

CITY OF ASHLAND
DRAINAGE MASTER PLAN

November 1985

City of Ashland
20 E. Main Street
Ashland, Oregon 97520



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CITY OF ASHLAND DRAINAGE MASTER PLAN

EXECUTIVE SUMMARY

1. INTRODUCTION

The City of Ashland, like many urban areas that have experienced high population growth rates and associated levels of development, realizes that stormwater drainage cannot be left to take care of itself. New development increases impervious area and hence increases peak stormwater runoff with its associated problems of flooding, water quality degradation, erosion and sedimentation.

One of the goals of Ashland's 1982 Comprehensive Plan was "to provide an adequate stormwater drainage system throughout the entire City of Ashland". This drainage master plan is a first step which will provide the City with a tool to guide the improvement and expansion of the existing storm drainage system. As the cornerstone of the City's drainage management program, it will guide the installation of new drainage systems to accommodate future growth without causing problems in already developed areas.

2. EXISTING CONDITIONS

Study Area

The study area for this plan includes all land located within the Ashland Urban Growth Boundary. This boundary follows Bear Creek on the north, Crowson and Dead Indian Roads on the east, and the city limits of Ashland on the south and southwest. Five identifiable streams drain the study area: Wrights Creek, Ashland Creek, Clay Creek, Hamilton Creek, and Tolman Creek.

Drainage normally occurs from south to north toward Bear Creek. Stormwater is typically channeled into one of the five natural streams which terminate in Bear Creek. Channeling is generally through closed conduits and in open roadside ditches. Many of the existing conduits are either undersized for handling future flows, subject to abrasion which reduces their capacity, or in disrepair. A majority of open ditches used to convey runoff are located in public rights-of-way. However, many are located on private property. These latter ditches are maintenance problems which result in flooding of private property. The Talent irrigation canal located in the southern portion of the study area is of benefit to the City, but, because it was not designed as a combined drainage/irrigation structure, it has detrimental effects on routing of

storm runoff. Runoff which is intercepted by the canal is frequently discharged at points which are not capable of handling increased flows.

3. RECOMMENDED PLAN

Recommendations for improving the Ashland drainage system have a total cost of \$16.1 million. Of this total, \$14.2 million have been identified as improvements within the existing developed area of Ashland. The remaining \$1.9 million worth of improvements are located in areas yet to be developed.

These recommendations were developed from computer analyses of the existing system under build-out conditions and are based on policies that the City would like to see implemented in their drainage management program.

Closed Conduit System

One of the major goals of the City is to provide an all-pipe drainage system. Some natural streams would be maintained, but the majority of all stormwater would be diverted into and channeled in closed conduits.

Ditch Improvements

This policy would hasten the implementation of a closed conduit system. In developed areas, ditches would be replaced with closed conduits, except where natural streams occur. In undeveloped areas, ditch improvements would be made to improve hydraulic efficiency, prevent siltation and erosion, and allow routine maintenance to be done. As development occurs, open channels would be replaced with closed conduits.

Relocate Drainage System Improvements in Public Rights-of-Way

Problems associated with routing stormwater in drainageways located on private property have been a maintenance problem and a public nuisance. Relocating improvements in public rights-of-way would improve maintenance of the system, enhance private property which now may be bisected by a public right-of-way, and facilitate attainment of an all-conduit system.

Improvements Along Talent Irrigation Ditch

These improvements would reduce the volume of runoff into the canal, control where overtopping of the canal would occur, and channel runoff into downstream systems that would have adequate capacity. The improvements would involve building a berm on the uphill side of the canal, constructing piped diversions under the canal, and building overflow structures at critical locations along the canal's length.

Abrasion Resistant Pipe Materials

All improvements would require use of abrasion resistant concrete pipe. Some conduits in the existing system have been subject to abrasion which creates maintenance problems and reduces their efficiency. All pipes should be a minimum of 10 inches in diameter.

Catchbasins

Due to topographic relief and local subsurface conditions, runoff volumes occur soon after rainfall events. Improvements would require installation of catchbasins that are designed to intercept larger volumes of runoff with less chance of clogging due to surface debris. Maximum spacing requirements of 250 feet, or at every street intersection, would be required on slopes greater than 15 percent.

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SECTION 1

INTRODUCTION

1.1 PROJECT BACKGROUND

One of the goals of Ashland's 1982 comprehensive plan is "to provide an adequate stormwater drainage system throughout the entire City of Ashland." The City maintains a storm drainage system consisting of closed conduits, open ditches and culverts throughout most of the City. Drainage problems that now occur are associated with overflowing pipes, manholes, and ditches which result in the flooding or undermining of streets and damage to private and public property. As infilling of land within the City's Urban Growth Boundary (UGB) occurs in the future, a drainage master plan will be needed to provide for the design and implementation of a storm drainage system which addresses the present and future needs of the City. To address existing drainage problems and to plan for growth throughout the City's urban area, the Ashland City Council authorized Kramer, Chin, & Mayo, Inc. to prepare this drainage master plan.

1.2 OBJECTIVES AND GUIDELINES

The drainage master plan prepared by KCM will guide the improvement and expansion of the storm drainage system within the Ashland urban area. Plan objectives include:

- o Solutions to the City's existing drainage problems over the next twenty years.
- o A design and planning tool to guide the installation of new drainage systems which will accommodate future growth without causing problems in already developed areas.
- o A guide to assist in the management and maintenance of the storm drainage system.
- o Estimated costs for the recommended improvements.

1.3 PURPOSE AND SCOPE

The purpose of this drainage master plan is to provide the City with a planning tool to assist and guide the improvement and expansion of the Ashland storm drainage area. The scope of work for this drainage master plan consisted of the following elements:

1.3.1 Review Existing Conditions

KCM, in cooperation with the City, collected and reviewed all available data that were relevant to the drainage characteristics of the study area. Data included mapping and detailed information of the existing drainage system, topography, soils and geology, precipitation patterns and climate, and proposed land use from the City's Comprehensive Plan. City maps with contour information were used predominantly. USGS topographic maps were used to supplement information not provided on City maps. Rainfall information recorded by the U.S. Weather Service at the Ashland rain gauge and Jackson County Airport in Medford, Oregon, were used to update intensity-duration curves and develop design storm hyetographs.

1.3.2 Analyze the Existing System

KCM utilized a computerized hydrologic model, known as the Stormwater Management Model (SWMM), to analyze the existing drainage system (6 inches in diameter and larger). This involved reviewing future land use requirements from the Comprehensive Plan, analyses of the existing drainage system with future flows that can be expected from these areas once they develop, and development of the recommended plan for upgrading and expanding the existing system. The model was calibrated using regression equations that were developed for ungauged watersheds in western Oregon.

1.3.3 Recommend a Drainage Plan

The recommended plan was selected based on consideration of cost, ease of maintenance, location, environmental impact, aesthetic impact, and design features.

1.3.4 Develop Cost Estimates

This involved development of costs for the recommended system to assist in the evaluation, recommendation, and implementation of future drainage improvements and development of future funding.

1.3.5 Funding Options

Ten funding options for storm water management are introduced in Section 6 of this text. Selection of the optimum combination of the options will require detailed review by City staff and Council, with outside technical assistance as needed.

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SECTION 2

STUDY AREA CHARACTERISTICS

2.1 STUDY AREA

The study area for the Ashland Area Drainage Master Plan (See Figure 2.1, Regional Setting/Vicinity Map) is the area within the City of Ashland's Urban Growth Boundary. This area contains approximately 8 square miles. Its borders are: Bear Creek on the north, Crowson and Dead Indian Roads on the east, and the City limits of Ashland on the south and southwest. Figure 2.1 depicts the 17 drainage basins which were identified by KCM for detailed analyses. No basin was identified as Basin 1. In this Drainage Master Plan, discussion of recommendations and improvements has been organized based upon these basins. Three of these basins, 16, 17 and 18, were combined and are presented as a single basin.

Not included in this study is the drainage basin located south of the study area above Reeder Reservoir.

2.2 TOPOGRAPHY

2.2.1 General

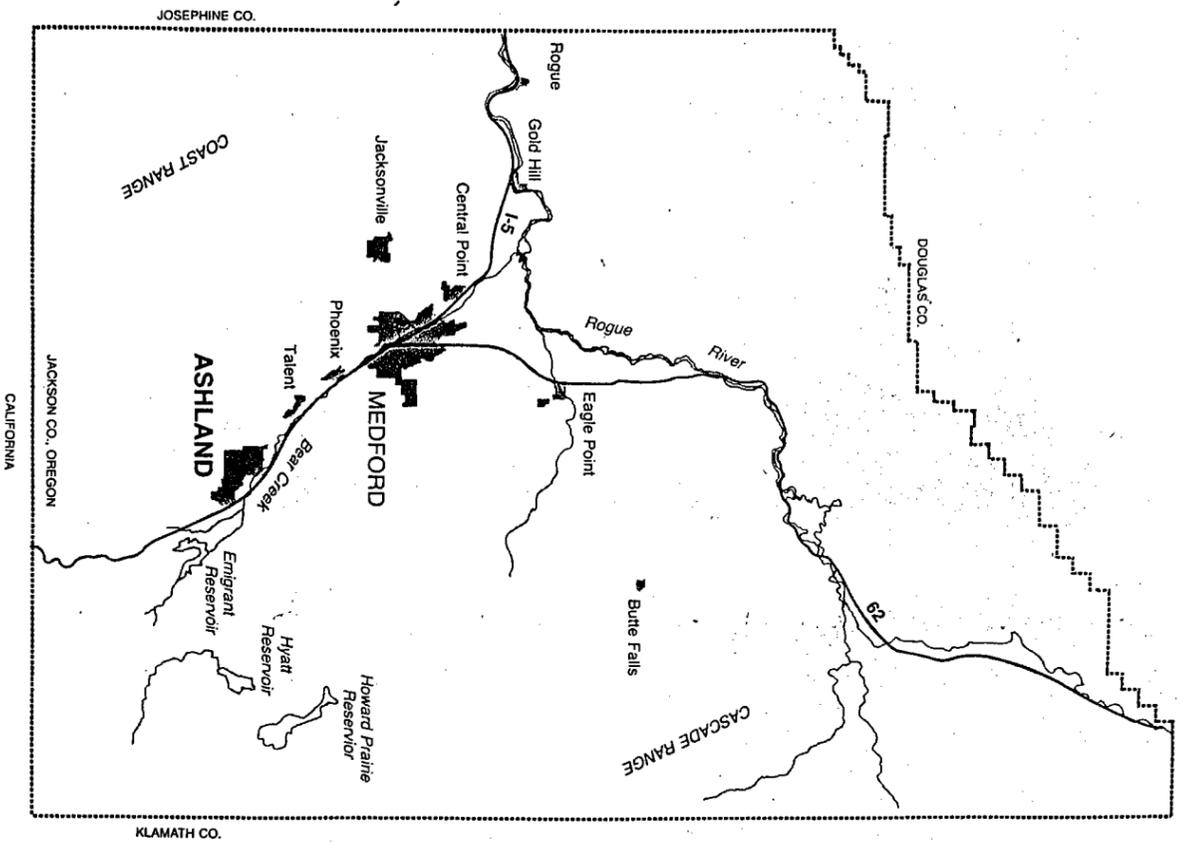
Topography, as it relates to natural drainage, flooding and surface slope, has directly influenced the existing and planned drainage facilities to serve the Ashland study area. These terrain features not only determine what drainage systems can be built, but also have direct bearing on land use, development and other factors associated with urbanization which affect runoff.

Within the study area, surface elevations range from 1,720 feet along Bear Creek, to 2,100 feet in the valley lowlands to the east of the study area along Interstate 5, and rise to a maximum of 5,600 feet in the upland and hillside areas to the west and south. The average surface slopes found throughout the study area range from 5 percent, along Bear Creek, to as much as 50 percent in the foothills to the southwest. Local slopes greater or less than these average values occur throughout the study area.

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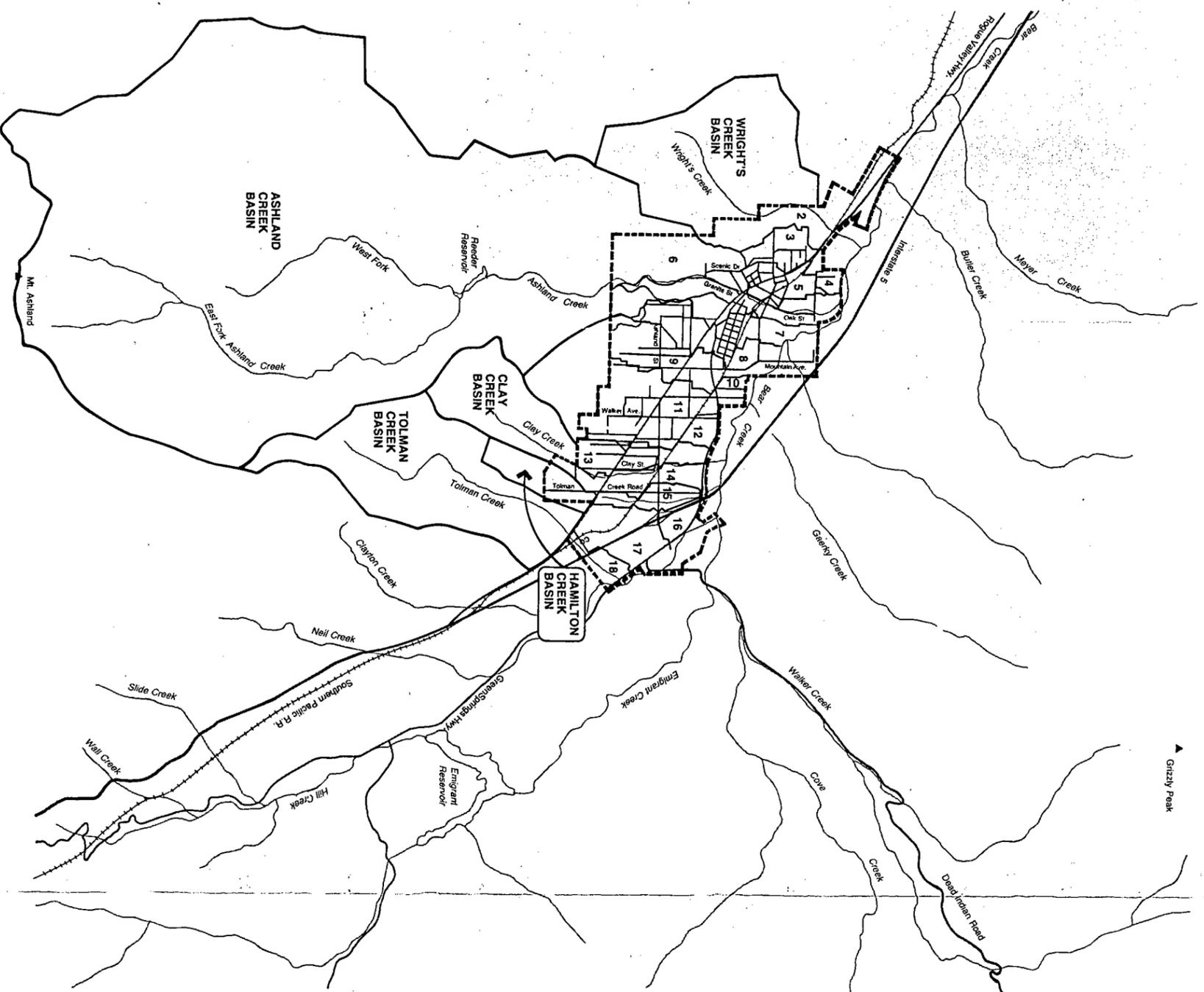
REGIONAL SETTING

NO SCALE



VICINITY MAP

NO SCALE



LEGEND

- Ashland Urban Growth Boundary (Study Area)
- Street/Highway
- ~~~~~ Stream/Creek
- Drainage Basin Boundary
- 10 Drainage Basin Identification Number

Basin Number	Name
1.	Not Used
2.	Wright's Creek
3.	Hospital
4.	Cambridge Street
5.	Laural Street
6.	Ashland Creek
7.	Railroad Yard
8.	Mountain Avenue
9.	Beach Street
10.	Fordyce Street
11.	Walker Avenue
12.	East Main Street
13.	Park Street
14.	Clay Street
15.	Hamilton Creek
16.	I-5 Basins
17.	I-5 Basins
18.	I-5 Basins

**Figure 2.1
REGIONAL SETTING/
VICINITY MAP**

2.2.2 Drainage Characteristics

Four major streams are located within the study area. These are, from north to south, Wildcat Gulch, Wrights Creek (north and south forks), Ashland Creek (below the lower reservoir) and Tolman Creek. Bear Creek and its two tributaries (Neil and Emigrant) border the study area on the north and northeast, but were not addressed in this study. Many seasonally active drainage ditches and open channels carry runoff from within the study area and discharge into Bear Creek. Drainage in the study area occurs predominantly from south to north.

Stream characteristics of drainage courses in the Ashland UGB have been addressed in Bulletin 94, published by the State Department of Geology as follows:

"Drainage courses in the Ashland UGB are subject to high-velocity flows in the hillside areas where narrow canyons and steep gradients exist. Also there is a high potential for bank overflow and flooding in the valley lowlands. Significant bank and channel erosion occurs during torrents and sediments deposited are generally coarse (ranging from silt or sands to silty gravel/cobbles). The upper reaches of Wrights Creek, Bear Creek, and Ashland Creek have a high probability for torrential flows; Tolman Creek and Wildcat Gulch may also be subject to torrential flows. The areas prone to overbank flows and flooding (50 to 100 year frequency) are limited to the valley lowlands along Ashland Creek (downstream of Lithia Park), and near the northern UGB along Bear, Neil and Emigrant Creeks."

2.3 CLIMATE AND RAINFALL PATTERNS

Because of its location at the southern end of Bear Creek Valley and its close proximity to the Siskiyou Mountains, Ashland experiences four mild seasons throughout the year. The climate in Ashland is typical of the interior valleys of southwestern Oregon - summers have hot, dry days and cool nights; winters are mild. Fog, which frequently develops on the Bear Creek Valley floor during the winter, does not usually reach Ashland. Average seasonal temperature extremes range from near 32 degrees Fahrenheit to 90 degrees Fahrenheit. Rainfall usually occurs between the months of October and March, although intense late summer thunderstorms can occur in August and September. Rainfall in Ashland is usually of less magnitude than that experienced in Medford, Oregon, located to the northwest of Ashland. This phenomenon is attributed to Ashland being located in the rain shadow of the Siskiyou Mountains located west and south of the study area. The yearly average rainfall recorded at the weather service station in Ashland is approximately 20 inches.

The weather service station in Ashland has been collecting 24-hour precipitation and temperature data continuously for 106 years and is the oldest recording weather station in Oregon. These data are available from the National Oceanic and Atmospheric Administration (NOAA) located in Asheville, North Carolina.

KCM utilized these 24-hour precipitation totals to update the City's existing rainfall intensity-duration curves. KCM assumed a Log-Pearson Type III distribution for these 24-hour rainfall intensities and calculated the best fit of the rainfall data to that distribution. Products were 24-hour rainfall intensities for 2-, 5-, 10-, 25-, 50- and 100-year recurrence intervals.

To develop intensity-duration curves for durations less than 24-hours, KCM adjusted the intensity-duration (IDF) curves developed for the City of Medford, Oregon as part of its drainage master plan. This was accomplished by determining the percent difference between the 24-hour intensities at each station for a specific recurrence interval (e.g. 2-year, 5-year, 10-year, etc.) Each intensity-duration curve that was developed for Medford was then multiplied by the appropriate correction factor for a specified return frequency. The resulting curves are the revised IDF curves for Ashland. See Figure 2.2. Table 2.1 lists the correction factors for the Medford data and the recurrence interval curve to which they were applied.

TABLE 2.1

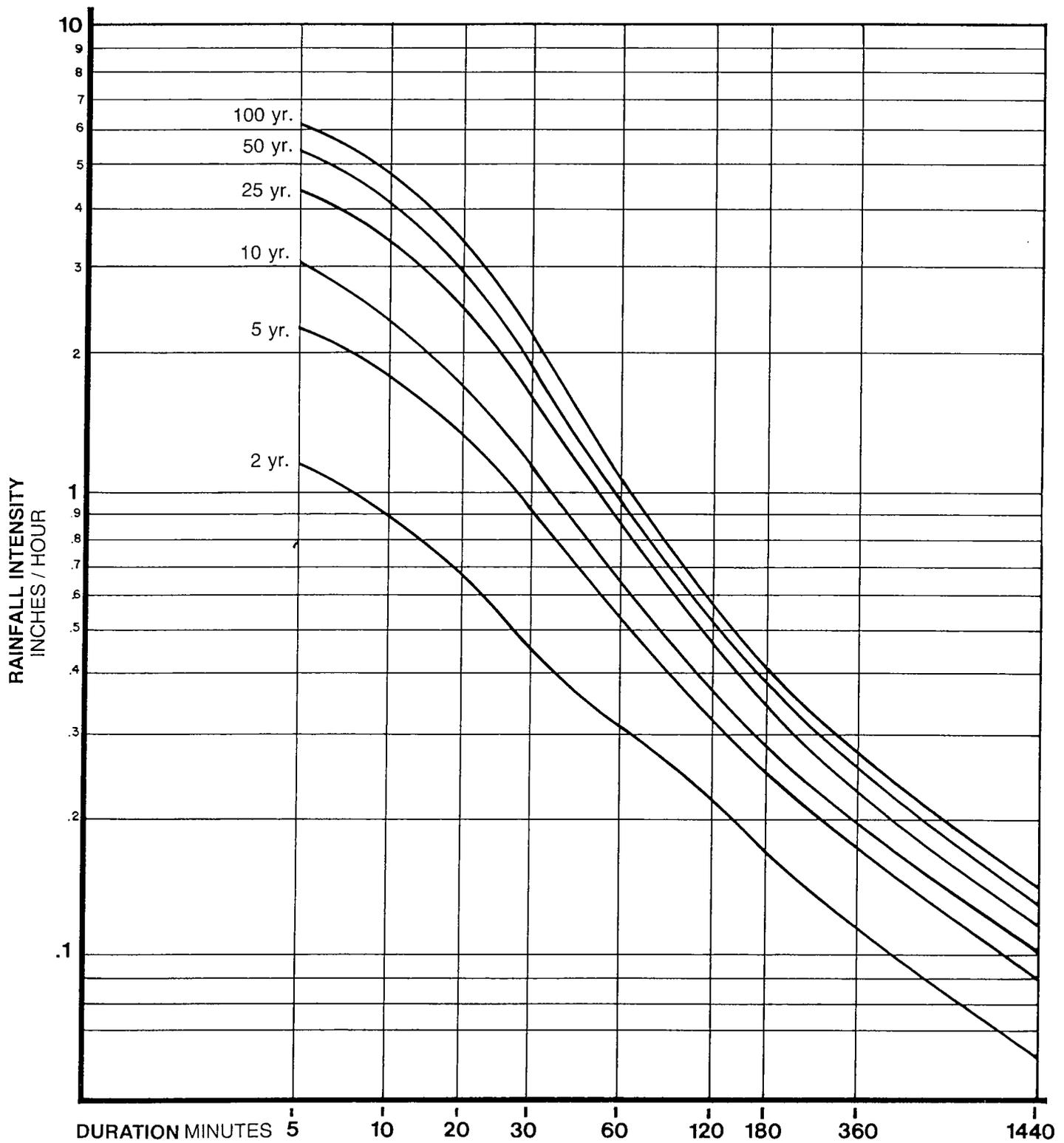
Correction Factors For Transposing
Medford, Oregon Rainfall Intensity Curves
Into Rainfall Intensity Curves for Ashland, Oregon

Return Frequency	Correction* Factor
2-year	.75
5-year	.82
10-year	.77
25-year	.80
50-year	.76
100-year	.74

* Correction Factor = $(24\text{-hour } RF_{Med} - 24\text{-hour } RF_{Ash}) / 24\text{-hour } RF_{Med}$

Limitations of the Medford curves, based on the amount of data used to develop them, also apply to the curves developed for Ashland. However, reasonable values of rainfall intensities for storms more probable than the 10 percent exceedance probability (10-year recurrence interval) may be expected.

The City of Ashland has used at least two other IDF rainfall intensity-duration curves for design of storm drains in recent years. Curves published by the Oregon Department of Transportation (1974) may have been used for drainage design in the Ashland area. These curves are intended for use throughout the State of Oregon and, as such, represent a regional average not intended specifically for use in Ashland. The City presently uses an intensity-duration curve for the design of storm drainage



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Figure 2.2
 INTENSITY-DURATION-FREQUENCY CURVES

improvements. This curve was prepared from rainfall data collected over several years from a rain gauge located in the City of Ashland. The rain gauge is presently maintained at the sewage treatment plant. In Table 2.2, the rainfall intensities for the 10-year recurrence interval storm as predicted from these sets of resources are presented. Previous IDF curves are, at best, based on only partial data. The curves in Figure 2.2 best represent local rainfall patterns. Their use is recommended for future storm drainage design in Ashland.

TABLE 2.2

Comparison of 10-year IDF Curves for Ashland From Various Sources (Exceedance Probability 0.10)			
Time Interval (minutes)	Existing Ashland Curve	Regional ODOT Curve	Updated Ashland Curve (This Plan)
5	3.50	2.97	3.03
10	2.63	2.24	2.37
30	1.28	1.18	1.20
60	0.75	0.71	0.63

2.4 VEGETATION

Because of its location, the City of Ashland enjoys the potential for a large diversity of naturally-occurring vegetation. However, due to increased urbanization, evidence of original vegetative cover cannot be found except at scattered, protected locations throughout the study area. A general description of the vegetation to be found throughout the study area can be related to the topography of the area, although such simplification does not begin to address the complex interrelated factors which influence vegetation positioning.

Three general landscape types are found throughout the study area: valley lowlands, located north and northeast of Highway 99W; uplands, located south and southwest of Highway 99W to the edge of the City limits; and hillside areas, located south of the upland areas and extending into the heavily forested slopes of the Siskiyou. Within the study area valley, lowland and upland vegetative types predominate. In the lowlands areas, where development has not occurred, existing areas are covered with various grasses and other ground cover. The occurrence of isolated pockets of deciduous trees (predominantly oak and willow) are found along drainages. In the upland areas a variety of deciduous and conifer trees (pine, oak and cedar) are found in open and cleared areas. Further west within the hillside areas, a mixed Douglas Fir and pine forest is present.

2.5 GEOLOGIC SURVEY AND SOILS

Local geology plays a significant role in drainage master planning. Soil data are necessary in determining the feasibility and scope of proposed drainage facilities, in evaluation of land uses, in locating hazardous areas and in the identification of soil conditions. KCM worked with Kelly/Strazer Associates, Inc. (Geotechnical Consultants) to develop a general picture of the subsurface geology and surface soil conditions that affect drainage in the Ashland area. Utilizing published and unpublished data obtained from the USGS, the Oregon State Department of Geology and Mineral Industries, and the Soil Conservation Service (SCS), a general overview of the geologic and soil conditions in the study area was developed. That soil/geologic inventory is included as an appendix to this report and is summarized here.

The underlying geology is characterized by the presence of three geologic units found within the study area: alluvial fan deposits and stream alluvium; sedimentary rock consisting of conglomerate overlying sandstone and shales; and intrusive crystalline bedrock.

- o Alluvium

This unit, covering approximately 45 percent of the study area, is found only in the valley lowlands, occurring along Bear Creek and at the toe of drainages which cross the study area. Soil types found within this unit include clays overlying clays with lenses of gravel at depth. Thickness of these deposits ranges from 4 to 32 feet with the thickest deposits occurring along Bear Creek.

- o Sedimentary

Sedimentary rock is found at sporadic locations throughout the study area (less than 20 percent). Most of the identified unit is located in the southeastern portion of the study area near the foothills drained by Tolman and Hamilton Creeks. The majority of this unit underlies alluvium found in the valley lowlands. The makeup of this unit is alternating layers of sandstone and shale. Where it is found beneath alluvium, its upper 20 to 50 feet consist of conglomerate (cemented sand, gravel and cobbles).

- o Granite

Found through 35 percent of the study area, this unit is the predominant geologic unit underlying the hillside areas in the west portion of the study area. The surficial weathered zone of soils consists of clay/silts, with less weathered gravel to boulder-size rocks at depth. Depths of the weatherized zone range from 2 to 35 feet, depending on the surface slope.

2.5.1 Groundwater

Groundwater levels throughout the study area vary seasonally and locally throughout the year. In the valley lowlands, the regional groundwater level ranges from 5 to 40 feet below the surface. However, locally perched groundwater is found along stream beds during the wet months of the year. In the upland and hillside areas, regional groundwater levels range from 20 to nearly 100 feet below the surface. This wide variation of levels may be due to the physical condition of the granite aquifer which underlies these areas.

2.5.2 Soils

The SCS has prepared maps of the soils found in the Ashland area. In addition to the basic classification from the SCS report, other pertinent characteristics of the Ashland area soils as they relate to drainage are also included.

The near-surface soils within the Urban Growth Boundary project area range from clayey silts in the valley lowlands to gravelly, silty sand in the steeper hillside areas. Permeability ranges from very slow in the clayey silt soils to moderate in the gravelly sand soils. The groundwater table is shallow in the valley and of variable depth in the hillsides.

o Erosion Potential

Soil erosion potential estimates are based primarily on soil characteristics, ground slope, runoff, and surface exposure. The areas within the study area range in erodibility from low, in the valley lowland, to severe, in the locally steep and/or exposed hillside slopes and stream channels. Soil erosion within the stream channels is primarily a function of bank and channel characteristics.

In exposed hillside areas, erosion potential is considered moderate to severe depending primarily on slope and degree of surface exposure. In areas of dense forest cover erosion potential is considered moderate. Erosion hazards likely include deposition of silts and sands at the foot of slopes, gully erosion, and possible contribution of turbidity and bed-load to major stream channels. These streams include Wildcat Gulch, Wrights Creek, Ashland Creek and Tolman Creek.

In the hillside areas, stream bank erosion is considered the primary cause of excess turbidity and bed-load deposition. The potential for channel erosion is considered high in areas with high torrential flooding potential. Subject to erosion are artificial fills, bridge abutments and other engineered obstructions, as well as natural stream banks, especially in areas of mass-wasting.

In the valley lowland, stream bank erosion potential is considered low in most areas, but moderate in segments where the stream channel has historically changed direction, on the outside of meander bends, or where the channel is constricted by natural or artificial barriers to flow.

SECTION 3

EXISTING DRAINAGE SYSTEM

3.1 DESCRIPTION OF THE EXISTING SYSTEM

Due to the occurrence of many natural drainage features throughout the study area and the complexity of the City of Ashland's storm drainage system, the study area was divided into 17 geographically defined basins. Basin boundaries were based primarily on the proximity of storm drainage facilities serving each area and topographic information. The following sections provide general descriptions of the existing system serving each area. The existing storm drainage system is shown in Figure 3.1.

3.1.1 Wrights Creek Basin

This is the most westerly basin found within the study area. It includes 2,200 acres. It is quite narrow with extremely steep slopes. Wrights Creek flows the entire length of the basin. Its southern, western, and northern boundaries are defined by the Urban Growth Boundary. The basin's eastern boundary is defined by a series of peaks and ridges which form a substantial geographic border. The basin is primarily undeveloped. Development which does exist is single-family residential and agricultural in nature.

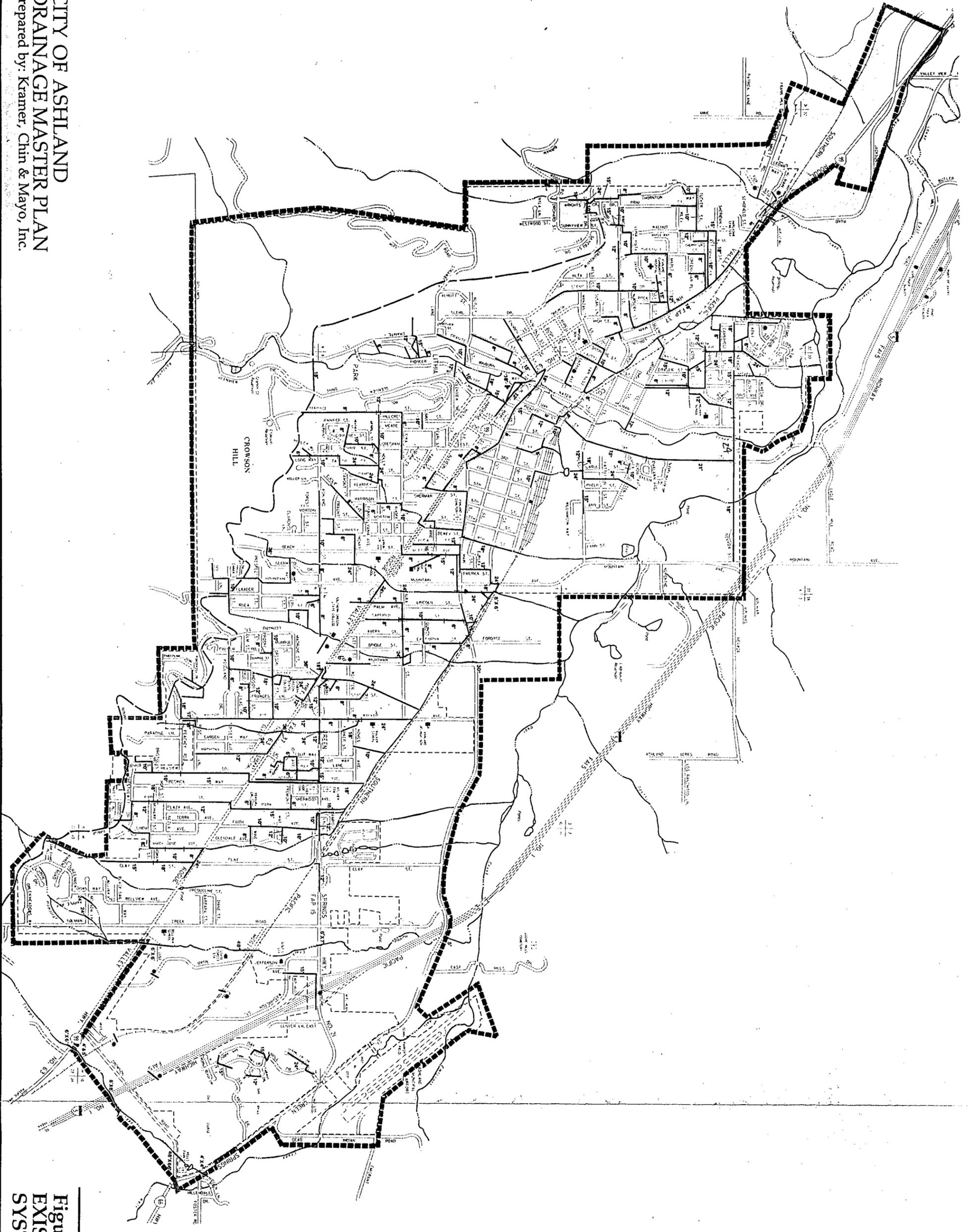
The present storm drainage system consists of natural swales and streams in undeveloped areas with storm drains in portions of the developed areas. Much of the drainage in the developed area occurs as overland flow along streets and gutters. Wrights Creek passes through a 48-inch culvert beneath State Highway 99W and the Southern Pacific Railroad grade.

Proposed development in the basin will be single-family residential. Any future development will require storm drains to transport runoff into Wrights Creek. Increased runoff resulting from this development will impact the culverts which pass under the Southern Pacific Railroad grade and State Highway 99W.

3.1.2 Hospital Basin

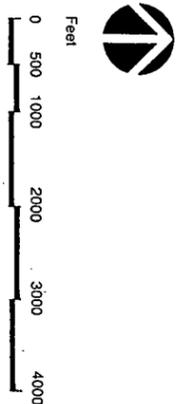
Located in the northwesterly portion of the study area this basin contains 175 acres. Surface slopes are steep to severe. Drainage occurs to the northeast. The basin boundaries are North Main Street and Scenic Drive on the east, Ashland Creek drainage basin on the south, Wrights Creek basin on the west, and the Urban Growth Boundary on the north. It is moderately developed with single- and multi-family residences, and includes the Ashland Hospital facility.

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LEGEND

- Ashland Urban Growth Boundary
- City Limits
- Existing Pipe
- - - Existing Ditch
- - - Existing Irrigation Canal
- Size Unknown



BASE MAP SOURCE:
OREGON DEPARTMENT OF TRANSPORTATION 1985

**Figure 3.1
EXISTING DRAINAGE
SYSTEM**

The present drainage system is well developed and consists of closed conduits and open ditches. Many of the pipes are less than 10 inches in diameter - the minimum pipe size recommended for maintenance equipment. Replacement of these small-diameter pipes will be recommended. (See Chapter 5.)

Future development will be low density, single-family residential. Improvements to the existing drainage system will be required to handle increased runoff resulting from this development.

3.1.3 Cambridge Street Basin

This 60-acre basin, located near Bear Creek, is the most northerly found in the study area. Its boundaries are defined by Glendover and Nevada Streets on the east and south, and the Urban Growth Boundary on the west and north. It is essentially flat with little topographic relief. Drainage occurs toward Bear Creek. Existing development throughout the basin is single-family residential. Runoff is transported from the basin through a well-developed system of gutters and drainage pipes. Because no future development is anticipated within this basin, the existing storm drainage system should prove to be adequate.

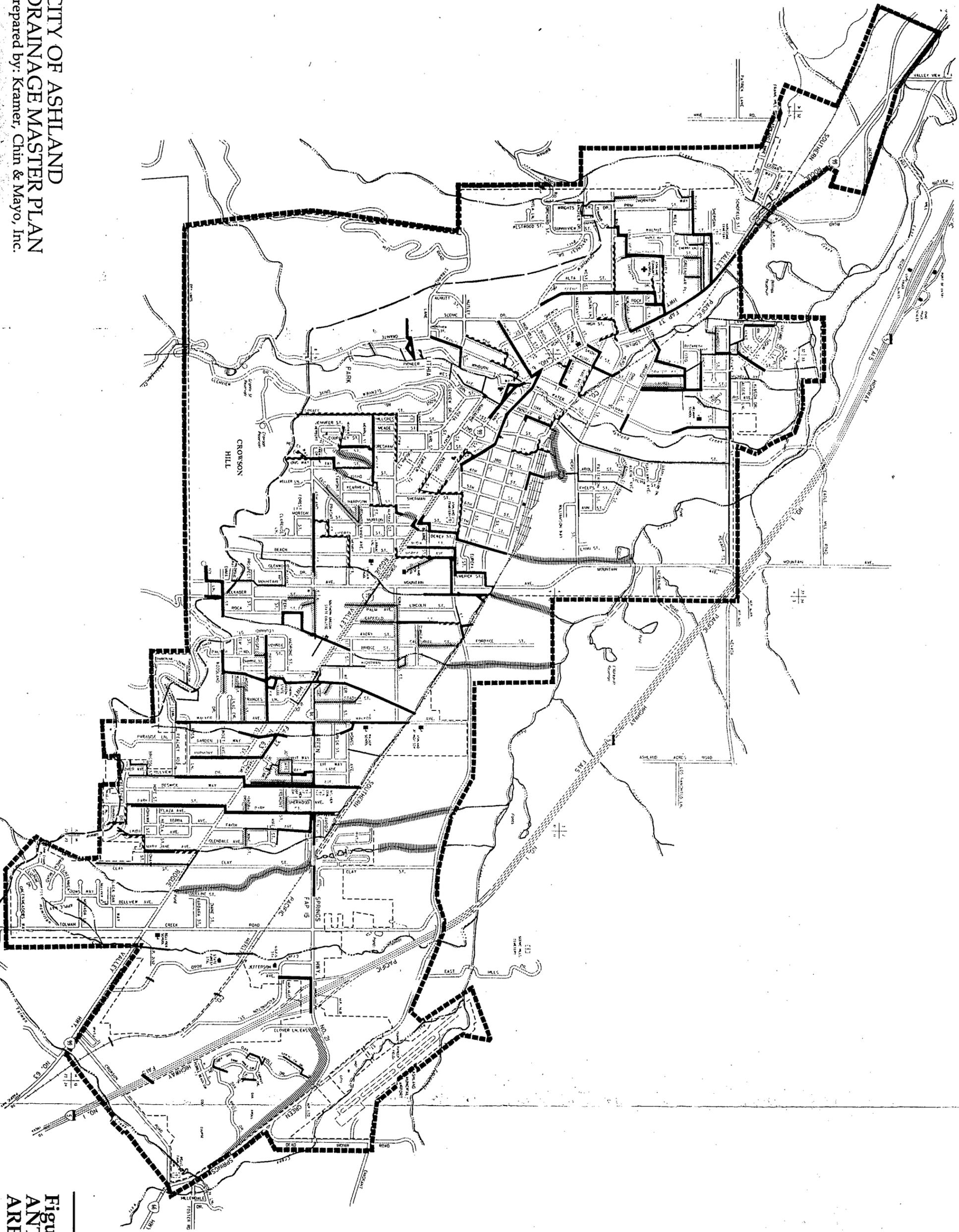
3.1.4 Laurel Street Basin

This basin is located in the northwestern portion of the study area and contains 175 acres. Its boundaries are defined by Willow, Laurel, and Helman Streets on the east; Bush Street on the south; the Hospital basin on the west; and Cambridge Street basin on the north. Surface slopes across the basin range from moderate, in the north, to shallow in the south. Drainage occurs in a northeasterly direction. The basin is substantially developed. Land use is primarily single-family, with multi-family residences and commercial/industrial development occurring along State Highway 99W near the City's downtown area.

The present drainage system consists primarily of closed conduits with open ditches in undeveloped areas. A major drainage feature of this system is the open ditch located along the Southern Pacific Railroad. All surface runoff from areas north of the railroad is intercepted at this ditch and redirected into the storm drain in Willow Street. A significant amount of the existing system will require upsizing to accommodate increased runoff as development occurs.

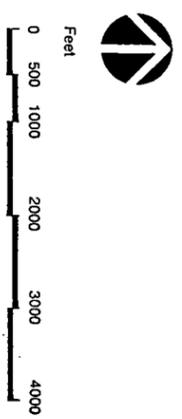
3.1.5 Ashland Creek Basin

This basin contains 550 acres within the west central portion of the study area. It is drained entirely by Ashland Creek which flows through the entire length of the basin. Its boundaries are defined by the railroad yard and Eighth Street basins on the east; the Urban Growth Boundary on the south; Wrights Creek, Hospital and Laurel Street Basins on the west;



LEGEND

- Ashland Urban Growth Boundary
- City Limits
- Existing Pipe
- - - Existing Ditch
- ~ Existing Irrigation Canal
- Pipe: 10 inches in Diameter or Greater and Under Capacity
- Pipe: Less than 10 inches in Diameter and Under Capacity
- Pipe: Less than 10 inches in Diameter with adequate capacity
- - - Under Capacity Ditch



BASE MAP SOURCE:
 OREGON DEPARTMENT OF TRANSPORTATION 1985

Figure 3.2
 ANTICIPATED PROBLEM
 AREAS

and Bear Creek on the north. Ashland Creek receives runoff from 15,500 acres outside of the study area.

The southern section of the basin above Lithia Park is sparsely developed with single-family residences, many of which are on over-sized lots. The central section between Lithia Park and the Southern Pacific Railroad is moderately developed with single-family, multi-family and commercial developments. The northern section between the Southern Pacific Railroad and Bear Creek is undeveloped, and contains many areas reserved as open space.

Ashland Creek itself is a well developed stream which falls 5,000 feet over a length of 4.8 miles. It meanders through a well-developed floodway which borders on extreme local ground slopes.

The existing local drainage system throughout the basin consists of closed conduits, open ditches, streams, and street gutters. Piped systems have been installed in most of the developed areas and along major roads. The majority of these systems discharge directly into Ashland Creek. Ashland Creek is crossed at State Highway 99W and the Southern Pacific Railroad by bridge structures.

Future development in the northern section will likely tax the existing drainage systems. The central section is presently well-developed. Existing drainage system problem areas in the central section will need to be improved. The southern section is designated as open space land with scattered residential areas. Any development in the southern section will require new storm drainage system improvements.

3.1.6 Railroad Yard Basin

This basin, comprised of 169 acres, is located in the northwestern section of the study area. Its borders are: Bear Creek on the north; Mountain Avenue basin on the east; East Main Street and Lithia Way on the south; and Ashland Creek Basin on the west. It is broken into two distinct halves by the Southern Pacific Railroad yard. The northern half, 99 acres, is principally undeveloped; the development that does exist is limited to single-family dwellings. The southern half, 70 acres, is well-developed, consisting of single-family dwellings, with scattered commercial/industrial areas.

The existing drainage system consists primarily of open ditches, swales, and gutters; small-diameter closed conduits exist in the upper reaches of the basin.

Future development will consist of commercial/industrial development near the Southern Pacific Railroad yard, with single-family residences in the northern portion of the basin. These developments will require new storm drain systems and improvements to the existing system.

3.1.7 Mountain Avenue Basin

This 285-acre basin, located in the central section of the study area, begins in the foothills along the southern Urban Growth Boundary and terminates near Bear Creek. It is bordered on the west by the railroad yard and Ashland Creek basin, and on the east by Central Creek basin. The topography consists of extremely steep surface slopes in the southern section of the basin, and mild surface slopes as one proceeds north toward the Bear Creek flood plain.

The central part of the basin is completely developed with single-family dwellings. The extreme northern and southern sections have much less existing development, but have the greatest potential for development in the future.

Much of the existing storm drainage system consists of conduits, open ditches, and roadside gutters. Small diameter pipes, less than 10 inches in diameter, are found throughout the basin. Future development in the southern section will tax the existing storm drainage systems.

3.1.8 Beach Street Basin

This basin, containing 400 acres, is located in the central section of the study area. Its topography can be characterized by steep surface slopes in the south, along the Urban Growth Boundary, and gentle surface slopes in the north near Bear Creek. Central Creek is a small perennial watercourse that flows the entire length of the basin.

The central section of the basin south of State Highway 99W is developed with single- and multi-family housing and scattered commercial/industrial development. Also included is a portion of the Southern Oregon State College campus and Ashland High School. The northern section is virtually undeveloped, with much of this area lying within the Bear Creek flood plain. The southern section of the basin is characterized by steep, densely forested slopes which are zoned for low and medium density and single-family residences.

The existing storm drain system consists of closed conduits, roadside gutters and open ditches. Drainage systems in developed areas discharge into Central Creek.

Future development in the southern section of the basin will likely tax existing storm drain facilities. Increased runoff resulting from new development will cause local and isolated flooding problems. Increased flows into Central Creek will also impact creek crossings at major roads and the railroad.

Future development in the northern section will likely require new storm drain systems which will terminate in Central Creek or Bear Creek. No substantial future development is expected in the central area of the basin.

3.1.9 Fordyce Street Basin

This is a very small basin in the north central portion of the study area north of the Southern Pacific Railroad. It has no existing development and no existing drainage system other than surface runoff to Bear Creek.

3.1.10 Walker Avenue Basin

This basin, containing 606 acres, is located in the central-eastern section of the study area. Slopes are moderately steep to extreme, south of Siskiyou Avenue, and shallow in the northern section near Bear Creek. The basin boundaries are the Urban Growth Boundary on the south; the Southern Pacific Railroad and the Urban Growth Boundary on the north; several city streets and naturally-occurring topographic breaks form the eastern and western boundaries.

The central area of the basin is substantially developed, with single-family housing, commercial/industrial developments and Southern Oregon State College. The northern section is undeveloped, although it is zoned for single-family residential development. The southern section of the basin is moderately developed with single-family residences.

The existing storm drainage system has developed along two branches of a stream which join at Wrightman Street and the Southern Pacific Railroad. A well-developed system of pipes collects and transports storm water from the basin east of Walker Avenue to the eastern branch of the stream. The western section has a storm system comprised of closed conduits, gutters and open ditches. An existing problem area within the basin involves the pipe which carries one of the branches of the stream under the Southern Oregon State College campus. This metal culvert is difficult to maintain and has been subject to abrasion.

Future developments in the extreme northern and southern sections of the basin will likely tax the existing systems and require new drainage systems. Many of the existing developed areas do not have an adequate collection system. The principle drainage system in these areas is road-side gutters.

3.1.11 East Main Street Basin

This 92-acre basin is located north of Walker Avenue basin between the Southern Pacific Railroad and the Urban Growth Boundary along Main Street.

Its topography is characterized as sloping north toward Bear Creek. The only existing development is Ashland Junior High school. The remainder of the basin is zoned for single-family residential development. A small area located west of Walker Avenue is earmarked for expansion of Southern Oregon State College.

There are no known drainage systems in the basin; all drainage occurs as overland flow. Future development will require new drainage systems.

3.1.12 Park Street Basin

This basin, containing 200 acres, is located in the east-central section of the study area. It extends from the northern to the southern Urban Growth Boundaries and is bounded on the east by Hamilton Creek basin and on the west by Central Creek basin. It has steep surface slopes along its southern border, with moderate slopes in the northern section.

Existing development consists primarily of single-family housing with some multi-family and commercial developments. The northern section, north of Greensprings Highway, is principally undeveloped but is designated for suburban residential development. The remainder of the basin, south of Greensprings Highway, is approximately 60 percent developed. Undeveloped land in this area is zoned for single-family residential use.

The principle elements of the existing storm drain system are a drainage swale and two closed conduits along Park and Fifth Streets. Open ditches along Siskiyou Street collect runoff from other small conduits and direct runoff into the drainage swale along Park Street.

Future development will increase the quantity of storm runoff from the southern section of the basin. Transporting these flows from the basin will require replacement of existing conduits with larger sizes or installation of parallel pipes along major drainage routes. Development in the northern section will require new storm drainage systems which will terminate in the existing swales or drainageways.

3.1.13 Clay Creek Basin

This 180-acre basin is located along Clay Creek in the eastern section of the study area. Its boundaries are the northern Urban Growth Boundary on the north; Tolman Creek Road on the east; the southern Urban Growth Boundary on the south; and Clay Street on the west.

Existing development is primarily single-family residential. The southern section of the basin (south of Siskiyou Street) is approximately 50 percent developed. The central and northern areas are developed to lesser degrees, with most of the development in the central area.

The primary feature of the existing drainage system is Clay Creek which runs the length of the basin and collects the majority of the runoff. Clay Creek is crossed at two locations with bridges. The first occurs at Siskiyou Street and the other near the intersection of Ashland Street/Greensprings Highway and the Southern Pacific Railroad. The remainder of the basin area generally lacks major drainage facilities. Existing storm drainage into Clay Creek is by street gutters and ditches or by private systems.

Five ponds are located along Clay Creek just north of Ashland Street and the Southern Pacific Railroad. The ponds appear to be primarily decorative in nature and were not considered in the study as providing any runoff detention.

Future development will require new storm drainage systems, all of which will discharge into Clay Creek.

3.1.14 Hamilton Creek Basin

This 173-acre basin is located in the eastern section of the study area. Its boundaries are East Main Street on the north; Mistletoe Road and Interstate 5 on the east; Highway 99W on the south; and Clay Creek basin on the west. Its drainage area includes approximately 4 square miles of undeveloped land that lie outside the Urban Growth Boundary.

The basin, within the study area, is extremely narrow, varying between 400 and 1,600 feet in width.

Topography varies across the basin. Surface slopes range from steep to extremely steep in the southern section, to nearly flat where Hamilton Creek passes under East Main Street.

There is little development in the basin. The southern section, south of Highway 99W, is most extensively developed with single-family residences. Much of the remaining development is commercial/industrial in nature.

The principle drainage system for the basin is Hamilton Creek. One detention pond, located in the extreme northern section of the basin, is the only other noted drainage structure.

Future development through the basin will require new and separate drainage systems, all of which will discharge into Hamilton Creek. The existing creek crossing under East Main Street will be unaffected by future development.

3.1.15 Interstate 5 Basins

These three basins, containing a total of approximately 150 acres, are located in the extreme eastern section of the study area. They are discussed together in this report, since all display essentially the same topographic and development characteristics.

The boundaries which surround these basins are the Urban Growth Boundary on the north, east and south, and Hamilton Creek basin on the west. Interstate 5 cuts through the center of these basins and provides a major drainage barrier between land east and west of the freeway.

The land slopes mildly to the north. Interstate 5, the Southern Pacific Railroad, and major roads provide the most dramatic breaks in topography within the basin.

The existing drainage consists almost entirely of overland flow into drainage ditches, natural streams and gutters. Private systems serving industrial developments and subdivisions may exist.

The existing development within the basin consists primarily of single-family residences, commercial/industrial development and the City's municipal golf course.

The undeveloped area is zoned for single-family residential use and includes areas for commercial/industrial development. Future developments will tax the existing system of natural swales and ditches and will require new storm drain systems. Drainage system improvements may include new piped storm drainage systems and drainage channel improvements.

3.2 ANTICIPATED DRAINAGE PROBLEMS

A number of problems have been identified within the existing drainage system, resulting from future development within the study area. These problems are associated with undersized conduits, erosion, maintenance, and abrasion of elements making up the drainage system. The following paragraphs describe these anticipated problems.

3.2.1 Undersized Pipes

Two types of undersized pipes have been identified within the study area: 1) those having capacity problems, and 2) those which have high maintenance requirements.

Pipes which are undersized, based on capacity, are those which now or in the future will be unable to pass required flows based on the 10-year design storm. Included are collector pipes which serve subcatchments. These pipes have been identified on Figure 3.2.

Pipes which are undersized based on maintenance requirements are those less than 10 inches in diameter. This is the minimum pipe size that City-owned public works equipment is able to maintain. Pipes less than 10 inches in diameter tend to clog easily with large debris and require more attention, thus incurring higher maintenance costs than pipes of larger diameter. In addition, the initial incremental cost savings realized when installing smaller diameter pipes does not justify their use when long-term maintenance costs are considered.

3.2.2 Catch Basins

Problems associated with intercepting storm runoff at catchbasins should be addressed when considering future system improvements. Along the southern border of the study area, extreme surface slopes increase runoff velocity so that a large percentage of the runoff does not enter the storm drainage system, which results in temporary flooding at street intersections.

Catch basins with flange gutter inlet grates angled upgrade should be placed on grades of greater than 8 percent. These grates, as manufactured by Neenah Foundry Company, are designed to increase interception of storm water and decrease clogging due to surface debris. Furthermore, slopes

which exceed 15 percent should receive double catch basins spaced at no greater than 250 feet or at each intersection, whichever is less.

3.2.4 Erosion

Soil erosion potential, based primarily on soil characteristics, ground slope, runoff and surface exposure, varies from low, in the valley lowlands, to severe in the locally steep, exposed hillside slopes and channels. In exposed hillside areas, erosion is considered moderate to severe depending on slope and degree of surface exposure. In areas of dense forest cover, erosion potential is considered moderate. Erosion hazards are likely to include deposition of silts and sands at the foot of slopes, gully erosion, possible contribution to turbidity and bed-load in major stream channels, loss of topsoil, and undercutting of stream banks. In hillside areas, stream bank erosion is considered the primary cause of excess turbidity and bed-load deposition.

Future development will increase runoff into all streams and drainage structures, thus aggravating existing erosion problems. Areas of particular concern are segments of stream channels which have historically changed direction, areas on the outside of meander bends, or where constricted by natural or artificial barriers to flow.

3.3 FEMA FLOOD INSURANCE STATUS

In 1968, the U.S. Congress passed the Flood Insurance Act, which established a federal program enabling property owners to buy flood insurance at a reasonable cost (FEMA, 1980). In return, communities carry out local flood plain management measures to protect lives and new construction from future flooding. The program is administered by the Federal Insurance Administration within the Federal Emergency Management Agency (FEMA).

A community qualifies for the program in two separate phases, the Emergency and Regular "programs".

During the initial Emergency Program, limited amounts of flood insurance became available to local property owners. A community's efforts to reduce flood losses are general, in many cases guided only by preliminary flood data. The map which FEMA provides to the community at this stage is called a Flood Hazard Boundary Map. It outlines the flood-prone areas within the community. Subsidized rates are charged for all structures regardless of their flood risk.

Under the Regular Program, with full limits of flood insurance coverage available locally, the premiums charged for new construction vary according to exposure to flood damage. A structure's exposure is based upon the elevation of its lowest floor above or below the "Base Flood Elevation". The community's flood plain management efforts become more comprehensive under the Regular Program where new buildings must be elevated or flood-proofed above certain flood levels. These levels are derived from FEMA's detailed on-site engineering survey in the community. The community is

issued a detailed map called a Flood Insurance Rate Map which shows flood elevations and risk zones used for insurance purposes.

To qualify for the flood insurance program, a community must: 1) require development permits for all proposed construction or other development in the community, and 2) review the permit to assure that sites are reasonably free from flooding. For its flood-prone areas, the community must also require: 1) proper anchoring of structures, 2) the use of construction materials and methods that will minimize flood damage, 3) adequate drainage for new subdivisions, 4) the location and design of new or replacement utility systems to prevent flood loss, and 5) that all new construction and substantial improvements to existing structures in FEMA-identified flood-prone areas be elevated or flood-proofed to the level of the base flood.

The base flood is a term used to describe the level of flooding against which the program is geared to protect. While sometimes referred to as the "100-year flood", it is more appropriately the flood having a one percent chance of occurrence in any year. Over a 30-year period, the life of most mortgages, there is about one chance in four (26 percent) that this level of flooding will occur in a given area.

The City of Ashland participates in the flood insurance program. The flood insurance study includes flood profiles and maps for Ashland Creek, Clay Creek, Hamilton Creek and Bear Creek. For each creek, the study defines flood plains for the 100-year and 500-year floods and a 100-year, 1-foot rise floodway (the portion of the stream necessary to convey flow). To continue in the flood insurance program, the City must require that all construction on the floodplain be elevated so the first floor is above the 100-year flood or be flood-proofed. Any construction on the floodway must be prohibited unless an engineering study can demonstrate the construction would not raise the 100-year flood elevation more than 1 foot. It has been the policy within the City to allow no development within the floodplain.

3.3.1 Principle Flood Problems

The chief source of flood problems within the City of Ashland is Ashland Creek. Other smaller creeks with smaller drainage basins present less of a flooding problem. The focus of this report is localized flooding primarily due to either undersized or clogged conduits.

3.4 TALENT IRRIGATION CANAL

The Talent irrigation canal runs along the Southern Urban Growth Boundary of the City, from Bear Creek to Ashland Creek. There it turns north, proceeds to cross under Strawberry Lane and terminates near Grandview Avenue.

The canal provides irrigation water for residents along its route. In water shortage years, the canal has provided an additional source of potable water for the filter plant.

The canal is owned by the Talent Irrigation District and the City of Ashland (in sections). It provides a valuable resource and should be maintained. Regarding storm drainage, the canal has the potential to intercept a significant amount of overland runoff. The canal's slope is too flat for it to achieve self-scouring velocities. Winter storms carry large amounts of silt into the canal, which becomes an annual maintenance problem. Silting of the canal, if it becomes severe, will divert irrigation water into the storm system which is not designed to accommodate it.

To prevent interception of storm water and reduce its impact on downstream drainage systems, it is recommended that the City take a three-part approach. First, construct a small berm along the uphill side of the canal to direct storm water to points of concentration where it could be piped under the canal. Second, require new developments that will increase runoff into the canal to be assessed a percentage of the cost of providing piped crossings under the canal at intersections and critical low points. Third, construct overflow structures at critical locations to redirect excess canal flows into downstream drainage system and natural streams. These overflow structures should be sized so that flows will not exceed canal capacity resulting in overflows at unplanned locations.

SECTION 4

DRAINAGE SYSTEM ANALYSIS

4.1 HYDROLOGIC ANALYSIS UTILIZING COMPUTERIZED MATHEMATICAL MODEL

Runoff simulation using computerized models is now an everyday aid to practicing engineers involved in drainage planning, management and design. Simulation has been found to provide an excellent representation of real-world conditions whenever adequate calibration data are available. Used properly, computer simulation can accurately predict runoff from large areas, simulate the effects of runoff detention, and afford the engineer an opportunity to test drainage management alternatives, examine the effects of improvements, and determine probable inadequacies in a drainage system.

A number of different approaches have been proposed for simulation of the rainfall-runoff process, but most of them can be considered as somewhat comparable. Nearly all of the simulation techniques take rainfall as the driving variable and, using a time series of rainfall intensities (hyetograph), compute the amount of rainfall which infiltrates into the soil-cover complex to determine how much rainfall remains available for overland flow (rainfall excess). The excess is then routed overland until it is intercepted by drainage channels. A hydrograph (the time series of runoff quantities simulated from the driving hyetograph) is computed for each subcatchment. The computed hydrographs are routed downstream at each time interval with travel distance computed based on channel characteristics. Such routing results in a basin runoff hydrograph at the downstream outlet.

There are numerous computer models available which perform this simulation. They vary, not so much in approach, as in the specific methodology (set of equations) used to model a portion of the hydrologic cycle. For example, the process of infiltration is modeled using the Horton equation in one program, the Phillips equation in another. The value of the simulation is less dependent upon the methodology than on the data used as input to the program and the skill of the user.

The major disadvantages of computer simulation are the time and equipment necessary to conduct the analysis and the difficulty in checking the assumptions that go into the analysis. It is extremely difficult for one engineer to check the hydrologic calculations of another engineer when the analysis involved a computerized hydrologic simulation. Thus, computerized hydrologic simulations should be used sparingly and only by hydrologists experienced in their application. They remain the best method available for sizing runoff detention facilities. Computerized analyses are also useful when numerous repetitive hydrologic calculations are necessary, such as were required in the preparation of this study.

4.1.1 Calculation Procedures for this Master Plan

In preparing the Ashland Drainage Master Plan, KCM utilized the Stormwater Management Model (SWMM), a computerized hydrologic simulation model developed for the U.S. Environmental Protection Agency and currently maintained by the University of Florida. The SWMM program can be purchased from the University of Florida or accessed on any of several timesharing services. KCM used the most recent version of the SWMM model on KCM's in-house computer system for the analysis.

The SWMM program exhibits several features which can be utilized for drainage studies depending on the degree of sensitivity and specific analysis required. For the purposes of the Ashland study the "Runoff" feature was judged to be adequate.

"Runoff" is the portion of SWMM in which hydrologic calculations are performed. As with other hydrologic computer models, the runoff portion of SWMM uses rainfall as the driving mechanism in the mathematical model. A basin is represented mathematically as a series of subareas (subcatchments) linked together by a series of gutters (open channels or pipes). Details of the program can be found in the Environmental Protection Agency's User Manual for SWMM (SWMM, 1982). Data collection and assumptions for this analysis are described in the following sections.

4.1.2 Design Storm

The design storm recurrence interval is a measure of the degree of protection desired from the drainage system. A design storm with a low probability of being exceeded, such as the 100-year storm, gives a high degree of safety in drainage system design. A design storm with a high exceedance probability, such as the 2-year storm, will result in a lower-cost drainage system whose capacity is exceeded every few years, with possible property damage, public inconvenience, and personal hazard.

For the purposes of this study, the 10-year frequency storm was selected by the City to analyze the collection system. Creek crossings at major streets and along main drainage channels should be unaffected by this storm. Two 10-year storms were analyzed, one short- and one long-duration.

The response of each basin to the rainfall input was rapid, peak outflows from all subcatchments followed within one hour of the input hyetograph peak (as shown in Figures 4-1 and 4-2). Peak flow from the short-duration storm always produced the highest peak runoff quantities.

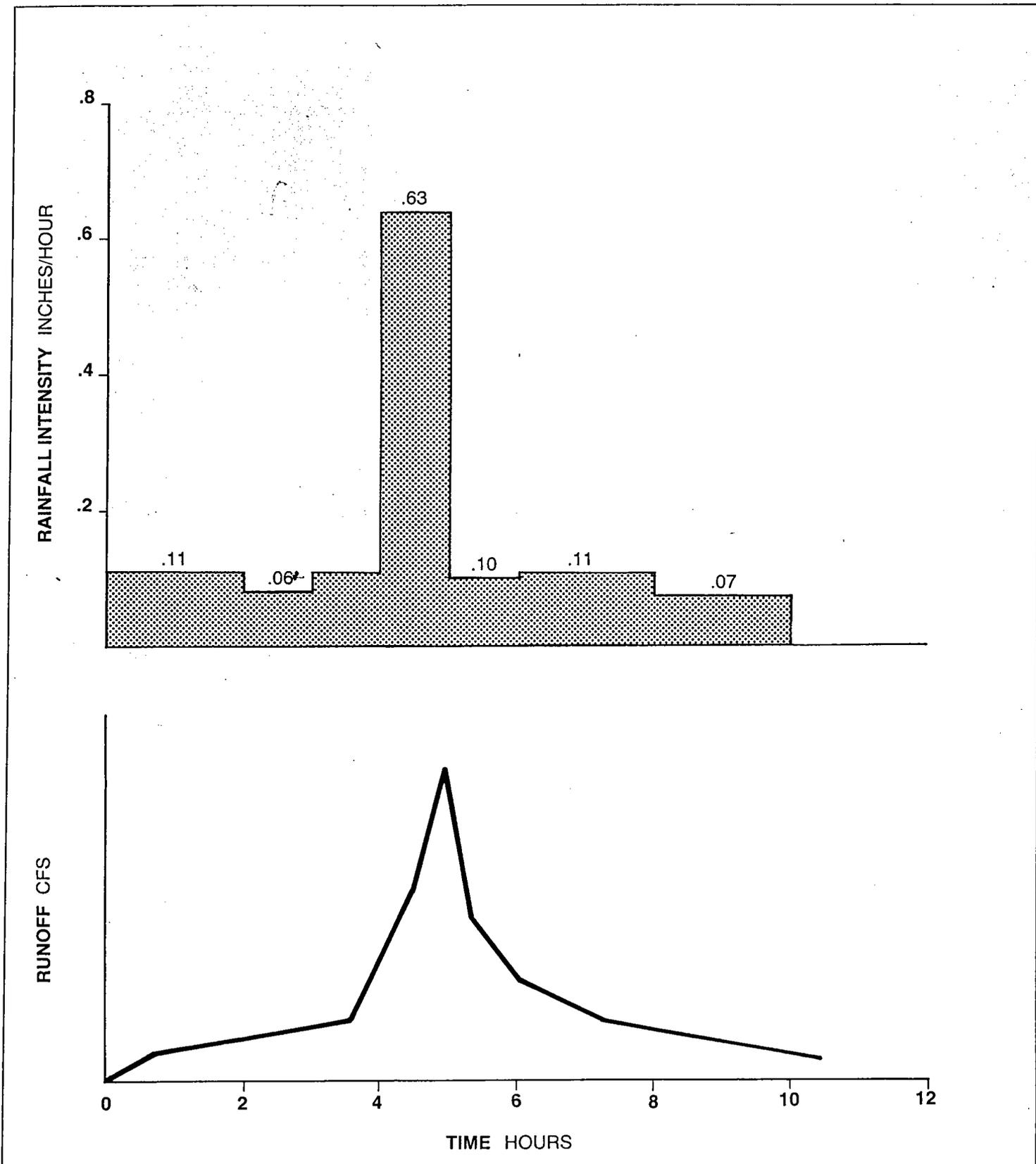
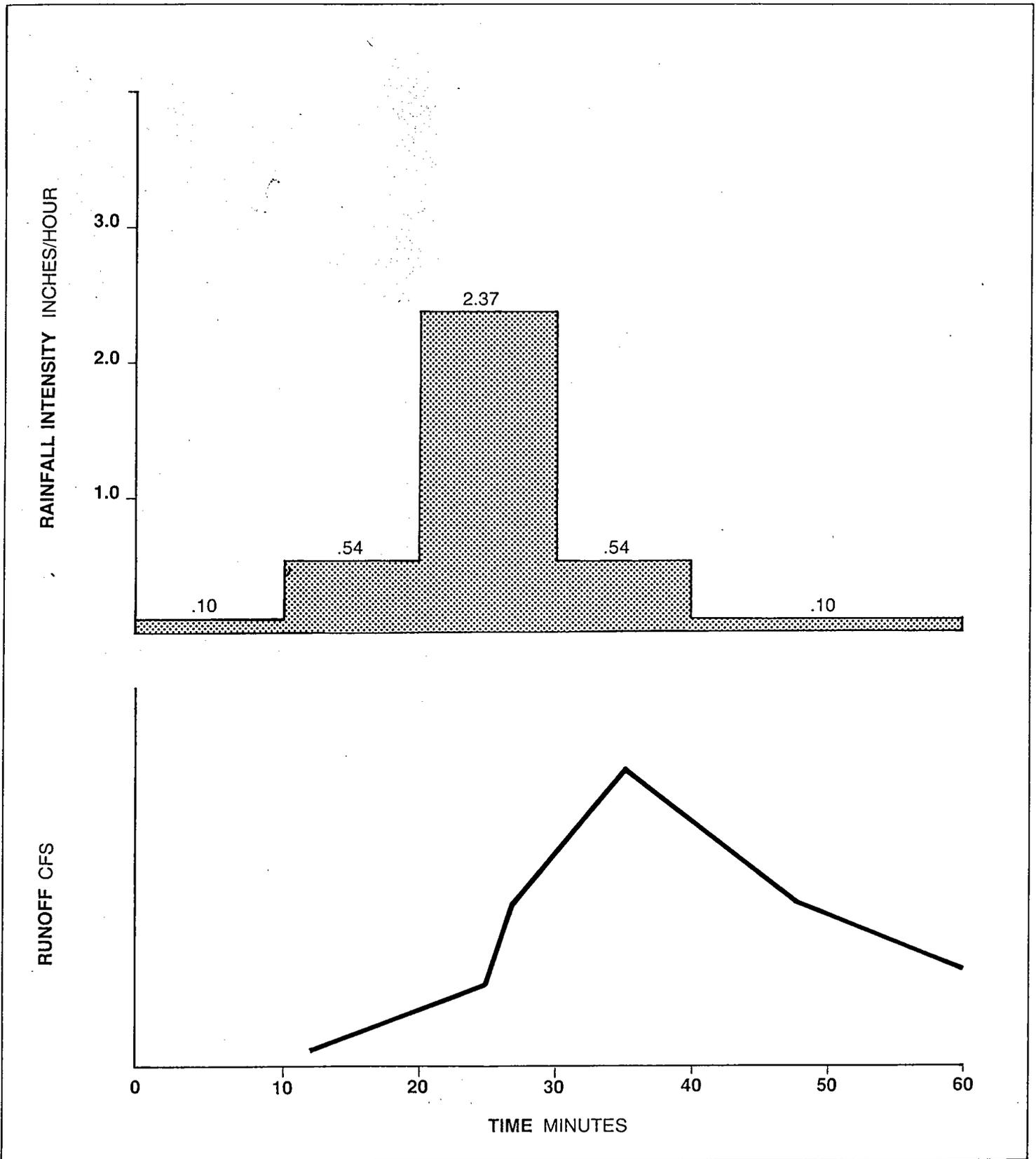


Figure 4.1
DESIGN STORM HYETOGRAPH
(10 YR./10 HR.) AND TYPICAL
RUNOFF HYDROGRAPH

CITY OF ASHLAND
 DRAINAGE MASTER PLAN
 Prepared by: Kramer, Chin & Mayo, Inc.



CITY OF ASHLAND
 DRAINAGE MASTER PLAN
 Prepared by: Kramer, Chin & Mayo, Inc.

Figure 4.2
DESIGN STORM HYETOGRAPH
(10 YR./1HR.) AND TYPICAL
RUNOFF HYDROGRAPH

4.1.3 Land Use Characteristics

Each drainage basin was divided into subcatchments which varied in area from one to more than 50 acres. Contributing areas outside the study area, such as the basins for Ashland and Hamilton Creeks, were modeled as single subcatchments. Generally, subcatchments were 10 to 20 acres; they were identified to analyze individual conduits and catchbasins.

Future land uses were used to determine the impervious area for each subcatchment. These were delineated from the Comprehensive Land Use map provided to KCM by the City Planning Department. Four land use categories (single-family residential, multi-family residential, commercial/industrial, and park/open space) were assigned impervious area coefficients. An area-weighted average was determined and used to combine different land uses within a subcatchment and provide an average impervious area coefficient for the basin.

Topographic maps of the City were used to define geographic boundaries of all drainage basins and subbasins. These were planimetered to provide basin area inputs for the model. Conduit slopes were assumed to be equivalent to the existing ground slope, unless other specific information was known. Other types of topographic information which were delineated from these maps included topographic relief along conduit routes and local basin ground slopes.

As mentioned in the previous section, topographic relief varies from gentle to extreme within the study area. The topographic relief is a major factor which impacts each basin's runoff response characteristics (i.e. how quickly peak runoff occurs after the maximum rainfall intensity).

Infiltration factors based on soil characteristics were delineated from the soils report prepared by Kelly/Strazer Associates, Inc. An area-weighted average of soil types within each subcatchment was determined. In the analysis, it was assumed that soil infiltration reached a constant rate immediately after the rainfall began, a situation which would occur if the soil was saturated by rainfall from previous storms and the best assumption for a design situation.

4.1.4 Calibration

The SWMM program was calibrated to flows calculated using the U.S. Geological Survey Linear Regression equation for ungauged drainage basins in western Oregon (from "Magnitude and Frequency of Floods in Western Oregon Report 79-553"). Raw data used to describe each basin were collected from topographic maps prepared by Chickering-Green Empire Inc. and provided by the City; the Soil Conservation Service soils report for the Ashland area; and the soils and geology report prepared by Kelly/Strazer.

The model was calibrated through a trial and error procedure which compared peak runoff values from the SWMM model for typical basins to those calculated using the regression equations. Basin width, slope and impervious area were adjusted until the SWMM output correlated well with the

regression equations' peak runoff values. To achieve this correlation, it was necessary to decrease the soil infiltration factor, decrease the impervious area, and increase the basin width as compared to directly measured values. Soil infiltration factors were decreased to 50% of the weighted average for each basin. Measured Impervious Area (MIA) was decreased using the following equation:

$$\text{Equivalent Impervious Area (EIA)} = (\text{MIA (in percent)} \times 0.43) + 3.6$$

Values of equivalent impervious areas were then reduced to one-tenth of this calculated value. Basin width was increased by a factor of 2.0. The input data were consistently varied in the same manner for all drainage sub-basins.

4.2 CONVEYANCE STRUCTURE CAPACITIES

4.2.1 Closed Conduits

Pipe capacities were calculated using the Chezy-Mannings equation (Chow 1959). An "n" value of 0.013 was assumed for concrete pipe and 0.024 for metal pipe and culverts. Entrance and exit losses for culverts and bridges were neglected since that was beyond the scope of this project, but these factors should be considered in system design.

All new pipes were assumed to be concrete. Pipe slopes were selected so that, when flowing full, the velocity in the pipe exceeded 3.0 feet per second. No upper limit of velocity was considered. Achieving the 3.0-feet-per-second criteria is not a problem in Ashland due to the steep slopes. Where receiving water could produce a backwater effect in the pipe, backwater calculations were used to complete required pipe sizing.

4.2.2 Open Channels

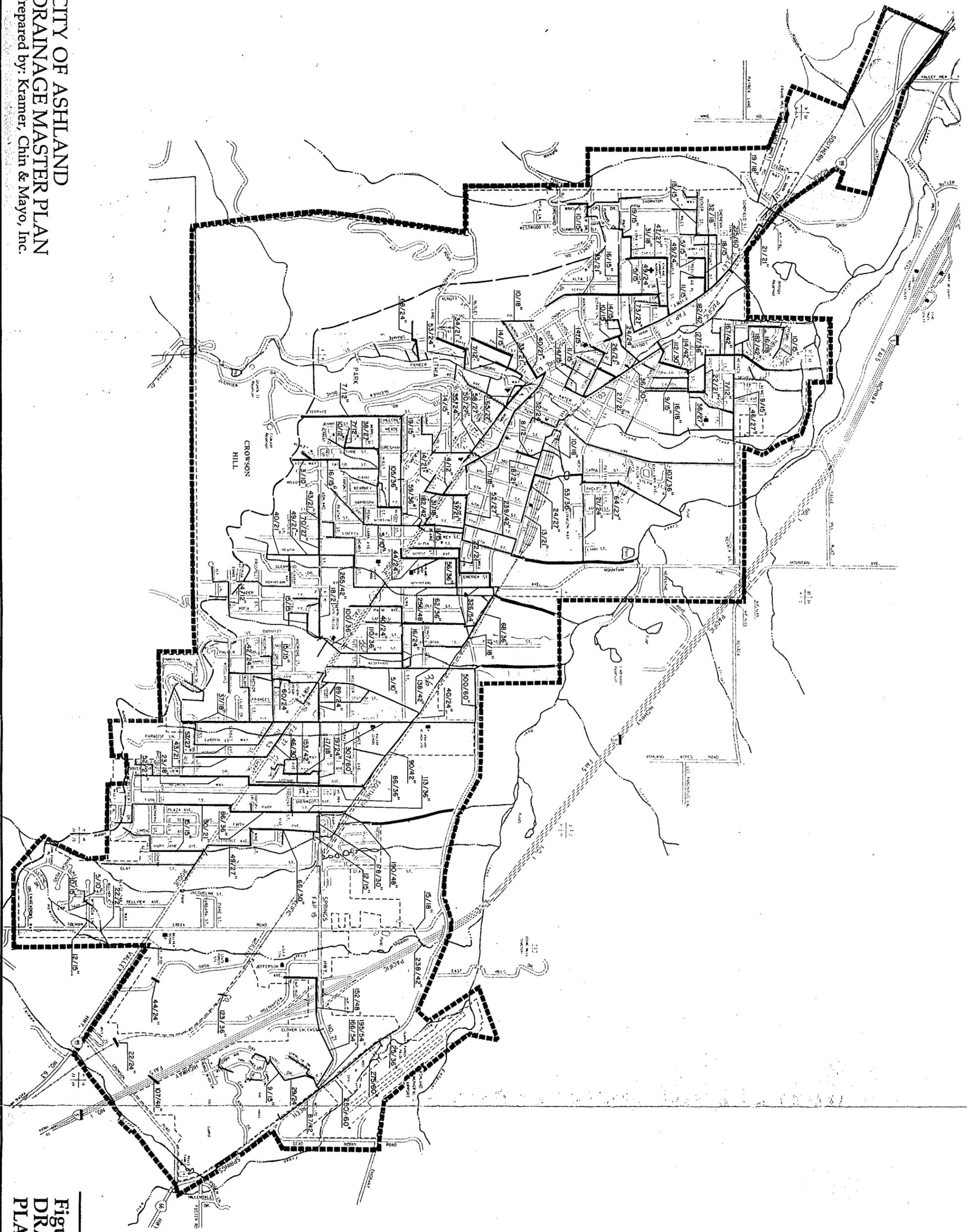
To estimate the capacity of open channels, slope and cross section were determined from topographic maps and from information provided by City staff. Roughness coefficients (Manning's "n") were estimated based on vegetation cover and soil type. Channel capacity was calculated using Manning's equation, assuming one foot of freeboard. For open channels, backwater from Bear Creek was not considered because the steep slopes made backwater effects minor.

With the exception of Wrights, Ashland, Clay, Hamilton, Tolman and Bear Creeks, all recommended stormwater conveyance systems are closed conduits. Sizes and slopes of pipes required to replace open channels are shown on the Master Plan. No new open channels are recommended.

4.2.3 Problem Areas

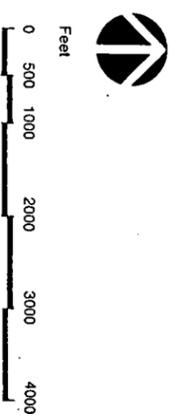
Drainage structures (conduits and ditches) were determined to be inadequate to handle future flows using the 10-year design storm and based on criteria noted in Section 4.2, Conveyance Structure Capacities. Those

identified constitute the "Anticipated Problem Areas," and are graphically presented in Figure 3.2. When these will become problems depends upon the amount and time frame that urbanization will occur within a basin. This analysis assumed complete urbanization based on the City's adopted Comprehensive Plan. Improvements were sized to pass future peak flows.



LEGEND

-  Ashland Urban Growth Boundary
-  City Limits
-  Existing Pipe
-  Existing Ditch
-  Existing Irrigation Canal
-  New Pipe
-  Design flow in C.F.S.
 Flow based on the 10-year design storm; pipes assumed to be concrete
 Pipe Size
-  New Channel Improvement



BASE MAP SOURCE:
 OREGON DEPARTMENT OF TRANSPORTATION 1985

Figure 5.1
 DRAINAGE MASTER PLAN

SECTION 5

RECOMMENDED DRAINAGE MASTER PLAN

5.1 INTRODUCTION

The recommended Drainage Master Plan for the City of Ashland is shown in Figure 5.1. This plan was developed from concepts identified by the City of Ashland which, when implemented, would address short and long term goals for improving and managing the City's storm drainage system. These concepts were considered in all basins throughout the study area. General descriptions of these concepts follow.

5.1.1 Locate Drainage System Improvements in Public Right-of-Way (wherever possible)

Natural drainageways proliferate throughout the study area. These have governed the present location of the existing drainage system and dictated its development.

The routing of storm runoff from all public rights-of-ways, into piped systems and away from open ditches is a primary goal of the City. This would serve to improve maintenance by making them more accessible and it would increase the quantity of land within the City available for development.

5.1.2 Provide All Piped Drainage System

The existing drainage system consists of closed conduits, open ditches and street gutters. City staff have identified an all-pipe drainage system as the most desirable system when the study area fully develops. This would reduce the cost for maintaining the present system and would eliminate open channels in residential areas. Riprap areas of severe erosion along streams in developed areas, some stream cleaning may be required.

Open channels would remain in the City along the perennial waterways (Wrights, Ashland, Clay, Tolman, Hamilton and Bear Creeks), and in undeveloped areas. Ditch improvements would be required for ditches in undeveloped areas.

5.1.3 Maintain Existing Drainage Patterns

As noted previously, the existing drainage system has developed, following the predominant direction of overland flow. These general drainage patterns are maintained throughout the recommended plan.

5.1.4 Reduce or Eliminate Erosion Products From Entering the Storm Drainage System

Due to local factors found throughout the study area, erosive debris and soil sediment enters the system at many locations. These are the products of erosive forces acting on the steep hillsides in the south of the study area. Impacts of these products on drainage system elements include reduced hydraulic capacity, reduced performance, and shorter useful life.

To reduce the frequency of erosion-related problems, the following recommendations are incorporated in the recommended Drainage Master Plan: all pipes should have a minimum diameter of 10 inches and be capable of passing most large debris that can enter the drainage system; all pipes used to implement drainage improvements should be abrasion resistant, i.e. concrete; debris intercepting structures will be installed in areas which experience has identified to be major debris and sediment collectors.

5.1.5 Maintenance Considerations

Many closed conduits in the existing system have diameters less than 10 inches. These pipes are maintenance problems because large debris entering these small conduits may become lodged inside the pipe, effectively blocking storm runoff from being carried by it. Removal of lodged debris is further hindered because maintenance equipment owned by the City cannot be used in small diameter pipes. All pipes less than 10 inches in diameter are recommended for removal and should be replaced with a minimum 10-inch diameter pipe.

5.2 CONDITIONS AND LIMITATIONS

All pipe sizes and slopes given in this plan are approximate only. The peak flow value given for each pipe reach should be the controlling criterion used for final design of drainage improvements. All peak flow values are based on the 10-year design storm, any changes in design storm (i.e. frequency or duration) must be taken into account during final design of improvements. Available slope, and hence pipe size, may differ from that shown in this plan. During final design, the designers may find there are alternative means or routes to convey peak flows which are more cost effective than the systems shown. For example, in some areas it may be possible to construct a small pipe for low flows and allow high flows to pass along a street or other floodway above ground. Detailed surveys and ongoing management are necessary to ensure the safety of such an option. In other areas it may be possible to allow sections of an existing system to surcharge without causing hazardous water levels. For short reaches of existing pipe, the surcharge may increase capacity sufficiently to pass the design flow. These non-standard approaches to handling the design flow should be addressed during final design of storm drain improvements.

The Drainage Master Plan applies only to the trunk drainage system in undeveloped areas. Small systems, those draining less than 50 acres, may

not be shown in this Master Plan. These smaller systems should be defined during final design.

Runoff calculations were made using the SWMM computer model and assuming ultimate land use. The model was calibrated to regression equations for urban runoff developed by the U.S. Geological Survey. No field measurements of runoff quantities have been made in Ashland. If such data become available in the future, it is recommended the SWMM model be recalibrated to reflect the new data.

5.3 CONSTRUCTION COSTS

After analyzing the existing drainage system, costs were estimated for the recommended master plan. All improvements to the existing drainage system involve replacing the existing system with a new system that will have adequate capacity to carry the future peak flows. All costs reflect those which a private contractor may charge for this type of work. Cost savings might be realized if work were done in-house using City employees and equipment.

5.3.1 Estimated Unit Costs

Estimates of construction costs are based on storm drain pipes at \$3 per inch-diameter foot; ditch excavation costs of \$3 per cubic yard; and boring and jacking costs at \$450 per linear foot. Costs for channel improvements were estimated based on the assumption that no ditch presently existed and a prism of soil needed to provide a trapezoidal channel with 3:1 side slopes and large enough in cross section to be capable of passing peak design flows with 1 foot of freeboard. These unit costs include all incidental costs such as manholes, inlets, outfalls, slope protection and pavement restoration. Capital costs were computed by adding a factor for contingencies, engineering costs, legal costs and administrative costs to the construction cost. This factor was 45 percent of construction costs.

Capital cost estimates in this report are planning level estimates only. They have an estimated accuracy of plus or minus 30 percent. The total estimated capital cost for all improvements is \$16.1 million. Presented in Table 5.1 is a basin-by-basin breakdown of these costs.

TABLE 5.1

Summary of Capital Costs of Recommended Improvements (1985 Dollars)
Based on an Engineering News Record Construction Cost Index
of 4600 for Seattle, Washington

<u>Basin</u>	<u>Capital Costs</u>
Wrights Creek	\$ 16,200
Hospital	904,500
Cambridge Street	230,400
Laurel Street	798,750
Ashland Creek	952,200
Railroad Yard	495,900
Mountain Avenue	1,058,550
Beach Street*	1,687,900
Fordyce Street	None
Walker Avenue	41,000
East Main Street	2,628,950
Park Street	252,000
Clay Creek	922,950
Hamilton Creek	24,450
Interstate 5 Basins	<u>1,070,100</u>
	Subtotal = \$11,083,850
Contingency - Legal, Administrative and Engineering at 45 Percent =	<u>4,987,733</u>
	\$16,071,583

* Ditching cost is included in Beach Street Basin estimate.

SECTION 6

IMPLEMENTATION PLAN

6.1 FUNDING OPTIONS

The funding options available for drainage are similar to those funding options available for other existing municipal enterprise activities. The application of some of these options to drainage is somewhat new in Oregon, but all of the methods identified below are in effect in one or more communities in the State.

6.1.1 Utility Service Charge

Under Oregon State law it is possible for a municipality to levy a monthly service charge for drainage in the same manner as many presently do for water and sewer utilities. This approach to drainage financing has been successfully undertaken by the cities of Corvallis, Portland and Medford as well as a number of cities in the State of Washington. The principles applied in establishing charges for drainage as a utility service are similar to those for any other utility service. The expenditures must meet the needs of the public receiving the service, and the charges must relate to the use of the service. Of the options available, a utility service charge is the most recent innovation in drainage financing. It is probably the most reliable source of funds for regular operation and maintenance of the drainage system.

6.1.2 Sewer Utility Revenues

Some cities divert a certain amount of sanitary sewer user funds each year for use in financing drainage. The use of such a charge is not as equitable as specific drainage service fees since the amounts collected do not relate to the service provided or the runoff generated.

6.1.3 General Fund

Pressures on the general fund in Ashland are severe. Under the State of Oregon's tax base limitation law, general fund revenues are not keeping up with inflation or growth. To expect to obtain more funds for drainage from the general fund would appear to be difficult. Additionally, the use of general fund taxes to provide drainage service is not particularly equitable, since the taxes are based on assessed valuation and not a characteristic of a particular parcel of land that would relate to its drainage-runoff characteristics. The use of the general fund, however, is well established and has long been associated with streets and drainage.

6.1.4 Special Assessments

It is possible for cities to institute special assessments against the properties in the city or against special portions of the city for specific benefits received. It would theoretically be possible to levy a one-year-only special assessment for both capital and operation and maintenance of the drainage system. The problem with this approach, however, is that it is not a reliable source of funding in that it must be periodically approved by the voters. It is impossible to develop a consistent program of staffing and budgeting when you do not know from year to year what your available resource is going to be.

6.1.5 Local Improvement Districts

Local improvement districts (LID's) can be established to fund capital or maintenance costs. The method used to assess property owners can be designed to equitably relate to their use of the drainage system. A difficulty with this approach is that LID's normally include only a small area and are thus a piecemeal source of funding. Each district requires council approval and is subject to remonstrance from the members of the district. The LID process makes it difficult to increase revenues to offset inflation, thus making it a poor choice for operation and maintenance revenues. The LID process is well suited to funding localized drainage improvements.

6.1.6 Bonds

Cities have the power to issue both general obligation and revenue bonds under Oregon State law. Bonds could be repaid from surpluses generated by service charges if a utility form of funding were to be adopted. While bonds are a useful means of funding capital improvements, they are not available for funding operation and maintenance of a drainage system, and therefore would not be a total solution to the funding requirements of drainage management.

6.1.7 Developer Funded

Significant sections of the drainage system are often installed by developers when they improve the adjoining property. In some cities the City pays a portion of the developers' costs for oversizing storm drains to handle upstream runoff. Unless some form of City reimbursement is utilized, developer funding does not equitably distribute drainage system costs since the needed drainage system will depend on the location of the development. Developers in downstream areas pay for large systems to provide drainage for people upstream. It is, however, often politically easier to require developers to bear the full cost.

6.1.8 Systems Development Charges

Charges levied on each lot as it is developed, to pay for the expansion of City systems to serve that lot, are becoming increasingly common in Oregon. A portion of the systems development charge is often based on a drainage-related characteristic such as the impervious area of the developed lot. This is an equitable source of funds for the capital improvements to the trunk drainage system necessitated by growth of the City. New developments are often required to pay an initial fee to amortize the cost for down stream improvements, sized to accommodate runoff due to the new development. One drawback of user charges is that it does not provide initial financing, it merely amortizes the debt and pays operation and maintenance costs.

6.1.9 Real Estate Transfer Tax

A variation of the systems development charge currently being considered by several Oregon cities is a real estate transfer tax. This tax is placed on all sales of property within the City. The advantage of this tax is it is imposed at a time when the seller has cash and is thus able to pay. The major disadvantage is that the charge does not relate to the amount of stormwater runoff generated and hence cannot be considered equitable.

6.1.10 Summary

Funding for drainage management should come from a combination of the listed options. Selection of the optimum combination will require detailed review by City staff and Council with outside technical assistance as needed.

6.2 DRAINAGE UTILITY

Because the money needed to support drainage services and management is difficult to obtain from traditional tax sources, little has been done to meet drainage needs. However, if drainage is considered as a utility, regular service charges can be levied. Establishing a drainage utility is an equitable means of distributing the cost of drainage service to the public that is served.

To ensure that charges to the public are fair, the charges should be established on the basis of use; in this case, on the amount, or rate, of runoff from a particular property. The most commonly used measure of runoff is the amount of impervious surface (roof, driveway, etc.) on a property.

This can be as sophisticated as an actual measurement of the impervious surface on all properties, or, as is commonly used, an Equivalent Residential Unit (ERU) computation based on average values for all residences and measured values for others.

Oregon State laws permit the issuance of revenue bonds supported by service charges for utilities, including drainage. The decision to issue revenue bonds is made by the elected body on the basis of need, usually following some master plan and appropriate public hearings. Rates are then established to cover bond redemption debt service as well as operational costs. A vote of the public is normally not required on the issuance of revenue bonds.

6.2.1 Rate Concepts

Communities throughout the United States have used a variety of concepts in setting municipal utility rates. Rate concepts fit into three general types: flat rate, variable rate, and combinations of flat and variable rates. Each of these approaches has advantages and disadvantages, and selection of a preferred rate concept is nearly always based on local circumstances, primarily the nature of the information available to calculate each bill.

Utility rate structures for water, sewer, and solid waste have become increasingly sophisticated in recent years, with most incorporating variable rates or a combination of flat and variable rates for different classes of users. Early drainage rate structures were less complex than those of other utilities but, in the past few years, they also have become more complicated.

Greater knowledge has been gained of stormwater program requirements through better cost of service analysis, program accounting, and rate studies. This is reflected in more detailed rate concepts. None of the rate structure concepts presented in this chapter is a purely flat-rate approach (some involve a flat rate for one or more classes of property). Special consideration is given to methods which would ensure that properties developing in the future would be included in financing drainage improvements.

Seven different rate structure concepts are noted in the following paragraph. Four are variable-rate concepts, and three combine flat and variable rates. The rate structure concepts are as follows;

- o Charges based on impervious area.
- o Charges based on intensity of development and land use.
- o Charges based on gross area and impervious area.
- o Charges based on gross area and intensity of development.
- o A flat rate for all single family residences, combined with a variable rate charge for other properties based on gross area and intensity of development.
- o A flat rate charge to each account for "uniform costs of service, combined with variable charges based on gross area and intensity of development.

- o A flat rate for all single family residences, combined with a variable rate charge for other properties based on impervious area.

Purely variable rate structures are most common in utility operations which provide a commodity or service that is easily and accurately quantifiable, such as water, electricity, and gas supply. Equity considerations are a strong influence in the selection of variable rates over flat-rate approaches. Variable rates allow a utility to distribute costs more closely approximating the differing demands that customers place on systems and services.

When precise measurement of demand or other rate parameters for most or all customers make purely variable rates uneconomical, variable-rate concepts may be augmented by using classes of ratepayers. Typically, rate structures which use classes of customers combine flat-rate and variable-rate concepts. Flat rates may be used for all ratepayers in a given class, but charges vary from class to class.

In some cases, a flat-rate minimum charge is assessed below a certain threshold. Another common approach is to use flat rates only for certain classes of customers who have relatively consistent demands, while variable rates are used for other classes whose demands are less consistent from one user to another. Combinations of variable and flat-rates for stormwater utilities are common, and most treat single-family residential properties as a class of user while assessing variable charges on non-residential parcels.

Communities using combined flat-rate and variable-rate approaches include Portland, Corvallis, and Medford, Oregon, and Tacoma and Clark County, Washington. Bellevue, Washington uses a variable rate structure in which each property's bill is based on gross area and intensity of development.

The experiences of other storm drainage utilities across the nation suggests that single family residences are willing to pay about one-third (up to a maximum of one-half) of the cost of their sewer or water bills for storm drainage management. This generally converts to a drainage charge of no more than \$3 per month per single-family household.

Each of the seven rate structure concepts mentioned has been utilized by one or more cities for drainage funding. The rate concept and level of charge selected in Ashland will depend on specific local objectives and the data available to calculate actual billings. A rate concept and a level for charges should be selected through a process that involves City staff and Council and makes all Council members aware of the policy implications of the selected program.

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