2 AUG 0000	265	3.
24 JUL 1300	62	6.	*	27 JUL 0900	130	4.	*	30 JUL 0500	198	4.	*	2 AUG 0100	266	3.
24 JUL 1400	63	5.	*	27 JUL 1000	131	4.	*	30 JUL 0600	199	4.	*	2 AUG 0200	267	3.
24 JUL 1500	64	5.	*	27 JUL 1100	132	4.	*	30 JUL 0700	200	4.	*	2 AUG 0300	268	3.
24 JUL 1600	65	5.	*	27 JUL 1200	133	4.	*	30 JUL 0800	201	4.	*	2 AUG 0400	269	3.
24 JUL 1700	66	5.	*	27 JUL 1300	134	4.	*	30 JUL 0900	202	4.	*	2 AUG 0500	270	3.
24 JUL 1800	67	5.	*	27 JUL 1400	135	4.	*	30 JUL 1000	203	4.	*			
24 JUL 1900	68	5.	*	27 JUL 1500	136	4.	*	30 JUL 1100	204	4.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 60.	27.00		58.	43.	19.	8.
		(INCHES)	.041	.121	.164	.252
		(AC-FT)	29.	85.	115.	177.

CUMULATIVE AREA = 13.20 SQ MI

*** ***

```
          **************
          *            *
47 KK     *     STA4   *     COMBINED HYDROGRAPH FOR CHANNEL REACH3 AND GLADY CREEK
          *            *
          **************
```

48 HC HYDROGRAPH COMBINATION

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

****

HYDROGRAPH AT STATION STA4

SUM OF 2 HYDROGRAPHS

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	52.	*	24 JUL 2000	69	78.	*	27 JUL 1600	137	66.	*	30 JUL 1200	205	56.
22 JUL 0100	2	52.	*	24 JUL 2100	70	78.	*	27 JUL 1700	138	66.	*	30 JUL 1300	206	56.
22 JUL 0200	3	52.	*	24 JUL 2200	71	78.	*	27 JUL 1800	139	66.	*	30 JUL 1400	207	56.
22 JUL 0300	4	52.	*	24 JUL 2300	72	78.	*	27 JUL 1900	140	66.	*	30 JUL 1500	208	56.
22 JUL 0400	5	52.	*	25 JUL 0000	73	77.	*	27 JUL 2000	141	66.	*	30 JUL 1600	209	56.
22 JUL 0500	6	52.	*	25 JUL 0100	74	77.	*	27 JUL 2100	142	65.	*	30 JUL 1700	210	56.
22 JUL 0600	7	52.	*	25 JUL 0200	75	77.	*	27 JUL 2200	143	65.	*	30 JUL 1800	211	56.
22 JUL 0700	8	52.	*	25 JUL 0300	76	77.	*	27 JUL 2300	144	65.	*	30 JUL 1900	212	55.
22 JUL 0800	9	52.	*	25 JUL 0400	77	77.	*	28 JUL 0000	145	65.	*	30 JUL 2000	213	55.
22 JUL 0900	10	52.	*	25 JUL 0500	78	76.	*	28 JUL 0100	146	65.	*	30 JUL 2100	214	55.
22 JUL 1000	11	51.	*	25 JUL 0600	79	76.	*	28 JUL 0200	147	65.	*	30 JUL 2200	215	55.

22 JUL 1100	12	51.	*	25 JUL 0700	80	76.	*	28 JUL 0300	148	65.	*	30 JUL 2300	216	55.
22 JUL 1200	13	51.	*	25 JUL 0800	81	76.	*	28 JUL 0400	149	64.	*	31 JUL 0000	217	55.
22 JUL 1300	14	51.	*	25 JUL 0900	82	76.	*	28 JUL 0500	150	64.	*	31 JUL 0100	218	55.
22 JUL 1400	15	51.	*	25 JUL 1000	83	75.	*	28 JUL 0600	151	64.	*	31 JUL 0200	219	55.
22 JUL 1500	16	51.	*	25 JUL 1100	84	75.	*	28 JUL 0700	152	64.	*	31 JUL 0300	220	54.
22 JUL 1600	17	54.	*	25 JUL 1200	85	75.	*	28 JUL 0800	153	64.	*	31 JUL 0400	221	54.
22 JUL 1700	18	83.	*	25 JUL 1300	86	75.	*	28 JUL 0900	154	64.	*	31 JUL 0500	222	54.
22 JUL 1800	19	141.	*	25 JUL 1400	87	75.	*	28 JUL 1000	155	63.	*	31 JUL 0600	223	54.
22 JUL 1900	20	188.	*	25 JUL 1500	88	75.	*	28 JUL 1100	156	63.	*	31 JUL 0700	224	54.
22 JUL 2000	21	210.	*	25 JUL 1600	89	74.	*	28 JUL 1200	157	63.	*	31 JUL 0800	225	54.
22 JUL 2100	22	232.	*	25 JUL 1700	90	74.	*	28 JUL 1300	158	63.	*	31 JUL 0900	226	54.
22 JUL 2200	23	307.	*	25 JUL 1800	91	74.	*	28 JUL 1400	159	63.	*	31 JUL 1000	227	54.
22 JUL 2300	24	402.	*	25 JUL 1900	92	74.	*	28 JUL 1500	160	63.	*	31 JUL 1100	228	53.
23 JUL 0000	25	461.	*	25 JUL 2000	93	74.	*	28 JUL 1600	161	63.	*	31 JUL 1200	229	53.
23 JUL 0100	26	489.	*	25 JUL 2100	94	74.	*	28 JUL 1700	162	62.	*	31 JUL 1300	230	53.
23 JUL 0200	27	494.	*	25 JUL 2200	95	73.	*	28 JUL 1800	163	62.	*	31 JUL 1400	231	53.
23 JUL 0300	28	492.	*	25 JUL 2300	96	73.	*	28 JUL 1900	164	62.	*	31 JUL 1500	232	53.
23 JUL 0400	29	484.	*	26 JUL 0000	97	73.	*	28 JUL 2000	165	62.	*	31 JUL 1600	233	53.
23 JUL 0500	30	468.	*	26 JUL 0100	98	73.	*	28 JUL 2100	166	62.	*	31 JUL 1700	234	53.
23 JUL 0600	31	444.	*	26 JUL 0200	99	73.	*	28 JUL 2200	167	62.	*	31 JUL 1800	235	53.
23 JUL 0700	32	418.	*	26 JUL 0300	100	72.	*	28 JUL 2300	168	62.	*	31 JUL 1900	236	52.
23 JUL 0800	33	390.	*	26 JUL 0400	101	72.	*	29 JUL 0000	169	61.	*	31 JUL 2000	237	52.
23 JUL 0900	34	363.	*	26 JUL 0500	102	72.	*	29 JUL 0100	170	61.	*	31 JUL 2100	238	52.
23 JUL 1000	35	337.	*	26 JUL 0600	103	72.	*	29 JUL 0200	171	61.	*	31 JUL 2200	239	52.
23 JUL 1100	36	313.	*	26 JUL 0700	104	72.	*	29 JUL 0300	172	61.	*	31 JUL 2300	240	52.
23 JUL 1200	37	289.	*	26 JUL 0800	105	72.	*	29 JUL 0400	173	61.	*	1 AUG 0000	241	52.
23 JUL 1300	38	266.	*	26 JUL 0900	106	71.	*	29 JUL 0500	174	61.	*	1 AUG 0100	242	52.
23 JUL 1400	39	245.	*	26 JUL 1000	107	71.	*	29 JUL 0600	175	61.	*	1 AUG 0200	243	52.
23 JUL 1500	40	226.	*	26 JUL 1100	108	71.	*	29 JUL 0700	176	60.	*	1 AUG 0300	244	51.
23 JUL 1600	41	209.	*	26 JUL 1200	109	71.	*	29 JUL 0800	177	60.	*	1 AUG 0400	245	51.
23 JUL 1700	42	193.	*	26 JUL 1300	110	71.	*	29 JUL 0900	178	60.	*	1 AUG 0500	246	51.
23 JUL 1800	43	178.	*	26 JUL 1400	111	71.	*	29 JUL 1000	179	60.	*	1 AUG 0600	247	51.
23 JUL 1900	44	165.	*	26 JUL 1500	112	70.	*	29 JUL 1100	180	60.	*	1 AUG 0700	248	51.
23 JUL 2000	45	153.	*	26 JUL 1600	113	70.	*	29 JUL 1200	181	60.	*	1 AUG 0800	249	51.
23 JUL 2100	46	142.	*	26 JUL 1700	114	70.	*	29 JUL 1300	182	60.	*	1 AUG 0900	250	51.
23 JUL 2200	47	133.	*	26 JUL 1800	115	70.	*	29 JUL 1400	183	59.	*	1 AUG 1000	251	51.
23 JUL 2300	48	125.	*	26 JUL 1900	116	70.	*	29 JUL 1500	184	59.	*	1 AUG 1100	252	50.
24 JUL 0000	49	117.	*	26 JUL 2000	117	70.	*	29 JUL 1600	185	59.	*	1 AUG 1200	253	50.
24 JUL 0100	50	111.	*	26 JUL 2100	118	69.	*	29 JUL 1700	186	59.	*	1 AUG 1300	254	50.
24 JUL 0200	51	105.	*	26 JUL 2200	119	69.	*	29 JUL 1800	187	59.	*	1 AUG 1400	255	50.
24 JUL 0300	52	100.	*	26 JUL 2300	120	69.	*	29 JUL 1900	188	59.	*	1 AUG 1500	256	50.
24 JUL 0400	53	96.	*	27 JUL 0000	121	69.	*	29 JUL 2000	189	59.	*	1 AUG 1600	257	50.
24 JUL 0500	54	92.	*	27 JUL 0100	122	69.	*	29 JUL 2100	190	58.	*	1 AUG 1700	258	50.
24 JUL 0600	55	89.	*	27 JUL 0200	123	69.	*	29 JUL 2200	191	58.	*	1 AUG 1800	259	50.
24 JUL 0700	56	86.	*	27 JUL 0300	124	68.	*	29 JUL 2300	192	58.	*	1 AUG 1900	260	50.
24 JUL 0800	57	84.	*	27 JUL 0400	125	68.	*	30 JUL 0000	193	58.	*	1 AUG 2000	261	49.
24 JUL 0900	58	83.	*	27 JUL 0500	126	68.	*	30 JUL 0100	194	58.	*	1 AUG 2100	262	49.
24 JUL 1000	59	82.	*	27 JUL 0600	127	68.	*	30 JUL 0200	195	58.	*	1 AUG 2200	263	49.
24 JUL 1100	60	81.	*	27 JUL 0700	128	68.	*	30 JUL 0300	196	58.	*	1 AUG 2300	264	49.
24 JUL 1200	61	80.	*	27 JUL 0800	129	68.	*	30 JUL 0400	197	57.	*	2 AUG 0000	265	49.
24 JUL 1300	62	80.	*	27 JUL 0900	130	67.	*	30 JUL 0500	198	57.	*	2 AUG 0100	266	49.
24 JUL 1400	63	79.	*	27 JUL 1000	131	67.	*	30 JUL 0600	199	57.	*	2 AUG 0200	267	49.
24 JUL 1500	64	79.	*	27 JUL 1100	132	67.	*	30 JUL 0700	200	57.	*	2 AUG 0300	268	49.
24 JUL 1600	65	79.	*	27 JUL 1200	133	67.	*	30 JUL 0800	201	57.	*	2 AUG 0400	269	48.
24 JUL 1700	66	79.	*	27 JUL 1300	134	67.	*	30 JUL 0900	202	57.	*	2 AUG 0500	270	48.
24 JUL 1800	67	78.	*	27 JUL 1400	135	67.	*	30 JUL 1000	203	57.	*			
24 JUL 1900	68	78.	*	27 JUL 1500	136	66.	*	30 JUL 1100	204	56.	*			
			*				*				*			

****

```
 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR    269.00-HR
+   (CFS)       (HR)
                          (CFS)
+    494.     26.00                 480.         337.         172.          90.
                        (INCHES)    .050         .141         .216         .420
                         (AC-FT)    238.         668.        1024.        1996.

                        CUMULATIVE AREA =   89.10 SQ MI
```

*** ***

```
          **************
          *            *
 49 KK    *   REACH4   *     OUTFLOW HYDROGRAPH FOR CHANNEL REACH4
          *            *
          **************

            HYDROGRAPH ROUTING DATA

 51 RL        ROUTING LOSSES
                   QLOSS       -5.60  INITIAL LOSS
                   CLOSS         .00  ADDITIONAL FRACTION LOST

 50 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

 52 RC        NORMAL DEPTH CHANNEL
                     ANL        .100  LEFT OVERBANK N-VALUE
                    ANCH        .060  MAIN CHANNEL N-VALUE
                     ANR        .100  RIGHT OVERBANK N-VALUE
                   RLNTH       6800.  REACH LENGTH
                     SEL      .0010  ENERGY SLOPE
                   ELMAX      1028.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                   CROSS-SECTION DATA
                        --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 54 RY      ELEVATION   1028.00   1026.00   1025.00   1018.00   1018.00   1025.00   1026.00   1028.00
 53 RX      DISTANCE        .00      1.00     50.00     55.00    100.00    105.00    155.00    156.00

                                                  ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

        STORAGE        .00      3.73      7.52     11.37     15.28     19.26     23.30     27.39     31.55     35.78
        OUTFLOW        .00     12.06     38.12     74.61    120.05    173.51    234.37    302.13    376.44    456.99
      ELEVATION    1018.00   1018.53   1019.05   1019.58   1020.11   1020.63   1021.16   1021.68   1022.21   1022.74

        STORAGE      40.06     44.41     48.81     53.28     58.85     68.51     81.09     93.80    106.55    119.35
        OUTFLOW     543.54    635.89    733.88    837.38    956.02   1093.59   1257.14   1442.46   1646.11   1866.60
      ELEVATION    1023.26   1023.79   1024.32   1024.84   1025.37   1025.89   1026.42   1026.95   1027.47   1028.00

                        COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                COMPUTATION TIME STEP
              ELEMENT    ALPHA       M        DT        DX      PEAK   TIME TO    VOLUME   MAXIMUM
                                                                          PEAK              CELERITY
                                             (MIN)      (FT)     (CFS)    (MIN)     (IN)     (FPS)
```

MAIN 33.00 3400.00 493.04 1617.00 .42 2.48

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN 60.00 492.91 1620.00 .42

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1998E+04 EXCESS= .0000E+00 OUTFLOW= .1998E+04 BASIN STORAGE=-.3916E+00 PERCENT ERROR= .0

****

HYDROGRAPH AT STATION REACH4

****

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	58.	24 JUL 2000	69	84.	27 JUL 1600	137	72.	30 JUL 1200	205	62.
22 JUL 0100	2	58.	24 JUL 2100	70	84.	27 JUL 1700	138	72.	30 JUL 1300	206	62.
22 JUL 0200	3	58.	24 JUL 2200	71	84.	27 JUL 1800	139	72.	30 JUL 1400	207	62.
22 JUL 0300	4	58.	24 JUL 2300	72	83.	27 JUL 1900	140	72.	30 JUL 1500	208	62.
22 JUL 0400	5	58.	25 JUL 0000	73	83.	27 JUL 2000	141	71.	30 JUL 1600	209	62.
22 JUL 0500	6	58.	25 JUL 0100	74	83.	27 JUL 2100	142	71.	30 JUL 1700	210	61.
22 JUL 0600	7	58.	25 JUL 0200	75	83.	27 JUL 2200	143	71.	30 JUL 1800	211	61.
22 JUL 0700	8	58.	25 JUL 0300	76	83.	27 JUL 2300	144	71.	30 JUL 1900	212	61.
22 JUL 0800	9	57.	25 JUL 0400	77	82.	28 JUL 0000	145	71.	30 JUL 2000	213	61.
22 JUL 0900	10	57.	25 JUL 0500	78	82.	28 JUL 0100	146	71.	30 JUL 2100	214	61.
22 JUL 1000	11	57.	25 JUL 0600	79	82.	28 JUL 0200	147	71.	30 JUL 2200	215	61.
22 JUL 1100	12	57.	25 JUL 0700	80	82.	28 JUL 0300	148	70.	30 JUL 2300	216	61.
22 JUL 1200	13	57.	25 JUL 0800	81	82.	28 JUL 0400	149	70.	31 JUL 0000	217	61.
22 JUL 1300	14	57.	25 JUL 0900	82	82.	28 JUL 0500	150	70.	31 JUL 0100	218	60.
22 JUL 1400	15	57.	25 JUL 1000	83	81.	28 JUL 0600	151	70.	31 JUL 0200	219	60.
22 JUL 1500	16	57.	25 JUL 1100	84	81.	28 JUL 0700	152	70.	31 JUL 0300	220	60.
22 JUL 1600	17	57.	25 JUL 1200	85	81.	28 JUL 0800	153	70.	31 JUL 0400	221	60.
22 JUL 1700	18	59.	25 JUL 1300	86	81.	28 JUL 0900	154	69.	31 JUL 0500	222	60.
22 JUL 1800	19	86.	25 JUL 1400	87	81.	28 JUL 1000	155	69.	31 JUL 0600	223	60.
22 JUL 1900	20	144.	25 JUL 1500	88	80.	28 JUL 1100	156	69.	31 JUL 0700	224	60.
22 JUL 2000	21	192.	25 JUL 1600	89	80.	28 JUL 1200	157	69.	31 JUL 0800	225	60.
22 JUL 2100	22	219.	25 JUL 1700	90	80.	28 JUL 1300	158	69.	31 JUL 0900	226	59.
22 JUL 2200	23	258.	25 JUL 1800	91	80.	28 JUL 1400	159	69.	31 JUL 1000	227	59.
22 JUL 2300	24	341.	25 JUL 1900	92	80.	28 JUL 1500	160	69.	31 JUL 1100	228	59.
23 JUL 0000	25	424.	25 JUL 2000	93	80.	28 JUL 1600	161	68.	31 JUL 1200	229	59.
23 JUL 0100	26	474.	25 JUL 2100	94	79.	28 JUL 1700	162	68.	31 JUL 1300	230	59.
23 JUL 0200	27	495.	25 JUL 2200	95	79.	28 JUL 1800	163	68.	31 JUL 1400	231	59.
23 JUL 0300	28	499.	25 JUL 2300	96	79.	28 JUL 1900	164	68.	31 JUL 1500	232	59.
23 JUL 0400	29	494.	26 JUL 0000	97	79.	28 JUL 2000	165	68.	31 JUL 1600	233	59.
23 JUL 0500	30	483.	26 JUL 0100	98	79.	28 JUL 2100	166	68.	31 JUL 1700	234	58.
23 JUL 0600	31	464.	26 JUL 0200	99	78.	28 JUL 2200	167	68.	31 JUL 1800	235	58.
23 JUL 0700	32	440.	26 JUL 0300	100	78.	28 JUL 2300	168	67.	31 JUL 1900	236	58.
23 JUL 0800	33	414.	26 JUL 0400	101	78.	29 JUL 0000	169	67.	31 JUL 2000	237	58.
23 JUL 0900	34	387.	26 JUL 0500	102	78.	29 JUL 0100	170	67.	31 JUL 2100	238	58.
23 JUL 1000	35	361.	26 JUL 0600	103	78.	29 JUL 0200	171	67.	31 JUL 2200	239	58.
23 JUL 1100	36	336.	26 JUL 0700	104	78.	29 JUL 0300	172	67.	31 JUL 2300	240	58.
23 JUL 1200	37	312.	26 JUL 0800	105	77.	29 JUL 0400	173	67.	1 AUG 0000	241	58.
23 JUL 1300	38	289.	26 JUL 0900	106	77.	29 JUL 0500	174	66.	1 AUG 0100	242	57.

23 JUL 1400	39	267.	*	26 JUL 1000	107	77.	*	29 JUL 0600	175	66.	*	1 AUG 0200	243	57.
23 JUL 1500	40	247.	*	26 JUL 1100	108	77.	*	29 JUL 0700	176	66.	*	1 AUG 0300	244	57.
23 JUL 1600	41	229.	*	26 JUL 1200	109	77.	*	29 JUL 0800	177	66.	*	1 AUG 0400	245	57.
23 JUL 1700	42	212.	*	26 JUL 1300	110	77.	*	29 JUL 0900	178	66.	*	1 AUG 0500	246	57.
23 JUL 1800	43	196.	*	26 JUL 1400	111	76.	*	29 JUL 1000	179	66.	*	1 AUG 0600	247	57.
23 JUL 1900	44	182.	*	26 JUL 1500	112	76.	*	29 JUL 1100	180	66.	*	1 AUG 0700	248	57.
23 JUL 2000	45	169.	*	26 JUL 1600	113	76.	*	29 JUL 1200	181	65.	*	1 AUG 0800	249	57.
23 JUL 2100	46	158.	*	26 JUL 1700	114	76.	*	29 JUL 1300	182	65.	*	1 AUG 0900	250	56.
23 JUL 2200	47	148.	*	26 JUL 1800	115	76.	*	29 JUL 1400	183	65.	*	1 AUG 1000	251	56.
23 JUL 2300	48	139.	*	26 JUL 1900	116	76.	*	29 JUL 1500	184	65.	*	1 AUG 1100	252	56.
24 JUL 0000	49	131.	*	26 JUL 2000	117	75.	*	29 JUL 1600	185	65.	*	1 AUG 1200	253	56.
24 JUL 0100	50	123.	*	26 JUL 2100	118	75.	*	29 JUL 1700	186	65.	*	1 AUG 1300	254	56.
24 JUL 0200	51	117.	*	26 JUL 2200	119	75.	*	29 JUL 1800	187	65.	*	1 AUG 1400	255	56.
24 JUL 0300	52	112.	*	26 JUL 2300	120	75.	*	29 JUL 1900	188	64.	*	1 AUG 1500	256	56.
24 JUL 0400	53	107.	*	27 JUL 0000	121	75.	*	29 JUL 2000	189	64.	*	1 AUG 1600	257	56.
24 JUL 0500	54	103.	*	27 JUL 0100	122	75.	*	29 JUL 2100	190	64.	*	1 AUG 1700	258	56.
24 JUL 0600	55	99.	*	27 JUL 0200	123	74.	*	29 JUL 2200	191	64.	*	1 AUG 1800	259	55.
24 JUL 0700	56	95.	*	27 JUL 0300	124	74.	*	29 JUL 2300	192	64.	*	1 AUG 1900	260	55.
24 JUL 0800	57	93.	*	27 JUL 0400	125	74.	*	30 JUL 0000	193	64.	*	1 AUG 2000	261	55.
24 JUL 0900	58	90.	*	27 JUL 0500	126	74.	*	30 JUL 0100	194	64.	*	1 AUG 2100	262	55.
24 JUL 1000	59	89.	*	27 JUL 0600	127	74.	*	30 JUL 0200	195	64.	*	1 AUG 2200	263	55.
24 JUL 1100	60	87.	*	27 JUL 0700	128	74.	*	30 JUL 0300	196	63.	*	1 AUG 2300	264	55.
24 JUL 1200	61	87.	*	27 JUL 0800	129	73.	*	30 JUL 0400	197	63.	*	2 AUG 0000	265	55.
24 JUL 1300	62	86.	*	27 JUL 0900	130	73.	*	30 JUL 0500	198	63.	*	2 AUG 0100	266	55.
24 JUL 1400	63	86.	*	27 JUL 1000	131	73.	*	30 JUL 0600	199	63.	*	2 AUG 0200	267	54.
24 JUL 1500	64	85.	*	27 JUL 1100	132	73.	*	30 JUL 0700	200	63.	*	2 AUG 0300	268	54.
24 JUL 1600	65	85.	*	27 JUL 1200	133	73.	*	30 JUL 0800	201	63.	*	2 AUG 0400	269	54.
24 JUL 1700	66	85.	*	27 JUL 1300	134	73.	*	30 JUL 0900	202	63.	*	2 AUG 0500	270	54.
24 JUL 1800	67	84.	*	27 JUL 1400	135	72.	*	30 JUL 1000	203	62.	*			
24 JUL 1900	68	84.	*	27 JUL 1500	136	72.	*	30 JUL 1100	204	62.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 499.	27.00		482.	342.	178.	95.
		(INCHES)	.050	.143	.222	.446
		(AC-FT)	239.	678.	1057.	2120.

CUMULATIVE AREA = 89.10 SQ MI

*** ***

```
            **************
            *            *
  55 KK     *    BASIN7  *     KINGS CREEK SUBBASIN HYDROGRAPH
            *            *
            **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/KINGS/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/KINGS/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/KINGS/FLOW/01AUG1976/1HOUR/COMP/
```

SUBBASIN RUNOFF DATA

56 BA SUBBASIN CHARACTERISTICS

TAREA 45.00 SUBBASIN AREA

***

HYDROGRAPH AT STATION BASIN7

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	19.	24 JUL 2000	69	31.	27 JUL 1600	137	26.	30 JUL 1200	205	22.
22 JUL 0100	2	19.	24 JUL 2100	70	31.	27 JUL 1700	138	26.	30 JUL 1300	206	22.
22 JUL 0200	3	19.	24 JUL 2200	71	31.	27 JUL 1800	139	26.	30 JUL 1400	207	22.
22 JUL 0300	4	19.	24 JUL 2300	72	31.	27 JUL 1900	140	26.	30 JUL 1500	208	22.
22 JUL 0400	5	19.	25 JUL 0000	73	31.	27 JUL 2000	141	26.	30 JUL 1600	209	21.
22 JUL 0500	6	19.	25 JUL 0100	74	30.	27 JUL 2100	142	26.	30 JUL 1700	210	21.
22 JUL 0600	7	19.	25 JUL 0200	75	30.	27 JUL 2200	143	25.	30 JUL 1800	211	21.
22 JUL 0700	8	19.	25 JUL 0300	76	30.	27 JUL 2300	144	25.	30 JUL 1900	212	21.
22 JUL 0800	9	19.	25 JUL 0400	77	30.	28 JUL 0000	145	25.	30 JUL 2000	213	21.
22 JUL 0900	10	19.	25 JUL 0500	78	30.	28 JUL 0100	146	25.	30 JUL 2100	214	21.
22 JUL 1000	11	19.	25 JUL 0600	79	30.	28 JUL 0200	147	25.	30 JUL 2200	215	21.
22 JUL 1100	12	18.	25 JUL 0700	80	30.	28 JUL 0300	148	25.	30 JUL 2300	216	21.
22 JUL 1200	13	18.	25 JUL 0800	81	30.	28 JUL 0400	149	25.	31 JUL 0000	217	21.
22 JUL 1300	14	18.	25 JUL 0900	82	30.	28 JUL 0500	150	25.	31 JUL 0100	218	21.
22 JUL 1400	15	18.	25 JUL 1000	83	30.	28 JUL 0600	151	25.	31 JUL 0200	219	21.
22 JUL 1500	16	18.	25 JUL 1100	84	30.	28 JUL 0700	152	25.	31 JUL 0300	220	21.
22 JUL 1600	17	21.	25 JUL 1200	85	30.	28 JUL 0800	153	25.	31 JUL 0400	221	21.
22 JUL 1700	18	34.	25 JUL 1300	86	30.	28 JUL 0900	154	25.	31 JUL 0500	222	21.
22 JUL 1800	19	64.	25 JUL 1400	87	29.	28 JUL 1000	155	25.	31 JUL 0600	223	21.
22 JUL 1900	20	111.	25 JUL 1500	88	29.	28 JUL 1100	156	25.	31 JUL 0700	224	21.
22 JUL 2000	21	162.	25 JUL 1600	89	29.	28 JUL 1200	157	25.	31 JUL 0800	225	21.
22 JUL 2100	22	207.	25 JUL 1700	90	29.	28 JUL 1300	158	25.	31 JUL 0900	226	21.
22 JUL 2200	23	240.	25 JUL 1800	91	29.	28 JUL 1400	159	24.	31 JUL 1000	227	20.
22 JUL 2300	24	261.	25 JUL 1900	92	29.	28 JUL 1500	160	24.	31 JUL 1100	228	20.
23 JUL 0000	25	275.	25 JUL 2000	93	29.	28 JUL 1600	161	24.	31 JUL 1200	229	20.
23 JUL 0100	26	280.	25 JUL 2100	94	29.	28 JUL 1700	162	24.	31 JUL 1300	230	20.
23 JUL 0200	27	277.	25 JUL 2200	95	29.	28 JUL 1800	163	24.	31 JUL 1400	231	20.
23 JUL 0300	28	266.	25 JUL 2300	96	29.	28 JUL 1900	164	24.	31 JUL 1500	232	20.
23 JUL 0400	29	250.	26 JUL 0000	97	29.	28 JUL 2000	165	24.	31 JUL 1600	233	20.
23 JUL 0500	30	231.	26 JUL 0100	98	29.	28 JUL 2100	166	24.	31 JUL 1700	234	20.
23 JUL 0600	31	212.	26 JUL 0200	99	29.	28 JUL 2200	167	24.	31 JUL 1800	235	20.
23 JUL 0700	32	193.	26 JUL 0300	100	28.	28 JUL 2300	168	24.	31 JUL 1900	236	20.
23 JUL 0800	33	174.	26 JUL 0400	101	28.	29 JUL 0000	169	24.	31 JUL 2000	237	20.
23 JUL 0900	34	156.	26 JUL 0500	102	28.	29 JUL 0100	170	24.	31 JUL 2100	238	20.
23 JUL 1000	35	139.	26 JUL 0600	103	28.	29 JUL 0200	171	24.	31 JUL 2200	239	20.
23 JUL 1100	36	123.	26 JUL 0700	104	28.	29 JUL 0300	172	24.	31 JUL 2300	240	20.
23 JUL 1200	37	108.	26 JUL 0800	105	28.	29 JUL 0400	173	24.	1 AUG 0000	241	20.
23 JUL 1300	38	95.	26 JUL 0900	106	28.	29 JUL 0500	174	24.	1 AUG 0100	242	20.
23 JUL 1400	39	84.	26 JUL 1000	107	28.	29 JUL 0600	175	23.	1 AUG 0200	243	20.
23 JUL 1500	40	74.	26 JUL 1100	108	28.	29 JUL 0700	176	23.	1 AUG 0300	244	20.
23 JUL 1600	41	66.	26 JUL 1200	109	28.	29 JUL 0800	177	23.	1 AUG 0400	245	20.
23 JUL 1700	42	59.	26 JUL 1300	110	28.	29 JUL 0900	178	23.	1 AUG 0500	246	20.
23 JUL 1800	43	54.	26 JUL 1400	111	28.	29 JUL 1000	179	23.	1 AUG 0600	247	19.
23 JUL 1900	44	49.	26 JUL 1500	112	28.	29 JUL 1100	180	23.	1 AUG 0700	248	19.
23 JUL 2000	45	45.	26 JUL 1600	113	28.	29 JUL 1200	181	23.	1 AUG 0800	249	19.
23 JUL 2100	46	42.	26 JUL 1700	114	27.	29 JUL 1300	182	23.	1 AUG 0900	250	19.
23 JUL 2200	47	39.	26 JUL 1800	115	27.	29 JUL 1400	183	23.	1 AUG 1000	251	19.

23 JUL 2300	48	36.	*	26 JUL 1900	116	27.	*	29 JUL 1500	184	23.	*	1 AUG 1100	252	19.
24 JUL 0000	49	33.	*	26 JUL 2000	117	27.	*	29 JUL 1600	185	23.	*	1 AUG 1200	253	19.
24 JUL 0100	50	32.	*	26 JUL 2100	118	27.	*	29 JUL 1700	186	23.	*	1 AUG 1300	254	19.
24 JUL 0200	51	32.	*	26 JUL 2200	119	27.	*	29 JUL 1800	187	23.	*	1 AUG 1400	255	19.
24 JUL 0300	52	32.	*	26 JUL 2300	120	27.	*	29 JUL 1900	188	23.	*	1 AUG 1500	256	19.
24 JUL 0400	53	32.	*	27 JUL 0000	121	27.	*	29 JUL 2000	189	23.	*	1 AUG 1600	257	19.
24 JUL 0500	54	32.	*	27 JUL 0100	122	27.	*	29 JUL 2100	190	23.	*	1 AUG 1700	258	19.
24 JUL 0600	55	32.	*	27 JUL 0200	123	27.	*	29 JUL 2200	191	22.	*	1 AUG 1800	259	19.
24 JUL 0700	56	32.	*	27 JUL 0300	124	27.	*	29 JUL 2300	192	22.	*	1 AUG 1900	260	19.
24 JUL 0800	57	32.	*	27 JUL 0400	125	27.	*	30 JUL 0000	193	22.	*	1 AUG 2000	261	19.
24 JUL 0900	58	32.	*	27 JUL 0500	126	27.	*	30 JUL 0100	194	22.	*	1 AUG 2100	262	19.
24 JUL 1000	59	32.	*	27 JUL 0600	127	27.	*	30 JUL 0200	195	22.	*	1 AUG 2200	263	19.
24 JUL 1100	60	32.	*	27 JUL 0700	128	26.	*	30 JUL 0300	196	22.	*	1 AUG 2300	264	19.
24 JUL 1200	61	32.	*	27 JUL 0800	129	26.	*	30 JUL 0400	197	22.	*	2 AUG 0000	265	19.
24 JUL 1300	62	31.	*	27 JUL 0900	130	26.	*	30 JUL 0500	198	22.	*	2 AUG 0100	266	19.
24 JUL 1400	63	31.	*	27 JUL 1000	131	26.	*	30 JUL 0600	199	22.	*	2 AUG 0200	267	18.
24 JUL 1500	64	31.	*	27 JUL 1100	132	26.	*	30 JUL 0700	200	22.	*	2 AUG 0300	268	18.
24 JUL 1600	65	31.	*	27 JUL 1200	133	26.	*	30 JUL 0800	201	22.	*	2 AUG 0400	269	18.
24 JUL 1700	66	31.	*	27 JUL 1300	134	26.	*	30 JUL 0900	202	22.	*	2 AUG 0500	270	18.
24 JUL 1800	67	31.	*	27 JUL 1400	135	26.	*	30 JUL 1000	203	22.	*			
24 JUL 1900	68	31.	*	27 JUL 1500	136	26.	*	30 JUL 1100	204	22.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 280.	25.00		267.	171.	79.	38.
		(INCHES)	.055	.141	.195	.351
		(AC-FT)	133.	339.	469.	843.

CUMULATIVE AREA = 45.00 SQ MI

*** ***

```
            **************
            *            *
 58 KK      *     STA5   *     COMBINED HYDROGRAPH FOR CHANNEL REACH4 AND KINGS CREEK
            *            *
            **************
```

59 HC HYDROGRAPH COMBINATION

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

****

HYDROGRAPH AT STATION STA5

SUM OF 2 HYDROGRAPHS

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
			*				*				*			

22 JUL 0000	1	77.	*	24 JUL 2000	69	115.	*	27 JUL 1600	137	98.	*	30 JUL 1200	205	84.
22 JUL 0100	2	77.	*	24 JUL 2100	70	115.	*	27 JUL 1700	138	98.	*	30 JUL 1300	206	84.
22 JUL 0200	3	77.	*	24 JUL 2200	71	114.	*	27 JUL 1800	139	98.	*	30 JUL 1400	207	83.
22 JUL 0300	4	77.	*	24 JUL 2300	72	114.	*	27 JUL 1900	140	97.	*	30 JUL 1500	208	83.
22 JUL 0400	5	77.	*	25 JUL 0000	73	114.	*	27 JUL 2000	141	97.	*	30 JUL 1600	209	83.
22 JUL 0500	6	76.	*	25 JUL 0100	74	113.	*	27 JUL 2100	142	97.	*	30 JUL 1700	210	83.
22 JUL 0600	7	76.	*	25 JUL 0200	75	113.	*	27 JUL 2200	143	97.	*	30 JUL 1800	211	83.
22 JUL 0700	8	76.	*	25 JUL 0300	76	113.	*	27 JUL 2300	144	96.	*	30 JUL 1900	212	83.
22 JUL 0800	9	76.	*	25 JUL 0400	77	113.	*	28 JUL 0000	145	96.	*	30 JUL 2000	213	82.
22 JUL 0900	10	76.	*	25 JUL 0500	78	112.	*	28 JUL 0100	146	96.	*	30 JUL 2100	214	82.
22 JUL 1000	11	76.	*	25 JUL 0600	79	112.	*	28 JUL 0200	147	96.	*	30 JUL 2200	215	82.
22 JUL 1100	12	76.	*	25 JUL 0700	80	112.	*	28 JUL 0300	148	96.	*	30 JUL 2300	216	82.
22 JUL 1200	13	75.	*	25 JUL 0800	81	112.	*	28 JUL 0400	149	95.	*	31 JUL 0000	217	82.
22 JUL 1300	14	75.	*	25 JUL 0900	82	111.	*	28 JUL 0500	150	95.	*	31 JUL 0100	218	81.
22 JUL 1400	15	75.	*	25 JUL 1000	83	111.	*	28 JUL 0600	151	95.	*	31 JUL 0200	219	81.
22 JUL 1500	16	75.	*	25 JUL 1100	84	111.	*	28 JUL 0700	152	95.	*	31 JUL 0300	220	81.
22 JUL 1600	17	78.	*	25 JUL 1200	85	111.	*	28 JUL 0800	153	94.	*	31 JUL 0400	221	81.
22 JUL 1700	18	93.	*	25 JUL 1300	86	110.	*	28 JUL 0900	154	94.	*	31 JUL 0500	222	81.
22 JUL 1800	19	150.	*	25 JUL 1400	87	110.	*	28 JUL 1000	155	94.	*	31 JUL 0600	223	81.
22 JUL 1900	20	255.	*	25 JUL 1500	88	110.	*	28 JUL 1100	156	94.	*	31 JUL 0700	224	80.
22 JUL 2000	21	354.	*	25 JUL 1600	89	110.	*	28 JUL 1200	157	94.	*	31 JUL 0800	225	80.
22 JUL 2100	22	426.	*	25 JUL 1700	90	109.	*	28 JUL 1300	158	93.	*	31 JUL 0900	226	80.
22 JUL 2200	23	498.	*	25 JUL 1800	91	109.	*	28 JUL 1400	159	93.	*	31 JUL 1000	227	80.
22 JUL 2300	24	602.	*	25 JUL 1900	92	109.	*	28 JUL 1500	160	93.	*	31 JUL 1100	228	80.
23 JUL 0000	25	699.	*	25 JUL 2000	93	109.	*	28 JUL 1600	161	93.	*	31 JUL 1200	229	79.
23 JUL 0100	26	754.	*	25 JUL 2100	94	108.	*	28 JUL 1700	162	93.	*	31 JUL 1300	230	79.
23 JUL 0200	27	772.	*	25 JUL 2200	95	108.	*	28 JUL 1800	163	92.	*	31 JUL 1400	231	79.
23 JUL 0300	28	765.	*	25 JUL 2300	96	108.	*	28 JUL 1900	164	92.	*	31 JUL 1500	232	79.
23 JUL 0400	29	744.	*	26 JUL 0000	97	108.	*	28 JUL 2000	165	92.	*	31 JUL 1600	233	79.
23 JUL 0500	30	714.	*	26 JUL 0100	98	107.	*	28 JUL 2100	166	92.	*	31 JUL 1700	234	79.
23 JUL 0600	31	676.	*	26 JUL 0200	99	107.	*	28 JUL 2200	167	91.	*	31 JUL 1800	235	78.
23 JUL 0700	32	633.	*	26 JUL 0300	100	107.	*	28 JUL 2300	168	91.	*	31 JUL 1900	236	78.
23 JUL 0800	33	588.	*	26 JUL 0400	101	107.	*	29 JUL 0000	169	91.	*	31 JUL 2000	237	78.
23 JUL 0900	34	543.	*	26 JUL 0500	102	106.	*	29 JUL 0100	170	91.	*	31 JUL 2100	238	78.
23 JUL 1000	35	500.	*	26 JUL 0600	103	106.	*	29 JUL 0200	171	91.	*	31 JUL 2200	239	78.
23 JUL 1100	36	459.	*	26 JUL 0700	104	106.	*	29 JUL 0300	172	90.	*	31 JUL 2300	240	77.
23 JUL 1200	37	420.	*	26 JUL 0800	105	106.	*	29 JUL 0400	173	90.	*	1 AUG 0000	241	77.
23 JUL 1300	38	384.	*	26 JUL 0900	106	105.	*	29 JUL 0500	174	90.	*	1 AUG 0100	242	77.
23 JUL 1400	39	351.	*	26 JUL 1000	107	105.	*	29 JUL 0600	175	90.	*	1 AUG 0200	243	77.
23 JUL 1500	40	321.	*	26 JUL 1100	108	105.	*	29 JUL 0700	176	90.	*	1 AUG 0300	244	77.
23 JUL 1600	41	295.	*	26 JUL 1200	109	105.	*	29 JUL 0800	177	89.	*	1 AUG 0400	245	77.
23 JUL 1700	42	271.	*	26 JUL 1300	110	104.	*	29 JUL 0900	178	89.	*	1 AUG 0500	246	76.
23 JUL 1800	43	250.	*	26 JUL 1400	111	104.	*	29 JUL 1000	179	89.	*	1 AUG 0600	247	76.
23 JUL 1900	44	231.	*	26 JUL 1500	112	104.	*	29 JUL 1100	180	89.	*	1 AUG 0700	248	76.
23 JUL 2000	45	215.	*	26 JUL 1600	113	104.	*	29 JUL 1200	181	89.	*	1 AUG 0800	249	76.
23 JUL 2100	46	200.	*	26 JUL 1700	114	103.	*	29 JUL 1300	182	88.	*	1 AUG 0900	250	76.
23 JUL 2200	47	187.	*	26 JUL 1800	115	103.	*	29 JUL 1400	183	88.	*	1 AUG 1000	251	76.
23 JUL 2300	48	175.	*	26 JUL 1900	116	103.	*	29 JUL 1500	184	88.	*	1 AUG 1100	252	75.
24 JUL 0000	49	164.	*	26 JUL 2000	117	103.	*	29 JUL 1600	185	88.	*	1 AUG 1200	253	75.
24 JUL 0100	50	156.	*	26 JUL 2100	118	102.	*	29 JUL 1700	186	88.	*	1 AUG 1300	254	75.
24 JUL 0200	51	149.	*	26 JUL 2200	119	102.	*	29 JUL 1800	187	87.	*	1 AUG 1400	255	75.
24 JUL 0300	52	144.	*	26 JUL 2300	120	102.	*	29 JUL 1900	188	87.	*	1 AUG 1500	256	75.
24 JUL 0400	53	139.	*	27 JUL 0000	121	102.	*	29 JUL 2000	189	87.	*	1 AUG 1600	257	75.
24 JUL 0500	54	135.	*	27 JUL 0100	122	101.	*	29 JUL 2100	190	87.	*	1 AUG 1700	258	74.
24 JUL 0600	55	131.	*	27 JUL 0200	123	101.	*	29 JUL 2200	191	87.	*	1 AUG 1800	259	74.
24 JUL 0700	56	127.	*	27 JUL 0300	124	101.	*	29 JUL 2300	192	86.	*	1 AUG 1900	260	74.
24 JUL 0800	57	125.	*	27 JUL 0400	125	101.	*	30 JUL 0000	193	86.	*	1 AUG 2000	261	74.
24 JUL 0900	58	122.	*	27 JUL 0500	126	101.	*	30 JUL 0100	194	86.	*	1 AUG 2100	262	74.
24 JUL 1000	59	120.	*	27 JUL 0600	127	100.	*	30 JUL 0200	195	86.	*	1 AUG 2200	263	74.
24 JUL 1100	60	119.	*	27 JUL 0700	128	100.	*	30 JUL 0300	196	86.	*	1 AUG 2300	264	73.

24 JUL 1200	61	118.	*	27 JUL 0800	129	100.	*	30 JUL 0400	197	85.	*	2 AUG 0000	265	73.
24 JUL 1300	62	118.	*	27 JUL 0900	130	100.	*	30 JUL 0500	198	85.	*	2 AUG 0100	266	73.
24 JUL 1400	63	117.	*	27 JUL 1000	131	99.	*	30 JUL 0600	199	85.	*	2 AUG 0200	267	73.
24 JUL 1500	64	116.	*	27 JUL 1100	132	99.	*	30 JUL 0700	200	85.	*	2 AUG 0300	268	73.
24 JUL 1600	65	116.	*	27 JUL 1200	133	99.	*	30 JUL 0800	201	85.	*	2 AUG 0400	269	73.
24 JUL 1700	66	116.	*	27 JUL 1300	134	99.	*	30 JUL 0900	202	84.	*	2 AUG 0500	270	72.
24 JUL 1800	67	115.	*	27 JUL 1400	135	98.	*	30 JUL 1000	203	84.	*			
24 JUL 1900	68	115.	*	27 JUL 1500	136	98.	*	30 JUL 1100	204	84.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 772.	26.00		740.	511.	256.	133.
		(INCHES)	.051	.142	.213	.414
		(AC-FT)	367.	1014.	1525.	2963.

CUMULATIVE AREA = 134.10 SQ MI

*** ***

```
          **************
          *            *
 60 KK    *   REACH5   *     OUTFLOW HYDROGRAPH FOR CHANNEL REACH5
          *            *
          **************
```

HYDROGRAPH ROUTING DATA

```
 62 RL        ROUTING LOSSES
                    QLOSS      -10.30  INITIAL LOSS
                    CLOSS         .00  ADDITIONAL FRACTION LOST

 61 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

 63 RC        NORMAL DEPTH CHANNEL
                     ANL        .100  LEFT OVERBANK N-VALUE
                    ANCH        .060  MAIN CHANNEL N-VALUE
                     ANR        .100  RIGHT OVERBANK N-VALUE
                   RLNTH      11200.  REACH LENGTH
                     SEL       .0013  ENERGY SLOPE
                   ELMAX      1015.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION
```

CROSS-SECTION DATA

		--- LEFT OVERBANK ---			+ ------ MAIN CHANNEL -------		+ --- RIGHT OVERBANK ---		
65 RY	ELEVATION	1015.00	1013.00	1012.00	1005.00	1005.00	1012.00	1013.00	1015.00
64 RX	DISTANCE	.00	1.00	50.00	55.00	115.00	120.00	170.00	171.00

***

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	8.17	16.44	24.82	33.29	41.87	50.55	59.33	68.21	77.19
OUTFLOW	.00	18.36	58.08	113.79	183.21	264.97	358.07	461.77	575.49	698.75

ELEVATION	1005.00	1005.53	1006.05	1006.58	1007.11	1007.63	1008.16	1008.68	1009.21	1009.74
STORAGE	86.28	95.47	104.76	114.15	125.34	143.27	166.03	188.99	212.02	235.13
OUTFLOW	831.16	972.38	1122.14	1280.18	1458.26	1660.35	1894.12	2154.73	2438.21	2742.84
ELEVATION	1010.26	1010.79	1011.32	1011.84	1012.37	1012.89	1013.42	1013.95	1014.47	1015.00

COMPUTED MUSKINGUM-CUNGE PARAMETERS

COMPUTATION TIME STEP

ELEMENT	ALPHA	M	DT (MIN)	DX (FT)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	MAXIMUM CELERITY (FPS)
MAIN			33.00	3733.33	768.63	1617.00	.41	2.94

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN			60.00		768.47	1620.00	.41	

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2966E+04 EXCESS= .0000E+00 OUTFLOW= .2967E+04 BASIN STORAGE=-.6182E+00 PERCENT ERROR= .0

****

HYDROGRAPH AT STATION REACH5

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	87.	*	24 JUL 2000	69	126.	*	27 JUL 1600	137	109.	*	30 JUL 1200	205	95.
22 JUL 0100	2	87.	*	24 JUL 2100	70	125.	*	27 JUL 1700	138	108.	*	30 JUL 1300	206	94.
22 JUL 0200	3	87.	*	24 JUL 2200	71	125.	*	27 JUL 1800	139	108.	*	30 JUL 1400	207	94.
22 JUL 0300	4	87.	*	24 JUL 2300	72	125.	*	27 JUL 1900	140	108.	*	30 JUL 1500	208	94.
22 JUL 0400	5	87.	*	25 JUL 0000	73	125.	*	27 JUL 2000	141	108.	*	30 JUL 1600	209	94.
22 JUL 0500	6	87.	*	25 JUL 0100	74	124.	*	27 JUL 2100	142	108.	*	30 JUL 1700	210	94.
22 JUL 0600	7	87.	*	25 JUL 0200	75	124.	*	27 JUL 2200	143	107.	*	30 JUL 1800	211	93.
22 JUL 0700	8	87.	*	25 JUL 0300	76	124.	*	27 JUL 2300	144	107.	*	30 JUL 1900	212	93.
22 JUL 0800	9	87.	*	25 JUL 0400	77	123.	*	28 JUL 0000	145	107.	*	30 JUL 2000	213	93.
22 JUL 0900	10	87.	*	25 JUL 0500	78	123.	*	28 JUL 0100	146	107.	*	30 JUL 2100	214	93.
22 JUL 1000	11	86.	*	25 JUL 0600	79	123.	*	28 JUL 0200	147	106.	*	30 JUL 2200	215	93.
22 JUL 1100	12	86.	*	25 JUL 0700	80	123.	*	28 JUL 0300	148	106.	*	30 JUL 2300	216	92.
22 JUL 1200	13	86.	*	25 JUL 0800	81	122.	*	28 JUL 0400	149	106.	*	31 JUL 0000	217	92.
22 JUL 1300	14	86.	*	25 JUL 0900	82	122.	*	28 JUL 0500	150	106.	*	31 JUL 0100	218	92.
22 JUL 1400	15	86.	*	25 JUL 1000	83	122.	*	28 JUL 0600	151	106.	*	31 JUL 0200	219	92.
22 JUL 1500	16	86.	*	25 JUL 1100	84	122.	*	28 JUL 0700	152	105.	*	31 JUL 0300	220	92.
22 JUL 1600	17	85.	*	25 JUL 1200	85	121.	*	28 JUL 0800	153	105.	*	31 JUL 0400	221	92.
22 JUL 1700	18	86.	*	25 JUL 1300	86	121.	*	28 JUL 0900	154	105.	*	31 JUL 0500	222	91.
22 JUL 1800	19	90.	*	25 JUL 1400	87	121.	*	28 JUL 1000	155	105.	*	31 JUL 0600	223	91.
22 JUL 1900	20	121.	*	25 JUL 1500	88	121.	*	28 JUL 1100	156	105.	*	31 JUL 0700	224	91.
22 JUL 2000	21	222.	*	25 JUL 1600	89	120.	*	28 JUL 1200	157	104.	*	31 JUL 0800	225	91.
22 JUL 2100	22	343.	*	25 JUL 1700	90	120.	*	28 JUL 1300	158	104.	*	31 JUL 0900	226	91.
22 JUL 2200	23	432.	*	25 JUL 1800	91	120.	*	28 JUL 1400	159	104.	*	31 JUL 1000	227	90.
22 JUL 2300	24	514.	*	25 JUL 1900	92	120.	*	28 JUL 1500	160	104.	*	31 JUL 1100	228	90.
23 JUL 0000	25	617.	*	25 JUL 2000	93	119.	*	28 JUL 1600	161	103.	*	31 JUL 1200	229	90.
23 JUL 0100	26	709.	*	25 JUL 2100	94	119.	*	28 JUL 1700	162	103.	*	31 JUL 1300	230	90.
23 JUL 0200	27	762.	*	25 JUL 2200	95	119.	*	28 JUL 1800	163	103.	*	31 JUL 1400	231	90.

23 JUL 0300	28	779.	*	25 JUL 2300	96	119.	*	28 JUL 1900	164	103.	*	31 JUL 1500	232	90.
23 JUL 0400	29	771.	*	26 JUL 0000	97	118.	*	28 JUL 2000	165	103.	*	31 JUL 1600	233	89.
23 JUL 0500	30	749.	*	26 JUL 0100	98	118.	*	28 JUL 2100	166	102.	*	31 JUL 1700	234	89.
23 JUL 0600	31	719.	*	26 JUL 0200	99	118.	*	28 JUL 2200	167	102.	*	31 JUL 1800	235	89.
23 JUL 0700	32	681.	*	26 JUL 0300	100	118.	*	28 JUL 2300	168	102.	*	31 JUL 1900	236	89.
23 JUL 0800	33	639.	*	26 JUL 0400	101	117.	*	29 JUL 0000	169	102.	*	31 JUL 2000	237	89.
23 JUL 0900	34	596.	*	26 JUL 0500	102	117.	*	29 JUL 0100	170	102.	*	31 JUL 2100	238	89.
23 JUL 1000	35	552.	*	26 JUL 0600	103	117.	*	29 JUL 0200	171	101.	*	31 JUL 2200	239	88.
23 JUL 1100	36	510.	*	26 JUL 0700	104	117.	*	29 JUL 0300	172	101.	*	31 JUL 2300	240	88.
23 JUL 1200	37	471.	*	26 JUL 0800	105	116.	*	29 JUL 0400	173	101.	*	1 AUG 0000	241	88.
23 JUL 1300	38	433.	*	26 JUL 0900	106	116.	*	29 JUL 0500	174	101.	*	1 AUG 0100	242	88.
23 JUL 1400	39	398.	*	26 JUL 1000	107	116.	*	29 JUL 0600	175	101.	*	1 AUG 0200	243	88.
23 JUL 1500	40	366.	*	26 JUL 1100	108	116.	*	29 JUL 0700	176	100.	*	1 AUG 0300	244	87.
23 JUL 1600	41	337.	*	26 JUL 1200	109	115.	*	29 JUL 0800	177	100.	*	1 AUG 0400	245	87.
23 JUL 1700	42	311.	*	26 JUL 1300	110	115.	*	29 JUL 0900	178	100.	*	1 AUG 0500	246	87.
23 JUL 1800	43	288.	*	26 JUL 1400	111	115.	*	29 JUL 1000	179	100.	*	1 AUG 0600	247	87.
23 JUL 1900	44	267.	*	26 JUL 1500	112	115.	*	29 JUL 1100	180	99.	*	1 AUG 0700	248	87.
23 JUL 2000	45	248.	*	26 JUL 1600	113	114.	*	29 JUL 1200	181	99.	*	1 AUG 0800	249	87.
23 JUL 2100	46	231.	*	26 JUL 1700	114	114.	*	29 JUL 1300	182	99.	*	1 AUG 0900	250	86.
23 JUL 2200	47	216.	*	26 JUL 1800	115	114.	*	29 JUL 1400	183	99.	*	1 AUG 1000	251	86.
23 JUL 2300	48	203.	*	26 JUL 1900	116	114.	*	29 JUL 1500	184	99.	*	1 AUG 1100	252	86.
24 JUL 0000	49	191.	*	26 JUL 2000	117	113.	*	29 JUL 1600	185	98.	*	1 AUG 1200	253	86.
24 JUL 0100	50	180.	*	26 JUL 2100	118	113.	*	29 JUL 1700	186	98.	*	1 AUG 1300	254	86.
24 JUL 0200	51	171.	*	26 JUL 2200	119	113.	*	29 JUL 1800	187	98.	*	1 AUG 1400	255	86.
24 JUL 0300	52	164.	*	26 JUL 2300	120	113.	*	29 JUL 1900	188	98.	*	1 AUG 1500	256	85.
24 JUL 0400	53	158.	*	27 JUL 0000	121	112.	*	29 JUL 2000	189	98.	*	1 AUG 1600	257	85.
24 JUL 0500	54	153.	*	27 JUL 0100	122	112.	*	29 JUL 2100	190	97.	*	1 AUG 1700	258	85.
24 JUL 0600	55	148.	*	27 JUL 0200	123	112.	*	29 JUL 2200	191	97.	*	1 AUG 1800	259	85.
24 JUL 0700	56	144.	*	27 JUL 0300	124	112.	*	29 JUL 2300	192	97.	*	1 AUG 1900	260	85.
24 JUL 0800	57	140.	*	27 JUL 0400	125	111.	*	30 JUL 0000	193	97.	*	1 AUG 2000	261	85.
24 JUL 0900	58	137.	*	27 JUL 0500	126	111.	*	30 JUL 0100	194	97.	*	1 AUG 2100	262	84.
24 JUL 1000	59	134.	*	27 JUL 0600	127	111.	*	30 JUL 0200	195	96.	*	1 AUG 2200	263	84.
24 JUL 1100	60	132.	*	27 JUL 0700	128	111.	*	30 JUL 0300	196	96.	*	1 AUG 2300	264	84.
24 JUL 1200	61	130.	*	27 JUL 0800	129	111.	*	30 JUL 0400	197	96.	*	2 AUG 0000	265	84.
24 JUL 1300	62	129.	*	27 JUL 0900	130	110.	*	30 JUL 0500	198	96.	*	2 AUG 0100	266	84.
24 JUL 1400	63	128.	*	27 JUL 1000	131	110.	*	30 JUL 0600	199	96.	*	2 AUG 0200	267	84.
24 JUL 1500	64	128.	*	27 JUL 1100	132	110.	*	30 JUL 0700	200	96.	*	2 AUG 0300	268	83.
24 JUL 1600	65	127.	*	27 JUL 1200	133	110.	*	30 JUL 0800	201	95.	*	2 AUG 0400	269	83.
24 JUL 1700	66	127.	*	27 JUL 1300	134	109.	*	30 JUL 0900	202	95.	*	2 AUG 0500	270	83.
24 JUL 1800	67	126.	*	27 JUL 1400	135	109.	*	30 JUL 1000	203	95.	*			
24 JUL 1900	68	126.	*	27 JUL 1500	136	109.	*	30 JUL 1100	204	95.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 779.	27.00		746.	521.	266.	144.
		(INCHES)	.052	.144	.222	.446
		(AC-FT)	370.	1031.	1585.	3193.

CUMULATIVE AREA = 134.11 SQ MI

*** ***

```
            **************
            *            *
 66 KK      *   BASIN8   *     MUDDY CREEK SUBBASIN HYDROGRAPH
            *            *
            **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MUDDY/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MUDDY/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/MUDDY/FLOW/01AUG1976/1HOUR/COMP/

              SUBBASIN RUNOFF DATA

 67 BA          SUBBASIN CHARACTERISTICS
                      TAREA       22.90  SUBBASIN AREA

                                                    ***
```

HYDROGRAPH AT STATION BASIN8

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	4.	24 JUL 2000	69	6.	27 JUL 1600	137	5.	30 JUL 1200	205	4.
22 JUL 0100	2	4.	24 JUL 2100	70	6.	27 JUL 1700	138	5.	30 JUL 1300	206	4.
22 JUL 0200	3	4.	24 JUL 2200	71	6.	27 JUL 1800	139	5.	30 JUL 1400	207	4.
22 JUL 0300	4	4.	24 JUL 2300	72	6.	27 JUL 1900	140	5.	30 JUL 1500	208	4.
22 JUL 0400	5	4.	25 JUL 0000	73	6.	27 JUL 2000	141	5.	30 JUL 1600	209	4.
22 JUL 0500	6	4.	25 JUL 0100	74	6.	27 JUL 2100	142	5.	30 JUL 1700	210	4.
22 JUL 0600	7	4.	25 JUL 0200	75	6.	27 JUL 2200	143	5.	30 JUL 1800	211	4.
22 JUL 0700	8	4.	25 JUL 0300	76	6.	27 JUL 2300	144	5.	30 JUL 1900	212	4.
22 JUL 0800	9	4.	25 JUL 0400	77	6.	28 JUL 0000	145	5.	30 JUL 2000	213	4.
22 JUL 0900	10	4.	25 JUL 0500	78	6.	28 JUL 0100	146	5.	30 JUL 2100	214	4.
22 JUL 1000	11	4.	25 JUL 0600	79	6.	28 JUL 0200	147	5.	30 JUL 2200	215	4.
22 JUL 1100	12	4.	25 JUL 0700	80	6.	28 JUL 0300	148	5.	30 JUL 2300	216	4.
22 JUL 1200	13	4.	25 JUL 0800	81	6.	28 JUL 0400	149	5.	31 JUL 0000	217	4.
22 JUL 1300	14	4.	25 JUL 0900	82	6.	28 JUL 0500	150	5.	31 JUL 0100	218	4.
22 JUL 1400	15	4.	25 JUL 1000	83	6.	28 JUL 0600	151	5.	31 JUL 0200	219	4.
22 JUL 1500	16	4.	25 JUL 1100	84	6.	28 JUL 0700	152	5.	31 JUL 0300	220	4.
22 JUL 1600	17	5.	25 JUL 1200	85	6.	28 JUL 0800	153	5.	31 JUL 0400	221	4.
22 JUL 1700	18	7.	25 JUL 1300	86	6.	28 JUL 0900	154	5.	31 JUL 0500	222	4.
22 JUL 1800	19	12.	25 JUL 1400	87	6.	28 JUL 1000	155	5.	31 JUL 0600	223	4.
22 JUL 1900	20	22.	25 JUL 1500	88	6.	28 JUL 1100	156	5.	31 JUL 0700	224	4.
22 JUL 2000	21	36.	25 JUL 1600	89	6.	28 JUL 1200	157	5.	31 JUL 0800	225	4.
22 JUL 2100	22	52.	25 JUL 1700	90	6.	28 JUL 1300	158	5.	31 JUL 0900	226	4.
22 JUL 2200	23	67.	25 JUL 1800	91	6.	28 JUL 1400	159	5.	31 JUL 1000	227	4.
22 JUL 2300	24	80.	25 JUL 1900	92	6.	28 JUL 1500	160	5.	31 JUL 1100	228	4.
23 JUL 0000	25	90.	25 JUL 2000	93	6.	28 JUL 1600	161	5.	31 JUL 1200	229	4.
23 JUL 0100	26	97.	25 JUL 2100	94	6.	28 JUL 1700	162	5.	31 JUL 1300	230	4.
23 JUL 0200	27	102.	25 JUL 2200	95	6.	28 JUL 1800	163	5.	31 JUL 1400	231	4.
23 JUL 0300	28	104.	25 JUL 2300	96	6.	28 JUL 1900	164	5.	31 JUL 1500	232	4.
23 JUL 0400	29	103.	26 JUL 0000	97	6.	28 JUL 2000	165	5.	31 JUL 1600	233	4.
23 JUL 0500	30	101.	26 JUL 0100	98	6.	28 JUL 2100	166	5.	31 JUL 1700	234	4.
23 JUL 0600	31	98.	26 JUL 0200	99	6.	28 JUL 2200	167	5.	31 JUL 1800	235	4.
23 JUL 0700	32	93.	26 JUL 0300	100	6.	28 JUL 2300	168	5.	31 JUL 1900	236	4.
23 JUL 0800	33	89.	26 JUL 0400	101	6.	29 JUL 0000	169	5.	31 JUL 2000	237	4.
23 JUL 0900	34	84.	26 JUL 0500	102	6.	29 JUL 0100	170	5.	31 JUL 2100	238	4.
23 JUL 1000	35	79.	26 JUL 0600	103	6.	29 JUL 0200	171	5.	31 JUL 2200	239	4.
23 JUL 1100	36	74.	26 JUL 0700	104	6.	29 JUL 0300	172	5.	31 JUL 2300	240	4.

23 JUL 1200	37	69.	*	26 JUL 0800	105	6.	*	29 JUL 0400	173	5.	*	1 AUG 0000	241	4.									
23 JUL 1300	38	64.	*	26 JUL 0900	106	6.	*	29 JUL 0500	174	5.	*	1 AUG 0100	242	4.									
23 JUL 1400	39	59.	*	26 JUL 1000	107	6.	*	29 JUL 0600	175	5.	*	1 AUG 0200	243	4.									
23 JUL 1500	40	55.	*	26 JUL 1100	108	6.	*	29 JUL 0700	176	5.	*	1 AUG 0300	244	4.									
23 JUL 1600	41	50.	*	26 JUL 1200	109	6.	*	29 JUL 0800	177	5.	*	1 AUG 0400	245	4.									
23 JUL 1700	42	46.	*	26 JUL 1300	110	6.	*	29 JUL 0900	178	5.	*	1 AUG 0500	246	4.									
23 JUL 1800	43	42.	*	26 JUL 1400	111	6.	*	29 JUL 1000	179	5.	*	1 AUG 0600	247	4.									
23 JUL 1900	44	38.	*	26 JUL 1500	112	6.	*	29 JUL 1100	180	5.	*	1 AUG 0700	248	4.									
23 JUL 2000	45	35.	*	26 JUL 1600	113	6.	*	29 JUL 1200	181	5.	*	1 AUG 0800	249	4.									
23 JUL 2100	46	32.	*	26 JUL 1700	114	6.	*	29 JUL 1300	182	5.	*	1 AUG 0900	250	4.									
23 JUL 2200	47	29.	*	26 JUL 1800	115	6.	*	29 JUL 1400	183	5.	*	1 AUG 1000	251	4.									
23 JUL 2300	48	26.	*	26 JUL 1900	116	6.	*	29 JUL 1500	184	5.	*	1 AUG 1100	252	4.									
24 JUL 0000	49	24.	*	26 JUL 2000	117	6.	*	29 JUL 1600	185	5.	*	1 AUG 1200	253	4.									
24 JUL 0100	50	22.	*	26 JUL 2100	118	6.	*	29 JUL 1700	186	5.	*	1 AUG 1300	254	4.									
24 JUL 0200	51	20.	*	26 JUL 2200	119	6.	*	29 JUL 1800	187	5.	*	1 AUG 1400	255	4.									
24 JUL 0300	52	18.	*	26 JUL 2300	120	6.	*	29 JUL 1900	188	5.	*	1 AUG 1500	256	4.									
24 JUL 0400	53	17.	*	27 JUL 0000	121	6.	*	29 JUL 2000	189	5.	*	1 AUG 1600	257	4.									
24 JUL 0500	54	15.	*	27 JUL 0100	122	6.	*	29 JUL 2100	190	5.	*	1 AUG 1700	258	4.									
24 JUL 0600	55	14.	*	27 JUL 0200	123	6.	*	29 JUL 2200	191	5.	*	1 AUG 1800	259	4.									
24 JUL 0700	56	13.	*	27 JUL 0300	124	6.	*	29 JUL 2300	192	5.	*	1 AUG 1900	260	4.									
24 JUL 0800	57	12.	*	27 JUL 0400	125	5.	*	30 JUL 0000	193	5.	*	1 AUG 2000	261	4.									
24 JUL 0900	58	11.	*	27 JUL 0500	126	5.	*	30 JUL 0100	194	5.	*	1 AUG 2100	262	4.									
24 JUL 1000	59	11.	*	27 JUL 0600	127	5.	*	30 JUL 0200	195	5.	*	1 AUG 2200	263	4.									
24 JUL 1100	60	10.	*	27 JUL 0700	128	5.	*	30 JUL 0300	196	5.	*	1 AUG 2300	264	4.									
24 JUL 1200	61	9.	*	27 JUL 0800	129	5.	*	30 JUL 0400	197	5.	*	2 AUG 0000	265	4.									
24 JUL 1300	62	9.	*	27 JUL 0900	130	5.	*	30 JUL 0500	198	5.	*	2 AUG 0100	266	4.									
24 JUL 1400	63	8.	*	27 JUL 1000	131	5.	*	30 JUL 0600	199	5.	*	2 AUG 0200	267	4.									
24 JUL 1500	64	7.	*	27 JUL 1100	132	5.	*	30 JUL 0700	200	5.	*	2 AUG 0300	268	4.									
24 JUL 1600	65	7.	*	27 JUL 1200	133	5.	*	30 JUL 0800	201	5.	*	2 AUG 0400	269	4.									
24 JUL 1700	66	6.	*	27 JUL 1300	134	5.	*	30 JUL 0900	202	4.	*	2 AUG 0500	270	4.									
24 JUL 1800	67	6.	*	27 JUL 1400	135	5.	*	30 JUL 1000	203	4.	*												
24 JUL 1900	68	6.	*	27 JUL 1500	136	5.	*	30 JUL 1100	204	4.	*												
			*				*				*												

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 104.	27.00		101.	74.	32.	12.
		(INCHES)	.041	.120	.156	.219
		(AC-FT)	50.	146.	191.	268.

CUMULATIVE AREA = 22.90 SQ MI

*** ***

```
          **************
          *            *
 69 KK    *     STA6   *     COMBINED HYDROGRAPH FOR CHANNEL REACH5 AND MUDDY CREEK
          *            *
          **************

 70 HC          HYDROGRAPH COMBINATION
                     ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
```

***

HYDROGRAPH AT STATION STA6
SUM OF 2 HYDROGRAPHS

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	91.	24 JUL 2000	69	132.	27 JUL 1600	137	114.	30 JUL 1200	205	99.
22 JUL 0100	2	91.	24 JUL 2100	70	132.	27 JUL 1700	138	114.	30 JUL 1300	206	99.
22 JUL 0200	3	91.	24 JUL 2200	71	131.	27 JUL 1800	139	114.	30 JUL 1400	207	99.
22 JUL 0300	4	91.	24 JUL 2300	72	131.	27 JUL 1900	140	113.	30 JUL 1500	208	98.
22 JUL 0400	5	91.	25 JUL 0000	73	131.	27 JUL 2000	141	113.	30 JUL 1600	209	98.
22 JUL 0500	6	91.	25 JUL 0100	74	131.	27 JUL 2100	142	113.	30 JUL 1700	210	98.
22 JUL 0600	7	91.	25 JUL 0200	75	130.	27 JUL 2200	143	113.	30 JUL 1800	211	98.
22 JUL 0700	8	91.	25 JUL 0300	76	130.	27 JUL 2300	144	112.	30 JUL 1900	212	98.
22 JUL 0800	9	90.	25 JUL 0400	77	130.	28 JUL 0000	145	112.	30 JUL 2000	213	97.
22 JUL 0900	10	90.	25 JUL 0500	78	129.	28 JUL 0100	146	112.	30 JUL 2100	214	97.
22 JUL 1000	11	90.	25 JUL 0600	79	129.	28 JUL 0200	147	112.	30 JUL 2200	215	97.
22 JUL 1100	12	90.	25 JUL 0700	80	129.	28 JUL 0300	148	111.	30 JUL 2300	216	97.
22 JUL 1200	13	90.	25 JUL 0800	81	129.	28 JUL 0400	149	111.	31 JUL 0000	217	97.
22 JUL 1300	14	90.	25 JUL 0900	82	128.	28 JUL 0500	150	111.	31 JUL 0100	218	96.
22 JUL 1400	15	90.	25 JUL 1000	83	128.	28 JUL 0600	151	111.	31 JUL 0200	219	96.
22 JUL 1500	16	89.	25 JUL 1100	84	128.	28 JUL 0700	152	111.	31 JUL 0300	220	96.
22 JUL 1600	17	90.	25 JUL 1200	85	127.	28 JUL 0800	153	110.	31 JUL 0400	221	96.
22 JUL 1700	18	93.	25 JUL 1300	86	127.	28 JUL 0900	154	110.	31 JUL 0500	222	96.
22 JUL 1800	19	103.	25 JUL 1400	87	127.	28 JUL 1000	155	110.	31 JUL 0600	223	95.
22 JUL 1900	20	142.	25 JUL 1500	88	127.	28 JUL 1100	156	110.	31 JUL 0700	224	95.
22 JUL 2000	21	257.	25 JUL 1600	89	126.	28 JUL 1200	157	109.	31 JUL 0800	225	95.
22 JUL 2100	22	394.	25 JUL 1700	90	126.	28 JUL 1300	158	109.	31 JUL 0900	226	95.
22 JUL 2200	23	499.	25 JUL 1800	91	126.	28 JUL 1400	159	109.	31 JUL 1000	227	95.
22 JUL 2300	24	594.	25 JUL 1900	92	126.	28 JUL 1500	160	109.	31 JUL 1100	228	94.
23 JUL 0000	25	707.	25 JUL 2000	93	125.	28 JUL 1600	161	108.	31 JUL 1200	229	94.
23 JUL 0100	26	806.	25 JUL 2100	94	125.	28 JUL 1700	162	108.	31 JUL 1300	230	94.
23 JUL 0200	27	864.	25 JUL 2200	95	125.	28 JUL 1800	163	108.	31 JUL 1400	231	94.
23 JUL 0300	28	883.	25 JUL 2300	96	124.	28 JUL 1900	164	108.	31 JUL 1500	232	94.
23 JUL 0400	29	874.	26 JUL 0000	97	124.	28 JUL 2000	165	108.	31 JUL 1600	233	94.
23 JUL 0500	30	850.	26 JUL 0100	98	124.	28 JUL 2100	166	107.	31 JUL 1700	234	93.
23 JUL 0600	31	816.	26 JUL 0200	99	124.	28 JUL 2200	167	107.	31 JUL 1800	235	93.
23 JUL 0700	32	775.	26 JUL 0300	100	123.	28 JUL 2300	168	107.	31 JUL 1900	236	93.
23 JUL 0800	33	728.	26 JUL 0400	101	123.	29 JUL 0000	169	107.	31 JUL 2000	237	93.
23 JUL 0900	34	680.	26 JUL 0500	102	123.	29 JUL 0100	170	106.	31 JUL 2100	238	93.
23 JUL 1000	35	631.	26 JUL 0600	103	123.	29 JUL 0200	171	106.	31 JUL 2200	239	92.
23 JUL 1100	36	584.	26 JUL 0700	104	122.	29 JUL 0300	172	106.	31 JUL 2300	240	92.
23 JUL 1200	37	540.	26 JUL 0800	105	122.	29 JUL 0400	173	106.	1 AUG 0000	241	92.
23 JUL 1300	38	497.	26 JUL 0900	106	122.	29 JUL 0500	174	106.	1 AUG 0100	242	92.
23 JUL 1400	39	457.	26 JUL 1000	107	122.	29 JUL 0600	175	105.	1 AUG 0200	243	92.
23 JUL 1500	40	420.	26 JUL 1100	108	121.	29 JUL 0700	176	105.	1 AUG 0300	244	91.
23 JUL 1600	41	387.	26 JUL 1200	109	121.	29 JUL 0800	177	105.	1 AUG 0400	245	91.
23 JUL 1700	42	357.	26 JUL 1300	110	121.	29 JUL 0900	178	105.	1 AUG 0500	246	91.
23 JUL 1800	43	329.	26 JUL 1400	111	121.	29 JUL 1000	179	104.	1 AUG 0600	247	91.
23 JUL 1900	44	305.	26 JUL 1500	112	120.	29 JUL 1100	180	104.	1 AUG 0700	248	91.
23 JUL 2000	45	283.	26 JUL 1600	113	120.	29 JUL 1200	181	104.	1 AUG 0800	249	91.
23 JUL 2100	46	263.	26 JUL 1700	114	120.	29 JUL 1300	182	104.	1 AUG 0900	250	90.
23 JUL 2200	47	245.	26 JUL 1800	115	119.	29 JUL 1400	183	104.	1 AUG 1000	251	90.
23 JUL 2300	48	229.	26 JUL 1900	116	119.	29 JUL 1500	184	103.	1 AUG 1100	252	90.
24 JUL 0000	49	215.	26 JUL 2000	117	119.	29 JUL 1600	185	103.	1 AUG 1200	253	90.

24 JUL 0100	50	202.	*	26 JUL 2100	118	119.	*	29 JUL 1700	186	103.	*	1 AUG 1300	254	90.
24 JUL 0200	51	191.	*	26 JUL 2200	119	118.	*	29 JUL 1800	187	103.	*	1 AUG 1400	255	89.
24 JUL 0300	52	182.	*	26 JUL 2300	120	118.	*	29 JUL 1900	188	103.	*	1 AUG 1500	256	89.
24 JUL 0400	53	174.	*	27 JUL 0000	121	118.	*	29 JUL 2000	189	102.	*	1 AUG 1600	257	89.
24 JUL 0500	54	168.	*	27 JUL 0100	122	118.	*	29 JUL 2100	190	102.	*	1 AUG 1700	258	89.
24 JUL 0600	55	162.	*	27 JUL 0200	123	117.	*	29 JUL 2200	191	102.	*	1 AUG 1800	259	89.
24 JUL 0700	56	157.	*	27 JUL 0300	124	117.	*	29 JUL 2300	192	102.	*	1 AUG 1900	260	89.
24 JUL 0800	57	152.	*	27 JUL 0400	125	117.	*	30 JUL 0000	193	101.	*	1 AUG 2000	261	88.
24 JUL 0900	58	148.	*	27 JUL 0500	126	117.	*	30 JUL 0100	194	101.	*	1 AUG 2100	262	88.
24 JUL 1000	59	145.	*	27 JUL 0600	127	116.	*	30 JUL 0200	195	101.	*	1 AUG 2200	263	88.
24 JUL 1100	60	142.	*	27 JUL 0700	128	116.	*	30 JUL 0300	196	101.	*	1 AUG 2300	264	88.
24 JUL 1200	61	140.	*	27 JUL 0800	129	116.	*	30 JUL 0400	197	101.	*	2 AUG 0000	265	88.
24 JUL 1300	62	138.	*	27 JUL 0900	130	116.	*	30 JUL 0500	198	100.	*	2 AUG 0100	266	88.
24 JUL 1400	63	136.	*	27 JUL 1000	131	116.	*	30 JUL 0600	199	100.	*	2 AUG 0200	267	87.
24 JUL 1500	64	135.	*	27 JUL 1100	132	115.	*	30 JUL 0700	200	100.	*	2 AUG 0300	268	87.
24 JUL 1600	65	134.	*	27 JUL 1200	133	115.	*	30 JUL 0800	201	100.	*	2 AUG 0400	269	87.
24 JUL 1700	66	133.	*	27 JUL 1300	134	115.	*	30 JUL 0900	202	100.	*	2 AUG 0500	270	87.
24 JUL 1800	67	133.	*	27 JUL 1400	135	115.	*	30 JUL 1000	203	99.	*			
24 JUL 1900	68	132.	*	27 JUL 1500	136	114.	*	30 JUL 1100	204	99.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 883.	27.00		846.	594.	298.	156.
		(INCHES)	.050	.141	.212	.413
		(AC-FT)	420.	1178.	1775.	3461.

CUMULATIVE AREA = 157.00 SQ MI

*** ***

```
          **************
          *            *
 71 KK    *   REACH6   *     OUTFLOW HYDROGRAPH FOR CHANNEL REACH6
          *            *
          **************
```

HYDROGRAPH ROUTING DATA

```
 62 RL        ROUTING LOSSES
                    QLOSS        .00  INITIAL LOSS
                    CLOSS        .00  ADDITIONAL FRACTION LOST

 72 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

 73 RC        NORMAL DEPTH CHANNEL
                      ANL       .100  LEFT OVERBANK N-VALUE
                     ANCH       .060  MAIN CHANNEL N-VALUE
                      ANR       .100  RIGHT OVERBANK N-VALUE
                    RLNTH      9800.  REACH LENGTH
                      SEL      .0012  ENERGY SLOPE
                    ELMAX     1005.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION
```

CROSS-SECTION DATA

		--- LEFT OVERBANK ---			+ ------ MAIN CHANNEL -------			+ --- RIGHT OVERBANK ---	
75 RY	ELEVATION	1005.00	1003.00	1002.00	995.00	995.00	1002.00	1003.00	1005.00
74 RX	DISTANCE	.00	1.00	50.00	55.00	125.00	130.00	180.00	181.00

***

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	8.33	16.76	25.27	33.87	42.56	51.33	60.20	69.16	78.20
OUTFLOW	.00	20.59	65.17	127.72	205.73	297.62	402.30	518.93	646.84	785.50
ELEVATION	995.00	995.53	996.05	996.58	997.11	997.63	998.16	998.68	999.21	999.74
STORAGE	87.34	96.56	105.87	115.27	126.25	143.13	164.22	185.49	206.83	228.23
OUTFLOW	934.45	1093.31	1261.75	1439.48	1638.14	1861.36	2116.35	2398.42	2703.75	3030.63
ELEVATION	1000.26	1000.79	1001.32	1001.84	1002.37	1002.89	1003.42	1003.95	1004.47	1005.00

COMPUTED MUSKINGUM-CUNGE PARAMETERS

COMPUTATION TIME STEP

ELEMENT	ALPHA	M	DT (MIN)	DX (FT)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	MAXIMUM CELERITY (FPS)
MAIN			33.00	3266.67	879.15	1683.00	.41	2.88

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN			60.00		878.89	1680.00	.41	

CONTINUITY SUMMARY (AC-FT) - INFLOW= .3465E+04 EXCESS= .0000E+00 OUTFLOW= .3465E+04 BASIN STORAGE=-.5304E+00 PERCENT ERROR= .0

****

HYDROGRAPH AT STATION REACH6

****

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	91.	*	24 JUL 2000	69	132.	*	27 JUL 1600	137	114.	*	30 JUL 1200	205	99.
22 JUL 0100	2	91.	*	24 JUL 2100	70	132.	*	27 JUL 1700	138	114.	*	30 JUL 1300	206	99.
22 JUL 0200	3	91.	*	24 JUL 2200	71	132.	*	27 JUL 1800	139	114.	*	30 JUL 1400	207	99.
22 JUL 0300	4	91.	*	24 JUL 2300	72	132.	*	27 JUL 1900	140	114.	*	30 JUL 1500	208	99.
22 JUL 0400	5	91.	*	25 JUL 0000	73	131.	*	27 JUL 2000	141	114.	*	30 JUL 1600	209	99.
22 JUL 0500	6	91.	*	25 JUL 0100	74	131.	*	27 JUL 2100	142	113.	*	30 JUL 1700	210	98.
22 JUL 0600	7	91.	*	25 JUL 0200	75	131.	*	27 JUL 2200	143	113.	*	30 JUL 1800	211	98.
22 JUL 0700	8	91.	*	25 JUL 0300	76	130.	*	27 JUL 2300	144	113.	*	30 JUL 1900	212	98.
22 JUL 0800	9	91.	*	25 JUL 0400	77	130.	*	28 JUL 0000	145	113.	*	30 JUL 2000	213	98.
22 JUL 0900	10	91.	*	25 JUL 0500	78	130.	*	28 JUL 0100	146	112.	*	30 JUL 2100	214	98.
22 JUL 1000	11	90.	*	25 JUL 0600	79	130.	*	28 JUL 0200	147	112.	*	30 JUL 2200	215	97.
22 JUL 1100	12	90.	*	25 JUL 0700	80	129.	*	28 JUL 0300	148	112.	*	30 JUL 2300	216	97.
22 JUL 1200	13	90.	*	25 JUL 0800	81	129.	*	28 JUL 0400	149	112.	*	31 JUL 0000	217	97.
22 JUL 1300	14	90.	*	25 JUL 0900	82	129.	*	28 JUL 0500	150	111.	*	31 JUL 0100	218	97.
22 JUL 1400	15	90.	*	25 JUL 1000	83	128.	*	28 JUL 0600	151	111.	*	31 JUL 0200	219	97.
22 JUL 1500	16	90.	*	25 JUL 1100	84	128.	*	28 JUL 0700	152	111.	*	31 JUL 0300	220	96.

22 JUL 1600	17	90.	*	25 JUL 1200	85	128.	*	28 JUL 0800	153	111.	*	31 JUL 0400	221	96.
22 JUL 1700	18	90.	*	25 JUL 1300	86	128.	*	28 JUL 0900	154	110.	*	31 JUL 0500	222	96.
22 JUL 1800	19	91.	*	25 JUL 1400	87	127.	*	28 JUL 1000	155	110.	*	31 JUL 0600	223	96.
22 JUL 1900	20	96.	*	25 JUL 1500	88	127.	*	28 JUL 1100	156	110.	*	31 JUL 0700	224	96.
22 JUL 2000	21	122.	*	25 JUL 1600	89	127.	*	28 JUL 1200	157	110.	*	31 JUL 0800	225	95.
22 JUL 2100	22	225.	*	25 JUL 1700	90	127.	*	28 JUL 1300	158	110.	*	31 JUL 0900	226	95.
22 JUL 2200	23	382.	*	25 JUL 1800	91	126.	*	28 JUL 1400	159	109.	*	31 JUL 1000	227	95.
22 JUL 2300	24	503.	*	25 JUL 1900	92	126.	*	28 JUL 1500	160	109.	*	31 JUL 1100	228	95.
23 JUL 0000	25	611.	*	25 JUL 2000	93	126.	*	28 JUL 1600	161	109.	*	31 JUL 1200	229	95.
23 JUL 0100	26	723.	*	25 JUL 2100	94	125.	*	28 JUL 1700	162	109.	*	31 JUL 1300	230	94.
23 JUL 0200	27	814.	*	25 JUL 2200	95	125.	*	28 JUL 1800	163	108.	*	31 JUL 1400	231	94.
23 JUL 0300	28	865.	*	25 JUL 2300	96	125.	*	28 JUL 1900	164	108.	*	31 JUL 1500	232	94.
23 JUL 0400	29	879.	*	26 JUL 0000	97	125.	*	28 JUL 2000	165	108.	*	31 JUL 1600	233	94.
23 JUL 0500	30	867.	*	26 JUL 0100	98	124.	*	28 JUL 2100	166	108.	*	31 JUL 1700	234	94.
23 JUL 0600	31	842.	*	26 JUL 0200	99	124.	*	28 JUL 2200	167	108.	*	31 JUL 1800	235	94.
23 JUL 0700	32	806.	*	26 JUL 0300	100	124.	*	28 JUL 2300	168	107.	*	31 JUL 1900	236	93.
23 JUL 0800	33	765.	*	26 JUL 0400	101	124.	*	29 JUL 0000	169	107.	*	31 JUL 2000	237	93.
23 JUL 0900	34	719.	*	26 JUL 0500	102	123.	*	29 JUL 0100	170	107.	*	31 JUL 2100	238	93.
23 JUL 1000	35	672.	*	26 JUL 0600	103	123.	*	29 JUL 0200	171	107.	*	31 JUL 2200	239	93.
23 JUL 1100	36	625.	*	26 JUL 0700	104	123.	*	29 JUL 0300	172	106.	*	31 JUL 2300	240	93.
23 JUL 1200	37	579.	*	26 JUL 0800	105	123.	*	29 JUL 0400	173	106.	*	1 AUG 0000	241	92.
23 JUL 1300	38	536.	*	26 JUL 0900	106	122.	*	29 JUL 0500	174	106.	*	1 AUG 0100	242	92.
23 JUL 1400	39	495.	*	26 JUL 1000	107	122.	*	29 JUL 0600	175	106.	*	1 AUG 0200	243	92.
23 JUL 1500	40	457.	*	26 JUL 1100	108	122.	*	29 JUL 0700	176	106.	*	1 AUG 0300	244	92.
23 JUL 1600	41	421.	*	26 JUL 1200	109	121.	*	29 JUL 0800	177	105.	*	1 AUG 0400	245	92.
23 JUL 1700	42	388.	*	26 JUL 1300	110	121.	*	29 JUL 0900	178	105.	*	1 AUG 0500	246	91.
23 JUL 1800	43	359.	*	26 JUL 1400	111	121.	*	29 JUL 1000	179	105.	*	1 AUG 0600	247	91.
23 JUL 1900	44	332.	*	26 JUL 1500	112	121.	*	29 JUL 1100	180	105.	*	1 AUG 0700	248	91.
23 JUL 2000	45	308.	*	26 JUL 1600	113	120.	*	29 JUL 1200	181	104.	*	1 AUG 0800	249	91.
23 JUL 2100	46	287.	*	26 JUL 1700	114	120.	*	29 JUL 1300	182	104.	*	1 AUG 0900	250	91.
23 JUL 2200	47	267.	*	26 JUL 1800	115	120.	*	29 JUL 1400	183	104.	*	1 AUG 1000	251	91.
23 JUL 2300	48	250.	*	26 JUL 1900	116	120.	*	29 JUL 1500	184	104.	*	1 AUG 1100	252	90.
24 JUL 0000	49	234.	*	26 JUL 2000	117	119.	*	29 JUL 1600	185	104.	*	1 AUG 1200	253	90.
24 JUL 0100	50	219.	*	26 JUL 2100	118	119.	*	29 JUL 1700	186	103.	*	1 AUG 1300	254	90.
24 JUL 0200	51	206.	*	26 JUL 2200	119	119.	*	29 JUL 1800	187	103.	*	1 AUG 1400	255	90.
24 JUL 0300	52	195.	*	26 JUL 2300	120	119.	*	29 JUL 1900	188	103.	*	1 AUG 1500	256	90.
24 JUL 0400	53	186.	*	27 JUL 0000	121	118.	*	29 JUL 2000	189	103.	*	1 AUG 1600	257	89.
24 JUL 0500	54	178.	*	27 JUL 0100	122	118.	*	29 JUL 2100	190	103.	*	1 AUG 1700	258	89.
24 JUL 0600	55	171.	*	27 JUL 0200	123	118.	*	29 JUL 2200	191	102.	*	1 AUG 1800	259	89.
24 JUL 0700	56	165.	*	27 JUL 0300	124	118.	*	29 JUL 2300	192	102.	*	1 AUG 1900	260	89.
24 JUL 0800	57	160.	*	27 JUL 0400	125	117.	*	30 JUL 0000	193	102.	*	1 AUG 2000	261	89.
24 JUL 0900	58	155.	*	27 JUL 0500	126	117.	*	30 JUL 0100	194	102.	*	1 AUG 2100	262	89.
24 JUL 1000	59	151.	*	27 JUL 0600	127	117.	*	30 JUL 0200	195	101.	*	1 AUG 2200	263	88.
24 JUL 1100	60	147.	*	27 JUL 0700	128	117.	*	30 JUL 0300	196	101.	*	1 AUG 2300	264	88.
24 JUL 1200	61	144.	*	27 JUL 0800	129	116.	*	30 JUL 0400	197	101.	*	2 AUG 0000	265	88.
24 JUL 1300	62	141.	*	27 JUL 0900	130	116.	*	30 JUL 0500	198	101.	*	2 AUG 0100	266	88.
24 JUL 1400	63	139.	*	27 JUL 1000	131	116.	*	30 JUL 0600	199	101.	*	2 AUG 0200	267	88.
24 JUL 1500	64	137.	*	27 JUL 1100	132	116.	*	30 JUL 0700	200	100.	*	2 AUG 0300	268	88.
24 JUL 1600	65	136.	*	27 JUL 1200	133	115.	*	30 JUL 0800	201	100.	*	2 AUG 0400	269	87.
24 JUL 1700	66	135.	*	27 JUL 1300	134	115.	*	30 JUL 0900	202	100.	*	2 AUG 0500	270	87.
24 JUL 1800	67	134.	*	27 JUL 1400	135	115.	*	30 JUL 1000	203	100.	*			
24 JUL 1900	68	133.	*	27 JUL 1500	136	115.	*	30 JUL 1100	204	100.	*			
			*				*				*			

****

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)				
		(CFS)			
+ 879.	28.00	841.	592.	298.	156.

```
                    (INCHES)      .050        .140        .212        .413
                     (AC-FT)      417.       1174.       1774.       3462.

                    CUMULATIVE AREA =  157.00 SQ MI


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


          **************
          *            *
  76 KK   *    BASIN9  *     UNNAMED TRIBUTARY SUBBASIN HYDROGRAPH
          *            *
          **************
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/TRIB/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/TRIB/FLOW/01JUL1976/1HOUR/COMP/
-----DSS--- ZREAD Unit  71; Vers.    1:  /MAD/TRIB/FLOW/01AUG1976/1HOUR/COMP/

             SUBBASIN RUNOFF DATA

  77 BA          SUBBASIN CHARACTERISTICS
                       TAREA        4.20  SUBBASIN AREA

                                                          ***

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

                                          HYDROGRAPH AT STATION   BASIN9

*****************************************************************************************************************************
```

DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW	*	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	3.	*	24 JUL 2000	69	4.	*	27 JUL 1600	137	3.	*	30 JUL 1200	205	3.
22 JUL 0100	2	3.	*	24 JUL 2100	70	4.	*	27 JUL 1700	138	3.	*	30 JUL 1300	206	3.
22 JUL 0200	3	3.	*	24 JUL 2200	71	4.	*	27 JUL 1800	139	3.	*	30 JUL 1400	207	3.
22 JUL 0300	4	3.	*	24 JUL 2300	72	4.	*	27 JUL 1900	140	3.	*	30 JUL 1500	208	3.
22 JUL 0400	5	3.	*	25 JUL 0000	73	4.	*	27 JUL 2000	141	3.	*	30 JUL 1600	209	3.
22 JUL 0500	6	3.	*	25 JUL 0100	74	4.	*	27 JUL 2100	142	3.	*	30 JUL 1700	210	3.
22 JUL 0600	7	3.	*	25 JUL 0200	75	4.	*	27 JUL 2200	143	3.	*	30 JUL 1800	211	3.
22 JUL 0700	8	3.	*	25 JUL 0300	76	4.	*	27 JUL 2300	144	3.	*	30 JUL 1900	212	3.
22 JUL 0800	9	3.	*	25 JUL 0400	77	4.	*	28 JUL 0000	145	3.	*	30 JUL 2000	213	3.
22 JUL 0900	10	3.	*	25 JUL 0500	78	4.	*	28 JUL 0100	146	3.	*	30 JUL 2100	214	3.
22 JUL 1000	11	3.	*	25 JUL 0600	79	4.	*	28 JUL 0200	147	3.	*	30 JUL 2200	215	3.
22 JUL 1100	12	3.	*	25 JUL 0700	80	4.	*	28 JUL 0300	148	3.	*	30 JUL 2300	216	3.
22 JUL 1200	13	3.	*	25 JUL 0800	81	4.	*	28 JUL 0400	149	3.	*	31 JUL 0000	217	3.
22 JUL 1300	14	3.	*	25 JUL 0900	82	4.	*	28 JUL 0500	150	3.	*	31 JUL 0100	218	3.
22 JUL 1400	15	3.	*	25 JUL 1000	83	4.	*	28 JUL 0600	151	3.	*	31 JUL 0200	219	3.
22 JUL 1500	16	3.	*	25 JUL 1100	84	4.	*	28 JUL 0700	152	3.	*	31 JUL 0300	220	3.
22 JUL 1600	17	7.	*	25 JUL 1200	85	4.	*	28 JUL 0800	153	3.	*	31 JUL 0400	221	3.
22 JUL 1700	18	21.	*	25 JUL 1300	86	4.	*	28 JUL 0900	154	3.	*	31 JUL 0500	222	3.
22 JUL 1800	19	40.	*	25 JUL 1400	87	4.	*	28 JUL 1000	155	3.	*	31 JUL 0600	223	3.
22 JUL 1900	20	53.	*	25 JUL 1500	88	4.	*	28 JUL 1100	156	3.	*	31 JUL 0700	224	3.
22 JUL 2000	21	56.	*	25 JUL 1600	89	4.	*	28 JUL 1200	157	3.	*	31 JUL 0800	225	3.
22 JUL 2100	22	51.	*	25 JUL 1700	90	4.	*	28 JUL 1300	158	3.	*	31 JUL 0900	226	3.
22 JUL 2200	23	43.	*	25 JUL 1800	91	4.	*	28 JUL 1400	159	3.	*	31 JUL 1000	227	3.
22 JUL 2300	24	36.	*	25 JUL 1900	92	4.	*	28 JUL 1500	160	3.	*	31 JUL 1100	228	3.
23 JUL 0000	25	31.	*	25 JUL 2000	93	4.	*	28 JUL 1600	161	3.	*	31 JUL 1200	229	3.

23 JUL 0100	26	24.	*	25 JUL 2100	94	4.	*	28 JUL 1700	162	3.	*	31 JUL 1300	230	3.
23 JUL 0200	27	16.	*	25 JUL 2200	95	4.	*	28 JUL 1800	163	3.	*	31 JUL 1400	231	3.
23 JUL 0300	28	10.	*	25 JUL 2300	96	4.	*	28 JUL 1900	164	3.	*	31 JUL 1500	232	3.
23 JUL 0400	29	6.	*	26 JUL 0000	97	4.	*	28 JUL 2000	165	3.	*	31 JUL 1600	233	3.
23 JUL 0500	30	4.	*	26 JUL 0100	98	4.	*	28 JUL 2100	166	3.	*	31 JUL 1700	234	3.
23 JUL 0600	31	4.	*	26 JUL 0200	99	4.	*	28 JUL 2200	167	3.	*	31 JUL 1800	235	3.
23 JUL 0700	32	4.	*	26 JUL 0300	100	4.	*	28 JUL 2300	168	3.	*	31 JUL 1900	236	3.
23 JUL 0800	33	4.	*	26 JUL 0400	101	4.	*	29 JUL 0000	169	3.	*	31 JUL 2000	237	3.
23 JUL 0900	34	4.	*	26 JUL 0500	102	4.	*	29 JUL 0100	170	3.	*	31 JUL 2100	238	3.
23 JUL 1000	35	4.	*	26 JUL 0600	103	4.	*	29 JUL 0200	171	3.	*	31 JUL 2200	239	3.
23 JUL 1100	36	4.	*	26 JUL 0700	104	4.	*	29 JUL 0300	172	3.	*	31 JUL 2300	240	3.
23 JUL 1200	37	4.	*	26 JUL 0800	105	4.	*	29 JUL 0400	173	3.	*	1 AUG 0000	241	3.
23 JUL 1300	38	4.	*	26 JUL 0900	106	4.	*	29 JUL 0500	174	3.	*	1 AUG 0100	242	3.
23 JUL 1400	39	4.	*	26 JUL 1000	107	4.	*	29 JUL 0600	175	3.	*	1 AUG 0200	243	3.
23 JUL 1500	40	4.	*	26 JUL 1100	108	4.	*	29 JUL 0700	176	3.	*	1 AUG 0300	244	3.
23 JUL 1600	41	4.	*	26 JUL 1200	109	4.	*	29 JUL 0800	177	3.	*	1 AUG 0400	245	3.
23 JUL 1700	42	4.	*	26 JUL 1300	110	4.	*	29 JUL 0900	178	3.	*	1 AUG 0500	246	3.
23 JUL 1800	43	4.	*	26 JUL 1400	111	4.	*	29 JUL 1000	179	3.	*	1 AUG 0600	247	3.
23 JUL 1900	44	4.	*	26 JUL 1500	112	4.	*	29 JUL 1100	180	3.	*	1 AUG 0700	248	2.
23 JUL 2000	45	4.	*	26 JUL 1600	113	4.	*	29 JUL 1200	181	3.	*	1 AUG 0800	249	2.
23 JUL 2100	46	4.	*	26 JUL 1700	114	4.	*	29 JUL 1300	182	3.	*	1 AUG 0900	250	2.
23 JUL 2200	47	4.	*	26 JUL 1800	115	4.	*	29 JUL 1400	183	3.	*	1 AUG 1000	251	2.
23 JUL 2300	48	4.	*	26 JUL 1900	116	4.	*	29 JUL 1500	184	3.	*	1 AUG 1100	252	2.
24 JUL 0000	49	4.	*	26 JUL 2000	117	4.	*	29 JUL 1600	185	3.	*	1 AUG 1200	253	2.
24 JUL 0100	50	4.	*	26 JUL 2100	118	4.	*	29 JUL 1700	186	3.	*	1 AUG 1300	254	2.
24 JUL 0200	51	4.	*	26 JUL 2200	119	3.	*	29 JUL 1800	187	3.	*	1 AUG 1400	255	2.
24 JUL 0300	52	4.	*	26 JUL 2300	120	3.	*	29 JUL 1900	188	3.	*	1 AUG 1500	256	2.
24 JUL 0400	53	4.	*	27 JUL 0000	121	3.	*	29 JUL 2000	189	3.	*	1 AUG 1600	257	2.
24 JUL 0500	54	4.	*	27 JUL 0100	122	3.	*	29 JUL 2100	190	3.	*	1 AUG 1700	258	2.
24 JUL 0600	55	4.	*	27 JUL 0200	123	3.	*	29 JUL 2200	191	3.	*	1 AUG 1800	259	2.
24 JUL 0700	56	4.	*	27 JUL 0300	124	3.	*	29 JUL 2300	192	3.	*	1 AUG 1900	260	2.
24 JUL 0800	57	4.	*	27 JUL 0400	125	3.	*	30 JUL 0000	193	3.	*	1 AUG 2000	261	2.
24 JUL 0900	58	4.	*	27 JUL 0500	126	3.	*	30 JUL 0100	194	3.	*	1 AUG 2100	262	2.
24 JUL 1000	59	4.	*	27 JUL 0600	127	3.	*	30 JUL 0200	195	3.	*	1 AUG 2200	263	2.
24 JUL 1100	60	4.	*	27 JUL 0700	128	3.	*	30 JUL 0300	196	3.	*	1 AUG 2300	264	2.
24 JUL 1200	61	4.	*	27 JUL 0800	129	3.	*	30 JUL 0400	197	3.	*	2 AUG 0000	265	2.
24 JUL 1300	62	4.	*	27 JUL 0900	130	3.	*	30 JUL 0500	198	3.	*	2 AUG 0100	266	2.
24 JUL 1400	63	4.	*	27 JUL 1000	131	3.	*	30 JUL 0600	199	3.	*	2 AUG 0200	267	2.
24 JUL 1500	64	4.	*	27 JUL 1100	132	3.	*	30 JUL 0700	200	3.	*	2 AUG 0300	268	2.
24 JUL 1600	65	4.	*	27 JUL 1200	133	3.	*	30 JUL 0800	201	3.	*	2 AUG 0400	269	2.
24 JUL 1700	66	4.	*	27 JUL 1300	134	3.	*	30 JUL 0900	202	3.	*	2 AUG 0500	270	2.
24 JUL 1800	67	4.	*	27 JUL 1400	135	3.	*	30 JUL 1000	203	3.	*			
24 JUL 1900	68	4.	*	27 JUL 1500	136	3.	*	30 JUL 1100	204	3.	*			
			*				*				*			

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 56.	20.00		46.	18.	9.	5.
		(INCHES)	.101	.163	.234	.451
		(AC-FT)	23.	37.	53.	101.

CUMULATIVE AREA = 4.20 SQ MI

*** ***

```
          **************
          *            *
79 KK     *     STA7   *     COMBINED HYDROGRAPH FOR CHANNEL REACH6 AND UNNAMED TRIBUTARY
          *            *
          **************

80 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          0  PRINT CONTROL
                     IPLOT          2  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

81 HC          HYDROGRAPH COMBINATION
                     ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                   ***
```

****

HYDROGRAPH AT STATION STA7
SUM OF 2 HYDROGRAPHS

****

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
22 JUL 0000	1	94.	24 JUL 2000	69	136.	27 JUL 1600	137	118.	30 JUL 1200	205	102.
22 JUL 0100	2	94.	24 JUL 2100	70	136.	27 JUL 1700	138	118.	30 JUL 1300	206	102.
22 JUL 0200	3	94.	24 JUL 2200	71	136.	27 JUL 1800	139	117.	30 JUL 1400	207	102.
22 JUL 0300	4	94.	24 JUL 2300	72	136.	27 JUL 1900	140	117.	30 JUL 1500	208	102.
22 JUL 0400	5	94.	25 JUL 0000	73	135.	27 JUL 2000	141	117.	30 JUL 1600	209	101.
22 JUL 0500	6	93.	25 JUL 0100	74	135.	27 JUL 2100	142	117.	30 JUL 1700	210	101.
22 JUL 0600	7	93.	25 JUL 0200	75	135.	27 JUL 2200	143	116.	30 JUL 1800	211	101.
22 JUL 0700	8	93.	25 JUL 0300	76	134.	27 JUL 2300	144	116.	30 JUL 1900	212	101.
22 JUL 0800	9	93.	25 JUL 0400	77	134.	28 JUL 0000	145	116.	30 JUL 2000	213	101.
22 JUL 0900	10	93.	25 JUL 0500	78	134.	28 JUL 0100	146	116.	30 JUL 2100	214	100.
22 JUL 1000	11	93.	25 JUL 0600	79	133.	28 JUL 0200	147	115.	30 JUL 2200	215	100.
22 JUL 1100	12	93.	25 JUL 0700	80	133.	28 JUL 0300	148	115.	30 JUL 2300	216	100.
22 JUL 1200	13	93.	25 JUL 0800	81	133.	28 JUL 0400	149	115.	31 JUL 0000	217	100.
22 JUL 1300	14	93.	25 JUL 0900	82	133.	28 JUL 0500	150	115.	31 JUL 0100	218	99.
22 JUL 1400	15	92.	25 JUL 1000	83	132.	28 JUL 0600	151	114.	31 JUL 0200	219	99.
22 JUL 1500	16	93.	25 JUL 1100	84	132.	28 JUL 0700	152	114.	31 JUL 0300	220	99.
22 JUL 1600	17	97.	25 JUL 1200	85	132.	28 JUL 0800	153	114.	31 JUL 0400	221	99.
22 JUL 1700	18	111.	25 JUL 1300	86	131.	28 JUL 0900	154	114.	31 JUL 0500	222	99.
22 JUL 1800	19	131.	25 JUL 1400	87	131.	28 JUL 1000	155	113.	31 JUL 0600	223	98.
22 JUL 1900	20	149.	25 JUL 1500	88	131.	28 JUL 1100	156	113.	31 JUL 0700	224	98.
22 JUL 2000	21	178.	25 JUL 1600	89	131.	28 JUL 1200	157	113.	31 JUL 0800	225	98.
22 JUL 2100	22	275.	25 JUL 1700	90	130.	28 JUL 1300	158	113.	31 JUL 0900	226	98.
22 JUL 2200	23	425.	25 JUL 1800	91	130.	28 JUL 1400	159	112.	31 JUL 1000	227	98.
22 JUL 2300	24	540.	25 JUL 1900	92	130.	28 JUL 1500	160	112.	31 JUL 1100	228	97.
23 JUL 0000	25	642.	25 JUL 2000	93	129.	28 JUL 1600	161	112.	31 JUL 1200	229	97.
23 JUL 0100	26	747.	25 JUL 2100	94	129.	28 JUL 1700	162	112.	31 JUL 1300	230	97.
23 JUL 0200	27	830.	25 JUL 2200	95	129.	28 JUL 1800	163	112.	31 JUL 1400	231	97.
23 JUL 0300	28	875.	25 JUL 2300	96	129.	28 JUL 1900	164	111.	31 JUL 1500	232	97.
23 JUL 0400	29	885.	26 JUL 0000	97	128.	28 JUL 2000	165	111.	31 JUL 1600	233	97.
23 JUL 0500	30	872.	26 JUL 0100	98	128.	28 JUL 2100	166	111.	31 JUL 1700	234	96.
23 JUL 0600	31	846.	26 JUL 0200	99	128.	28 JUL 2200	167	111.	31 JUL 1800	235	96.
23 JUL 0700	32	811.	26 JUL 0300	100	128.	28 JUL 2300	168	110.	31 JUL 1900	236	96.
23 JUL 0800	33	769.	26 JUL 0400	101	127.	29 JUL 0000	169	110.	31 JUL 2000	237	96.

23 JUL 0900	34	723.	*	26 JUL 0500	102	127.	*	29 JUL 0100	170	110.	*	31 JUL 2100	238	96.
23 JUL 1000	35	676.	*	26 JUL 0600	103	127.	*	29 JUL 0200	171	110.	*	31 JUL 2200	239	95.
23 JUL 1100	36	629.	*	26 JUL 0700	104	126.	*	29 JUL 0300	172	109.	*	31 JUL 2300	240	95.
23 JUL 1200	37	584.	*	26 JUL 0800	105	126.	*	29 JUL 0400	173	109.	*	1 AUG 0000	241	95.
23 JUL 1300	38	540.	*	26 JUL 0900	106	126.	*	29 JUL 0500	174	109.	*	1 AUG 0100	242	95.
23 JUL 1400	39	499.	*	26 JUL 1000	107	126.	*	29 JUL 0600	175	109.	*	1 AUG 0200	243	95.
23 JUL 1500	40	461.	*	26 JUL 1100	108	125.	*	29 JUL 0700	176	109.	*	1 AUG 0300	244	94.
23 JUL 1600	41	425.	*	26 JUL 1200	109	125.	*	29 JUL 0800	177	108.	*	1 AUG 0400	245	94.
23 JUL 1700	42	393.	*	26 JUL 1300	110	125.	*	29 JUL 0900	178	108.	*	1 AUG 0500	246	94.
23 JUL 1800	43	363.	*	26 JUL 1400	111	125.	*	29 JUL 1000	179	108.	*	1 AUG 0600	247	94.
23 JUL 1900	44	337.	*	26 JUL 1500	112	124.	*	29 JUL 1100	180	108.	*	1 AUG 0700	248	94.
23 JUL 2000	45	312.	*	26 JUL 1600	113	124.	*	29 JUL 1200	181	107.	*	1 AUG 0800	249	93.
23 JUL 2100	46	291.	*	26 JUL 1700	114	124.	*	29 JUL 1300	182	107.	*	1 AUG 0900	250	93.
23 JUL 2200	47	271.	*	26 JUL 1800	115	123.	*	29 JUL 1400	183	107.	*	1 AUG 1000	251	93.
23 JUL 2300	48	254.	*	26 JUL 1900	116	123.	*	29 JUL 1500	184	107.	*	1 AUG 1100	252	93.
24 JUL 0000	49	238.	*	26 JUL 2000	117	123.	*	29 JUL 1600	185	107.	*	1 AUG 1200	253	93.
24 JUL 0100	50	223.	*	26 JUL 2100	118	123.	*	29 JUL 1700	186	106.	*	1 AUG 1300	254	92.
24 JUL 0200	51	210.	*	26 JUL 2200	119	122.	*	29 JUL 1800	187	106.	*	1 AUG 1400	255	92.
24 JUL 0300	52	199.	*	26 JUL 2300	120	122.	*	29 JUL 1900	188	106.	*	1 AUG 1500	256	92.
24 JUL 0400	53	190.	*	27 JUL 0000	121	122.	*	29 JUL 2000	189	106.	*	1 AUG 1600	257	92.
24 JUL 0500	54	182.	*	27 JUL 0100	122	122.	*	29 JUL 2100	190	105.	*	1 AUG 1700	258	92.
24 JUL 0600	55	175.	*	27 JUL 0200	123	121.	*	29 JUL 2200	191	105.	*	1 AUG 1800	259	92.
24 JUL 0700	56	169.	*	27 JUL 0300	124	121.	*	29 JUL 2300	192	105.	*	1 AUG 1900	260	91.
24 JUL 0800	57	164.	*	27 JUL 0400	125	121.	*	30 JUL 0000	193	105.	*	1 AUG 2000	261	91.
24 JUL 0900	58	159.	*	27 JUL 0500	126	121.	*	30 JUL 0100	194	105.	*	1 AUG 2100	262	91.
24 JUL 1000	59	155.	*	27 JUL 0600	127	120.	*	30 JUL 0200	195	104.	*	1 AUG 2200	263	91.
24 JUL 1100	60	151.	*	27 JUL 0700	128	120.	*	30 JUL 0300	196	104.	*	1 AUG 2300	264	91.
24 JUL 1200	61	148.	*	27 JUL 0800	129	120.	*	30 JUL 0400	197	104.	*	2 AUG 0000	265	90.
24 JUL 1300	62	145.	*	27 JUL 0900	130	120.	*	30 JUL 0500	198	104.	*	2 AUG 0100	266	90.
24 JUL 1400	63	143.	*	27 JUL 1000	131	119.	*	30 JUL 0600	199	103.	*	2 AUG 0200	267	90.
24 JUL 1500	64	141.	*	27 JUL 1100	132	119.	*	30 JUL 0700	200	103.	*	2 AUG 0300	268	90.
24 JUL 1600	65	140.	*	27 JUL 1200	133	119.	*	30 JUL 0800	201	103.	*	2 AUG 0400	269	90.
24 JUL 1700	66	139.	*	27 JUL 1300	134	119.	*	30 JUL 0900	202	103.	*	2 AUG 0500	270	90.
24 JUL 1800	67	138.	*	27 JUL 1400	135	118.	*	30 JUL 1000	203	103.	*			
24 JUL 1900	68	137.	*	27 JUL 1500	136	118.	*	30 JUL 1100	204	102.	*			
			*				*				*			

****

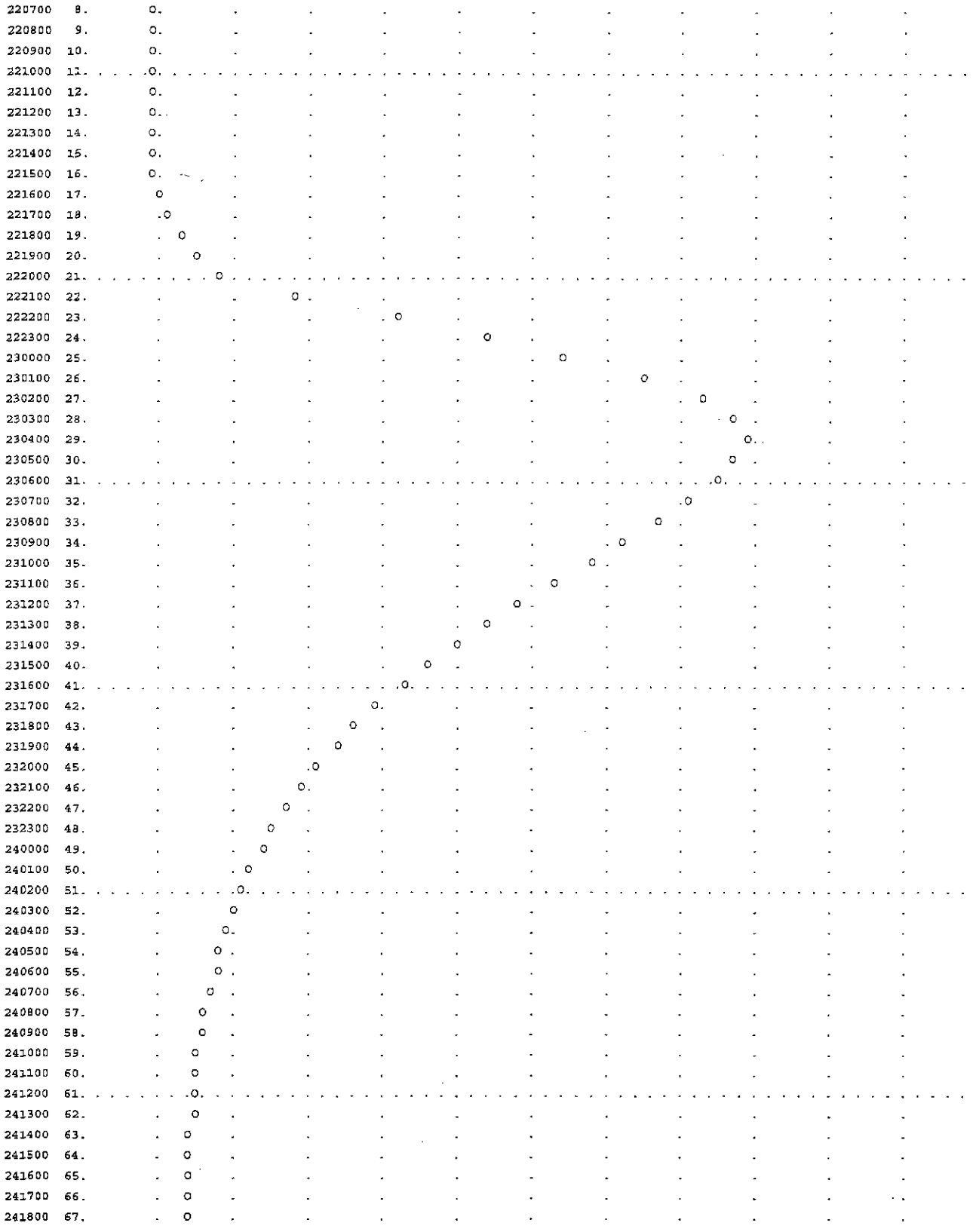
PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	269.00-HR
+ (CFS)	(HR)					
		(CFS)				
+ 885.	28.00		848.	603.	306.	160.
		(INCHES)	.049	.139	.212	.414
		(AC-FT)	421.	1196.	1819.	3563.

CUMULATIVE AREA = 161.20 SQ MI

1 STATION STA7

(O) OUTFLOW

```
         0.      100.      200.      300.      400.      500.      600.      700.      800.      900.        0.        0.        0.
DAHRMN PER
220000   1.--------O.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
220100   2.        O.         .         .         .         .         .         .         .         .         .         .         .
220200   3.        O.         .         .         .         .         .         .         .         .         .         .         .
220300   4.        O.         .         .         .         .         .         .         .         .         .         .         .
220400   5.        O.         .         .         .         .         .         .         .         .         .         .         .
220500   6.        O.         .         .         .         .         .         .         .         .         .         .         .
220600   7.        O.         .         .         .         .         .         .         .         .         .         .         .
```


220700 8.
220800 9.
220900 10.
221000 11.
221100 12.
221200 13.
221300 14.
221400 15.
221500 16.
221600 17.
221700 18.
221800 19.
221900 20.
222000 21.
222100 22.
222200 23.
222300 24.
230000 25.
230100 26.
230200 27.
230300 28.
230400 29.
230500 30.
230600 31.
230700 32.
230800 33.
230900 34.
231000 35.
231100 36.
231200 37.
231300 38.
231400 39.
231500 40.
231600 41.
231700 42.
231800 43.
231900 44.
232000 45.
232100 46.
232200 47.
232300 48.
240000 49.
240100 50.
240200 51.
240300 52.
240400 53.
240500 54.
240600 55.
240700 56.
240800 57.
240900 58.
241000 59.
241100 60.
241200 61.
241300 62.
241400 63.
241500 64.
241600 65.
241700 66.
241800 67.

241900	68.	O
242000	69.	O
242100	70.	O
242200	71.	O
242300	72.	O
250000	73.	O
250100	74.	O
250200	75.	O
250300	76.	O
250400	77.	O
250500	78.	O
250600	79.	O
250700	80.	O
250800	81.	O
250900	82.	O
251000	83.	O
251100	84.	O
251200	85.	O
251300	86.	O
251400	87.	O
251500	88.	O
251600	89.	O
251700	90.	O
251800	91.	O
251900	92.	O
252000	93.	O
252100	94.	O
252200	95.	O
252300	96.	O
260000	97.	O
260100	98.	O
260200	99.	O
260300	100.	O
260400	101.	O
260500	102.	O
260600	103.	O
260700	104.	O
260800	105.	O
260900	106.	O
261000	107.	O
261100	108.	O
261200	109.	O
261300	110.	O
261400	111.	O
261500	112.	O
261600	113.	O
261700	114.	O
261800	115.	O
261900	116.	O
262000	117.	O
262100	118.	O
262200	119.	O
262300	120.	O
270000	121.	O
270100	122.	O
270200	123.	O
270300	124.	O
270400	125.	O
270500	126.	O
270600	127.	O

270700 128. . O
270800 129. . O
270900 130. . O
271000 131. . O
271100 132. . O
271200 133. . O
271300 134. . O
271400 135. . O
271500 136. . O
271600 137. . O
271700 138. . O
271800 139. . O
271900 140. . O
272000 141. . O
272100 142. . O
272200 143. . O
272300 144. . O
280000 145. . O
280100 146. . O
280200 147. . O
280300 148. . O
280400 149. .O
280500 150. .O
280600 151. .O
280700 152. .O
280800 153. .O
280900 154. .O
281000 155. .O
281100 156. .O
281200 157. .O
281300 158. .O
281400 159. .O
281500 160. .O
281600 161. .O
281700 162. .O
281800 163. .O
281900 164. .O
282000 165. .O
282100 166. .O
282200 167. .O
282300 168. .O
290000 169. .O
290100 170. .O
290200 171. .O
290300 172. .O
290400 173. .O
290500 174. .O
290600 175. .O
290700 176. .O
290800 177. .O
290900 178. .O
291000 179. .O
291100 180. .O
291200 181. .O
291300 182. .O
291400 183. .O
291500 184. .O
291600 185. .O
291700 186. .O
291800 187. .O

```
291900 188.      .O
292000 189.      .O
292100 190.      .O
292200 191.      .O
292300 192.      O
300000 193.      O
300100 194.      O
300200 195.      O
300300 196.      O
300400 197.      O
300500 198.      O
300600 199.      O
300700 200.      O
300800 201.      O
300900 202.      O
301000 203.      O
301100 204.      O
301200 205.      O
301300 206.      O
301400 207.      O
301500 208.      O
301600 209.      O
301700 210.      O
301800 211.      O
301900 212.      O
302000 213.      O
302100 214.      O
302200 215.      O
302300 216.      O
310000 217.      O
310100 218.      O
310200 219.      O
310300 220.      O
310400 221.      O
310500 222.      O
310600 223.      O
310700 224.      O
310800 225.      O
310900 226.      O
311000 227.      O
311100 228.      O
311200 229.      O
311300 230.      O
311400 231.      O
311500 232.      O
311600 233.      O
311700 234.      O
311800 235.      O
311900 236.      O
312000 237.      O
312100 238.      O
312200 239.      O
312300 240.      O
 10000 241.      .O
 10100 242.      O.
 10200 243.      O.
 10300 244.      O.
 10400 245.      O.
 10500 246.      O.
 10600 247.      O.
```

```
 10700 248.         O.        .         .         .         .         .         .         .         .         .         .         .
 10800 249.         O.        .         .         .         .         .         .         .         .         .         .         .
 10900 250.         O.        .         .         .         .         .         .         .         .         .         .         .
 11000 251. . . . .O. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
 11100 252.         O.        .         .         .         .         .         .         .         .         .         .         .
 11200 253.         O.        .         .         .         .         .         .         .         .         .         .         .
 11300 254.         O.        .         .         .         .         .         .         .         .         .         .         .
 11400 255.         O.        .         .         .         .         .         .         .         .         .         .         .
 11500 256.         O.        .         .         .         .         .         .         .         .         .         .         .
 11600 257.         O.        .         .         .         .         .         .         .         .         .         .         .
 11700 258.         O.        .         .         .         .         .         .         .         .         .         .         .
 11800 259.         O.        .         .         .         .         .         .         .         .         .         .         .
 11900 260.         O.        .         .         .         .         .         .         .         .         .         .         .
 12000 261. . . . .O. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
 12100 262.         O.        .         .         .         .         .         .         .         .         .         .         .
 12200 263.         O.        .         .         .         .         .         .         .         .         .         .         .
 12300 264.         O.        .         .         .         .         .         .         .         .         .         .         .
 20000 265.         O.        .         .         .         .         .         .         .         .         .         .         .
 20100 266.         O.        .         .         .         .         .         .         .         .         .         .         .
 20200 267.         O.        .         .         .         .         .         .         .         .         .         .         .
 20300 268.         O.        .         .         .         .         .         .         .         .         .         .         .
 20400 269.         O.        .         .         .         .         .         .         .         .         .         .         .
 20500 270.--------O.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
1
1
```

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	BASIN1	209	24.00	201.	137.	65.	36.60		
+	HYDROGRAPH AT	BASIN2	123.	25.00	117.	72.	30.	19.10		
+	2 COMBINED AT	STA1	329	25.00	316.	208.	95.	55.70		
+	ROUTED TO	REACH1	329.	26.00	315.	207.	95.	55.70		
+	HYDROGRAPH AT	BASIN3	64.	20.00	55.	22.	11.	5.20		
+	2 COMBINED AT	STA2	360	25.00	345.	229.	106.	60.90		
+	ROUTED TO	REACH2	356.	27.00	343.	228.	106.	60.90		
+	HYDROGRAPH AT	BASIN4	120.	19.00	95.	43.	26.	7.60		
+	HYDROGRAPH AT	BASIN5	62.	23.00	58.	33.	17.	7.40		

```
        3 COMBINED AT
+                       STA3      432.   25.00        418.        290.        148.      75.90

        ROUTED TO
+                     REACH3      435.   26.00        422.        294.        153.      75.90

        HYDROGRAPH AT
+                     BASIN6       60.   27.00         58.         43.         19.      13.20

        2 COMBINED AT
+                       STA4      494.   26.00        480.        337.        172.      89.10

        ROUTED TO
+                     REACH4      499.   27.00        482.        342.        178.      89.10

        HYDROGRAPH AT
+                     BASIN7      280.   25.00        267.        171.         79.      45.00

        2 COMBINED AT
+                       STA5      772.   26.00        740.        511.        256.     134.10

        ROUTED TO
+                     REACH5      779.   27.00        746.        520.        266.     134.10

        HYDROGRAPH AT
+                     BASIN8      104.   27.00        101.         74.         32.      22.90

        2 COMBINED AT
+                       STA6      883.   27.00        846.        594.        298.     157.00

        ROUTED TO
+                     REACH6      879.   28.00        841.        592.        298.     157.00

        HYDROGRAPH AT
+                     BASIN9       56.   20.00         46.         18.          9.       4.20

        2 COMBINED AT
+                       STA7      885.   28.00        848.        603.        306.     161.20
1
                                 SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                     (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                          INTERPOLATED TO
                                                                       COMPUTATION INTERVAL
          ISTAQ    ELEMENT      DT        PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                               (MIN)      (CFS)     (MIN)      (IN)    (MIN)      (CFS)     (MIN)       (IN)

           REACH1  MANE        20.97     329.43   1564.39       .34    60.00     329.39   1560.00        .34

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1004E+04 EXCESS= .0000E+00 OUTFLOW= .1004E+04 BASIN STORAGE=-.8812E-01 PERCENT ERROR=    .0

           REACH2  MANE        30.00     358.32   1620.00       .35    60.00     358.32   1620.00        .35

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1125E+04 EXCESS= .0000E+00 OUTFLOW= .1126E+04 BASIN STORAGE=-.4871E+00 PERCENT ERROR=    .0
```

```
          REACH3  MANE        30.00    430.65   1530.00       .42     60.00    430.51   1560.00         .42

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1713E+04 EXCESS= .0000E+00 OUTFLOW= .1713E+04 BASIN STORAGE=-.3066E+00 PERCENT ERROR=    .0

          REACH4  MANE        33.00    493.04   1617.00       .42     60.00    492.91   1620.00         .42

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1998E+04 EXCESS= .0000E+00 OUTFLOW= .1998E+04 BASIN STORAGE=-.3916E+00 PERCENT ERROR=    .0

          REACH5  MANE        33.00    768.63   1617.00       .41     60.00    768.47   1620.00         .41

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2966E+04 EXCESS= .0000E+00 OUTFLOW= .2967E+04 BASIN STORAGE=-.6182E+00 PERCENT ERROR=    .0

          REACH6  MANE        33.00    879.15   1683.00       .41     60.00    878.89   1680.00         .41

CONTINUITY SUMMARY (AC-FT) - INFLOW= .3465E+04 EXCESS= .0000E+00 OUTFLOW= .3465E+04 BASIN STORAGE=-.5304E+00 PERCENT ERROR=    .0


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


  -----DSS---ZCLOSE Unit:  71,   File: H1DSS.DSS
            Pointer Utilization:   .27
            Number of Records:     55
            File Size:    136.1  Kbytes
            Percent Inactive:   .00
```