Master Storm Drainage Plan

Hidden Valley Lake, California

May 2000

Prepared for:

Hidden Valley Lake CSD
Hidden Valley Lake HOA
Lake County Flood Control
and Water Conservation District

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CHAPTER 1 - SUMMARY

I. PURPOSE

This Storm Water Master Plan has been prepared to provide a detailed overview of the adequacy of the storm drainage facilities serving the Hidden Valley Lake Subdivision. This Storm Water Master Plan provides the following review of the hydrology and hydraulics of the watershed:

- An assessment of the carrying capacity and existing facilities,
- Preliminary recommendations on upgrades required, and
- The cost of these upgrades.
- Encroachment Standards.
- Storm Water Best Management Practices.

II. METHODOLOGY

This Storm Water Master Plan began with the development of a watershed tributary to the Hidden Valley Lake Subdivision and the design storm.

The tributary watershed and its sub-watersheds were developed using available 200-scale topographic mapping and U.S. Geological Survey 2000-scale topographic mapping. The total tributary watershed is approximately 10.5 square miles. It can be subdivided into six tributary watersheds with areas varying from .89 to 3.7 square miles.

The design storms were developed using the *Hydrology Design Standards, Lake County*. These standards allow for use of a 10-year storm for watersheds less than one square mile in area and a 25-year storm for watershed more than one square mile in area. The 100-year design storm was also routed through critical drainage systems. Chapter 3 provides a detailed discussion of the development of the design criteria.

Hydrologic modeling was performed using Haested Methods HEC-1[1] and Pond Pack. Hydraulic modeling of major channels was performed using Haested Methods HEC-2. Drainage culverts were evaluated using Manning's equation and design nomographs. Chapter 4 provides a detailed discussion of the hydrologic analysis. Chapter 5 provides a detailed discussion of the hydraulic analysis.

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[1] Haested's Graphical HEC-1, Version 1.0

III. IMPROVEMENTS WITHIN THE HIDDEN VALLEY LAKE SUBDIVISION

The analysis indicates approximately 78 drainage structures within the Hidden Valley Lake Subdivision are undersized for the design flow. The total estimated cost of correcting these deficiencies is $3,600,520. Chapter 6 provides a prioritization of the recommended improvements.

In addition to the drainage structures (culverts), a storm water pump station, located at the southeast end of the subdivision (Watershed 1), has inadequate capacity to carry the 10-year design storm. The upstream portion of Watershed 1 through the golf course could be used as a detention facility to reduce peak flows to the pump station. However, major upsizing of the station would still be required. A gravity system alternative to the pump station was analyzed that would carry flows downstream entering Putah Creek at a hydraulic grade elevation that would prevent upstream flooding. The costs for these various alternatives range from $90,000 to $3.7 million (excluding right-of-way).

IV. IMPROVEMENTS OUTSIDE THE HIDDEN VALLEY LAKE SUBDIVISION

Coyote Creek, a major tributary of Putah Creek, passes through the Subdivision and through Hidden Valley Lake. The creek runs just outside the southern boundary of the Subdivision to its confluence with Putah Creek. Gallagher Creek splits the Subdivision into two parts and joins Coyote Creek just downstream from Mountain Meadow North. An analysis by the Federal Emergency Management Agency (FEMA) indicated that Coyote Creek and Gallagher Creek have the potential to flood portions of the Hidden Valley Lake Subdivision.

This Storm Water Master Plan confirms the FEMA analysis, both Coyote Creek and Gallagher Creek are incapable of carrying the 100-year storm without flooding. Modeling indicates that in order to carry the 100-year flow, Coyote Creek must be widened by approximately 100 feet. This channel widening can be significantly reduced if Hidden Valley Lake can be utilized to provide storm water flood control storage. The channel improvements would be based on the acceptable range of lake level fluctuation during the rainy season. This would reduce the downstream improvements (that are located outside District boundaries) necessary on Coyote Creek.

The hydraulic analysis would benefit from additional surveys of the topography of Coyote Creek and from a more detailed analysis of the operational flexibility of Hidden Valley Lake.

The cost estimates for improvements to Coyote Creek range from $241,000 to $713,000 and the cost estimate to improve Gallagher Creek is $79,000.

V. FINANCIAL RECOMMENDATIONS

Without clear ownership/responsibilities of the stormwater conveyance facilities within Hidden Valley Lake, a stormwater management program cannot be successfully implemented. A number of factors emerge from the review of the material.

- Determine the authority to implement and manage the stormwater facilities for Hidden Valley Lake.
- Grants and funding from FEMA and other government agencies generally require a government entity for administering the funds.
- A defined tax base must be established to dedicate funds for operation/maintenance and implementation of the recommendations.
- A user-fee approach appears to be best suited for Hidden Valley Lake.

CHAPTER 2 – INTRODUCTION

I. BACKGROUND AND PURPOSE OF STUDY

A. BACKGROUND

The Hidden Valley Lake Subdivision (the Subdivision) is located in southern Lake County, approximately 4 miles north of the unincorporated community of Middletown, California, along State Highway 29. The Subdivision is bordered by Putah Creek to the south, Highway 29 to the west, a subdivision of 5-acre ranchettes (known as the Ranchos) to the east, and undeveloped lands to the north. Figure 2-1 illustrates the location of the Subdivision.

The U.S. Land Company originally held title to the Subdivision; the Land Company started development of the Subdivision in 1968. The Land Company sold the property to Boise Cascade Corporation, prior to completing the subdivision improvements. Boise Cascade completed the development in 1973. In its final development certificates, Boise Cascade dedicated responsibility for some subdivision drainage to the County of Lake. Remaining drainage and all roadway responsibilities were dedicated to the Hidden Valley Lake Homeowners Association (Homeowners Association) and responsibility for water and limited sewer service were dedicated to Stonehouse Mutual Water Company (Stonehouse Mutual). Responsibility for a small stormwater pump station, located at the southeast end of the Subdivision, was also dedicated to Stonehouse Mutual.

In 1984, under the provisions of the Cortese-Knox Local Government Reorganization Act, the voters of the Subdivision elected to form a Community Services District. The Hidden Valley Lake Community Services District (the District) is an independent special district with 5 locally elected directors. Community Services Districts, by state law, have very broad latent powers. This type of special district may provide water, sewer, stormwater, recreation, police, fire and transportation services. The original formation documents of the District granted it the authority to provide sanitary sewer service throughout the whole of the subdivision. In 1992, after passage of special legislation and another election by the voters in the Subdivision, the District merged with Stonehouse Mutual. The District now provides all water and sewer service within the Subdivision. The District also has some interest in storm drainage, as it inherited the stormwater pump station originally dedicated to Stonehouse Mutual.

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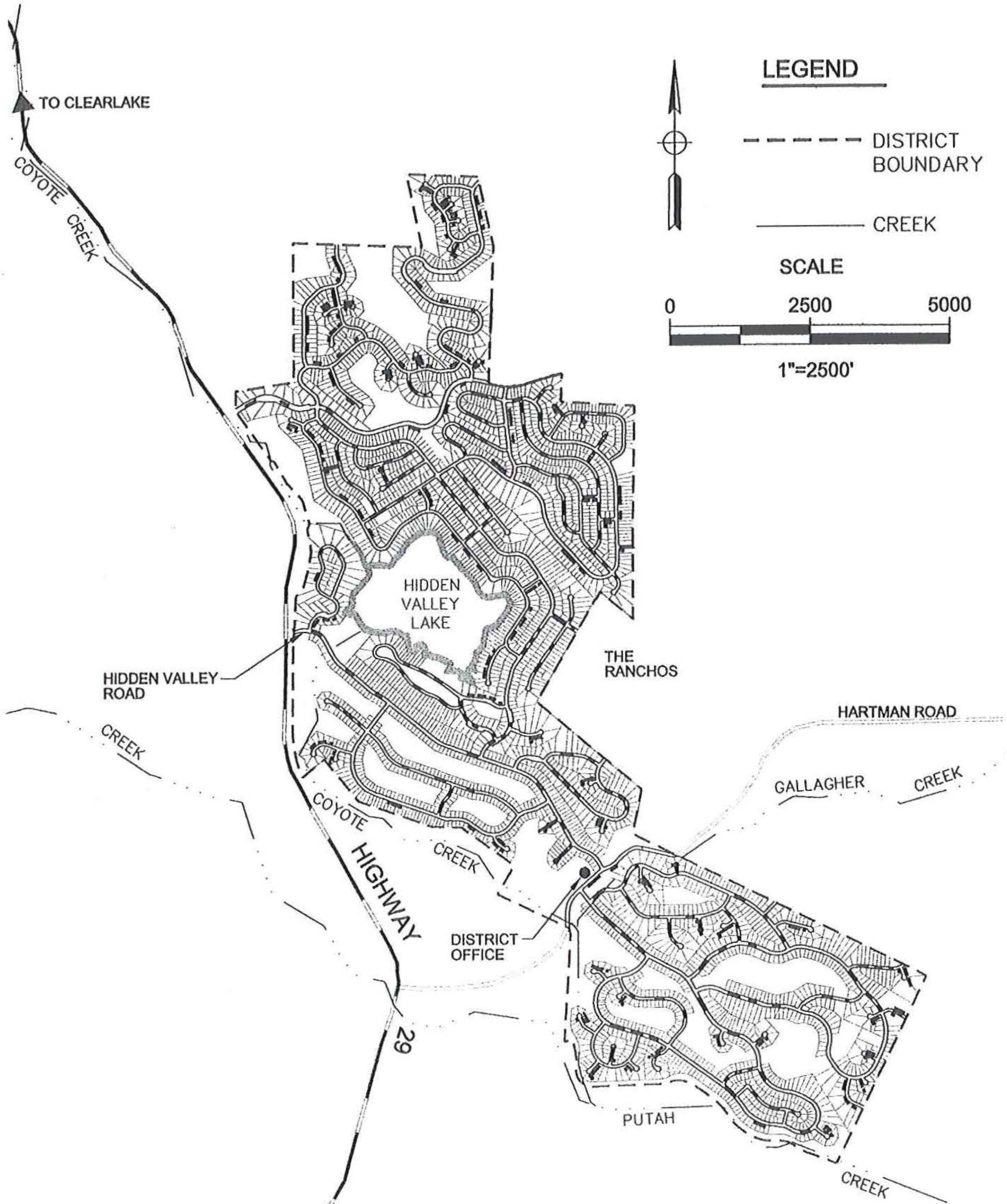

FIGURE 2-1
LOCATION MAP

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Since the merger in 1992, the District has constructed and operates sewer collection facilities, provides water system improvements, repaved roadways and made improvements to the irrigation system on the community Golf Course.

B. PURPOSE

The only comprehensive review of the drainage system in the Hidden Valley Lake area was conducted in the late 1960s and early 1970s as part of the original subdivision process. Portions of the Subdivision have experienced periodic flooding over the course of the past 25 years, with several severe flooding incidents in the late 1980s and early 1990s. This stormwater master planning effort will identify an orderly approach to correcting existing problems and identify storm run-off flows so future facilities can be integrated into the entire flood control system. The objectives of the Stormwater Master Plan include:

- Identifying the existing flow patterns and quantities of runoff that can be expected to occur.
- Evaluating the capacities of the existing stormwater facilities.
- Developing and evaluating solutions to capacity deficiencies.
- Estimating the costs of implementing the solutions.
- Prioritizing the required improvements

The Lake County Flood Control and Water Conservation District provided the funds for the Stormwater Master Plan and the District administered the funding. The District served as the project manager for this planning effort on behalf of the Lake County Flood Control and Water Conservation District. Winzler & Kelly, Consulting Engineers prepared the Stormwater Master Plan under contract to the District.

C. SCOPE OF WORK

The Scope of Work for the Stormwater Master Plan is comprised of the following tasks:

- ***Data Collection.*** This work included obtaining zoning maps, soil surveys and base topographical mapping and digitizing this information; also, reviewing existing data available through the Lake County Flood Control and Water Conservation District, the Division of Safety of Dams, and the Federal Emergency Management Agency's Flood Insurance Rate Mapping; obtaining Rainfall Intensity Curves; and meetings with property owners, District personnel, and Lake County staff.

- ***Data Reduction.*** This work included the defining of the drainage basins and developing spreadsheets to organize the data for each basin reach; determining base flows for each basin reach; evaluating the capacities of the existing stormwater facilities and identifying undersized stormwater facilities.

- ***Technical Recommendations and Cost Estimates.*** Comprised of developing potential solutions to identified problems, estimating the costs for the solutions, and recommending a course of action for correcting the problems.

- ***Financing Alternatives.*** Identify current funding sources and possible alternatives. These alternatives are for long-term funding of the proposal storm water recommendations and recommending a course of action.

- ***Report Preparation.*** Within this overall scope of work, the Lake County Flood Control and Water Conservation District identified specific areas of interest that needed to be included in the analysis. These specific tasks include:

  - Review the hydrology of Coyote Creek below the Hidden Valley Lake Dam. Below the dam near Fishhook Court, Coyote Creek splits and a portion of the flow goes through two culverts that pass below Highway 29 and outside the boundaries of the Subdivision. The remainder of Coyote Creek flows to a crossing on Hartmann Road that has historically been a flooding problem. The Master Plan should develop solutions that reduce the flooding in the area and allow for modifications to the Flood Insurance Rate Maps.

  - Review the hydrology of Coyote Creek at the confluence of Gallagher Creek. Prepare solutions for increasing the size of the culvert crossing Hartmann Road.

  - Develop driveway encroachment standards.

  - Prepare a set of Best Management Practices (BMP's) for property owners.

A Stormwater Master Plan that satisfies these objectives will provide the framework for developing storm drainage requirements for the Subdivision, and will satisfy Lake County Flood Control Conservation District.

II. REPORT PREPARERS

This report was prepared under the direction of Mr. Mel Aust, General Manager, Hidden Valley Lake Community Services District.

- Mr. Robert Lossius, Deputy Director of Water Resources, County of Lake
- Mr. Tom Smythe, Water Resources Engineer of Lake County Flood Control and Water Conservation District;
- Mr. Bill Stewart of the Homeowners Association provided review comments.

Winzler & Kelly, Consulting Engineer's project staff included:

- Mr. Iver Skavdal, Principal-in-Charge
- Mr. Jim Winter, Project Manager
- Mr. Rick Jorgensen, Project Engineer
- Mr. Tony Cinquini, Field Review, Modeling and Report Figures

CHAPTER 3 – STUDY AREA CHARACTERISTICS

I. INTRODUCTION

This chapter provides background data on the Study Area for this Stormwater Master Plan. The chapter defines the Study Area boundaries and watershed boundaries that form the basis for the hydrologic analysis; develops the land use and soils information used to calculate run-off coefficients; and outlines the hydrologic patterns that form the basis for the selection of rainfall intensity curves.

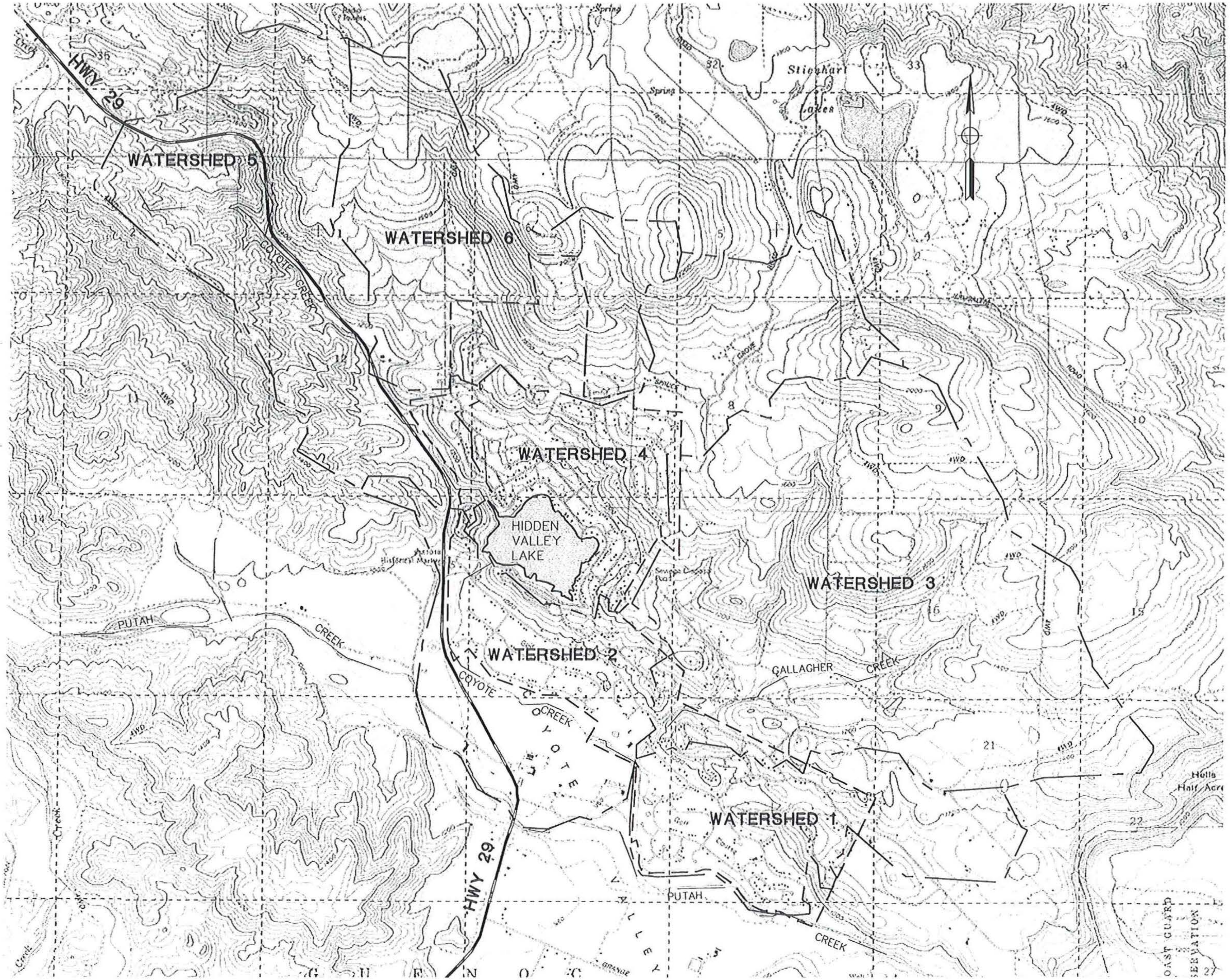
II. STUDY AREA BOUNDARIES

The Study Area is part of the Putah Creek Basin. This large watershed drains from southern Lake County, southeast to Lake Berryessa in Solano County, and ultimately into the Sacramento River. Lake Berryessa is the primary water supply for Solano County. The Putah Creek watershed is included in the ongoing studies conducted under the Cal-Fed Bay-Delta program.

The Subdivision is located in Coyote Valley on the northerly side of Putah Creek and extends from the flat alluvial plain of Coyote Valley into the hillsides. Two main tributaries, Coyote Creek and Gallagher Creek, pass through the Subdivision and eventually combine and discharge into Putah Creek. In order to evaluate the amount of runoff generated or passing through the Subdivision, the Study Area *includes* upstream drainage basin reaches that extend beyond the Subdivision boundaries. The total drainage basin tributary to the Subdivision's stormwater management system is 6,750 acres (10.55 square miles).

The drainage basin can be subdivided into 6 tributary watersheds, 3 of which are located outside of the Subdivision Boundaries. Watersheds 2, 4, 5 and 6 are tributary to Coyote Creek. Coyote Creek is dammed within the Subdivision boundaries to form Hidden Valley Lake. Watersheds 4, 5 and 6 contribute flow to Coyote Creek above the dam. Watershed 2 is located below the dam. Watershed 3 is tributary to Gallagher Creek. Watershed 1 is tributary directly to Putah Creek. Figure 3-1 illustrates the drainage basin and tributary watersheds developed for this Master Plan.

While this Master Plan, identifies and models a drainage basin well outside of the Subdivision boundaries, its recommendations are generally focused on areas within the Subdivision boundaries. Identification of improvements in the upstream watersheds is beyond the scope of this Master Plan.



LEGEND

- WATERSHED
- DISTRICT BOUNDARY
- CREEK
- HIGHWAY

SCALE

0 2500 5000

1"=2500'

FIGURE 3-1

WATERSHED BOUNDARY MAP

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III. GEOGRAPHICAL SETTING

A. Topography

The terrain within the drainage basin is quite diverse. Portions of the subdivision lie in the Coyote Valley, which consists of the alluvial plain formed by Putah Creek. However, large portions of the drainage basin are composed of steep hillsides.

Watersheds 1 and 2 are relatively flat; large portions of these watersheds are under 5-percent slopes. The surrounding hills vary from 10 to 30 percent slopes. Watersheds 3 and 4 consist of moderately sloping hillsides at approximately 15 percent slopes. Watersheds 5 and 6 are quite steep, with many slopes in excess of 30 percent.

B. Soils

The underlying soil types in the Study Area are used to assist in the development of the runoff coefficient in the hydrologic model. For this project, the Soil Conservation Service (now the Natural Resources Conservation Service or NRCS), Soil Survey for Lake County was used to determine soil type. The Study Area includes three distinct types of hydrologic soils. Soil Type B includes sandy loams and shallow loess (wind-blown volcanic ashes). Soil Type C consists predominantly of soils with a high clay content, including clay loams and some shallow sandy loams. Soil Type D consists of heavy, plastic clays with significant swell potential. The soil types are illustrated in Figure 3-2.

IV. CLIMATE

The climate in Lake County is typically dry in the summers, with mostly seasonal rainfall in the period from October through April. Countywide, rainfall averages from 22 to 80 inches per year Average seasonal rainfall in Middletown, just south of the Study Area, is 45 inches per year.

V. HYDROLOGY

Stormwater master planning and the design of drainage facilities are highly dependent on the selection of the "design storm." This storm, typically expressed in terms of its expected recurrence interval (e.g., 10 years), is used to determine rainfall intensity. The length of the design storm also affects storm flows and runoffs. This study is based on a 24-hour storm, which simulates the volume of rainfall anticipated to occur in 24 hours.

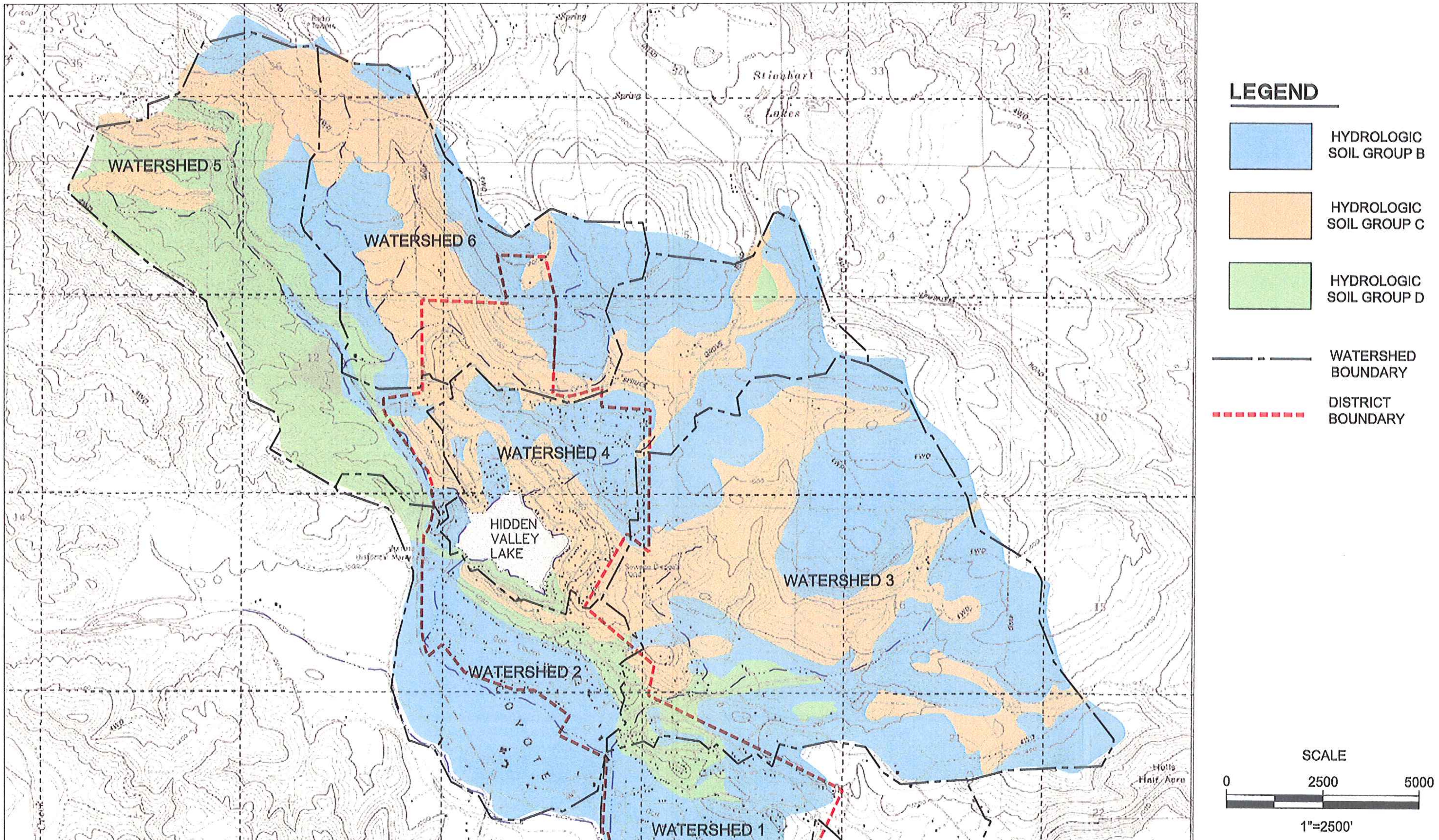

FIGURE 3-2

SOIL TYPES

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The *NOAA Atlas 2 Precipitation-Frequency Atlas of the Western United States, Volume XI – California* was used to determine the 24-hour design rainfall for the project site. The Atlas gives 6- and 24-hour rainfall for 2-, 5-, 10-, 25-, 50- and 100-year events throughout California. Figures 3-3, 3-4 and 3-5 indicate the 10-year, 24-hour; 25-year, 24-hour; and 100-year, 24-hour rainfall events taken from the NOAA Atlas are used in this study.

VI. LAND USE

Land use patterns also affect stormwater master planning efforts because the rate at which stormwater runs off, as opposed to the amount that percolates into the soil, is proportional to the amount of impervious area in a watershed. For long-term planning efforts, it is important to look not only at current development, but also at planned development patterns. Storm drain infrastructure is intended to provide service for 50 to 100 years, and facilities must be designed to accommodate future development in a watershed.

The Lake County zoning map was used to identify land use projections within the study area. By far the most intensive projected development within the Study Area is the Hidden Valley Lake Subdivision. The Subdivision contains approximately 3,300 one-quarter acre residential lots. Approximately one-half of the residential lots are developed at this time. The Subdivision does include areas of open space consisting of an 18-hole Golf Course and Hidden Valley Lake. The "Ranchos," east of the subdivision includes approximately 200, 5-acre residential parcels. The remainder of the drainage basin is zoned for relatively low levels of development, with an emphasis on agricultural zoning. Figure 3-6 illustrates the land use patterns in the Study Area.

VII. EXISTING FACILITIES

The majority of the Study Area drains through natural channels and roadside ditches. The exception is within the boundaries of the Subdivision, where a storm drainage network has been developed.

The Subdivision is centered around Hidden Valley Lake, a man-made impoundment on Coyote Creek. Drainage is carried through the Subdivision in a network of corrugated metal (CMP) culverts and roadside ditches. Individual driveway crossings of the roadside ditch typically include a CMP or reinforced concrete (RCP) culvert.

At the southeastern edge of the Subdivision, east of Hartman Road, there is a levee along Putah Creek and a portion of Coyote Creek. Drainage from this area (Watershed 1) is piped through the

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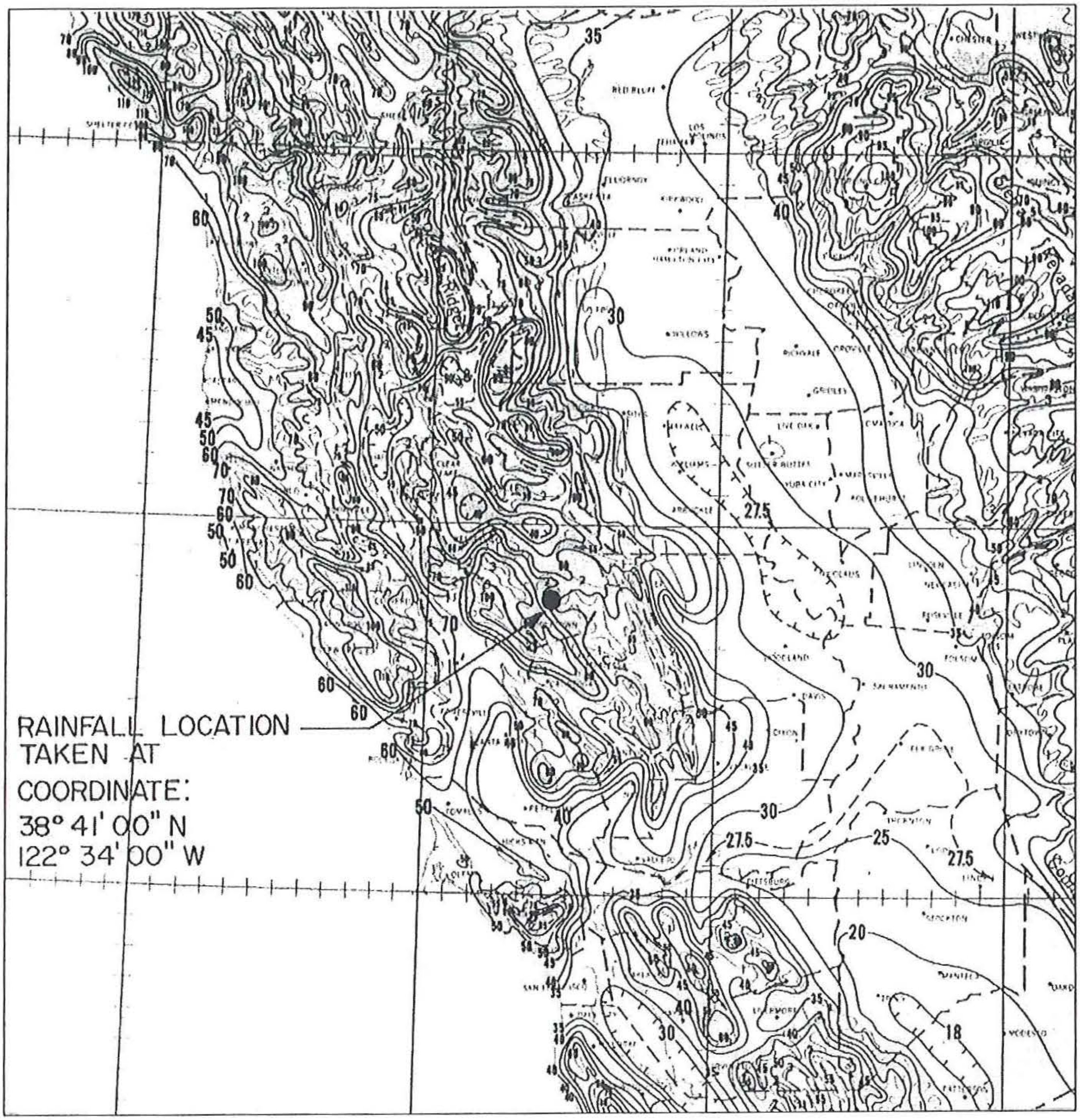

RAINFALL LOCATION TAKEN AT COORDINATE:
38° 41' 00" N
122° 34' 00" W

FIGURE 3-3

10-YEAR, 24 HOUR RAINFALL-NOAA ATLAS

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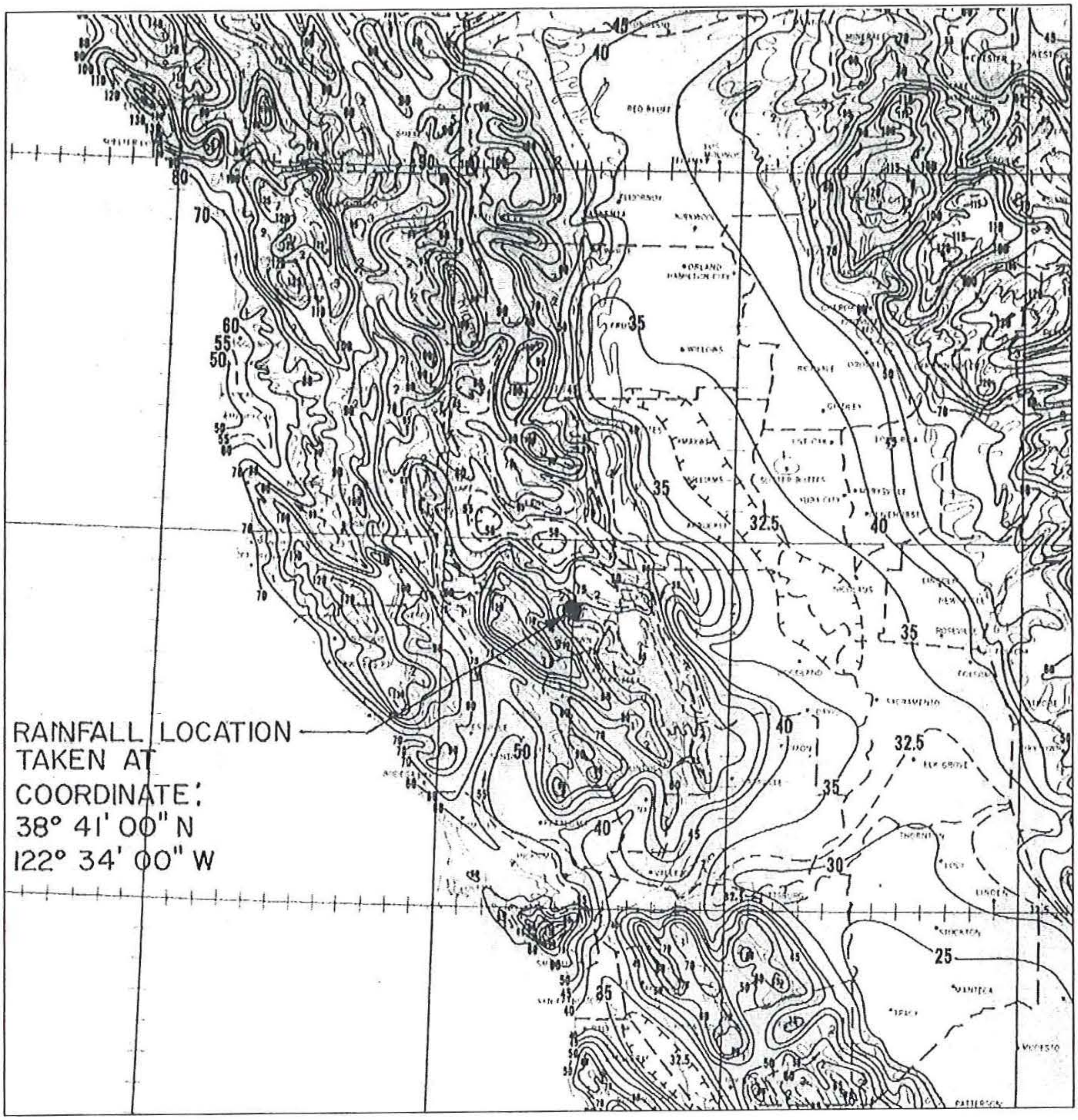

FIGURE 3-4

25-YEAR, 24 HOUR
RAINFALL-NOAA ATLAS

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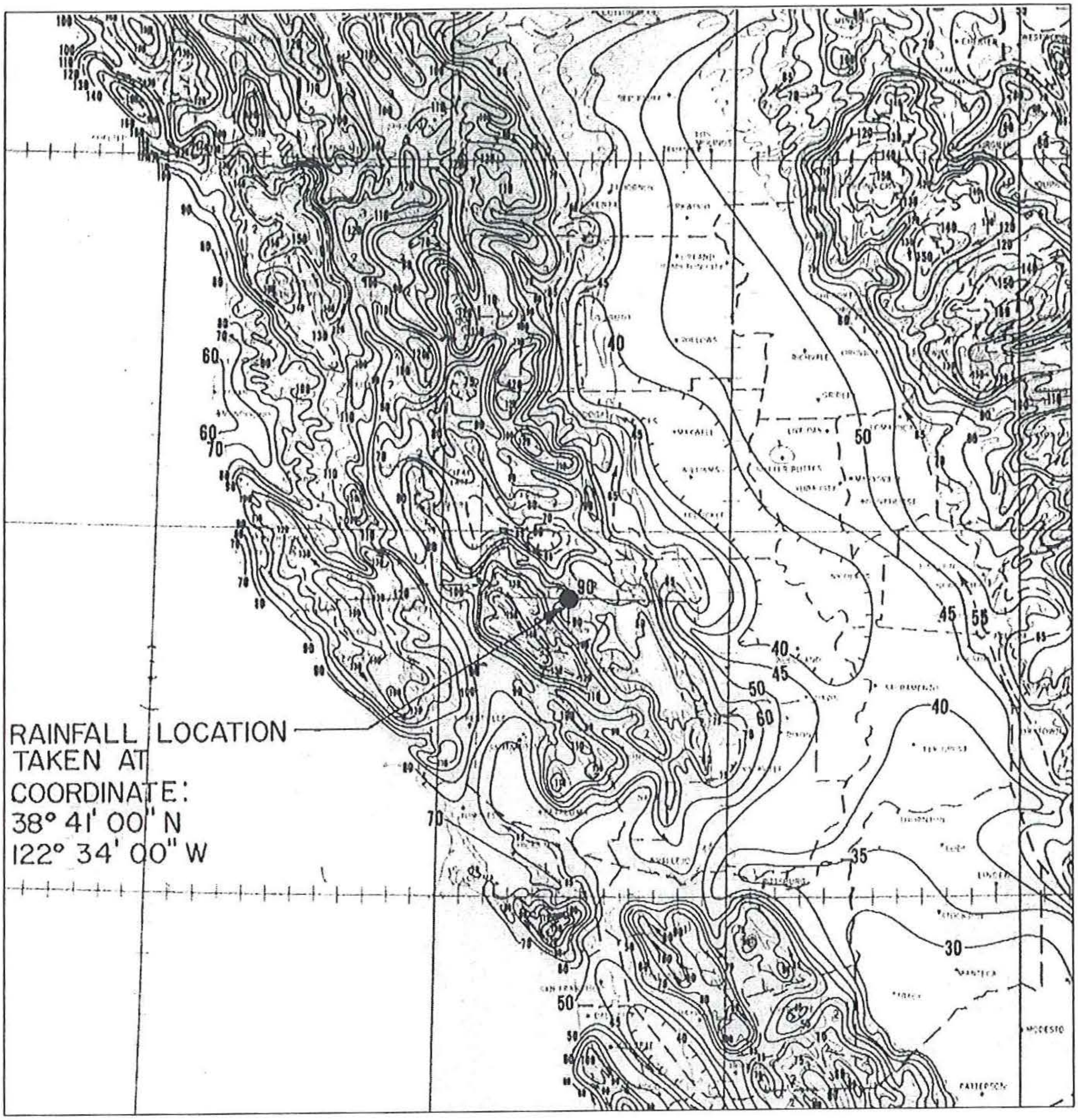

FIGURE 3-5

100-YEAR, 24 HOUR RAINFALL-NOAA ATLAS

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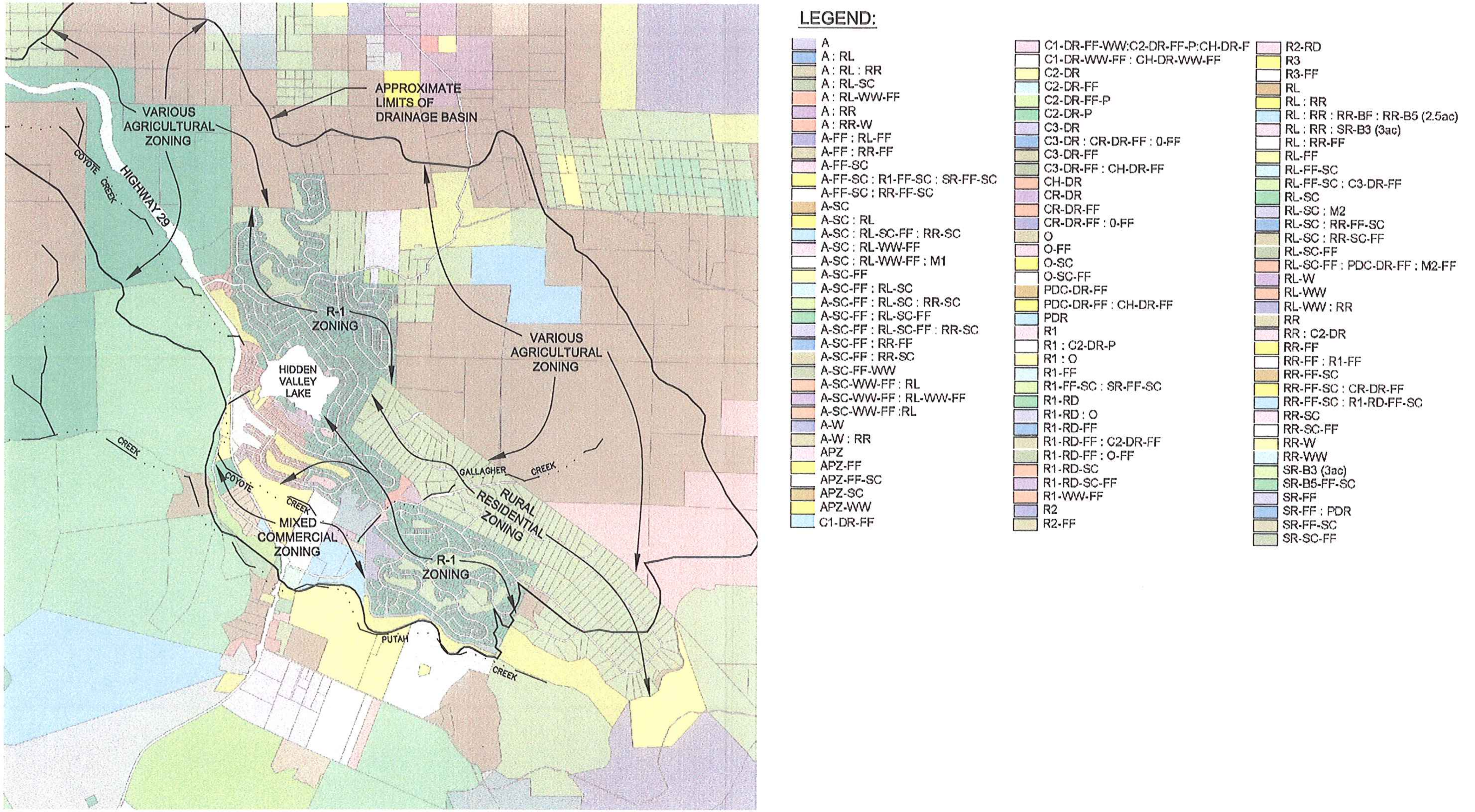

FIGURE 3-6

LANDUSE MAP

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levee in a 72-inch diameter culvert. A flap gate closes during high flows in Putah Creek. When the flap gate is closed, water held behind the levee is pumped into Putah Creek via a stormwater pump station.

VIII. SUMMARY

The following Table 3-1 summarizes the primary characteristics of each of the tributary watersheds considered in this Master Plan.

TABLE 3-1
SUMMARY OF TRIBUTARY WATERSHED DATA

Watershed	Area (sq. mi.)	Slope	Soil Types	Land Use	Tributary
Watershed 1	0.895	5% to 30%	B and D	Residential	Putah Creek
Watershed 2	1.297	5% to 30%	B and D	Residential	Coyote Creek
Watershed 3	3.675	15%	B and C	Rural Residential/Agricultural	Gallagher Creek
Watershed 4	1.117	15%	B and C	Residential/Agricultural	Coyote Creek
Watershed 5	1.940	>30%	B, C – D along Hwy 29	Agricultural	Coyote Creek
Watershed 6	1.624	>30%	Predominantly D	Agricultural Preserve - Scenic Resource	Coyote Creek

CHAPTER 4 - STUDY METHODOLOGY

I. DESIGN CRITERIA

The Lake County Flood Control and Water Conservation District has developed a set of design standards incorporated in a document entitled: *Hydrology Design Standards, Lake County (The Lake County Standards).* The *Lake County Standards* prescribe design storms for various types of waterways. The *Lake County Standards* defines a minor waterway as one with a watershed area of one square mile or less. Major waterways drain watersheds in excess of one square mile. Prescribed design storms are:

- The 10-year, 24-hour event for minor waterways
- The 25-year, 24-hour event for major waterways

This Master Plan calculates the two design flow events specified in the *Lake County Standards* and also develops the 100-year, 24-hour event. The 100-year, 24-hour event is used by FEMA in preparing Flood Insurance Rate Maps and provides an important point of comparison between this work and the work previously developed by FEMA.

Table 3-1 presented previously, summarizes the watershed areas under consideration. Most drainage features will be required to meet the minor waterway standard. Only drainage structures in the lower reaches of the watersheds will need to be designed for 25 or 100-year events.

The Lake County Standards allow the use of the Rational Method for minor waterways. This rather simple equation (Q=CIA) presents the relationship between rainfall runoff (Q), rainfall intensity (I) watershed area (A) and development intensity (C). The relationship is reasonably accurate when the watershed area is less than one square mile, but can produce unreliable results for larger watersheds.

In this Master Plan, as the drainage flows are routed downstream, the overall watershed size exceeds one square mile. This Master Plan will use the Soil Conservation Service (SCS) Unit Hydrograph available in HEC-1 for all run-off analysis. This use of a single, consistent modeling device will result in coordinated improvements throughout the Subdivision.

II. MAPPING

Watershed areas provide the basis for all hydrologic calculations. In order to arrive at appropriate watershed areas for this Master Plan, topographic mapping of the Subdivision developed in 1982 was digitized using AutoCAD. This mapping is at a scale of 1 inch equals 200 feet with 5-foot contours. For areas outside of the Subdivision, watershed areas were calculated using the U.S.G.S 15-Minute Quadrangle for Middletown, California. This mapping is at a scale of 1 inch equals 2000 feet with 20-foot contour intervals.

III. DATA REVIEW AND FIELD INVESTIGATIONS

A. DATA REVIEW

The Lake County Flood Control and Water Conservation District, the Homeowners Association and the District all keep files on drainage issues in the Subdivision. These files were reviewed to gather relevant data for this Master Plan. Existing drainage facilities and their contributory watersheds were identified from the available topographic mapping.

B. FIELD REVIEW

Once the file and map review was complete, the identified drainage facilities and their contributory watersheds were field verified. The mapping presented in Chapter 5 of this Master Plan reflects the results of the field review effort.

Each drainage facility located in the field was photographed. The size and material of each drainage facility was recorded on a field investigation form. The detailed information was compiled to be used in developing Mannings "n" values for subsequent modeling effort.

IV. HYDROLOGY MODEL

Each of the six individual watersheds was modeled using the Soil Conservation Service (SCS) Unit Hydrograph, available in HEC- 1. In addition to watershed area (A) and rainfall intensity (I), this model uses a Run-off Curve Number (CN) and Run-off Lag (L) to define the runoff hydrograph.

A. RUNOFF CURVE NUMBER

The Runoff Curve Number (CN) is a relationship between runoff and soil type and land use. The higher the CN-value, the greater the runoff. CN-value increases with density of development and with the relative impermeability of the underlying soils. The relatively dense residential development found in the Subdivision increases the CN value in Watershed 1, 2 and 4. Watersheds with a higher percentage of Type C and D soils will have a higher CN-value than those with predominantly Type B Soils.

B. RUNOFF LAG

The Runoff Lag (L) is defined as the time in hours from the center of mass of rainfall excess to the peak discharge. It has a relationship to the time of concentration of:

$$\mathbf{t_c = 1.67L.}$$

The lag for the various watersheds was determined by estimating the time of concentration or travel time for runoff, and then using the above relationship to calculate the lag. A minimum lag of 6 minutes (t_c of 10 minutes) was assumed if the calculations for t_c for the various sub-watersheds indicated a shorter time of concentration.

C. RAINFALL EVENT

In addition, to Runoff Curve Number and Runoff Lag, the design rainfall and a rainfall distribution must be defined. *The Lake County Design Criteria* prescribes 24-hour design events (rainfall intensity and volume is predicted over a 24-hour period), with the design frequency which varies by size of watershed. For this Master Plan, 10-year, 25-year and 100-year frequencies are modeled.

Rainfall events can be developed by statistical review of rainfall records in the area under study or "synthetic" storms may be used. This Master Plan utilizes a synthetic storm developed by the Soil Conservation Service (SCS). The SCS synthetic storms were developed using the United States Weather Bureau's Rainfall Frequency Atlases. The SCS defined four different rainfall distributions, depending on the region of the country. These rainfall distributions are included in the HEC-1 modeling package. A Type IA distribution is assumed for the project site.

V. HYDRAULIC MODELS

The Hydrology Model predicts the volume of flow generated at any point in a watershed from the defined rainfall event. This volume of flow can then be used to size the hydraulic structures (open channels or closed conduits) that carry the flow through a given area. Hydraulic sizing is based on several parameters including flow (Q), cross sectional area of the drainage structure (A), slope of the ground through the structure (S), and roughness of the ground (in this case, modeled by the roughness coefficient Manning's "n").

When designing single isolated drainage structures, hand calculations of the hydraulic capacity are often performed. However, when networks of interconnected structures are developed, as is the case with certain watersheds identified in this Master Plan, computer models are utilized to simulate hydraulic performance throughout the system.

The Lake County Flood Control and Water Conservation District provided a HEC-2 model for portions of the watershed that had been developed by FEMA. The cross sectional areas, ground slopes and roughness' developed by FEMA, were used as the basis of this Master Plan.

The design flows used in this Master Plan were developed using the Hydrologic Modeling Tool, HEC-1 (described above). Cross sectional areas and roughness coefficients were modified based on field review data, where it was available.

Open channels were modeled using HEC-2[1], FLOWMASTER I[2] or FLOWMASTER[3] and closed conduits, such as storm drains and culverts were modeled using StormCAD and Inlet Control Nomographs.

All drainage nodes were numbered based on the watershed tributary to them. For example; Drainage Node 1.0-1 is in Watershed 1 and Drainage Node 4.0-2 is in Watershed 4.

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[1] HEC-2, Version 4.6.2.

[2] FLOWMASTER I, Version 3.21, Haested's.

[3] StormCAD, Version 1.0, Haested's.

CHAPTER 5 - HYDRAULIC CAPACITY ANALYSIS

I. INTRODUCTION

As described earlier, the drainage area through the Subdivision includes the Coyote Creek watershed, the Gallagher Creek watershed and that portion of the Subdivision that drains directly to Putah Creek by way of a stormwater pump station. The hydraulic capacity analysis has been divided to review the drainage facilities within the Subdivision proper, which are typically closed conduits, and the larger open channels carrying Coyote Creek. Gallagher Creek has been modeled to provide information on the hydraulic capacity at its confluence with Coyote Creek.

II. HIDDEN VALLEY LAKE SUBDIVISION

A. DESCRIPTION

In order to analyze the capacity of drainage facilities within the Subdivision, the larger watersheds were divided into sub-watersheds at key nodes that corresponded to identify drainage structures. The design storm flow (Q), at each node, was estimated using HEC-1. The capacity of the existing feature was then compared to the design storm flow.

For the most part, the sub-watersheds are less than one square mile in area (a "Minor Watershed") and the design flow was estimated using a 24-hour, 10-year event (Q_{10}). Where the sub-watersheds exceeded one square mile, the design storm was increased to a 24-hour, 25-year event (Q_{25}). The 100-year flow (Q_{100}) was also estimated throughout the sub-watersheds. The Q_{100} provides an important capacity check at key nodes, most particularly where drainage structures cross major roadways.

B. CAPACITY OF EXISTING DRAINAGE FACILITIES

In addition to modeling runoff flow, the capacities of the drainage facilities at the key nodes were estimated. This allows for each drainage facility to be checked for adequate sizing. The capacities along with the design flows are presented in Table 5-1, following. Figures 5-1, 5-2, 5-3, 5-4, 5-5 and 5-6 graphically illustrate the results of modeling.

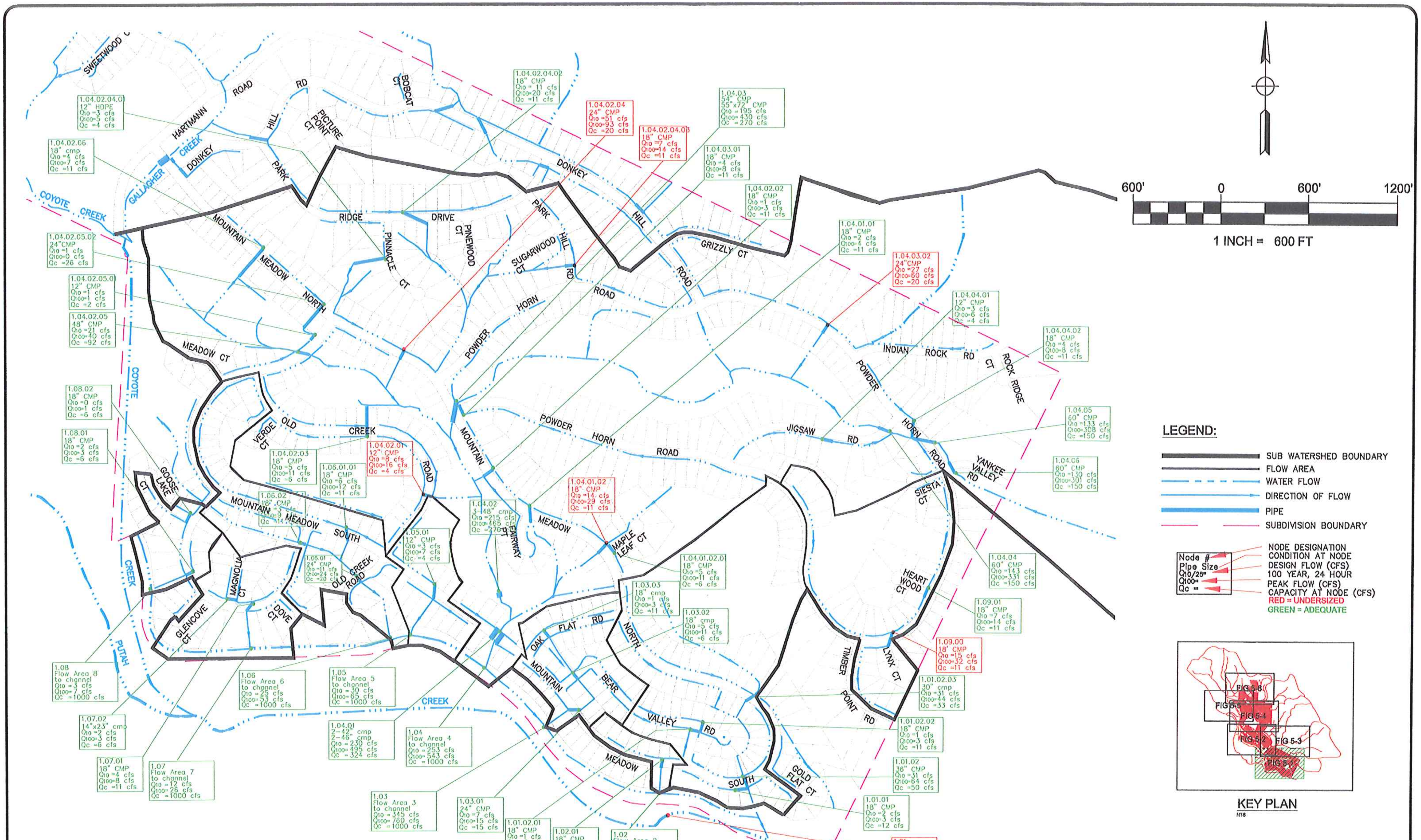

FIGURE 5-1

WATERSHED 1-
DRAINAGE CAPACITY MAP

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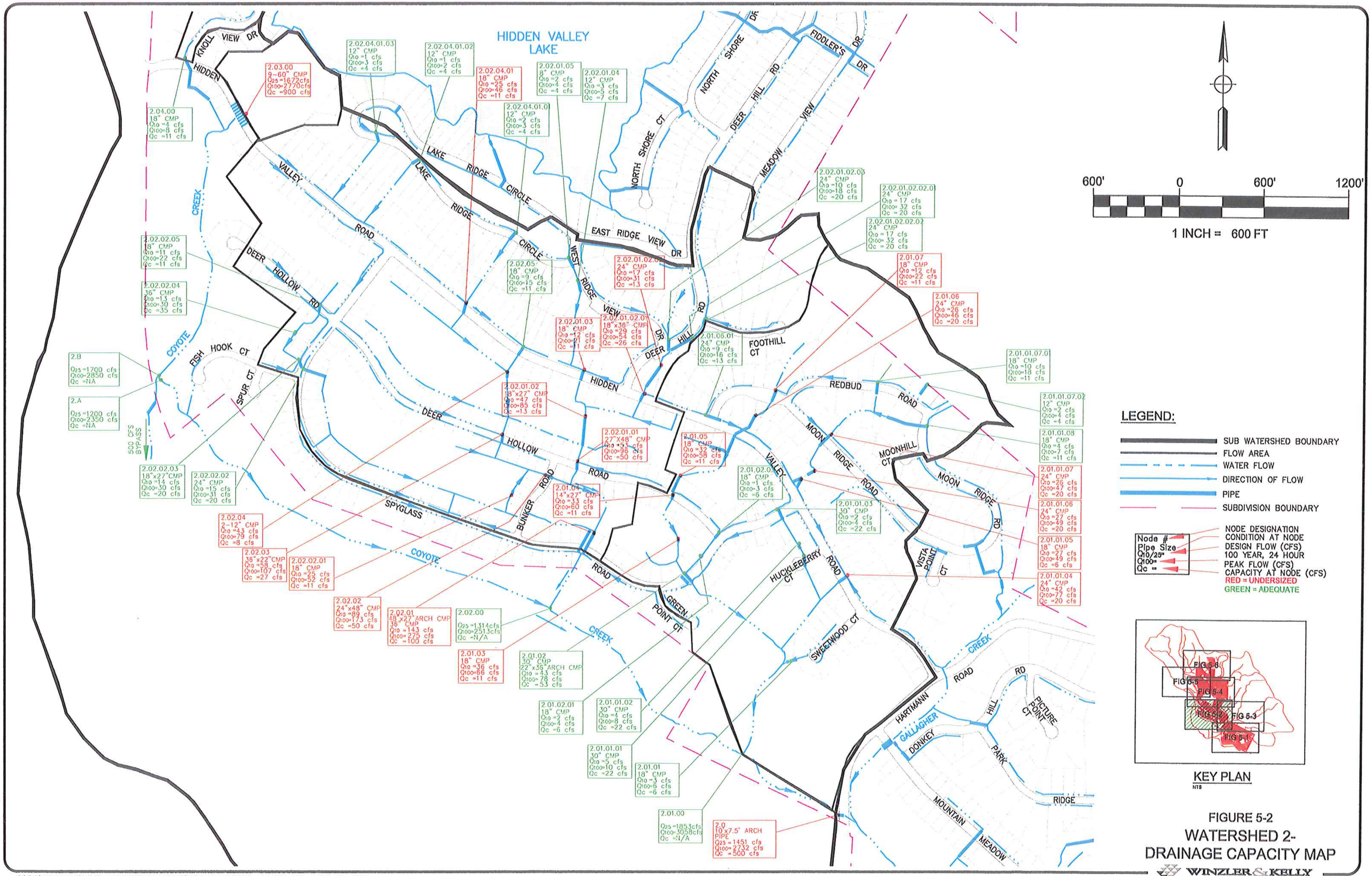

FIGURE 5-2

WATERSHED 2-
DRAINAGE CAPACITY MAP

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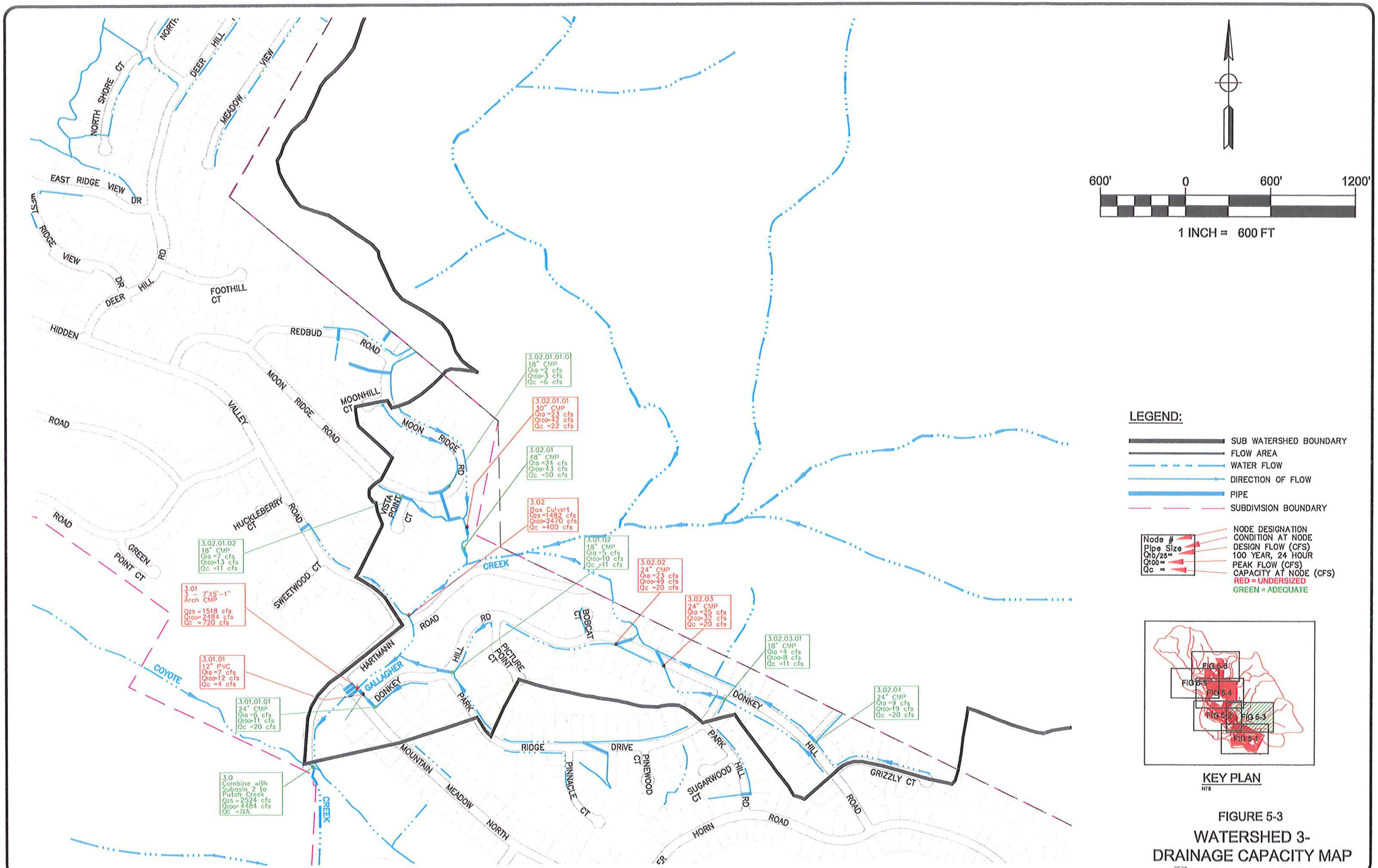

FIGURE 5-3

WATERSHED 3-
DRAINAGE CAPACITY MAP

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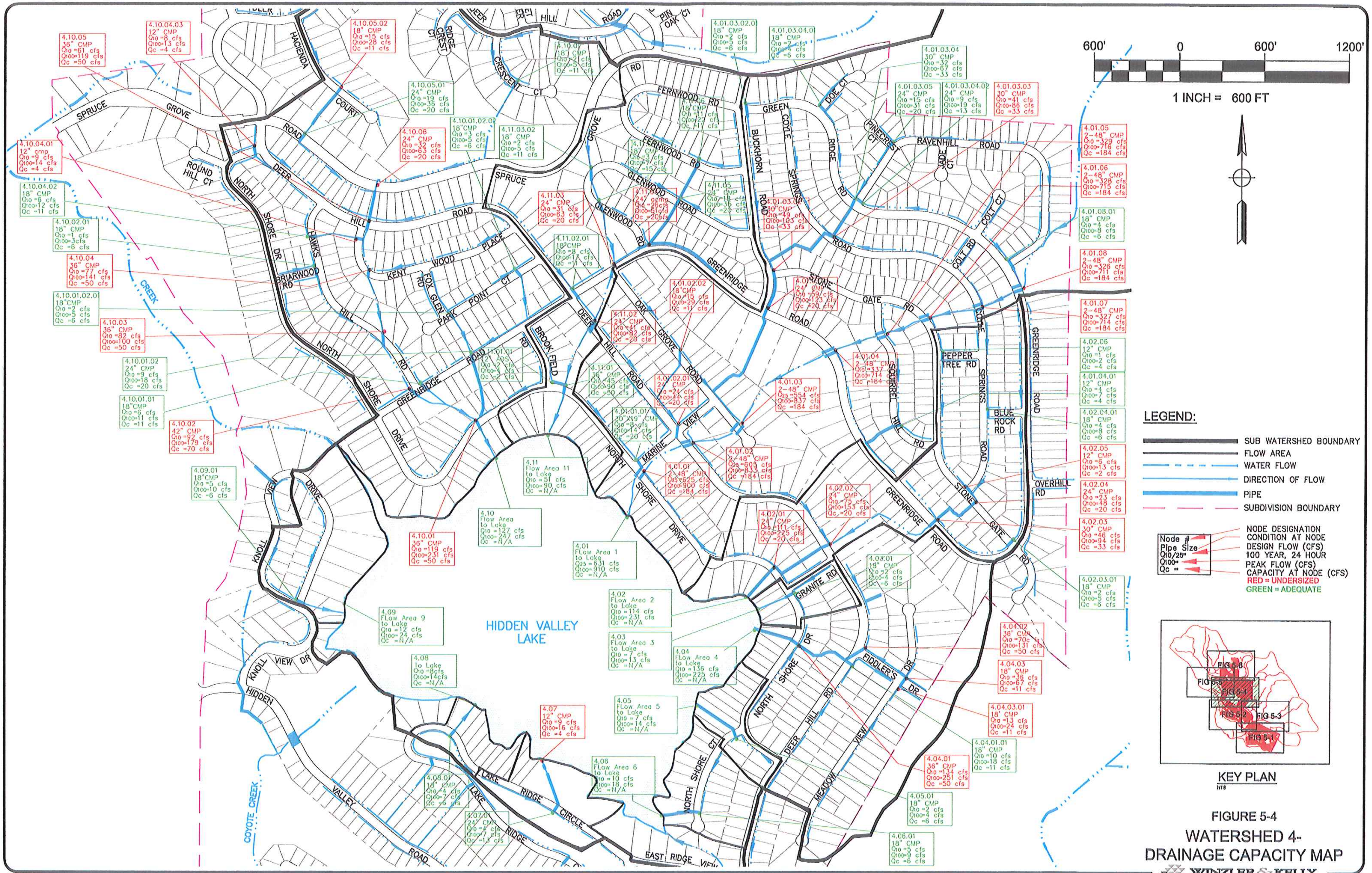

FIGURE 5-4

WATERSHED 4-
DRAINAGE CAPACITY MAP

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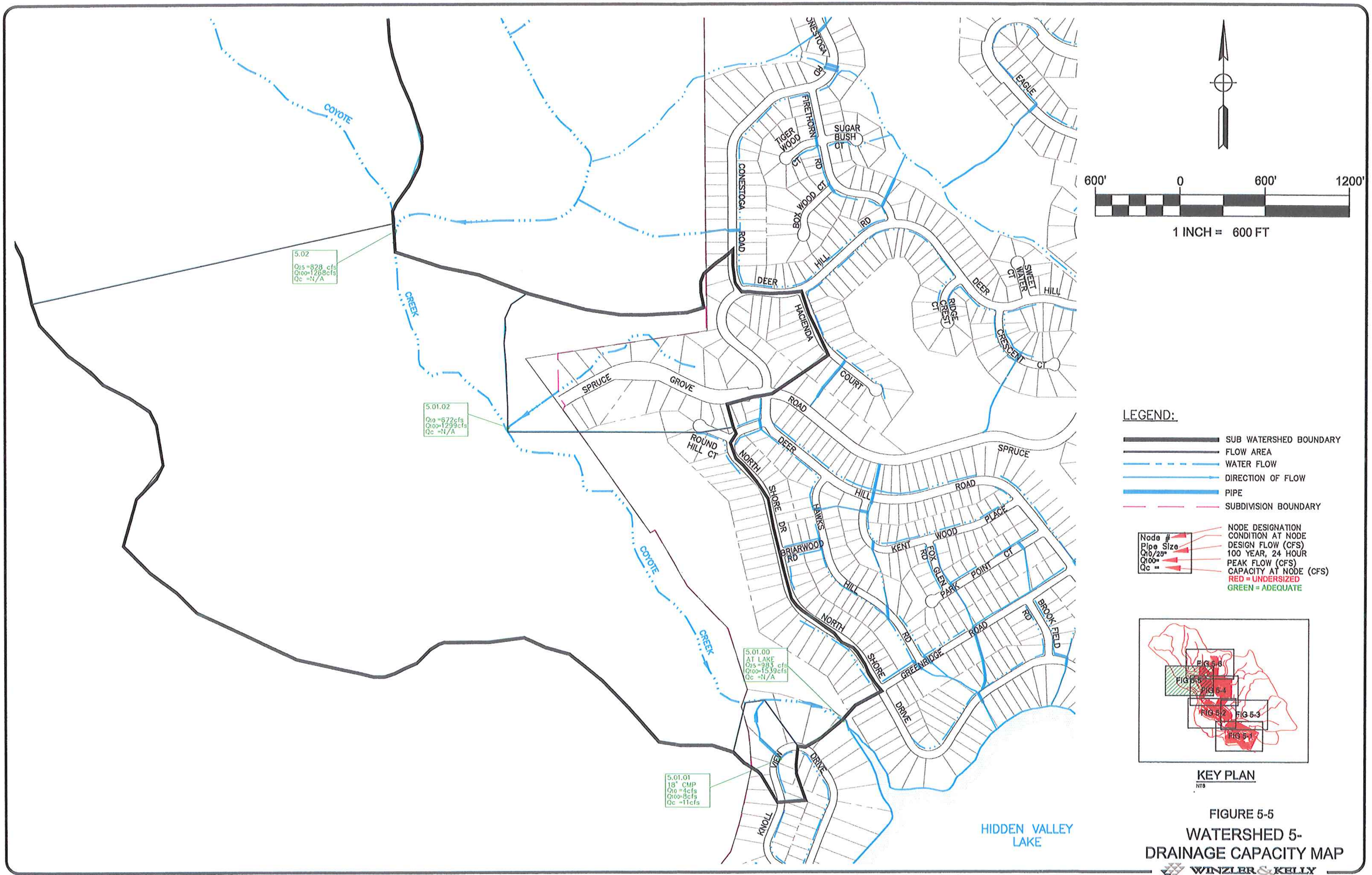

FIGURE 5-5

WATERSHED 5-
DRAINAGE CAPACITY MAP

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J:\99\205301\HVL-REPORT-FIGS\FIG5-5.DWG 10-21-99 2:19:23 PM

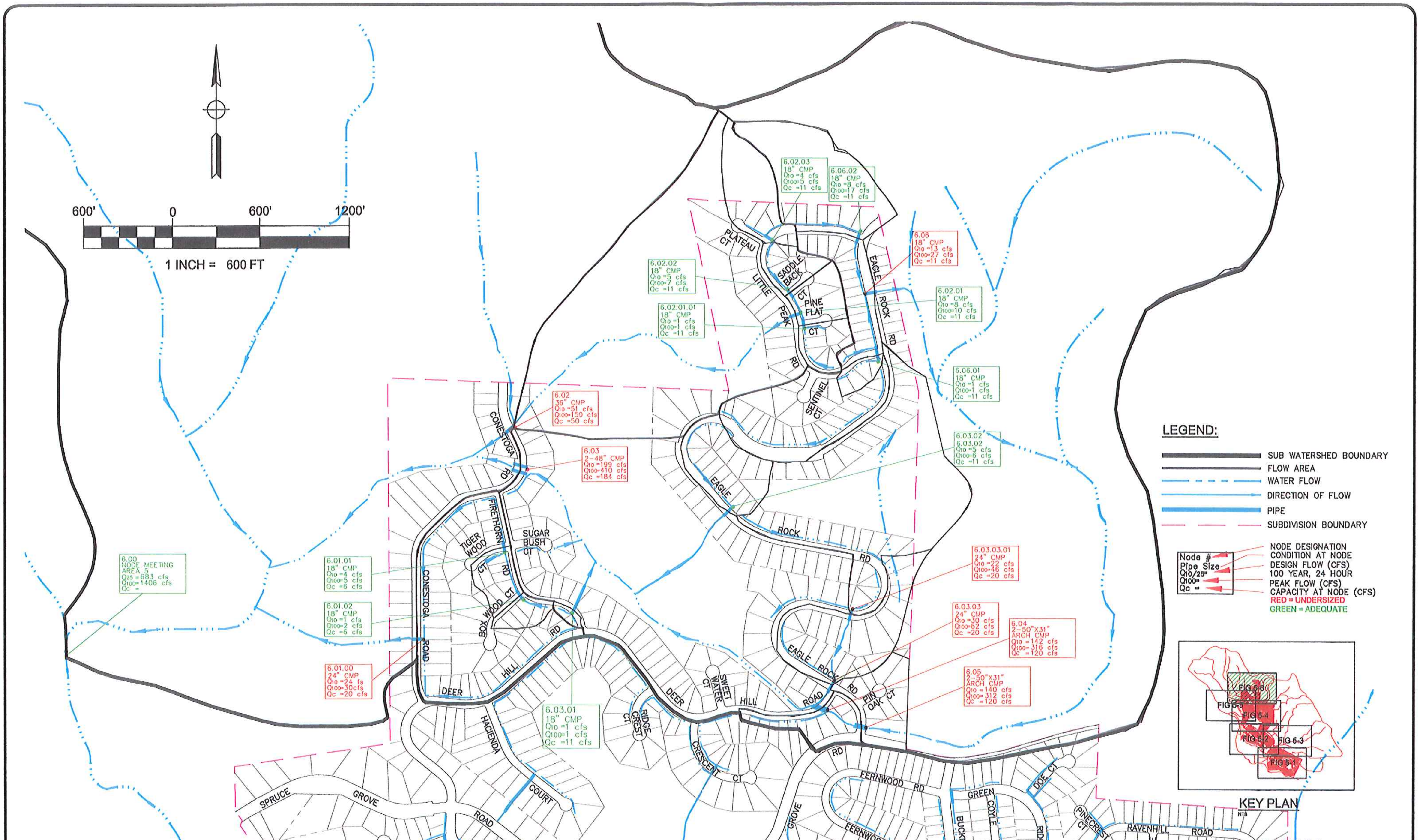

FIGURE 5-6

WATERSHED 6-
DRAINAGE CAPACITY MAP

WINZLER & KELLY
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J:\99\205301\HVL-REPORT-FIGS\FIG5-6.DWG 10-21-99 9:06:53 AM

Note:
Bold Italicized = Undersized

TABLE 5-1
CAPACITY ANALYSIS EXISTING DRAINAGE FACILITIES

Pipe Number	Existing Storm Drainage System	Existing Capacity (cfs)	Estimated Flows (cfs)		
			10-Year	25-Year	100-Year
1.01.00	***Pump Station***	***13 to 18***	***275***		***592***
1.01.01	18" CMP	12	2		3
1.01.02	36" CMP	50	31		64
1.01.02.01	18" CMP	11	1		3
1.01.02.02	18" CMP	11	1		3
1.01.02.03	30" CMP	33	31		44
1.02.00	Channel	1000	346		763
1.02.01	18" CMP	11	2		3
1.03.00	Channel	1000	345		760
1.03.01	24" CMP	15	7		15
1.03.02	18" CMP	6	5		11
1.03.03	18" CMP	11	1		3
1.04.00	CHANNEL	1000	253		543
1.04.01	2-48"CMP, 2-42"CMP	324	230		495
1.04.01.01	18" CMP	11	2		4
1.04.01.02	***18" CMP***	***11***	***14***		***29***
1.04.01.02.01	18" CMP	6	5		11
1.04.02	***3-48" CMP***	***276***	***215***		***465***
1.04.02.01	***12" CMP***	***4***	***8***		***16***
1.04.02.02	18" CMP	11	1		3
1.04.02.03	18" CMP	6	5		11
1.04.02.04	***24" CMP***	***20***	***51***		***93***
1.04.02.04.01	12" HDPE	4	3		5
1.04.02.04.02	18" CMP	11	11		20
1.04.02.04.03	18" CMP	11	7		14
1.04.02.05	48" CMP	92	21		40
1.04.02.05.01	12" CMP	2	1		1
1.04.02.05.02	24" CMP	20	1		0
1.04.02.06	18" CMP	11	4		7
1.04.03	54" CMP, 72"x55"	270	195		430
1.04.03.01	18" CMP	11	4		8
1.04.03.02	***24" CMP***	***20***	***27***		***60***
1.04.04	60" CMP	150	143		331
1.04.04.01	12" CMP	4	3		6
1.04.04.02	18" CMP	11	4		8
1.04.05	60" CMP	150	133		308
1.04.06	60" CMP	150	130		301
1.05.00	Channel	1000	30		65
1.05.01	12" CMP	4	3		7
1.06.00	Channel	1000	25		53
1.06.01	24" CMP	20	11		24
1.06.01.01	18" CMP	11	6		12

Note:
Bold Italicized = Undersized

TABLE 5-1
CAPACITY ANALYSIS EXISTING DRAINAGE FACILITIES

Pipe Number	Existing Storm Drainage System	Existing Capacity (cfs)	Estimated Flows (cfs)		
			10-Year	25-Year	100-Year
1.06.02	18" CMP	11	3		9
1.07.00	Channel	1000	12		26
1.07.01	18" CMP	11	4		8
1.07.02	23"x14" CMP	6	2		3
1.08.00	Channel	1000	3		7
1.08.01	18" CMP	6	2		3
1.08.02	18" CMP	6	0		1
1.09.00	***18" CMP***	***11***	***15***		***32***
1.09.01	18" CMP	11	7		14
2.00.00	10'x7.5' ARCH CMP	500		1451	2732
2.01.00	Channel			1853	3058
2.01.01	18" CMP	6	3		6
2.01.01.01	30" CMP	22	5		10
2.01.01.02	30" CMP	22	4		8
2.01.01.03	30" CMP	22	2		4
2.01.01.04	***24" CMP***	***20***	***42***		***77***
2.01.01.05	***18" CMP***	***6***	***27***		***49***
2.01.01.06	***24" CMP***	***20***	***27***		***49***
2.01.01.07	***24" CMP***	***20***	***26***		***47***
2.01.01.07.01	18" CMP	11	10		18
2.01.01.07.02	12" CMP	4	2		4
2.01.01.08	18" CMP	11	4		7
2.01.02	30" CMP,36"x22" CMP	53	43		78
2.01.02.01	18" CMP	6	2		4
2.01.02.02	18" CMP	6	1		3
2.01.03	***18" CMP***	***11***	***36***		***66***
2.01.04	***18" CMP***	***11***	***33***		***60***
2.01.05	***18" CMP***	***11***	***32***		***58***
2.01.06	***24" CMP***	***20***	***26***		***46***
2.01.06.01	24" CMP	13	9		16
2.01.07	***18" CMP***	***11***	***12***		***22***
2.02.00	Channel		150	1314	2513
2.02.01	***48"x27"CMP, 36" CMP***	***100***	***143***		***275***
2.02.01.01	***48"x27" CMP***	***50***	***53***		***96***
2.02.01.02	***27"x18" CMP***	***13***	***47***		***85***
2.02.01.02.01	***27"x18" CMP***	***26***	***29***		***54***
2.02.01.02.02	***24" CMP***	***13***	***17***		***31***
2.02.01.02.02.01	24" CMP	20	17		32
2.02.01.02.02.02	24" CMP	20	17		31
2.02.01.02.03	24" CMP	20	10		18
2.02.01.03	***18" CMP***	***11***	***12***		***21***
2.02.01.04	12" CMP	7	3		5
2.02.01.05	8" CMP	4	2		4
2.02.02	***48"x27" CMP***	***50***	***89***		***173***

Note:
Bold Italicized = Undersized

TABLE 5-1
CAPACITY ANALYSIS EXISTING DRAINAGE FACILITIES

Pipe Number	Existing Storm Drainage System	Existing Capacity (cfs)	Estimated Flows (cfs)		
			10-Year	25-Year	100-Year
2.02.02.01	***18" CMP***	***11***	***25***		***52***
2.02.02.02	24" CMP	20	15		31
2.02.02.03	27"x18" CMP	20	14		30
2.02.02.04	36" CMP	35	13		28
2.02.02.05	18" CMP	11	11		22
2.02.03	***36"x22" CMP***	***27***	***58***		***107***
2.02.04	***2-12" CMP***	***8***	***43***		***79***
2.02.04.01	***18" CMP***	***11***	***25***		***46***
2.02.04.01.01	12" CMP	4	2		3
2.02.04.01.02	12" CMP	4	1		2
2.02.04.01.03	12" CMP	4	1		3
2.02.05	18" CMP	11	9		15
2.03.00	***9-60" CMP***	***900***		***1672***	***2770***
2.04.00	18" CMP	11	4		8
3.00.00	Channel to Putah Creek			2524	4484
3.01.00	***3- 7'x5'1" CMP***	***720***		***1518***	***2484***
3.01.01	***12" CMP***	***4***	***7***		***12***
3.01.01.01	24" CMP	20	6		11
3.01.02	18" CMP	11	5		10
3.02.00	***Box Culvert***	***400***		***1482***	***2470***
3.02.01	48" CMP	50	24		43
3.02.01.01	***30" CMP***	***22***	***23***		***42***
3.02.01.01.01	18" CMP	6	2		3
3.02.01.02	18" CMP	11	7		13
3.02.02	***24" CMP***	***20***	***23***		***49***
3.02.03	24" CMP	20	25		32
3.02.03.01	18" CMP	11	4		8
3.02.04	24" CMP	20	9		19
4.01.00	Lake	-		631	910
4.01.01	***2-48" CMP***	***184***		***625***	***900***
4.01.01.01	18" CMP	20	8		14
4.01.02	***2-48" CMP***	***184***		***605***	***883***
4.01.02.01	24" CMP	20	24		44
4.01.02.02	***18" CMP***	***11***	***15***		***29***
4.01.03	***2-48" CMP***	***184***		***544***	***837***
4.01.03.01	***24" CMP***	***20***	***59***		***123***
4.01.03.02	***30" CMP***	***33***	***49***		***103***
4.01.03.02.01	18" CMP	6	2		5
4.01.03.03	***30" CMP***	***22***	***41***		***86***
4.01.03.04	30" CMP	33	32		67
4.01.03.04.01	18" CMP	6	2		4
4.01.03.04.02	24" CMP	13	9		19
4.01.03.05	24" CMP	20	15		31
4.01.04	***2-48" CMP***	***184***	***337***		***714***

Note:
Bold Italicized = Undersized

TABLE 5-1
CAPACITY ANALYSIS EXISTING DRAINAGE FACILITIES

Pipe Number	Existing Storm Drainage System	Existing Capacity (cfs)	Estimated Flows (cfs)		
			10-Year	25-Year	100-Year
4.01.04.01	12" CMP	4	4		7
4.01.05	***2-48" CMP***	***184***	***329***		***716***
4.01.06	***2-48" CMP***	***184***	***328***		***715***
4.01.07	***2-48" CMP***	***184***	***327***		***714***
4.01.08	***2-48" CMP***	***184***	***326***		***711***
4.01.08.01	18" CMP	6	4		8
4.02.00	Lake	-	114		231
4.02.01	***24" CMP***	***20***	***111***		***225***
4.02.02	***24" CMP***	***20***	***75***		***153***
4.02.03	***30" CMP***	***33***	***46***		***94***
4.02.03.01	18" CMP	6	2		5
4.02.04	24" CMP	20	23		48
4.02.04.01	18" CMP	6	4		8
4.02.05	12" CMP	2	6		13
4.02.06	12" CMP	4	1		2
4.03.00	Lake	-	7		13
4.03.01	18" CMP	6	2		4
4.04.00	Lake	-	136		255
4.04.01	**36" CMP**	**50**	**134**		**251**
4.04.01.01	18" CMP	11	10		18
4.04.02	***36" CMP***	***50***	***70***		***131***
4.04.03	***18" CMP***	***11***	***36***		***67***
4.04.03.01	***18" CMP***	***11***	***13***		***24***
4.05.00	Lake	-	7		14
4.05.01	18" CMP	6	2		4
4.06.00	Lake	-	10		18
4.06.01	18" CMP	6	5		9
4.07.00	***12" CMP***	***4***	***9***		***16***
4.07.01	24" CMP	13	4		7
4.08.00	Lake	-	8		14
4.08.01	18" CMP	6	4		7
4.09.00	Lake	-	12		24
4.09.01	18" CMP	6	5		10
4.10.00	Lake	-	127		247
4.10.01	***36" CMP***	***50***	***119***		***231***
4.10.01.01	18" CMP	11	6		11
4.10.01.02	18" CMP	11	9		18
4.10.01.02.01	18" CMP	6	2		5
4.10.01.02.02	18" CMP	6	3		5
4.10.02	***42" CMP***	***70***	***92***		***179***
4.10.02.01	18" CMP	6	1		3
4.10.03	***36" CMP***	***50***	***82***		***100***
4.10.04	***36" CMP***	***50***	***77***		***141***
4.10.04.01	***12" CMP***	***4***	***9***		***14***

Note:
Bold Italicized = Undersized

TABLE 5-1
CAPACITY ANALYSIS EXISTING DRAINAGE FACILITIES

Pipe Number	Existing Storm Drainage System	Existing Capacity (cfs)	Estimated Flows (cfs)		
			10-Year	25-Year	100-Year
4.10.04.02	18" CMP	11	6		12
4.10.04.03	12" CMP	4	8		13
4.10.05	***36" CMP***	***50***	***61***		***119***
4.10.05.01	24" CMP	20	19		36
4.10.05.02	***18" CMP***	***11***	***15***		***28***
4.10.06	***24" CMP***	***20***	***32***		***63***
4.10.07	18" CMP	11	2		5
4.11.00	Lake	-	51		90
4.11.01	36" CMP	50	45		90
4.11.01.01	12" CMP	2	2		4
4.11.02	***24" CMP***	***20***	***41***		***82***
4.11.02.01	18" CMP	11	8		17
4.11.03	***24" CMP***	***20***	***31***		***63***
4.11.03.01	18" CMP	11	3		7
4.11.03.02	18" CMP	11	2		5
4.11.04	***24" CMP***	***20***	***26***		***51***
4.11.05	24" CMP	15	18		35
4.11.06	18" CMP	11	11		22
5.01.00	Lake	-		983	1539
5.01.01	18" CMP	11	4		8
5.01.02	Node	-	672		1299
5.02.00	Node	-	656		1268
6.00.00	Node Meeting SW 5	-		683	1406
6.01.00	***24" CMP***	***20***	***24***		***30***
6.01.01	18" CMP	6	4		5
6.01.02	18" CMP	6	1		2
6.02.00	***36" CMP***	***50***	***51***		***150***
6.02.01	18" CMP	11	8		10
6.02.01.01	18" CMP	11	1		1
6.02.02	18" CMP	11	5		7
6.02.03	18" CMP	11	4		5
6.03.00	***2-48" CMP***	***104***	***199***		***410***
6.03.01	18" CMP	11	1		1
6.03.02	18" CMP	11	5		6
6.03.03	***24" CMP***	***20***	***30***		***62***
6.03.03.01	***24" CMP***	***20***	***22***		***46***
6.04.00	***2-50"x31" CMP***	***120***	***142***		***316***
6.05.00	***2-50"x31" CMP***	***120***	***140***		***312***
6.06.00	***18" CMP***	***11***	***13***		***27***
6.06.01	18" CMP	11	1		1
6.06.02	18" CMP	11	8		17

If the drainage facility capacity is less than the design flow, the structure is assumed to be inadequate and recommendations for correction or replacement are provided. Table 5-2 provides a listing of the locations were the existing facilities are undersize. Replacement costs are presented in Chapter 6.

TABLE 5-2
IDENTIFIED DEFICIENT FACILITIES

Pipe Number	Existing Storm Drainage System	Node Location	Proposed Improvements
1.01.00	Pump Station	Mt. Meadow South	Increase Pump Capacity
1.04.01.02	18" CMP	Maple Leaf Ct.	Replace with 24" RCP
1.04.02	3-48" CMP	Golf Course Near Mt. Meadow South	Add 21" RCP
1.04.02.01	12" CMP	Old Creek Road	Replace with 18" RCP
1.04.02.04	24" CMP	Mt. Meadow North	Add 30" RCP
1.04.03.02	24" CMP	Powder Horn	Add 18" RCP
1.09.00	18" CMP	Powder Horn	Replace with 21" RCP
2.01.01.04	24" CMP	Hidden Valley Road	Add 27" RCP
2.01.01.05	18" CMP	Hidden Valley Road	Replace with 30" RCP
2.01.01.06	24" CMP	Hidden Valley Road	Replace with 30" RCP
2.01.01.07	24" CMP	Moon Ridge Road	Replace with 30" RCP
2.01.03	18" CMP	Golf Course near Spyglass Road	Add 30" RCP
2.01.04	18" CMP	Deer Hollow Road	Replace with 30" RCP
2.01.05	18" CMP	Deer Hollow Road	Replace with 30" RCP
2.01.06	24" CMP	Hidden Valley Road	Add 18" RCP
2.01.07	18" CMP	Moon Ridge Road	Replace with 21" RCP
2.02.01	48"x27" CMP, 36" CMP	Spyglass Road	Replace w/ 7½x3 Box Culvert
2.02.01.01	48"x27" CMP	Deer Hollow Road	Replace with 50"x31" RCP
2.02.01.02	27"x18" CMP	Golf Course near Deer Hollow Road	Replace with 45"x29" RCP
2.02.01.02.01	27"x18" CMP	Hidden Valley Road	Replace with 30" RCP
2.02.01.02.02	24" CMP	Hidden Valley Road	Add 21" RCP
2.02.01.03	18" CMP	Hidden Valley Road	Replace with 21" RCP
2.02.02	48"x24" CMP	Bunker Road	Add 36" RCP
2.02.02.01	18" CMP	Golf Course Near Bunker Road	Add 21" RCP
2.02.03	36"x22" CMP	Deer Hollow Road	Replace with 30" RCP
2.02.04	2-12" CMP	Golf Course near Deer Hollow Road	Replace with 50"x31" RCP
2.02.04.01	18" CMP	Hidden Valley Road	Add 21" RCP
2.03.00	9-60" CMP	Hidden Valley Road	Replace 4 Pipes w/ 4-54"RCP
3.01.00	3-7'-5'1" CMP	Mt. Meadow North	Replace w/ 8-5x5 Box Culverts
3.01.01	12" CMP	Donkey Hill Road	Replace with 18" RCP

TABLE 5-2 IDENTIFIED DEFICIENT FACILITIES			
Pipe Number	**Existing Storm Drainage System**	**Node Location**	**Proposed Improvements**
3.02.00	Box Culvert	Hartman Road	Replace with Box Culvert
3.02.01.01	30" CMP	Camp Ground	Replace with 33" RCP
3.02.02	24" CMP	Donkey Hill Road	Replace with 30" RCP
3.02.03	24" CMP	Donkey Hill Road	Replace with 30" RCP
4.01.01	2-48" CMP	North Shore Drive	Replace w/ 20'x4' Box Culvert
4.01.02	2-48" CMP	Deer Hill Road	Replace w/ 20'x4' Box Culvert
4.01.02.02	18" CMP	Deer Hill & Marine View Roads	Replace with 21" RCP
4.01.03	2-48" CMP	Oak Grove Road	Replace w/ 20'x4' Box Culvert
4.01.03.01	24" CMP	Greenridge Road	Add 24" RCP
4.01.03.02	30" CMP	Buckhorn Road	Add 24" RCP
4.01.03.03	30" CMP	Coyle Springs Road	Add 24" RCP
4.01.04	2-48" CMP	Greenridge Road	Replace w/ 12'x4' Box Culvert
4.01.05	2-48" CMP	Squirrel Hill Road	Replace w/ 12'x4' Box Culvert
4.01.06	2-48" CMP	Stonegate Road	Replace w/ 12'x4' Box Culvert
4.01.07	2-48" CMP	Coyle Springs Road	Replace w/ 12'x4' Box Culvert
4.02.01	24" CMP	North Shore Drive	Replace with 2-42" RCP
4.02.02	24" CMP	Deer Hill Road	Replace with 2-33" RCP
4.02.03	30" CMP	Greenridge Road	Add 21" RCP
4.02.05	12" CMP	Coyle Springs Road	Replace with 15" RCP
4.04.01	36" CMP	North Shore Drive	Replace with 2-42" RCP
4.04.02	36" CMP	Deer Hill Road	Replace with 42" RCP
4.04.03	18" CMP	Meadow View Drive	Replace with 33" RCP
4.04.03.01	18" CMP	Fiddlers Drive	Replace with 21" RCP
4.07.00	12" CMP	Lake Ridge Circle	Replace with 18" RCP
4.10.01	36" CMP	North Shore Drive	Add 42" RCP
4.10.02	42" CMP	Greenridge Road	Add 27" RCP
4.10.03	36" CMP	Hawk's Hill Road	Add 30" RCP
4.10.04	36" CMP	Kentwood Place	Add 27" RCP
4.10.04.01	12" CMP	Kentwood Place	Add 15" RCP
4.10.04.03	12" CMP	Spruce Grove Road	Replace with 18" RCP
4.10.05	36" CMP	Deer Hill Road	Add 18" RCP
4.10.05.02	18" CMP	Hacienda Court	Add 15" RCP
4.10.06	24" CMP	Spruce Grove Road	Add 21" RCP
4.11.02	24" CMP	Deer Hill Road	Add 27" RCP
4.11.03	24" CMP	Greenridge & Oak Grove Roads	Add 18" RCP
4.11.04	24" CMP	Greenridge Road	Add 15" RCP
6.01.00	24" CMP	Conestoga Road	Add 15" RCP

TABLE 5-2
IDENTIFIED DEFICIENT FACILITIES

Pipe Number	Existing Storm Drainage System	Node Location	Proposed Improvements
6.02.00	36" CMP	Conestoga Road	Replace with 42" RCP
6.03.00	2-48" CMP	Conestoga Road	Replace with 2-54" RCP
6.03.03	24" CMP	Eagle Rock Road	Add 18" RCP
6.03.03.01	24" CMP	Eagle Rock Road	Replace with 27" RCP
6.04.00	2-50"x31" CMP	Deer Hill Road	Replace with 2-58"x36" RCP
6.05.00	2-50"x31" CMP	Eagle Rock Road	Replace with 2-58"x36" RCP
6.06.00	18" CMP	Eagle Rock Road	Replace with 24" RCP

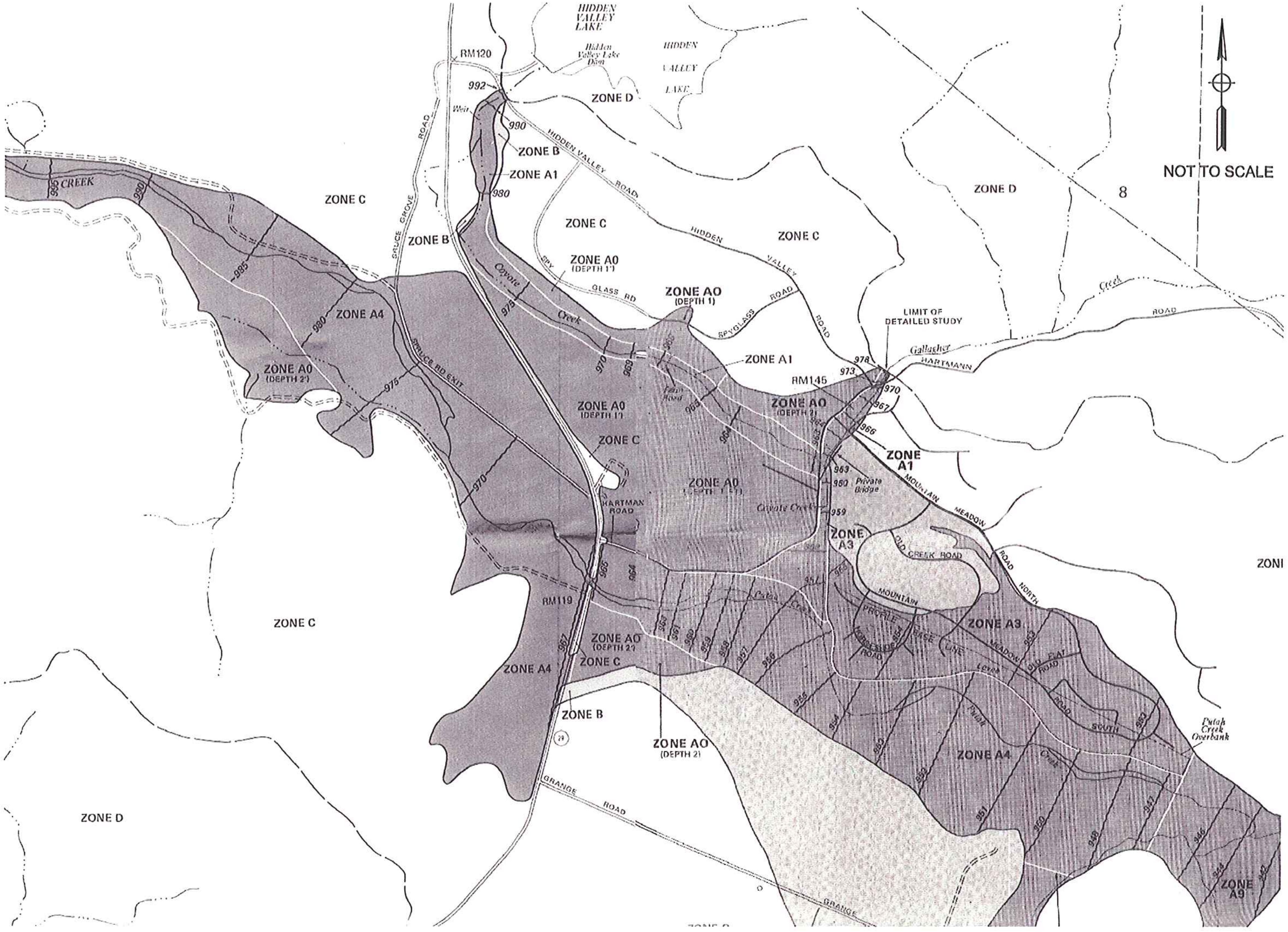
In addition to drainage ditches and culverts, the existing stormwater pump station has been analyzed. The station accepts flow from a tributary drainage area that is less than one square mile: By the *Lake County Standards* the design flow could be as low as the 10-year flow. The station has an approximate capacity of 6,000 to 8,000 gpm (13.4 to 17.8 cfs). The 10-year flow is 368 cfs.

III. COYOTE CREEK AND GALLAGHER CREEK ANALYSIS

A. DESCRIPTION

In March 1998, FEMA published an analysis of Coyote and Gallagher Creeks, which indicated potential for flooding along the Coyote Creek corridor. The flooding pattern is published in the March 2, 1998 Flood Insurance Rate Maps (FIRM) and illustrated in Figure 5-7. In order to develop the FIRM Maps, FEMA developed a series of creek cross-sections and an HEC-2 model. The FEMA cross-sections for Coyote Creek and Gallagher Creek were used as the basis for this Storm Water Mater Plan.

This Storm Water Mater Plan developed independent 100-year design flows for both the Coyote Creek and Gallagher Creek Watershed, using HEC-1 and the SCS Type 1A rainfall distribution. These flows are higher than the design flows used in the FEMA modeling effort. Information regarding how FEMA design flows were generated could not be determined. Department of Water Resources calculated 100-year design flows which were slightly higher than the design flows presented in the report. Discussions with Lake County regarding the design flows concluded that design flows presented in the report are reasonable and should be utilized for Master Plan design. When the current estimated flows are entered into the original HEC-2 model, flooding exceeds the flooding limits indicated on the FIRM mapping.



LEGEND

500-Year Flood Boundary	ZONE B
100-Year Flood Boundary	
Zone Designations*	ZONE A1 ZONE A5
100-Year Flood Boundary	
500-Year Flood Boundary	ZONE B
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
Zone D Boundary	— — —
River Mile	•M1.5
Approximate 100- Year Flood Boundary	ZONE A

**Reference to the National Geodetic Vertical Datum of 1929

UNDEVELOPED COASTAL BARRIERS†

▨	▨	▨
Identified 1983	Identified 1990	Otherwise Protected Areas

†Coastal barrier areas are normally located within or adjacent to special flood hazard areas.

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
AO	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

FIGURE 5-7

FLOOD ZONE MAP

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J:\99\205301\HVL-REPORT-FIGS\FIG5-7.DWG 3-21-00 11:17:43 AM

B. CAPACITY OF EXISTING FACILITIES

Coyote Creek currently is a relatively natural channel that averages 15 to 25 feet wide and 3 to 8 feet deep. The hydraulic capacity of this channel is estimated to be 600- to 1000-cfs.

The existing Gallagher Creek channel from its confluence with Coyote Creek upstream to the crossing of Hartman is incapable of handling the 10-year storm event without over topping its banks.

Recommendations for the improvement work along Coyote and Gallagher Creek are presented in Chapter 6.

CHAPTER 6 - RECOMMENDATIONS AND COST ESTIMATES

I. COST ESTIMATE AND PRIORITIES

A. COST ESTIMATE DEVELOPMENT

Cost estimates for the drainage improvements are developed using Means Construction Cost Data. The following items are added to this subtotal amount:

- General Conditions (30%)
- Sales Tax (4%)
- General Contractors Overhead and Profit (8%)
- Legal, Administration & Engineering (25%)
- Bond (0.15%)
- Contingency (10%)

B. PROJECT PRIORITY ANALYSIS

The costs for all drainage improvements are substantial, ranging in cost from $3,689,770 to $8,707,110, and will require a number of years to complete. This Master Plan prioritizes the various improvements by watershed. Several factors were used in prioritizing the projects. Generally entire sub-watersheds were picked for improvement based on how undersized the drainage facilities are and the potential for flooding impacts if known: improvements were made from downstream to upstream within the individual sub-watersheds, although this factor was modified depending on the severity of the storm drain deficiency.

C. SUMMARY COSTS AND PRIORITIES

This chapter summarizes proposed drainage improvements, their costs and priority. All improvements are listed in Table 6-1. The projects are prioritized within each watershed.

TABLE 6-1
RECOMMENDED ORDER OF IMPROVEMENTS

Priority	Pipe No.	Location	Improvement	Cost
1		Coyote Creek Alternative 3	Widen Channel & Install Weir	$240,160*
1		Coyote Creek Alternative 2	Widen Channel & Install Weir	$427,900
1		Coyote Creek Alternative 1	Excavate to Widen Channel	$713,000
2		Gallagher Creek	Widen Channel	$79,020
3	1.01.00	Pump Station Alternative 1	Construct new Pump Station	$4,633,750
3	1.01.00	Pump Station Alternative 2A	10' x 5' Box Culvert	$3,707,000
3	1.01.00	Pump Station Alternative 2B	Graded Channel	$89,250*
1	1.04.02.04	Mt. Meadow North	Add 30" RCP	$26,670
2	1.04.02.01	Old Creek Road	Replace with 18" RCP	$19,630
3	1.04.01.02	Maple Leaf CT.	Replace with 24" RCP	$20,960
4	1.04.03.02	Powder Horn	Add 18" RCP	$19,260
5	1.09.00	Powder Horn	Replace with 21" RCP	$20,220
6	1.04.02	Golf Course Near Mt. Meadow South	Add 21" RCP	$17,440
1	2.03.00	Hidden Valley Road	Replace 4 Pipes w/ 4-54"RCP	$60,570
2	2.0	Hartman Road	Replace w/ 3-10x6 Box Culvert	$278,030
3	2.02.01	Spyglass Road	Replace w/ 7½x3 Box Culvert	$126,540
4	2.02.04	Golf Course near Deer Hollow Road	Replace with 50"x31" RCP	$28,750
5	2.02.03	Deer Hollow Road	Replace with 30" RCP	$27,200
6	2.02.02	Bunker Road	Add 36" RCP	$28,380
7	2.02.04.01	Hidden Valley Road	Add 21" RCP	$19,850
8	2.01.01.04	Hidden Valley Road	Add 27" RCP	$26,000
9	2.01.01.05	Hidden Valley Road	Replace with 30" RCP	$27,040
10	2.01.03	Golf Course near Spyglass Road	Add 30" RCP	$26,670
11	2.01.04	Deer Hollow Road	Replace with 30" RCP	$26,250
12	2.01.05	Deer Hollow Road	Replace with 30" RCP	$27,040
13	2.02.02.01	Golf Course Near Bunker Road	Add 21" RCP	$19,850
14	2.01.01.06	Hidden Valley Road	Replace with 30" RCP	$27,040
15	2.01.01.07	Moon Ridge Road	Replace with 30" RCP	$27,040
16	2.02.01.01	Deer Hollow Road	Replace with 50"x31" RCP	$44,530
17	2.02.01.02	Golf Course near Deer Hollow Road	Replace with 45"x29" RCP	$28,900
18	2.02.01.02.01	Hidden Valley Road	Replace with 30" RCP	$26,250
19	2.02.01.02.02	Hidden Valley Road	Add 21" RCP	$19,850
20	2.02.01.03	Hidden Valley Road	Replace with 21" RCP	$19,750
21	2.01.06	Hidden Valley Road	Add 18" RCP	$18,890
22	2.01.07	Moon Ridge Road	Replace with 21" RCP	$32,620
1	3.01.00	Mt. Meadow North	Replace w/ 8-5x5 Box Culverts	$159,860
2	3.02.00	Hartman Road	Replace with Box Culvert	25,950
3	3.02.03	Donkey Hill Road	Replace with 30" RCP	$27,200

TABLE 6-1
RECOMMENDED ORDER OF IMPROVEMENTS

Priority	Pipe No.	Location	Improvement	Cost
4	3.02.02	Donkey Hill Road	Replace with 30" RCP	$27,200
5	3.01.01	Donkey Hill Road	Replace with 18" RCP	$19,200
6	3.02.01.01	Camp Ground	Replace with 33" RCP	$28,280
1	4.01.01	North Shore Drive	Replace w/ 20'x4' Box Culvert	$85,630
2	4.01.02	Deer Hill Road	Replace w/ 20'x4' Box Culvert	$85,630
3	4.01.03	Oak Grove Road	Replace w/ 20'x4' Box Culvert	$85,630
4	4.01.04	Greenridge Road	Replace w/ 12'x4' Box Culvert	$62,650
5	4.01.05	Squirrel Hill Road	Replace w/ 12'x4' Box Culvert	$62,650
6	4.01.06	Stonegate Road	Replace w/ 12'x4' Box Culvert	$62,650
7	4.01.07	Coyle Springs Road	Replace w/ 12'x4' Box Culvert	$62,650
8	4.01.08	Greenridge Road	Replace w/ 12'x4' Box Culvert	$62,650
9	4.01.03.01	Greenridge Road	Add 24" RCP	$20,590
10	4.01.03.04 to 4.01.03.02	Coyle Springs Road	Replace w/ 36" RCP	$202,320
11	4.01.02.01	Green Ridge	Add 21" RCP	$19,850
12	4.01.02.02	Deer Hill & Marine View Roads	Replace with 21" RCP	$20,220
13	4.10.01	North Shore Drive	Add 42" RCP	$29,750
14	4.10.02	Greenridge Road	Add 27" RCP	$26,000
15	4.10.03	Hawk's Hill Road	Add 30" RCP	$26,670
16	4.10.04	Kentwood Place	Add 27" RCP	$26,000
17	4.10.05	Deer Hill Road	Add 18" RCP	$19,260
18	4.10.06	Spruce Grove Road	Add 21" RCP	$19,850
19	4.10.04.01	Kentwood Place	Add 15" RCP	$18,630
20	4.02.01	North Shore Drive	Replace with 2-42" RCP	$49,120
21	4.02.02	Deer Hill Road	Replace with 2-33" RCP	$44,890
22	4.02.03	Greenridge Road	Add 21" RCP	$23,560
23	4.04.01	North Shore Drive	Replace with 2-42" RCP	$41,700
24	4.04.02	Deer Hill Road	Replace with 42" RCP	$30,120
25	4.04.03	Meadow View Drive	Replace with 33" RCP	$28,010
26	4.04.03.01	Fiddlers Drive	Replace with 21" RCP	$20,220
27	4.02.04	Stonegate Road	Add 27" RCP	$26,000
28	4.02.05	Coyle Springs Road	Add 15" RCP	$19,000
29	4.10.04.03	North Shore Drive	Add 18" RCP	$19,630
30	4.10.05.02	Hacienda Court	Add 15" RCP	$18,630
31	4.11.02	Deer Hill Road	Add 27" RCP	$26,000
32	4.11.03	Greenridge & Oak Grove Roads	Add 18" RCP	$19,260
33	4.11.04	Greenridge Road	Add 15" RCP	$18,630
34	4.07.00	Lake Ridge Circle	Replace with 18" RCP	$19,630
35	4.11.03.02	Fernwood Road to Deer Hill Road	Replace with 30" RCP	$225,000
1	6.04.00	Deer Hill Road	Replace with 2-58"x36" RCP	$52,010
2	6.05.00	Eagle Rock Road	Replace with 2-58"x36" RCP	$52,010
3	6.03.00	Conestoga Road	Replace with 2-54" RCP	$54,380
4	6.03.03	Eagle Rock Road	Add 18" RCP	$19,260

TABLE 6-1 RECOMMENDED ORDER OF IMPROVEMENTS				
Priority	**Pipe No.**	**Location**	**Improvement**	**Cost**
5	6.01.00	Conestoga Road	Add 15" RCP	$18,630
6	6.03.03.01	Eagle Rock Road	Replace with 27" RCP	$26,380
7	6.06.00	Eagle Rock Road	Replace with 24" RCP	$20,960
8	6.02.00	Conestoga Road	Replace with 42" RCP	$30,120
			PROJECT TOTAL	$3,689,770

*Alternative included in Project Total Cost

II. HIDDEN VALLEY LAKE SUBDIVISION

A. DRAINAGE STRUCTURES

Approximately 78 culverts within the Subdivision will need to be replaced to accommodate the design flows. The replacements are generally recommended in areas where the culverts cross roadways within the subdivision. Figures 6-1 through 6-5 illustrates the location of the proposed improvements. The total estimated cost of improvements is $ 3,689,770.

B. PUMP STATION

The existing storm water pump station should be upgraded if 100-year flood protection is desired in Watershed 1. The Putah Creek Levee Evaluation will determine the storm recurrence interval for the interior and exterior of the levee. The District has developed some preliminary design work for the addition of two additional high capacity stormwater pumps.

With the available detention storage under 10-year design conditions, the pump station and bypass system must provide a total capacity of 235 cfs. This is available through the bypass conduit; however, the existing pumping station and detention pond is undersized to provide adequate flood protection when high flows in Putah Creek eliminate the bypass conduit.

The existing pump station configuration provides for 235 cfs of bypass capacity through a 72-inch CMP. The 72-inch CMP is operational until the flood level in Putah Creek reaches elevation 935. The pump station itself has approximately 6,000 to 8,000 gpm (13.4 to 17.8 cfs) of pumping capacity and approximately 10-acre feet of storm water detention storage.

With the available detention storage under 100-year design conditions, the required capacity of the pump station is 555 cfs. This is well beyond the existing available capacity.

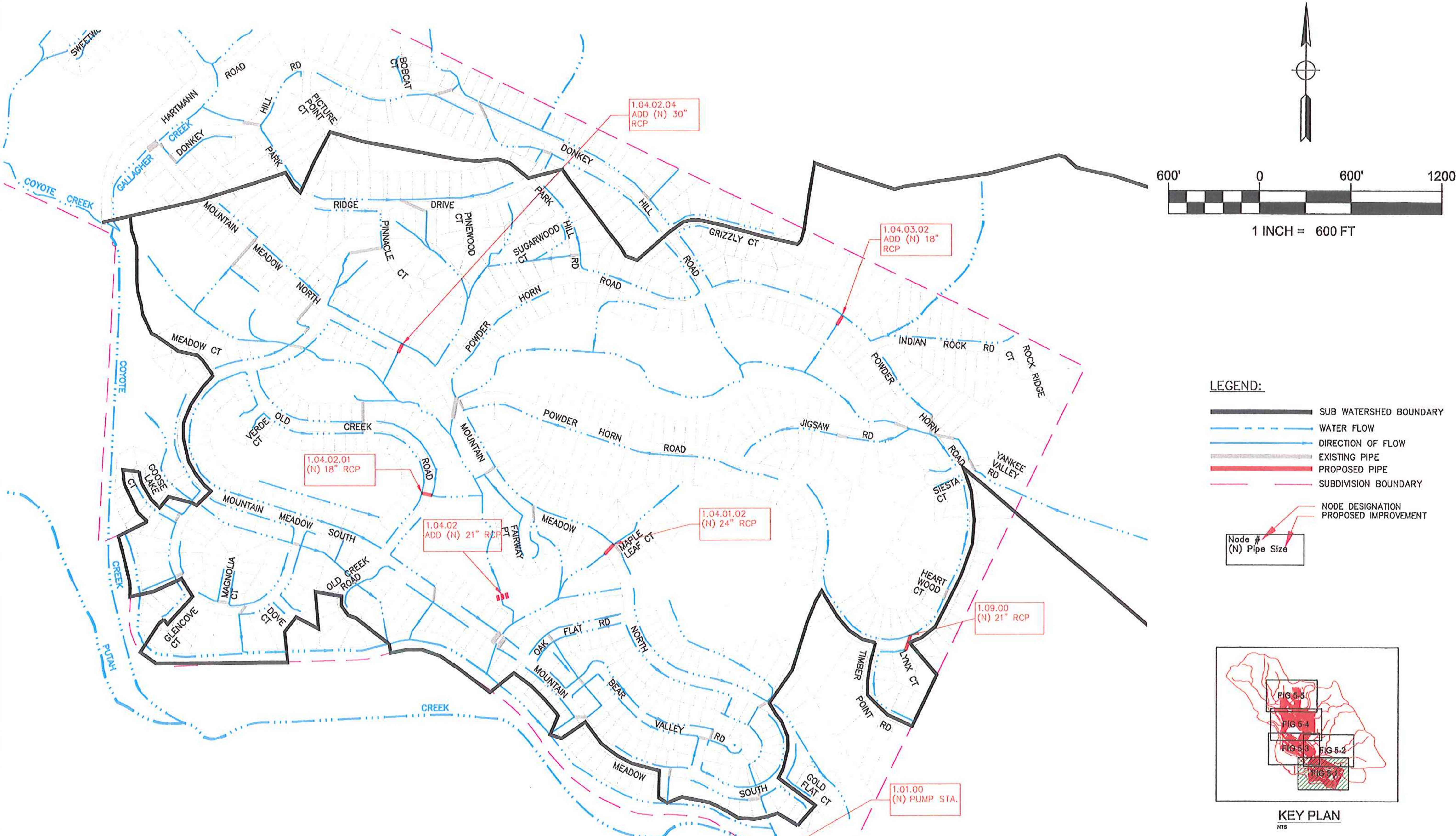

FIGURE 6-1

WATERSHED 1-
PROPOSED IMPROVEMENTS

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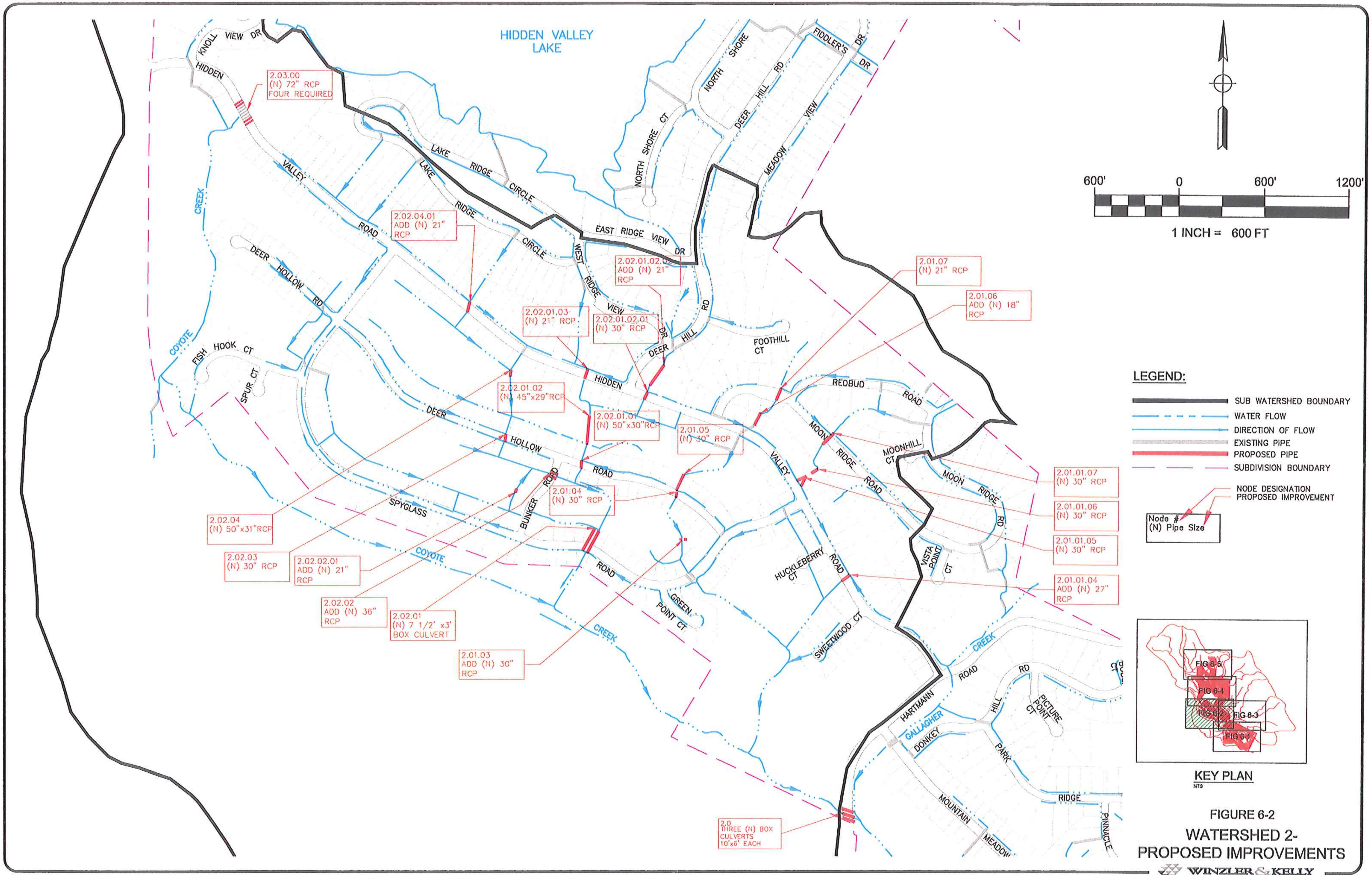

FIGURE 6-2

WATERSHED 2-
PROPOSED IMPROVEMENTS

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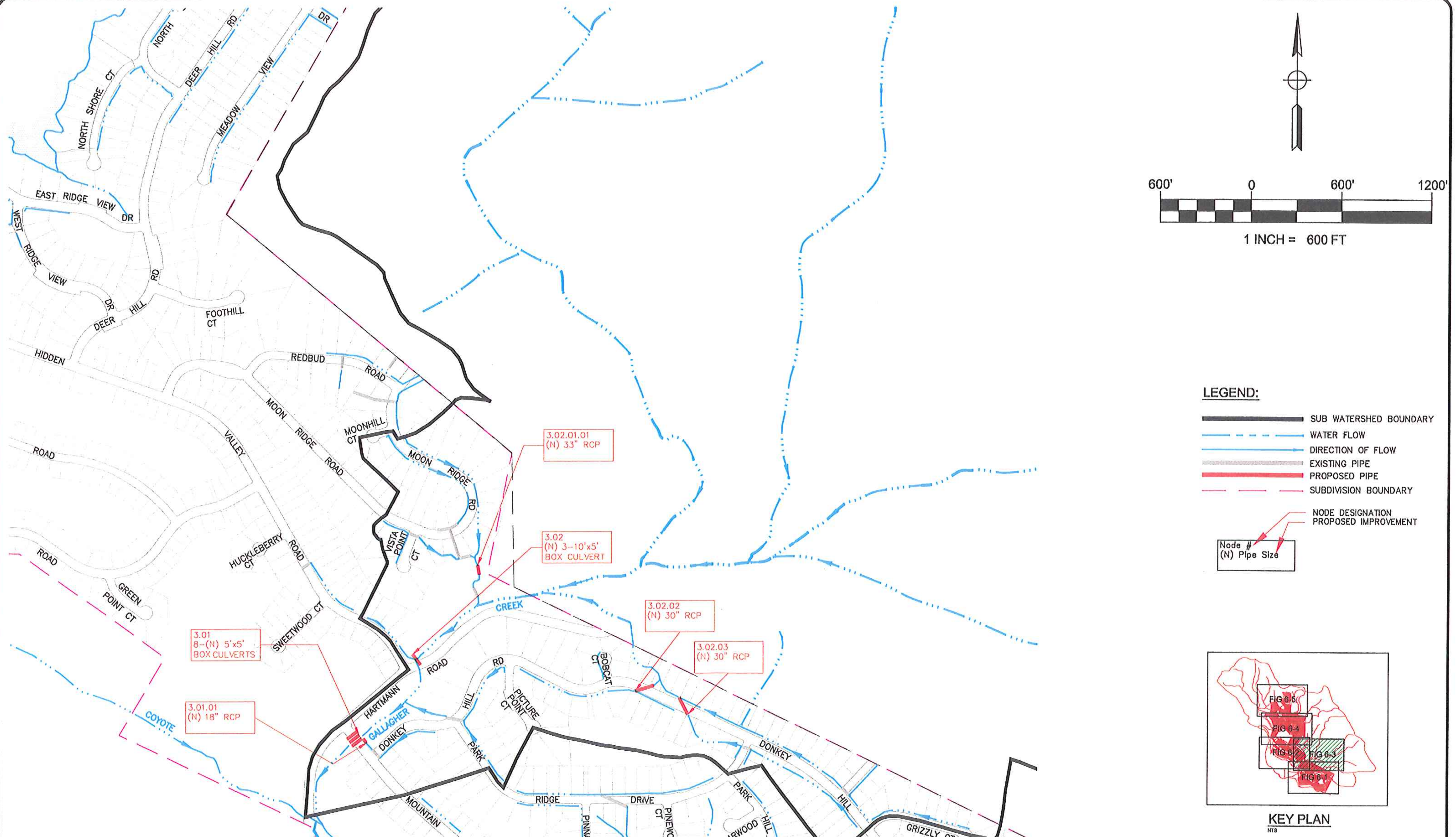

FIGURE 6-3

WATERSHED 3-
PROPOSED IMPROVEMENTS

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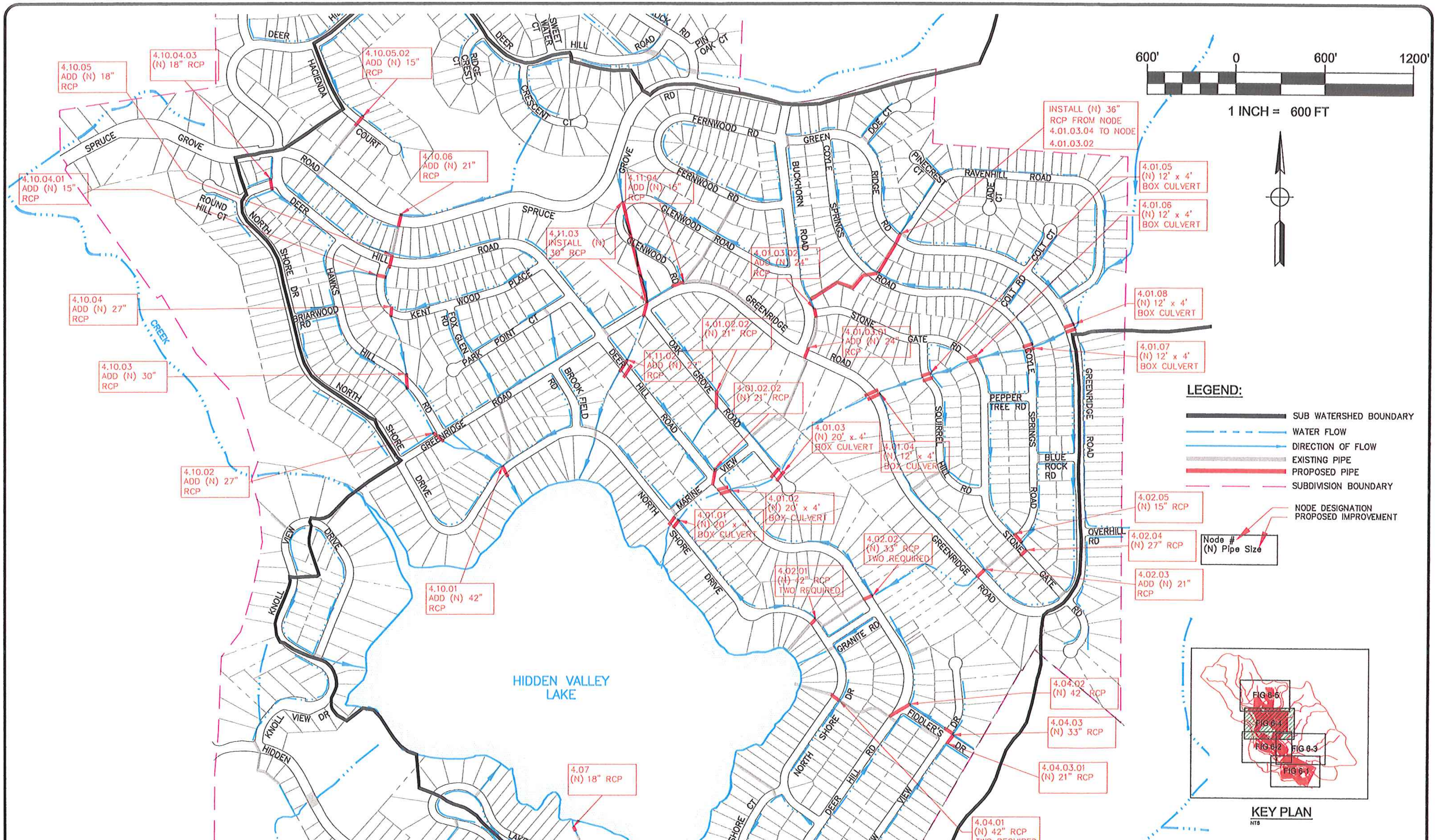

FIGURE 6-4

WATERSHED 4-
PROPOSED IMPROVEMENTS

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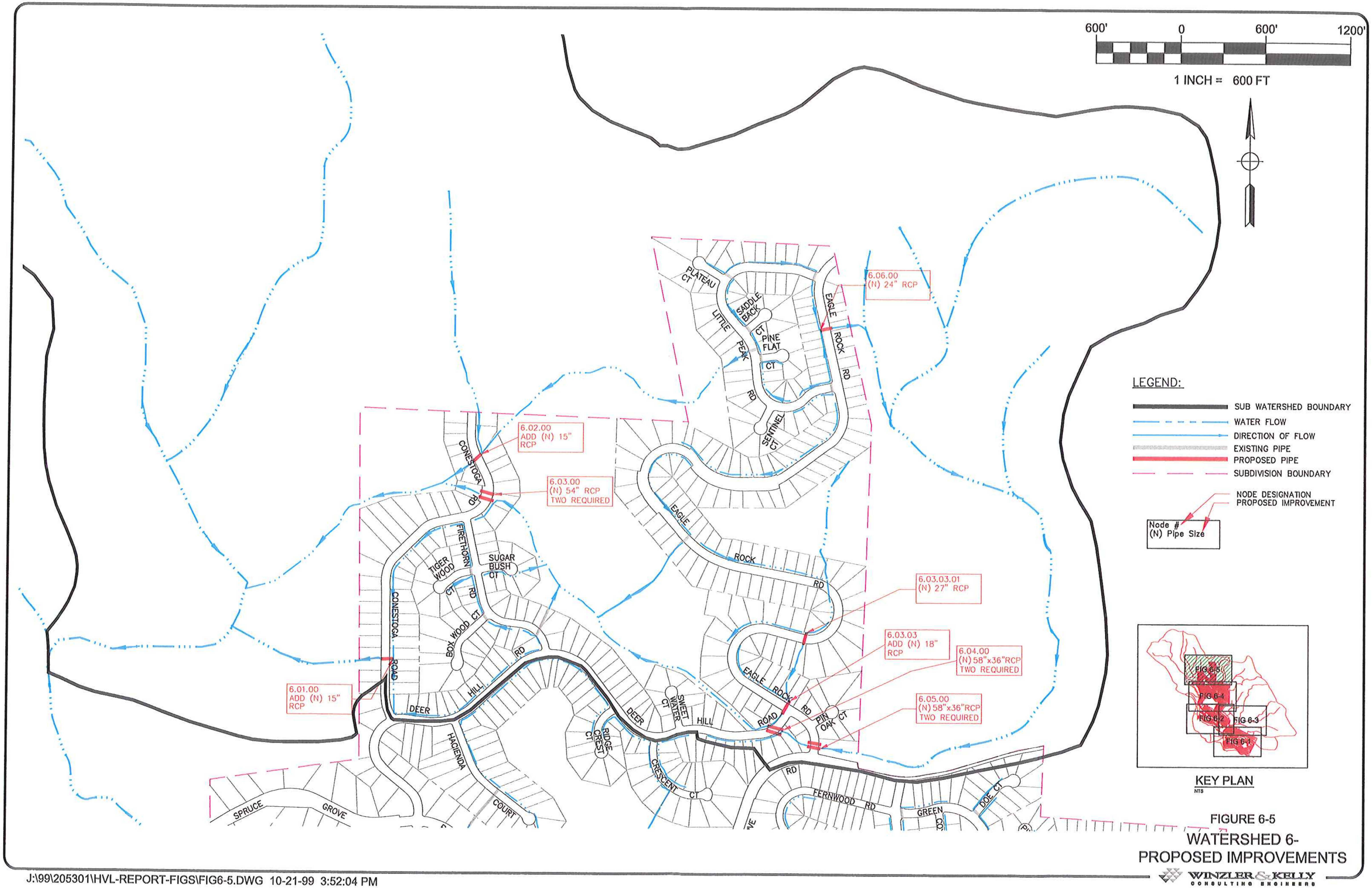

FIGURE 6-5

WATERSHED 6-
PROPOSED IMPROVEMENTS

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J:\99\205301\HVL-REPORT-FIGS\FIG6-5.DWG 10-21-99 3:52:04 PM

The district has purchased two 100 HP pumps, when installation will increase the capacity of the pump station adding approximately 44 cfs. As can be seen from the above analysis, these pumps will not be adequate to handle the 10-year or 100-year runoff during high water conditions on Putah Creek.

Several options have been explored. It may be possible to extend a gravity system downstream tying into Putah Creek at a water surface that would allow gravity flow even at 100-year flows in Putah Creek. Based on the existing FEMA mapping, a water surface of 944 on Putah Creek occurs approximately 2000 feet downstream of the pump station site. However, a large gravity pipe system would be required to handle the total flows, estimated as three 10'x 5' RCB's or, alternatively, it may be possible to construct an earthen channel to carry this flow. This channel is estimated to be 30 feet wide, 6 feet deep with 2:1 side slopes.

It may be possible to construct detention basin facilities upstream through the golf course. Rough estimates indicate that 18 to 27 acre-feet of storage could be developed by construction of earthen berms across the channel at key locations. This storage would potentially reduce runoff to the pump station to between 130 and 165 cfs during a 10-year event and between 395 and 470 cfs during a 100-year event. With the maximum sized detention capacity in place, the gravity system would still require dual 10'x 5' RCB's or an earthen channel with a bottom width of 15 feet.

The other option would be to upsize the pump station as required depending on what other improvements (such as detention basins) are constructed. The alternatives need to be further investigated during the evaluation of the Putah Creek levee. The actual design criteria approved by FEMA needs to be established. It is unclear at this time what the internal design (pump station) and external Putah Creek flooding levels are.

III. COYOTE CREEK CHANNEL

A. ALTERNATIVES REVIEWED

The hydraulic capacity of the Coyote Creek channel within the subdivision was reviewed utilizing the FEMA cross sections as a basis for the hydraulic analysis. Coyote Creek, in its current configuration below the Hidden Valley Lake Dam (20 to 25 feet wide and 3 feet deep), has an approximate carrying capacity of 650 to 950 cubic feet per second (cfs). Currently, the creek splits below Hidden Valley Lake; a 500-cfs bypass system carries a portion of the Creek under Highway 29. The remaining flow is carried in the main creek channel along the southern boundary of the Subdivision. Coyote Creek meets Putah Creek near Hartman Road. An existing flood control levee separates Putah Creek from the Subdivision below the confluence. Table 6-2 below outlines the anticipated flows and channel capacity in Coyote Creek downstream from Hidden Valley Lake Dam.

TABLE 6-2 SUMMARY OF COYOTE CREEK FLOW AND CAPACITY					
Design Flow	**Below Hidden Valley Lake**	**At Highway 29 Bypass**	**At Hartman Road**	**At Putah Creek Confluence**	**Estimated Channel Capacity**
25-Year	1672 cfs	1170 cfs	1451 cfs	2621 cfs	650–950 cfs
100-Year	2770 cfs	2270 cfs	2732 cfs	4643 cfs	650–950 cfs

In order to accommodate the 100-year design flows, the Coyote Creek section would need to be increased to 65- to 100-feet wide and 5-feet deep, with 2 to 1 side slopes to form a trapezoidal channel. Figure 6-6 illustrates the proposed Creek cross section (Alternate 1).

Because of the dramatic increase required in the creek's cross section, an alternative was developed that used Hidden Valley Lake to provide flood storage. Hidden Valley Lake has an approximate surface area of 99 acres. Both 3 feet (Alternate 2) and 6 feet (Alternate 3) of storage capacity were analyzed which equates to approximately 289 acre-feet and 594 acre-feet of flood storage. When a hydraulic routing analysis was performed using these flood storage volumes, the outlet flow from Hidden Valley Lake was reduced as indicated in Table 6-3.

TABLE 6-3 ROUTED FLOWS FROM HIDDEN VALLEY LAKE		
LAKE STORAGE	**25-Year Runoff**	**100-Year Runoff**
0' Lake Storage (Alternate 1)	1672 cfs	2770 cfs
3' Lake Storage (Alternate 2)	780 cfs	1200 cfs
6' Lake Storage (Alternate 3)	560 cfs	835 cfs

Alternate 2, assumes 3 feet of storage in Hidden Valley Lake. The downstream improved channel could be reduced to a range of 35 to 50 feet wide; 5 feet deep; with 2:1 side slopes. This cross section is illustrated in Figure 6-7. Alternate 3, assumes 6 feet of storage in Hidden Valley Lake. The existing channel section is generally adequate. It is recommended that the bottom of the channel be graded to get rid of irregularities and deepen the channel in sections where it is

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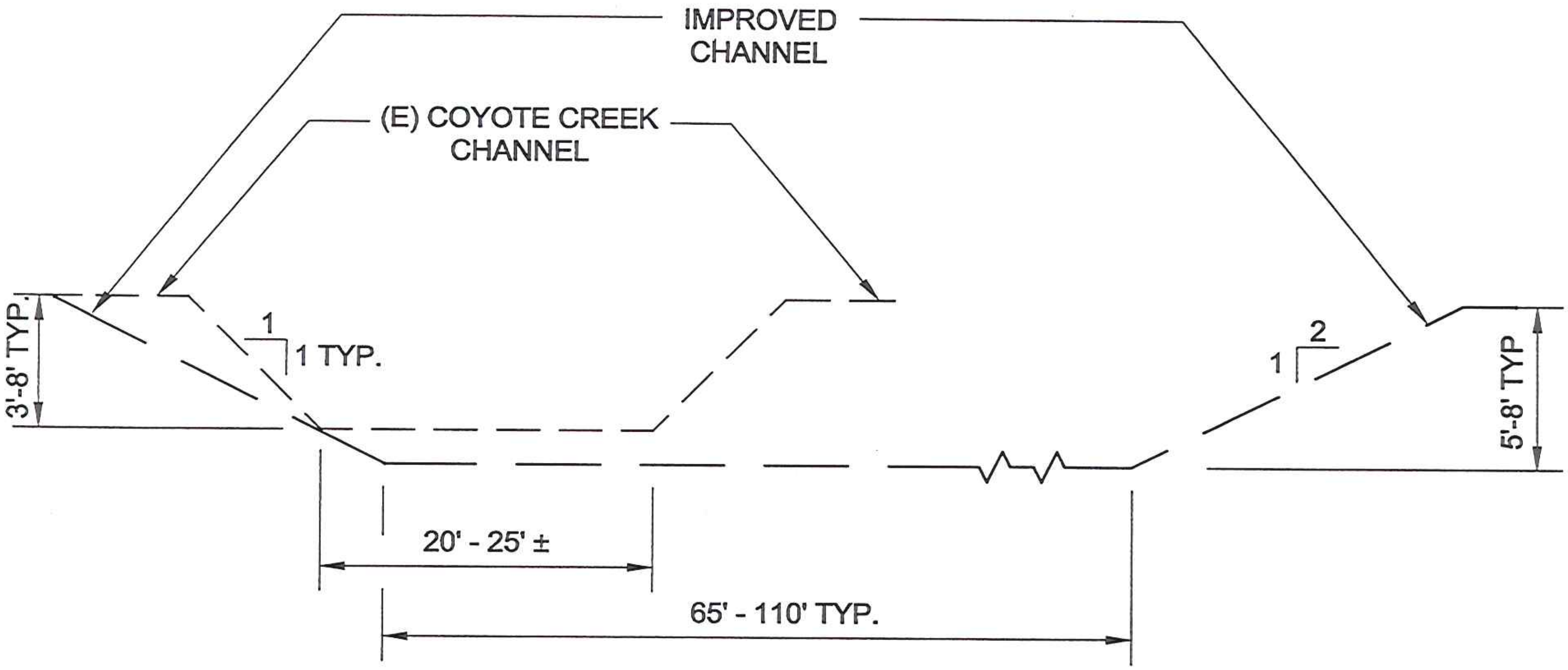

SCALE: 1"=10'

FIGURE 6-6
ALTERNATE 1
COYOTE CREEK
Q_{100} CHANNEL

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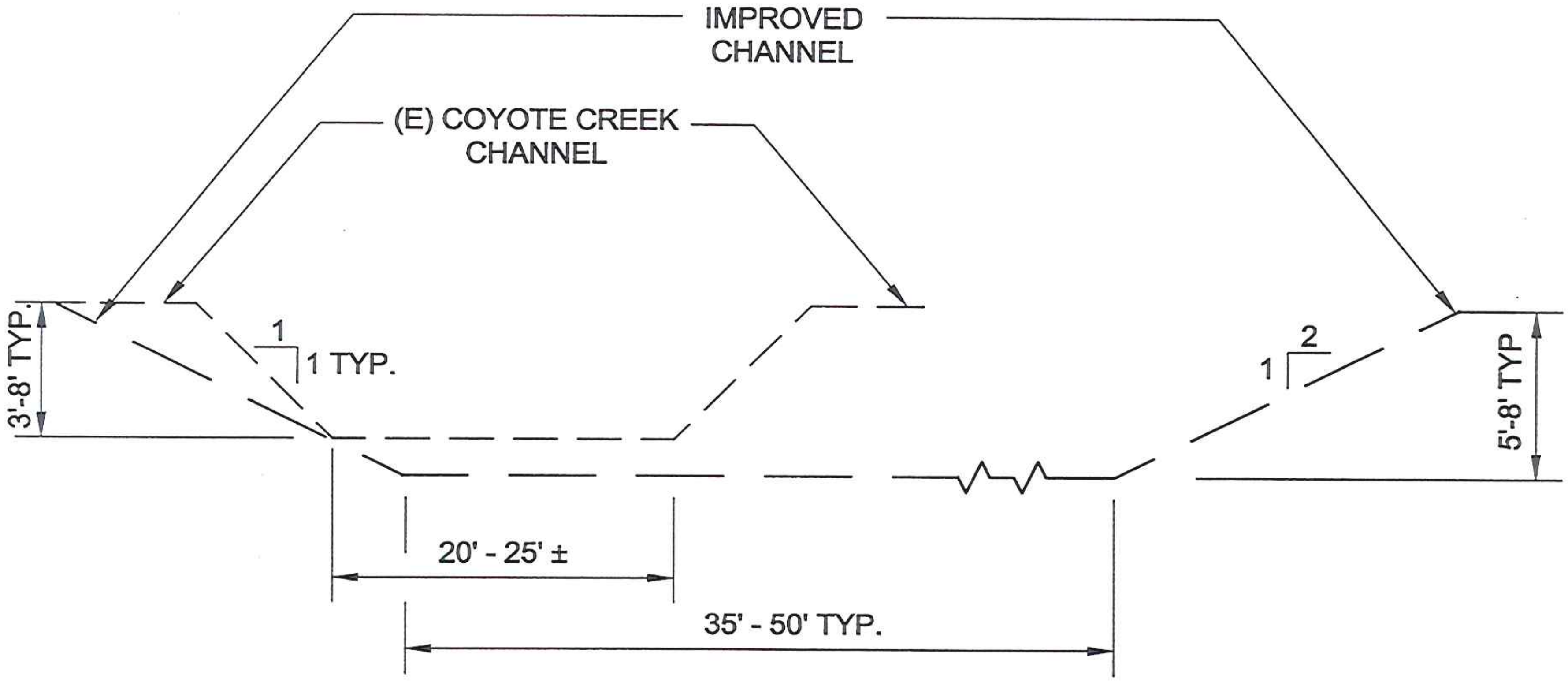

SCALE: 1"=10'

FIGURE 6-7

ALTERNATE 2
COYOTE CREEK
Q_{100} CHANNEL WITH
3' LAKE STORAGE

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currently less than 4 feet deep. Figure 6-8 shows the general channel configuration utilizing 6 feet of lake storage.

Reconstruction of the channel between its confluence with Putah Creek, upstream to the crossing at Hartman Road where Gallagher Creek enters is necessary. This section requires deepening and widening to reduce the water surface at the Hartman Road crossing. The typical cross section is illustrated in Figure 6-9. This analysis needs to be further refined during the Putah Creek Levee evaluation as it is presently unclear if a less that 100-year Putah Creek water surface elevation can be assumed during the peak Coyote Creek runoff.

B. RECOMMENDATIONS

The initial hydraulic modeling for Coyote Creek, utilized creek cross sections prepared by FEMA. Review of these cross sections indicates a high probability that they do not accurately represent the field conditions encountered in the subdivision. Because FEMA's work is quite broad-based, it is likely that they did not have access to the quality of mapping the District has and the creek cross sections may not have been field verified. Prior to developing any detailed design recommendations, it will be important to perform field surveys of the reach of Coyote Creek that is in questions and re-run the HEC-2 models with more precise input data.

Use of the Hidden Valley Lake provides significant attenuation of peak design flows. In order to achieve flood control benefits, it may be necessary to modify the operations of the dam and reservoir. Reservoir levels would need to be drawn down in the fall to provide a "buffer" for flood storage. This type of operation could compromise recreational and aesthetic benefits associated with the Hidden Valley Lake. However, because if the potential cost savings involved, it is important to explore this option.

IV. GALLAGHER CREEK CHANNEL

C. ALTERNATIVES REVIEWED

The hydraulic capacity of the Gallagher Creek channel from its confluence with Coyote Creek upstream approximately 0.5 miles where it diverges away from Hartman Road was reviewed. The FIRM Map indicates substantial flooding through this reach and our analysis confirms this flooding. Section II A of Chapter 6 indicates that the crossings of Mountain Meadow North and Hartman are both significantly undersized. However, upsizing of these drainage facilities will do little to alleviate the flooding of the area. The existing channel is undersized for the estimated 10-

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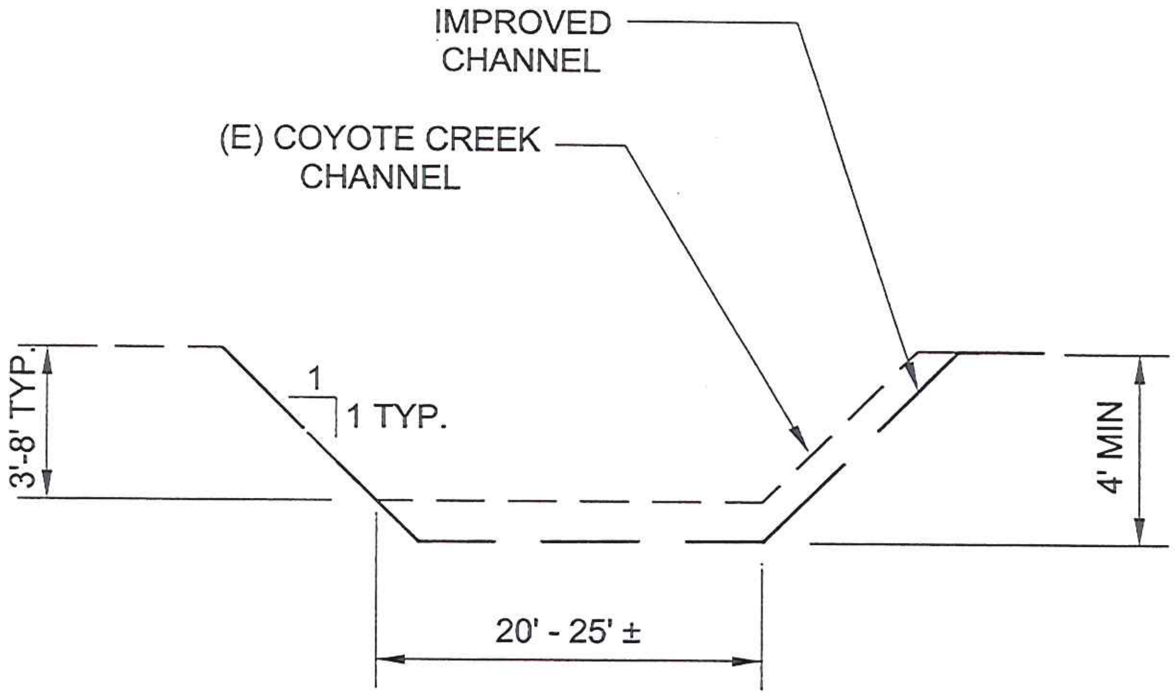

SCALE: 1"=10'

FIGURE 6-8
ALTERNATE 3
COYOTE CREEK
Q_{100} CHANNEL WITH
6' LAKE STORAGE

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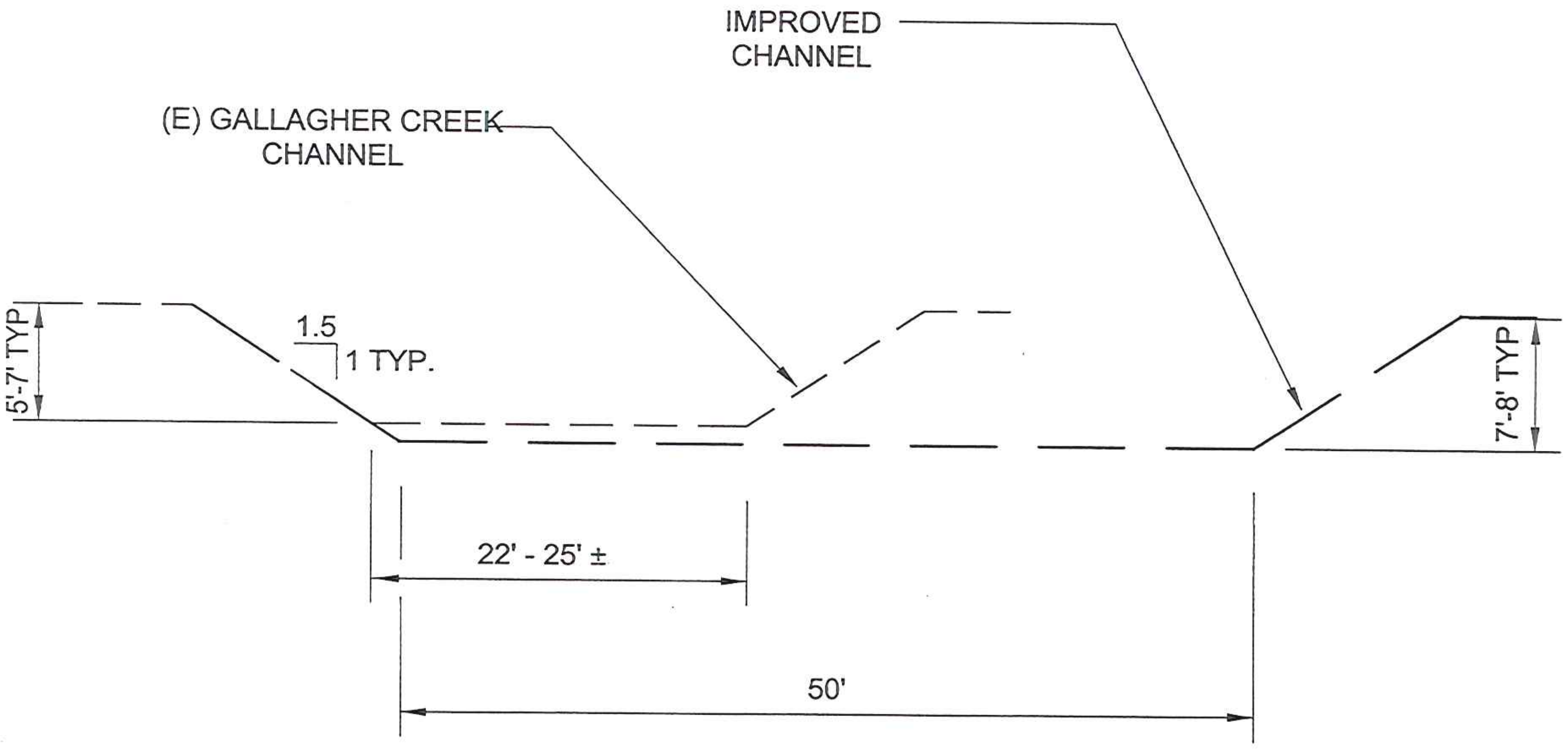

SCALE: 1"=10'

FIGURE 6-9

COYOTE CREEK Q_{100} CHANNEL
IMPROVEMENTS DOWNSTREAM
OF GALLAGHER CREEK

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year flows. This channel has relatively low banks on the southeast side of the channel and a relatively wide flood plain. The channel section would need to be substantially widened and deepened in order to contain the 10-year flows and reduce the FEMA flood plain. A typical channel section is indicated on Figure 6-10.

V. YEARLY COSTS

A. MAINTENANCE COSTS

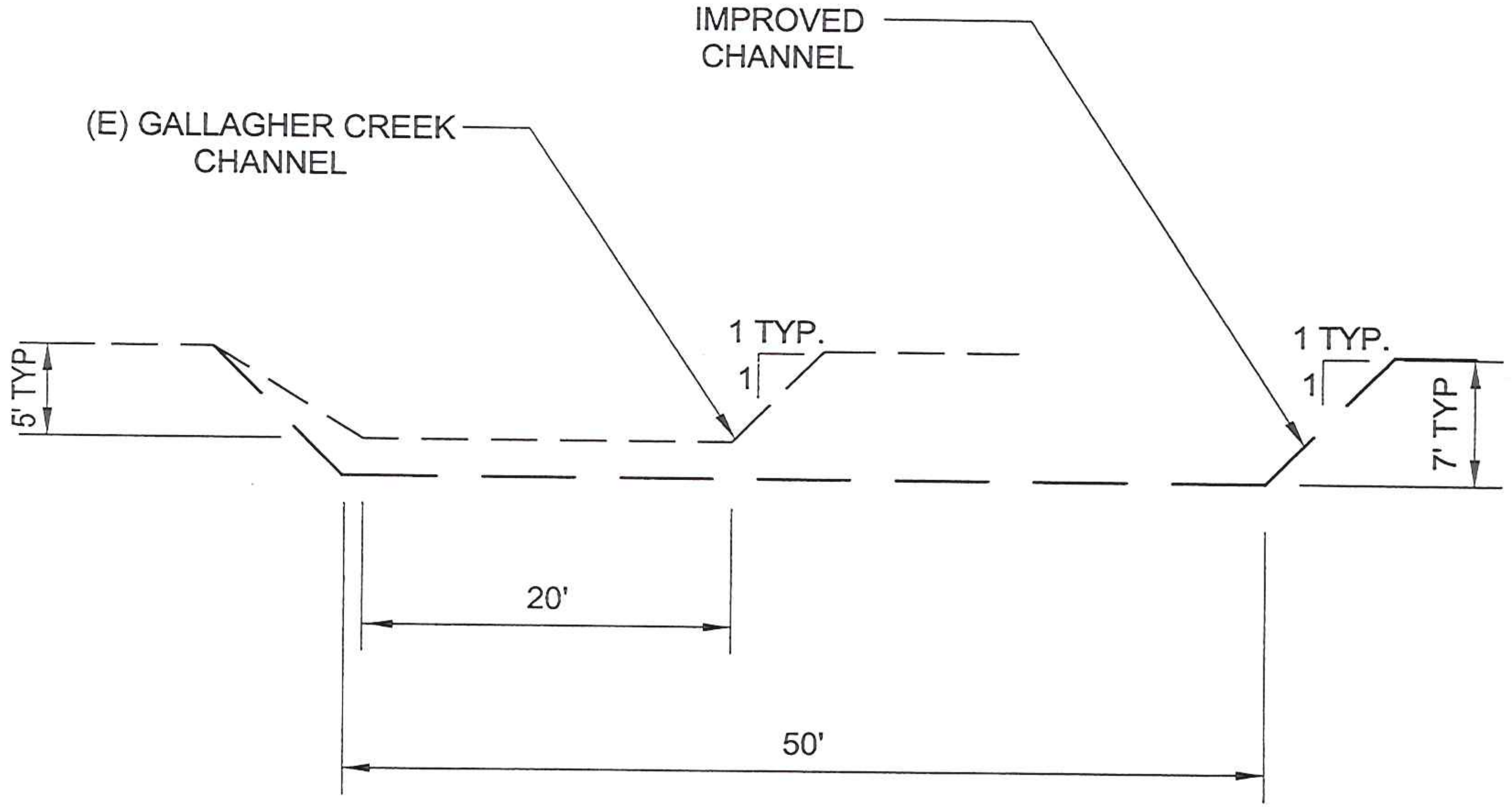
Since the establishment of the subdivision, there has not been a basic yearly maintenance operation established. The typical yearly maintenance operation would consist of cleaning of the ditches, channels, and culverts from debris, vegetation, and silt. Over time, without the yearly maintenance, the long-term effects of sediment buildup and vegetation growth will develop into changes in the flow path of the storm water. The lack of yearly maintenance is primarily due to the ownership of the storm drain system which is divided between three individual agencies: County of Lake, Hidden Valley Lake Homeowners Association, and Hidden Valley Lake Community Services District. As stated earlier in the report, the County of Lake has limited resources, and the entire County is vying for the available dollars. Hidden Valley Lake Homeowners Association has limited resource capacities and these have not been focused on storm drain management. Hidden Valley Lake Community Services District is not authorized to handle storm water management and does not have a current source of funding.

The yearly maintenance cost would generally comprise of workmen, equipment, materials, and administration for implementation.

B. IMPROVEMENT COSTS

The estimated cost for all drainage improvements ranges from $3,689,770 to $8,707,110. These drainage improvements would require a number of years to complete. As an example, if these improvements were completed by borrowing money and repaid through a 20-year loan of $3,689,770 at 5 percent interest, the amortized repayment is $292,210 per year. The cost of the loan would require additional administration for the loan maintenance.

J:\99\205301\HVL-REPORT-FIGS\FIG6-9.DWG 3-29-00 1:40:28 PM



SCALE: 1"=10'

FIGURE 6-10
GALLAGHER CREEK Q_{100} CHANNEL
IMPROVEMENTS UPSTREAM
OF COYOTE CREEK

WINZLER & KELLY
CONSULTING ENGINEERS

C. COST SUMMARY

The following is a summary of the yearly anticipated costs for Hidden Valley Lake as an example:

Foreman, 2 Operators, 2 Laborers, a Backhoe and Dump Truck for 2 months	$75,612
Materials	25,000
Administration	35,000
Billing	33,000
Loan Repayment	292,210
Total Estimate Yearly Cost	**$460,822**
Estimated Yearly Cost per Lot (3,300 lots)	$139.64
Monthly Cost per Lot	$11.64

CHAPTER 7 - PROJECT FINANCING

I. BACKGROUND

Lake County Flood Control and Water Conservation District, is generally financed by a portion of the county property tax. The Lake County Flood Control District encompasses the entire Lake County. The 1999-2000 property tax revenue is estimated to be approximately $278,300. Since these funds are used throughout the county, all projects within the County vie for a portion of the available funds. The cost of development and implementation of the stormwater and flood control solutions will place an increased and significant financial burden on the County. Therefore, it is difficult to obtain any funds without other influences to have Hidden Valley Lake placed higher priority on the funding.

Financing the storm drainage improvements and maintenance operations will require a well-planned, long-range effort by an agency that has jurisdiction over the drainage conveyance facilities. Multiple ownership of the storm drain conveyance facilities results in difficult funding and project solutions:

- Hidden Valley Lake Association has ownership of the property for the levee on Putah Creek and a portion of the subdivision drainage;
- Lake County, has been dedicated the roads and some subdivision drainage;
- Hidden Valley Lake Community Services District (through merger with Stonehouse Mutual Water District) owns the storm water pump station.

This multiple ownership of these conveyance facilities precludes typical stormwater agency functions necessary to develop and carry out a well-planned, long-range effort to control or eliminate negative stormwater impacts. Single ownership/responsibility will be capable of correcting long-standing flooding and erosion problems.

Over the last few years emergency storm water grants from FEMA, administered by Hidden Valley Lake Community Services District, has repaired and maintained a portion of the drainage conveyance facilities within the subdivision.

A stormwater management program cannot be successful without a consistent, dedicated source of revenue on which it can rely. Hidden Valley area is not much different from many communities that are grappling with how to fund and administer a new service while trying to upgrade and maintain their already inadequate drainage infrastructure.

In recognition of the need to assess the financial impact of the proposed improvements, an appropriate revenue plan for both construction and operation/maintenance costs is warranted. This report is intended to serve, in part, as a basis for further evaluation and creation of a new stormwater and flood control revenue plan for Hidden Valley Lake.

II. ALTERNATIVE STORMWATER REVENUE

Historically, stormwater management has been financed with general revenues from property taxes, but these taxes have proven to be undependable and inadequate. The best alternative to property-tax-supported general fund stormwater management appears to be a stormwater utility through which service or user charges and related funding mechanisms distribute the costs among owners of properties in proportion to some estimate of the amount of runoff from their properties. Faced with the reduction in tax-based revenue many agencies have identified the need to develop additional revenue sources to supplement general fund obligations, and develop a cost and revenue stream to recover the costs of stormwater management and compliance.

For most agencies, there are basic revenue alternatives available to avoid the continued use of general funds to support stormwater related activities. These alternatives are to establish a benefit assessment or special tax for all county property owners, or to create a new user charge or fee for allocation to the users/beneficiaries of the stormwater program. These mechanisms are discussed in the following sections. Stormwater services can secure increased recognition under both funding systems, rather than having to compete with the more politically powerful police, fire, and other municipal departments for general funds.

A. BENEFIT ASSESSMENTS

Benefit assessments are a common way of funding capital improvements and maintenance activities. In establishing a benefit assessment program, an agency is charged with determining who benefits from the proposed improvements. Assessment proceedings can only be used when properties receive special benefits. Protection from flooding, either as a result of new construction or regular maintenance, is the common benefit for assessments funding flood control and drainage activities.

The State codes provide various Acts by which public agencies may establish and levy assessments, and these designate specifically what types of improvements are allowed to be funded. Flood control facilities can be funded under the Improvement Act of 1911 (the 1911 Act), the Municipal Improvement Act of 1913 (the 1913 Act), and the Benefit Assessment Act of 1982 (the 1982 Act). In addition, many District Acts also provide agencies with the authority to levee assessments.

Assessments formed under the authority of the 1913 Act, the 1982 Act or an agency's own District Act is the most commonly used. The 1913 Act can fund flood control capital improvements, and can fund maintenance only when the 1913 Act is used to construct the improvements. The 1913 Act also allows the use of land-secured bonds to fund the capital improvements. The 1982 Act may fund both capital improvements and maintenance. The 1911 Act can fund both capital improvements and maintenance of flood control facilities, but is seldom used and only on small projects due to its requirement that bonds be sold after the improvements have been constructed.

The assessment process is usually seen as the most attainable funding mechanism available to public agencies because it relies on majority approval (50% or more). For flood control projects, however, the assessment process may not be the most appropriate tool because it concentrates the costs on only the benefiting properties (primarily those being removed from a flood plain). This can result in large costs spread on only a small number of properties.

Some municipal entities, nationally and throughout the State, have used benefit assessments for stormwater management. This method appears to be used throughout California primarily by Special Flood Control Districts where legislation empowered the Districts to levy assessments or taxes upon property to pay specific costs and expenses. For most counties, the use of benefit assessments is dependent upon the legislative enabling acts to authorize the funding of stormwater operational costs and capital expenditures.

B. USER-FEE-FUNDED STORMWATER UTILITIES

User fees are also a common way of funding capital improvements and maintenance activities. In establishing a user fee program, an agency is required to determine who uses the proposed improvements. In the case of drainage facilities, a user fee allows an agency to collect revenue from properties that contribute runoff into the system but may not flood because of their location.

A user fee can be structured proportionally to the amount each parcel uses the flood control facilities rather than how much each property benefits from the services or improvements provided. This allows program costs to be spread over a larger customer base. For flood control work, user fees are typically related to impervious area on the property, which can be equated to runoff. Like the benefit assessment, a user fee may also be implemented by a 50% vote; however, before the vote may be initiated, a noticed protest hearing must take place and less than 50% written protest must be received. The Proposition 218 voting requirements are new and relatively untested for storm water utilities. Some agency counsel has interpreted the voter pool to be property owners (the user fee is a property-based fee); others are inclined to view the storm drain utility ratepayers as the voter pool. In areas where the storm drain fee is collected with the water and sewer bill and paid by the property resident, this may result in a situation where tenants, rather than the owners, vote.

Funded primarily through service charges user-fee-funded programs provide stable and adequate revenue and equitably distribute the cost of stormwater services and facilities. The concept of a user-fee-funded program or stormwater is not new. The financing is from dedicated user charges, not property taxes. Dedicated user charges means that the charges can only be for stormwater management. Generally these charges are based on the total amount or percentage of run-off (or impervious area) for each parcel of land. This method of calculation of charges requires a change in the thinking of the users: Users are properties that add runoff to a stormwater system; and beneficiaries are properties that gain from the stormwater management.

Stormwater user fees are currently used in many counties throughout the country to fund storm drainage related activities. Although less prevalent in California, State law provides the legal authority to establish a fee for storm drainage services in direct proportion to the beneficiaries of those costs. It is through this general authority that some California counties have established user fees to fund stormwater activity.

Hidden Valley Lake Community Services District currently has water and sewer powers but is not responsible for storm drainage facilities. If the district passed a storm drainage user-fee: based on an estimated 3,300 single-family units within the district, a monthly fee of between $5 and $10 per lot would generate $200,000 to $400,000 annually assuming that all property owners, both on developed and undeveloped lots paid the fee.

C. SPECIAL TAXES

As a funding tool, special taxes provide an agency with the most flexibility. There is no benefit or use requirement to satisfy, and the special tax may fund any public improvement or activity the agency undertakes. However, when contemplating a special tax, an agency must obtain a 2/3-voter approval. This is clearly the challenge of a special tax proposal, as a 2/3 approval is very difficult to obtain on even very popular measures.

Another type of special tax is a Mello-Roos Community Facilities District. Although this is sometimes thought of as an assessment district, it is actually a special tax district that allows land-secured bonds. Its establishment procedures can be cumbersome, requiring both a public hearing process and an election process. The Mello-Roos CFD can be a very useful tool for funding development-related capital projects: it provides for a property owner election (rather than a registered voter election) if there are less than 12 registered voters within the district.

Table 7-1 provides a summary of relevant issues for the benefit assessment, user fee and special tax.

Table 7-1
Funding Mechanism Summary

Funding Mechanism	Hearing Required	Vote Required	Voter Pool	Weighted Votes	Rate Structure
Benefit Assessment	Yes	50%	Property Owners	Yes	Benefit
User Fee	Yes	50%	Property Owners	Yes	Use
Special Tax	No	2/3	Registered Voters	No	Any

III. BILLING METHODOLOGY

There are three primary methods that could be utilized to accommodate the billing of stormwater fees: utilization of the County Auditor/Controller's Office: utilization of an existing utility billing system or creating a new utility billing system. Each option requires the assessment of County tax roll data for the size and type of land use of each applicable parcel. However, creating a new billing system requires additional data correlation based on parcel address/APN number, as well as additional billing administration and mailing costs.

A. COUNTY TAX ROLLS

The County Auditor/Controller's Office provides for the billing of property taxes to all property owners in the County. This system is used as a billing mechanism for taxes and user charges by other municipalities, particularly when the municipality does not have a mechanism to bill charges to the appropriate beneficiaries. The County tax rolls can be used to bill new/special taxes and non-tax (user charges) items.

The advantages of recovering costs through the tax billings are: the percentage of collection is usually very high; as a semi-annual bill, the County should receive minimal customer service calls; the data files are in place; it readily provides for the billing of all property including undeveloped land; and, bills will be sent to property owners without special handling. The disadvantages of this mechanism are: billing costs are relatively high; initial billing errors (estimated at approximately 1% to 2%) may be time consuming and expensive to reconcile; and the County requires a setup fee and annual property tax administrative fee that must be negotiated. To pursue this methodology, the County must adopt the appropriate legal authority and submit the charge per parcel to the County Auditor's Office by the first of August of each year.

B. UTILIZE AN EXISTING UTILITY BILLING SYSTEM:

The advantages of using an existing billing system mechanism are: database and billing corrections are all completed by one agency; and cash flow from revenue receipts is continuous. The disadvantages of this methodology are: existing billing schedule would have to be utilized; costs may be incurred for utilizing another agencies billing system; initial number of customers calls/complaints is expected to exceed the calls from the tax mechanism; a special utility bill would be required to bill owners of undeveloped land.

C. CREATE A NEW BILLING SYSTEM

The advantages of using a new billing system mechanism are: it provides a flexible implementation schedule; data base adjustments and billing corrections are all completed by one agency; and, cash flow from revenue receipts is continuous. The disadvantages of this methodology are: the billing system must be created; utility accounts billed directly to rental property tenants may require reconciliation to accommodate a special bill to property owners; initial number of customers calls/complaints is expected to exceed the calls from the tax mechanism; and, a special utility bill is required to bill owners of undeveloped land.

IV. RECOMMENDATIONS

Without clear ownership/responsibilities of the stormwater conveyance facilities within Hidden Valley Lake, a stormwater management program cannot be successfully implemented. A number of factors emerge from the review of the material:

- Determine the authority to implement and manage the storm water facilities for Hidden Valley Lake.
- Grants and funding from FEMA and other government agencies generally require a government entity for administering the funds.
- A defined tax base must be established to dedicate funds for operation/maintenance and implementation of the recommendations.
- A user-fee approach appears to be best suited for Hidden Valley Lake.

APPENDIX A - HEC OUTPUT FILES

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                                                          K:\RICKJ\HECPACK\GHEC1\99205301\AREA1\1-00.OUT
HEC1 S/N: 1343001909         HMVersion: 6.33     Data File: C:\WINDOWS\TEMP\-vbh2235.TMP

*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*            VERSION 4.0.1E             *
*                                       *
*  RUN DATE  07/21/1999  TIME  10:19:47 *
*                                       *
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                                                             *                                     *
                                                             *    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


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                     :::                                    :::
                     :::  Full Microcomputer Implementation :::
                     :::                 by                 :::
                     :::        Haestad Methods, Inc.       :::
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              37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

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


                                    HEC-1 INPUT                                                    PAGE  1
     LINE
                ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

       1        ID  HVL SWMP - Subasin 1 -  10 Year Storm
       2        IT       1                     1440
       3        IO       5       0

       4        KK  0406
       5        KM  SCS 24 Hour Type IA Rainfall HVLSWMP Node 1.04.06
       6        KO                                       22
       7        BA   .3602
       8        PB       6
       9        IN       6
      10        PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
      11        PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
      12        PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
      13        PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
      14        PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
      15        PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
      16        PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
      17        PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
      18        PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
      19        PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
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                       ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       0.017  TIME INTERVAL IN HOURS


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

            **************
            *            *
1668 KK     *    0101    *
            *            *
            **************

1670 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                        IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       0.017  TIME INTERVAL IN HOURS


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

            **************
            *            *
1701 KK     *    1.01    *
            *            *
            **************

1703 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                        IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       0.017  TIME INTERVAL IN HOURS

                                                          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
                 0406         130.    8.10          51.         26.         26.       0.36

         ROUTED TO
                 R406         130.    8.12          51.         26.         26.       0.36

         HYDROGRAPH AT
                 0405           3.    8.02           1.          1.          1.       0.01

         2 COMBINED AT
                 P405         133.    8.10          52.         27.         27.       0.37

         ROUTED TO
                 R405         132.    8.12          52.         27.         27.       0.37

         HYDROGRAPH AT
                 040401         3.    8.00           1.          1.          1.       0.01

         ROUTED TO
                 R40401         3.    8.02           1.          1.          1.       0.01

         HYDROGRAPH AT
                 040402         4.    8.00           1.          1.          1.       0.01

         ROUTED TO
                 R40402         4.    8.02           1.          1.          1.       0.01

         HYDROGRAPH AT
                 0404           5.    8.02           2.          1.          1.       0.01

         4 COMBINED AT
                 P404         143.    8.10          56.         29.         29.       0.39
```

```
   ROUTED TO
            R404          143.     8.18       56.       29.       29.     0.39

   HYDROGRAPH AT
            040302         27.     8.02       10.        5.        5.     0.06

   ROUTED TO
            40302          27.     8.13       10.        5.        5.     0.06

   HYDROGRAPH AT
            0403           33.     8.10       13.        7.        7.     0.08

   HYDROGRAPH AT
            040301          4.     8.07        1.        1.        1.     0.01

   4 COMBINED AT
            P403          205.     8.17       80.       41.       41.     0.55

   ROUTED TO
            R403          204.     8.23       80.       41.       41.     0.55

   HYDROGRAPH AT
            040206          4.     7.95        1.        1.        1.     0.01

   ROUTED TO
            R40206          4.     8.20        1.        1.        1.     0.01

   HYDROGRAPH AT
            040205         16.     8.17        6.        3.        3.     0.03

   HYDROGRAPH AT
            420502          0.     0.02        0.        0.        0.     0.01

   HYDROGRAPH AT
            420501          1.     8.00        0.        0.        0.     0.00

   4 COMBINED AT
            P40205         21.     8.17        8.        4.        4.     0.04

   ROUTED TO
            R40205         14.     8.68        8.        4.        4.     0.04

   HYDROGRAPH AT
            420401          3.     7.95        1.        0.        0.     0.00

   ROUTED TO
            R42401          3.     8.00        1.        0.        0.     0.00

   HYDROGRAPH AT
            420402         11.     7.97        3.        2.        2.     0.02

   ROUTED TO
            R42402         11.     8.02        3.        2.        2.     0.02

   HYDROGRAPH AT
            420403          7.     7.98        2.        1.        1.     0.01

   ROUTED TO
            R42402          7.     8.05        2.        1.        1.     0.01

   HYDROGRAPH AT
            040204         30.     7.95       10.        5.        5.     0.04

   4 COMBINED AT
            P40204         51.     7.98       17.        8.        8.     0.08

   ROUTED TO
            R40204         50.     8.10       17.        8.        8.     0.08

   HYDROGRAPH AT
            040202          1.     8.00        1.        0.        0.     0.00

   ROUTED TO
            R40202          1.     8.12        1.        0.        0.     0.00

   HYDROGRAPH AT
            040201          8.     8.12        3.        1.        1.     0.02

   ROUTED TO
            R40201          8.     8.25        3.        1.        1.     0.02

   HYDROGRAPH AT
            040203          5.     8.07        2.        1.        1.     0.01

   ROUTED TO
            R40203          5.     8.20        2.        1.        1.     0.01

   HYDROGRAPH AT
            0402           16.     8.42        7.        4.        4.     0.04

   7 COMBINED AT
            P402          289.     8.22      117.       59.       59.     0.74

   ROUTED TO
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            R402          288.     8.23         116.         59.          59.         0.74

     HYDROGRAPH AT
            410201          5.     8.00           2.          1.           1.         0.01

     HYDROGRAPH AT
            040102          9.     8.00           3.          2.           2.         0.02

     2 COMBINED AT
            P40102         14.     8.00           5.          2.           2.         0.03

     ROUTED TO
            R40102         14.     8.07           5.          2.           2.         0.03

     HYDROGRAPH AT
            040101          2.     8.00           1.          0.           0.         0.00

     ROUTED TO
            R40101          2.     8.03           1.          0.           0.         0.00
```

```
HYDROGRAPH AT
          0401       8.   8.07     3.     1.     1.   0.02

4 COMBINED AT
         P0401     308.   8.22   125.    63.    63.   0.78

ROUTED TO
         R0401     308.   8.22   125.    63.    63.   0.78

HYDROGRAPH AT
          0802       0.   7.97     0.     0.     0.   0.00

ROUTED TO
         R0802       0.   8.10     0.     0.     0.   0.00

HYDROGRAPH AT
          0801       1.   7.98     0.     0.     0.   0.00

2 COMBINED AT
         P0801       2.   8.02     1.     0.     0.   0.00

ROUTED TO
         R0801       2.   8.23     1.     0.     0.   0.00

HYDROGRAPH AT
          0800       2.   8.07     1.     0.     0.   0.00

2 COMBINED AT
          1.08       3.   8.12     1.     1.     1.   0.01

ROUTED TO
           R08       3.   8.32     1.     1.     1.   0.01

HYDROGRAPH AT
          0702       2.   8.00     1.     0.     0.   0.00

ROUTED TO
         R0702       2.   8.08     1.     0.     0.   0.00

HYDROGRAPH AT
          0701       2.   8.02     1.     0.     0.   0.00

2 COMBINED AT
         P0701       4.   8.05     1.     1.     1.   0.01

ROUTED TO
         R0701       4.   8.08     1.     1.     1.   0.01

HYDROGRAPH AT
          0700       6.   8.02     2.     1.     1.   0.01

3 COMBINED AT
          1.07      12.   8.08     5.     2.     2.   0.03

ROUTED TO
           R07      12.   8.18     5.     2.     2.   0.03

HYDROGRAPH AT
          0602       3.   8.03     1.     1.     1.   0.01

ROUTED TO
         R0602       3.   8.13     1.     1.     1.   0.01

HYDROGRAPH AT
        060101       6.   8.37     3.     1.     1.   0.01

ROUTED TO
        R60101       6.   8.42     3.     1.     1.   0.01

HYDROGRAPH AT
          0601       4.   8.05     1.     1.     1.   0.01

3 COMBINED AT
         P0601      11.   8.17     5.     3.     3.   0.03

ROUTED TO
         R0604      11.   8.23     5.     3.     3.   0.03

HYDROGRAPH AT
          0600       3.   8.00     1.     0.     0.   0.01

3 COMBINED AT
          1.06      25.   8.18    11.     5.     5.   0.06

ROUTED TO
           R06      25.   8.20    11.     5.     5.   0.06

HYDROGRAPH AT
          0501       3.   8.00     1.     1.     1.   0.01

ROUTED TO
         R0501       3.   8.05     1.     1.     1.   0.01

HYDROGRAPH AT
```

```
            0500          3.     8.00         1.         1.        1.      0.01

 3 COMBINED AT
            1.05         30.     8.13        13.         7.        7.      0.07

 ROUTED TO
           R05           30.     8.18        13.         6.        6.      0.07

 HYDROGRAPH AT
            0400          2.     7.97         1.         0.        0.      0.00

 3 COMBINED AT
            1.04        339.     8.22       138.        70.       70.      0.86

 ROUTED TO
           R04          339.     8.23       138.        70.       70.      0.86

 HYDROGRAPH AT
            0303          1.     8.02         0.         0.        0.      0.00
```

```
    ROUTED TO
             R0303          1.     8.07         0.        0.        0.      0.00

    HYDROGRAPH AT
             0302           4.     8.00         1.        1.        1.      0.01

    2 COMBINED AT
             P0302          5.     8.00         2.        1.        1.      0.01

    ROUTED TO
             R0302          5.     8.05         2.        1.        1.      0.01

    HYDROGRAPH AT
             0301           2.     8.05         1.        0.        0.      0.00

    2 COMBINED AT
             P0301          7.     8.05         3.        1.        1.      0.01

    ROUTED TO
             R0301          7.     8.07         3.        1.        1.      0.01

    HYDROGRAPH AT
             0300           1.     8.00         0.        0.        0.      0.00

    3 COMBINED AT
             1.03         345.     8.23       141.       71.       71.      0.88

    ROUTED TO
             R03          344.     8.27       141.       71.       71.      0.88

    HYDROGRAPH AT
             0201           2.     8.02         1.        0.        0.      0.00

    ROUTED TO
             R0201          2.     8.05         1.        0.        0.      0.00

    HYDROGRAPH AT
             010201         1.     8.02         0.        0.        0.      0.00

    3 COMBINED AT
             1.02         346.     8.27       142.       72.       72.      0.89

    ROUTED TO
             R02          346.     8.30       142.       71.       71.      0.89

    HYDROGRAPH AT
             010203        21.     8.00         7.        4.        4.      0.04

    ROUTED TO
             R10203        21.     8.03         7.        4.        4.      0.04

    HYDROGRAPH AT
             010202         1.     8.00         0.        0.        0.      0.00

    ROUTED TO
             R10202         1.     8.03         0.        0.        0.      0.00

    HYDROGRAPH AT
             010201         1.     8.02         0.        0.        0.      0.00

    ROUTED TO
             R10201         1.     8.03         0.        0.        0.      0.00

    HYDROGRAPH AT
             0102           7.     8.07         3.        1.        1.      0.02

    4 COMBINED AT
             P0102         31.     8.05        11.        5.        5.      0.06

    ROUTED TO
             R0102         31.     8.05        11.        5.        5.      0.06

    HYDROGRAPH AT
             0101           2.     8.00         1.        0.        0.      0.00

    3 COMBINED AT
             1.01         368.     8.28       154.       77.       77.
0.95

                              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)

    R406     MANE        0.50   129.84   486.87     2.69      1.00   129.82   487.00      2.69

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5178E+02 EXCESS=0.0000E+00 OUTFLOW=0.5177E+02 BASIN STORAGE=0.3232E-01 PERCENT ERROR=   0.0
```

```
          R405    MANE         0.35   132.51   486.65     2.69     1.00   132.48   487.00      2.59

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5293E+02 EXCESS=0.0000E+00 OUTFLOW=0.5291E+02 BASIN STORAGE=0.2129E-01 PERCENT ERROR=   0.0

          R40401  MANE         1.00     2.99   481.00     3.27     1.00     2.99   481.00      3.27
```

```
                                                              K:\RICKJ\HECPACK\GHEC1\99205301\AREA1\1-00.OUT
 HEC1 S/N: 1343001909          HMVersion: 6.33     Data File: C:\WINDOWS\TEMP\-vbh203A.TMP

****************************************                                                       ****************************************
*                                      *                                                       *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                       *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY   1991              *                                                       *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.0.1E             *                                                       *         609 SECOND STREET            *
*                                      *                                                       *       DAVIS, CALIFORNIA 95616        *
*  RUN DATE  07/21/1999  TIME  10:28:28 *                                                      *          (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



                                ::::::::::::::::::::::::::::::::::::::::::
                                ::::::::::::::::::::::::::::::::::::::::::
                                :::                                    :::
                                :::  Full Microcomputer Implementation :::
                                :::               by                   :::
                                :::        Haestad Methods, Inc.       :::
                                :::                                    :::
                                ::::::::::::::::::::::::::::::::::::::::::
                                ::::::::::::::::::::::::::::::::::::::::::

                       37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666



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

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


                                         HEC-1 INPUT                                                    PAGE  1

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

            1         ID  HVL SWMP - Subasin 1 -  100 Year Storm
            2         IT       1                       1440
            3         IO       5       0

            4         KK  0406
            5         KM  SCS 24 Hour Type IA Rainfall HVLSWMP Node 1.04.06
            6         KO                                              22
            7         BA   .3602
            8         PB     9.5
            9         IN       6
           10         PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
           11         PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
           12         PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
           13         PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
           14         PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
           15         PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
           16         PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
           17         PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
           18         PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
           19         PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
```

```
                  ISAV2          1440  LAST ORDINATE PUNCHED OR SAVED
                 TIMINT         0.017  TIME INTERVAL IN HOURS


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

              **************
              *            *
 1668 KK      *    0101    *
              *            *
              **************

 1670 KO           OUTPUT CONTROL VARIABLES
                       IPRNT            5  PRINT CONTROL
                       IPLOT            0  PLOT CONTROL
                       QSCAL           0.  HYDROGRAPH PLOT SCALE
                       IPNCH            0  PUNCH COMPUTED HYDROGRAPH
                        IOUT           22  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2         1440  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        0.017  TIME INTERVAL IN HOURS


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

              **************
              *            *
 1701 KK      *    1.01    *
              *            *
              **************

 1703 KO           OUTPUT CONTROL VARIABLES
                       IPRNT            5  PRINT CONTROL
                       IPLOT            0  PLOT CONTROL
                       QSCAL           0.  HYDROGRAPH PLOT SCALE
                       IPNCH            0  PUNCH COMPUTED HYDROGRAPH
                        IOUT           22  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2         1440  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        0.017  TIME INTERVAL IN HOURS

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

             OPERATION       STATION      PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN     MAXIMUM     TIME OF
                                          FLOW     PEAK                                              AREA       STAGE     MAX STAGE
                                                    6-HOUR
 24-HOUR       72-HOUR

             HYDROGRAPH AT
                    0406          301.    8.08          109.        54.        54.        0.36

             ROUTED TO
                    R406          301.    8.08          109.        54.        54.        0.36

             HYDROGRAPH AT
                    0405            7.    7.98            2.         1.         1.        0.01

             2 COMBINED AT
                    P405          308.    8.08          111.        56.        56.        0.37

             ROUTED TO
                    R405          308.    8.08          111.        56.        56.        0.37

             HYDROGRAPH AT
                    040401          6.    7.97            2.         1.         1.        0.01

             ROUTED TO
                    R40401          6.    7.98            2.         1.         1.        0.01

             HYDROGRAPH AT
                    040402          8.    7.97            3.         1.         1.        0.01

             ROUTED TO
                    R40402          8.    7.98            3.         1.         1.        0.01

             HYDROGRAPH AT
                    0404           11.    7.98            4.         2.         2.        0.01

             4 COMBINED AT
                    P404          331.    8.08          119.        60.        60.        0.39
```

```
ROUTED TO
           R404      331.    8.15       119.       59.       59.      0.39

HYDROGRAPH AT
           040302     60.    8.00        20.       10.       10.      0.06

ROUTED TO
           40302      60.    8.08        20.       10.       10.      0.06

HYDROGRAPH AT
           0403       75.    8.08        27.       13.       13.      0.08

HYDROGRAPH AT
           040301      8.    8.05         3.        1.        1.      0.01

4 COMBINED AT
           P403      471.    8.13       169.       84.       84.      0.55

ROUTED TO
           R403      469.    8.18       169.       84.       84.      0.55

HYDROGRAPH AT
           040206      7.    7.93         2.        1.        1.      0.01

ROUTED TO
           R40206      7.    8.15         2.        1.        1.      0.01

HYDROGRAPH AT
           040205     32.    8.15        12.        6.        6.      0.03

HYDROGRAPH AT
           420502      0.    0.02         0.        0.        0.      0.01

HYDROGRAPH AT
           420501      1.    7.95         0.        0.        0.      0.00

4 COMBINED AT
           P40205     40.    8.13        15.        7.        7.      0.04

ROUTED TO
           R40205     28.    8.43        14.        7.        7.      0.04

HYDROGRAPH AT
           420401      5.    7.93         2.        1.        1.      0.00

ROUTED TO
           R42401      5.    7.98         2.        1.        1.      0.00

HYDROGRAPH AT
           420402     20.    7.95         6.        3.        3.      0.02

ROUTED TO
           R42402     20.    8.00         6.        3.        3.      0.02

HYDROGRAPH AT
           420403     14.    7.95         4.        2.        2.      0.01

ROUTED TO
           R42402     14.    8.02         4.        2.        2.      0.01

HYDROGRAPH AT
           040204     55.    7.93        18.        9.        9.      0.04

4 COMBINED AT
           P40204     93.    7.97        30.       15.       15.      0.08

ROUTED TO
           R40204     93.    8.07        30.       15.       15.      0.08

HYDROGRAPH AT
           040202      3.    7.95         1.        0.        0.      0.00

ROUTED TO
           R40202      3.    8.08         1.        0.        0.      0.00

HYDROGRAPH AT
           040201     16.    8.10         6.        3.        3.      0.02

ROUTED TO
           R40201     16.    8.22         6.        3.        3.      0.02

HYDROGRAPH AT
           040203     11.    8.05         4.        2.        2.      0.01

ROUTED TO
           R40203     11.    8.17         4.        2.        2.      0.01

HYDROGRAPH AT
           0402       32.    8.40        14.        7.        7.      0.04

7 COMBINED AT
           P402      638.    8.17       237.      118.      118.      0.74

ROUTED TO
```

```
            R402       636.     8.18       237.       118.       118.      0.74

 HYDROGRAPH AT
           410201       11.     7.97         4.         2.         2.      0.01

 HYDROGRAPH AT
           040102       18.     7.97         6.         3.         3.      0.02

 2 COMBINED AT
           P40102       29.     7.97         9.         5.         5.      0.03

 ROUTED TO
           R40102       29.     8.03         9.         5.         5.      0.03

 HYDROGRAPH AT
           040101        4.     7.97         1.         1.         1.      0.00

 ROUTED TO
           R40101        4.     8.00         1.         1.         1.      0.00
```

```
   HYDROGRAPH AT
           0401        16.     8.07        6.        3.        3.      0.02

   4 COMBINED AT
          P0401       679.     8.17      253.      126.      126.      0.78

   ROUTED TO
          R0401       678.     8.17      253.      126.      126.      0.78

   HYDROGRAPH AT
           0802         1.     7.95        0.        0.        0.      0.00

   ROUTED TO
          R0802         1.     8.07        0.        0.        0.      0.00

   HYDROGRAPH AT
           0801         3.     7.95        1.        0.        0.      0.00

   2 COMBINED AT
          P0801         3.     7.98        1.        1.        1.      0.00

   ROUTED TO
          R0801         3.     8.17        1.        1.        1.      0.00

   HYDROGRAPH AT
           0800         4.     8.05        2.        1.        1.      0.00

   2 COMBINED AT
           1.08         7.     8.08        3.        1.        1.      0.01

   ROUTED TO
            R08         7.     8.23        3.        1.        1.      0.01

   HYDROGRAPH AT
           0702         3.     7.95        1.        1.        1.      0.00

   ROUTED TO
          R0702         3.     8.05        1.        1.        1.      0.00

   HYDROGRAPH AT
           0701         5.     8.02        2.        1.        1.      0.00

   2 COMBINED AT
          P0701         8.     8.02        3.        1.        1.      0.01

   ROUTED TO
          R0701         8.     8.05        3.        1.        1.      0.01

   HYDROGRAPH AT
           0700        12.     8.02        4.        2.        2.      0.01

   3 COMBINED AT
           1.07        26.     8.07        9.        5.        5.      0.03

   ROUTED TO
            R07        26.     8.15        9.        5.        5.      0.03

   HYDROGRAPH AT
           0602         6.     8.02        2.        1.        1.      0.01

   ROUTED TO
          R0602         6.     8.10        2.        1.        1.      0.01

   HYDROGRAPH AT
         060101        12.     8.35        5.        3.        3.      0.01

   ROUTED TO
         R60101        12.     8.38        5.        3.        3.      0.01

   HYDROGRAPH AT
           0601         8.     8.03        3.        1.        1.      0.01

   3 COMBINED AT
          P0601        24.     8.15       10.        5.        5.      0.03

   ROUTED TO
          R0604        24.     8.20       10.        5.        5.      0.03

   HYDROGRAPH AT
           0600         5.     7.97        2.        1.        1.      0.01

   3 COMBINED AT
           1.06        53.     8.15       21.       10.       10.      0.06

   ROUTED TO
            R06        53.     8.15       21.       10.       10.      0.06

   HYDROGRAPH AT
           0501         7.     7.98        2.        1.        1.      0.01

   ROUTED TO
          R0501         7.     8.02        2.        1.        1.      0.01

   HYDROGRAPH AT
```

```
           0500          7.     7.97         2.         1.        1.      0.01

 3 COMBINED AT
           1.05         65.     8.10        26.        13.       13.      0.07

 ROUTED TO
           R05          65.     8.13        26.        13.       13.      0.07

 HYDROGRAPH AT
           0400          4.     7.95         1.         1.        1.      0.00

 3 COMBINED AT
           1.04        746.     8.17       280.       139.      139.      0.86

 ROUTED TO
           R04         745.     8.18       280.       139.      139.      0.86

 HYDROGRAPH AT
           0303          3.     8.00         1.         0.        0.      0.00
```

```
                                    K:\RICKJ\HECPACK\GHEC1\99205301\AREA1\1-00.OUT
          ROUTED TO
                R0303          3.     8.03          1.         0.         0.      0.00

          HYDROGRAPH AT
                 0302          8.     7.97          3.         1.         1.      0.01

          2 COMBINED AT
                P0302         11.     7.98          4.         2.         2.      0.01

          ROUTED TO
                R0302         11.     8.02          4.         2.         2.      0.01

          HYDROGRAPH AT
                 0301          4.     8.03          1.         1.         1.      0.00

          2 COMBINED AT
                P0301         15.     8.02          5.         3.         3.      0.01

          ROUTED TO
                R0301         15.     8.05          5.         3.         3.      0.01

          HYDROGRAPH AT
                 0300          3.     7.95          1.         0.         0.      0.00

          3 COMBINED AT
                 1.03        760.     8.18        286.       142.       142.      0.88

          ROUTED TO
                  R03        758.     8.22        286.       142.       142.      0.88

          HYDROGRAPH AT
                 0201          3.     8.00          1.         1.         1.      0.00

          ROUTED TO
                R0201          3.     8.02          1.         1.         1.      0.00

          HYDROGRAPH AT
               010201          3.     8.00          1.         0.         0.      0.00

          3 COMBINED AT
                 1.02        763.     8.22        288.       143.       143.      0.89

          ROUTED TO
                  R02        763.     8.22        288.       143.       143.      0.89

          HYDROGRAPH AT
               010203         44.     7.97         14.         7.         7.      0.04

          ROUTED TO
               R10203         44.     8.00         14.         7.         7.      0.04

          HYDROGRAPH AT
               010202          3.     7.95          1.         0.         0.      0.00

          ROUTED TO
               R10202          3.     8.00          1.         0.         0.      0.00

          HYDROGRAPH AT
               010201          3.     8.00          1.         0.         0.      0.00

          ROUTED TO
               R10201          3.     8.02          1.         0.         0.      0.00

          HYDROGRAPH AT
                 0102         15.     8.05          5.         3.         3.      0.02

          4 COMBINED AT
                P0102         64.     8.02         21.        11.        11.      0.06

          ROUTED TO
                R0102         64.     8.03         21.        11.        11.      0.06

          HYDROGRAPH AT
                 0101          3.     7.95          1.         1.         1.      0.00

          3 COMBINED AT
                 1.01        813.     8.20        311.       154.       154.
 0.95


                              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)

          R406      MANE        0.38    301.37   485.47     5.61    1.00    301.24   485.00      5.62

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1079E+03 EXCESS=0.0000E+00 OUTFLOW=0.1079E+03 BASIN STORAGE=0.4742E-01 PERCENT ERROR=   0.0
```

```
****************************************                                                      ****************************************
*                                      *                                                      *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                      *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY    1991             *                                                      *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.0.1E             *                                                      *         609 SECOND STREET            *
*                                      *                                                      *       DAVIS, CALIFORNIA 95616        *
* RUN DATE  08/14/1999  TIME  07:13:22 *                                                      *           (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


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                                         :::::::::::::::::::::::::::::::::::::::::
                                         :::                                   :::
                                         :::  Full Microcomputer Implementation :::
                                         :::                by                 :::
                                         :::        Haestad Methods, Inc.      :::
                                         :::                                   :::
                                         :::::::::::::::::::::::::::::::::::::::::
                                         :::::::::::::::::::::::::::::::::::::::::

                        37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

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


                                          HEC-1 INPUT                                                PAGE  1

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

          1          ID  HVL SWMP Node 1.09 10 Year Storm
          2          IT       1                 1440
          3          IO       5       0

          4          KK  0901
          5          KM  SCS 24 Hour Type IA Rainfall HVLSWMP Node 1.09.01 10  Year Storm
          6          KO                                         22
          7          BA  0.0131
          8          PB       6
          9          IN       6
         10          PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
         11          PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
         12          PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
         13          PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
         14          PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
         15          PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
         16          PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
         17          PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
         18          PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
         19          PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
         20          PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
         21          PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
                   **************
                   *            *
   41 KK           *    0900    *
                   *            *
                   **************

   43 KO                OUTPUT CONTROL VARIABLES
                             IPRNT          5  PRINT CONTROL
                             IPLOT          0  PLOT CONTROL
                             QSCAL         0.  HYDROGRAPH PLOT SCALE
                             IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                              IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                             ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                             ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                            TIMINT      0.017  TIME INTERVAL IN HOURS


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

                   **************
                   *            *
   74 KK           *    1.09    *
                   *            *
                   **************

   76 KO                OUTPUT CONTROL VARIABLES
                             IPRNT          5  PRINT CONTROL
                             IPLOT          0  PLOT CONTROL
                             QSCAL         0.  HYDROGRAPH PLOT SCALE
                             IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                              IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                             ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                             ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                            TIMINT      0.017  TIME INTERVAL IN HOURS


                                                  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
                  0901          7.    8.00          2.          1.          1.       0.01

        ROUTED TO
                 R0901          7.    8.02          2.          1.          1.       0.01

        HYDROGRAPH AT
                  0900          9.    8.00          3.          2.          2.       0.02

        2 COMBINED AT
                  1.09         15.    8.02          5.          3.          3.       0.03


                                      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)

          R0901     MANE       1.00      6.62     482.00      3.26       1.00      6.62     482.00      3.26


CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2285E+01 EXCESS=0.0000E+00 OUTFLOW=0.2280E+01 BASIN STORAGE=0.5249E-02 PERCENT ERROR=   0.0


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

```
                                                         K:\RICKJ\GHEC1\99205301\AREA1\1-09.OUT
HEC1 S/N: 1343001909          HMVersion: 6.33      Data File: C:\WINDOWS\TEMP\-vbh2534.TMP

*****************************************                                                ****************************************
*                                       *                                                *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY  1991                *                                                *   HYDROLOGIC ENGINEERING CENTER      *
*            VERSION 4.0.1E             *                                                *         609 SECOND STREET            *
*                                       *                                                *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE  08/14/1999  TIME  07:15:39 *                                                *          (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


                                     ::::::::::::::::::::::::::::::::::::::::::
                                     ::::::::::::::::::::::::::::::::::::::::::
                                     :::                                    :::
                                     :::  Full Microcomputer Implementation :::
                                     :::                by                  :::
                                     :::         Haestad Methods, Inc.      :::
                                     :::                                    :::
                                     ::::::::::::::::::::::::::::::::::::::::::
                                     ::::::::::::::::::::::::::::::::::::::::::

                           37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

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


                                                         HEC-1 INPUT                                              PAGE  1

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

                   1         ID  HVL SWMP Node 1.09 100 Year Storm
                   2         IT       1                    1440
                   3         IO       5       0

                   4         KK  0901
                   5         KM  SCS 24 Hour Type IA Rainfall HVLSWMP Node 1.09.01 100 Year Storm
                   6         KO                                        22
                   7         BA  0.0131
                   8         PB     9.5
                   9         IN       6
                  10         PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
                  11         PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
                  12         PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
                  13         PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
                  14         PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
                  15         PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
                  16         PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
                  17         PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
                  18         PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
                  19         PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
                  20         PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
                  21         PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
                 **************
                 *            *
  41 KK          *    0900    *
                 *            *
                 **************

  43 KO            OUTPUT CONTROL VARIABLES
                        IPRNT          5  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                         IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT      0.017  TIME INTERVAL IN HOURS


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

                 **************
                 *            *
  74 KK          *    1.09    *
                 *            *
                 **************

  76 KO            OUTPUT CONTROL VARIABLES
                        IPRNT          5  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                         IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT      0.017  TIME INTERVAL IN HOURS

                                                    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
                  0901            14.     7.97          4.           2.           2.       0.01

           ROUTED TO
                 R0901            14.     7.98          4.           2.           2.       0.01

           HYDROGRAPH AT
                  0900            19.     7.97          6.           3.           3.       0.02

           2 COMBINED AT
                  1.09            32.     7.98         11.           5.           5.       0.03

                                        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)

            R0901     MANE         1.00      13.68     479.00        6.38      1.00      13.68    479.00        6.38

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.4466E+01 EXCESS=0.0000E+00 OUTFLOW=0.4459E+01 BASIN STORAGE=0.7869E-02 PERCENT ERROR=    0.0


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

```
                                                  K:\RICKJ\GHEC1\99205301\AREA2\2-00.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33    Data File: C:\WINDOWS\TEMP\-vbh0D08.TMP

*****************************************                                      *****************************************
*                                       *                                      *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                      *   U.S. ARMY CORPS OF ENGINEERS        *
*               MAY   1991              *                                      *   HYDROLOGIC ENGINEERING CENTER       *
*           VERSION 4.0.1E              *                                      *         609 SECOND STREET             *
*                                       *                                      *       DAVIS, CALIFORNIA 95616         *
*  RUN DATE  07/27/1999  TIME  12:09:05 *                                      *         (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


                                     :::::::::::::::::::::::::::::::::::::::::::
                                     :::::::::::::::::::::::::::::::::::::::::::
                                     :::                                     :::
                                     :::  Full Microcomputer Implementation  :::
                                     :::                 by                  :::
                                     :::         Haestad Methods, Inc.       :::
                                     :::                                     :::
                                     :::::::::::::::::::::::::::::::::::::::::::
                                     :::::::::::::::::::::::::::::::::::::::::::

                          37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666



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

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


                                               HEC-1 INPUT                                                PAGE  1

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

             1          ID  HVL SWMP - Subbasin 2 - 10 Year Storm
             2          IT       1                       1440
             3          IO       5       0

             4          KK  021222
             5          KM  SCS 24 Hour Type IA Rainfall  Subbasin 2.02.01.02.02.02
             6          KO                                               22
             7          BA   .0255
             8          PB       6
             9          IN       6
            10          PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
            11          PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
            12          PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
            13          PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
            14          PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
            15          PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
            16          PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
            17          PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
            18          PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
            19          PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  800 KK      *    R01     *
              *            *
              **************

  802 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                         IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       0.017  TIME INTERVAL IN HOURS


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

              **************
              *            *
  804 KK      *    2.0     *
              *            *
              **************

  806 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                         IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       0.017  TIME INTERVAL IN HOURS


     *** WARNING ***   UNIT HYDROGRAPH TRUNCATED FROM 369 TO 300 INTERVALS

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

              **************
              *            *
  837 KK      *    2.0     *
              *            *
              **************

  839 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                         IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       0.017  TIME INTERVAL IN HOURS


                                                   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
                    021222        17.     7.97         6.        3.        3.      0.03
```

```
 ROUTED TO
           R21222         17.     7.97          6.          3.          3.        0.03

 HYDROGRAPH AT
           021221          0.     7.92          0.          0.          0.        0.00

 2 COMBINED AT
           021221         17.     7.97          6.          3.          3.        0.03

 ROUTED TO
           R21221         17.     7.97          6.          3.          3.        0.03

 HYDROGRAPH AT
           02123          10.     7.95          3.          2.          2.        0.01

 ROUTED TO
           R02123         10.     7.95          3.          2.          2.        0.01

 HYDROGRAPH AT
           02122           1.     7.95          0.          0.          0.        0.00

 3 COMBINED AT
           02122p         28.     7.97          9.          5.          5.        0.04

 ROUTED TO
           R02122         28.     7.97          9.          5.          5.        0.04

 HYDROGRAPH AT
           02121           1.     7.95          0.          0.          0.        0.00

 2 COMBINED AT
           02121p         29.     7.97         10.          5.          5.        0.04

 ROUTED TO
           R02121         29.     7.98         10.          5.          5.        0.04

 HYDROGRAPH AT
           0215            2.     7.95          1.          0.          0.        0.00

 ROUTED TO
           R0215           2.     7.95          1.          0.          0.        0.00

 HYDROGRAPH AT
           020104          1.     7.95          0.          0.          0.        0.00

 2 COMBINED AT
           0214p           3.     7.95          1.          0.          0.        0.00

 ROUTED TO
           R0214           3.     7.98          1.          0.          0.        0.00

 HYDROGRAPH AT
           0213            9.     7.95          3.          1.          1.        0.01

 2 COMBINED AT
           0213p          12.     7.97          4.          2.          2.        0.02

 ROUTED TO
           R0213          12.     7.98          4.          2.          2.        0.02

 HYDROGRAPH AT
           0212            5.     7.95          2.          1.          1.        0.01

 3 COMBINED AT
           0212p          47.     7.98         15.          8.          8.        0.07

 ROUTED TO
           R0212          47.     7.98         15.          8.          8.        0.07

 HYDROGRAPH AT
           0211            6.     7.97          2.          1.          1.        0.01

 2 COMBINED AT
           0211p          53.     7.98         17.          9.          9.        0.08

 ROUTED TO
           R0211          53.     8.02         17.          9.          9.        0.08

 HYDROGRAPH AT
           0225           11.     8.10          4.          2.          2.        0.02

 ROUTED TO
           R0225          11.     8.12          4.          2.          2.        0.02

 HYDROGRAPH AT
           0224            3.     8.00          1.          0.          0.        0.01

 2 COMBINED AT
           0224p          13.     8.07          5.          2.          2.        0.03

 ROUTED TO
           R0224          13.     8.10          5.          2.          2.        0.03

 HYDROGRAPH AT
```

```
             0223        1.    8.00        0.      0.      0.     0.00
   2 COMBINED AT
             0223p      14.    8.08        5.      3.      3.     0.03
   ROUTED TO
             R0223      14.    8.08        5.      3.      3.     0.03
   HYDROGRAPH AT
             0222        1.    7.98        0.      0.      0.     0.00
   2 COMBINED AT
             0222p      15.    8.08        6.      3.      3.     0.03
   ROUTED TO
             R0222      15.    8.28        6.      3.      3.     0.03
   HYDROGRAPH AT
             0221       10.    8.22        4.      2.      2.     0.02
```

```
 2 COMBINED AT
         0221p        25.    8.27        10.         5.         5.       0.06

 ROUTED TO
         R0221        25.    8.28        10.         5.         5.       0.06

 HYDROGRAPH AT
         02413         1.    7.95         0.         0.         0.       0.00

 ROUTED TO
         R02413        1.    7.95         0.         0.         0.       0.00

 HYDROGRAPH AT
         02412         1.    7.95         0.         0.         0.       0.00

 ROUTED TO
         R02412        1.    8.03         0.         0.         0.       0.00

 HYDROGRAPH AT
         02411         2.    7.95         1.         0.         0.       0.00

 ROUTED TO
         R02411        2.    7.98         1.         0.         0.       0.00

 HYDROGRAPH AT
         0241         21.    8.10         8.         4.         4.       0.03

 4 COMBINED AT
         0241p        25.    8.08         9.         4.         4.       0.04

 ROUTED TO
         R241         25.    8.12         9.         4.         4.       0.04

 HYDROGRAPH AT
         025           9.    7.95         3.         1.         1.       0.01

 ROUTED TO
         R025          9.    7.97         3.         1.         1.       0.01

 HYDROGRAPH AT
         024          11.    8.00         4.         2.         2.       0.02

 3 COMBINED AT
         024p         43.    8.05        15.         8.         8.       0.07

 ROUTED TO
         R024         43.    8.07        15.         8.         8.       0.07

 HYDROGRAPH AT
         023          14.    8.05         5.         2.         2.       0.02

 2 COMBINED AT
         023p         58.    8.07        20.        10.        10.       0.09

 ROUTED TO
         R023         57.    8.10        20.        10.        10.       0.09

 HYDROGRAPH AT
         022          10.    8.13         4.         2.         2.       0.02

 3 COMBINED AT
         022p         89.    8.13        34.        17.        17.       0.17

 ROUTED TO
         R022         88.    8.18        34.        17.        17.       0.17

 HYDROGRAPH AT
         021           8.    8.00         3.         1.         1.       0.01

 3 COMBINED AT
         021p        143.    8.10        53.        27.        27.       0.26

 ROUTED TO
         R021        143.    8.12        53.        27.        27.       0.26

 HYDROGRAPH AT
         2.04          4.    7.98         1.         1.         1.       0.01

 ROUTED TO
         R04           4.    8.00         1.         1.         1.       0.01

 HYDROGRAPH AT
         2.03          9.    7.97         3.         2.         2.       0.02

 2 COMBINED AT
         2.03         13.    7.98         4.         2.         2.       0.02

 ROUTED TO
         R03          13.    8.65         4.         2.         2.       0.02

 HYDROGRAPH AT
         2.02          4.    8.07         2.         1.         1.       0.01

 3 COMBINED AT
```

```
          2.02        150.    8.12         59.        30.        30.       0.29
   ROUTED TO
          R02         146.    8.27         59.        29.        29.       0.29
   HYDROGRAPH AT
          01172         2.    7.95          1.         0.         0.       0.00
   ROUTED TO
          R01172        2.    7.97          1.         0.         0.       0.00
   HYDROGRAPH AT
          01171         8.    7.95          3.         1.         1.       0.01
   2 COMBINED AT
          01171p       10.    7.97          3.         2.         2.       0.01
   ROUTED TO
          R01171       10.    7.98          3.         2.         2.       0.01
```

```
HYDROGRAPH AT
            0118          4.     7.97          1.          1.          1.       0.01

ROUTED TO
           R0118          4.     7.98          1.          1.          1.       0.01

HYDROGRAPH AT
            0117         13.     7.95          4.          2.          2.       0.02

3 COMBINED AT
           0117p         26.     7.97          8.          4.          4.       0.04

ROUTED TO
           R0117         26.     7.98          8.          4.          4.       0.04

HYDROGRAPH AT
            0116          1.     7.95          0.          0.          0.       0.00

2 COMBINED AT
           0116p         27.     7.98          9.          4.          4.       0.04

ROUTED TO
           R0116         27.     7.98          9.          4.          4.       0.04

HYDROGRAPH AT
            0115          0.     7.92          0.          0.          0.       0.00

2 COMBINED AT
           0115p         27.     7.98          9.          4.          4.       0.04

ROUTED TO
           R0115         27.     8.02          9.          4.          4.       0.04

HYDROGRAPH AT
            0114         16.     7.95          5.          3.          3.       0.02

2 COMBINED AT
           0114p         42.     8.00         14.          7.          7.       0.06

ROUTED TO
           R0114         42.     8.07         14.          7.          7.       0.06

HYDROGRAPH AT
            0161          9.     7.95          3.          1.          1.       0.01

ROUTED TO
           R0161          9.     7.97          3.          1.          1.       0.01

HYDROGRAPH AT
             017         12.     7.95          4.          2.          2.       0.02

ROUTED TO
            R017         12.     7.97          4.          2.          2.       0.02

HYDROGRAPH AT
             016          4.     7.95          1.          1.          1.       0.01

3 COMBINED AT
            016p         26.     7.97          8.          4.          4.       0.04

ROUTED TO
            R016         26.     7.97          8.          4.          4.       0.04

HYDROGRAPH AT
             015          6.     7.97          2.          1.          1.       0.01

2 COMBINED AT
            015p         32.     7.97         10.          5.          5.       0.05

ROUTED TO
            R015         32.     7.98         10.          5.          5.       0.05

HYDROGRAPH AT
             014          1.     7.95          0.          0.          0.       0.00

2 COMBINED AT
            014p         33.     7.98         11.          5.          5.       0.05

ROUTED TO
            R014         33.     7.98         11.          5.          5.       0.05

HYDROGRAPH AT
             013          3.     7.97          1.          0.          0.       0.00

2 COMBINED AT
            013p         36.     7.98         12.          6.          6.       0.05

ROUTED TO
            R013         36.     8.00         12.          6.          6.       0.05

HYDROGRAPH AT
            0122          1.     8.00          0.          0.          0.       0.00
```

```
              R0122            1.     8.00          0.         0.        0.       0.00

        HYDROGRAPH AT
             0121              1.     7.98          0.         0.        0.       0.00

        2 COMBINED AT
             0121p             2.     8.00          1.         0.        0.       0.00

        ROUTED TO
              R0121            2.     8.00          1.         0.        0.       0.00

        HYDROGRAPH AT
             012               5.     7.97          2.         1.        1.       0.01

        3 COMBINED AT
             012p             43.     8.00         14.         7.        7.       0.06

        ROUTED TO
             R012             42.     8.13         14.         7.        7.       0.06
```

```
          HYDROGRAPH AT
                  0113         2.     8.00         1.         0.         0.       0.00

          ROUTED TO
                 R0113         2.     8.02         1.         0.         0.       0.00

          HYDROGRAPH AT
                  0112         2.     8.00         1.         0.         0.       0.00

          2 COMBINED AT
                 0112p         4.     8.00         1.         1.         1.       0.01

          ROUTED TO
                 R0112         4.     8.00         1.         1.         1.       0.01

          HYDROGRAPH AT
                  0111         1.     7.98         0.         0.         0.       0.00

          2 COMBINED AT
                 0111p         5.     8.00         2.         1.         1.       0.01

          ROUTED TO
                 R0111         5.     8.07         2.         1.         1.       0.01

          HYDROGRAPH AT
                   011         3.     7.97         1.         1.         1.       0.01

          4 COMBINED AT
                  011p        91.     8.08        31.        15.        15.       0.14

          ROUTED TO
                   R11        91.     8.13        31.        15.        15.       0.14

          HYDROGRAPH AT
                  2.01        23.     8.10         8.         4.         4.       0.04

          3 COMBINED AT
                  2.01       254.     8.20        98.        48.        48.       0.47

          ROUTED TO
                   R01       253.     8.23        98.        48.        48.       0.47

          HYDROGRAPH AT
                   2.0       201.     9.32       131.        65.        65.       0.83

          2 COMBINED AT
                   2.0       351.     8.30       226.       114.       114.
 1.30

                                      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)

           R21222     MANE          0.20      17.04    477.78      4.08       1.00      17.04    478.00         4.08

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5545E+01 EXCESS=0.0000E+00 OUTFLOW=0.5544E+01 BASIN STORAGE=0.9749E-03 PERCENT ERROR=   0.0

           R21221     MANE          0.19      17.34    478.04      4.08       1.00      17.34    478.00         4.08

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5641E+01 EXCESS=0.0000E+00 OUTFLOW=0.5640E+01 BASIN STORAGE=0.9423E-03 PERCENT ERROR=   0.0

           R02123     MANE          0.22       9.98    477.39      4.26       1.00       9.98    477.00         4.26

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.3224E+01 EXCESS=0.0000E+00 OUTFLOW=0.3223E+01 BASIN STORAGE=0.6157E-03 PERCENT ERROR=   0.0

           R02122     MANE          0.18      28.37    478.02      4.15       1.00      28.37    478.00         4.15

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.9205E+01 EXCESS=0.0000E+00 OUTFLOW=0.9204E+01 BASIN STORAGE=0.1500E-02 PERCENT ERROR=   0.0

           R02121     MANE          1.00      29.28    479.00      4.15       1.00      29.28    479.00         4.15

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.9502E+01 EXCESS=0.0000E+00 OUTFLOW=0.9488E+01 BASIN STORAGE=0.1569E-01 PERCENT ERROR=   0.0

           R0215      MANE          0.39       2.21    477.56      4.19       1.00       2.21    478.00         4.19

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.7157E+00 EXCESS=0.0000E+00 OUTFLOW=0.7154E+00 BASIN STORAGE=0.2385E-03 PERCENT ERROR=   0.0
```

```
HEC1 S/N: 1343001909        HMVersion: 6.33        K:\RICKJ\GHEC1\99205301\AREA2\2-YEAR25.OUT
                                                   Data File: C:\WINDOWS\TEMP\-vbh003B.TMP

****************************************                                  ****************************************
*                                      *                                  *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                  *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY   1991              *                                  *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.0.1E             *                                  *        609 SECOND STREET             *
*                                      *                                  *     DAVIS, CALIFORNIA 95616          *
*  RUN DATE  09/29/1999  TIME  10:06:29 *                                 *         (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


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                              :::::::::::::::::::::::::::::::::::::::::::
                              :::                                     :::
                              :::  Full Microcomputer Implementation  :::
                              :::                 by                  :::
                              :::         Haestad Methods, Inc.       :::
                              :::                                     :::
                              :::::::::::::::::::::::::::::::::::::::::::
                              :::::::::::::::::::::::::::::::::::::::::::

                      37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

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


                                     HEC-1 INPUT                                              PAGE  1

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

   1           ID  HVL SWMP - Subbasin 2 - 25 Year Storm
   2           IT       1                   1440
   3           IO       5       0

   4           KK  021222
   5           KM  SCS 24 Hour Type IA Rainfall  Subbasin 2.02.01.02.02.02
   6           KO                                        22
   7           BA   .0255
   8           PB       7
   9           IN       6
  10           PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
  11           PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
  12           PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
  13           PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
  14           PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
  15           PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
  16           PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
  17           PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
  18           PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
  19           PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
  20           PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
  21           PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

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                  **************
                  *            *
 871 KK           *    2.0     *
                  *            *
                  **************

 873 KO             OUTPUT CONTROL VARIABLES
                        IPRNT          5  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                         IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT      0.017  TIME INTERVAL IN HOURS


                                                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
                  021222          21.     7.95          7.          3.          3.        0.03

           ROUTED TO
                  R21222          21.     7.95          7.          3.          3.        0.03

           HYDROGRAPH AT
                  021221           0.     7.92          0.          0.          0.        0.00

           2 COMBINED AT
                  021221          21.     7.95          7.          3.          3.        0.03

           ROUTED TO
                  R21221          21.     7.95          7.          3.          3.        0.03

           HYDROGRAPH AT
                   02123          12.     7.95          4.          2.          2.        0.01

           ROUTED TO
                  R02123          12.     7.95          4.          2.          2.        0.01

           HYDROGRAPH AT
                   02122           1.     7.95          0.          0.          0.        0.00

           3 COMBINED AT
                  02122p          35.     7.95         11.          6.          6.        0.04

           ROUTED TO
                  R02122          35.     7.95         11.          6.          6.        0.04

           HYDROGRAPH AT
                   02121           1.     7.95          0.          0.          0.        0.00

           2 COMBINED AT
                  02121p          36.     7.95         12.          6.          6.        0.04

           ROUTED TO
                  R02121          36.     7.98         12.          6.          6.        0.04

           HYDROGRAPH AT
                    0215           3.     7.95          1.          0.          0.        0.00

           ROUTED TO
                   R0215           3.     7.95          1.          0.          0.        0.00

           HYDROGRAPH AT
                  020104           1.     7.95          0.          0.          0.        0.00

           2 COMBINED AT
                   0214p           4.     7.95          1.          1.          1.        0.00

           ROUTED TO
                   R0214           4.     7.98          1.          1.          1.        0.00

           HYDROGRAPH AT
                    0213          11.     7.95          4.          2.          2.        0.01

           2 COMBINED AT
                   0213p          15.     7.95          5.          2.          2.        0.02

           ROUTED TO
                   R0213          15.     7.97          5.          2.          2.        0.02

           HYDROGRAPH AT
                    0212           7.     7.95          2.          1.          1.        0.01

           3 COMBINED AT
                   0212p          57.     7.98         19.          9.          9.        0.07
```

```
ROUTED TO
       R0212         57.    7.98        19.        9.        9.      0.07

HYDROGRAPH AT
       0211           8.    7.95         3.        1.        1.      0.01

2 COMBINED AT
       0211p         65.    7.98        21.       11.       11.      0.08
```

```
ROUTED TO
      R0211          65.     8.02         21.         11.         11.         0.08

HYDROGRAPH AT
      0225           14.     8.10          5.          3.          3.         0.02

ROUTED TO
      R0225          14.     8.12          5.          3.          3.         0.02

HYDROGRAPH AT
      0224            3.     7.98          1.          1.          1.         0.01

2 COMBINED AT
      0224p          17.     8.07          6.          3.          3.         0.03

ROUTED TO
      R0224          17.     8.10          6.          3.          3.         0.03

HYDROGRAPH AT
      0223            2.     7.97          1.          0.          0.         0.00

2 COMBINED AT
      0223p          18.     8.07          7.          3.          3.         0.03

ROUTED TO
      R0223          18.     8.08          7.          3.          3.         0.03

HYDROGRAPH AT
      0222            1.     7.97          0.          0.          0.         0.00

2 COMBINED AT
      0222p          19.     8.07          7.          4.          4.         0.03

ROUTED TO
      R0222          19.     8.27          7.          4.          4.         0.03

HYDROGRAPH AT
      0221           13.     8.20          5.          3.          3.         0.02

2 COMBINED AT
      0221p          32.     8.23         12.          6.          6.         0.06

ROUTED TO
      R0221          32.     8.27         12.          6.          6.         0.06

HYDROGRAPH AT
      02413           1.     7.95          0.          0.          0.         0.00

ROUTED TO
      R02413          1.     7.95          0.          0.          0.         0.00

HYDROGRAPH AT
      02412           2.     7.95          1.          0.          0.         0.00

ROUTED TO
      R02412          2.     8.02          1.          0.          0.         0.00

HYDROGRAPH AT
      02411           2.     7.95          1.          0.          0.         0.00

ROUTED TO
      R02411          2.     7.97          1.          0.          0.         0.00

HYDROGRAPH AT
      0241           26.     8.10          9.          5.          5.         0.03

4 COMBINED AT
      0241p          31.     8.07         11.          5.          5.         0.04

ROUTED TO
      R241           31.     8.10         11.          5.          5.         0.04

HYDROGRAPH AT
      025            11.     7.95          3.          2.          2.         0.01

ROUTED TO
      R025           11.     7.95          3.          2.          2.         0.01

HYDROGRAPH AT
      024            13.     8.00          4.          2.          2.         0.02

3 COMBINED AT
      024p           54.     8.05         19.          9.          9.         0.07

ROUTED TO
      R024           54.     8.07         19.          9.          9.         0.07

HYDROGRAPH AT
      023            18.     8.05          6.          3.          3.         0.02

2 COMBINED AT
      023p           72.     8.07         25.         12.         12.         0.09

ROUTED TO
      R023           71.     8.10         25.         12.         12.         0.09
```

```
             022          13.    8.13        5.         2.         2.       0.02

         3 COMBINED AT
             022p        112.    8.13       42.        21.        21.       0.17

         ROUTED TO
             R022        112.    8.17       42.        21.        21.       0.17

         HYDROGRAPH AT
             021          10.    8.00        3.         2.         2.       0.01

         3 COMBINED AT
             021p        181.    8.10       66.        33.        33.       0.26

         ROUTED TO
             R021        180.    8.12       66.        33.        33.       0.26

         HYDROGRAPH AT
             2.04          5.    7.97        2.         1.         1.       0.01
```

```
ROUTED TO
       R04          5.    7.98         2.         1.         1.       0.01

HYDROGRAPH AT
       2.03        12.    7.97         4.         2.         2.       0.02

HYDROGRAPH AT
       WS4       2752.    8.25      1277.       638.       638.       5.22

3 COMBINED AT
       2.03      2762.    8.25      1283.       641.       641.       5.24

ROUTED TO
       R03       2749.    8.33      1282.       637.       637.       5.24

HYDROGRAPH AT
       2.02         5.    8.07         2.         1.         1.       0.01

3 COMBINED AT
       2.02      2902.    8.32      1350.       671.       671.       5.51

ROUTED TO
       R02       2892.    8.37      1350.       668.       668.       5.51

HYDROGRAPH AT
       01172        2.    7.95         1.         0.         0.       0.00

ROUTED TO
       R01172       2.    7.97         1.         0.         0.       0.00

HYDROGRAPH AT
       01171        9.    7.95         3.         2.         2.       0.01

2 COMBINED AT
       01171p      12.    7.95         4.         2.         2.       0.01

ROUTED TO
       R01171      12.    7.97         4.         2.         2.       0.01

HYDROGRAPH AT
       0118         4.    7.95         1.         1.         1.       0.01

ROUTED TO
       R0118        4.    7.98         1.         1.         1.       0.01

HYDROGRAPH AT
       0117        16.    7.95         5.         3.         3.       0.02

3 COMBINED AT
       0117p       32.    7.97        10.         5.         5.       0.04

ROUTED TO
       R0117       32.    7.97        10.         5.         5.       0.04

HYDROGRAPH AT
       0116         1.    6.63         0.         0.         0.       0.00

2 COMBINED AT
       0116p       32.    7.97        11.         5.         5.       0.04

ROUTED TO
       R0116       32.    7.97        11.         5.         5.       0.04

HYDROGRAPH AT
       0115         0.    6.60         0.         0.         0.       0.00

2 COMBINED AT
       0115p       32.    7.97        11.         5.         5.       0.04

ROUTED TO
       R0115       32.    8.00        11.         5.         5.       0.04

HYDROGRAPH AT
       0114        23.    6.65         7.         3.         3.       0.02

2 COMBINED AT
       0114p       38.    8.00        18.         9.         9.       0.06

ROUTED TO
       R0114       38.    8.08        18.         8.         8.       0.06

HYDROGRAPH AT
       0161        13.    6.65         4.         2.         2.       0.01

ROUTED TO
       R0161       13.    6.65         4.         2.         2.       0.01

HYDROGRAPH AT
       017         15.    7.95         5.         2.         2.       0.02

ROUTED TO
       R017        15.    7.97         5.         2.         2.       0.02

HYDROGRAPH AT
       016          6.    7.95         2.         1.         1.       0.01

3 COMBINED AT
```

```
             016p          24.    7.95        11.        5.        5.      0.04
    ROUTED TO
             R016          24.    7.95        11.        5.        5.      0.04
    HYDROGRAPH AT
             015            8.    7.95         3.        1.        1.      0.01
    2 COMBINED AT
             015p          32.    7.95        13.        6.        6.      0.05
    ROUTED TO
             R015          32.    7.97        13.        6.        6.      0.05
    HYDROGRAPH AT
             014            1.    7.95         0.        0.        0.      0.00
    2 COMBINED AT
             014p          33.    7.97        14.        7.        7.      0.05
```

```
 ROUTED TO
         R014           33.    7.97          14.          7.          7.       0.05

 HYDROGRAPH AT
         013             4.    7.95           1.          1.          1.       0.00

 2 COMBINED AT
         013p           37.    7.97          15.          7.          7.       0.05

 ROUTED TO
         R013           37.    7.98          15.          7.          7.       0.05

 HYDROGRAPH AT
         0122            2.    7.97           1.          0.          0.       0.00

 ROUTED TO
         R0122           2.    7.98           1.          0.          0.       0.00

 HYDROGRAPH AT
         0121            1.    7.97           0.          0.          0.       0.00

 2 COMBINED AT
         0121p           3.    7.98           1.          0.          0.       0.00

 ROUTED TO
         R0121           3.    8.00           1.          0.          0.       0.00

 HYDROGRAPH AT
         012             6.    7.97           2.          1.          1.       0.01

 3 COMBINED AT
         012p           45.    7.98          17.          9.          9.       0.06

 ROUTED TO
         R012           45.    8.12          17.          9.          9.       0.06

 HYDROGRAPH AT
         0113            3.    7.98           1.          0.          0.       0.00

 ROUTED TO
         R0113           3.    8.00           1.          0.          0.       0.00

 HYDROGRAPH AT
         0112            2.    7.98           1.          0.          0.       0.00

 2 COMBINED AT
         0112p           5.    8.00           2.          1.          1.       0.01

 ROUTED TO
         R0112           5.    8.00           2.          1.          1.       0.01

 HYDROGRAPH AT
         0111            1.    7.97           0.          0.          0.       0.00

 2 COMBINED AT
         0111p           6.    8.00           2.          1.          1.       0.01

 ROUTED TO
         R0111           6.    8.05           2.          1.          1.       0.01

 HYDROGRAPH AT
         011             4.    7.97           1.          1.          1.       0.01

 4 COMBINED AT
         011p           93.    8.08          38.         19.         19.       0.14

 ROUTED TO
         R11            92.    8.13          38.         19.         19.       0.14

 HYDROGRAPH AT
         2.01           28.    8.10          10.          5.          5.       0.04

 3 COMBINED AT
         2.01         2986.    8.35        1395.        692.        692.       5.69

 ROUTED TO
         R01          2985.    8.37        1395.        691.        691.       5.69

 HYDROGRAPH AT
         2.0           266.    9.28         169.         83.         83.       0.83

 2 COMBINED AT
         2.0          3143.    8.38        1561.        775.        775.       6.52

                               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)

   R21222   MANE         0.19      21.13    477.31      5.01      1.00    21.13    477.00       5.01

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.6815E+01 EXCESS=0.0000E+00 OUTFLOW=0.6814E+01 BASIN STORAGE=0.1106E-02 PERCENT ERROR=   0.0
```

```
 HEC1 S/N: 1343001909         HMVersion: 6.33     K:\RICKJ\GHEC1\99205301\AREA2\2-YR100.OUT
                                                Data File: C:\WINDOWS\TEMP\-vbh364E.TMP

 *****************************************                                                                   *****************************************
 *                                       *                                                                   *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                                   *   U.S. ARMY CORPS OF ENGINEERS        *
 *             MAY   1991                *                                                                   *   HYDROLOGIC ENGINEERING CENTER       *
 *          VERSION 4.0.1E               *                                                                   *         609 SECOND STREET             *
 *                                       *                                                                   *       DAVIS, CALIFORNIA 95616         *
 * RUN DATE  09/29/1999  TIME  13:17:13  *                                                                   *          (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


                                           ::::::::::::::::::::::::::::::::::::::::
                                           ::::::::::::::::::::::::::::::::::::::::
                                           :::                                  :::
                                           :::  Full Microcomputer Implementation  :::
                                           :::                by                :::
                                           :::       Haestad Methods, Inc.      :::
                                           :::                                  :::
                                           ::::::::::::::::::::::::::::::::::::::::
                                           ::::::::::::::::::::::::::::::::::::::::

                                  37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

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


                                                     HEC-1 INPUT                                                      PAGE  1

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

                 1            ID  HVL SWMP - Subbasin 2 - 100 Year Storm
                 2            IT       1                       1440
                 3            IO       5       0

                 4            KK  021222
                 5            KM  SCS 24 Hour Type IA Rainfall  Subbasin 2.02.01.02.02.02
                 6            KO                                      22
                 7            BA   .0255
                 8            PB     9.5
                 9            IN       6
                10            PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
                11            PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
                12            PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
                13            PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
                14            PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
                15            PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
                16            PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
                17            PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
                18            PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
                19            PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
                20            PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
                21            PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
                              K:\RICKJ\GHEC1\99205301\AREA2\2-YR100.OUT
                            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
        021222          31.    7.95          10.          5.            5.        0.03

ROUTED TO
        R21222          31.    7.95          10.          5.            5.        0.03

HYDROGRAPH AT
        021221           1.    7.92           0.          0.            0.        0.00

2 COMBINED AT
        021221          32.    7.95          10.          5.            5.        0.03

ROUTED TO
        R21221          32.    7.95          10.          5.            5.        0.03

HYDROGRAPH AT
         02123          18.    7.93           6.          3.            3.        0.01

ROUTED TO
        R02123          18.    7.95           6.          3.            3.        0.01

HYDROGRAPH AT
         02122           2.    7.93           1.          0.            0.        0.00

3 COMBINED AT
        02122p          52.    7.95          17.          8.            8.        0.04

ROUTED TO
        R02122          52.    7.95          17.          8.            8.        0.04

HYDROGRAPH AT
         02121           2.    7.93           1.          0.            0.        0.00

2 COMBINED AT
        02121p          54.    7.95          17.          9.            9.        0.04

ROUTED TO
        R02121          53.    7.97          17.          9.            9.        0.04

HYDROGRAPH AT
          0215           4.    7.93           1.          1.            1.        0.00

ROUTED TO
         R0215           4.    7.95           1.          1.            1.        0.00

HYDROGRAPH AT
        020104           1.    7.93           0.          0.            0.        0.00

2 COMBINED AT
         0214p           5.    7.95           2.          1.            1.        0.00

ROUTED TO
         R0214           5.    7.97           2.          1.            1.        0.00

HYDROGRAPH AT
          0213          16.    7.93           5.          3.            3.        0.01

2 COMBINED AT
         0213p          21.    7.95           7.          3.            3.        0.02

ROUTED TO
         R0213          21.    7.95           7.          3.            3.        0.02

HYDROGRAPH AT
          0212          10.    7.95           3.          2.            2.        0.01

3 COMBINED AT
         0212p          85.    7.97          28.         14.           14.        0.07

ROUTED TO
         R0212          85.    7.97          28.         14.           14.        0.07

HYDROGRAPH AT
          0211          12.    7.95           4.          2.            2.        0.01

2 COMBINED AT
         0211p          96.    7.97          31.         16.           16.        0.08

ROUTED TO
         R0211          96.    8.00          31.         16.           16.        0.08

HYDROGRAPH AT
          0225          22.    8.08           8.          4.            4.        0.02

ROUTED TO
         R0225          22.    8.10           8.          4.            4.        0.02

HYDROGRAPH AT
          0224           5.    7.97           2.          1.            1.        0.01
```

```
             0224p        27.    8.07        10.        5.        5.      0.03
   ROUTED TO
             R0224        27.    8.08        10.        5.        5.      0.03
   HYDROGRAPH AT
             0223          3.    7.95         1.        0.        0.      0.00
   2 COMBINED AT
             0223p        30.    8.07        11.        5.        5.      0.03
   ROUTED TO
             R0223        30.    8.07        11.        5.        5.      0.03
   HYDROGRAPH AT
             0222          2.    7.95         1.        0.        0.      0.00
   2 COMBINED AT
             0222p        31.    8.07        11.        6.        6.      0.03
```

```
ROUTED TO
          R0222       31.    8.23         11.        6.        6.     0.03

HYDROGRAPH AT
          0221        21.    8.20          8.        4.        4.     0.02

2 COMBINED AT
          0221p       52.    8.22         19.       10.       10.     0.06

ROUTED TO
          R0221       52.    8.23         19.       10.       10.     0.06

HYDROGRAPH AT
          02413        2.    7.93          1.        0.        0.     0.00

ROUTED TO
          R02413       2.    7.93          1.        0.        0.     0.00

HYDROGRAPH AT
          02412        3.    7.93          1.        0.        0.     0.00

ROUTED TO
          R02412       3.    8.00          1.        0.        0.     0.00

HYDROGRAPH AT
          02411        3.    7.93          1.        0.        0.     0.00

ROUTED TO
          R02411       3.    7.97          1.        0.        0.     0.00

HYDROGRAPH AT
          0241        39.    8.10         14.        7.        7.     0.03

4 COMBINED AT
          0241p       46.    8.07         16.        8.        8.     0.04

ROUTED TO
          R241        46.    8.10         16.        8.        8.     0.04

HYDROGRAPH AT
          025         15.    7.93          5.        2.        2.     0.01

ROUTED TO
          R025        15.    7.95          5.        2.        2.     0.01

HYDROGRAPH AT
          024         20.    7.98          7.        3.        3.     0.02

3 COMBINED AT
          024p        79.    8.03         28.       14.       14.     0.07

ROUTED TO
          R024        79.    8.07         28.       14.       14.     0.07

HYDROGRAPH AT
          023         27.    8.05          9.        5.        5.     0.02

2 COMBINED AT
          023p       107.    8.05         37.       18.       18.     0.09

ROUTED TO
          R023       106.    8.08         37.       18.       18.     0.09

HYDROGRAPH AT
          022         20.    8.12          7.        3.        3.     0.02

3 COMBINED AT
          022p       173.    8.12         63.       31.       31.     0.17

ROUTED TO
          R022       173.    8.15         63.       31.       31.     0.17

HYDROGRAPH AT
          021         15.    7.98          5.        2.        2.     0.01

3 COMBINED AT
          021p       275.    8.08         99.       49.       49.     0.26

ROUTED TO
          R021       275.    8.10         99.       49.       49.     0.26

HYDROGRAPH AT
          2.04         8.    7.95          3.        1.        1.     0.01

ROUTED TO
          R04          8.    7.97          3.        1.        1.     0.01

HYDROGRAPH AT
          2.03        18.    7.95          6.        3.        3.     0.02

HYDROGRAPH AT
          WS4       4322.    8.25       1937.      962.      962.     5.22

3 COMBINED AT
          2.03      4338.    8.25       1945.      966.      966.     5.24
```

```
ROUTED TO
          R03          4326.     8.30         1945.        961.        961.        5.24

HYDROGRAPH AT
          2.02            4.    20.42            4.          1.          1.        0.01

3 COMBINED AT
          2.02         4559.     8.28         2044.       1012.       1012.        5.51

ROUTED TO
          R02          4545.     8.33         2044.       1008.       1008.        5.51

HYDROGRAPH AT
          01172           1.    20.35            1.          1.          1.        0.00

ROUTED TO
          R01172          1.    20.42            1.          1.          1.        0.00

HYDROGRAPH AT
          01171           6.    20.42            5.          2.          2.        0.01
```

```
2 COMBINED AT
       01171p        7.   20.42        7.        3.        3.      0.01

ROUTED TO
       R01171        7.   20.40        7.        3.        3.      0.01

HYDROGRAPH AT
         0118        3.   20.37        3.        1.        1.      0.01

ROUTED TO
        R0118        3.   20.42        3.        1.        1.      0.01

HYDROGRAPH AT
         0117        9.   20.40        8.        4.        4.      0.02

3 COMBINED AT
        0117p       19.   20.42       17.        8.        8.      0.04

ROUTED TO
        R0117       19.   20.40       17.        8.        8.      0.04

HYDROGRAPH AT
         0116        2.    6.63        1.        0.        0.      0.00

2 COMBINED AT
        0116p       19.   20.03       18.        8.        8.      0.04

ROUTED TO
        R0116       19.   20.03       18.        8.        8.      0.04

HYDROGRAPH AT
         0115        0.    6.62        0.        0.        0.      0.00

2 COMBINED AT
        0115p       19.   20.03       18.        8.        8.      0.04

ROUTED TO
        R0115       19.   20.08       18.        8.        8.      0.04

HYDROGRAPH AT
         0114       34.    6.63       10.        5.        5.      0.02

2 COMBINED AT
        0114p       37.    6.65       21.       13.       13.      0.06

ROUTED TO
        R0114       37.    6.73       21.       13.       13.      0.06

HYDROGRAPH AT
         0161       19.    6.63        6.        3.        3.      0.01

ROUTED TO
        R0161       19.    6.65        6.        3.        3.      0.01

HYDROGRAPH AT
          017       22.    7.95        7.        4.        4.      0.02

ROUTED TO
         R017       22.    7.95        7.        4.        4.      0.02

HYDROGRAPH AT
          016        8.    7.93        3.        1.        1.      0.01

3 COMBINED AT
         016p       35.    7.93       15.        7.        7.      0.04

ROUTED TO
         R016       35.    7.95       15.        7.        7.      0.04

HYDROGRAPH AT
          015       12.    7.95        4.        2.        2.      0.01

2 COMBINED AT
         015p       47.    7.95       19.        9.        9.      0.05

ROUTED TO
         R015       47.    7.95       19.        9.        9.      0.05

HYDROGRAPH AT
          014        2.    7.93        1.        0.        0.      0.00

2 COMBINED AT
         014p       49.    7.95       20.       10.       10.      0.05

ROUTED TO
         R014       49.    7.97       20.       10.       10.      0.05

HYDROGRAPH AT
          013        6.    7.95        2.        1.        1.      0.00

2 COMBINED AT
         013p       55.    7.95       22.       11.       11.      0.05

ROUTED TO
         R013       55.    7.97       22.       11.       11.      0.05
```

```
HYDROGRAPH AT
        0122         3.    7.95        1.        0.        0.      0.00

ROUTED TO
       R0122         3.    7.97        1.        0.        0.      0.00

HYDROGRAPH AT
        0121         1.    7.95        0.        0.        0.      0.00

2 COMBINED AT
       0121p         4.    7.97        1.        1.        1.      0.00

ROUTED TO
       R0121         4.    7.98        1.        1.        1.      0.00

HYDROGRAPH AT
         012         9.    7.95        3.        1.        1.      0.01

3 COMBINED AT
        012p        67.    7.97       26.       13.       13.      0.06
```

```
         ROUTED TO
                 R012          67.     8.10          26.         13.         13.       0.06

         HYDROGRAPH AT
                 0113           4.     7.97           1.          1.          1.       0.00

         ROUTED TO
                 R0113          4.     7.98           1.          1.          1.       0.00

         HYDROGRAPH AT
                 0112           4.     7.97           1.          1.          1.       0.00

         2 COMBINED AT
                 0112p          8.     7.97           3.          1.          1.       0.01

         ROUTED TO
                 R0112          8.     7.97           3.          1.          1.       0.01

         HYDROGRAPH AT
                 0111           2.     7.95           1.          0.          0.       0.00

         2 COMBINED AT
                 0111p         10.     7.97           3.          2.          2.       0.01

         ROUTED TO
                 R0111         10.     8.03           3.          2.          2.       0.01

         HYDROGRAPH AT
                 011            6.     7.95           2.          1.          1.       0.01

         4 COMBINED AT
                 011p          96.     8.07          49.         28.         28.       0.14

         ROUTED TO
                 R11           96.     8.10          49.         28.         28.       0.14

         HYDROGRAPH AT
                 2.01          17.    23.98          16.          7.          7.       0.04

         3 COMBINED AT
                 2.01        4627.     8.32        2095.       1043.       1043.       5.69

         ROUTED TO
                 R01         4625.     8.33        2095.       1042.       1042.       5.69

         HYDROGRAPH AT
                 2.0          436.     9.23         269.        131.        131.       0.83

         2 COMBINED AT
                 2.0         4890.     8.35        2359.       1174.       1174.       6.52

                                           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)

            R21222   MANE         0.17      31.42   477.01      7.39      1.00     31.42   477.00         7.39

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1006E+02 EXCESS=0.0000E+00 OUTFLOW=0.1006E+02 BASIN STORAGE=0.1410E-02 PERCENT ERROR=   0.0

            R21221   MANE         0.16      31.95   477.05      7.40      1.00     31.95   477.00         7.40

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1023E+02 EXCESS=0.0000E+00 OUTFLOW=0.1022E+02 BASIN STORAGE=0.1362E-02 PERCENT ERROR=   0.0

            R02123   MANE         0.19      18.00   476.38      7.61      1.00     18.00   477.00         7.61

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5761E+01 EXCESS=0.0000E+00 OUTFLOW=0.5760E+01 BASIN STORAGE=0.8856E-03 PERCENT ERROR=   0.0

            R02122   MANE         0.15      51.85   477.04      7.48      1.00     51.85   477.00         7.48

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1660E+02 EXCESS=0.0000E+00 OUTFLOW=0.1659E+02 BASIN STORAGE=0.2151E-02 PERCENT ERROR=   0.0

            R02121   MANE         1.00      53.49   478.00      7.47      1.00     53.49   478.00         7.47

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1713E+02 EXCESS=0.0000E+00 OUTFLOW=0.1711E+02 BASIN STORAGE=0.2257E-01 PERCENT ERROR=   0.0

            R0215    MANE         0.34       4.02   476.55      7.53      1.00      4.02   477.00         7.53

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1286E+01 EXCESS=0.0000E+00 OUTFLOW=0.1285E+01 BASIN STORAGE=0.3456E-03 PERCENT ERROR=   0.0
```

```
HEC1 S/N: 1343001909        HMVersion: 6.33     K:\RICKJ\GHEC1\99205301\AREA3\3-00.OUT
                                                 Data File: C:\WINDOWS\TEMP\-vbh332F.TMP

 *****************************************                    ****************************************
 *                                       *                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *   U.S. ARMY CORPS OF ENGINEERS       *
 *              MAY   1991               *                    *   HYDROLOGIC ENGINEERING CENTER      *
 *           VERSION 4.0.1E              *                    *         609 SECOND STREET            *
 *                                       *                    *      DAVIS, CALIFORNIA 95616         *
 * RUN DATE  08/03/1999  TIME  10:27:05  *                    *          (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


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                      :::::::::::::::::::::::::::::::::::::::::
                      :::                                   :::
                      :::  Full Microcomputer Implementation :::
                      :::               by                  :::
                      :::        Haestad Methods, Inc.      :::
                      :::                                   :::
                      :::::::::::::::::::::::::::::::::::::::::
                      :::::::::::::::::::::::::::::::::::::::::

              37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

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


                                          HEC-1 INPUT                                            PAGE  1

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

   1            ID  HVL SWMP - Subasin 3 - 10  Year Storm
   2            IT       1                 1440
   3            IO       5       0

   4            KK  0204
   5            KM  SCS 24 Hour Type IA Rainfall HVL SWMP - 3.02.04 Subbasin
   6            KO                                       22
   7            BA     .02
   8            PB       6
   9            IN       6
  10            PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
  11            PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
  12            PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
  13            PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
  14            PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
  15            PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
  16            PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
  17            PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
  18            PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
  19            PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
```

```
          *             *
          ***************

503 KO         OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                      IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT      0.017  TIME INTERVAL IN HOURS


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

          ***************
          *             *
534 KK    *    3.0      *
          *             *
          ***************

536 KO         OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                      IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT      0.017  TIME INTERVAL IN HOURS

                                                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
                0204            9.     7.93            3.          2.          2.       0.02

        ROUTED TO
               R0204            9.     8.00            3.          2.          2.       0.02

        HYDROGRAPH AT
              020301            4.     7.93            1.          1.          1.       0.01

        ROUTED TO
              R20301            4.     7.95            1.          1.          1.       0.01

        HYDROGRAPH AT
                0203            2.     7.90            1.          0.          0.       0.00

        3 COMBINED AT
               P0203           15.     8.00            5.          3.          3.       0.03

        ROUTED TO
               R0203           15.     8.00            5.          3.          3.       0.03

        HYDROGRAPH AT
                0202            8.     7.90            3.          1.          1.       0.01

        2 COMBINED AT
               P0202           23.     8.00            8.          4.          4.       0.05

        ROUTED TO
               R0202           23.     8.07            8.          4.          4.       0.05

        HYDROGRAPH AT
              020111            2.     7.90            1.          0.          0.       0.00

        ROUTED TO
              R20111            2.     7.90            1.          0.          0.       0.00

        HYDROGRAPH AT
              020102            7.     7.92            2.          1.          1.       0.01

        ROUTED TO
              R20102            7.     7.92            2.          1.          1.       0.01

        HYDROGRAPH AT
              020101           14.     7.92            5.          2.          2.       0.02

        3 COMBINED AT
              P20101           23.     7.92            7.          4.          4.       0.03

        ROUTED TO
```

```
          HYDROGRAPH AT
                 0201          1.     7.90        0.        0.        0.      0.00

          2 COMBINED AT
                P0201         24.     7.92        8.        4.        4.      0.03

          ROUTED TO
                R0201         24.     7.92        8.        4.        4.      0.03

          HYDROGRAPH AT
                 0200       1196.     8.45      579.      290.      290.      3.55

          3 COMBINED AT
                P0200       1217.     8.45      594.      298.      298.      3.64

          ROUTED TO
                R0200       1217.     8.47      594.      298.      298.      3.64

          HYDROGRAPH AT
               010101          6.     7.90        2.        1.        1.      0.01

          ROUTED TO
               R10101          6.     7.90        2.        1.        1.      0.01

          HYDROGRAPH AT
                 0101          1.     7.93        0.        0.        0.      0.00

          2 COMBINED AT
                P0101          7.     7.90        2.        1.        1.      0.01

          ROUTED TO
               R10101          7.     7.90        2.        1.        1.      0.01

          HYDROGRAPH AT
                 0102          5.     7.92        2.        1.        1.      0.01

          ROUTED TO
                R0102          5.     7.95        2.        1.        1.      0.01

          HYDROGRAPH AT
                 0100          6.     8.02        2.        1.        1.      0.01

          4 COMBINED AT
                P0100       1225.     8.47      600.      301.      301.      3.67

          ROUTED TO
                  R01       1225.     8.47      600.      301.      301.      3.67

          HYDROGRAPH AT
                 0000          8.     7.93        3.        1.        1.      0.01

          2 COMBINED AT
3.67               3.0      1228.     8.47      602.      302.      302.


                              SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                  (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                           INTERPOLATED TO
          ISTAQ    ELEMENT      DT      PEAK    TIME TO    VOLUME     DT  COMPUTATION INTERVAL
                                                 PEAK                          PEAK    TIME TO      VOLUME
                                                                                         PEAK

                              (MIN)     (CFS)     (MIN)      (IN)    (MIN)     (CFS)     (MIN)       (IN)

           R0204    MANE       1.00      8.83    480.00      2.93     1.00      8.83    480.00      2.93

   CONTINUITY SUMMARY (AC-FT) - INFLOW=0.3135E+01 EXCESS=0.0000E+00 OUTFLOW=0.3124E+01 BASIN STORAGE=0.1189E-01 PERCENT ERROR=    0.0

          R20301    MANE       1.00      3.96    478.00      3.12     1.00      3.96    478.00      3.12

   CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1369E+01 EXCESS=0.0000E+00 OUTFLOW=0.1367E+01 BASIN STORAGE=0.2901E-02 PERCENT ERROR=    0.0

           R0203    MANE       0.76     15.09    479.88      3.02     1.00     15.09    480.00      3.02

   CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5295E+01 EXCESS=0.0000E+00 OUTFLOW=0.5291E+01 BASIN STORAGE=0.4014E-02 PERCENT ERROR=    0.0

           R0202    MANE       1.00     23.01    484.00      3.15     1.00     23.01    484.00      3.15

   CONTINUITY SUMMARY (AC-FT) - INFLOW=0.8025E+01 EXCESS=0.0000E+00 OUTFLOW=0.7979E+01 BASIN STORAGE=0.5150E-01 PERCENT ERROR=   -0.1

          R20111    MANE       0.89      1.59    473.95      4.51     1.00      1.59    474.00      4.51

   CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5057E+00 EXCESS=0.0000E+00 OUTFLOW=0.5053E+00 BASIN STORAGE=0.3683E-03 PERCENT ERROR=    0.0
```

```
                                                     K:\RICKJ\GHEC1\99205301\AREA3\3-YEAR25.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33      Data File: C:\WINDOWS\TEMP\-vbh1C4B.TMP

****************************************                                                  ****************************************
*                                      *                                                  *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                  *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY   1991              *                                                  *   HYDROLOGIC ENGINEERING CENTER      *
*          VERSION 4.0.1E              *                                                  *        609 SECOND STREET             *
*                                      *                                                  *     DAVIS, CALIFORNIA 95616          *
*  RUN DATE  09/29/1999  TIME  10:17:28 *                                                 *         (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


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                                  ::::::::::::::::::::::::::::::::::::::::
                                  :::                                  :::
                                  :::  Full Microcomputer Implementation  :::
                                  :::               by                 :::
                                  :::        Haestad Methods, Inc.      :::
                                  :::                                  :::
                                  ::::::::::::::::::::::::::::::::::::::::
                                  ::::::::::::::::::::::::::::::::::::::::

                    37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

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


                                        HEC-1 INPUT                                              PAGE  1

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

  1         ID  HVL SWMP - Subasin 3 - 25  Year Storm
  2         IT       1                      1440
  3         IO       5         0

  4         KK  0204
  5         KM  SCS 24 Hour Type IA Rainfall HVL SWMP - 3.02.04 Subbasin
  6         KO                                        22
  7         BA     .02
  8         PB       7
  9         IN       6
 10         PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
 11         PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
 12         PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
 13         PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
 14         PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
 15         PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
 16         PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
 17         PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
 18         PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
 19         PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
 20         PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
 21         PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
              TIMINT       0.017  TIME INTERVAL IN HOURS


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

            **************
            *            *
683 KK      *    3.0     *
            *            *
            **************

685 KO           OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                      IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT      0.017  TIME INTERVAL IN HOURS


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

    OPERATION        STATION      PEAK   TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM     TIME OF
                                  FLOW    PEAK                                           AREA      STAGE     MAX STAGE
                                         6-HOUR      24-HOUR      72-HOUR

    HYDROGRAPH AT
               0204        12.     7.93        4.         2.         2.       0.02
    ROUTED TO
              R0204        12.     7.98        4.         2.         2.       0.02
    HYDROGRAPH AT
             020301         5.     7.92        2.         1.         1.       0.01
    ROUTED TO
             R20301         5.     7.95        2.         1.         1.       0.01
    HYDROGRAPH AT
               0203         3.     7.90        1.         1.         1.       0.00
    3 COMBINED AT
              P0203        20.     7.98        7.         3.         3.       0.03
    ROUTED TO
              R0203        20.     7.98        7.         3.         3.       0.03
    HYDROGRAPH AT
               0202        11.     7.90        3.         2.         2.       0.01
    2 COMBINED AT
              P0202        30.     7.92       10.         5.         5.       0.05
    ROUTED TO
              R0202        30.     8.00       10.         5.         5.       0.05
    HYDROGRAPH AT
             020111         2.     7.90        1.         0.         0.       0.00
    ROUTED TO
             R20111         2.     7.90        1.         0.         0.       0.00
    HYDROGRAPH AT
             020102         9.     7.90        3.         1.         1.       0.01
    ROUTED TO
             R20102         9.     7.92        3.         1.         1.       0.01
    HYDROGRAPH AT
             020101        18.     7.92        6.         3.         3.       0.02
    3 COMBINED AT
             P20101        28.     7.92        9.         5.         5.       0.03
    ROUTED TO
             R20101        28.     7.92        9.         5.         5.       0.03
    HYDROGRAPH AT
               0201         1.     7.90        0.         0.         0.       0.00
    2 COMBINED AT
              P0201        30.     7.90       10.         5.         5.       0.03
    ROUTED TO
              R0201        30.     7.92       10.         5.         5.       0.03
    HYDROGRAPH AT
               0200      1577.     8.45      743.       370.       370.       3.55
    3 COMBINED AT
```

```
      P0200        1605.   8.43        762.       380.        380.       3.64

ROUTED TO
      R0200        1605.   8.45        762.       380.        380.       3.64

HYDROGRAPH AT
      010101          7.   7.90          2.         1.          1.       0.01
```

```
        ROUTED TO
                 R10101          7.      7.90          2.          1.          1.       0.01

        HYDROGRAPH AT
                 0101            1.      7.93          0.          0.          0.       0.00

        2 COMBINED AT
                 P0101           8.      7.90          3.          1.          1.       0.01

        ROUTED TO
                 R10101          8.      7.90          3.          1.          1.       0.01

        HYDROGRAPH AT
                 0102            7.      7.92          2.          1.          1.       0.01

        ROUTED TO
                 R0102           7.      7.93          2.          1.          1.       0.01

        HYDROGRAPH AT
                 0100            8.      8.02          3.          1.          1.       0.01

        4 COMBINED AT
                 P0100        1615.      8.45        770.        384.        384.       3.67

        ROUTED TO
                 R01          1614.      8.47        770.        383.        383.       3.67

        HYDROGRAPH AT
                 0000            5.      7.95          2.          1.          1.       0.01

        HYDROGRAPH AT
                 WS2          3143.      8.38       1561.        775.        775.       6.52

        3 COMBINED AT
                 3.0          4748.      8.42       2332.       1159.       1159.      10.19

                                  SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                        (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                 INTERPOLATED TO
        ISTAQ    ELEMENT        DT        PEAK     TIME TO     VOLUME      DT    COMPUTATION INTERVAL
                                                     PEAK                             PEAK    TIME TO       VOLUME
                                                                                                PEAK

                               (MIN)      (CFS)     (MIN)       (IN)      (MIN)      (CFS)     (MIN)         (IN)

         R0204    MANE          1.00      11.71     479.00      3.76       1.00      11.71     479.00        3.76

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.4019E+01 EXCESS=0.0000E+00 OUTFLOW=0.4007E+01 BASIN STORAGE=0.1374E-01 PERCENT ERROR=   0.0

         R20301   MANE          1.00       5.18     477.00      3.97       1.00       5.18     477.00        3.97

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1741E+01 EXCESS=0.0000E+00 OUTFLOW=0.1738E+01 BASIN STORAGE=0.3332E-02 PERCENT ERROR=   0.0

         R0203    MANE          0.71      19.85     479.41      3.86       1.00      19.84     479.00        3.86

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.6761E+01 EXCESS=0.0000E+00 OUTFLOW=0.6757E+01 BASIN STORAGE=0.4630E-02 PERCENT ERROR=   0.0

         R0202    MANE          1.00      30.06     480.00      4.00       1.00      30.06     480.00        4.00

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1019E+02 EXCESS=0.0000E+00 OUTFLOW=0.1013E+02 BASIN STORAGE=0.5911E-01 PERCENT ERROR=  -0.1

         R20111   MANE          0.85       1.93     473.67      5.47       1.00       1.93     474.00        5.47

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.6134E+00 EXCESS=0.0000E+00 OUTFLOW=0.6130E+00 BASIN STORAGE=0.4166E-03 PERCENT ERROR=   0.0

         R20102   MANE          0.94       8.93     474.84      5.32       1.00       8.93     475.00        5.32

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2839E+01 EXCESS=0.0000E+00 OUTFLOW=0.2837E+01 BASIN STORAGE=0.2240E-02 PERCENT ERROR=   0.0

         R20101   MANE          0.31      28.42     474.73      5.20       1.00      28.42     475.00        5.20

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.9049E+01 EXCESS=0.0000E+00 OUTFLOW=0.9046E+01 BASIN STORAGE=0.2411E-02 PERCENT ERROR=   0.0

         R0201    MANE          0.80      29.60     475.31      5.20       1.00      29.60     475.00        5.20
```

```
                                                             K:\RICKJ\GHEC1\99205301\AREA3\3-YR100.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33       Data File: C:\WINDOWS\TEMP\-vbh0B1F.TMP

*****************************************                                                       ****************************************
*                                       *                                                       *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                       *     U.S. ARMY CORPS OF ENGINEERS     *
*              MAY  1991                *                                                       *     HYDROLOGIC ENGINEERING CENTER    *
*            VERSION 4.0.1E             *                                                       *           609 SECOND STREET          *
*                                       *                                                       *        DAVIS, CALIFORNIA 95616       *
*  RUN DATE  09/29/1999  TIME  13:23:18 *                                                       *            (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


                                         :::::::::::::::::::::::::::::::::::::::::::
                                         :::::::::::::::::::::::::::::::::::::::::::
                                         :::                                     :::
                                         :::  Full Microcomputer Implementation  :::
                                         :::                 by                  :::
                                         :::        Haestad Methods, Inc.        :::
                                         :::                                     :::
                                         :::::::::::::::::::::::::::::::::::::::::::
                                         :::::::::::::::::::::::::::::::::::::::::::

                        37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666



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

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


                                             HEC-1 INPUT                                             PAGE  1

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

              1           ID  HVL SWMP - Subasin 3 - 100  Year Storm
              2           IT       1                  1440
              3           IO       5       0

              4           KK  0204
              5           KM  SCS 24 Hour Type IA Rainfall HVL SWMP - 3.02.04 Subbasin
              6           KO                                          22
              7           BA     .02
              8           PB     9.5
              9           IN       6
             10           PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
             11           PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
             12           PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
             13           PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
             14           PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
             15           PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
             16           PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
             17           PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
             18           PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
             19           PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
             20           PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
             21           PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
           TIMINT       0.017  TIME INTERVAL IN HOURS


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

            **************
            *            *
 683 KK     *    3.0     *
            *            *
            **************

 685 KO          OUTPUT CONTROL VARIABLES
                         IPRNT          5  PRINT CONTROL
                         IPLOT          0  PLOT CONTROL
                         QSCAL          0.  HYDROGRAPH PLOT SCALE
                         IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                          IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                         ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                         ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                        TIMINT      0.017  TIME INTERVAL IN HOURS

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

          OPERATION         STATION       PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN    MAXIMUM    TIME OF
                                          FLOW     PEAK                                                AREA     STAGE    MAX STAGE
                                                        6-HOUR       24-HOUR       72-HOUR

          HYDROGRAPH AT
                    0204          19.     7.93          6.          3.          3.      0.02

          ROUTED TO
                   R0204          19.     7.97          6.          3.          3.      0.02

          HYDROGRAPH AT
                  020301           8.     7.92          3.          1.          1.      0.01

          ROUTED TO
                  R20301           8.     7.95          3.          1.          1.      0.01

          HYDROGRAPH AT
                    0203           5.     7.90          2.          1.          1.      0.00

          3 COMBINED AT
                   P0203          32.     7.95         11.          5.          5.      0.03

          ROUTED TO
                   R0203          32.     7.97         11.          5.          5.      0.03

          HYDROGRAPH AT
                    0202          16.     7.90          5.          3.          3.      0.01

          2 COMBINED AT
                   P0202          49.     7.92         16.          8.          8.      0.05

          ROUTED TO
                   R0202          49.     7.98         16.          8.          8.      0.05

          HYDROGRAPH AT
                  020111           3.     7.80          1.          0.          0.      0.00

          ROUTED TO
                  R20111           3.     7.82          1.          0.          0.      0.00

          HYDROGRAPH AT
                  020102          13.     7.90          4.          2.          2.      0.01

          ROUTED TO
                  R20102          13.     7.92          4.          2.          2.      0.01

          HYDROGRAPH AT
                  020101          26.     7.90          8.          4.          4.      0.02

          3 COMBINED AT
                  P20101          42.     7.90         13.          7.          7.      0.03

          ROUTED TO
                  R20101          42.     7.90         13.          7.          7.      0.03

          HYDROGRAPH AT
                    0201           2.     7.90          1.          0.          0.      0.00

          2 COMBINED AT
                   P0201          43.     7.90         14.          7.          7.      0.03

          ROUTED TO
                   R0201          43.     7.92         14.          7.          7.      0.03

          HYDROGRAPH AT
                    0200        2587.     8.43       1173.        580.        580.      3.55
```

```
         P0200       2628.    8.42        1202.       595.        595.       3.64

ROUTED TO
         R0200       2627.    8.43        1202.       594.        594.       3.64

HYDROGRAPH AT
        010101         11.    7.80           3.         2.          2.       0.01
```

```
   ROUTED TO
           R10101        11.     7.80        3.        2.        2.      0.01

   HYDROGRAPH AT
           0101           1.     7.93        0.        0.        0.      0.00

   2 COMBINED AT
           P0101         12.     7.90        4.        2.        2.      0.01

   ROUTED TO
           R10101        12.     7.90        4.        2.        2.      0.01

   HYDROGRAPH AT
           0102          10.     7.92        3.        2.        2.      0.01

   ROUTED TO
           R0102         10.     7.93        3.        2.        2.      0.01

   HYDROGRAPH AT
           0100          13.     8.00        4.        2.        2.      0.01

   4 COMBINED AT
           P0100       2643.     8.43     1213.      600.      600.      3.67

   ROUTED TO
           R01         2642.     8.45     1213.      600.      600.      3.67

   HYDROGRAPH AT
           0000           8.     7.93        3.        1.        1.      0.01

   HYDROGRAPH AT
           Node79      4890.     8.35     2359.     1174.     1174.      6.52

   3 COMBINED AT
           3.0         7509.     8.40     3574.     1775.     1775.     10.20

                                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)

           R0204     MANE          1.00     19.35    478.00      5.94     1.00     19.35    478.00        5.94

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.6354E+01 EXCESS=0.0000E+00 OUTFLOW=0.6338E+01 BASIN STORAGE=0.1802E-01 PERCENT ERROR=   0.0

           R20301    MANE          1.00      8.37    477.00      6.20     1.00      8.37    477.00        6.20

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2717E+01 EXCESS=0.0000E+00 OUTFLOW=0.2714E+01 BASIN STORAGE=0.4326E-02 PERCENT ERROR=   0.0

           R0203     MANE          0.62     32.40    477.98      6.07     1.00     32.40    478.00        6.07

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1062E+02 EXCESS=0.0000E+00 OUTFLOW=0.1062E+02 BASIN STORAGE=0.6056E-02 PERCENT ERROR=   0.0

           R0202     MANE          1.00     48.59    479.00      6.23     1.00     48.59    479.00        6.23

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1585E+02 EXCESS=0.0000E+00 OUTFLOW=0.1578E+02 BASIN STORAGE=0.7662E-01 PERCENT ERROR=  -0.1

           R20111    MANE          0.78      2.79    468.85      7.91     1.00      2.79    469.00        7.91

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.8860E+00 EXCESS=0.0000E+00 OUTFLOW=0.8856E+00 BASIN STORAGE=0.5294E-03 PERCENT ERROR=   0.0

           R20102    MANE          0.86     12.98    474.53      7.74     1.00     12.98    475.00        7.74

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.4129E+01 EXCESS=0.0000E+00 OUTFLOW=0.4126E+01 BASIN STORAGE=0.2845E-02 PERCENT ERROR=   0.0

           R20101    MANE          0.28     41.65    474.34      7.61     1.00     41.65    474.00        7.61

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1323E+02 EXCESS=0.0000E+00 OUTFLOW=0.1323E+02 BASIN STORAGE=0.3064E-02 PERCENT ERROR=   0.0

           R0201     MANE          0.71     43.40    474.23      7.60     1.00     43.40    475.00        7.60
```

```
                                                  K:\RICKJ\GHEC1\99205301\AREA4\4-00.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33      Data File: C:\WINDOWS\TEMP\-vbh1533.TMP

****************************************                                                  ****************************************
*                                      *                                                  *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                  *  U.S. ARMY CORPS OF ENGINEERS        *
*             MAY  1991                *                                                  *  HYDROLOGIC ENGINEERING CENTER       *
*           VERSION 4.0.1E             *                                                  *        609 SECOND STREET             *
*                                      *                                                  *      DAVIS, CALIFORNIA 95616         *
* RUN DATE  07/27/1999  TIME  13:29:50 *                                                  *         (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


                                                :::::::::::::::::::::::::::::::::::::::::
                                                :::::::::::::::::::::::::::::::::::::::::
                                                :::                                   :::
                                                :::  Full Microcomputer Implementation :::
                                                :::               by                  :::
                                                :::       Haestad Methods, Inc.       :::
                                                :::                                   :::
                                                :::::::::::::::::::::::::::::::::::::::::
                                                :::::::::::::::::::::::::::::::::::::::::

                                        37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

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


                                                HEC-1 INPUT                                                  PAGE  1

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

        1           ID  HVL SWMP - Subbasin 4 - 10 Year Storm
        2           IT       5                      283
        3           IO       5       0

        4           KK  0181
        5           KM  SCS 24 Hour Type IA Rainfall Subbasin 4.01.08.01
        6           KO                                        22
        7           BA   .0081
        8           PB       6
        9           IN       6
       10           PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
       11           PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
       12           PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
       13           PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
       14           PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
       15           PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
       16           PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
       17           PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
       18           PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
       19           PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
```

```
                    QSCAL          0.  HYDROGRAPH PLOT SCALE
                    IPNCH          0   PUNCH COMPUTED HYDROGRAPH
                     IOUT         22   SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1          1   FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2        283   LAST ORDINATE PUNCHED OR SAVED
                   TIMINT      0.083   TIME INTERVAL IN HOURS


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

              **************
              *            *
2879 KK       *   4.11     *
              *            *
              **************

2881 KO          OUTPUT CONTROL VARIABLES
                    IPRNT          5   PRINT CONTROL
                    IPLOT          0   PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE
                    IPNCH          0   PUNCH COMPUTED HYDROGRAPH
                     IOUT         22   SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1          1   FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2        283   LAST ORDINATE PUNCHED OR SAVED
                   TIMINT      0.083   TIME INTERVAL IN HOURS


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

              **************
              *            *
2912 KK       *   HVLAKE   *
              *            *
              **************

2914 KO          OUTPUT CONTROL VARIABLES
                    IPRNT          5   PRINT CONTROL
                    IPLOT          0   PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE
                    IPNCH          0   PUNCH COMPUTED HYDROGRAPH
                     IOUT         22   SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1          1   FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2        283   LAST ORDINATE PUNCHED OR SAVED
                   TIMINT      0.083   TIME INTERVAL IN HOURS


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

              OPERATION        STATION     PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN    MAXIMUM    TIME OF
                                           FLOW    PEAK                                               AREA     STAGE    MAX STAGE
                                                     6-HOUR
24-HOUR        72-HOUR

              HYDROGRAPH AT
                         0181          4.      8.00         1.          1.          1.      0.01

              ROUTED TO
                        R0181          4.      8.00         1.          1.          1.      0.01

              HYDROGRAPH AT
                          018        323.      8.25       139.         70.         70.      0.86

              2 COMBINED AT
                         018p        326.      8.25       140.         71.         71.      0.86

              ROUTED TO
                         R018        326.      8.25       140.         71.         71.      0.86

              HYDROGRAPH AT
                          017          2.      8.00         1.          0.          0.      0.01

              2 COMBINED AT
                         017p        327.      8.25       141.         71.         71.      0.87

              ROUTED TO
                         R017        327.      8.25       141.         71.         71.      0.87

              HYDROGRAPH AT
                          016          2.      8.00         1.          0.          0.      0.00
```

```
2 COMBINED AT
        016p       328.    8.25         141.         72.         72.        0.87

ROUTED TO
        R016       328.    8.25         141.         72.         72.        0.87

HYDROGRAPH AT
        015          2.    8.00           1.          0.          0.        0.00

2 COMBINED AT
        015p       329.    8.25         142.         72.         72.        0.88

ROUTED TO
        R015       329.    8.25         142.         72.         72.        0.88

HYDROGRAPH AT
        0141         7.    8.00           2.          1.          1.        0.01

ROUTED TO
        R0141        7.    8.00           2.          1.          1.        0.01

HYDROGRAPH AT
        014         16.    8.00           5.          3.          3.        0.02

3 COMBINED AT
        014p       344.    8.25         150.         76.         76.        0.90

ROUTED TO
        R014       344.    8.25         150.         76.         76.        0.90

HYDROGRAPH AT
        0135        31.    8.00          11.          5.          5.        0.03

ROUTED TO
        R0135       31.    8.00          11.          5.          5.        0.03

HYDROGRAPH AT
        01341        4.    8.00           1.          1.          1.        0.00

ROUTED TO
        R01341       4.    8.00           1.          1.          1.        0.00

HYDROGRAPH AT
        01342       19.    8.00           6.          3.          3.        0.02

HYDROGRAPH AT
        0134        12.    8.00           4.          2.          2.        0.01

4 COMBINED AT
        0134p       67.    8.00          22.         11.         11.        0.07

ROUTED TO
        R0134       67.    8.00          22.         11.         11.        0.07

HYDROGRAPH AT
        0133        19.    8.00           6.          3.          3.        0.02

2 COMBINED AT
        0133p       86.    8.00          29.         14.         14.        0.08

ROUTED TO
        R0133       86.    8.00          29.         14.         14.        0.08

HYDROGRAPH AT
        01321        5.    8.00           1.          1.          1.        0.00

ROUTED TO
        R01321       5.    8.00           1.          1.          1.        0.00

HYDROGRAPH AT
        0132        13.    8.00           4.          2.          2.        0.01

3 COMBINED AT
        0132p      103.    8.00          34.         17.         17.        0.10

ROUTED TO
        R0132      103.    8.00          34.         17.         17.        0.10

HYDROGRAPH AT
        0131        20.    8.00           7.          3.          3.        0.02

2 COMBINED AT
        0131p      123.    8.00          41.         21.         21.        0.12

ROUTED TO
        R0131      122.    8.00          41.         21.         21.        0.12

HYDROGRAPH AT
        013         12.    8.00           4.          2.          2.        0.01

3 COMBINED AT
        013p       448.    8.08         194.         99.         99.        1.03
```

```
         R013         447.    8.17         194.        99.        99.       1.03

  HYDROGRAPH AT
         0122          29.    8.00           9.         5.         5.       0.02

  ROUTED TO
        R0122          29.    8.00           9.         5.         5.       0.02

  HYDROGRAPH AT
         0121          15.    8.00           5.         3.         3.       0.01

  2 COMBINED AT
        0121p          44.    8.00          15.         7.         7.       0.04

  ROUTED TO
        R0121          44.    8.00          15.         7.         7.       0.04

  HYDROGRAPH AT
         012           18.    8.00           6.         3.         3.       0.02
```

```
3 COMBINED AT
        012p         503.    8.08         214.        109.        109.        1.09

ROUTED TO
        R012         501.    8.08         214.        109.        109.        1.09

HYDROGRAPH AT
        0111          14.    8.00           5.          2.          2.        0.01

HYDROGRAPH AT
        011           11.    8.00           4.          2.          2.        0.01

3 COMBINED AT
        011p         524.    8.08         222.        113.        113.        1.11

ROUTED TO
        R011         520.    8.08         222.        113.        113.        1.11

HYDROGRAPH AT
        1052          15.    8.00           5.          2.          2.        0.02

ROUTED TO
        R1052         15.    8.00           5.          2.          2.        0.02

HYDROGRAPH AT
        1051           5.    8.00           2.          1.          1.        0.01

2 COMBINED AT
        1051p         19.    8.00           6.          3.          3.        0.03

ROUTED TO
        R1051         19.    8.00           6.          3.          3.        0.03

HYDROGRAPH AT
        107            2.    8.00           1.          0.          0.        0.00

ROUTED TO
        R107           2.    8.00           1.          0.          0.        0.00

HYDROGRAPH AT
        106           30.    8.00          10.          5.          5.        0.05

2 COMBINED AT
        106p          32.    8.00          11.          6.          6.        0.06

ROUTED TO
        R106          32.    8.00          11.          6.          6.        0.06

HYDROGRAPH AT
        105           10.    8.00           3.          2.          2.        0.02

3 COMBINED AT
        105p          61.    8.00          21.         10.         10.        0.11

ROUTED TO
        R105          61.    8.00          21.         10.         10.        0.11

HYDROGRAPH AT
        1043           1.    8.00           0.          0.          0.        0.00

ROUTED TO
        R1043          1.    8.00           0.          0.          0.        0.00

HYDROGRAPH AT
        1042           6.    8.00           2.          1.          1.        0.01

2 COMBINED AT
        1043p          8.    8.00           3.          1.          1.        0.01

ROUTED TO
        R1042          8.    8.00           3.          1.          1.        0.01

HYDROGRAPH AT
        1041           2.    8.00           1.          0.          0.        0.00

2 COMBINED AT
        1041p          9.    8.00           3.          2.          2.        0.01

ROUTED TO
        R1041          9.    8.00           3.          2.          2.        0.01

HYDROGRAPH AT
        104            7.    8.00           2.          1.          1.        0.01

3 COMBINED AT
        104p          77.    8.00          26.         13.         13.        0.13

ROUTED TO
        R104          76.    8.00          26.         13.         13.        0.13

HYDROGRAPH AT
        103            6.    8.00           2.          1.          1.        0.01
```

```
            103p        82.    8.00       28.       14.       14.      0.14
ROUTED TO
            R103        82.    8.00       28.       14.       14.      0.14
HYDROGRAPH AT
            1021         1.    8.00        0.        0.        0.      0.00
ROUTED TO
            R1021        1.    8.00        0.        0.        0.      0.00
HYDROGRAPH AT
            102          9.    8.00        3.        1.        1.      0.01
3 COMBINED AT
            102p        92.    8.00       31.       16.       16.      0.16
ROUTED TO
            R102        92.    8.00       31.       16.       16.      0.16
```

```
HYDROGRAPH AT
       10121          2.    8.00          1.          0.          0.       0.00

ROUTED TO
      R10121          2.    8.00          1.          0.          0.       0.00

HYDROGRAPH AT
       10122          5.    8.00          2.          1.          1.       0.00

ROUTED TO
      R10122          5.    8.00          2.          1.          1.       0.00

HYDROGRAPH AT
        1012          9.    8.00          3.          1.          1.       0.01

3 COMBINED AT
       1012p         16.    8.00          5.          3.          3.       0.02

ROUTED TO
       R1012         16.    8.00          5.          3.          3.       0.02

HYDROGRAPH AT
        1011         11.    8.00          4.          2.          2.       0.01

ROUTED TO
       R1011         11.    8.00          4.          2.          2.       0.01

HYDROGRAPH AT
        101          23.    8.00          8.          4.          4.       0.02

4 COMBINED AT
        101p        142.    8.00         48.         24.         24.       0.20

ROUTED TO
        R101        142.    8.00         48.         24.         24.       0.20

HYDROGRAPH AT
        026           1.    8.00          0.          0.          0.       0.00

ROUTED TO
        R026          1.    8.08          0.          0.          0.       0.00

HYDROGRAPH AT
        025           5.    8.00          2.          1.          1.       0.01

2 COMBINED AT
        025p          6.    8.00          2.          1.          1.       0.01

ROUTED TO
        R025          6.    8.00          2.          1.          1.       0.01

HYDROGRAPH AT
        0241          4.    8.00          1.          1.          1.       0.01

ROUTED TO
        R0241         4.    8.00          1.          1.          1.       0.01

HYDROGRAPH AT
        024          13.    8.00          4.          2.          2.       0.03

3 COMBINED AT
        024p         23.    8.00          8.          4.          4.       0.05

ROUTED TO
        R024         23.    8.00          8.          4.          4.       0.05

HYDROGRAPH AT
        0231          2.    8.00          1.          0.          0.       0.00

ROUTED TO
        R0231         2.    8.00          1.          0.          0.       0.00

HYDROGRAPH AT
        023          42.    8.00         14.          7.          7.       0.04

3 COMBINED AT
        023p         67.    8.00         23.         12.         12.       0.09

ROUTED TO
        R023         67.    8.00         23.         12.         12.       0.09

HYDROGRAPH AT
        022          59.    8.00         20.         10.         10.       0.05

2 COMBINED AT
        022p        126.    8.00         42.         21.         21.       0.14

ROUTED TO
        R022        126.    8.00         42.         21.         21.       0.14

HYDROGRAPH AT
        021          72.    8.00         24.         12.         12.       0.07

2 COMBINED AT
```

```
             021p           198.    8.00        66.       33.       33.      0.21
         ROUTED TO
             R021           198.    8.00        66.       33.       33.      0.21
         HYDROGRAPH AT
             116             11.    8.00         4.        2.        2.      0.02
         ROUTED TO
             R116            11.    8.00         4.        2.        2.      0.02
         HYDROGRAPH AT
             115              7.    8.00         2.        1.        1.      0.01
         2 COMBINED AT
             115p            18.    8.00         6.        3.        3.      0.03
         ROUTED TO
             R115            18.    8.00         6.        3.        3.      0.03
```

```
HYDROGRAPH AT
          114          8.    8.00          3.          1.          1.       0.01

2 COMBINED AT
          114p        26.    8.00          9.          4.          4.       0.05

ROUTED TO
          R114        26.    8.00          9.          4.          4.       0.05

HYDROGRAPH AT
          1132         2.    8.00          1.          0.          0.       0.00

ROUTED TO
          R1132        2.    8.00          1.          0.          0.       0.00

HYDROGRAPH AT
          1131         1.    8.00          0.          0.          0.       0.00

2 COMBINED AT
          1131p        3.    8.00          1.          1.          1.       0.01

ROUTED TO
          R1131        3.    8.00          1.          1.          1.       0.01

HYDROGRAPH AT
          113          2.    8.00          1.          0.          0.       0.00

3 COMBINED AT
          113p        31.    8.00         11.          5.          5.       0.06

ROUTED TO
          R113        31.    8.00         11.          5.          5.       0.06

HYDROGRAPH AT
          1121         8.    8.00          3.          1.          1.       0.02

ROUTED TO
          R1121        8.    8.00          3.          1.          1.       0.02

HYDROGRAPH AT
          112          1.    8.00          0.          0.          0.       0.00

3 COMBINED AT
          112p        41.    8.00         14.          7.          7.       0.07

ROUTED TO
          R112        41.    8.00         14.          7.          7.       0.07

HYDROGRAPH AT
          111          2.    8.00          1.          0.          0.       0.00

HYDROGRAPH AT
          1111         2.    8.00          1.          0.          0.       0.00

3 COMBINED AT
          111p        45.    8.00         16.          8.          8.       0.08

ROUTED TO
          R111        45.    8.00         16.          8.          8.       0.08

HYDROGRAPH AT
          043         23.    8.00          8.          4.          4.       0.04

HYDROGRAPH AT
          0431        13.    8.00          4.          2.          2.       0.02

2 COMBINED AT
          043p        36.    8.00         12.          6.          6.       0.06

ROUTED TO
          R043        36.    8.00         12.          6.          6.       0.06

HYDROGRAPH AT
          042         34.    8.00         11.          6.          6.       0.05

2 COMBINED AT
          042p        70.    8.00         23.         12.         12.       0.11

ROUTED TO
          R042        70.    8.00         23.         12.         12.       0.11

HYDROGRAPH AT
          0411        10.    8.00          3.          2.          2.       0.01

ROUTED TO
          R0411       10.    8.00          3.          2.          2.       0.01

HYDROGRAPH AT
          041         55.    8.00         18.          9.          9.       0.08

3 COMBINED AT
          041p       134.    8.00         45.         23.         23.       0.21

ROUTED TO
```

```
          R041          134.     8.00        45.        23.        23.      0.21
   HYDROGRAPH AT
          031             2.     8.00         1.         0.         0.      0.00
   ROUTED TO
          R031            2.     8.00         1.         0.         0.      0.00
   HYDROGRAPH AT
          0501            2.     8.00         1.         0.         0.      0.00
   ROUTED TO
          R0501           2.     8.00         1.         0.         0.      0.00
   HYDROGRAPH AT
          0601            5.     8.00         2.         1.         1.      0.01
   ROUTED TO
          R0601           5.     8.00         2.         1.         1.      0.01
```

```
         HYDROGRAPH AT
                0701           4.     8.00          1.          1.          1.       0.01

         ROUTED TO
               R0701           4.     8.00          1.          1.          1.       0.01

         HYDROGRAPH AT
                0801           4.     8.00          1.          1.          1.       0.00

         ROUTED TO
               R0801           4.     8.00          1.          1.          1.       0.00

         HYDROGRAPH AT
                0901           5.     8.00          2.          1.          1.       0.01

         ROUTED TO
               R0901           5.     8.00          2.          1.          1.       0.01

         HYDROGRAPH AT
                4.01           5.     8.00          2.          1.          1.       0.01

         HYDROGRAPH AT
                4.04           2.     8.00          1.          0.          0.       0.00

         HYDROGRAPH AT
                4.02           3.     8.00          1.          0.          0.       0.00

         HYDROGRAPH AT
                4.03           5.     8.00          2.          1.          1.       0.01

         HYDROGRAPH AT
                4.05           5.     8.00          2.          1.          1.       0.01

         HYDROGRAPH AT
                4.06           5.     8.00          2.          1.          1.       0.01

         HYDROGRAPH AT
                4.07           5.     8.00          2.          1.          1.       0.01

         HYDROGRAPH AT
                4.08           4.     8.00          1.          1.          1.       0.00

         HYDROGRAPH AT
                4.09           7.     8.00          2.          1.          1.       0.01

         HYDROGRAPH AT
                4.10          16.     8.00          5.          3.          3.       0.01

         HYDROGRAPH AT
                4.11           6.     8.00          2.          1.          1.       0.01

        22 COMBINED AT
               HVLAKE       1098.     8.00        423.        215.        215.
1.94

                                             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)

           R0181     MANE          0.92       4.12     480.16       3.26      5.00       4.11     480.00         3.27

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1411E+01 EXCESS=0.0000E+00 OUTFLOW=0.1410E+01 BASIN STORAGE=0.1270E-02 PERCENT ERROR=    0.0

           R018      MANE          0.24     325.94     494.88       3.00      5.00     325.94     495.00         3.00

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1380E+03 EXCESS=0.0000E+00 OUTFLOW=0.1380E+03 BASIN STORAGE=0.3455E-01 PERCENT ERROR=    0.0

           R017      MANE          0.46     327.31     494.88       3.00      5.00     327.31     495.00         3.00

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1388E+03 EXCESS=0.0000E+00 OUTFLOW=0.1388E+03 BASIN STORAGE=0.6635E-01 PERCENT ERROR=    0.0

           R016      MANE          0.26     328.36     495.24       3.00      5.00     328.33     495.00         3.00

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1394E+03 EXCESS=0.0000E+00 OUTFLOW=0.1394E+03 BASIN STORAGE=0.3874E-01 PERCENT ERROR=    0.0

           R015      MANE          0.19     329.29     495.12       2.99      5.00     329.25     495.00         3.00

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1399E+03 EXCESS=0.0000E+00 OUTFLOW=0.1399E+03 BASIN STORAGE=0.2812E-01 PERCENT ERROR=    0.0
```

```
                                                          K:\RICKJ\GHEC1\99205301\AREA4\4-YEAR25.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33      Data File: C:\WINDOWS\TEMP\-vbh2A78.TMP

****************************************                                                 ****************************************
*                                      *                                                 *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                 *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY  1991               *                                                 *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.0.1E             *                                                 *         609 SECOND STREET            *
*                                      *                                                 *       DAVIS, CALIFORNIA 95616        *
* RUN DATE  09/29/1999  TIME  09:54:02 *                                                 *           (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


                             :::::::::::::::::::::::::::::::::::::::::
                             :::::::::::::::::::::::::::::::::::::::::
                             :::                                   :::
                             :::  Full Microcomputer Implementation :::
                             :::                by                 :::
                             :::       Haestad Methods, Inc.       :::
                             :::                                   :::
                             :::::::::::::::::::::::::::::::::::::::::
                             :::::::::::::::::::::::::::::::::::::::::

                     37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666



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

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


                                                  HEC-1 INPUT                                                PAGE  1

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

              1           ID  HVL SWMP - Subbasin 4 - 25 Year Storm
              2           IT       5                      283
              3           IO       5       0

              4           KK  0181
              5           KM  SCS 24 Hour Type IA Rainfall Subbasin 4.01.08.01
              6           KO                                      22
              7           BA   .0081
              8           PB       7
              9           IN       6
             10           PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
             11           PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
             12           PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
             13           PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
             14           PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
             15           PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
             16           PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
             17           PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
             18           PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
             19           PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
             20           PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
             21           PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

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

2914 KO         OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
                      IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                       IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2        283  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT      0.083  TIME INTERVAL IN HOURS


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

              **************
              *            *
3061 KK       *   HVLAKE   *
              *            *
              **************

3063 KO         OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
                      IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                       IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2        283  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT      0.083  TIME INTERVAL IN HOURS

                                        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
             0181          5.    8.00          2.           1.           1.      0.01

         ROUTED TO
             R0181         5.    8.00          2.           1.           1.      0.01

         HYDROGRAPH AT
             018         427.    8.25        178.          90.          90.      0.86

         2 COMBINED AT
             018p        431.    8.17        180.          91.          91.      0.86

         ROUTED TO
             R018        430.    8.25        180.          91.          91.      0.86

         HYDROGRAPH AT
             017           3.    8.00          1.           1.           1.      0.01

         2 COMBINED AT
             017p        432.    8.25        181.          91.          91.      0.87

         ROUTED TO
             R017        432.    8.25        181.          91.          91.      0.87

         HYDROGRAPH AT
             016           2.    8.00          1.           0.           0.      0.00

         2 COMBINED AT
             016p        434.    8.25        182.          92.          92.      0.87

         ROUTED TO
             R016        434.    8.25        182.          92.          92.      0.87

         HYDROGRAPH AT
             015           2.    8.00          1.           0.           0.      0.00

         2 COMBINED AT
             015p        435.    8.25        183.          92.          92.      0.88

         ROUTED TO
             R015        435.    8.25        183.          92.          92.      0.88

         HYDROGRAPH AT
             0141          7.    8.00          2.           1.           1.      0.01

         ROUTED TO
             R0141         7.    8.00          2.           1.           1.      0.01

         HYDROGRAPH AT
             014          16.    8.00          5.           3.           3.      0.02

         3 COMBINED AT
             014p        450.    8.25        190.          96.          96.      0.90
```

```
ROUTED TO
        R014        450.    8.25        190.        96.         96.       0.90
```

```
HYDROGRAPH AT
    0135           31.     8.00          11.          5.          5.       0.03

ROUTED TO
   R0135           31.     8.00          11.          5.          5.       0.03

HYDROGRAPH AT
   01341            4.     8.00           1.          1.          1.       0.00

ROUTED TO
  R01341            4.     8.00           1.          1.          1.       0.00

HYDROGRAPH AT
   01342           19.     8.00           6.          3.          3.       0.02

HYDROGRAPH AT
    0134           12.     8.00           4.          2.          2.       0.01

4 COMBINED AT
   0134p           67.     8.00          22.         11.         11.       0.07

ROUTED TO
   R0134           67.     8.00          22.         11.         11.       0.07

HYDROGRAPH AT
    0133           19.     8.00           6.          3.          3.       0.02

2 COMBINED AT
   0133p           86.     8.00          29.         14.         14.       0.08

ROUTED TO
   R0133           86.     8.00          29.         14.         14.       0.08

HYDROGRAPH AT
   01321            5.     8.00           1.          1.          1.       0.00

ROUTED TO
  R01321            5.     8.00           1.          1.          1.       0.00

HYDROGRAPH AT
    0132           13.     8.00           4.          2.          2.       0.01

3 COMBINED AT
   0132p          103.     8.00          34.         17.         17.       0.10

ROUTED TO
   R0132          103.     8.00          34.         17.         17.       0.10

HYDROGRAPH AT
    0131           20.     8.00           7.          3.          3.       0.02

2 COMBINED AT
   0131p          123.     8.00          41.         21.         21.       0.12

ROUTED TO
   R0131          122.     8.00          41.         21.         21.       0.12

HYDROGRAPH AT
     013           12.     8.00           4.          2.          2.       0.01

3 COMBINED AT
    013p          554.     8.17         235.        119.        119.       1.03

ROUTED TO
    R013          554.     8.17         235.        119.        119.       1.03

HYDROGRAPH AT
    0122           29.     8.00           9.          5.          5.       0.02

ROUTED TO
   R0122           29.     8.00           9.          5.          5.       0.02

HYDROGRAPH AT
    0121           15.     8.00           5.          3.          3.       0.01

2 COMBINED AT
   0121p           44.     8.00          15.          7.          7.       0.04

ROUTED TO
   R0121           44.     8.00          15.          7.          7.       0.04

HYDROGRAPH AT
     012           18.     8.00           6.          3.          3.       0.02

3 COMBINED AT
    012p          605.     8.08         255.        129.        129.       1.09

ROUTED TO
    R012          603.     8.08         255.        129.        129.       1.09

HYDROGRAPH AT
    0111           14.     8.00           5.          2.          2.       0.01

HYDROGRAPH AT
     011           11.     8.00           4.          2.          2.       0.01
```

```
 3 COMBINED AT
        011p         625.    8.08        263.       133.       133.      1.11

 ROUTED TO
        R011         620.    8.08        263.       133.       133.      1.11

 HYDROGRAPH AT
        1052          18.    8.00          6.         3.         3.      0.02

 ROUTED TO
        R1052         18.    8.00          6.         3.         3.      0.02

 HYDROGRAPH AT
        1051           6.    8.00          2.         1.         1.      0.01

 2 COMBINED AT
        1051p         24.    8.00          8.         4.         4.      0.03

 ROUTED TO
        R1051         24.    8.00          8.         4.         4.      0.03
```

```
 HYDROGRAPH AT
         107            3.     8.00           1.          1.          1.      0.00

 ROUTED TO
        R107            3.     8.00           1.          1.          1.      0.00

 HYDROGRAPH AT
         106           38.     8.00          13.          6.          6.      0.05

 2 COMBINED AT
        106p           41.     8.00          14.          7.          7.      0.06

 ROUTED TO
        R106           41.     8.00          14.          7.          7.      0.06

 HYDROGRAPH AT
         105           13.     8.00           4.          2.          2.      0.02

 3 COMBINED AT
        105p           77.     8.00          26.         13.         13.      0.11

 ROUTED TO
        R105           77.     8.00          26.         13.         13.      0.11

 HYDROGRAPH AT
        1043            2.     8.00           1.          0.          0.      0.00

 ROUTED TO
       R1043            2.     8.00           1.          0.          0.      0.00

 HYDROGRAPH AT
        1042            8.     8.00           3.          1.          1.      0.01

 2 COMBINED AT
       1043p           10.     8.00           3.          2.          2.      0.01

 ROUTED TO
       R1042           10.     8.00           3.          2.          2.      0.01

 HYDROGRAPH AT
        1041            2.     8.00           1.          0.          0.      0.00

 2 COMBINED AT
       1041p           11.     8.00           4.          2.          2.      0.01

 ROUTED TO
       R1041           11.     8.00           4.          2.          2.      0.01

 HYDROGRAPH AT
         104            8.     8.00           3.          1.          1.      0.01

 3 COMBINED AT
        104p           97.     8.00          33.         16.         16.      0.13

 ROUTED TO
        R104           97.     8.00          33.         16.         16.      0.13

 HYDROGRAPH AT
         103            7.     8.00           2.          1.          1.      0.01

 2 COMBINED AT
        103p          104.     8.00          35.         18.         18.      0.14

 ROUTED TO
        R103          104.     8.00          35.         18.         18.      0.14

 HYDROGRAPH AT
        1021            2.     8.00           1.          0.          0.      0.00

 ROUTED TO
       R1021            2.     8.00           1.          0.          0.      0.00

 HYDROGRAPH AT
         102           11.     8.00           4.          2.          2.      0.01

 3 COMBINED AT
        102p          116.     8.00          39.         20.         20.      0.16

 ROUTED TO
        R102          116.     8.00          39.         20.         20.      0.16

 HYDROGRAPH AT
       10121            3.     8.00           1.          1.          1.      0.00

 ROUTED TO
      R10121            3.     8.00           1.          1.          1.      0.00

 HYDROGRAPH AT
       10122            3.     8.00           1.          1.          1.      0.00

 ROUTED TO
      R10122            3.     8.00           1.          1.          1.      0.00

 HYDROGRAPH AT
```

```
3 COMBINED AT
       1012p        12.    8.00          4.         2.         2.      0.02

ROUTED TO
       R1012        12.    8.00          4.         2.         2.      0.02

HYDROGRAPH AT
       1011          7.    8.00          2.         1.         1.      0.01

ROUTED TO
       R1011         7.    8.00          2.         1.         1.      0.01

HYDROGRAPH AT
       101          15.    8.00          5.         3.         3.      0.02

4 COMBINED AT
       101p        150.    8.00         51.        26.        26.      0.20

ROUTED TO
       R101        150.    8.00         51.        26.        26.      0.20
```

```
HYDROGRAPH AT
      026          2.    8.00        1.        0.        0.     0.00

ROUTED TO
     R026          1.    8.08        1.        0.        0.     0.00

HYDROGRAPH AT
      025          7.    8.00        2.        1.        1.     0.01

2 COMBINED AT
      025p         8.    8.00        3.        1.        1.     0.01

ROUTED TO
     R025          8.    8.00        3.        1.        1.     0.01

HYDROGRAPH AT
      0241         5.    8.00        2.        1.        1.     0.01

ROUTED TO
     R0241         5.    8.00        2.        1.        1.     0.01

HYDROGRAPH AT
      024         17.    8.00        6.        3.        3.     0.03

3 COMBINED AT
      024p        30.    8.00       10.        5.        5.     0.05

ROUTED TO
     R024         30.    8.00       10.        5.        5.     0.05

HYDROGRAPH AT
      0231         3.    8.00        1.        1.        1.     0.00

ROUTED TO
     R0231         3.    8.00        1.        1.        1.     0.00

HYDROGRAPH AT
      023         26.    8.00        9.        5.        5.     0.04

3 COMBINED AT
      023p        59.    8.00       20.       10.       10.     0.09

ROUTED TO
     R023         59.    8.00       20.       10.       10.     0.09

HYDROGRAPH AT
      022         38.    8.00       13.        6.        6.     0.05

2 COMBINED AT
      022p        96.    8.00       33.       17.       17.     0.14

ROUTED TO
     R022         96.    8.00       33.       17.       17.     0.14

HYDROGRAPH AT
      021         46.    8.00       16.        8.        8.     0.07

2 COMBINED AT
      021p       143.    8.00       48.       24.       24.     0.21

ROUTED TO
     R021        142.    8.00       48.       24.       24.     0.21

HYDROGRAPH AT
      116         14.    8.00        5.        2.        2.     0.02

ROUTED TO
     R116         14.    8.00        5.        2.        2.     0.02

HYDROGRAPH AT
      115          9.    8.00        3.        1.        1.     0.01

2 COMBINED AT
      115p        23.    8.00        8.        4.        4.     0.03

ROUTED TO
     R115         23.    8.00        8.        4.        4.     0.03

HYDROGRAPH AT
      114         11.    8.00        4.        2.        2.     0.01

2 COMBINED AT
      114p        33.    8.00       11.        6.        6.     0.05

ROUTED TO
     R114         33.    8.00       11.        6.        6.     0.05

HYDROGRAPH AT
      1132         3.    8.00        1.        0.        0.     0.00

ROUTED TO
     R1132         3.    8.00        1.        0.        0.     0.00

HYDROGRAPH AT
      1131         1.    8.00        0.        0.        0.     0.00
```

```
2 COMBINED AT
       1131p          4.     8.00          1.          1.          1.        0.01

ROUTED TO
       R1131          4.     8.00          1.          1.          1.        0.01

HYDROGRAPH AT
       113            3.     8.00          1.          1.          1.        0.00

3 COMBINED AT
       113p          40.     8.00         14.          7.          7.        0.06

ROUTED TO
       R113          40.     8.00         14.          7.          7.        0.06

HYDROGRAPH AT
       1121          11.     8.00          4.          2.          2.        0.02

ROUTED TO
       R1121         11.     8.00          4.          2.          2.        0.02
```

```
HYDROGRAPH AT
      112           2.    8.00         1.          0.          0.      0.00

3 COMBINED AT
      112p         53.    8.00        18.          9.          9.      0.07

ROUTED TO
     R112          52.    8.00        18.          9.          9.      0.07

HYDROGRAPH AT
      111           2.    8.00         1.          0.          0.      0.00

HYDROGRAPH AT
     1111           3.    8.00         1.          0.          0.      0.00

3 COMBINED AT
      111p         58.    8.00        20.         10.         10.      0.08

ROUTED TO
     R111          58.    8.00        20.         10.         10.      0.08

HYDROGRAPH AT
      043          28.    8.00         9.          5.          5.      0.04

HYDROGRAPH AT
     0431          16.    8.00         5.          3.          3.      0.02

2 COMBINED AT
      043p         45.    8.00        15.          7.          7.      0.06

ROUTED TO
     R043          44.    8.00        15.          7.          7.      0.06

HYDROGRAPH AT
      042          43.    8.00        14.          7.          7.      0.05

2 COMBINED AT
      042p         87.    8.00        29.         15.         15.      0.11

ROUTED TO
     R042          87.    8.00        29.         15.         15.      0.11

HYDROGRAPH AT
     0411          12.    8.00         4.          2.          2.      0.01

ROUTED TO
     R0411         12.    8.00         4.          2.          2.      0.01

HYDROGRAPH AT
      041          68.    8.00        22.         11.         11.      0.08

3 COMBINED AT
      041p        167.    8.00        55.         28.         28.      0.21

ROUTED TO
     R041         167.    8.00        55.         28.         28.      0.21

HYDROGRAPH AT
      031           3.    8.00         1.          0.          0.      0.00

ROUTED TO
     R031           3.    8.00         1.          0.          0.      0.00

HYDROGRAPH AT
     0501           2.    8.00         1.          0.          0.      0.00

ROUTED TO
     R0501          2.    8.00         1.          0.          0.      0.00

HYDROGRAPH AT
     0601           6.    8.00         2.          1.          1.      0.01

ROUTED TO
     R0601          6.    8.00         2.          1.          1.      0.01

HYDROGRAPH AT
     0701           5.    8.00         2.          1.          1.      0.01

ROUTED TO
     R0701          5.    8.00         2.          1.          1.      0.01

HYDROGRAPH AT
     0801           5.    8.00         1.          1.          1.      0.00

ROUTED TO
     R0801          5.    8.00         1.          1.          1.      0.00

HYDROGRAPH AT
     0901           7.    8.00         2.          1.          1.      0.01

ROUTED TO
     R0901          7.    8.00         2.          1.          1.      0.01

HYDROGRAPH AT
     4.01           6.    8.00         2.          1.          1.      0.01
```

```
HYDROGRAPH AT
      4.04          2.    8.00         1.         0.        0.      0.00

HYDROGRAPH AT
      4.02          4.    8.00         1.         1.        1.      0.00

HYDROGRAPH AT
      4.03          6.    8.00         2.         1.        1.      0.01

HYDROGRAPH AT
      4.05          7.    8.00         2.         1.        1.      0.01

HYDROGRAPH AT
      4.06          6.    8.00         2.         1.        1.      0.01

HYDROGRAPH AT
      4.07          6.    8.00         2.         1.        1.      0.01

HYDROGRAPH AT
      4.08          5.    8.00         1.         1.        1.      0.00
```

```
    HYDROGRAPH AT
           4.09           9.    8.00          3.          2.          2.        0.01

    HYDROGRAPH AT
           4.10          11.    8.00          4.          2.          2.        0.01

    HYDROGRAPH AT
           4.11           7.    8.00          2.          1.          1.        0.01

    HYDROGRAPH AT
            WS5        1783.    8.33        811.        405.        405.        3.56

  23 COMBINED AT
          HVLAKE       2752.    8.25       1277.        642.        642.        5.50

                                      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)

        R0181    MANE         0.86       5.33     480.30       4.13       5.00      5.32    480.00        4.13

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1785E+01 EXCESS=0.0000E+00 OUTFLOW=0.1784E+01 BASIN STORAGE=0.1461E-02 PERCENT ERROR=   0.0

        R018     MANE         0.22     430.75     490.49       3.83       5.00    430.48    495.00        3.83

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1763E+03 EXCESS=0.0000E+00 OUTFLOW=0.1763E+03 BASIN STORAGE=0.3978E-01 PERCENT ERROR=   0.0

        R017     MANE         0.43     432.46     494.83       3.83       5.00    432.40    495.00        3.83

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1773E+03 EXCESS=0.0000E+00 OUTFLOW=0.1773E+03 BASIN STORAGE=0.7639E-01 PERCENT ERROR=   0.0

        R016     MANE         0.24     433.84     495.00       3.83       5.00    433.84    495.00        3.83

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1781E+03 EXCESS=0.0000E+00 OUTFLOW=0.1780E+03 BASIN STORAGE=0.4451E-01 PERCENT ERROR=   0.0

        R015     MANE         0.17     435.11     494.96       3.83       5.00    435.11    495.00        3.83

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1788E+03 EXCESS=0.0000E+00 OUTFLOW=0.1787E+03 BASIN STORAGE=0.3231E-01 PERCENT ERROR=   0.0

        R0141    MANE         2.67       7.43     480.58       6.37       5.00      7.41    480.00        6.38

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2420E+01 EXCESS=0.0000E+00 OUTFLOW=0.2415E+01 BASIN STORAGE=0.5921E-02 PERCENT ERROR=   0.0

        R014     MANE         0.71     450.57     491.39       3.88       5.00    450.19    495.00        3.89

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1865E+03 EXCESS=0.0000E+00 OUTFLOW=0.1864E+03 BASIN STORAGE=0.1466E+00 PERCENT ERROR=   0.0

        R0135    MANE         0.70      31.36     480.52       6.06       5.00     31.36    480.00        6.06

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1031E+02 EXCESS=0.0000E+00 OUTFLOW=0.1030E+02 BASIN STORAGE=0.6670E-02 PERCENT ERROR=   0.0

        R01341   MANE         2.20       4.46     479.88       7.24       5.00      4.46    480.00        7.24

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1432E+01 EXCESS=0.0000E+00 OUTFLOW=0.1429E+01 BASIN STORAGE=0.2681E-02 PERCENT ERROR=   0.0

        R0134    MANE         0.39      66.91     480.20       6.26       5.00     66.90    480.00        6.26

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2187E+02 EXCESS=0.0000E+00 OUTFLOW=0.2186E+02 BASIN STORAGE=0.7826E-02 PERCENT ERROR=   0.0
```

```
                                                   K:\RICKJ\GHEC1\99205301\AREA4\4-YR100.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33      Data File: C:\WINDOWS\TEMP\-vbh3968.TMP

****************************************                          ***************************************
*                                      *                          *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                          *   U.S. ARMY CORPS OF ENGINEERS      *
*              MAY  1991               *                          *   HYDROLOGIC ENGINEERING CENTER     *
*            VERSION 4.0.1E            *                          *         609 SECOND STREET           *
*                                      *                          *       DAVIS, CALIFORNIA 95616       *
* RUN DATE  09/29/1999  TIME  13:11:09 *                          *          (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


                      :::::::::::::::::::::::::::::::::::::::::
                      :::::::::::::::::::::::::::::::::::::::::
                      :::                                   :::
                      :::   Full Microcomputer Implementation :::
                      :::                 by                :::
                      :::          Haestad Methods, Inc.    :::
                      :::                                   :::
                      :::::::::::::::::::::::::::::::::::::::::
                      :::::::::::::::::::::::::::::::::::::::::

               37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666



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

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


                                      HEC-1 INPUT                                                 PAGE  1

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

   1           ID  HVL SWMP - Subbasin 4 -100 Year Storm
   2           IT      5                 283
   3           IO      5       0

   4           KK  0181
   5           KM  SCS 24 Hour Type IA Rainfall Subbasin 4.01.08.01
   6           KO                                        22
   7           BA   .0081
   8           PB     9.5
   9           IN       6
  10           PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
  11           PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
  12           PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
  13           PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
  14           PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
  15           PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
  16           PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
  17           PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
  18           PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
  19           PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
  20           PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
  21           PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
          **************

2914 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                        IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        283  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT      0.083  TIME INTERVAL IN HOURS


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

          **************
          *            *
3061 KK   *   HVLAKE   *
          *            *
          **************

3063 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                        IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        283  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT      0.083  TIME INTERVAL IN HOURS

                                                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
                  0181          8.    8.00          3.           1.           1.      0.01

         ROUTED TO
                 R0181          8.    8.00          3.           1.           1.      0.01

         HYDROGRAPH AT
                   018        705.    8.17        282.         141.         141.      0.86

         2 COMBINED AT
                  018p        711.    8.17        285.         143.         143.      0.86

         ROUTED TO
                  R018        710.    8.17        285.         143.         143.      0.86

         HYDROGRAPH AT
                   017          5.    8.00          2.           1.           1.      0.01

         2 COMBINED AT
                  017p        714.    8.17        287.         144.         144.      0.87

         ROUTED TO
                  R017        712.    8.17        287.         143.         143.      0.87

         HYDROGRAPH AT
                   016          4.    8.00          1.           1.           1.      0.00

         2 COMBINED AT
                  016p        715.    8.17        288.         144.         144.      0.87

         ROUTED TO
                  R016        714.    8.17        288.         144.         144.      0.87

         HYDROGRAPH AT
                   015          3.    8.00          1.           1.           1.      0.00

         2 COMBINED AT
                  015p        716.    8.17        289.         145.         145.      0.88

         ROUTED TO
                  R015        716.    8.17        289.         145.         145.      0.88

         HYDROGRAPH AT
                  0141          7.    8.00          2.           1.           1.      0.01

         ROUTED TO
                 R0141          7.    8.00          2.           1.           1.      0.01

         HYDROGRAPH AT
                   014         16.    8.00          5.           3.           3.      0.02

         3 COMBINED AT
                  014p        734.    8.17        297.         149.         149.      0.90
```

```
ROUTED TO
       R014          731.    8.17          297.        149.         149.         0.90
```

```
HYDROGRAPH AT
          0135        31.    8.00        11.         5.         5.      0.03

ROUTED TO
          R0135       31.    8.00        11.         5.         5.      0.03

HYDROGRAPH AT
          01341        4.    8.00         1.         1.         1.      0.00

ROUTED TO
          R01341       4.    8.00         1.         1.         1.      0.00

HYDROGRAPH AT
          01342       19.    8.00         6.         3.         3.      0.02

HYDROGRAPH AT
          0134        12.    8.00         4.         2.         2.      0.01

4 COMBINED AT
          0134p       67.    8.00        22.        11.        11.      0.07

ROUTED TO
          R0134       67.    8.00        22.        11.        11.      0.07

HYDROGRAPH AT
          0133        19.    8.00         6.         3.         3.      0.02

2 COMBINED AT
          0133p       86.    8.00        29.        14.        14.      0.08

ROUTED TO
          R0133       86.    8.00        29.        14.        14.      0.08

HYDROGRAPH AT
          01321        5.    8.00         1.         1.         1.      0.00

ROUTED TO
          R01321       5.    8.00         1.         1.         1.      0.00

HYDROGRAPH AT
          0132        13.    8.00         4.         2.         2.      0.01

3 COMBINED AT
          0132p      103.    8.00        34.        17.        17.      0.10

ROUTED TO
          R0132      103.    8.00        34.        17.        17.      0.10

HYDROGRAPH AT
          0131        20.    8.00         7.         3.         3.      0.02

2 COMBINED AT
          0131p      123.    8.00        41.        21.        21.      0.12

ROUTED TO
          R0131      122.    8.00        41.        21.        21.      0.12

HYDROGRAPH AT
          013         12.    8.00         4.         2.         2.      0.01

3 COMBINED AT
          013p       837.    8.17       342.       171.       171.      1.03

ROUTED TO
          R013       836.    8.17       342.       171.       171.      1.03

HYDROGRAPH AT
          0122        29.    8.00         9.         5.         5.      0.02

ROUTED TO
          R0122       29.    8.00         9.         5.         5.      0.02

HYDROGRAPH AT
          0121        15.    8.00         5.         3.         3.      0.01

2 COMBINED AT
          0121p       44.    8.00        15.         7.         7.      0.04

ROUTED TO
          R0121       44.    8.00        15.         7.         7.      0.04

HYDROGRAPH AT
          012         18.    8.00         6.         3.         3.      0.02

3 COMBINED AT
          012p       883.    8.17       362.       182.       182.      1.09

ROUTED TO
          R012       882.    8.17       362.       181.       181.      1.09

HYDROGRAPH AT
          0111        14.    8.00         5.         2.         2.      0.01

HYDROGRAPH AT
          011         11.    8.00         4.         2.         2.      0.01
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```
 3 COMBINED AT       900.    8.17        370.        186.       186.       1.11
        011p

 ROUTED TO           900.    8.17        370.        186.       186.       1.11
         R011

 HYDROGRAPH AT        28.    8.00          9.          5.         5.       0.02
         1052

 ROUTED TO            28.    8.00          9.          5.         5.       0.02
        R1052

 HYDROGRAPH AT         9.    8.00          3.          1.         1.       0.01
         1051

 2 COMBINED AT        36.    8.00         12.          6.         6.       0.03
        1051p

 ROUTED TO            36.    8.00         12.          6.         6.       0.03
        R1051
```

```
HYDROGRAPH AT          5.    8.00      2.      1.      1.    0.00
     107
ROUTED TO              5.    8.00      2.      1.      1.    0.00
     R107
HYDROGRAPH AT         59.    8.00     19.     10.     10.    0.05
     106
2 COMBINED AT         63.    8.00     21.     11.     11.    0.06
     106p
ROUTED TO             63.    8.00     21.     11.     11.    0.06
     R106
HYDROGRAPH AT         20.    8.00      7.      3.      3.    0.02
     105
3 COMBINED AT        119.    8.00     39.     20.     20.    0.11
     105p
ROUTED TO            119.    8.00     39.     20.     20.    0.11
     R105
HYDROGRAPH AT          3.    8.00      1.      0.      0.    0.00
     1043
ROUTED TO              3.    8.00      1.      0.      0.    0.00
     R1043
HYDROGRAPH AT         12.    8.00      4.      2.      2.    0.01
     1042
2 COMBINED AT         14.    8.00      5.      2.      2.    0.01
     1043p
ROUTED TO             14.    8.00      5.      2.      2.    0.01
     R1042
HYDROGRAPH AT          3.    8.00      1.      0.      0.    0.00
     1041
2 COMBINED AT         17.    8.00      6.      3.      3.    0.01
     1041p
ROUTED TO             17.    8.00      6.      3.      3.    0.01
     R1041
HYDROGRAPH AT         13.    8.00      4.      2.      2.    0.01
     104
3 COMBINED AT        149.    8.00     49.     25.     25.    0.13
     104p
ROUTED TO            149.    8.00     49.     25.     25.    0.13
     R104
HYDROGRAPH AT         11.    8.00      4.      2.      2.    0.01
     103
2 COMBINED AT        160.    8.00     53.     27.     27.    0.14
     103p
ROUTED TO            159.    8.00     53.     27.     27.    0.14
     R103
HYDROGRAPH AT          3.    8.00      1.      0.      0.    0.00
     1021
ROUTED TO              2.    8.00      1.      0.      0.    0.00
     R1021
HYDROGRAPH AT         17.    8.00      6.      3.      3.    0.01
     102
3 COMBINED AT        179.    8.00     59.     30.     30.    0.16
     102p
ROUTED TO            179.    8.00     59.     30.     30.    0.16
     R102
HYDROGRAPH AT          5.    8.00      2.      1.      1.    0.00
     10121
ROUTED TO              5.    8.00      2.      1.      1.    0.00
     R10121
HYDROGRAPH AT          5.    8.00      2.      1.      1.    0.00
     10122
ROUTED TO              5.    8.00      2.      1.      1.    0.00
     R10122
HYDROGRAPH AT          9.    8.00      3.      1.      1.    0.01
     1012
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```
3 COMBINED AT
        1012p      18.     8.00          6.          3.          3.       0.02

ROUTED TO
        R1012      18.     8.00          6.          3.          3.       0.02

HYDROGRAPH AT
         1011      11.     8.00          4.          2.          2.       0.01

ROUTED TO
        R1011      11.     8.00          4.          2.          2.       0.01

HYDROGRAPH AT
          101      23.     8.00          8.          4.          4.       0.02

4 COMBINED AT
         101p     231.     8.00         77.         38.         38.       0.20

ROUTED TO
         R101     231.     8.00         77.         38.         38.       0.20
```

```
 HYDROGRAPH AT        2.     8.00        1.        0.        0.      0.00
          026
 ROUTED TO            2.     8.00        1.        0.        0.      0.00
          R026
 HYDROGRAPH AT       11.     8.00        4.        2.        2.      0.01
          025
 2 COMBINED AT       13.     8.00        4.        2.        2.      0.01
          025p
 ROUTED TO           13.     8.00        4.        2.        2.      0.01
          R025
 HYDROGRAPH AT        8.     8.00        3.        1.        1.      0.01
          0241
 ROUTED TO            8.     8.00        3.        1.        1.      0.01
          R0241
 HYDROGRAPH AT       26.     8.00        9.        4.        4.      0.03
          024
 3 COMBINED AT       48.     8.00       16.        8.        8.      0.05
          024p
 ROUTED TO           47.     8.00       16.        8.        8.      0.05
          R024
 HYDROGRAPH AT        5.     8.00        2.        1.        1.      0.00
          0231
 ROUTED TO            5.     8.00        2.        1.        1.      0.00
          R0231
 HYDROGRAPH AT       42.     8.00       14.        7.        7.      0.04
          023
 3 COMBINED AT       94.     8.00       31.       16.       16.      0.09
          023p
 ROUTED TO           94.     8.00       31.       16.       16.      0.09
          R023
 HYDROGRAPH AT       59.     8.00       20.       10.       10.      0.05
          022
 2 COMBINED AT      153.     8.00       51.       26.       26.      0.14
          022p
 ROUTED TO          153.     8.00       51.       26.       26.      0.14
          R022
 HYDROGRAPH AT       72.     8.00       24.       12.       12.      0.07
          021
 2 COMBINED AT      225.     8.00       75.       38.       38.      0.21
          021p
 ROUTED TO          224.     8.00       75.       38.       38.      0.21
          R021
 HYDROGRAPH AT       22.     8.00        7.        4.        4.      0.02
          116
 ROUTED TO           22.     8.00        7.        4.        4.      0.02
          R116
 HYDROGRAPH AT       13.     8.00        4.        2.        2.      0.01
          115
 2 COMBINED AT       35.     8.00       12.        6.        6.      0.03
          115p
 ROUTED TO           35.     8.00       12.        6.        6.      0.03
          R115
 HYDROGRAPH AT       16.     8.00        5.        3.        3.      0.01
          114
 2 COMBINED AT       51.     8.00       17.        9.        9.      0.05
          114p
 ROUTED TO           51.     8.00       17.        9.        9.      0.05
          R114
 HYDROGRAPH AT        5.     8.00        2.        1.        1.      0.00
          1132
 ROUTED TO            5.     8.00        2.        1.        1.      0.00
          R1132
 HYDROGRAPH AT        2.     8.00        1.        0.        0.      0.00
          1131
```

```
 2 COMBINED AT
          1131p        7.    8.00        2.        1.        1.     0.01

 ROUTED TO
          R1131        7.    8.00        2.        1.        1.     0.01

 HYDROGRAPH AT
            113        5.    8.00        2.        1.        1.     0.00

 3 COMBINED AT
           113p       63.    8.00       21.       10.       10.     0.06

 ROUTED TO
           R113       63.    8.00       21.       10.       10.     0.06

 HYDROGRAPH AT
           1121       17.    8.00        6.        3.        3.     0.02

 ROUTED TO
          R1121       17.    8.00        6.        3.        3.     0.02
```

```
HYDROGRAPH AT
   112            2.    8.00       1.       0.       0.     0.00

3 COMBINED AT
   112p          82.    8.00      27.      14.      14.     0.07

ROUTED TO
   R112          82.    8.00      27.      14.      14.     0.07

HYDROGRAPH AT
   111            4.    8.00       1.       1.       1.     0.00

HYDROGRAPH AT
   1111           4.    8.00       1.       1.       1.     0.00

3 COMBINED AT
   111p          90.    8.00      30.      15.      15.     0.08

ROUTED TO
   R111          90.    8.00      30.      15.      15.     0.08

HYDROGRAPH AT
   043           43.    8.00      14.       7.       7.     0.04

HYDROGRAPH AT
   0431          24.    8.00       8.       4.       4.     0.02

2 COMBINED AT
   043p          67.    8.00      22.      11.      11.     0.06

ROUTED TO
   R043          67.    8.00      22.      11.      11.     0.06

HYDROGRAPH AT
   042           64.    8.00      21.      11.      11.     0.05

2 COMBINED AT
   042p         131.    8.00      43.      22.      22.     0.11

ROUTED TO
   R042         131.    8.00      43.      22.      22.     0.11

HYDROGRAPH AT
   0411          18.    8.00       6.       3.       3.     0.01

ROUTED TO
   R0411         18.    8.00       6.       3.       3.     0.01

HYDROGRAPH AT
   041          102.    8.00      34.      17.      17.     0.08

3 COMBINED AT
   041p         251.    8.00      83.      42.      42.     0.21

ROUTED TO
   R041         251.    8.00      83.      41.      41.     0.21

HYDROGRAPH AT
   031            4.    8.00       1.       1.       1.     0.00

ROUTED TO
   R031           4.    8.00       1.       1.       1.     0.00

HYDROGRAPH AT
   0501           4.    8.00       1.       1.       1.     0.00

ROUTED TO
   R0501          4.    8.00       1.       1.       1.     0.00

HYDROGRAPH AT
   0601           9.    8.00       3.       2.       2.     0.01

ROUTED TO
   R0601          9.    8.00       3.       2.       2.     0.01

HYDROGRAPH AT
   0701           7.    7.92       2.       1.       1.     0.01

ROUTED TO
   R0701          7.    8.00       2.       1.       1.     0.01

HYDROGRAPH AT
   0801           7.    7.92       2.       1.       1.     0.00

ROUTED TO
   R0801          7.    7.92       2.       1.       1.     0.00

HYDROGRAPH AT
   0901          10.    8.00       3.       2.       2.     0.01

ROUTED TO
   R0901         10.    8.00       3.       2.       2.     0.01

HYDROGRAPH AT
   4.01          10.    8.00       3.       2.       2.     0.01
```

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HYDROGRAPH AT
        4.04      4.    8.00      1.      1.      1.    0.00

HYDROGRAPH AT
        4.02      6.    8.00      2.      1.      1.    0.00

HYDROGRAPH AT
        4.03      9.    8.00      3.      1.      1.    0.01

HYDROGRAPH AT
        4.05     10.    8.00      3.      2.      2.    0.01

HYDROGRAPH AT
        4.06      9.    7.92      3.      1.      1.    0.01

HYDROGRAPH AT
        4.07      9.    7.92      3.      2.      2.    0.01

HYDROGRAPH AT
        4.08      7.    7.92      2.      1.      1.    0.00
```

```
   HYDROGRAPH AT
         4.09          14.     8.00          5.          2.          2.      0.01

   HYDROGRAPH AT
         4.10          16.     8.00          5.          3.          3.      0.01

   HYDROGRAPH AT
         4.11          11.     8.00          4.          2.          2.      0.01

   HYDROGRAPH AT
          WS5        2859.     8.33       1258.        627.        627.      3.56

  23 COMBINED AT
        HVLAKE       4322.     8.25       1937.        969.        969.      5.50
                          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)

      R0181    MANE        0.77      8.48   479.79      6.38      5.00       8.48   480.00       6.38

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2760E+01 EXCESS=0.0000E+00 OUTFLOW=0.2758E+01 BASIN STORAGE=0.1905E-02 PERCENT ERROR=   0.0

      R018     MANE        0.20    711.30   490.23      6.02      5.00     710.36   490.00       6.02

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2772E+03 EXCESS=0.0000E+00 OUTFLOW=0.2771E+03 BASIN STORAGE=0.5181E-01 PERCENT ERROR=   0.0

      R017     MANE        0.37    714.01   490.41      6.02      5.00     712.18   490.00       6.02

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2788E+03 EXCESS=0.0000E+00 OUTFLOW=0.2787E+03 BASIN STORAGE=0.9948E-01 PERCENT ERROR=   0.0

      R016     MANE        0.21    714.98   490.43      6.02      5.00     713.87   490.00       6.02

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2800E+03 EXCESS=0.0000E+00 OUTFLOW=0.2799E+03 BASIN STORAGE=0.5776E-01 PERCENT ERROR=   0.0

      R015     MANE        0.15    716.41   490.19      6.02      5.00     715.55   490.00       6.02

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2810E+03 EXCESS=0.0000E+00 OUTFLOW=0.2810E+03 BASIN STORAGE=0.4193E-01 PERCENT ERROR=   0.0

      R0141    MANE        2.67      7.43   480.58      6.37      5.00       7.41   480.00       6.38

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2420E+01 EXCESS=0.0000E+00 OUTFLOW=0.2415E+01 BASIN STORAGE=0.5921E-02 PERCENT ERROR=   0.0

      R014     MANE        0.61    733.47   491.19      6.02      5.00     730.58   490.00       6.02

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2888E+03 EXCESS=0.0000E+00 OUTFLOW=0.2886E+03 BASIN STORAGE=0.1866E+00 PERCENT ERROR=   0.0

      R0135    MANE        0.70     31.36   480.52      6.06      5.00      31.36   480.00       6.06

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1031E+02 EXCESS=0.0000E+00 OUTFLOW=0.1030E+02 BASIN STORAGE=0.6670E-02 PERCENT ERROR=   0.0

      R01341   MANE        2.20      4.46   479.88      7.24      5.00       4.46   480.00       7.24

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1432E+01 EXCESS=0.0000E+00 OUTFLOW=0.1429E+01 BASIN STORAGE=0.2681E-02 PERCENT ERROR=   0.0

      R0134    MANE        0.39     66.91   480.20      6.26      5.00      66.90   480.00       6.26

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2187E+02 EXCESS=0.0000E+00 OUTFLOW=0.2186E+02 BASIN STORAGE=0.7826E-02 PERCENT ERROR=   0.0
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                                    K:\RICKJ\HECPACK\GHEC1\99205301\AREA5\5-00.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33    Data File: C:\WINDOWS\TEMP\~vbh3B03.TMP

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*****************************************                          *                                      *
*                                       *                          *   U.S. ARMY CORPS OF ENGINEERS       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                          *   HYDROLOGIC ENGINEERING CENTER      *
*              MAY   1991               *                          *        609 SECOND STREET             *
*           VERSION 4.0.1E              *                          *     DAVIS, CALIFORNIA 95616          *
*                                       *                          *         (916) 756-1104               *
* RUN DATE  07/21/1999  TIME  11:22:53  *                          *                                      *
*                                       *                          ****************************************
*****************************************


                         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


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                     :::::::::::::::::::::::::::::::::::::::::
                     :::                                   :::
                     :::  Full Microcomputer Implementation :::
                     :::                by                 :::
                     :::        Haestad Methods, Inc.      :::
                     :::                                   :::
                     :::::::::::::::::::::::::::::::::::::::::
                     :::::::::::::::::::::::::::::::::::::::::

          37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666



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

                                                                                      PAGE  1
                               HEC-1 INPUT

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

   1          ID  HVL SWMP - Subbasing 5 - 10 Year Storm
   2          IT       1                      1440
   3          IO       5       0

   4          KK  0200
   5          KM  SCS 24 Hour Type IA Rainfall  Subbasin 5.02.00
                                                    22
   6          KO
   7          BA  1.4641
   8          PB       6
   9          IN       6
  10          PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
  11          PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
  12          PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
  13          PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
  14          PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
  15          PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
  16          PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
  17          PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
  18          PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
  19          PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
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152 KO          OUTPUT CONTROL VARIABLES
                         IPRNT          5  PRINT CONTROL
                         IPLOT          0  PLOT CONTROL
                         QSCAL         0.  HYDROGRAPH PLOT SCALE
                         IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                          IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                         ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                         ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                        TIMINT      0.017  TIME INTERVAL IN HOURS

                                             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
                 0200         656.     8.42          297.         147.         147.       1.46

           ROUTED TO
                R0200         655.     8.47          297.         146.         146.       1.46

           HYDROGRAPH AT
                 0102          40.     7.92           13.           7.           7.       0.07

           2 COMBINED AT
                P0102         672.     8.45          310.         153.         153.       1.53

           ROUTED TO
                R0102         672.     8.53          310.         152.         152.       1.53

           HYDROGRAPH AT
                 0101           4.     7.90            1.           1.           1.       0.01

           ROUTED TO
                R0101           4.     7.93            1.           1.           1.       0.01

           HYDROGRAPH AT
                 0000          95.     8.47           50.          26.          26.       0.40

           3 COMBINED AT
                  5.0         768.     8.53          360.         179.         179.
1.94

                                  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)

            R0200    MANE         1.00    655.44    508.00       3.72       1.00    655.44    508.00       3.72

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2911E+03 EXCESS=0.0000E+00 OUTFLOW=0.2903E+03 BASIN STORAGE=0.8654E+00 PERCENT ERROR=   0.0

            R0102    MANE         1.00    671.83    512.00       3.70       1.00    671.83    512.00       3.70

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.3035E+03 EXCESS=0.0000E+00 OUTFLOW=0.3022E+03 BASIN STORAGE=0.1480E+01 PERCENT ERROR=   0.0

            R0101    MANE         1.00      3.78    476.00       3.21       1.00      3.78    476.00       3.21

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1285E+01 EXCESS=0.0000E+00 OUTFLOW=0.1283E+01 BASIN STORAGE=0.2649E-02 PERCENT ERROR=   0.0


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

```
                                                       K:\RICKJ\GHEC1\99205301\AREA5\5-YEAR25.OUT
HEC1 S/N: 1343001909          HMVersion: 6.33     Data File: C:\WINDOWS\TEMP\-vbh1005.TMP

*****************************************                                                  ****************************************
*                                       *                                                  *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY  1991                *                                                  *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.0.1E              *                                                  *         609 SECOND STREET            *
*                                       *                                                  *      DAVIS, CALIFORNIA 95616         *
* RUN DATE  09/29/1999  TIME  09:46:30  *                                                  *          (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


                                          :::::::::::::::::::::::::::::::::::::::::::
                                          :::::::::::::::::::::::::::::::::::::::::::
                                          :::                                     :::
                                          :::  Full Microcomputer Implementation  :::
                                          :::                 by                  :::
                                          :::         Haestad Methods, Inc.       :::
                                          :::                                     :::
                                          :::::::::::::::::::::::::::::::::::::::::::
                                          :::::::::::::::::::::::::::::::::::::::::::

                           37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666



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

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


                                              HEC-1 INPUT                                                         PAGE  1

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

             1           ID  HVL SWMP - Subbasing 5 - 25 Year Storm
             2           IT       1                 1440
             3           IO       5       0

             4           KK  0200
             5           KM  SCS 24 Hour Type IA Rainfall  Subbasin 5.02.00
             6           KO                                       22
             7           BA  1.4641
             8           PB       7
             9           IN       6
            10           PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
            11           PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
            12           PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
            13           PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
            14           PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
            15           PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
            16           PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
            17           PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
            18           PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
            19           PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
            20           PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
            21           PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
                    IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                   ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                   ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                  TIMINT       0.017  TIME INTERVAL IN HOURS


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

              **************
              *            *
 299 KK       *    5.0     *
              *            *
              **************

 301 KO            OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE
                    IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                     IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT      0.017  TIME INTERVAL IN HOURS


                                                     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
                   0200       828.    8.42          369.        182.        182.       1.46

         ROUTED TO
                  R0200       828.    8.45          369.        182.        182.       1.46

         HYDROGRAPH AT
                   0102        51.    7.92           17.          8.          8.       0.07

         HYDROGRAPH AT
                   WS 6       904.    8.17          358.        179.        179.       1.62

         3 COMBINED AT
                  P0102      1653.    8.28          743.        370.        370.       3.15

         ROUTED TO
                  R0102      1652.    8.35          743.        368.        368.       3.15

         HYDROGRAPH AT
                   0101         5.    7.90            2.          1.          1.       0.01

         ROUTED TO
                  R0101         5.    7.93            2.          1.          1.       0.01

         HYDROGRAPH AT
                   0000       134.    8.45           67.         34.         34.       0.40

         3 COMBINED AT
                    5.0      1785.    8.35          811.        403.        403.       3.56

                                          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)

           R0200     MANE        1.00     827.61    507.00       4.62      1.00    827.61    507.00        4.62

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.3614E+03 EXCESS=0.0000E+00 OUTFLOW=0.3605E+03 BASIN STORAGE=0.9863E+00 PERCENT ERROR=    0.0

           R0102     MANE        1.00    1652.03    501.00       4.34      1.00   1652.03    501.00        4.34

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.7326E+03 EXCESS=0.0000E+00 OUTFLOW=0.7301E+03 BASIN STORAGE=0.2836E+01 PERCENT ERROR=    0.0

           R0101     MANE        1.00       4.91    476.00       4.06      1.00      4.91    476.00        4.06

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1629E+01 EXCESS=0.0000E+00 OUTFLOW=0.1626E+01 BASIN STORAGE=0.3052E-02 PERCENT ERROR=    0.0
```

```
                                                K:\RICKJ\GHEC1\99205301\AREA5\5-YR100.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33    Data File: C:\WINDOWS\TEMP\-vbh1C00.TMP

*****************************************                 ****************************************
*                                       *                 *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                 *   U.S. ARMY CORPS OF ENGINEERS       *
*              MAY  1991                *                 *   HYDROLOGIC ENGINEERING CENTER      *
*          VERSION 4.0.1E               *                 *         609 SECOND STREET            *
*                                       *                 *     DAVIS, CALIFORNIA 95616          *
* RUN DATE  09/29/1999  TIME  13:07:31  *                 *          (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



                    ::::::::::::::::::::::::::::::::::::::::
                    ::::::::::::::::::::::::::::::::::::::::
                    :::                                  :::
                    :::  Full Microcomputer Implementation :::
                    :::              by                  :::
                    :::       Haestad Methods, Inc.      :::
                    :::                                  :::
                    ::::::::::::::::::::::::::::::::::::::::
                    ::::::::::::::::::::::::::::::::::::::::

              37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666



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

                                                                                              PAGE  1
                                    HEC-1 INPUT

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

   1          ID  HVL SWMP - Subbasin 5 - 100 Year Storm
   2          IT       1                        1440
   3          IO       5       0

   4          KK  0200
   5          KM  SCS 24 Hour Type IA Rainfall  Subbasin 5.02.00
   6          KO                                             22
   7          BA  1.4641
   8          PB     9.5
   9          IN       6
  10          PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
  11          PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
  12          PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
  13          PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
  14          PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
  15          PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
  16          PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
  17          PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
  18          PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
  19          PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
  20          PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
  21          PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
                 IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
               TIMINT       0.017  TIME INTERVAL IN HOURS


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


           **************
           *            *
299 KK     *    5.0     *
           *            *
           **************

301 KO          OUTPUT CONTROL VARIABLES
                     IPRNT           5  PRINT CONTROL
                     IPLOT           0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE
                     IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                      IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT       0.017  TIME INTERVAL IN HOURS

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

                                                                                       BASIN     MAXIMUM    TIME OF
                                      PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      AREA      STAGE     MAX STAGE
      OPERATION          STATION      FLOW      PEAK
                                               6-HOUR       24-HOUR      72-HOUR


      HYDROGRAPH AT
          0200            1268.       8.40         555.         274.        274.        1.46

      ROUTED TO
          R0200           1267.       8.43         555.         273.        273.        1.46

      HYDROGRAPH AT
          0102              77.       7.92          25.          12.         12.        0.07

      HYDROGRAPH AT
          WS6             1487.       8.15         565.         281.        281.        1.62

      3 COMBINED AT
          P0102           2626.       8.25        1144.         567.        567.        3.15

      ROUTED TO
          R0102           2624.       8.30        1144.         565.        565.        3.15

      HYDROGRAPH AT
          0101               8.       7.90           3.           1.          1.        0.01

      ROUTED TO
          R0101              8.       7.92           3.           1.          1.        0.01

      HYDROGRAPH AT
          0000             239.       8.43         112.          56.         56.        0.40

      3 COMBINED AT
          5.0             2860.       8.32        1258.         622.        622.        3.56
                                     SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                          (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                              INTERPOLATED TO
                                                                          COMPUTATION INTERVAL
                                                                                                   VOLUME
                                                                  DT          PEAK     TIME TO
           ISTAQ    ELEMENT     DT        PEAK     TIME TO    VOLUME                      PEAK
                                                     PEAK

                                                                                         (IN)
                               (MIN)      (CFS)     (MIN)       (IN)      (MIN)     (CFS)     (MIN)

                                                                                         6.93
           R0200    MANE        1.00   1267.08    506.00       6.93      1.00   1267.08    506.00

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5423E+03 EXCESS=0.0000E+00 OUTFLOW=0.5412E+03 BASIN STORAGE=0.1266E+01 PERCENT ERROR=    0.0

           R0102    MANE        1.00   2624.39    498.00       6.66      1.00   2624.39    498.00       6.66

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1124E+04 EXCESS=0.0000E+00 OUTFLOW=0.1120E+04 BASIN STORAGE=0.3671E+01 PERCENT ERROR=    0.0

           R0101    MANE        1.00      7.86    475.00       6.31      1.00      7.86    475.00       6.31

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2529E+01 EXCESS=0.0000E+00 OUTFLOW=0.2525E+01 BASIN STORAGE=0.3984E-02 PERCENT ERROR=    0.0
```

```
                                              K:\RICKJ\GHEC1\99205301\AREA6\6-00.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33   Data File: C:\WINDOWS\TEMP\-vbh391C.TMP

                                                                  ****************************************
*****************************************                         *                                      *
*                                       *                         *   U.S. ARMY CORPS OF ENGINEERS       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                         *   HYDROLOGIC ENGINEERING CENTER      *
*              MAY   1991               *                         *        609 SECOND STREET             *
*           VERSION 4.0.1E              *                         *     DAVIS, CALIFORNIA 95616          *
*                                       *                         *         (916) 756-1104               *
*  RUN DATE  08/21/1999  TIME  15:38:02 *                         *                                      *
*                                       *                         ****************************************
*****************************************


                              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


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                              ::::::::::::::::::::::::::::::::::::::::
                              :::                                  :::
                              :::  Full Microcomputer Implementation  :::
                              :::               by                 :::
                              :::       Haestad Methods, Inc.      :::
                              :::                                  :::
                              ::::::::::::::::::::::::::::::::::::::::
                              ::::::::::::::::::::::::::::::::::::::::

                 37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

                                                                                                    PAGE  1

                                         HEC-1 INPUT

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

   1            ID  HVL SWMP - Subasin 6 - 10 Year Storm
   2            IT       1                        1440
   3            IO       5       0

   4            KK  0601
   5            KM  SCS 24 Hour Type IA Rainfall - Subbasin 6.06.01
   6            KO                                                22
   7            BA   .0013
   8            PB       6
   9            IN       6
  10            PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
  11            PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
  12            PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
  13            PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
  14            PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
  15            PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
  16            PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
  17            PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
  18            PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
  19            PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
  20            PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
  21            PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

K:\RICKJ\GHEC1\99205301\AREA6\6-00.OUT

```
             **************
             *            *
728 KK       *    6.0     *
             *            *
             **************

730 KO          OUTPUT CONTROL VARIABLES
                      IPRNT           5  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE
                      IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                       IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       0.017  TIME INTERVAL IN HOURS

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

                                                                                 BASIN   MAXIMUM    TIME OF
                                  PEAK    TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD       AREA    STAGE    MAX STAGE
   OPERATION        STATION       FLOW      PEAK
                                         6-HOUR     24-HOUR      72-HOUR

   HYDROGRAPH AT
                0601          1.      7.98         0.          0.          0.        0.00

   ROUTED TO
               R0601          1.      8.00         0.          0.          0.        0.00

   HYDROGRAPH AT
                0602          8.      8.00         3.          1.          1.        0.02

   ROUTED TO
               R0602          8.      8.02         3.          1.          1.        0.02

   HYDROGRAPH AT
                0600          4.      8.00         1.          1.          1.        0.01

   3 COMBINED AT
               P0600         13.      8.00         4.          2.          2.        0.03

   ROUTED TO
               R0600         13.      8.22         4.          2.          2.        0.03

   HYDROGRAPH AT
                0500        127.      8.18        53.         27.         27.        0.34

   2 COMBINED AT
               P0500        140.      8.20        57.         29.         29.        0.37

   ROUTED TO
               R0500        140.      8.20        57.         29.         29.        0.37

   HYDROGRAPH AT
                0400          2.      8.03         1.          0.          0.        0.01

   2 COMBINED AT
               P0400        142.      8.20        58.         29.         29.        0.38

   ROUTED TO
               R0400        142.      8.27        58.         29.         29.        0.38

   HYDROGRAPH AT
              030301         22.      8.00         8.          4.          4.        0.04

   ROUTED TO
              R30301         22.      8.00         8.          4.          4.        0.04

   HYDROGRAPH AT
                0303          8.      8.00         3.          1.          1.        0.02

   2 COMBINED AT
               P0303         30.      8.00        10.          5.          5.        0.06

   ROUTED TO
               R0303         30.      8.12        10.          5.          5.        0.06

   HYDROGRAPH AT
                0302          5.      7.97         2.          1.          1.        0.01

   ROUTED TO
               R0302          5.      8.05         2.          1.          1.        0.01

   HYDROGRAPH AT
                0301          0.      7.93         0.          0.          0.        0.00

   ROUTED TO
               R0301          0.      8.07         0.          0.          0.        0.00

   HYDROGRAPH AT
                0300         35.      8.03        13.          7.          7.        0.10

   5 COMBINED AT
```

```
ROUTED TO
        R0300       199.   8.25        83.        42.        42.      0.54

HYDROGRAPH AT
         0203         4.   8.00         1.         1.         1.      0.01

ROUTED TO
        R0203         4.   8.03         1.         1.         1.      0.01
```

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 HYDROGRAPH AT
      0202          2.     8.00          1.        0.        0.     0.00

 2 COMBINED AT
     P0202          5.     8.02          2.        1.        1.     0.01

 ROUTED TO
     R0202          5.     8.02          2.        1.        1.     0.01

 HYDROGRAPH AT
      0201          2.     7.98          1.        0.        0.     0.00

 HYDROGRAPH AT
    020101          1.     8.98          1.        0.        0.     0.00

 3 COMBINED AT
     P0201          8.     8.02          3.        2.        2.     0.02

 ROUTED TO
     R0201          8.     8.08          3.        2.        2.     0.02

 HYDROGRAPH AT
      0200         43.     8.00         15.        7.        7.     0.08

 2 COMBINED AT
     P0200         51.     8.00         18.        9.        9.     0.10

 ROUTED TO
     R0200         51.     8.08         18.        9.        9.     0.10

 HYDROGRAPH AT
      0102          2.     7.95          1.        0.        0.     0.00

 ROUTED TO
     R0102          2.     7.97          1.        0.        0.     0.00

 HYDROGRAPH AT
      0101          2.     7.95          1.        0.        0.     0.00

 2 COMBINED AT
     P0101          4.     7.97          1.        1.        1.     0.01

 ROUTED TO
     R0101          4.     8.03          1.        1.        1.     0.01

 HYDROGRAPH AT
      0100         20.     7.97          7.        3.        3.     0.03

 2 COMBINED AT
     P0100         24.     7.97          8.        4.        4.     0.04

 ROUTED TO
     R0100         24.     8.05          8.        4.        4.     0.04

 HYDROGRAPH AT
      0000        420.     8.18        170.       86.       86.     1.05

 4 COMBINED AT
       6.0        683.     8.18        279.      141.      141.     1.72

                              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)

          R0601     MANE        1.00      0.66    481.00      3.26     1.00      0.66    481.00      3.26

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2267E+00 EXCESS=0.0000E+00 OUTFLOW=0.2263E+00 BASIN STORAGE=0.4231E-03 PERCENT ERROR=   0.0

          R0602     MANE        0.99      8.07    480.71      3.03     1.00      8.07    481.00      3.04

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2851E+01 EXCESS=0.0000E+00 OUTFLOW=0.2849E+01 BASIN STORAGE=0.2803E-02 PERCENT ERROR=   0.0

          R0600     MANE        1.00     12.74    493.00      3.06     1.00     12.74    493.00      3.06

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.4467E+01 EXCESS=0.0000E+00 OUTFLOW=0.4395E+01 BASIN STORAGE=0.8313E-01 PERCENT ERROR=  -0.2

          R0500     MANE        0.50    140.10    491.91      2.90     1.00    140.10    492.00      2.90

 CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5733E+02 EXCESS=0.0000E+00 OUTFLOW=0.5730E+02 BASIN STORAGE=0.3125E-01 PERCENT ERROR=   0.0

          R0400     MANE        1.00    141.88    496.00      2.88     1.00    141.88    496.00      2.88

 CONTINUITY SUMMARY (AC-FT) -
```

```
                                                 K:\RICKJ\GHEC1\99205301\AREA6\6-YEAR25.OUT
HEC1 S/N: 1343001909          HMVersion: 6.33    Data File: C:\WINDOWS\TEMP\-vbh180F.TMP

*****************************************                          *****************************************
*                                       *                          *                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                          *   U.S. ARMY CORPS OF ENGINEERS        *
*             MAY   1991                *                          *   HYDROLOGIC ENGINEERING CENTER       *
*          VERSION 4.0.1E               *                          *          609 SECOND STREET            *
*                                       *                          *       DAVIS, CALIFORNIA 95616         *
*  RUN DATE  09/29/1999  TIME  09:28:34 *                          *           (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


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                          :::::::::::::::::::::::::::::::::::::::::::
                          :::                                     :::
                          :::  Full Microcomputer Implementation  :::
                          :::                by                   :::
                          :::        Haestad Methods, Inc.        :::
                          :::                                     :::
                          :::::::::::::::::::::::::::::::::::::::::::
                          :::::::::::::::::::::::::::::::::::::::::::

                   37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

                                                                                          PAGE  1
                                  HEC-1 INPUT

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

  1           ID  HVL SWMP - Subasin 6 - 25 Year Storm
  2           IT       1                      1440
  3           IO       5       0

  4           KK  0601
  5           KM  SCS 24 Hour Type IA Rainfall - Subbasin 6.06.01
  6           KO                                      22
  7           BA   .0013
  8           PB       7
  9           IN       6
 10           PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
 11           PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
 12           PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
 13           PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
 14           PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
 15           PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
 16           PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
 17           PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
 18           PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
 19           PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
 20           PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
 21           PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

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                              K:\RICKJ\GHEC1\99205301\AREA6\6-YEAR25.OUT

              ***************
              *             *
728 KK        *     6.0     *
              *             *
              ***************

730 KO          OUTPUT CONTROL VARIABLES
                    IPRNT           5  PRINT CONTROL
                    IPLOT           0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE
                    IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                     IOUT          22  SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2        1440  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT       0.017  TIME INTERVAL IN HOURS

                                         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
          0601            1.     7.97          0.         0.         0.       0.00

  ROUTED TO
          R0601           1.     8.00          0.         0.         0.       0.00

  HYDROGRAPH AT
          0602           11.     8.00          4.         2.         2.       0.02

  ROUTED TO
          R0602          11.     8.00          4.         2.         2.       0.02

  HYDROGRAPH AT
          0600            5.     7.98          2.         1.         1.       0.01

  3 COMBINED AT
          P0600          17.     8.00          6.         3.         3.       0.03

  ROUTED TO
          R0600          17.     8.20          6.         3.         3.       0.03

  HYDROGRAPH AT
          0500          170.     8.18         68.        34.        34.       0.34

  2 COMBINED AT
          P0500         187.     8.18         74.        37.        37.       0.37

  ROUTED TO
          R0500         187.     8.18         74.        37.        37.       0.37

  HYDROGRAPH AT
          0400            3.     8.02          1.         1.         1.       0.01

  2 COMBINED AT
          P0400         189.     8.18         75.        38.        38.       0.38

  ROUTED TO
          R0400         189.     8.25         75.        37.        37.       0.38

  HYDROGRAPH AT
          030301         29.     7.98         10.         5.         5.       0.04

  ROUTED TO
          R30301         29.     7.98         10.         5.         5.       0.04

  HYDROGRAPH AT
          0303           10.     7.97          3.         2.         2.       0.02

  2 COMBINED AT
          P0303          39.     7.98         13.         7.         7.       0.06

  ROUTED TO
          R0303          39.     8.08         13.         7.         7.       0.06

  HYDROGRAPH AT
          0302            6.     7.97          2.         1.         1.       0.01

  ROUTED TO
          R0302           6.     8.05          2.         1.         1.       0.01

  HYDROGRAPH AT
          0301            0.     7.93          0.         0.         0.       0.00

  ROUTED TO
          R0301           0.     8.05          0.         0.         0.       0.00

  HYDROGRAPH AT
          0300           48.     8.03         17.         9.         9.       0.10

  5 COMBINED AT
          P0300         266.     8.17        107.
```

```
ROUTED TO
       R0300        266.    8.22        107.        54.        54.        0.54

HYDROGRAPH AT
        0203          5.    8.00          2.         1.         1.        0.01

ROUTED TO
       R0203          5.    8.02          2.         1.         1.        0.01
```

```
    HYDROGRAPH AT
         0202          2.     7.98         1.         0.         0.      0.00

    2 COMBINED AT
        P0202          7.     8.00         2.         1.         1.      0.01

    ROUTED TO
        R0202          7.     8.02         2.         1.         1.      0.01

    HYDROGRAPH AT
         0201          3.     7.97         1.         0.         0.      0.00

    HYDROGRAPH AT
       020101          1.     8.97         1.         0.         0.      0.00

    3 COMBINED AT
        P0201         10.     8.02         4.         2.         2.      0.02

    ROUTED TO
        R0201         10.     8.07         4.         2.         2.      0.02

    HYDROGRAPH AT
         0200         56.     7.98        19.         9.         9.      0.08

    2 COMBINED AT
        P0200         66.     8.00        23.        11.        11.      0.10

    ROUTED TO
        R0200         66.     8.07        23.        11.        11.      0.10

    HYDROGRAPH AT
         0102          2.     7.95         1.         0.         0.      0.00

    ROUTED TO
        R0102          2.     7.97         1.         0.         0.      0.00

    HYDROGRAPH AT
         0101          3.     7.95         1.         0.         0.      0.00

    2 COMBINED AT
        P0101          5.     7.95         2.         1.         1.      0.01

    ROUTED TO
        R0101          5.     8.03         2.         1.         1.      0.01

    HYDROGRAPH AT
         0100         25.     7.95         8.         4.         4.      0.03

    2 COMBINED AT
        P0100         30.     7.97        10.         5.         5.      0.04

    ROUTED TO
        R0100         30.     8.03        10.         5.         5.      0.04

    HYDROGRAPH AT
         0000        554.     8.18       218.       110.       110.      1.05

    4 COMBINED AT
          6.0        904.     8.17       358.       179.       179.      1.72

                                   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)

           R0601     MANE         1.00       0.85     480.00       4.13      1.00      0.85     480.00        4.13

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2867E+00 EXCESS=0.0000E+00 OUTFLOW=0.2862E+00 BASIN STORAGE=0.4859E-03 PERCENT ERROR=   0.0

           R0602     MANE         0.92      10.62     480.51       3.87      1.00     10.61     480.00        3.87

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.3640E+01 EXCESS=0.0000E+00 OUTFLOW=0.3637E+01 BASIN STORAGE=0.3232E-02 PERCENT ERROR=   0.0

           R0600     MANE         1.00      16.68     492.00       3.90      1.00     16.68     492.00        3.90

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5684E+01 EXCESS=0.0000E+00 OUTFLOW=0.5603E+01 BASIN STORAGE=0.9490E-01 PERCENT ERROR=  -0.2

           R0500     MANE         0.46     186.92     491.45       3.72      1.00    186.87     491.00        3.72

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.7356E+02 EXCESS=0.0000E+00 OUTFLOW=0.7352E+02 BASIN STORAGE=0.3587E-01 PERCENT ERROR=   0.0

           R0400     MANE         1.00     189.30     495.00       3.70      1.00    189.30     495.00        3.70

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.7463E+02 EXCESS=0.0000E+00 OUTFLOW=0.7426E+02 BASIN STORAGE=0.4378E+00 PERCENT ERROR=  -0.1
```

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                                                    K:\RICKJ\GHEC1\99205301\AREA6\6-YR100.OUT
HEC1 S/N: 1343001909        HMVersion: 6.33        Data File: C:\WINDOWS\TEMP\-vbh0A1D.TMP

*****************************************                         *****************************************
*                                       *                         *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                         *   U.S. ARMY CORPS OF ENGINEERS        *
*              MAY  1991                *                         *   HYDROLOGIC ENGINEERING CENTER       *
*           VERSION 4.0.1E              *                         *        609 SECOND STREET              *
*                                       *                         *      DAVIS, CALIFORNIA 95616          *
*  RUN DATE  09/29/1999  TIME  13:04:22 *                         *          (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


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                   :::::::::::::::::::::::::::::::::::::::::::
                   :::                                     :::
                   :::  Full Microcomputer Implementation  :::
                   :::                 by                  :::
                   :::          Haestad Methods, Inc.      :::
                   :::                                     :::
                   :::::::::::::::::::::::::::::::::::::::::::
                   :::::::::::::::::::::::::::::::::::::::::::

             37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


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

                                                                                          PAGE  1
                                        HEC-1 INPUT

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

   1           ID  HVL SWMP - Subasin 6 - 100 Year Storm
   2           IT       1                      1440
   3           IO       5       0

   4           KK  0601
   5           KM  SCS 24 Hour Type IA Rainfall - Subbasin 6.06.01
                                                       22
   6           KO
   7           BA   .0013
   8           PB     9.5
   9           IN       6
  10           PC  0.0000 0.00224 0.00432 0.00628 0.00816 0.01000 0.01184 0.01372 0.01568 0.01776
  11           PC  0.0200 0.02276 0.02568 0.02872 0.03184 0.03500 0.03797 0.04095 0.04394 0.04695
  12           PC  0.0500 0.05315 0.05633 0.05954 0.06276 0.06600 0.06920 0.07240 0.07560 0.07880
  13           PC  0.0820 0.08514 0.08829 0.09147 0.09471 0.09800 0.10147 0.10502 0.10862 0.11229
  14           PC  0.1160 0.11969 0.12342 0.12721 0.13107 0.13500 0.13901 0.14310 0.14729 0.15159
  15           PC  0.1560 0.16059 0.16530 0.17011 0.17501 0.18000 0.18494 0.18999 0.19517 0.20049
  16           PC  0.2060 0.21196 0.21808 0.22432 0.23064 0.23700 0.24285 0.24878 0.25490 0.26127
  17           PC  0.2680 0.27517 0.28287 0.29118 0.30019 0.31000 0.33142 0.35469 0.37876 0.40255
  18           PC  0.4250 0.43936 0.45168 0.46232 0.47164 0.48000 0.48904 0.49752 0.50548 0.51296
  19           PC  0.5200 0.52664 0.53292 0.53888 0.54456 0.55000 0.55564 0.56116 0.56656 0.57184
  20           PC  0.5770 0.58198 0.58685 0.59163 0.59635 0.60100 0.60576 0.61044 0.61504 0.61956
  21           PC  0.6240 0.62836 0.63264 0.63684 0.64096 0.64500 0.64889 0.65272 0.65651 0.66026
```

```
                                        K:\RICKJ\GHEC1\99205301\AREA6\6-YR100.OUT

             **************
             *            *
728 KK       *    6.0     *
             *            *
             **************

730 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                      IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2       1440  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT      0.017  TIME INTERVAL IN HOURS

                                              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
                   `0601                1.     7.95          0.           0.           0.        0.00

   ROUTED TO
                    R0601               1.     7.98          0.           0.           0.        0.00

   HYDROGRAPH AT
                    0602               17.     7.97          6.           3.           3.        0.02

   ROUTED TO
                    R0602              17.     7.98          6.           3.           3.        0.02

   HYDROGRAPH AT
                    0600                8.     7.97          3.           1.           1.        0.01

 3 COMBINED AT
                    P0600              27.     7.97          9.           4.           4.        0.03

   ROUTED TO
                    R0600              27.     8.15          9.           4.           4.        0.03

   HYDROGRAPH AT
                    0500              284.     8.17        109.          54.          54.        0.34

 2 COMBINED AT
                    P0500             312.     8.17        118.          59.          59.        0.37

   ROUTED TO
                    R0500             311.     8.18        118.          59.          59.        0.37

   HYDROGRAPH AT
                    0400                5.     8.02          2.           1.           1.        0.01

 2 COMBINED AT
                    P0400             316.     8.17        120.          60.          60.        0.38

   ROUTED TO
                    R0400             316.     8.23        120.          59.          59.        0.38

   HYDROGRAPH AT
                    030301             46.     7.97         15.           8.           8.        0.04

   ROUTED TO
                    R30301             46.     7.97         15.           8.           8.        0.04

   HYDROGRAPH AT
                    0303               16.     7.95          5.           3.           3.        0.02

 2 COMBINED AT
                    P0303              62.     7.97         20.          10.          10.        0.06

   ROUTED TO
                    R0303              62.     8.07         20.          10.          10.        0.06

   HYDROGRAPH AT
                    0302               10.     7.95          3.           2.           2.        0.01

   ROUTED TO
                    R0302              10.     8.02          3.           2.           2.        0.01

   HYDROGRAPH AT
                    0301                1.     7.93          0.           0.           0.        0.00

   ROUTED TO
                    R0301               1.     8.03          0.           0.           0.        0.00

   HYDROGRAPH AT
                    0300               83.     8.02         28.          14.          14.        0.10

 5 COMBINED AT
```

```
ROUTED TO
          R0300        446.    8.18         171.          85.         85.         0.54

HYDROGRAPH AT
           0203          8.    7.97           3.           1.          1.         0.01

ROUTED TO
          R0203          8.    8.00           3.           1.          1.         0.01
```

```
 HYDROGRAPH AT
        0202         4.     7.97         1.        1.        1.       0.00

 2 COMBINED AT
       P0202        12.     7.98         4.        2.        2.       0.01

 ROUTED TO
       R0202        12.     7.98         4.        2.        2.       0.01

 HYDROGRAPH AT
        0201         4.     7.95         1.        1.        1.       0.00

 HYDROGRAPH AT
      020101         2.     8.92         1.        1.        1.       0.00

 3 COMBINED AT
       P0201        17.     8.00         7.        3.        3.       0.02

 ROUTED TO
       R0201        17.     8.05         7.        3.        3.       0.02

 HYDROGRAPH AT
        0200        88.     7.95        29.       14.       14.       0.08

 2 COMBINED AT
       P0200       105.     7.97        35.       18.       18.       0.10

 ROUTED TO
       R0200       105.     8.05        35.       18.       18.       0.10

 HYDROGRAPH AT
        0102         3.     7.93         1.        0.        0.       0.00

 ROUTED TO
       R0102         3.     7.95         1.        0.        0.       0.00

 HYDROGRAPH AT
        0101         4.     7.95         1.        1.        1.       0.00

 2 COMBINED AT
       P0101         7.     7.95         2.        1.        1.       0.01

 ROUTED TO
       R0101         7.     8.02         2.        1.        1.       0.01

 HYDROGRAPH AT
        0100        37.     7.95        12.        6.        6.       0.03

 2 COMBINED AT
       P0100        44.     7.95        14.        7.        7.       0.04

 ROUTED TO
       R0100        44.     8.02        14.        7.        7.       0.04

 HYDROGRAPH AT
        0000       908.     8.17       345.      172.      172.       1.05

 4 COMBINED AT
         6.0      1487.     8.15       565.      281.      281.       1.72
                               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)

    R0601    MANE         1.00     1.36    479.00      6.38      1.00      1.36    479.00        6.38

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.4432E+00 EXCESS=0.0000E+00 OUTFLOW=0.4427E+00 BASIN STORAGE=0.6309E-03 PERCENT ERROR=   0.0

    R0602    MANE         0.81    17.34    479.13      6.08      1.00     17.34    479.00        6.08

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.5715E+01 EXCESS=0.0000E+00 OUTFLOW=0.5711E+01 BASIN STORAGE=0.4224E-02 PERCENT ERROR=   0.0

    R0600    MANE         1.00    27.04    489.00      6.11      1.00     27.04    489.00        6.11

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.8876E+01 EXCESS=0.0000E+00 OUTFLOW=0.8773E+01 BASIN STORAGE=0.1217E+00 PERCENT ERROR=  -0.2

    R0500    MANE         0.39   311.46    490.44      5.89      1.00    311.34    491.00        5.89

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1164E+03 EXCESS=0.0000E+00 OUTFLOW=0.1164E+03 BASIN STORAGE=0.4642E-01 PERCENT ERROR=   0.0

    R0400    MANE         1.00   315.50    494.00      5.87      1.00    315.50    494.00        5.87

CONTINUITY SUMMARY (AC-FT) -
```

APPENDIX B - ENCROACHMENT STANDARDS

RECEIVED
AUG 25 1999
WINZLER & KELLY
SANTA ROSA

COUNTY OF LAKE
DEPARTMENT OF PUBLIC WORKS
Telephone (707) 263-2341 or 994-4824
Fax (707) 263-7748

INSTRUCTIONS FOR APPLYING FOR A DRIVEWAY ENCROACHMENT PERMIT

NON COUNTY-MAINTAINED ROADS

A portion of the roads (streets and easements) in Lake County have not been taken into the County-maintained System and are therefore classified as Non County-maintained Roads. If your driveway will be constructed on a Non County-maintained road, you do not require an Encroachment Permit from the County and the Department of Public Works will sign your Building Permit Application check-off sheet as "Encroachment Permit Not Required".

COUNTY-MAINTAINED ROADS

On County-maintained roads, streets, highways and easements, encroachment permits are required as follows:

- Any new driveway construction
- Modular home lot preparations
- Replacement of modular homes
- Construction of dwellings or structures that exceed 500 square feet and require building permits.
- Construction of agricultural structures that exceed 500 square feet. There is no agricultural exemption.
- Additions to structures, including carports, that exceed 500 square feet and require building permits.

INSTRUCTIONS FOR COMPLETING A DRIVEWAY ENCROACHMENT PERMIT APPLICATION

A. At the top of the application provide the owner's and contractor's name, address, site information, etc. as requested.

B. Draw a location map, or provide written directions to the site, in the box on the right side of the application form (include nearest cross street and distance to the lot).

C. Write the following information in the box entitled, "PLAN AND PROFILE" on the application form.

1. **PLAN VIEW OF DRIVEWAY:** If your driveway intersects the County road at ninety degrees (90°) perpendicular to the County road, choose one of the three options shown on **Drawing R9-7**. Then write "R9-7, Option #1" (or #2 or #3) in the box entitled "Plan & Profile" on the left side of the Encroachment Permit Application.

   - OR -

   Drawing R9-9 shows two options for a driveway not intersecting the County road at 90°. One option is for driveways intersecting the road at an angle between 60° and 89°, and the other for intersecting the road at an angle between 91° and 120°. Either option may be used, provided the slope of the 20 feet long driveway encroachment is laid out perpendicular (90°) to the edge of the road as shown in the two examples on the back of Drawing R9-9. If you wish to use one of these two angle driveway options, write "R9-9, 60° Option" (or 70, 120 or whatever angle you wish to use) in the box entitled "Plan & Profile" on the left side of the Encroachment Permit Application.

2. **PROFILE (Elevations) OF DRIVEWAY:** Choose the profile that applies to your driveway from Standard Drawings R9-1A, R9-1D, R9-2A or R9-2D. In the box on the left side of the Encroachment Permit Application, write "**R9-1A**" (or R9-1D, 2A or 2D; the four Standard Drawings show the maximum slopes permitted by the County Standards).

3. **PAVING AND DRAINAGE:** Drawing R9-6 shows the County requirements for paving (including base/sand compaction and reinforcement details) and drainage culverts. If your driveway requires fill that will block an existing roadside drainage ditch or block any drainage that flows across the first 20 feet of your driveway, you may be required to install a culvert pipe. The minimum culvert diameter is 12 inches. A larger diameter culvert may be required, depending on the size of the upstream drainage area. The Inspector will determine the need for a culvert at the preliminary inspection.

D. Draw your actual driveway profile on the sheet provided. Start at the top edge of the existing pavement of the road along the profile of the existing ground, to a point 20 feet out from said edge of pavement of the road.

The profile you selected under Item C2 above was for either Standard Drawing R9-1A, R9-1D, R9-2A or R9-2D. ***Those drawings show the maximum or steepest driveway slope permitted by the standards.*** If you are using the steepest slope permitted, draw the slopes, distances and elevations shown on the profile drawing you chose; then draw the profile of the existing ground. If the slope of your driveway will be less than the steepest driveway slopes permitted, draw the profile of what your driveway slope will actually be. If you need to go to your building site and look at your driveway location in order to draw the profile of the existing ground and driveway, you may take the profile sheet with you. Public Works will review the completed profile sheet when you return to pay the Encroachment Permit fee.

The profile sheet also has sign-off lines for the local fire protection agency. If any part of the first twenty feet (20') of your driveway has a slope steeper than sixteen percent (16%) you will need the profile sheet signed off by:

1. The California Division of Forestry, if your proposed driveway encroachment is in the State (fire protection) responsibility area; and/or
2. One of the following Fire Protection Districts, dependent upon where your proposed driveway encroachment is located:

   Clearlake Oaks-Glenhaven
   Kelseyville
   Lakeport County
   Lakeshore
   Lower Lake
   Lucerne Park & Recreation
   Nice Community Service
   South Lake
   Upper Lake

3. <u>You</u> may sign off on the profile sheet if any part of the driveway slope in the first **20 feet will not exceed 16%**, and Public Works will accept your signature in lieu of the California Division of Forestry or Fire Protection District sign-offs.

IDENTIFY YOUR DRIVEWAY

Drive a wood or metal stake at each side of your driveway approach and tie colored ribbon to the stakes, or mark location on the ground with paint. REMEMBER: A CLEAR LINE OF SITE AND VISIBILITY SHOULD BE A CONSIDERATION FOR YOUR DRIVEWAY LOCATION TO ALLOW FOR SAFE INGRESS AND EGRESS. **Post the address of the property on the stakes or erect a sign to show the address and/or property owner's name.** If you place an empty coffee can (with lid) or a similar container beside one of the stakes, the County Inspector will leave a card showing the date and results of each inspection. You may also phone (707) 263-2341 for information about your driveway inspection.

OTHER STANDARDS AVAILABLE:

A. **Existing Curbs and Sidewalks:** If you are planning to construct a residential or commercial driveway across an existing curb, gutter and sidewalk, ask the Department of Public Works for a copy of Drawing **R9-4C** and **R9-4NC**.

B. **Commercial Driveways:** If you are going to construct a commercial driveway, ask for a copy of **Drawings R9-4C and R9-4NC**. You can use those two standard drawings for most commercial driveways; but for the largest and busiest commercial driveways, additional width and other features to aid turning trucks will be required.

C. **Setting Garages Closer to the Road:** Standard Drawing **R9-17** shows an exception in the Zoning Ordinance that allows the front of your garage to be placed at your front property line, but no closer than 10' tc the edge of pavement of the County road. **This exception is permitted:** (1) if the slope of the front half of the lot is greater than one vertical foot rise or fall in a horizontal distance of seven feet (7:1 or 14.2%); or 2) if the elevation of your lot at the front property line is five feet or more above or below the elevation of the pavement of the County road. For further details, ask the Department of Public Works for a copy of **Drawing R9-17**.

APPROVAL OF WORK

All driveway work within the right-of-way of any County road is subject to inspection and approval by an inspector of the Public Works Department. Unsatisfactory work is subject to correction by the County if not corrected by the Permittee within fourteen (14) days of notification. Corrective work will be done by private contractor and the contractor's costs will be charged to the permittee.

NOTIFICATION FOR INSPECTION: The Department of Public Works will inspect your driveway three times as follows: **(Exception: When a culvert with headwalls is required, additional inspections may be necessary - see *Fees*, page 4.)**

1) An inspection prior to the issuance of the Encroachment Permit to determine existing conditions and restrictions;
2) A pre-pave (asphalt concrete) or pre-pour (concrete) inspection; and
3) A final inspection to assure compliance with all regulations.

First Inspection: The $100 Encroachment Permit fee cannot be paid nor the Encroachment Permit issued before the first inspection has been made to determine existing conditions and restrictions.

Second Inspection: The owner or builder must give the Department of Public Works **48 hours notice** before they want the pre-pave or pre-pour inspection to be made. Paving or concrete placement **shall not take place** until Public Works has inspected the fill, basework, drainage culvert (if required) and the formwork for the concrete driveway slab (if concrete is used) to determine: 1) that the driveway does not exceed the maximum slope permitted by the County Standards; and 2) to determine the driveway dimensions, configuration, baserock, etc. are as required by the County Standards. After this inspection, the Public Works Inspector will approve the pre-pave or pre-pour inspection. If the owner/builder places the asphalt or concrete pavement without an inspection, and the driveway does not meet County Standards, the Department of Public Works **will not sign off (final)** the driveway encroachment on the Building Department Inspection Record Card (in the Building Department's Office), and the occupancy of the house will, therefore, not be permitted.

Third Inspection (Final): The third and final inspection also requires the owner/builder give Public Works ***48 hour notice*** before they wish the inspection to be made. If this inspection determines that the first 20 feet of the driveway complies with the County Standards, Public Works will sign off on the Building Department Inspection Record Card. This Inspection Record Card is used to determine when the Occupancy Permit can be issued by the Building Department.

NOTE: If the owner or builder leaves a gap between the edge of road pavement and a concrete driveway slab they constructed, that gap must be filled with compacted Type B maximum 1/2" aggregate asphaltic concrete (hot mix) before Public Works will make the Final Inspection.

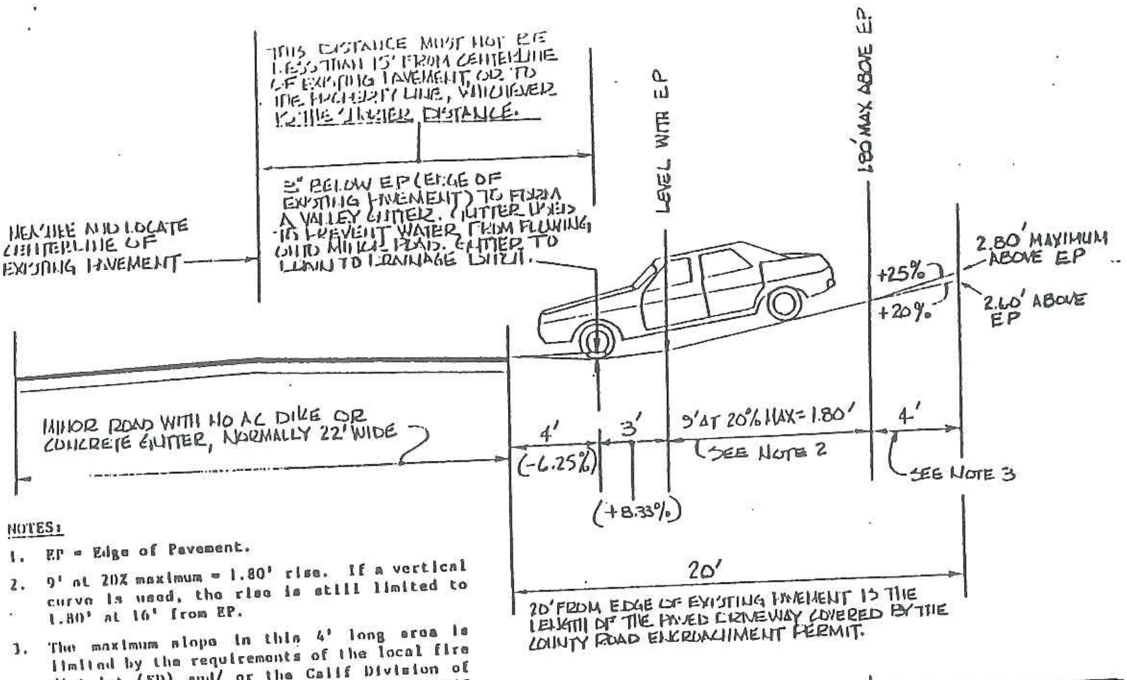
FEES: **If reinspections or other additional inspections are necessary, each reinspection will be charged at the rate of one-third of the Encroachment Permit fee (i.e. if permit fee is $100, reinspection fee would be $33.33).**

SAFETY: Adequate provisions shall be made by the permittee for the protection of the traveling public. Barricades shall be used and flashing yellow or red lights shall be in place between sunset and sunrise. Flagmen shall be employed if required by the particular work.

No materials shall be stored within three feet from the edge of the pavement or traveled way, unless specifically mentioned in the permit.

Upon determination of the inspector that a safety hazard exists to the public, the Permittee will be notified to correct said hazard within a twenty-four (24) hour period. If the hazard is not corrected within this time period, it will be done by the County and billed to the Permittee.

csj:e04
Rev 2/97

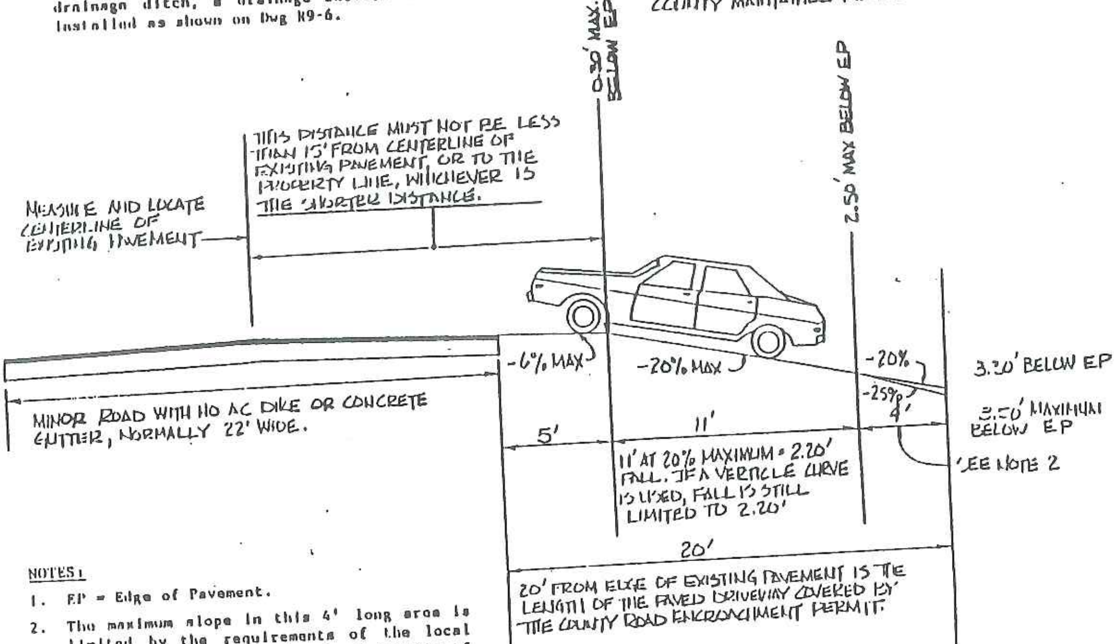


NOTES:

1. EP = Edge of Pavement.
2. 9' at 20% maximum = 1.80' rise. If a vertical curve is used, the rise is still limited to 1.80' at 16' from EP.
3. The maximum slope in this 4' long area is limited by the requirements of the local fire district (FD) and/ or the Calif Division of Forestry (CDF). The slope may not exceed 20% unless a steeper slope is approved by the FD or CDF. In no case may the slope exceed 25% (1.0' rise in the 4' distance).
4. For driveway base and paving, see Dwg R9-6.
5. If driveway fill will block existing roadside drainage ditch, a drainage culvert must be installed as shown on Dwg R9-6.

COUNTY OF LAKE – DEPT. OF PUBLIC WORKS	9/01/92
* MINOR ROAD – ASCENDING DRIVEWAY NO AC DIKE OR CONCRETE GUTTER	DWG R9-1A

* STANDARD FOR EXISTING COUNTY MAINTAINED ROADS

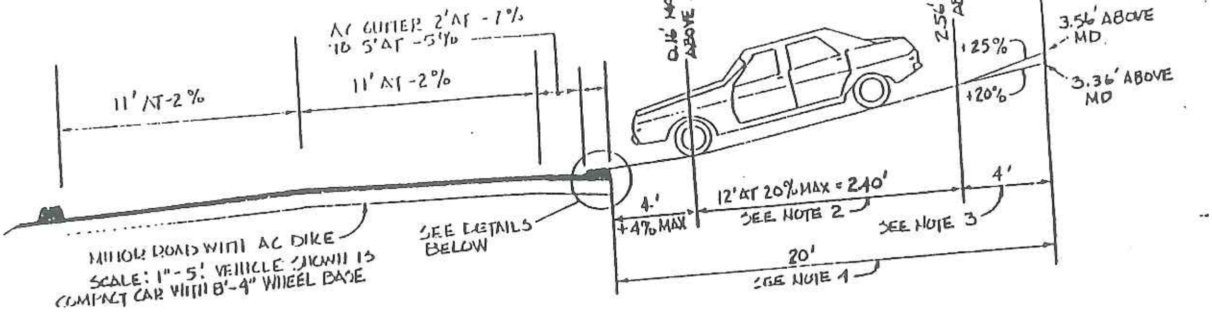


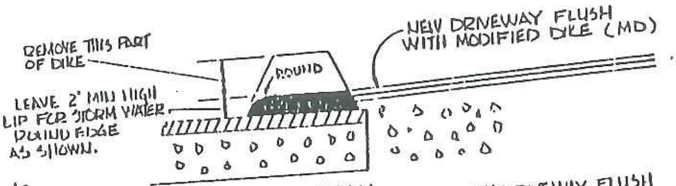
NOTES:

1. EP = Edge of Pavement.
2. The maximum slope in this 4' long area is limited by the requirements of the local fire district (FD) and/or the Calif Div of Forestry (CDF). The slope may not exceed 20% unless a steeper slope is approved by the FD or CDF. In no case may the slope exceed 25% (1.0' rise in the 4' distance).
3. For driveway base and paving, see DWG R9-6.
4. Rainfall runoff from the Minor Road will flow down the driveway shown above. It is the responsibility of the property owner and/or the builder to divert that water before it reaches the garage or residence.

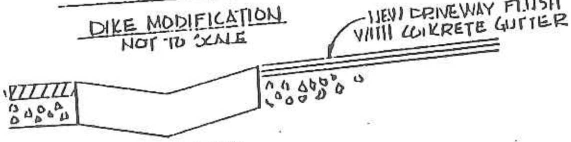
COUNTY OF LAKE - DEPT. OF PUBLIC WORKS	9/01/92
* MINOR ROAD - DESCENDING DRIVEWAY NO AC DIKE OR CONCRETE GUTTER	DWG R9-1D

* STANDARD FOR EXISTING COUNTY MAINTAINED ROADS.





DIKE MODIFICATION
NOT TO SCALE



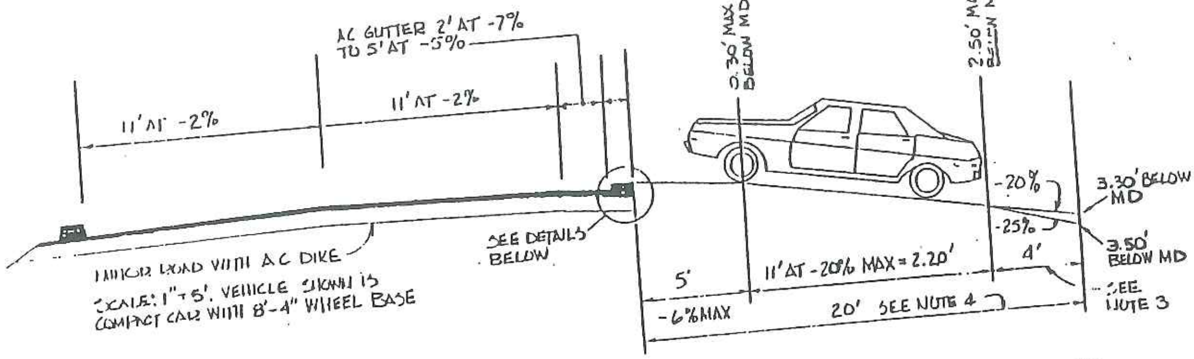
CONCRETE GUTTER
NOT TO SCALE

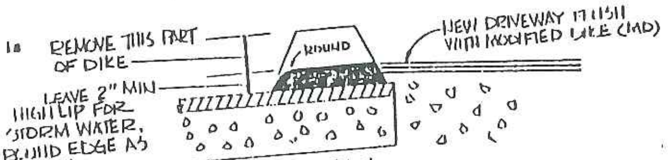
NOTES:

1. MD = Top of modified dike.
2. If a vertical curve is used, rise is still limited to 2.56' at 16' from dike.
3. The maximum slope in this 4' long area is limited by the requirements of the local fire district (FD) and/or the Calif Div of Forestry (CDF). The slope may not exceed 20% unless a steeper slope is approved by the FD or CDF. In no case may the slope exceed 25% (1.0' rise in the 4' distance).
4. 20' from edge of existing pavement is the length of the paved driveway covered by the County Road Encroachment Permit.
5. For driveway base and paving, see DWG R9-6.
6. If driveway fill will block existing roadside drainage ditch, a drainage culvert must be installed as shown on Dwg R9-6.

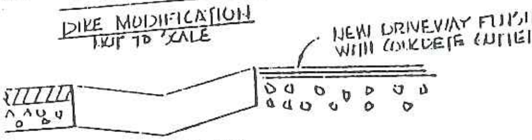
COUNTY OF LAKE – DEPT OF PUBLIC WORKS	9/01/92
* MINOR ROAD - ASCENDING DRIVEWAY WITH AC DIKE OR CONCRETE GUTTER	DWG R9-2A

* STANDARD FOR EXISTING COUNTY MAINTAINED ROADS





DIKE MODIFICATION
NOT TO SCALE



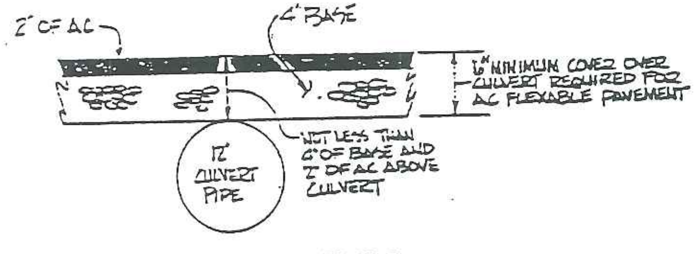
CONCRETE GUTTER
NOT TO SCALE

NOTES:

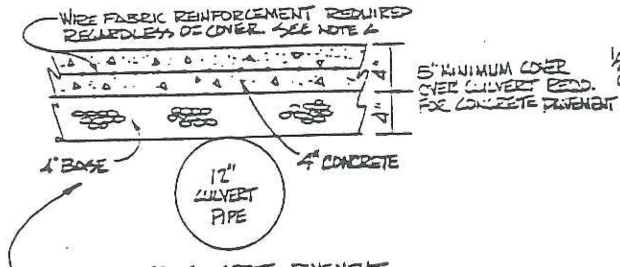
1. MD = Top of modified dike.
2. If a vertical curve is used, the fall is still limited to 2.50' at 16' from dike.
3. The maximum slope in this 4' long area is limited by the requirements of the local fire district (FD) and/or the Calif Div of Forestry (CDF). The slope may not exceed 20% unless a steeper slope is approved by the FD or CDF. In no case may the slope exceed 25% (1.0' rise in the 4' distance).
4. 20' from edge of existing pavement is the length of the paved driveway covered by the County Road Encroachment Permit.
5. For driveway base and paving, see DWG R9-6.
6. Be advised that during periods of peak rainfall runoff, water will flow over the 2" high lip of the AC dike or over the edge of the concrete gutter and down the driveway. It is the responsibility of the property owner and builder to divert that water before it reaches the garage or residence.

COUNTY OF LAKE – DEPT OF PUBLIC WORKS	9/01/92
* MINOR ROAD - DESCENDING DRIVEWAY WITH AC DIKE OR CONCRETE GUTTER	DWG R9-2D

* STANDARD FOR EXISTING COUNTY MAINTAINED ROADS

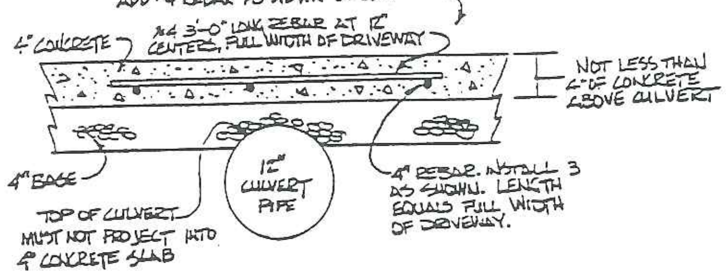


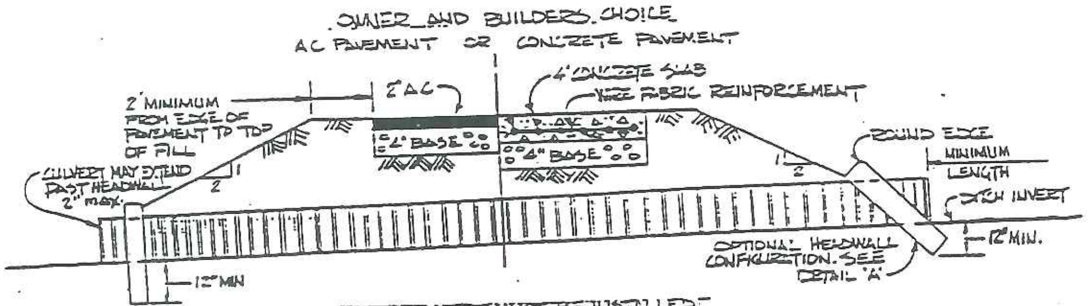
CULVERT UNDER AC PAVEMENT



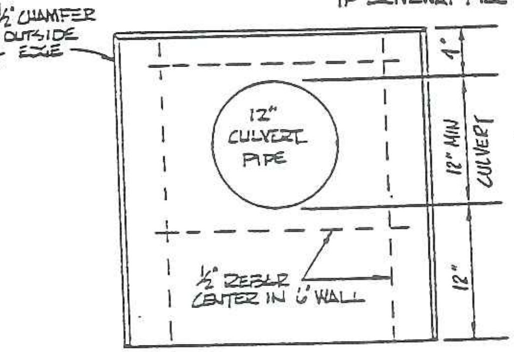
CULVERT UNDER CONCRETE PAVEMENT

NOTE: IF DEPTH OF EXISTING DITCH WILL NOT PERMIT INSTALLATION OF 4" OF BASEROCK ABOVE CULVERT, ADD #4 REBAR AS SHOWN BELOW

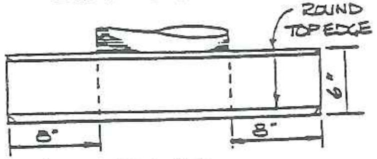




DRAINAGE CULVERT MUST BE INSTALLED IF DRIVEWAY FILL BLOCKS EXISTING DRAINAGE



DETAIL "A"
END VIEW OF HEADWALL



DETAIL "A"
PLAN VIEW OF HEADWALL

NOTES:
1. Option: Use either 2" of AC and 4" base; or 4" concrete and 4" base.
2. Base: Class II or III roadbase; redrock sand acceptable under concrete; 3/4" maximum aggregate; 95% relative compaction suggested, 90% compaction required.
3. CONCRETE: 3/4" maximum aggregate; 5 sacks cement per cubic yard; 4 ounces air entraining agent per cubic yard. Protect concrete for 72 hours by covering when nightime temperature will be below 32 degrees F.
4. WIRE FABRIC: Reinforce the first 20' of the 4" thick driveway slab with 6"X6"X10 gage welded wire fabric centered in slab.
5. AC: 2" thick asphaltic concrete surfacing; Type B with 1/2" maximum aggregate.
6. REBAR: 1/2" diameter grade 40 or grade 60. Install as shown. For convenience, each 1/2" diameter (#4) rebar may be replaced with two 3/8" diameter (#3) rebar.
**7. CULVERT: 12" minimum diameter by 16 gage corrugated metal culvert pipe. A larger culvert diameter may be required, depending on the upstream drainage area.
8. HEADWALLS: Install ends of culvert pipe and headwalls at the center of the existing drainage swale or ditch; culvert invert to match invert of ditch or swale.
9. EARTH SUBGRADE: No fill slopes steeper than 2 feet horizontal to one foot vertical; all fill compacted to minimum of 90% relative compaction; 95% compaction in the top 12" below the roadbase is recommended.

** ADS N-12 Pipe is acceptable in certain circumstances.

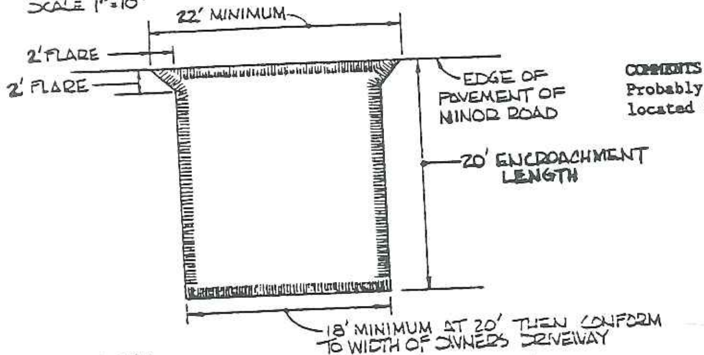
DRAWING NOT TO SCALE

COUNTY OF LAKE - DEPT OF PUBLIC WORKS	9/01/92
*RESIDENTIAL DRIVEWAY PAVEMENT DRAINAGE CULVERT & HEADWALL	DWG R9-6

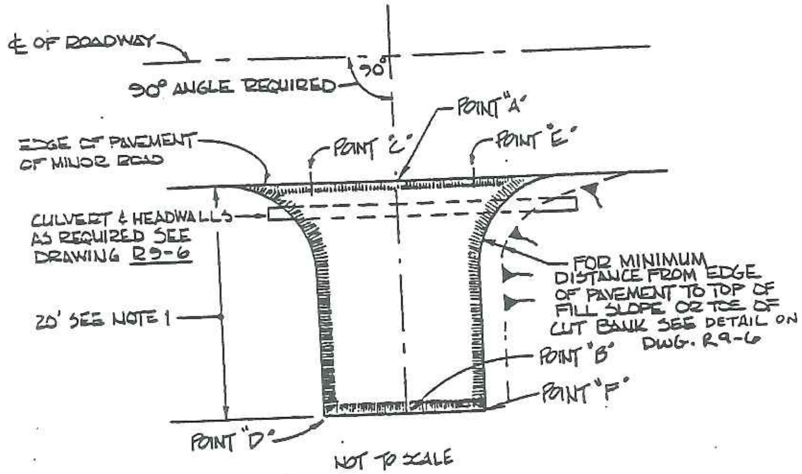
* STANDARD FOR EXISTING COUNTY-MAINTAINED ROAD

DRIVEWAY DIMENSIONS FOR EXISTING MINOR ROADS
One of the following three options may be used for a residential driveway encroachment intersecting a minor County road at a 90o angle.

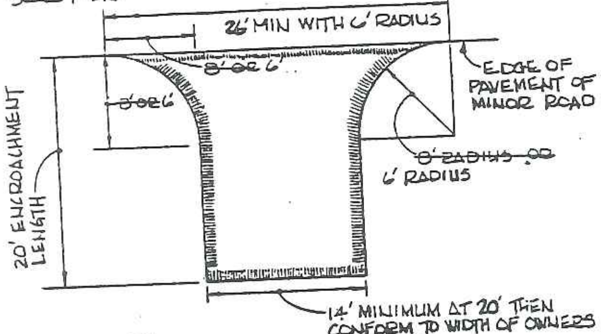
OPTION 1:
SCALE 1"=10'



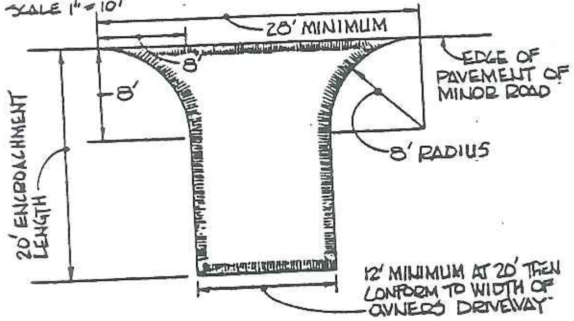
COMMENTS FOR OPTION 1:
Probably the best option for a two car garage located at the property setback line.



OPTION 2:
SCALE 1"=10'



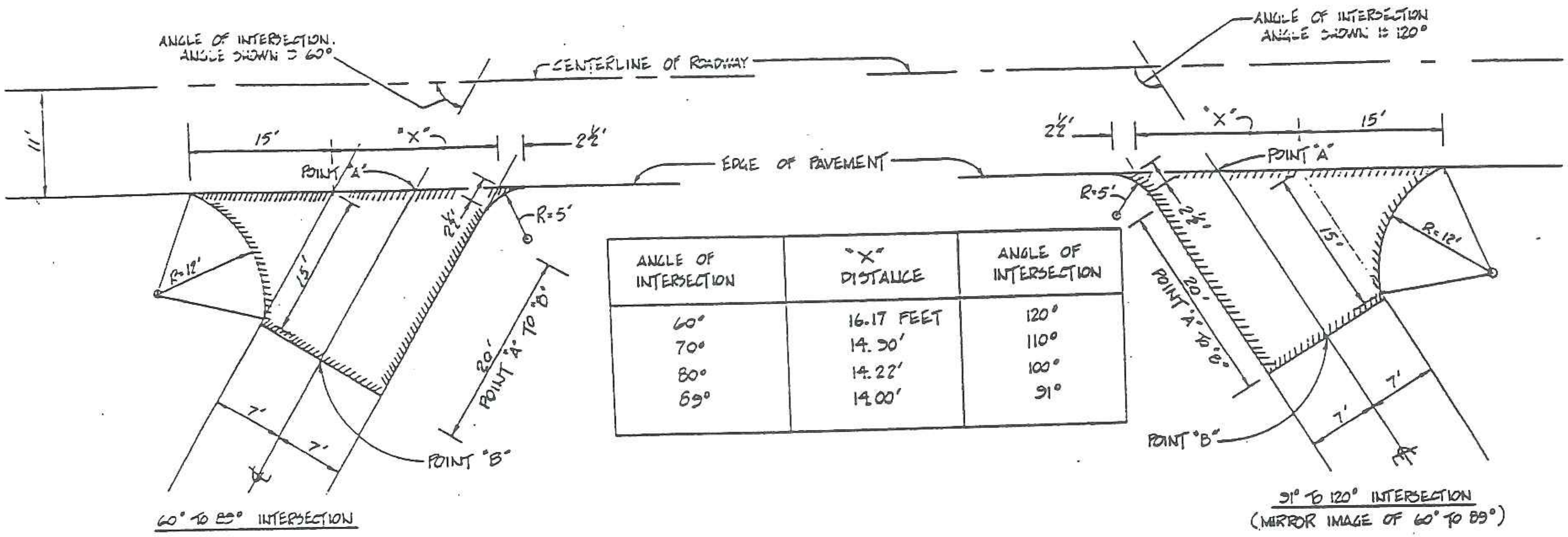
OPTION 3:
SCALE 1"=10'



COMMENTS FOR OPTION 3:
1. 12 feet is the minimum driveway width permitted by any option.

COUNTY OF LAKE - DEPT. OF PUBLIC WORKS	9/01/92
* DRIVEWAY INTERSECTING MINOR ROAD AT 90° ANGLE	DWG R9-7

* STANDARD FOR EXISTING COUNTY MAINTAINED ROAD.



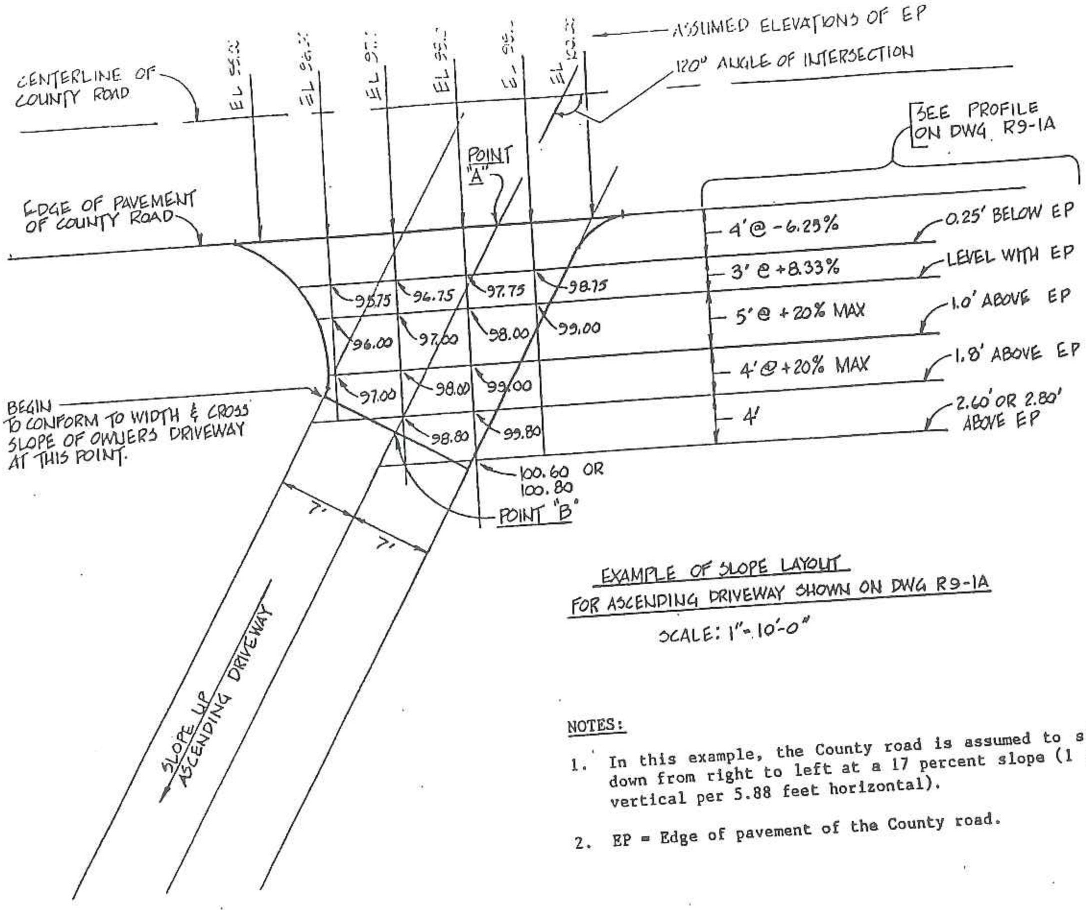
ANGLE OF INTERSECTION	"X" DISTANCE	ANGLE OF INTERSECTION
60°	16.17 FEET	120°
70°	14.30'	110°
80°	14.22'	100°
89°	14.00'	91°

NOTES:

1. Driveways are required to intersect the county road at 90 degrees (o). Driveways intersecting the road at an angle between 60o and 89o (or 91o to 120o) may be used only for steep lots and unusual conditions, and only with the permission of the Dept. of Public Works (DPW). Each driveway which does not intersect at 90o will be reviewed on a case by case basis.
2. The maximum driveway slope permitted is shown on Dwgs. R9-1A and R9-1D. If road has AC dike or concrete gutter, use Dwgs. R9-2A or R9-2D. This maximum driveway slope is measured perpendicular to the County road (see reverse side of this drawing for example of typical slope layouts).
3. The first 20 feet (20') of a driveway must be constructed as shown on this plan view. At a distance of 20' from the edge of road pavement, measured along centerline A-B, the driveway may begin to curve right or left.
4. The first, 20 feet of a driveway must be paved with AC or concrete, as shown on Dwg. R9-6. The 20' distance is measured along the centerline of driveway between Points A and B as shown.
5. Install pavement, culvert and headwalls as required by Dwg. R9-6.
6. A 2' minimum distance between edge of pavement and top of fill slope, or between edge of pavement and toe of cut bank, is required (see Dwg. R9-7).

* STANDARD FOR EXISTING COUNTY MAINTAINED ROADS & STREETS

COUNTY OF LAKE - DEPT OF PUBLIC WORKS	5/01/92
*DRIVEWAY INTERSECTING MINOR ROAD AT 60° TO 89° AND AT 91° TO 120°	DWG R9-9

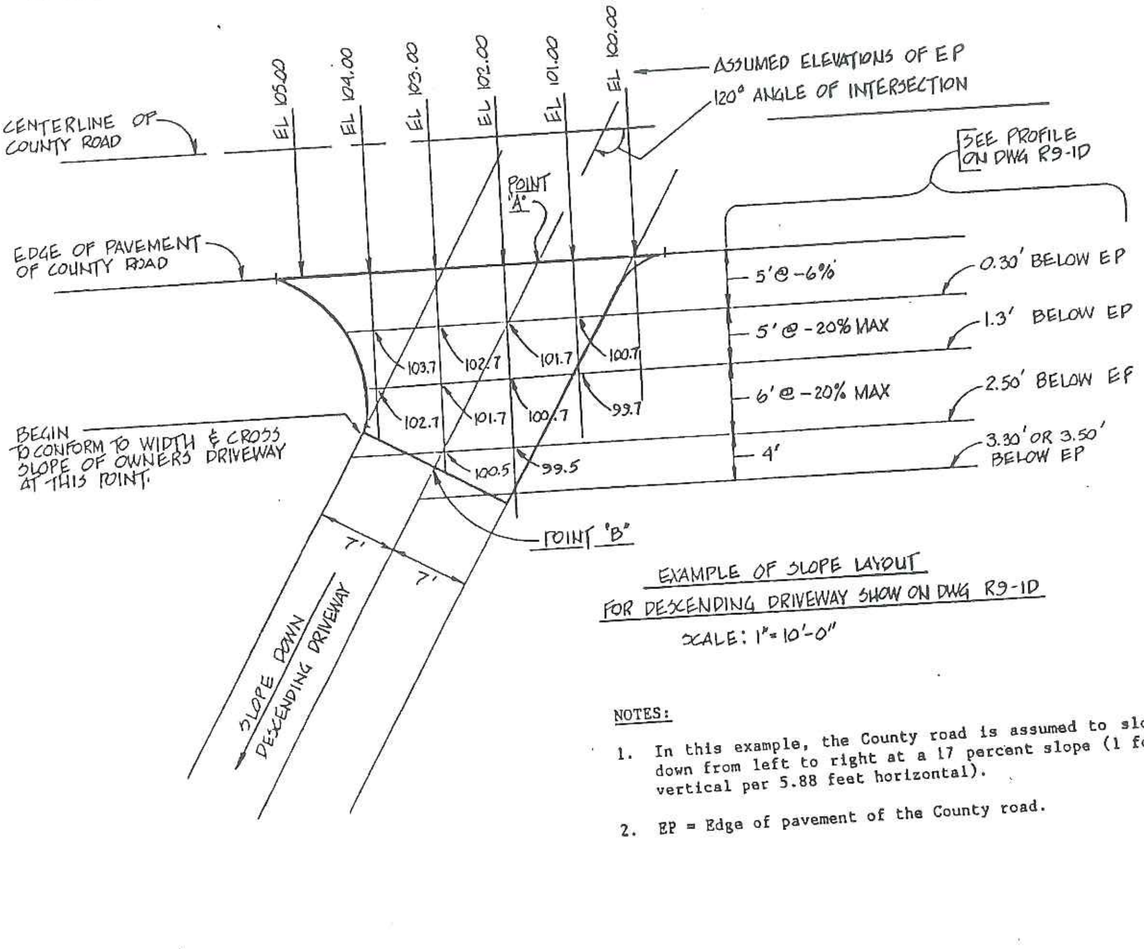


EXAMPLE OF SLOPE LAYOUT
FOR ASCENDING DRIVEWAY SHOWN ON DWG R9-1A
SCALE: 1"=10'-0"

NOTES:

1. In this example, the County road is assumed to slope down from right to left at a 17 percent slope (1 foot vertical per 5.88 feet horizontal).

2. EP = Edge of pavement of the County road.



EXAMPLE OF SLOPE LAYOUT
FOR DESCENDING DRIVEWAY SHOW ON DWG R9-1D
SCALE: 1"=10'-0"

NOTES:

1. In this example, the County road is assumed to slope down from left to right at a 17 percent slope (1 foot vertical per 5.88 feet horizontal).

2. EP = Edge of pavement of the County road.

NOTES:

1. Article 42 of the Lake County Zoning Ordinance allows a zoning exception for steep lots. The exception permits private garages, open parking platforms or outside staircases to be located at the front property line of the lot, provided the wall of the structure does not obstruct the sight distance thereby creating or increasing any traffic safety hazard. Article 42, as it applies to driveways and garages, can be summarized as follows:

   A. The exception is permitted if the slope of the front half of the lot is greater than one foot rise or fall in a distance of seven feet (7:1 or 14.2%); or permitted if the elevation of the lot at the front property line is five feet or more above or below the established street elevation.

   B. The exception allows a detached or attached private garage, open parking platform, or outside staircase to be built to the front property line. The staircase cannot be wider than 4 feet.

      Note: This exception does not apply to the house which cannot be located closer to the front property line than the front setback line of the property.

   C. The garage, parking platform or staircase cannot encroach on the setback required for the side yards.

   D. The entrance to the garage or carport must be oriented towards one of the two side lot lines.

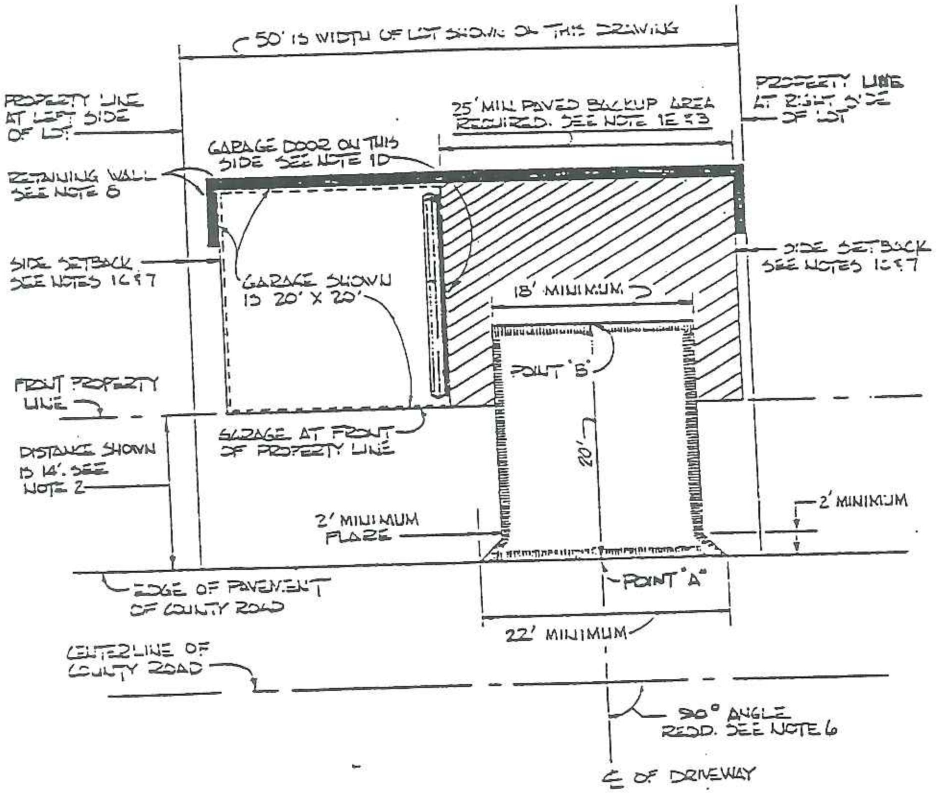
   E. The entrance to the garage or carport must have a minimum backup area of twenty five feet (25').

   F. The front wall of the garage (or parking platform or staircase) cannot obstruct the sight distance of a driver exiting the driveway. The sight distance required and the method by which the "Unobstructed Sightline" is determined are shown on Dwg. R9-8. On that drawing, the "eye" of the driver is located 10 feet from the edge of pavement, and 3.5 feet high above the center of the driveway.

      (1) If the front property line of the lot is less than 10 feet from the edge of pavement of the County road, the front wall of the garage, parking platform or staircase cannot be placed at the front property line. The garage will have to be constructed more distant from the road, and constructed at a distance from the edge of pavement that will permit the required minimum distances "DL" and "DR" on Dwg. R9-8 to be obtained.

      (2) If the front property line is 10 feet or more from the edge of pavement of the County road, the Owner/Builder will demonstrate to the Department of Public Works that the front wall of the garage

NOTE: THIS EXCEPTION DOES NOT APPLY TO THE RESIDENCE. SEE NOTE 1B.



* STANDARD FOR EXISTING COUNTY MAINTAINED ROAD

COUNTY OF LAKE - DEPT. OF PUBLIC WORKS	9/01/92
* MINOR ROAD ZONING EXCEPTION - GARAGE AT FRONT PROPERTY LINE	DWG R9-17

SCALE: 1" = 10'-0"

will not obstruct the line of sight of a driver exiting the driveway to the point where the required minimum distances "DL" and "DR" cannot be obtained. Additionally, the Owner/Builder will demonstrate that the front wall will not obstruct the line of site of a driver exiting a driveway on one of the adjacent lots. That situation can occur when the lots and driveways are located on the inside of a horizontal curve in the County road.

2. The distance between the front property line of the lot and the edge of pavement varies throughout the County. If a 22 feet wide paved road is centered in a 50 feet wide road right-of-way, the distance between edge of pavement and property line is 14 feet (50' -22' = 28'; 28' ÷ 2 sides = 14'). However, there are lots within the County where the front property line is at, or within 2 or 3 feet of, the edge of pavement; while the front property line of other lots may be 20 feet from edge of pavement. Owner/Builder should measure the actual distance at their lot to determine the practicality of using this zoning exception.

3. The first 20 feet of driveway, measured along the driveway centerline between Points A and B, is the driveway encroachment area and it must be constructed as shown on this plan view and with driveway baserock and paving as required on Dwg. R9-6. The 25 feet paved backup area, described above in Item 1.E and shown cross-hatched on the drawing, may be paved as Owner/Builder elect. The driveway widths shown on the drawing for the 20 feet long encroachment area are minimum widths and the Owner/Builder may elect to increase the driveway widths to facilitate entering and exiting the garage. The width of the 25 feet long paved backup area should not be less than the out-to-out width of the garage door(s).

4. The maximum driveway slope permitted in the first 20 feet of driveway encroachment is shown on Dwgs. R9-1A and R9-1D. If the County road has an AC dike or concrete gutter, use Dwgs. R9-2A or R9-2D. This maximum slope is measured along the driveway centerline between Points A and B. Install pavement, culvert and headwalls in the 20 feet long encroachment as required by Dwg. R9-6.

5. A two feet minimum distance between edge of driveway pavement and top of fill slope, or between edge of driveway pavement and toe of cut bank, is required.

6. The driveway shall be perpendicular to and intersect the County road at a 90 degree angle.

7. Owner/Builder to consult the County Planning Department for the side setback requirements. On the plan view shown on Dwg. R9-17, the side setbacks are: 1) the required minimum distance between the end of the garage and the left property line; and 2) the required minimum distance between the paved parking area and the right property line.

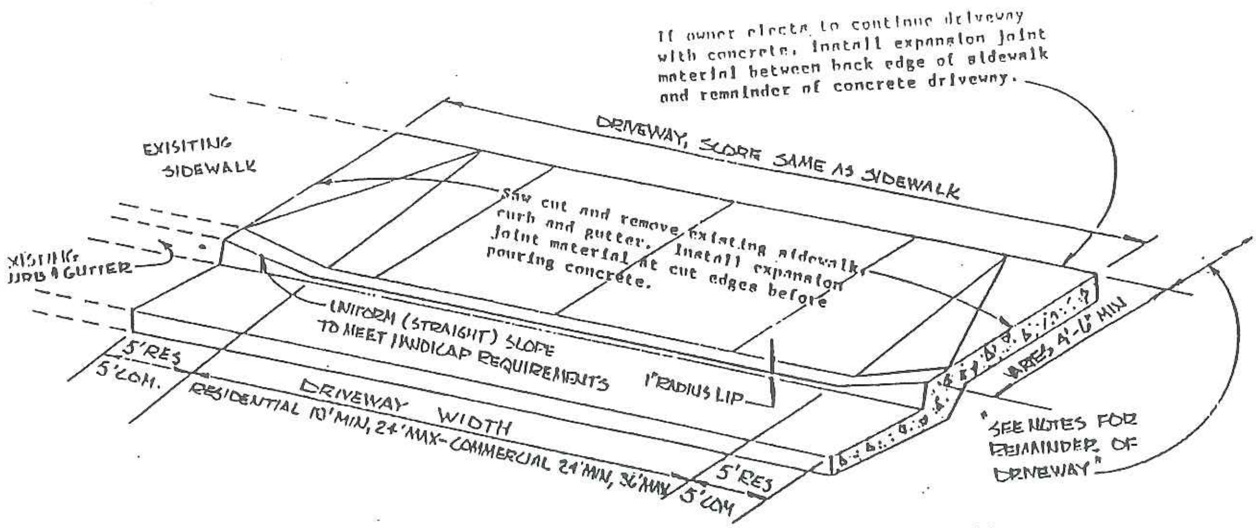
Note: Retaining walls are permitted on the property line.

(continued)

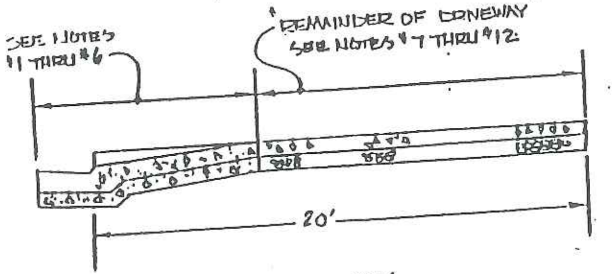
8. Dwg. R9-17 shows a retaining wall under the back and side walls of the garage and along the back and side of the backup area. The design of retaining walls 4 feet and higher must be reviewed by the County Building Department.

If the backup area and garage are located in cut, a 2:1 cut slope may be used in lieu of the retaining wall provided the toe of the cut bank is no closer to the wall of the garage that 5 feet. A lot wider than 50 feet will probably be needed to use cut slopes along the side property lines as the top of the cut bank must not be closer than 5 feet to a side property line.

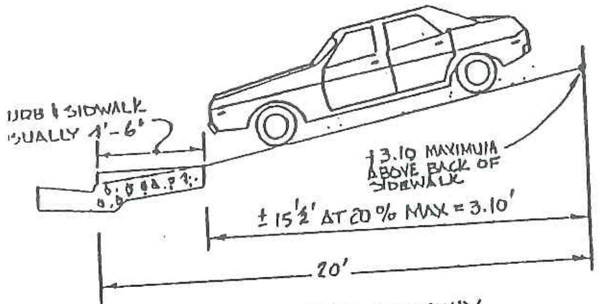
If the backup area and garage are located on fill, a 2:1 fill slope may be used in lieu of the retaining wall provided the toe of the fill slope is no closer than 5 feet to a side property line.



ISOMETRIC VIEW
NOT TO SCALE

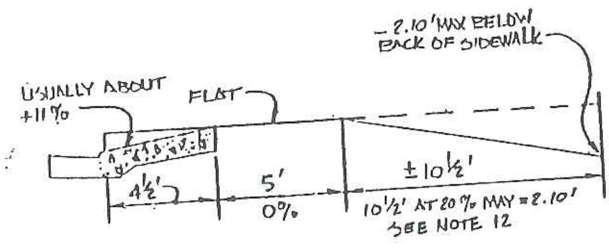


DRIVEWAY PAVING
NOT TO SCALE



PROFILE - ASCENDING DRIVEWAY

SCALE 1" = 5'. VEHICLE SHOWN IS COMPACT CAR WITH 8'-4" WHEEL BASE



PROFILE - DESCENDING DRIVEWAY

SCALE: 1" = 5'

NOTES FOR CURB, GUTTER AND SIDEWALK AREA

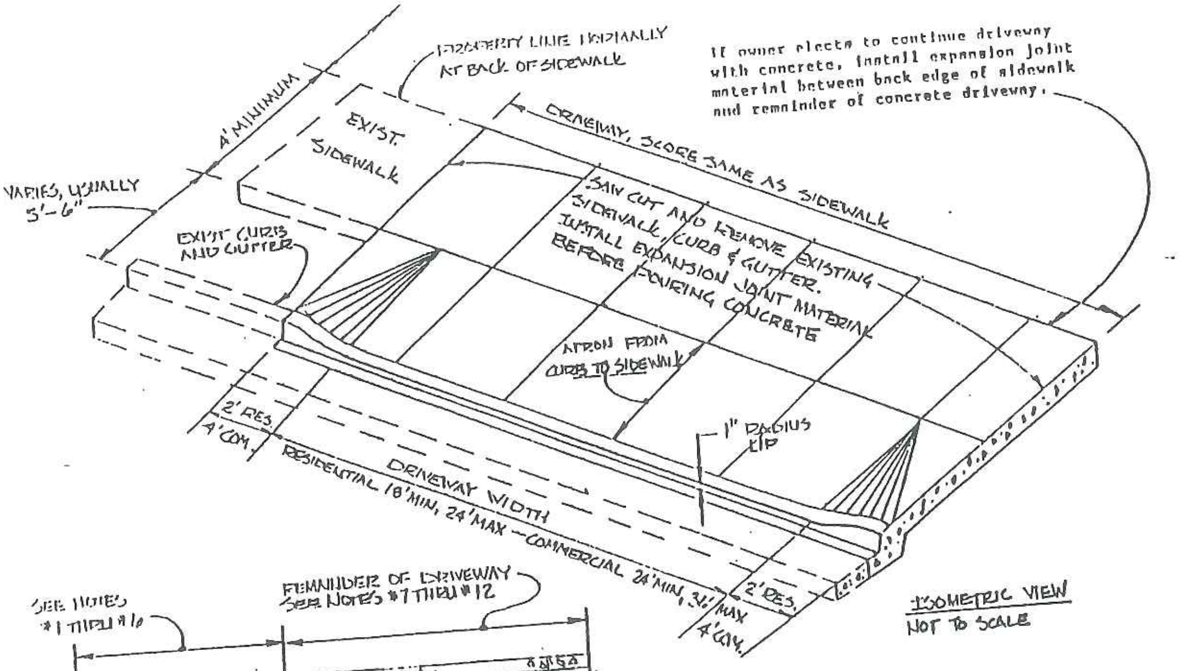
1. Saw cut face and top of curb, gutter and sidewalk to a minimum depth of 2".
2. Base is Class II roadbase, 3/4" maximum aggregate.
3. Driveway shall be 6" minimum thickness concrete for residential driveway and 8" minimum concrete for commercial driveway.
4. CONCRETE: 3/4" maximum aggregate; 5 sacks cement per cubic yard (cy); 4 ounces air entraining agent per cy. Protect concrete for 72 hours by covering when nighttime temperature will be below 32 degrees.
5. Reinforce curb, gutter and sidewalk with #3 bars 12" on center each way (OCEW) for residential driveway and #4 12" OCEW for commercial driveway.
6. Provide broom finish on ramp and sidewalk. Broom in direction parallel to curb.

NOTES FOR "REMAINDER OF DRIVEWAY"

7. Option: Use either 2" of AC and 4" base; or 4" concrete and 4" base.
8. Base: Class II or III roadbase; 3/4" maximum aggregate. Red rock sand acceptable under concrete.
9. Concrete mix: Same as Note 4.
10. Reinforce 4" thick driveway slab with 6" x 6" x 10 gauge welded wire fabric centered in slab.
11. 2" thick asphalt concrete surfacing: Type B with 1/2" maximum aggregate.
12. If vertical curve is used, the fall is still limited to 2.10' at 20' distance from face of curb.

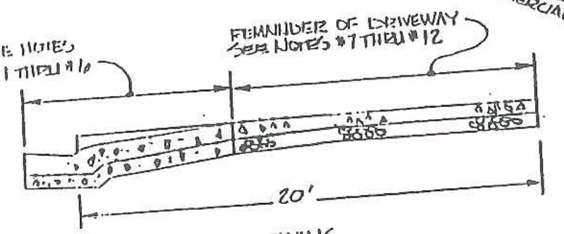
COUNTY OF LAKE - DEPT PUBLIC WORKS	9/01/92
* MINOR STREET NEW DRIVEWAY IN EXISTING CONTIGUOUS CURB & SIDEWALK	DWG R9-1C

* STANDARD FOR EXISTING COUNTY MAINTAINED STREETS

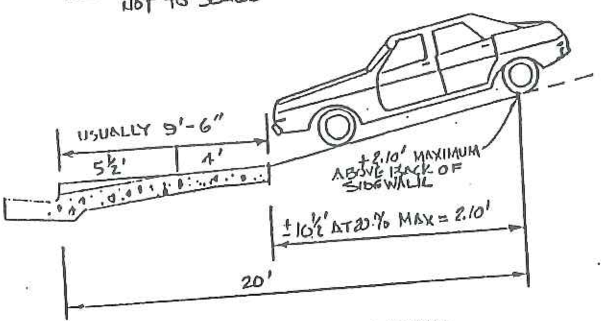


If owner elects to continue driveway with concrete, install expansion joint material between back edge of sidewalk and remainder of concrete driveway.

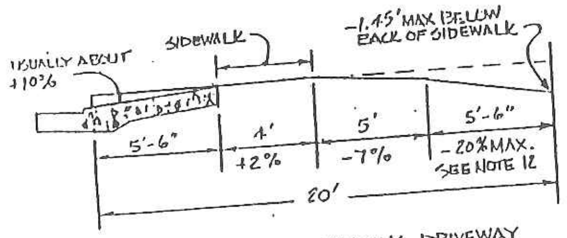
ISOMETRIC VIEW
NOT TO SCALE



DRIVEWAY PAVING
NOT TO SCALE



PROFILE - ASCENDING DRIVEWAY
VEHICLE SHOWN IS
COMPACT CAR WITH 8'-4" WHEEL BASE



PROFILE - DESCENDING DRIVEWAY

NOTES FOR CURB, GUTTER AND SIDEWALK AREA

1. Saw cut face and top of curb, gutter and sidewalk to a minimum depth of 2".
2. Base is Class II roadbase, 3/4" maximum aggregate.
3. Driveway shall be 6" minimum thickness concrete for residential driveway and 8" minimum concrete for commercial driveway.
4. CONCRETE: 3/4" maximum aggregate; 5 sacks cement per cubic yard (cy); 4 ounces air entraining agent per cy. Protect concrete for 72 hours by covering when nighttime temperature will be below 32 degrees.
5. Reinforce curb, gutter and sidewalk with #3 bars 12" on center each way (OCEW) for residential driveway and #4 12" OCEW for commercial driveway.
6. Provide broom finish on ramp and sidewalk. Broom in direction parallel to curb.

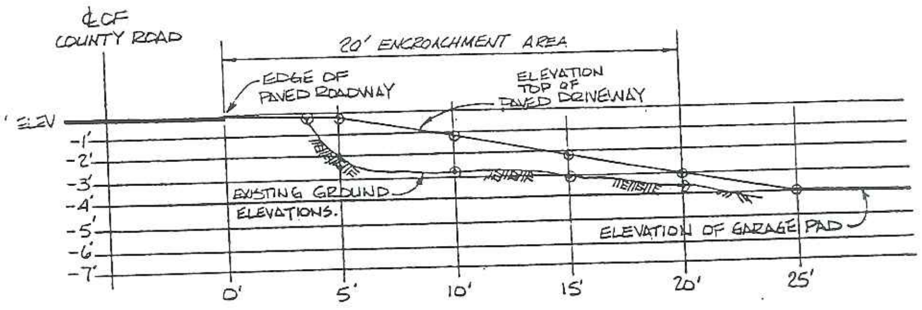
NOTES FOR "REMAINDER OF DRIVEWAY"

7. Option: Use either 2" of AC and 4" base; or 4" concrete and 4" base.
8. Base: Class II or III roadbase; 3/4" maximum aggregate. Red rock sand acceptable under concrete.
9. Concrete mix: Same as Note 4.
10. Reinforce 4" thick driveway slab with 6" x 6" x 10 gauge welded wire fabric centered in slab.
11. 2" thick asphalt concrete surfacing: Type B with 1/2" maximum aggregate.
12. If vertical curve is used, the fall is still limited to 1.45' at 20' distance from face of curb.

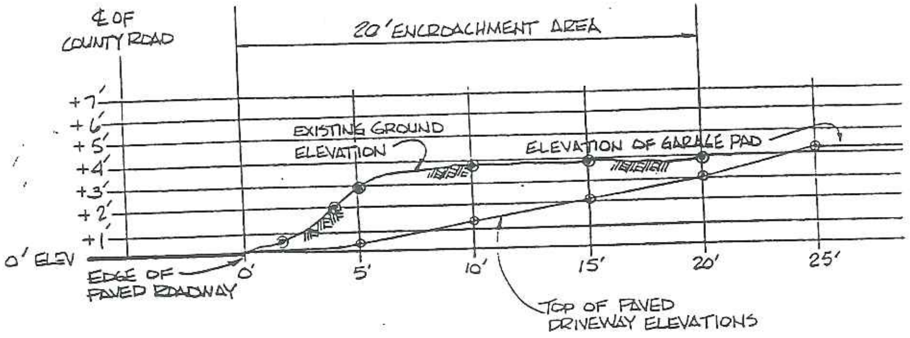
COUNTY OF LAKE — DEPT OF PUBLIC WORKS	9/01/92
* MINOR STREET NEW DRIVEWAY IN EXISTING NONCONTIGUOUS CURB & SIDEWALK	DWG R9-4NC

* STANDARD FOR EXISTING COUNTY MAINTAINED STREETS

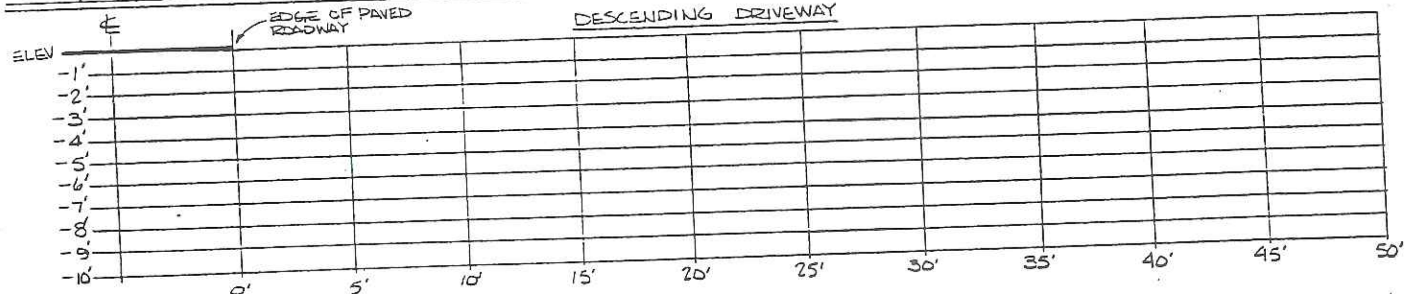
EXAMPLE OF DESCENDING DRIVEWAY
SHOWING ELEVATIONS AT 5' INTERVALS

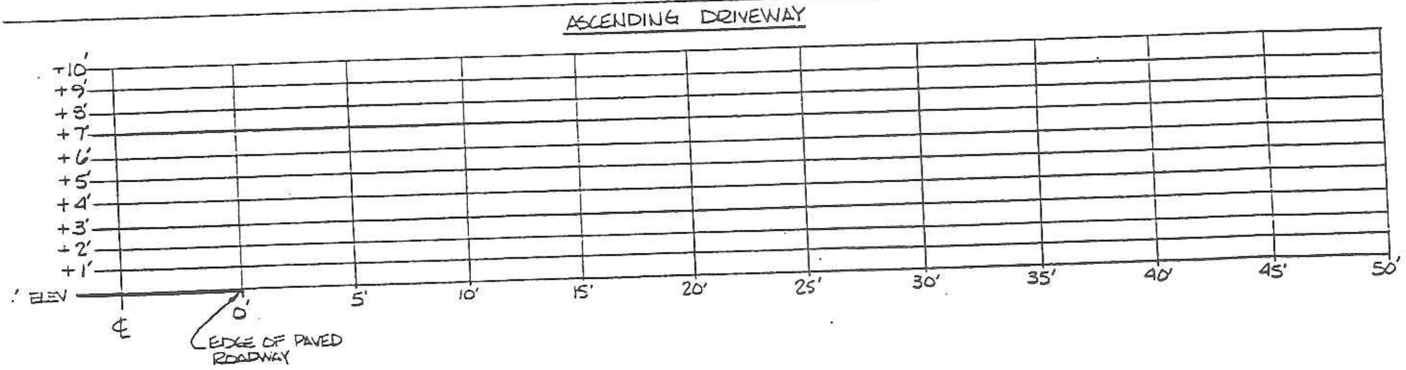


EXAMPLE OF ASCENDING DRIVEWAY
SHOWING ELEVATIONS AT 5' INTERVALS



PLOT YOUR DRIVEWAY BELOW. SHOW EXISTING GROUND, DRIVEWAY SURFACE AND GARAGE PAD.





County Road No. ________ Enc. No. ________

A.P. No(s). ________

____
Name of Property Owner

Property Address: ________

____

Owner's Telephone No. ________

Profile Drawn By: ________

____
Title (Owner, Builder, Agent)

Telephone No. ________

Date: ________

==

CDF ________ Date ________
Authorized Signature

Fire Dept. ________ Date ________
Authorized Signature

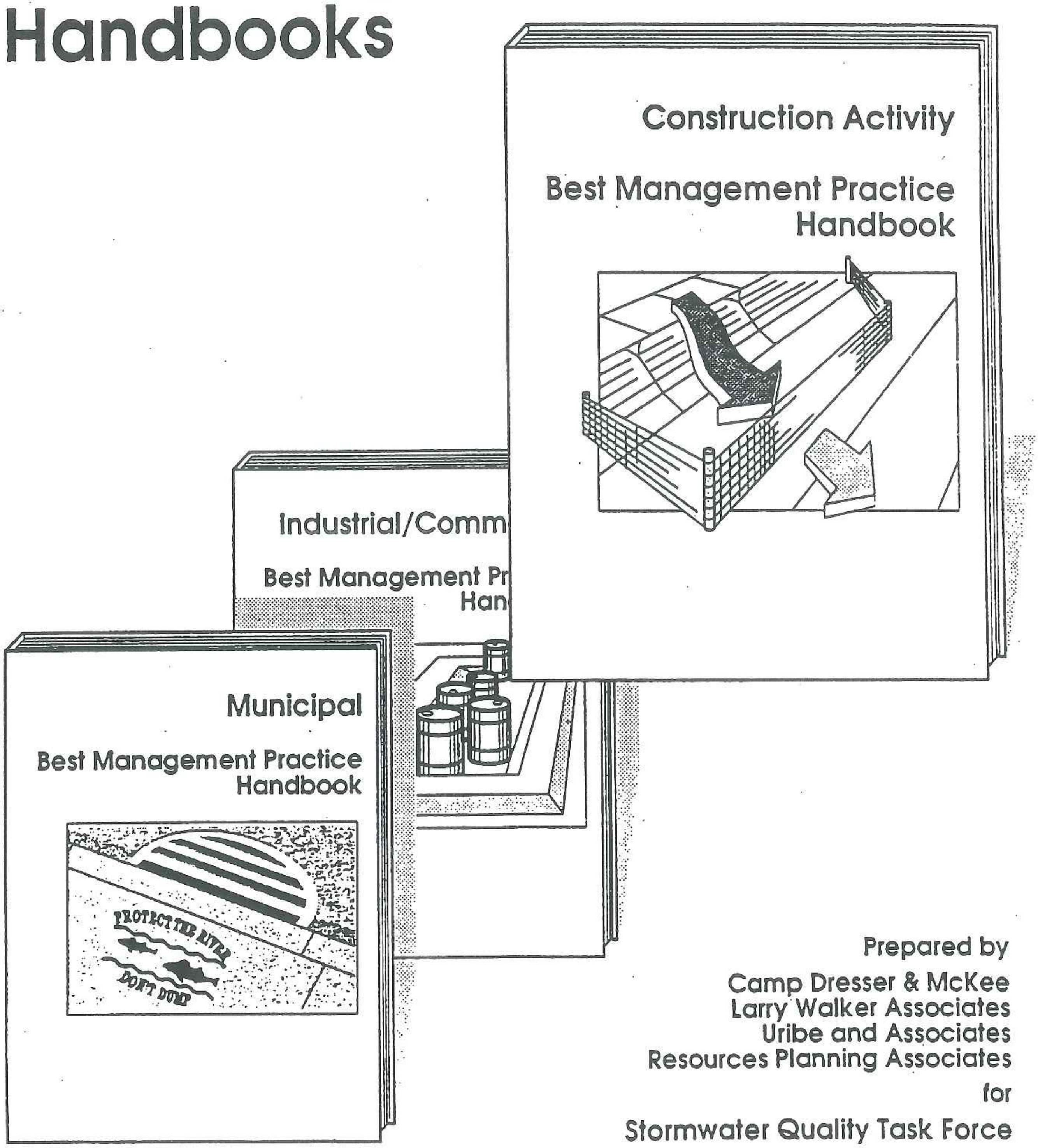
DRIVEWAY SLOPE WILL NOT EXCEED 16%

________ Date ________
Signature (Owner, Builder, Agent)

APPENDIX C - BEST MANAGEMENT PRACTICES

March, 1993

California Storm Water Best Management Practice Handbooks



Prepared by
Camp Dresser & McKee
Larry Walker Associates
Uribe and Associates
Resources Planning Associates
for
Stormwater Quality Task Force

4. BMPs FOR CONTRACTOR ACTIVITIES

INTRODUCTION

This chapter describes specific Best Management Practices (BMPs) for common construction activities that may pollute storm water. Chapter 2 led you through the steps of identifying activities at your site that can pollute storm water, while Chapter 3 provided guidance on BMP selection. This chapter will provide a list of BMPs that can be used to fit your site's needs.

BMP fact sheets are provided for each of the contractor's activities, noted in the box, are consistent with Worksheet 4 in Chapter 2.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Approach
- Requirements
  - Costs, including capital costs, and operation and maintenance (O&M) costs
  - Maintenance (including administrative and staffing)
- Limitations
- References

The side bar presents information on which BMP objective applies, targeted constituents, and an indication of the level of effort and costs to implement. For some BMPs, further information is provided in additional sheets.

Contractor Activities

Construction Practices
CA1 Dewatering Operations
CA2 Paving Operations
CA3 Structure Construction and Painting

Material Management
CA10 Material Delivery and Storage
CA11 Material Use
CA12 Spill Prevention and Control

Waste Management
CA20 Solid Waste Management
CA21 Hazardous Waste Management
CA22 Contaminated Soil Management
CA23 Concrete Waste Management
CA24 Sanitary/Septic Waste Management

Vehicle and Equipment Management
CA30 Vehicle and Equipment Cleaning
CA31 Vehicle and Equipment Fueling
CA32 Vehicle and Equipment Maintenance

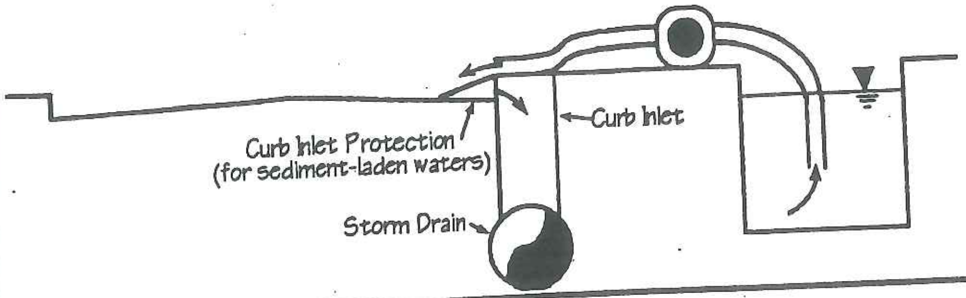
Contractor Training
CA40 Employee/Subcontractor Training

These BMP fact sheets are suitable for inclusion in many storm water pollution prevention plans for typical contractor activities. The BMPs listed are not an exhaustive list, nor will every BMP be appropriate for every situation. Therefore, suggested BMPs which are inappropriate may be deleted and additional BMPs for specific site conditions should be added. In addition, your selection and implementation of BMPs should be reviewed on a regular basis to match the changing conditions at construction sites.

TABLE 4.1 CONTRACTOR ACTIVITIES AND BMP OBJECTIVES

		BMP OBJECTIVES						
	BMP CATEGORY	PRACTICE GOOD HOUSE-KEEPING	CONTAIN WASTE	MINIMIZE DISTURBED AREA	STABILIZE DISTURBED AREA	PROTECT SLOPES AND CHANNELS	CONTROL SITE PERIMETER	CONTROL INTERNAL EROSION
	Construction Practices							
CA01	Dewatering Operations	✓				✓	✓	✓
CA02	Paving Operations	✓						
CA03	Structure Construction and Painting	✓			✓			
	Material Management							
CA10	Material Delivery and Storage	✓						
CA11	Material Use	✓						
CA12	Spill Prevention and Control	✓						
	Waste Management							
CA20	Solid Waste Management		✓					
CA21	Hazardous Waste Management		✓					
CA22	Contaminated Soil Management		✓	✓	✓			
CA23	Concrete Waste Management		✓					
CA24	Sanitary/Septic Waste Management		✓					
	Vehicle and Equipment Management							
CA30	Vehicle and Equipment Cleaning	✓					✓	✓
CA31	Vehicle and Equipment Fueling	✓						
CA32	Vehicle and Equipment Maintenance	✓						
	Contractor Training							
CA40	Employee/Subcontractor Training	✓	✓					

ACTIVITY: DEWATERING OPERATIONS



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from dewatering operations by using sediment controls and by testing the groundwater for pollution.

APPROACH

There are two general classes of pollutants that may result from dewatering operations; sediment, and toxics and petroleum products. A high sediment content in dewatering discharges is common because of the nature of the operation. On the other hand, toxics and petroleum products are not commonly found in dewatering discharges unless, the site or surrounding area has been used for light or heavy industrial activities, or the area has a history of groundwater contamination. The following steps will help reduce storm water pollution from dewatering discharges:

<u>Sediment</u>

- Use sediment controls to remove sediment from water generated by dewatering (See Sediment Trap (ESC 55) and Sediment Basin (ESC 56) in Chapter 5).
- Use filtration to remove sediment from a sediment trap or basin. Filtration can be achieved with:
    - Sump pit and a perforated or slit standpipe with holes and wrapped in filter fabric. The standpipe is surrounded by stones which filters the water as it collects in the pit before being pumped out.Wrapping the standpipe in filter fabric may require an increased suction inlet area to avoid clogging and unacceptable pump operation.
    - Floating suction hose to allow cleaner surface water to be pumped out.

<u>Toxics and Petroleum Products</u>

- In areas suspected of having groundwater pollution, sample the groundwater near the excavation site and have the water tested for known or suspected pollutants at a certified laboratory. Check with the Regional Water Quality Control Board and the local wastewater treatment plant for their requirements for dewatering, additional water quality tests, and disposal options.
- With a permit from the Regional Water Quality Control Board, you may be able to recycle/reuse pumped groundwater for landscape irrigation, or discharge to the storm sewer. With a permit from the local agency, you may be able to treat pumped groundwater and discharge it to the municipal wastewater treatment plant via the sanitary sewer.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

Objectives

[✓ *Housekeeping Practices*]
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
[✓ *Protect Slopes/Channels*]
[✓ *Control Site Perimeter*]
[✓ *Control Internal Erosion*]

Targeted Pollutants

● *Sediment*
○ *Nutrients*
◒ *Toxic Materials*
○ *Oil & Grease*
○ *Floatable Materials*
○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

◒ *Capital Costs*
◒ *O&M Costs*
◒ *Maintenance*
◒ *Training*
○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA1

Best Management Practices

CONTRACTOR ACTIVITY: DEWATERING OPERATIONS (Continue)

REQUIREMENTS

- Costs (Capital, O&M)
  - Sediment controls are low cost measures.
  - Treatment and/or discharge of polluted groundwater can be quite expensive.
- Maintenance
  - Maintain sediment controls and filters in good working order. (See Chapter 5 for details)
  - Inspect excavated areas daily for signs of contaminated water as evidenced by discoloration, oily sheen, or odors.

LIMITATIONS

- The presence of contaminated water may indicate contaminated soil as well. See CA22 (Contaminated Soil Management) in this chapter for more information.

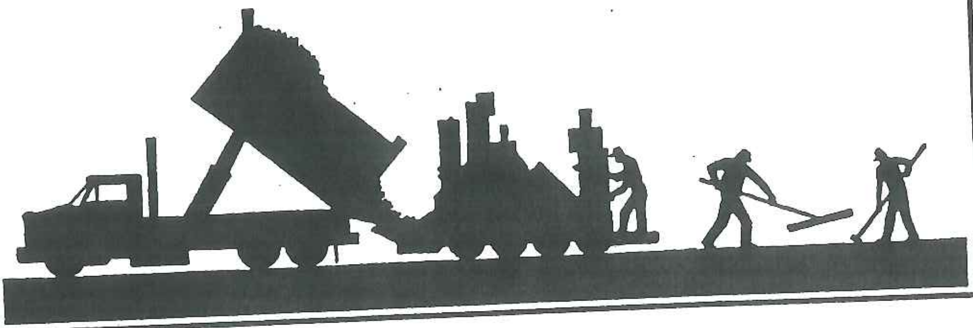
REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: PAVING OPERATIONS

Graphic: North Central Texas COG, 1993



DESCRIPTION

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

APPROACH

- Avoid paving during wet weather.
- Store materials away from drainage courses to prevent storm water runon (see CA10 Material Delivery and Storage).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or trap/filter sediment (see Chapter 5).
- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials rather than burying. See CA32 (Vehicle and Equipment Maintenance) and CA12 (Spill Prevention and Control) in this chapter.
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.
- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- If paving involves portland cement concrete, see CA23 (Concrete Waste Management) in this chapter.
- If paving involves asphaltic concrete, follow these steps:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks by sweeping. Properly dispose of this waste by referring to CA20 (Solid Waste Management) in this chapter.
  - Old asphalt must be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.
  - If paving involves on-site mixing plant, follow the storm water permitting requirements for industrial activities.
- Train employees and subcontractors.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect employees and subcontractors to ensure that measures are being followed.
  - Keep ample supplies of drip pans or absorbent materials on-site.

LIMITATIONS

- There are no major limitations to this best management practice.

Objectives

[✓ Housekeeping Practices]
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

◐ Sediment
○ Nutrients
◐ Toxic Materials
◐ Oil & Grease
○ Floatable Materials
○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

○ Capital Costs
○ O&M Costs
◐ Maintenance
◐ Training
○ Suitability for Slopes >5%

● High ○ Low

CA2

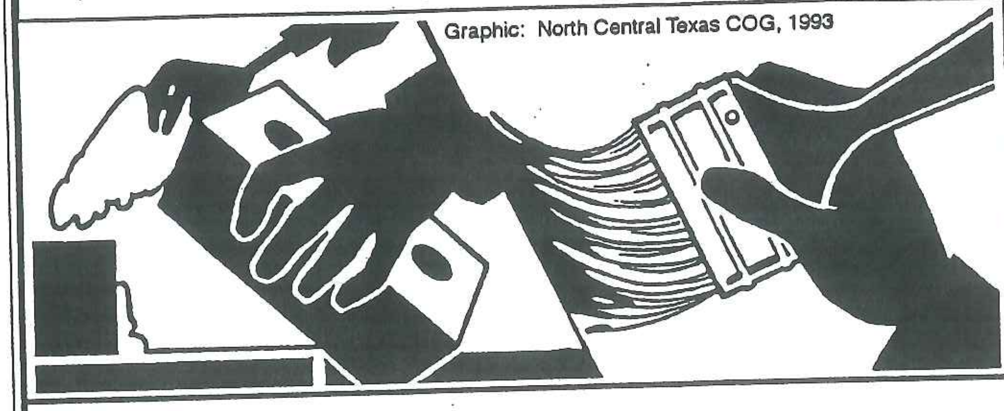
Best Management Practices

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Hot-mix Asphalt Paving Handbook, U.S, Army Corps of Engineers, AC 150/5370-14, Appendix I, July 1991.

ACTIVITY: STRUCTURE CONSTRUCTION AND PAINTING



Graphic: North Central Texas COG, 1993

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from structure construction and painting by enclosing or covering or berming building material storage areas, using good housekeeping practices, using safer alternative products, and training employees and subcontractors.

APPROACH

- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area.
- Use soil erosion control techniques if bare ground is exposed (See Chapter 5).
- Buy recycled or less hazardous products to the maximum extent practicable.
- Conduct painting operations consistent with local air quality and OSHA regulations.
- Properly store paints and solvents. See CA10 (Material Delivery and Storage) in this chapter.
- Properly store and dispose waste materials generated from the activity. See the waste management BMPs (CA20 to CA24) in this chapter.
- Recycle residual paints, solvents, lumber, and other materials to the maximum extent practicable.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.
- Clean the storm drain system in the immediate construction area after construction is completed.
- Educate employees who are doing the work.
- Inform subcontractors of company policy on these matters and include appropriate provisions in their contract to make certain proper housekeeping and disposal practices are implemented.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - These BMPs are generally of low to moderate cost.
- Maintenance
  - Maintenance should be minimal.

LIMITATIONS

- Safer alternative products may not be available, suitable, or effective in every case.
- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler.

Objectives

[✓ *Housekeeping Practices*]
Contain Waste
Minimize Disturbed Areas
[✓ *Stabilize Disturbed Areas*]
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

○ *Sediment*
○ *Nutrients*
◒ *Toxic Materials*
○ *Oil & Grease*
● *Floatable Materials*
● *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

○ *Capital Costs*
○ *O&M Costs*
○ *Maintenance*
◒ *Training*
○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA3

Best Management Practices

ACTIVITY: STRUCTURE CONSTRUCTION AND PAINTING (Continue)

- Be certain that actions to help storm water quality are consistent with Cal- and Fed-OSHA and air quality regulations.

Construction and painting activities can generate pollutants that can reach storm water if proper care is not taken. The sources of these contaminants may be solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos insulation. For specific information on some of these wastes see the following BMPs in this chapter:

CA20	Solid Waste,
CA21	Hazardous Waste, and
CA23	Concrete Waste.

More specific information on structure construction practices is listed below.

Erosion and Sediment Control

If the work involves exposing large areas of soil or if old buildings are being torn down and not replaced in the near future, employ the appropriate soil erosion and control techniques described in Chapter 5.

Storm/Sanitary Sewer Connections

Carefully install all plumbing and drainage systems. Cross connections between the sanitary and storm drain systems, as well as any other connections into the drainage system from inside a building, are illegal. Color code or flag pipelines on the project site to prevent such connections, and train construction personnel.

Painting

Local air pollution regulations may, in many areas of the state, specify painting procedures which if properly carried out are usually sufficient to protect storm water quality. These regulations may require that painting operations be properly enclosed or covered to avoid drift. Use temporary scaffolding to hang drop cloths or draperies to prevent drift. Application equipment that minimizes overspray also helps. When using sealants on wood, pavement, roofs, etc, quickly clean up spills. Remove excess liquid with absorbent material or rags.

If painting requires scraping or sand blasting of the existing surface, use a drop cloth to collect most of the chips. Dispose the residue properly. If the paint contains lead or tributyl tin, it is considered a hazardous waste. Refer to the waste management BMPs in this chapter for more information.

Mix paint indoors, in a containment area, or in a flat unpaved area not subject to significant erosion. Do so even during dry weather because cleanup of a spill will never be 100% effective. Dried paint will erode from sloped surfaces and be washed away by storms. If using water based paints, clean the application equipment in a sink that is connected to the sanitary sewer or in a containment area where the dried paint can be readily removed. Properly store leftover paints if they are to be kept for the next job, or dispose of properly.

Roof work

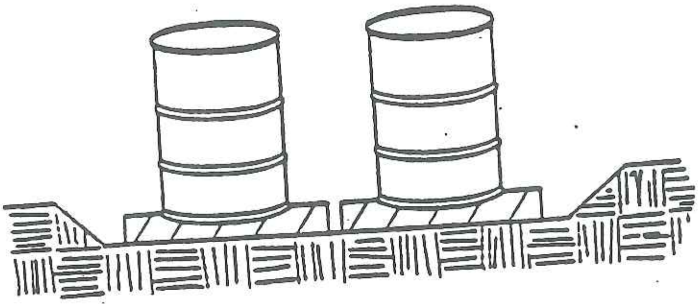
When working on roofs, if small particles have accumulated in the gutter, either sweep out the gutter or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is lined tight, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck, and clean the catch basin sump where you placed the plug.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

CA3

ACTIVITY: MATERIAL DELIVERY AND STORAGE



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material delivery and storage by minimizing the storage of hazardous materials on-site, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see CA11 (Material Use), or CA12 (Spill Prevention and Control). For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following materials are commonly stored on construction sites:

- Soil,
- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Plaster or other products,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Storage of these materials on-site can pose the following risks:

- Storm water pollution,
- Injury to workers or visitors,
- Groundwater pollution, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:

- Designate areas of the construction site for material delivery and storage.
  - Place near the construction entrances, away from waterways
  - Avoid transport near drainage paths or waterways
  - Surround with earth berms (see ESC30, Earth Dike.)
  - Place in an area which will be paved
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.
- Keep an accurate, up-to-date inventory of materials delivered and stored on-site.
- Keep your inventory down.

Objectives

[✓ Housekeeping Practices]
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

◒ Sediment
◒ Nutrients
◒ Toxic Materials
◒ Oil & Grease
◒ Floatable Materials
○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

○ Capital Costs
○ O&M Costs
○ Maintenance
◒ Training
○ Suitability for Slopes >5%

● High ○ Low

CA10

Best Management Practices

ACTIVITY: MATERIAL DELIVERY AND STORAGE (Continue)

- Minimize hazardous materials on-site storage.
- Handle hazardous materials as infrequently as possible.
- During the rainy season, consider storing materials in a covered area. Store materials in secondary containments such as an earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids and to reduce corrosion.
- Try to keep chemicals in their original containers, and keep them well labeled.
- Train employees and subcontractors.
- Employees trained in emergency spill cleanup procedures should be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove materials and any contaminated soil (See CA22). If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

REQUIREMENTS

- Cost (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Keep the designated storage area clean and well organized.
  - Conduct routine weekly inspections and check for external corrosion of material containers.
  - Keep an ample supply of spill cleanup materials near the storage area.

LIMITATIONS

- Storage sheds often must meet building and fire code requirements.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

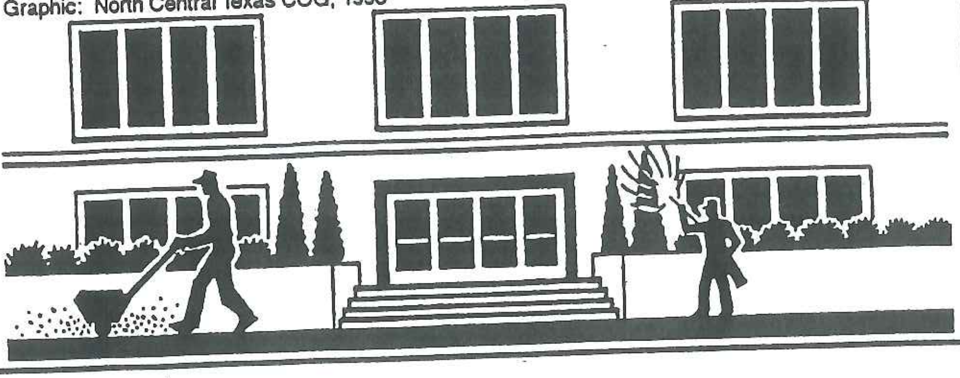
Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: MATERIAL USE

Graphic: North Central Texas COG, 1993



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material use by using alternative products, minimizing hazardous material use on-site, and training employees and subcontractors.

APPROACH

The following materials are commonly used on construction sites:

- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Plaster and other products,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Use of these materials on-site can pose the following risks:

- Storm water pollution,
- Injury to workers or visitors,
- Groundwater pollution, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:

- Use less hazardous, alternative materials as much as possible.
- Minimize use of hazardous materials on-site.
- Use materials only where and when needed to complete the construction activity.
- Follow manufacturer's instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Personnel who use pesticides should be trained in their use. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydroseeding. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains.
- Train employees and subcontractors in proper material use.

Objectives

[✓ *Housekeeping Practices*]

Contain Waste

Minimize Disturbed Areas

Stabilize Disturbed Areas

Protect Slopes/Channels

Control Site Perimeter

Control Internal Erosion

Targeted Pollutants

○ ***Sediment***

◒ ***Nutrients***

◒ ***Toxic Materials***

◒ ***Oil & Grease***

◒ ***Floatable Materials***

○ ***Other Construction Waste***

● ***Likely to Have Significant Impact***

○ ***Probable Low or Unknown Impact***

Implementation Requirements

○ ***Capital Costs***

○ ***O&M Costs***

○ Maintenance

◒ ***Training***

○ ***Suitability for Slopes >5%***

● ***High*** ○ ***Low***

CA11

Best Management Practices

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Maintenance of this best management practice is minimal.

LIMITATIONS

- Alternative materials may not be available, suitable, or effective in every case.

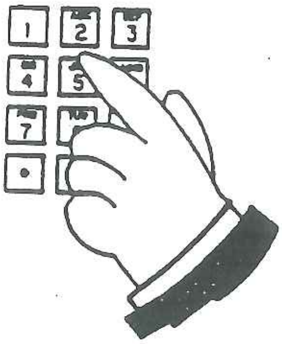
REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: SPILL PREVENTION AND CONTROL



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, CA10 (Material Delivery and Storage) and CA11 (Material Use), also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following steps will help reduce the storm water impacts of leaks and spills:

Define "Significant Spill"

- Different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.

General Measures

- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals.

Cleanup

- Clean up leaks and spills immediately.
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this chapter for specific information.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).

Objectives

[✓ *Housekeeping Practices*]
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

○ *Sediment*
○ *Nutrients*
◒ *Toxic Materials*
◒ *Oil & Grease*
○ *Floatable Materials*
○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

○ *Capital Costs*
◒ *O&M Costs*
○ *Maintenance*
◒ *Training*
○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA12

Best Management Practices

ACTIVITY: SPILL PREVENTION AND CONTROL (Continue)

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur on-site, use a designated area and/or a secondary containment, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trash cans or dumpsters can leak oil and pollute storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Discourage "topping-off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/leaks.

REQUIREMENTS

- Costs (Capital, O&M)
  - Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.
- Maintenance
  - Keep ample supplies of spill control and cleanup materials on-site, near storage, unloading, and maintenance areas.
  - Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals on-site.

LIMITATIONS

- If necessary, use a private spill cleanup company.

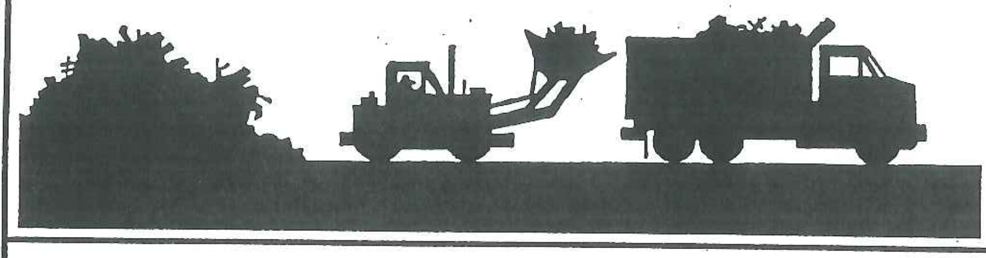
REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: SOLID WASTE MANAGEMENT

Graphic: North Central Texas COG, 1993



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

APPROACH

Solid waste is one of the major pollutants resulting from construction. Construction debris includes:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction;
- Packaging materials including wood, paper and plastic;
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products; and
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, and plastic wrappers, and cigarettes.

The following steps will help keep a clean site and reduce storm water pollution:

- Select designated waste collection areas on-site.
- Inform trash hauling contractors that you will accept only water-tight dumpsters for on-site use. Inspect dumpsters for leaks and repair any dumpster that is not water tight.
- Locate containers in a covered area and/or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it's windy.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Erosion and sediment control devices tend to collect litter. Remove this solid waste promptly.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Salvage or recycle any useful material. For example, trees and shrubs from land clearing can be used as a brush barrier (see ESC53), or converted into wood chips, then used as mulch on graded areas (see ESC11).
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to trash hauling contractor.
- Arrange for regular waste collection before containers overflow.

Objectives

Housekeeping Practices

[✓ *Contain Waste*]

Minimize Disturbed Areas

Stabilize Disturbed Areas

Protect Slopes/Channels

Control Site Perimeter

Control Internal Erosion

Targeted Pollutants

◒ *Sediment*

○ *Nutrients*

○ *Toxic Materials*

○ *Oil & Grease*

● *Floatable Materials*

● *Other Construction Waste*

● *Likely to Have Significant Impact*

○ *Probable Low or Unknown Impact*

Implementation Requirements

○ *Capital Costs*

○ *O&M Costs*

◒ *Maintenance*

◒ *Training*

○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA20

Best Management Practices

ACTIVITY: SOLID WASTE MANAGEMENT (Continue)

- If a container does spill, clean up immediately.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.
- Train employees and subcontractors in proper solid waste management.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Collect site trash daily.
  - Inspect construction waste area regularly.
  - Arrange for regular waste collection.

LIMITATIONS

- There are no major limitations to this best management practice.

REFERENCES

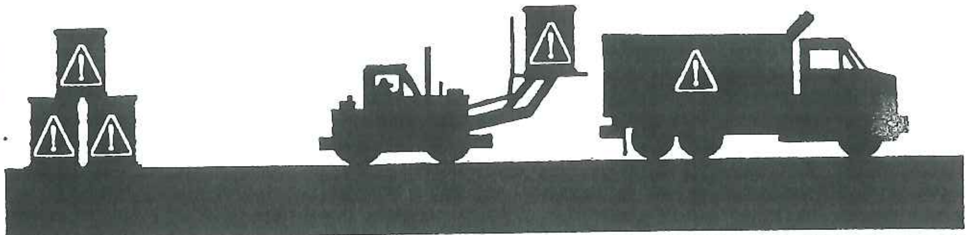
Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/9-73-007, 1973.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: HAZARDOUS WASTE MANAGEMENT

Graphic: North Central Texas COG, 1993



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

APPROACH

Many of the chemicals used on-site can be hazardous materials which become hazardous waste upon disposal. These wastes may include:

- Paints and solvents;
- Petroleum products such as oils, fuels, and grease;
- Herbicides and pesticides;
- Acids for cleaning masonry; and
- Concrete curing compounds.

In addition, sites with existing structures may contain wastes which must be disposed of in accordance with Federal, State, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints;
- Asbestos; and
- PCBs (particularly in older transformers).

The following steps will help reduce storm water pollution from hazardous wastes:

Material Use

- Use all of the product before disposing of the container.
- Do not remove the original product label, it contains important safety and disposal information.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with Federal and State regulations.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and re-use thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.

Objectives

Housekeeping Practices

[✓ Contain Waste]

Minimize Disturbed Areas

Stabilize Disturbed Areas

Protect Slopes/Channels

Control Site Perimeter

Control Internal Erosion

Targeted Pollutants

○ Sediment

○ Nutrients

◒ Toxic Materials

○ Oil & Grease

○ Floatable Materials

○ Other Construction Waste

● Likely to Have Significant Impact

○ Probable Low or Unknown Impact

Implementation Requirements

○ Capital Costs

○ O&M Costs

◒ Maintenance

◒ Training

○ Suitability for Slopes >5%

● High ○ Low

CA21

Best Management Practices

ACTIVITY: HAZARDOUS WASTE MANAGEMENT (Continue)

Waste Recycling/Disposal
- Select designated hazardous waste collection areas on-site.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, make recycling impossible, and complicate disposal.
- Recycle any useful material such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g. excess oil-based paint and sludges) is collected, removed, and disposed of only at authorized disposal areas.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

Training
- Train employees and subcontractors in proper hazardous waste management.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

REQUIREMENTS
- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect hazardous waste receptacles and area regularly.
  - Arrange for regular hazardous waste collection.

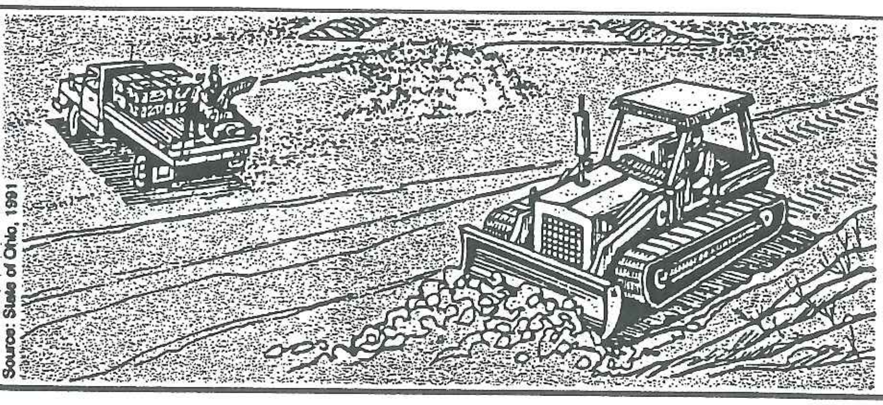
LIMITATIONS
- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.

REFERENCES
Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/9-73-007, 1973.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: CONTAMINATED SOIL MANAGEMENT



Source: State of Ohio, 1991

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

APPROACH

Contaminated soils may occur on your site for several reasons including:
- Past site uses and activities;
- Detected or undetected spills and leaks; and
- Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline-forming elements.

Most developers conduct pre-construction environmental assessments as a matter of routine. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil, highlight the need for contractors to confirm that a site assessment is completed before earth moving begins.

The following steps will help reduce storm water pollution from contaminated soil:
- Conduct thorough site planning including pre-construction geologic surveys.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills to the maximum extent practicable. Contaminated soil can be expensive to treat and/or dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- Test suspected soils at a certified laboratory.
- If the soil is contaminated, work with the local regulatory agencies to develop options for treatment and/or disposal.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil can be quite expensive.
- Maintenance
  - Inspect excavated areas daily for signs of contaminated soil.
  - Implement CA12, Spill Prevention and Control, to prevent leaks and spills as much as possible.

Objectives

Housekeeping Practices
[✓ *Contain Waste*]
[✓ *Minimize Disturbed Areas*]
[✓ *Stabilize Disturbed Areas*]
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

◓ *Sediment*
○ *Nutrients*
● *Toxic Materials*
○ *Oil & Grease*
○ *Floatable Materials*
○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

○ *Capital Costs*
◓ *O&M Costs*
◓ *Maintenance*
◓ *Training*
○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA22

Best Management Practices

ACTIVITY: CONTAMINATED SOIL MANAGEMENT (Continue)

LIMITATIONS

- Contaminated soils that cannot be treated on-site must be disposed of off-site by a licensed hazardous waste hauler.
- The presence of contaminated soil may indicate contaminated water as well. See CA1 (Dewatering Operations) in this chapter for more information.

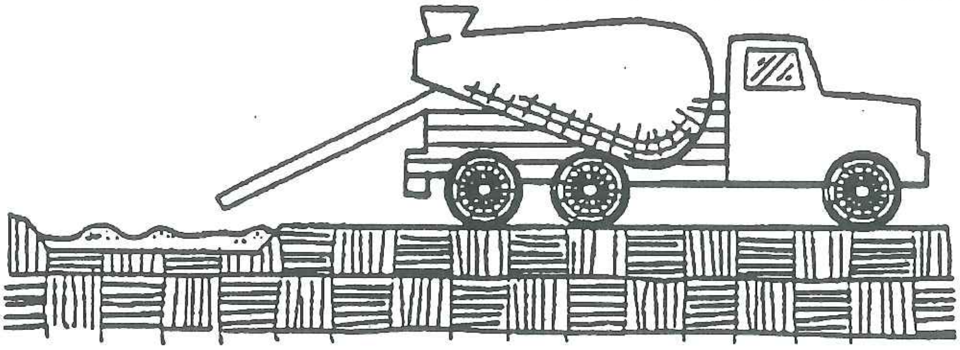
REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/9-73-007, 1973.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: CONCRETE WASTE MANAGEMENT



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from concrete waste by conducting washout off-site, performing on-site washout in a designated area, and training employees and subcontractors.

APPROACH

The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas.
- Avoid mixing excess amounts of fresh concrete or cement on-site.
- Perform washout of concrete trucks off site or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped on-site, except in designated areas.
- For on-site washout:
  - locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste;
  - wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed of properly.
- When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water to a bermed or level area.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stock pile, or dispose in the trash.
- Train employees and subcontractors in proper concrete waste management.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect subcontractors to ensure that concrete wastes are being properly managed.
  - If using a temporary pit, dispose hardened concrete on a regular basis.

LIMITATIONS

- Off-site washout of concrete wastes may not always be possible.

Objectives

Housekeeping Practices
[✓ Contain Waste]
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

○ *Sediment*
○ *Nutrients*
○ *Toxic Materials*
○ *Oil & Grease*
○ *Floatable Materials*
◓ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

○ *Capital Costs*
○ *O&M Costs*
◓ *Maintenance*
◓ *Training*
○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA23

Best Management Practices

ACTIVITY: CONCRETE WASTE MANAGEMENT (Continue)

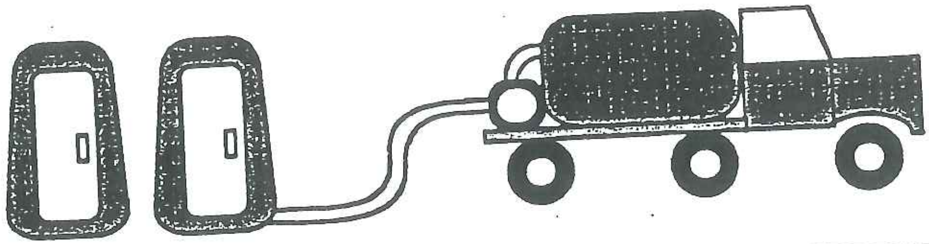
REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, July 1992.

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: SANITARY/SEPTIC WASTE MANAGEMENT



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from sanitary/septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

APPROACH

Sanitary or septic wastes should be treated or disposed of in accordance with State and local requirements. These requirements may include:

- Locate sanitary facilities in a convenient location.
- Untreated raw wastewater should never be discharged or buried.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an on-site disposal system (OSDS), such as a septic system, comply with local health agency requirements.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- If discharging to the sanitary sewer, contact the local wastewater treatment plant for their requirements.
- Sanitary/septic facilities should be maintained in good working order by a licensed service.
- Arrange for regular waste collection by a licensed hauler before facilities overflow.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect facilities regularly.
  - Arrange for regular waste collection.

LIMITATIONS

- There are no major limitations to this best management practice.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Objectives

Housekeeping Practices
[✓ Contain Waste]
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

○ Sediment
○ Nutrients
○ Toxic Materials
○ Oil & Grease
○ Floatable Materials
◒ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

○ Capital Costs
○ O&M Costs
◒ Maintenance
○ Training
○ Suitability for Slopes >5%

● High ○ Low

CA24

Best Management Practices

ACTIVITY: VEHICLE AND EQUIPMENT CLEANING

Graphic: North Central Texas COG, 1993

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment cleaning by using off-site facilities, washing in designated, contained areas only, eliminating discharges to the storm drain by infiltrating or recycling the wash water, and/or training employees and subcontractors.

APPROACH

- Use off-site commercial washing businesses as much as possible. Washing vehicles and equipment outdoors or in areas where wash water flows onto paved surfaces or into drainage pathways can pollute storm water. If you wash a large number of vehicles or pieces of equipment, consider conducting this work at an off-site commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Performing this work off-site can also be economical by eliminating the need for a separate washing operation at your site.
- If washing must occur on-site, use designated, bermed wash areas to prevent wash water contact with storm water, creeks, rivers, and other water bodies. The wash area can be sloped for wash water collection and subsequent infiltration into the ground.
- Use as little water as possible to avoid having to install erosion and sediment controls for the wash area.
- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning on-site. Steam cleaning can generate significant pollutant concentrations.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Minimal, some berm repair may be necessary.

LIMITATIONS

- Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades.
- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance).

REFERENCE

Swisher, R.D., 1987. Surfactant Biodegradation, Marcel Decker Corporation

Objectives

[✓ *Housekeeping Practices*]
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
[✓ *Control Site Perimeter*]
[✓ *Control Internal Erosion*]

Targeted Pollutants

○ *Sediment*
○ *Nutrients*
◒ *Toxic Materials*
◒ *Oil & Grease*
○ *Floatable Materials*
○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

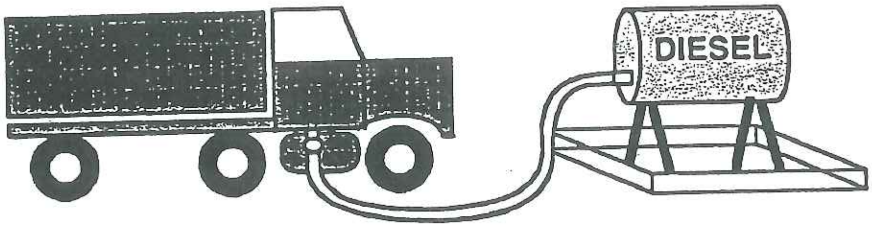
◒ *Capital Costs*
○ *O&M Costs*
◒ *Maintenance*
○ *Training*
○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA30

Best Management Practices

ACTIVITY: VEHICLE AND EQUIPMENT FUELING



DESCRIPTION

Prevent fuel spills and leaks, and reduce their impacts to storm water by using off-site facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors.

APPROACH

- Use off-site fueling stations as much as possible. Fueling vehicles and equipment outdoors or in areas where fuel may spill/leak onto paved surfaces or into drainage pathways can pollute storm water. If you fuel a large number of vehicles or pieces of equipment, consider using an off-site fueling station. These businesses are better equipped to handle fuel and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Discourage "topping-off" of fuel tanks.
- Always use secondary containment, such as a drain pan or drop cloth, when fueling to catch spills/leaks.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Carry out all Federal and State requirements regarding stationary above ground storage tanks.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and perhaps forklifts, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above measures are low cost, except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.
- Maintenance
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect fueling areas and storage tanks on a regular schedule.

LIMITATIONS

- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance).

Objectives

[✓ *Housekeeping Practices*]
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

○ *Sediment*
○ *Nutrients*
◒ *Toxic Materials*
◒ *Oil & Grease*
○ *Floatable Materials*
○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

◒ *Capital Costs*
○ *O&M Costs*
◒ *Maintenance*
◒ *Training*
○ *Suitability for Slopes >5%*

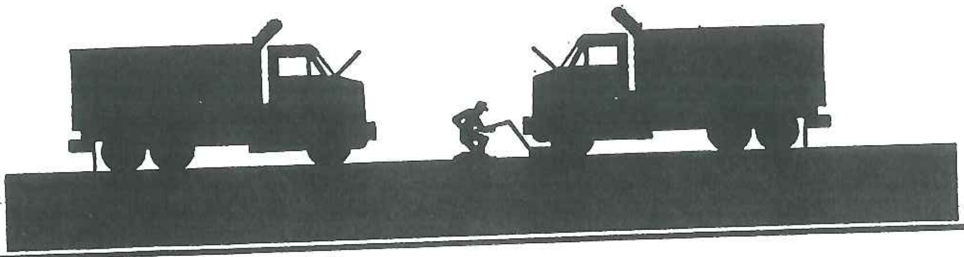
● *High* ○ *Low*

CA31

Best
Management
Practices

ACTIVITY: VEHICLE AND EQUIPMENT MAINTENANCE

Graphic: North Central Texas COG, 1993



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment maintenance by running a "dry site". This involves using off-site facilities, performing work in designated areas only, providing cover for materials stored outside, checking for leaks and spills, containing and cleaning up spills immediately, and training employees and subcontractors.

APPROACH

- Keep vehicles and equipment clean, don't allow excessive build-up of oil and grease.
- Use off-site repair shops as much as possible. Maintaining vehicles and equipment outdoors or in areas where vehicle or equipment fluids may spill or leak onto the ground can pollute storm water. If you maintain a large number of vehicles or pieces of equipment, consider using an off-site repair shop. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect maintenance areas on a regular schedule.

Objectives

[✓ Housekeeping Practices]
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

○ Sediment
○ Nutrients
◒ Toxic Materials
◒ Oil & Grease
○ Floatable Materials
○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

○ Capital Costs
○ O&M Costs
○ Maintenance
◒ Training
○ Suitability for Slopes >5%

● High ○ Low

CA32

Best Management Practices

ACTIVITY: VEHICLE AND EQUIPMENT MAINTENANCE (Continue)

LIMITATIONS

- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance).

Outdoor vehicle or equipment maintenance is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service, particularly changing or replacement of fluids, and outdoor equipment storage and parking (dripping engines). For further information on vehicle or equipment servicing, see CA30, Vehicle and Equipment Cleaning, and CA31, Vehicle and Equipment Fueling.

Listed below is further information if you must perform vehicle or equipment maintenance on-site.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane, or methylene chloride. Many of these parts cleaners are harmful and must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents (1,1,1-trichloroethane, methylene chloride, etc.) with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling/Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Do not bury used tires.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

ACTIVITY: EMPLOYEE/SUBCONTRACTOR TRAINING

Objectives

[✓ Housekeeping Practices]

[✓ Contain Waste]

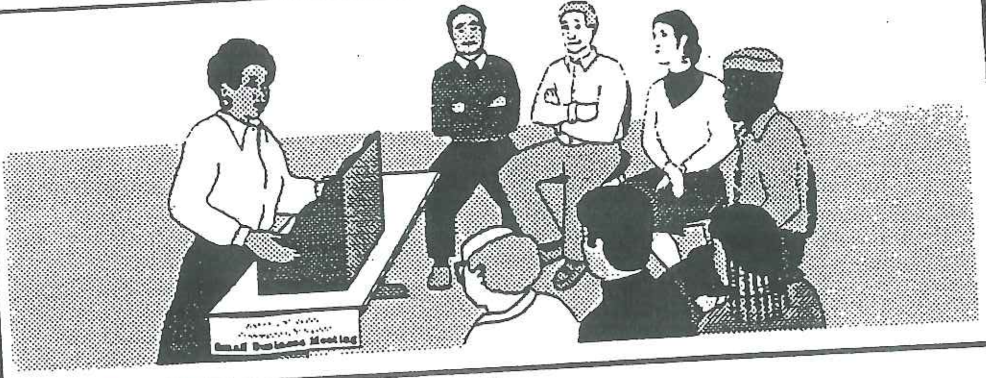
Minimize Disturbed Areas

Stabilize Disturbed Areas

Protect Slopes/Channels

Control Site Perimeter

Control Internal Erosion



DESCRIPTION

Employee/subcontractor training, like maintenance or a piece of equipment, is not so much a best management practice as it is a method by which to implement BMPs. This fact sheet highlights the importance of training and of integrating the elements of employee/subcontractor training from the individual source controls into a comprehensive training program as part of a company's Storm Water Pollution Prevention Plan (SWPPP).

The specific employee/subcontractor training aspects of each of the source controls are highlighted in the individual fact sheets. The focus of this fact sheet is more general, and includes the overall objectives and approach for assuring employee/subcontractor training in storm water pollution prevention. Accordingly, the organization of this fact sheet differs somewhat from the other fact sheets in this chapter.

OBJECTIVES

Employee/subcontractor training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

APPROACH

- Integrate training regarding storm water quality management with existing training programs that may be required for your business by other regulations such as: the Illness and Injury Prevention Program (IIPP) (SB 198) (California Code of Regulations Title 8, Section 3203), the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard (29 CFR 1910.120), the Spill Prevention Control and Countermeasure (SPCC) Plan (40 CFR 112), and the Hazardous Materials Management Plan (Business Plan) (California Health and Safety Code, Section 6.95).
- Businesses, particularly smaller ones that may not be regulated by Federal, State, or local regulations, may use the information in this Handbook to develop a training program to reduce their potential to pollute storm water.
- Use the quick reference on disposal alternatives (Table 4.2) to train employee/subcontractors in proper and consistent methods for disposal.

CA40

Best Management Practices

ACTIVITY: EMPLOYEE/SUBCONTRACTOR TRAINING (Continue)

- Consider posting the quick reference table around the job site or in the on-site office trailer to reinforce training.
- Train employee/subcontractors in standard operating procedures and spill cleanup techniques described in the fact sheets. Employee/subcontractors trained in spill containment and cleanup should be present during the loading/unloading and handling of materials.
- Personnel who use pesticides should be trained in their use. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employee/subcontractors can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do on-site.

TABLE 4.2 QUICK REFERENCE - DISPOSAL ALTERNATIVES

(Adopted from Santa Clara County Nonpoint Source Pollution Control Program - December 1992)

All of the waste products on this chart are prohibited from discharge to the storm drain system. Use this matrix to decide which alternative disposal strategies to use. **ALTERNATIVES ARE LISTED IN PRIORITY ORDER.**

Key:		
	HHW	Household hazardous waste (Government-sponsored drop-off events)
	POTW	Publically Owned Treatment Plant
	Reg.Bd.	Regional Water Quality Control Board (Oakland)

"Dispose to sanitary sewer" means dispose into sink, toilet, or sanitary sewer clean-out connection.
"Dispose as trash" means dispose in dumpsters or trash containers for pickup and/or eventual disposal in landfill.
"Dispose as hazardous waste" for business/commercial means contract with a hazardous waste hauler to remove and dispose.

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL		RESIDENTIAL
	Disposal Priorities	Approval	Disposal Priorities
General Construction and Painting; Street and Utility Maintenance			
Excess paint (oil-based)	1. Recycle/reuse. 2. Dispose as hazardous waste.		1. Recycle/reuse. 2. Take to HHW drop-off.
Excess paint (water-based)	1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, dispose as hazardous waste.		1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, take to HHW drop-off
Paint cleanup (oil-based)	Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Dispose as hazardous waste.		Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Take to HHW drop-off.
Paint cleanup (water-based)	Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.		Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.
Empty paint cans (dry)	1. Remove lids, dispose as trash.		1. Remove lids, dispose as trash.
Paint stripping (with solvent)	1. Dispose as hazardous waste.		1. Take to HHW drop-off.
Building exterior cleaning (high-pressure water)	1. Prevent entry into storm drain and remove offsite 2. Wash onto dirt area, spade in 3. Collect (e.g. mop up) and discharge to sanitary sewer	POTW	
Cleaning of building exteriors which have **HAZARDOUS MATERIALS** (e.g. mercury, lead) in paints	1. Use dry cleaning methods 2. Contain and dispose washwater as hazardous waste (Suggestion: dry material first to reduce volume)		

Table 4.1 (Continued)
Page 2

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Non-hazardous paint scraping/ sand blasting	1. Dry sweep, dispose as trash		1. Dry sweep, dispose as trash
HAZARDOUS paint scraping/sand blasting (e.g. marine paints or paints containing lead or tributyl tin)	1. Dry sweep, dispose as hazardous waste		1. Dry sweep, take to HHW drop-off
Soil from excavations during periods when storms are forecast	1. Should not be placed in street or on paved areas 2. Remove from site or backfill by end of day 3. Cover with tarpaulin or surround with hay bales, or use other runoff controls 4. Place filter mat over storm drain Note: Thoroughly sweep following removal of dirt in all four alternatives.		
Soil from excavations placed on paved surfaces during periods when storms are not forecast	1. Keep material out of storm conveyance systems and thoroughly remove via sweeping following removal of dirt		
Cleaning streets in construction areas	1. Dry sweep and minimize tracking of mud 2. Use silt ponds and/or similar pollutant reduction techniques when flushing pavement		
Soil erosion, sediments	1. Cover disturbed soils, use erosion controls, block entry to storm drain. 2. Seed or plant immediately.		
Fresh cement, grout, mortar	1. Use/reuse excess 2. Dispose to trash		1. Use/reuse excess 2. Dispose as trash
Washwater from concrete/mortar (etc.) cleanup	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	POTW	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer
Aggregate wash from driveway/patio construction	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate		1. Wash onto dirt area, spade in 2. Pump an

Table 4.1 (Continued)
Page 3

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Rinsewater from concrete mixing trucks	1. Return truck to yard for rinsing into pond or dirt area 2. At construction site, wash into pond or dirt area		
Non-hazardous construction and demolition debris	1. Recycle/reuse (concrete, wood, etc.) 2. Dispose as trash		1. Recycle/reuse (concrete, wood, etc. 2. Dispose as trash
Hazardous demolition and construction debris (e.g. asbestos)	1. Dispose as hazardous waste		1. Do not attempt to remove yourself. Contact asbestos removal service for safe removal and disposal. 2. Very small amounts (less than 5 lbs) may be double-wrapped in plastic and taken to HHW drop-off
Saw-cut slurry	1. Use dry cutting technique and sweep up residue 2. Vacuum slurry and dispose off-site. 3. Block storm drain or berm with low weir as necessary to allow most solids to settle. Shovel out gutters; dispose residue to dirt area, construction yard or landfill.		
Construction dewatering (Nonturbid, uncontaminated groundwater)	1. Recycle/Reuse 2. Discharge to storm drain		
Construction dewatering (Other than nonturbid, uncontaminated groundwater)	1. Recycle/reuse 2. Discharge to sanitary sewer 3. As appropriate, treat prior to discharge to storm drain	POTW Reg. Bd.	
Portable toilet waste	1. Leasing company shall dispose to sanitary sewer at POTW	POTW	
Leaks from garbage dumpsters	1. Collect, contain leaking material. Eliminate leak, keep covered, return to leasing company for immediate repair 2. If dumpster is used for liquid waste, use plastic liner		

Table 4.1 (Continued)
Page 4

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Leaks from construction debris bins	1. Insure that bins are used for dry nonhazardous materials only (Suggestion: Fencing, covering help prevent misuse)		
Dumpster cleaning water	1. Clean at dumpster owner's facility and discharge waste through grease interceptor to sanitary sewer 2. Clean on site and discharge through grease interceptor to sanitary sewer	POTW POTW	
Cleaning driveways, paved areas * (Special Focus = Restaurant alleys Grocery dumpster areas) * Note: Local drought ordinances may contain additional restrictions	1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, restaurant/grocery alleys, follow this 3-step process: a. Clean up leaks with rags or absorbents. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to the sanitary sewer). 3. Same as 2 above, but with rinsewater (2c)(no soap) discharged to storm drain.		1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, follow this 3-step process: a. Clean up leaks with rags or absorbents; dispose as hazardous waste. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer.
Steam cleaning of sidewalks, plazas * * Note: Local drought ordinances may contain additional restrictions	1. Collect all water and pump to sanitary sewer. 2. Follow this 3-step process: a. Clean oil leaks with rags or adsorbents b. Sweep (Use dry absorbent as needed) c. Use no soap, discharge to storm drain		
Potable water/line flushing Hydrant testing	1. Deactivate chlorine by maximizing time water will travel before reaching creeks		
Super-chlorinated (above 1 ppm) water from line flushing	1. Discharge to sanitary sewer 2. Complete dechlorination required before discharge to storm drain		

Table 4.1 (Continued)
Page 5

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL		RESIDENTIAL
	Disposal Priorities	Approval	Disposal Priorities
Landscape/Garden Maintenance			
Pesticides	1. Use up. Rinse containers use rinsewater as product. Dispose rinsed containers as trash 2. Dispose unused pesticide as hazardous waste		1. Use up. Rinse containers, use rinsewater as pesticide. Dispose rinsed container as trash. 2. Take unused pesticide to HHW drop-off
Garden clippings	1. Compost 2. Take to Landfill		1. Compost 2. Dispose as trash.
Tree trimming	1. Chip if necessary, before composting or recycling		1. Chip if necessary, before composting or recycling
Swimming pool, spa, fountain water (emptying)	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.	POTW	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.
Acid or other pool/spa/fountain cleaning	1. Neutralize and discharge to sanitary sewer	POTW	
Swimming pool, spa filter backwash	1. Reuse for irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer		1. Use for landscape irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer
Vehicle Wastes			
Used motor oil	1. Use secondary containment while storing, send to recycler.		1. Put out for curbside recycling pickup where available 2. Take to Recycling Facility or auto service facility with recycling program 3. Take to HHW events accepting motor oil
Antifreeze	1. Use secondary containment while storing, send to recycler.		1. Take to Recycling Facility
Other vehicle fluids and solvents	1. Dispose as hazardous waste		1. Take to HHW event
Automobile batteries	1. Send to auto battery recycler 2. Take to Recycling Center		1. Exchange at retail outlet 2. Take to Recycling Facility or HHW event where batteries are accepted
Motor home/construction trailer waste	1. Use holding tank. Dispose to sanitary sewer		1. Use holding tank, dispose to sanitary sewer.

Table 4.1 (Continued)
Page 6

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	BUSINESS/COMMERCIAL Approval	RESIDENTIAL Disposal Priorities
Vehicle Wastes (cont'd)			
Vehicle Washing	1. Recycle 2. Discharge to sanitary sewer, never to storm drain	POTW	1. Take to Commercial Car Wash. 2. Wash over lawn or dirt area 3. If soap is used, use a bucket for soapy water and discharge remaining soapy water to sanitary sewer.
Mobile Vehicle Washing	1. Collect washwater and discharge to sanitary sewer.	POTW	
Rinsewater from dust removal at new car fleets	1. Discharge to sanitary sewer 2. If rinsing dust from exterior surfaces from appearance purposes, use no soap (water only); discharge to storm drain.	POTW	
Vehicle leaks at Vehicle Repair Facilities	Follow this 3-step process: 1. Clean up leaks with rags or absorbents 2. Sweep, using granular absorbent material (cat litter) 3. Mop and dispose of mopwater to sanitary sewer.		
Other Wastes			
Carpet cleaning solutions & other mobile washing services	1. Dispose to sanitary sewer	POTW	1. Dispose to sanitary sewer
Roof drains	1. If roof is contaminated with industrial waste products, discharge to sanitary sewer 2. If no contamination is present, discharge to storm drain		
Cooling water Air conditioning condensate	1. Recycle/reuse 2. Discharge to sanitary sewer	POTW	
Pumped groundwater, infiltration/ foundation drainage (contaminated)	1. Recycle/reuse (landscaping, etc.) 2. Treat if necessary; discharge to sanitary sewer 3. Treat and discharge to storm drain	Reg. Bd. POTW Reg. Bd.	
Fire fighting flows	If contamination is present, Fire Dept. will attempt to prevent flow to stream		

Table 4.1 (Continued)
Page 7

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Other Wastes (cont'd)			
Kitchen Grease	1. Provide secondary containment, collect, send to recyler. 2. Provide secondary containment, collect, send to POTW via hauler.	POTW	1. Collect, solidify, dispose as trash
Restaurant cleaning of floor mats, exhaust filters, etc.	1. Clean inside building with discharge through grease trap to sanitary sewer. 2. Clean outside in container or bermed area with discharge to sanitary sewer.		
Clean-up wastewater from sewer back-up	1. Follow this procedure: a. Block storm drain, contain, collect, and return spilled material to the sanitary sewer. b. Block storm drain, rinse remaining material to collection point and pump to sanitary sewer. (no rinse-water may flow to storm drain)		

APPENDIX D - HYDROLOGY DESIGN STANDARDS, LAKE COUNTY

HYDROLOGY DESIGN STANDARDS

LAKE COUNTY

Lake County Department of Public Works
Water Resources Division
255 N. Forbes Street
Lakeport, CA 95453
(707)263-2341

Adopted ___________, 1999

DRAFT
4/28/99

These Standards provide design criteria and the methodology used to estimate peak flows for drainages within Lake County.

These Standards are based on information provided by the National Weather Service, the USDA Natural Resources Conservation Service, the California Department of Water Resources, and the California Department of Transportation.

It is the intent that these Standards be utilized for estimating flows in minor waterways (less than one square mile) with time of concentrations of less than two hours. For larger drainage areas, we recommend the use of more detailed calculations and/or models, such as TR20, TR-55, HEC-1 and HEC-HMS.

WATERWAY DESIGN CRITERIA

A "waterway" is defined as being a natural or artificial channel or depression in the surface of the earth or an underground conduit system which provides a course for water flowing as a consequence of storm water runoff.

For the purposes of design criteria contained herein, waterways are divided into three classifications:

1. Major Waterways: having a tributary drainage area of four square miles or more; shall require a design frequency of re-occurrence of one in 100 years. This frequency would only apply to design in urban and suburban areas and not, for instance, agricultural channel design.
2. Secondary Waterways: having a tributary drainage area of between one and four square miles; shall require a design frequency of re-occurrence of once in 25 years.
3. Minor Waterways: having a tributary drainage area less than one square mile; shall require a design frequency of re-occurrence of once in 10 years.

Commercial sites, industrial sites, residential subdivisions, and manufactured home parks or subdivisions shall be designed to carry the 10-year storm in the storm drain system, and the 100-year storm within the confines of the streets. Secondary and major waterways passing through the site shall be designed to their respective design flows. All new building pads should be designed such that they are not inundated by a 100-year flood event from local drainage facilities. Flooding from regional sources will be considered on a case-by-case basis.

Best Management Practices (BMPs), such as filter strips and sedimentation basins, are usually designed for the 2-year event. BMP's designed for the 2-year event will properly treat over 90% of the flow during its life. Design criteria, such as included in the <u>California Storm Water Best Management Practice Handbooks</u> should be used.

Open channels should be designed with a minimum of six inches of freeboard at the design flow. Closed conduit systems should be designed with no surcharging at the design flow. Culvert inlets may be surcharged to efficiently use the culvert. To reduce routine maintenance, facilities should be designed with a self-cleansing velocity of 3 feet per second. Erosive velocities in unlined channels and culvert outlets should be minimized, or erosion resistant lining provided.

ROADWAY DESIGN CRITERIA

Roadway drainage design is a matter of properly balancing technical principles and data with the environment giving due consideration to other factors such as safety and economics. Drainage features to remove runoff from the roadway and to convey surface and stream waters originating upstream of the roadway to the downstream side should be designed to accomplish these functions without causing objectionable backwater, excessive velocities or unduly affecting traffic safety. Chapters 800 to 890 of the CALTRANS Highway Design Manual should be used for drainage design of public roadways within Lake County. The following minimum design standards apply to Lake County:

Bridges/Major Culverts: Design in conformance with Chapter 820. For Major Waterways and streams that are included in the Flood Insurance Study (FIS), a 100-year flood should be used for design purposes. Bridges over streams included in the FIS may not increase the base flood elevation more than one foot. If a floodway is present, the bridge may not encroach on the floodway or must be designed with no increase the base flood elevation.

Arterial and Collector Roadways: Cross culverts should be designed for a 25-year flood event with headwater six inches below the edge of the traveled way. A 100-year event should be used if the drainage is defined as a Major Waterway.

Drainage along the roadway, i.e. gutter flow, should be designed for a 25-year event with flow contained within the shoulder or parking lane. Roadside ditches should be designed for a 25-year flood event with six inches of freeboard. The 100-year event should be contained within the roadway.

Local Roadways: Cross culverts must be designed for a 10-year flood event with headwater six inches below the edge of the traveled way. Secondary and Major Waterways should be designed for the corresponding recurrence interval.

Drainage along the roadway, i.e. gutter flow, should be designed for a 10-year event with flow contained within the shoulder or parking lane. Roadside ditches should be designed for a 10-year flood event with six inches of freeboard. The 100-year event should be contained within the roadway.

In the event of sheet flooding occurring in the area of a bridge or culvert, exceptions to the above standards will be considered on a case-by-case basis.

HYDROLOGIC DESIGN

Estimation of flood flows from minor waterways and for drainage areas that have significant areas of urban development should be through use of the Rational Formula. Secondary and major waterways should have the flood flows estimated from detailed calculations and/or models. Design shall be based on the assumption that all upstream areas are fully developed, consistent with zoning at the time of project approval.

Rational Formula

Design discharge for minor waterways and urban areas shall be determined by use of the rational formula:

$Q = C I A K$

Where:

Q = design discharge in cubic feet per second. cfs
C = runoff coefficient based on full development
I = rainfall intensity in inches per hour
A = drainage area in acres
K = coefficient of intensity

Runoff Coefficient:

The runoff coefficient for undeveloped areas is selected from Table 1. For developed areas, the runoff coefficient is calculated based on the runoff coefficient from Table 1 and the percentage of area that is covered by impermeable surfaces. Table 2 provides some typical ranges for the area covered by impermeable surfaces for different levels of development. Table 3 provides some typical runoff coefficients for different types of development. The runoff coefficient is calculated as follows:

$$Ct = (Ap/At)(Cp) + (Av/At)(Cv)$$

Where:
Ap = area covered by impermeable surfaces, such as paving and buildings
Av = area planted or vegetated
At = total area
Cp = coefficient of runoff of paved area, usually 0.95
Cv = coefficient of runoff for planted or vegetated areas, from Table 1
Ct = coefficient adjusted for vegetated area

Rainfall Intensity:

Rainfall Duration-Intensity Curves are included in Figure 1. Proper determination of the time of concentration has the greatest effect on the rainfall intensity. The time of concentration is the time required for water from the most remote point of the drainage area to travel to the point of interest. Because the flow velocity is dependent on the characteristics of the flow route, the route should be divided into segments where the route characteristics change (i.e. roughness, slope, wetted perimeter, channel slope, etc.) and the individual times added together to get the time of concentration. Figure 2 provides a relationship of slope, cover type and overland flow velocity. The flow velocities for natural channels can be estimated using Manning's equation. Because the depth of flow increases with higher intensity rainfall, the time of concentration will decrease as the storm intensity increases. Add 10 minutes to the calculated time of travel to obtain the time of concentration for the design rainfall intensity.

K: The "K" factor is determined by obtaining the mean annual precipitation for the drainage basin from Figure 3, and dividing it by 35.

General:

The Rational Method is based on the following assumptions:

1. All areas of the drainage basin contribute to the peak flow.
2. Rainfall falls at a uniform rate over the entire drainage basin.
3. The runoff coefficient is the same for storms of various frequencies.
4. The runoff coefficient is the same for all storms in a given watershed.
5. The frequency of peak discharge is the same as that of the rainfall intensity for the given time of concentration.
6. The base flow is negligible compared to the flood flow.

Because of these assumptions, use of the Rational Formula should be limited to small, simple watersheds. Diverse watersheds should be divided into homogenous subareas and the resultant flows accumulated based on the entire watershed's time of concentration. If a large amount of storage exists within the basin, development of a hydrograph and flood routing may be required.

Table 1: Runoff Coefficients For Undeveloped Areas

	Watershed Types			
	Extreme	High	Normal	Low
Relief	0.28-0.35 Steep Rugged terrain with average slopes above 30%	0.20-0.28 Hilly, with average slopes of 10 to 30%	0.14-0.20 Rolling with average slopes of 5 to 10%	0.08-0.14 Relatively flat land, with average slopes of 0 to 5%
Soil infiltration	0.12-0.16 No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity	0.08-0.12 Slow to take up water, clay or shallow loam soils of low soil infiltration capacity, imperfectly or poorly drained	0.06-0.08 Normal, well drained light or medium textured soils, sandy loams, silt and silt loams	0.04-0.06 High, deep sand or other soil that takes up water readily, very light well drained soils
Vegetal Cover	0.12-0.16 No effective plant cover, bare or very sparse cover	0.08-0.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	0.06-0.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	0.04-0.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover
Surface Storage	0.10-0.12 Negligible surface storage, depressions few and shallow; drainageways steep and small, no marshes	0.08-0.10 Low; well defined system of small drainageways; no ponds or marshes	0.06-0.08 Normal; considerable surface depression storage; lakes and pond marshes	0.04-0.06 High; surface storage high; drainage system not sharply defined; large floodplain storage or large number of ponds and marshes

Given: An undeveloped watershed consisting of 1) rolling terrain with average slopes of 5%, 2) clay type soils, 3) good grassland area, and 4) normal surface depressions

Find: The runoff coefficient, C, for the above watershed

Solution: Relief 0.14
Soil Infiltration 0.08
Vegetal Cover 0.04
Surface Storage 0.06
C = 0.32

Table 2: Typical Ranges of Impermeable Area

Development Type	Low, %	High, %
Suburban Residential (SR)	5	15
Single-Family Residential (R1)	45	65
Two-Family Residential (R2)	50	70
Multi-Family Residential (R3)	50	75
Commercial	50	100

Table 3: Typical Runoff Coefficients for Developed Areas

Type of Drainage Area	**Runoff Coefficient**	**Type of Drainage Area**	**Runoff Coefficient**
Business:		Residential	
Downtown Areas	0.70-0.95	Single Family Areas	0.30-0.50
Neighborhood Areas	0.50-0.70	Multi-units, detached	0.40-0.60
Industrial		Multi-units, attached	0.60-0.75
Light industrial areas	0.50-0.80	Suburban	0.25-0.40
Heavy industrial areas	0.60-0.90	Apartment dwelling areas	0.50-0.70
Parks, cemeteries	0.10-0.25	Playgrounds	0.20-0.40

Example:

Calculate the design flow for a subdivision in Kelseyville which has flow from 35 acres of adjacent, rolling, pasture land (zoned AG) and 15 acres of subdivision (zoned R1). The average slope of the agricultural land is 8 percent. The average slope within the subdivision is 3 percent. The soil is a normal Lake County loam.

Example Drainage Area

Calculate I:

The drainage area is less than 1 square mile, therefore, design for the 10-year event

Tc = 10 minutes + Overland Flow time + Channel Flow time

Overland Flow: Pasture; 500 feet, slope of 10%, good grass cover

From Figure 2, the flow velocity is 0.8 feet per second

Tof = (500/0.8)/60 = 10.4 minutes

Channel Flow: Pasture: 1200 feet of natural channel at 1.5%

Use Manning's equation to estimate velocity

$V = (1.49/0.035)(0.5)^{2/3} \times (0.015)^{1/2}$

V = 3.3 fps

Tc = (1200/3.3)/60 = 6.1 minutes

Subdivision: 800 feet of culvert at 1.25 %

$V = (1.49/0.013)(0.5)^{2/3} \times (.0125)^{1/2}$

V = 8 fps

Tc = (800/8)/60 = 1.7 minutes

Design Time of Concentration

Tc = 10 + 10.4 + 6.1 + 1.7 = 28.2 minutes, Use 30 minutes

Using Figure 1 for the 10-year event, the rainfall intensity is 0.96 inches/hour

Determine K

Using Figure 3, the average annual precipitation for Kelseyville is 26 inches/year

K = 26/35 = 0.74

Q = (0.47)(0.96)(50)(0.74) = 16.7 cfs

Design Drainage Facilities for 17 cfs

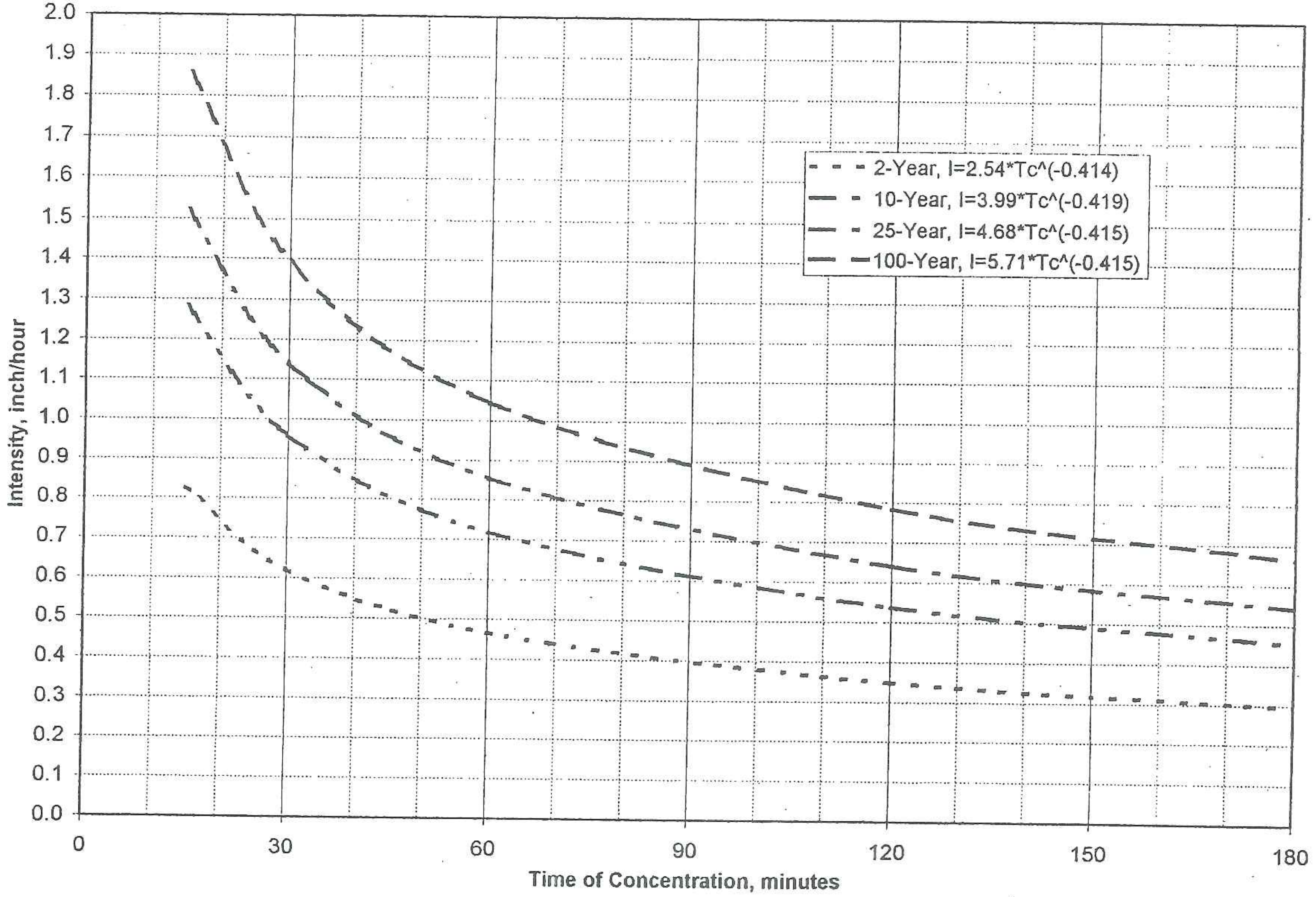


Figure 1: Rainfall Duration-Intensity Curves

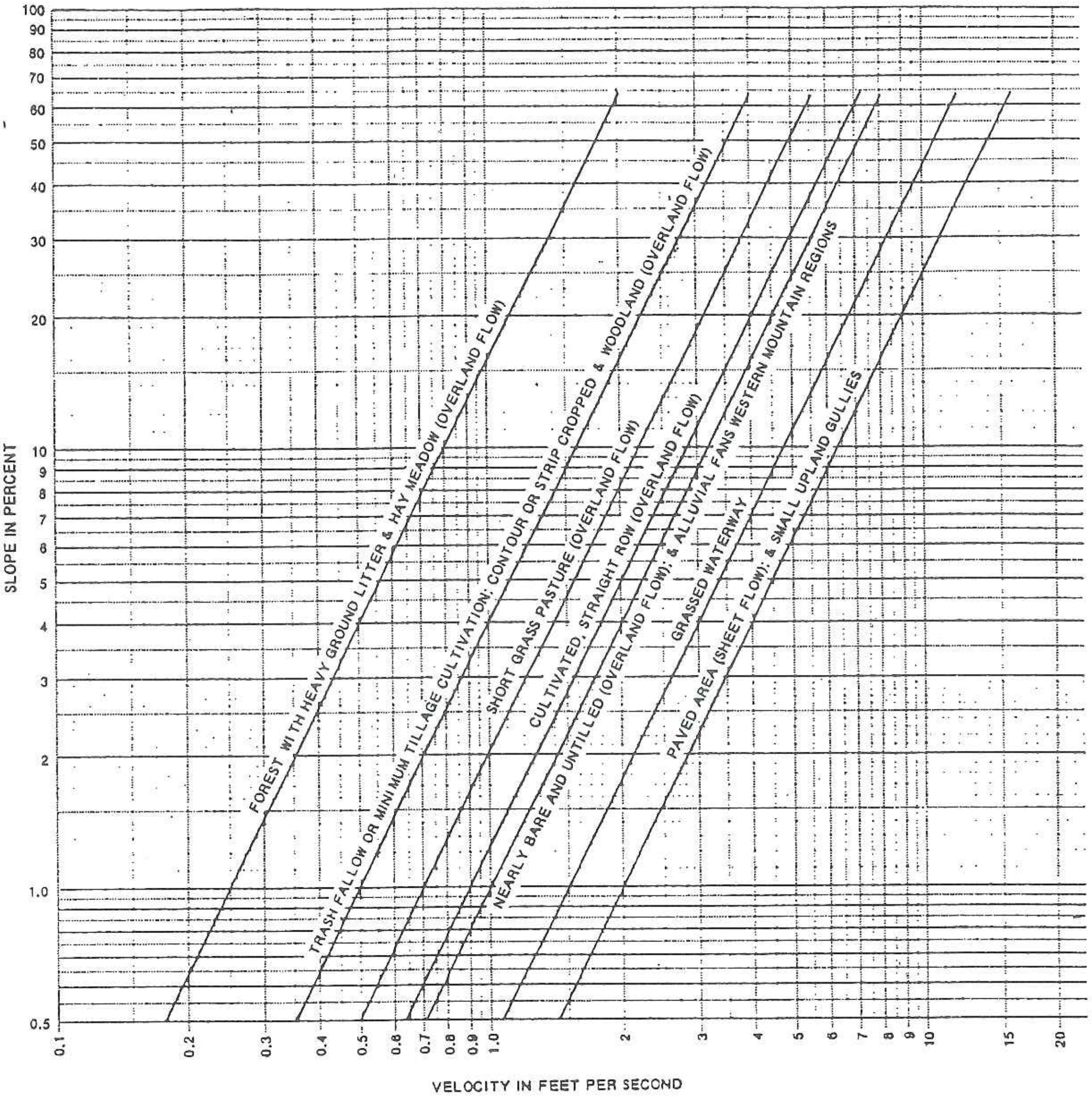


Figure 2: Overland Flow Velocities

From: USDA Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, March 1985, p. 15-8

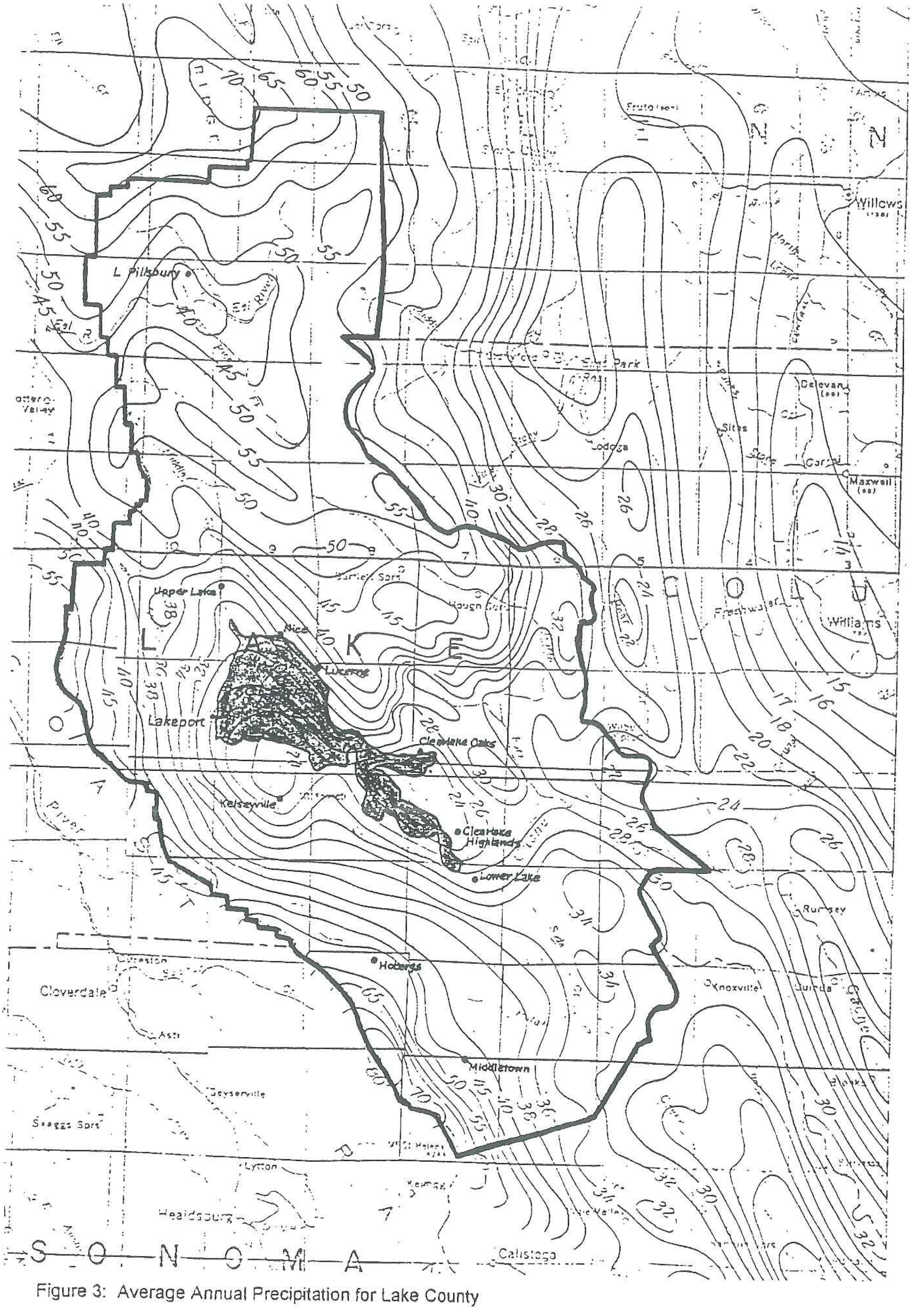


Figure 3: Average Annual Precipitation for Lake County

From: Calif. Department of Water Resources, Lines of Average Yearly Precipitation in the Central Valley, April 1966

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