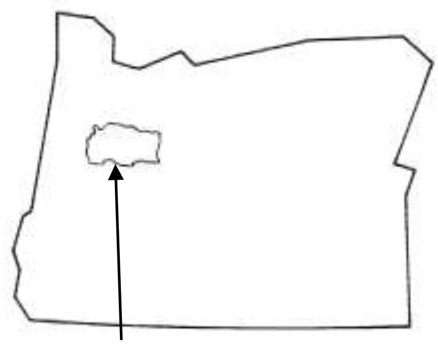
FLOOD INSURANCE STUDY

LINN COUNTY, OREGON
AND INCORPORATED AREAS
VOLUME 1 OF 2



	COMMUNITY NAME	COMMUNITY NUMBER
	ALBANY, CITY OF	410137
	BROWNSVILLE, CITY OF	410138
*	HALSEY, CITY OF	410139
	HARRISBURG, CITY OF	410140
	LEBANON, CITY OF	410141
	LINN COUNTY UNINCORPORATED AREAS	410136
	LYONS, CITY OF	410142
	MILL CITY, CITY OF	410143
	MILLERSBURG, CITY OF	410284
	SCIO, CITY OF	410144
	SODAVILLE, CITY OF	415594
	SWEET HOME, CITY OF	410146
	TANGENT, CITY OF	410147
*	WATERLOO, CITY OF	410148

*NO SPECIAL FLOOD HAZARD AREAS IDENTIFIED

Revised: December 8, 2016

Federal Emergency Management Agency
Flood Insurance Study Number
41043CV001B

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the Community Map Repository. Please contact the Community Map Repository for any additional data.

Part or all of this may be revised and republished at any time. In addition, part of this FIS may be revised by a Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS report components.

Initial Countywide FIS Effective Date: September 29, 2010

Revised Countywide Date: December 8, 2016

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PUBLISHED SEPARATELY

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FLOOD INSURANCE STUDY
LINN COUNTY, OREGON AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study revises and updates information on the existence and severity of flood hazards in the geographic area of Linn County, including the Cities of Albany, Brownsville, Halsey, Harrisburg, Lebanon, Lyons, Mill City, Millersburg, Scio, Sodaville, Sweet Home, Tangent, and Waterloo ; and the unincorporated areas of Linn County (referred to collectively herein as Linn County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the City of Albany is geographically located in Linn and Benton Counties and Cities of Gates, Idanha, and Mill City are geographically located in Linn and Marion Counties. The Cities of Albany and Mill City are included in their entirety in this Flood Insurance Report. The Cities of Gates and Idanha are shown as Areas Not Included in this study. See separately published FIS report and Flood Insurance Rate Map (FIRM) for Marion County for special flood hazard information.

Please note that on the effective date of this study, the Cities of Halsey and Waterloo have no identified Special Flood Hazard Areas (SFHA). This does not preclude future determinations of SFHAs that could be necessitated by changed conditions affecting the community (i.e., annexation of new lands) or the availability of new scientific or technical data about flood hazards.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the City of Mill City were performed by CH2M HILL, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. H-3994. This study, which was completed in October 1977, covered all significant flooding sources affecting Mill City.

The hydrologic and hydraulic analyses for the City of Brownsville were performed by the U.S. Army Corps of Engineers (USACE), Portland District for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 21. This study, which was completed in May 1979, covered all significant flooding sources affecting Brownsville.

The hydrologic and hydraulic analyses for the City of Harrisburg were performed by the U.S. Army Corps of Engineers (USACE), Portland District for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 21. This study, which was completed in July 1979, covered all significant flooding sources affecting Harrisburg.

The hydrologic and hydraulic analyses for the City of Lebanon were performed by the U.S. Army Corps of Engineers (USACE), Portland District for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 21. This study, which was completed in September 1979, covered all significant flooding sources affecting Lebanon.

The hydrologic and hydraulic analyses for the City of Sweet Home were performed by the U.S. Army Corps of Engineers (USACE), Portland District for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 21. This study, which was completed in December 1979, covered all significant flooding sources affecting Sweet Home.

The hydrologic and hydraulic analyses for the City of Millersburg were performed by the U.S. Army Corps of Engineers (USACE), Portland District for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 21. This study, which was completed in April 1980, covered all significant flooding sources affecting Millersburg.

The hydrologic and hydraulic analyses for the Cities of Lyons, Scio and Tangent were performed by the U.S. Army Corps of Engineers (USACE), Portland District for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 21. This study, which was completed in July 1980, covered all significant flooding sources.

The hydrologic and hydraulic analyses for the City of Albany were performed by the U.S. Army Corps of Engineers (USACE), Portland District for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 21. This study, which was completed in December 1980, covered all significant flooding sources affecting Albany.

The hydrologic and hydraulic analyses for Linn County Unincorporated Areas were performed by the U.S. Army Corps of Engineers (USACE), Portland District for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 21. This study, which was completed in July 1983.

The countywide update was performed by WEST Consultants, Inc. for FEMA under Contract No. EMS-20010-CO-0068. Work on the countywide update was completed in April 2009.

The digital base mapping information was provided by the Oregon Geospatial Enterprise Office (http://www.oregon.gov/DAS/EISPD/GEO/index.shtml), Oregon Parks and Recreation Department (http://www.oregon.gov/OPRD/), and the United States Fish and Wildlife Service Portland Office, 911 NE 11th Avenue, Portland, OR 97232-4181. This information was compiled from Oregon Water Resources Department (2006), OR/WA Bureau of Land Management (2000), U.S. Fish and Wildlife Service (2008), Oregon Parks and Recreation Department (2008), National Geodetic Survey (2007), the U.S.

Census Bureau (2007), and the U.S. Department of Agriculture Farm Service Agency (2005) at a scale of 1:24,000. The coordinate system used for the production of the FIRM is Universal Transverse Mercator, North American Datum of 1983, Geodetic Reference System 1980. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on this FIRM.

1.3 Coordination

The dates of the initial, intermediate, and final CCO meetings held for the previous FIS reports for Linn County and the incorporated communities within its boundaries are shown in Table 1, "Initial, Intermediate, and Final CCO Meetings". They were attended by representatives of FEMA, the U.S. Geological Survey (USGS), the communities, and the study contractor.

Table 1. Initial, Intermediate, and Final CCO Meetings

Community	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Albany, City of	February 15, 1978	July 25, 1980	December 7, 1982
Brownsville, City of	February 16, 1978	March 27, 1979	August 28, 1980
Halsey, City of	--[1]	--[1]	--[1]
Harrisburg, City of	February 16, 1978	May 17, 1979	--[1]
Lebanon, City of	February 16, 1978	August 1, 1979	--[1]
Linn County Unincorporated Areas	February 17, 1978	July 25, 1980 July 14, 1981	August 24, 1985
Lyons, City of	February 16, 1978	January 31, 1980 March 11, 1980	December 17, 1980
Mill City, City of	March 1976.	September 22, 1977 October 1976	April 11, 1978
Millersburg, City of	February 17, 1978	--[1]	July 15, 1981
Scio, City of	February 16, 1978	April 18, 1980 May 21, 1981	October 28, 1982
Sodaville, City of	--[1]	--[1]	--[1]
Sweet Home, City of	February 16, 1978	October 16, 1979	April 10, 1981
Tangent, City of	February 17, 1978	June 30, 1980	May 28, 1981
Waterloo, City of	--[1]	--[1]	--[1]

[1] Information not available

The initial community coordination meetings were held and attended by representatives of FEMA, Oregon Department of Water Resources, Linn County, city officials, the study contractor, and the community. The purpose of the initial coordination meetings was to identify stream reaches to be studied, explain the study concepts, identify data sources, and establish communication and coordination procedures.

Intermediate coordination meetings were held between FEMA, local officials and the study contractor to review plan and profile drawings showing water-surface profiles, floodway delineations, and flooded-area outlines.

Final community coordination meetings were held and attended by representatives of FEMA, local officials, the study contractor, and the community. All problems and concerns raised at the final meetings have been addressed in this study.

Countywide Update
An initial community coordination meeting for Linn County was held on March 20, 2006. This meeting was attended by representatives of the Cities of Albany, Harrisburg, Lebanon, Scio, Tangent, Linn County, Oregon Department of Land Conservation and Development, FEMA, and WEST Consultants, Inc. The results of the study were reviewed at the final Consultation Coordination Officer [CCO] meeting held on January 15, 2009, and attended by representatives of County Staff, Local City Staff, FEMA Region X, and Department of Land Conservation and Development. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the geographic area of Linn County, Oregon, including the incorporated communities listed in Section 1.1.

The flooding sources studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction for the City of Mills City through 1982, the Cities of Brownsville, Harrisburg, Lebanon, and Sweet Home through 1984, the Cities of Albany, Lyons, Millersburg, Scio, and Tangent through 1985, and Linn County unincorporated areas through 1989. Table 2 lists the flooding sources studied in detail and the included segments.

Table 2. Flooding Sources Studied by Detailed Methods

Flooding Source	Description of Reach Studied
Ames Creek	Confluence with South Santiam River to 0.2 miles upstream of southern corporate limits of Sweet Home
Burkhart Creek	Lebanon northern corporate limit to Vine Street
Calapooia River	Confluence with Willamette River to State Route 228 near Holley
Calapooia Split Flow	Confluence with Calapooia River to divergence with Calapooia River
Cox Creek	Confluence with Willamette River to Interstate Highway 5
North Lake Creek	Within the Tangent corporate limits, starting 500 feet downstream of State Highway 99E and extending approximately 1 mile upstream
Oak Creek	Confluence with Calapooia River to approximately 0.25 miles upstream of Fry Road and approximately 0.5 miles downstream of Stolitz Hill Road to Rock Hill Road

Table 2. Flooding Sources Studied by Detailed Methods (continued)

Flooding Source	Flooding Source
Peters Ditch	Confluence with Thomas Creek to just upstream of State Route 226 in the City of Scio
Santiam River	Interstate Highway 5 to confluence with North and South Santiam Rivers
North Santiam River	Confluence with South Santiam River to Greens Bridge, from 1 mile downstream of Stayton to approximately 1 mile upstream of Stayton, from approximately 1 mile downstream of Lyons to approximately 1 mile upstream of Lyons, from approximately 1 mile downstream of Mill City to approximately 1 mile upstream of Gates, and from Blowout Street in Idanha to approximately 0.5 miles upstream of Idanha corporate limit
South Santiam River	Confluence with North Santiam River to 700 feet below Foster Dam
Thomas Creek	From approximately 1 mile downstream of Scio to Richardson Gap Road
Truax Creek	Confluence with Willamette River to approximately 0.40 mile downstream of Clover Ridge Road
Willamette River	From Marion-Linn County boundary to Lane-Linn County boundary

Approximate analyses were used to study flooding sources in areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Linn County. Table 3 lists the flooding sources, grouped by watershed, which were studied by approximate methods.

Table 3. Flooding Sources Studied by Approximate Methods

Flooding Source	Description of Reach Studied
Bear Branch	Mouth to approximately 1.5 miles upstream of Cole School Road
Beaver Creek	Mouth to Kaufman Road
Brush Creek	Mouth to approximately 3 miles upstream
Burkhart Creek	Mouth of Scravel Hill Road
Burkhart-Truax Diversion Channel	Burkhart Creek to Truax Creek
Butte Creek	From Interstate 5 to approximately 3.6 miles upstream
Calapooia River	From State Highway 228 to approximately 3.2 miles upstream
Camous Creek	Extent of stream
Cochran Creek	Mouth to approximately 2 miles upstream
Courtney Creek	Mouth to Scravel Hill Road
Crabtree Creek	Mouth to approximately 2 miles upstream of Richardsons Gap Road
Dry Muddy Creek	Mouth to the Linn County line

Table 3. Flooding Sources Studied by Approximate Methods (continued)

Flooding Source	Description of Reach Studied
Foster Reservoir	Extent of Reservoir
Green Peter Reservoir	Extent of Reservoir
Lake Creek (tributary to Calapooia River)	From the Calapooia River detailed study limit to Glaser Road
Lake Creek (tributary to Willamette River)	Extent of stream
Little Muddy Creek	Mouth to approximately 0.5 miles downstream of Priceboro Road
Little Oak Creek	Mouth to Denny Scholl Road
Mill Creek	Mouth to approximately 1.4 miles upstream
Murder Creek	Interstate 5 to approximately 1.1 miles upstream
Muddy Creek	Burlington Northern Railroad near Fayetteville to Powerline Road
Neal Creek	Mouth to approximately 0.5 miles upstream
North Lake Creek	From the limit of the North Lake Creek detailed study limit to approximately 0.4 miles upstream of Seven Mile Road
North Santiam River	Greens Bridge to approximately 1 mile downstream of Stayton, 1 mile upstream of Stayton to approximately 0.5 mile downstream of Lyons, 1 mile upstream of Lyons to approximately 1 mile downstream of Mill City, and 1 mile upstream of Gates to Blowout Street in Idanha
Oak Creek	Approximately 0.25 miles upstream of Fry Road to 0.5 mile downstream of Stoltz Hill Road near Lebanon and from Rock Hill Road to 0.5 miles south of Sodaville
One Horse Slough	From the South Santiam River detailed study limit to 0.25 miles downstream of Mount. Pleasant Road
Periwinkle Creek	Interstate 5 to approximately 1.6 miles upstream
Peters Ditch	From the Peters Ditch detailed study limit to approximately 1.8 miles upstream
Pierce Creek	Interstate 5 to approximately 5.3 miles upstream
Plainview Creek	Mouth to approximately 3.6 miles upstream
Roaring River	Mouth to approximately 1.4 miles upstream
South Santiam River	From Foster Reservoir to approximately 0.3 miles upstream of Canyon Creek confluence
Spoon Creek	From the Calapooia River detailed study limit to Waggener Road
Sucker Slough	Mouth to approximately 0.2 miles upstream of Cole School Road
Thomas Creek	Mouth to 1 mile downstream of Scio and from Richardsons Gap Road to a small dam near Jordon
Truax Creek	From approximately 0.40 miles downstream of Clover Ridge Road to Scravel Hill Road

Table 3. Flooding Sources Studied by Approximate Methods (continued)

Flooding Source	Description of Reach Studied
White Creek	Mouth to approximately 0.8 miles upstream of Gap Road
Wiley Creek	Mouth to approximately 1 mile upstream of Jackson Creek confluence

2.2 Community Description

Linn County is located in west-central Oregon. It is bounded on the east by the Cascade Mountain Range, as well as Jefferson and Deschutes Counties; on the north by the westerly flowing North Santiam River and by Marion County; on the south by Lane County; on the west by the Willamette River, which separates Linn from Benton County, and on the northwest by Polk County.

Linn County encompasses an area of 2,297 square miles. In 1940, the population was 14,500 (Reference 1); by 1980, it had increased to 89,495 (Reference 2). The population was 111,489 in 2000 and estimated to be 116,672 in 2010 (Reference 3). The county seat, Albany, is the largest city in the county. The economy of Linn County is based on agriculture, manufacturing, exotic metal processing, and lumber.

The climate consists of warm, dry summers and mild, wet winters. Temperatures in the valleys are usually mild, ranging from an average January minimum of 33°F to an average July maximum of 82°F. Average annual precipitation varies from approximately 40 inches in the western valley to more than 140 inches in some areas of the mountainous eastern and central sections of the county. Approximately two-thirds of this precipitation occurs from October to April (Reference 4).

The county contains portions of three major drainage basins. From north to south, they are the Santiam River, the Calapooia River, and the Willamette River basins. The Calapooia and Santiam River basins originate in the Cascade Mountain Range and flow westerly into the Willamette River.

The South Santiam River forms at the confluence of Sevenmile and Squaw Creeks, on the west slopes of the Cascade Range. From that point it flows westerly for approximately 25 miles and then northwesterly for nearly 40 miles before joining the North Santiam River near the City of Jefferson. The North Santiam River originates in the Cascade Range east of Lyons and flows westerly for 90 miles before converging with the South Santiam River.

The Willamette River forms at the confluence of the Coast and Middle Forks Willamette River approximately 5 miles upstream of Eugene. The Coast Fork Willamette River originates in the Calapooia Mountains, while the Middle Fork Willamette River has its origins in the Cascade Range. At Eugene, the Willamette River emerges from the foothills and flows northerly through the Willamette Valley. The Willamette River flows northerly into the Columbia River just outside Portland, Oregon.

The Calapooia River originates on the western slopes of the Cascade Range. It emerges from the foothills near Brownsville, flows northerly across the Willamette Valley, and joins the Willamette River at Albany. The Calapooia River has a total drainage area of approximately 375 square miles.

These river basins are similar because the headwaters are all located in mountainous areas with narrow floodplains and each flows into the Willamette Valley with its typical wide, flat floodplain areas. The soils vary within the basins from sands and gravels in the steep mountainous areas to silty clays in the flatter areas. Most of the Willamette Valley floor is covered with Willamette silt, which consists of silt, sandy silt, clayey silt, and silty clay. Vegetation within the study areas varies from primarily timber in the mountainous areas to agricultural crops in the lower valley areas. There is little floodplain development in the unincorporated areas of the county. Flood damage has been little in those areas because the floodplains are sparsely developed.

City of Albany

The City of Albany was incorporated in 1864 and is located in northwest Linn County and northeast Benton County. It is approximately 40 miles north of Eugene, Oregon, and 20 miles south of Salem, the State capital. Adjacent to Albany to the northeast is the City of Millersburg; to the northwest unincorporated areas of Benton County; and to the east, south, and west unincorporated areas of Linn County. The city was incorporated in 1864. The population was 26,150 in 1978 (Reference 1). The population was 40,852 in 2000 and was estimated to be 50,158 in 2010 (Reference 3).

The economy is based on agriculture, food processing, rare metal processing, and wood products industries of the Willamette Valley. Manufacturing and commercial development has occurred along the Southern Pacific Railroad and the Willamette River. The central business district of Albany is located between the Willamette River and 5th Avenue, while residential development is spread throughout the city. Urban development is outside the 1-percent annual chance floodplain; however, city sewage treatment facilities are partly in the floodplain.

The Willamette River, Calapooia River, Calapooia River Split Flow, Oak Creek, Cox Creek and Truax Creek lie within the corporate limits of Albany. Upstream of Albany, the Willamette River drains approximately 4,840 square miles of mostly mountainous timberland. Oak Creek begins in the Cascade foothills south of Lebanon and flows northwesterly across the Willamette Valley to its confluence with the Calapooia River at Albany. Most of the 47-square-mile drainage area is agricultural land located on the valley floor. Cox Creek and Truax Creek originate in southern Lebanon and flow northwesterly to their confluences with the Willamette River near Albany. Cox Creek drains over 15 square miles of agricultural and urban land, while Truax Creek has a drainage area of approximately 8 square miles.

Topography is very flat south of the Willamette River and the soils are of the Willamette type, alluvial in origin. Indigenous vegetation consists of white oak, red alder, brush, and grasses.

City of Brownsville

The City of Brownsville was incorporated in 1876 and is located in the southwest portion of Linn County, at the base of the Cascade Range foothills. It is approximately 25 miles north of Eugene, Oregon, and 15 miles south of Albany, Oregon. Brownsville is surrounded by unincorporated county land. The population was 1,230 in 1977 (Reference 5). The population was 1,449 in 2000 and was estimated to be 1,620 in 2007 (Reference 3).

Brownville's central business district, which includes several historic buildings, is located along Main Street and Spaulding Avenue, on the north side of the Calapooia River. Residential development is located on both sides of the river. Considerable development has occurred between State Highway 228 and the Calapooia River which would be subject to direct flooding during and 100-year flood event. Additional areas would be susceptible to shallow flooding from a 1-percent annual chance flood including most of the land south of State Highway 228 and the area between Linn Way and Ash Street on the north side of the city.

The Calapooia River flows northwest through Brownsville and joins the Willamette River at Albany. Upstream of Brownsville, the Calapooia River drains approximately 150 square miles of mountainous timberland.

<u>City of Halsey</u>
The City of Halsey, founded in 1872, is located in the western part of Linn County. The city is located approximately 13 miles south of Albany and is situated between Muddy Creek and Spoon Creek. To the east of Halsey lies the City of Brownsville, approximately 6 miles away. The population of the city was 724 in 2000 and was estimated to be 821 in 2007 (Reference 3).

<u>City of Harrisburg</u>
Harrisburg was incorporated in 1866 and is located in southwestern Linn County. It is approximately 15 miles north of Eugene and approximately 20 miles south of Corvallis. The western corporate limits follow the centerline of the Willamette River. Upstream of Harrisburg, the Willamette River drains approximately 3,400 square miles of mostly mountainous country.

The population was 1,700 in 1977 (Reference 5). The population was 2,759 in 2000 and was estimated to be 3,451 in 2007 (Reference 3). Economic activity in Harrisburg is centered on the Willamette Valley's agricultural industry and its related commercial development, which is mainly along the Burlington Northern and Southern Pacific Railroads in the middle of the city. The central business district is along Second and Third Streets, outside of the Willamette River floodplain. Residential development is spread throughout the city, and several sections east of the railroads are prone to shallow flooding from the headwaters of Lake Creek. Soils in the community are poorly drained, and vegetation primarily consists of small trees, grasses, and shrubs.

<u>City of Lebanon</u>
The City of Lebanon was incorporated in 1878 and is located in west-central Linn County. It is approximately 35 miles north of the City of Eugene and 20 miles east of the City of Corvallis. The City of Lebanon is surrounded by the unincorporated areas of Linn County.

Agriculture and wood-related industries form the economic base of Lebanon. Several wood-products plants are located near the South Santiam River, but they are outside the 1-percent annual chance floodplain. The business district is near the center of the city, in the vicinity of Main and Grant Streets. Residential development is located throughout the city. There is little development in the 1-percent annual chance floodplain. The population of Lebanon has increased from 8,800 in 1977 to 12,950 in 2000 (References 3 and 6). The population was estimated to be 14,836 in 2007 (Reference 3).

The South Santiam River flows through the eastern portion of Lebanon and drains approximately 690 square miles of mountain timberlands before emerging from the Cascade Range foothills near Lebanon.

Cox Creek originates in southern Lebanon and flows northwesterly to its confluence with the Willamette River at Albany. At Tangent Street (in Lebanon), Cox Creek has a drainage area of 1.4 square miles, most of which is urban land.

The Lebanon-Santiam Canal is operated by the Pacific Power and Light Company. Water is diverted from the South Santiam River into the canal southeast of Lebanon and flows northerly through the middle of the city.

The incorporated area is highly urbanized. Grass and shrubs are the dominate vegetation The topography is relatively flat and consists of poorly drained soils.

City of Lyons

The City of Lyons was incorporated in 1958 and is located on the northern edge of Linn County. It is approximately 25 miles southeast of the City of Salem. The city is surrounded by unincorporated Marion County land and unincorporated Linn County land. The population of Lyons increased from 920 in 1978 to 1,008 in 2000 (Reference 3and 5). The population was estimated to be 1,126 in 2007 (Reference 3).

Lyons lies along the North Santiam River, which drains approximately 665 square miles of mountainous timberland upstream of the Lyons-Mehama bridge. Big Cliff and Detroit Reservoirs are located approximately 18 river miles upstream of Lyons.

Lyons occupies portions of three terraces on the south bank of the North Santiam River. The two upper terraces are above the floodplain, but some of the lower terrace is in the floodplain of the North Santiam River. All three terraces have moderately permeable soils and are covered mainly by trees or grass (Reference 7).

Commercial development is primarily along Main Street on the upper terrace, but residential development is scattered throughout the city. Recent residential development has occurred on the lower terrace, along Neal Park Road and North 14th Street.

Mill City

Mill City is located approximately 30 miles east of Salem. The North Santiam River, which is the county line between Linn and Marion Counties, divides Mill City into two parts. Approximately one-sixth of the city is in Marion County north of the river, with the remainder in Linn County south of the river. Mill City was incorporated 1947. The neighboring City of Gates is 3 miles to the east. The population of Mill City was 1,537 in 2000 and estimated to be 1,676 in 2007 (Reference 3). The economy of the area is based on forest products and recreation.

The North Santiam River has a drainage area of 524 square miles at Mill City, which is made up of the forested, mountainous west slope of the Cascade Mountain Range. The high Cascade Mountain Range is formed of young basaltic and andesitic lava flows that are generally very permeable to recharge. The lower elevations are composed of older volcanic formations that are moderately permeable to recharge. Mill City sits on alluvial formation of highly permeable coarse gravels, sands, and silts. The North Santiam River has cut a deep channel through the alluvial deposit. Bank conditions range from exposed alluvial material to heavy brush and trees. Floodplain development has not taken place in Mill City because no significant amount of floodplain exists.

City of Millersburg

The City of Millersburg is located in northwestern Linn County and is 25 miles south of Salem. Millersburg was incorporated in 1974. It is bordered by unincorporated areas of Linn County to the north, east, and west; by the City of Albany to the south; and by unincorporated areas of Benton County to the west. The population was 651 in 2000 and estimated to be 663 in 2007 (Reference 3).

The economy of Millersburg is based on Willamette Valley manufacturing and commercial industries. Industrial development has occurred along the Southern Pacific Railroad and Willamette River.

Millersburg lies along the east bank of the Willamette River, between River Miles 116.0 and 117.9. There is little development within the floodplain areas of Millersburg. Most of the residential development of the city is located outside of the floodplains of the Willamette River, Cox Creek, Truax Creek, and other flooding sources in the area.

Truax Creek originates northwest of the City of Lebanon and flows northwesterly approximately 10 miles to its confluence with Willamette River at Millersburg. Elevations in the Truax Creek basin range from approximately 210 feet in Millersburg to approximately 310 at its headwaters.

Burkhart Creek and Cox Creek are located in the southern portion of the city and flow northwesterly to their confluence with the Willamette River.

The topography of Millersburg is very flat and the soils are of Willamette type, alluvial in origin. Vegetation in Millersburg consists primarily of white oak and red alder trees, and brushes and grasses. The majority of the city is in agricultural use.

City of Scio

The City of Scio was incorporated in 1866. It is located in northwest Linn County, at the base of the Cascade Range foothills and is approximately 20 miles south of Salem. The city is surrounded by unincorporated areas of Linn County. Scio's population has increased from 479 in 1980 to 695 in 2000. (References 1 and 3). The population was estimated to be 752 in 2007 (Reference 3).

Thomas Creek originates on the western slopes of the Cascade Range. The stream flows west through Scio and joins the South Santiam River approximately 3 river miles upstream of the confluence of the North and South Santiam Rivers. Upstream of Scio, Thomas Creek drains approximately 120 square miles of mountainous timberland.

Peters Ditch begins in the foothills of the Cascade Range and flows west through Scio to join Thomas Creek just downstream of the corporate limits. Peters Ditch has a drainage area of approximately 4 square miles, most of which is flat agricultural land.

Most of Scio's commercial development is located along North Main Street, near Thomas Creek. Residential development is spread throughout Scio. The entire city is within the 1-percent annual chance floodplain.

City of Sodaville

The City of Sodaville, is located in the central portion of Linn County approximately 13 miles southeast of Albany. The city was incorporated in 1880. The population was 290 in 2000 and estimated to be 293 in 2007 (Reference 3). Portions of the western corporate boundary lie along Oak Creek.

City of Sweet Home

The City of Sweet Home is located in south-central Linn County, approximately 30 miles northeast of Eugene, and 30 miles southeast of Corvallis. The city was founded in 1893. The population of Sweet Home has increased from 7,100 in 1977 to 8,016 in 2000 (References 2 and 3). The population was estimated to be 8,769 in 2007 (Reference 3). The economy of Sweet Home is based on wood products, logging, and tourism. Commercial development is mainly located along Main and Long Streets, and residential development is located throughout the city.

There is little development on the floodplain along the South Santiam River. Floodplain development along Ames Creek is primarily residential. Ames Creek originates in the Cascade Range south of Sweet Home and flows northerly through the city to join the South Santiam River in northwest Sweet Home. At its mouth, Ames Creek has a drainage area of approximately 11 square miles, most of which is mountainous timberland upstream of Sweet Home.

Taylor Creek has a drainage area of approximately 1 square mile and joins Ames Creek near Long Street and 10th Avenue in Sweet Home.

Wiley Creek originates in the Cascade Range southeast of Sweet Home and joins the South Santiam River just downstream of Foster Reservoir. Wiley Creek drains 64 square miles and flows through the Foster area of Sweet Home.

Located in the South Santiam Valley, Sweet Home has moderately sloping topography and poorly drained soils. Grass, brush, and trees cover much of the incorporated area, particularly the floodplains.

City of Tangent

The City of Tangent was incorporated in 1893. It is located in the western portion of Linn County, approximately 34 miles north of Eugene and 6 miles south of Albany. Tangent is bordered completely by unincorporated areas of Linn County.

The population of Tangent was approximately 530 in 1978 (Reference 1). The population was 933 in 2000 and estimated to be 981 in 2007 (Reference 3). Economic activity centers around agriculture and its related industries. The central business district of the city is located along Birdfoot Drive, east of State Highway 99E. Residential development is located primarily between Old Oak Drive and Tangent Drive, and on both sides of State Highway 99E.

The Calapooia River flows northwesterly near Tangent's southern corporate limits and joins the Willamette River at Albany. Lake Creek flows northwesterly through Tangent and joins the Calapooia River west of the city. It drains approximately 15 square miles of rural farmland. North Lake Creek flows westerly across southern Tangent draining approximately 2 square miles before joining Lake Creek near the western corporate limits of Tangent. Floodplain development in Tangent is limited to residential development along North Creek through the center of the city.

Soils in the area are primarily silty clay loams with moderate to poor drainage characteristics. Vegetation consists of mostly grasses with some scattered deciduous trees.

City of Waterloo

The City of Waterloo was incorporated in 1893, and is located in the central portion of Linn County. The city is located approximately 15 miles southeast of Albany. The population was 239 in 2000 and estimated to be 241 in 2007 (Reference 3). The eastern corporate boundary lies along the west bank of the South Santiam River.

2.3 Principal Flood Problems

In Linn County, the annual flood season extends from October through April, with a majority of the larger flood occurring in December and January. During the winter, storms move inland from the Pacific Ocean, bringing periods of intense rainfall over the Pacific Northwest. Floods are a possibility whenever rainfall is abnormally intense or prolonged.

Floods in Linn County are normally widespread, rather than limited to a few streams in a single basin, and may occur several times during a flood season. They are caused primarily by intense rainfall lasting 2 to 5 days, augmented by snowmelt at a time when the soil is nearly saturated from prior rains. The freezing level may raise to 10,000 feet or higher during the more intense rainstorms, causing rapid melting of accumulated snow in the Cascade Range. When the ground is frozen or saturated, runoff becomes greater and more rapid. The direction of the storm path also influences the rate of runoff. Higher flows are generated when the storm front moves in a downstream direction, producing a buildup of floodwaters. Table 4 lists the maximum recorded floods and other major floods in Linn County.

Table 4. Historical Floods of Linn County

Stream Name	Location	Flood Dates	Discharge (cfs)	Recurrence Interval (years)
Calapooia River	Albany	December 22, 1955	32,700	40
		February 11, 1961	30,500	20
		December 22, 1964	28,400	13
		January 16, 1974	25,800	10
Calapooia River	Holley	December 22, 1964	12,600	20
		December 28, 1945	12,200	19
		January 21, 1972	10,500	11
North Santiam River	Mehama	December 28, 1945	76,600	20[1]
		November 22, 1909	63,200	8[1]
		December 22, 1964	58,400	140[2]
		February 7, 1996	53,800	100[2]
		January 21, 1972	43,300	50[2]

[1] Based on Unregulated Flow

[2] Based on Regulated Flow

Table 4. Historical Floods of Linn County (continued)

Stream Name	Location	Flood Dates	Discharge (cfs)	Recurrence Interval (years)
North Santiam River	Niagara	December 26, 1964	19,300	--[3]
		December 17, 1977	18,300	--[3]
Santiam River	Jefferson	December 22, 1964	255,000	125[1]
		January 21, 1972	180,000	22[1]
		February 7, 1996	168,000	--[3]
		January 16, 1974	84,500	8[2]
South Santiam River	Cascadia	February 7, 1996	31,700	--[3]
		November 25, 1999	28,200	--[3]
		December 22, 1964	27,600	22
		January 21, 1972	24,500	14
South Santiam River	Waterloo	December 22, 1964	95,200	65[1]
		December 28, 1945	74,200	--[3]
		March 31, 1931	70,000	--[3]
		February 7, 1996	29,200	--[3]
		January 21, 1972	22,500	--[3]
Thomas Creek	near Scio	December 22, 1964	27,400	200
		January 21, 1972	20,200	50
Willamette River	Albany	December 4, 1861	340,000	100[1]
		February 4, 1890	291,000	50[1]
		January 14, 1881	266,000	30[1]
		January 15, 1901	231,000	14[1]
		January 8, 1923	206,000	10[1]
		February 22,1927	191,000	8[1]
		December 23, 1964	320,000	80[2]
		February 9, 1996	125,000	13[2]
		January 17, 1974	118,000	11[2]
		January 21, 1972	102,000	7[2]
		November 21, 1996	101,000	6[2]
		December 8, 1981	94,500	5[2]

[1] Based on Unregulated Flow
[2] Based on Regulated Flow
[3] Data Not Available

The greatest known flood on the Willamette River at Albany occurred in December 1861, before there was a stream gaging network for recording flood heights. This flood had an estimated peak discharge of 340,000 cfs and a recurrence interval of 100 years. Discharges and crest elevations for large Willamette River floods at the USGS Albany gage (No. 14174000) from 1941 to 2007 are listed in Table 4. The most recent Willamette River flood occurred in 1997 and had a recurrence interval of about 6 years (Reference 8). The 1964 flood resulted from unusually intense precipitation on a frozen topsoil augmented by snowmelt in the mountains and valleys. Little damage occurred within the North Albany unincorporated area. Further upstream, the City of Harrisburg is located on high ground along the Willamette River, and has suffered only minor damage from past Willamette River flooding.

Without upstream regulation, the 1964 flood would have been the largest flood of the 20th century with a peak discharge of 320,000 cubic feet per second (cfs), with an estimated recurrence interval of 80 years. However, upstream regulation reduced the peak discharge to 186,000 cfs. The effect of flood-control storage on the discharges of the Willamette River floods is shown in Table 5.

Table 5. Effect of Flood Control Storage on Willamette River

Recurrence Interval	Regulated Flow (cfs)	Unregulated Flow (cfs)
1-percent annual chance (100-year)	205,000	335,000
0.2-percent annual chance (500-year)	310,000	435,000

In December 1964, Truax Creek overtopped its bank to wash out the Southern Pacific Railroad bridge and flood sections of Interstate Highway 5. Millersburg has not experienced extensive flood damage because of low development in flood-prone areas.

Flooding on Cox Creek is caused by intense rainfall from massive winter storms moving inland from the Pacific Ocean. This often results in simultaneous flooding on all streams adjacent to Cox Creek. Damaging floods may occur at any time between late October and late April. The most severe floods occur in December, January, and February. Because the drainage basin for Cox Creek is very flat, floods may rise slowly following a rainstorm and may last a full day. Flood peaks may last 2 hours or more. Cox Creek has flooded streets and yards, but has not caused much damage. Urbanization of the Cox Creek drainage basin could increase future flood problems.

A review of USGS crest gage records for Cox Creek for the period 1953 through 1968 shows that only two major floods occurred in this timeframe. Those floods are the 1964 flood (a 25-year recurrence interval flood) and the 1961 flood (a 20-year recurrence interval flood). The two floods caused only minimal flood damage due to the high stream banks from River Mile (RM) 0.6 to RM 1.4. In particular, Waverly Lake and Swan Lake from RM 0.6 to RM 1.3 have high bank elevations that preclude most flooding. Willamette River flooding in December 1964, however, inundated extensive areas of Cox Creek, between RM 0 and RM 0.6. This includes some flooding on the left bank near RM 0.4 at the Teledyne Wah Change Research Facility.

Historical data and estimated flood discharges indicate that Oak Creek overflows its banks annually. Major flooding occurs on the average of once every 5 years.

After heavy rainfall, Harrisburg has localized flooding (east of the railroad tracks) from the headwaters of Lake Creek. Runoff accumulates in open fields, due to the flat topography and poor drainage. This flooding causes little damage as the flooded area is relatively undeveloped and flood depths are shallow.

In the City of Albany, two of the largest floods that occurred along the Calapooia River took place in 1955 and 1964. The greatest recorded flood discharge on the Calapooia River occurred on December 22, 1955, when 14 inches of rain fell during December 18 to 26. The Calapooia River started rising rapidly on December 18th and crested at a stage of 22.1 feet at Albany on December 22nd.

In the Cities of Brownsville and Tangent, the two largest of those floods occurred along the Calapooia River in December 1964 and December 1945. Both floods had a return interval of approximately 20 years, with discharges at Holley of 12,600 cfs and 12,200 cfs, respectively. In both cities, the December 1964 flood caused minor damages. The 1-percent annual chance flood can be expected to cause more extensive damage, as it is estimated to be approximately 2 feet higher than 1964 the flood.

East of State Highway 99E, Tangent has had flooding from North Lake Creek following heavy rainstorms concentrated over its drainage basin. Flood elevations on North Lake Creek are affected by culverts and bridges, resulting in increased upstream flood heights. This flooding causes little damage because flood depths are shallow.

The potential for flooding in Mill City has been greatly reduced since the completion of the Detroit Dam in 1953 on the North Santiam River. Although steep riverbanks through most of Mill City contain most floodwaters, some historical inundation occurred at the JayCee Recreation Area and the lands north and east of here prior to the construction of the dam. The USACE has estimated that the natural peak discharge for the flood of 1964 at Detroit Dam would have been 80,000 cfs (Reference 9). The actual peak flow in 1964 was 19,400 cfs, an 80-year flood under current conditions.

The largest flood on North Santiam River since the completion of Detroit Reservoir in 1953 occurred on December 22, 1964. Rapid snowmelt combined with intense rainfall to produce a peak discharge of 58,400 cfs at the USGS stream gage at Mehama (across the river from Lyons) and had a return interval of approximately 140 years. There was little damage in Lyons along North Santiam River from the December 1964 flood, as the floodplain was still undeveloped. Upstream of the confluence with Little North Santiam River, the estimated peak North Santiam River discharge for the 1964 flood is only 22,400 cfs. Larger floods occurred prior to construction of Detroit Reservoir, including on in December 1945, which had a discharge of 76,600 cfs at Mehama. On January 21, 1972, the USGS stream gage at Mehama recorded a peak discharge of 43,300 cfs, which had a recurrence interval of approximately 50 years (Reference 10).

In December 1964, rapid snowmelt combined with intense rainfall to produce a discharge of 95,200 cfs on the South Santiam River at Waterloo. That is the largest recorded flood at Waterloo since the USGS established a stream gage there in 1923. The recurrence interval for that flood has been estimated at 65 years. The Lebanon business district sustained heavy damage when South Santiam River overflowed into Lebanon-Santiam Canal and the canal in turn flooded 42 blocks near the center of the city. Flood damage in Sweet Home was also extensive. Sweet Home city water and wastewater treatment plants were flooded, and more than one dozen families were forced to evacuate their homes, as reported on December 24, 1964, by the Albany Democrat-Herald. The water plant was shut down for several days, until the damaged pumps were repaired. Floods of similar magnitude to the 1964 flood occurred in 1861 and 1890. The next largest recorded floods occurred in December 1945 (74,200 cfs), and March 1931 (70,000 cfs).

Flood discharges from the South Santiam River are now substantially reduced by the existing Green Peter and Foster storage projects. Due to the flood reduction effects of these reservoirs, the previously established recurrence intervals of the above mentioned floods are no longer applicable. For example, the December 1964 storm event occurring today would produce a peak discharge of 37,000 cfs (Reference 11).

Simultaneous flooding often results on both Thomas Creek and Peters Ditch. In December 1964, however, intense rainfall combined with rapid snowmelt to produce a peak discharge of 27,400 cfs at the Thomas Creek stream gage near Scio. All of Scio was flooded. Depths were generally shallow, but they reached 3 feet in a few areas near Thomas Creek. Scio was flooded again in January 1972 when Thomas Creek reached a peak discharge of 20,200 cfs at the stream gage. A logjam destroyed Swindler Bridge, 4 miles upstream of Scio. The return intervals for the 1964 and 1972 floods were approximately 200 years and 50 years. During both floods Thomas Creek overflowed into Peters Ditch increasing the flow in the ditch.

Ames Creek has flooded numerous times, including December 1964, April 1966, and January 1974. The most serious flood problems occur within the City of Sweet Home, in the vicinity of 12th and 14th Avenues and upstream of Mountain View Road, because of debris accumulations at bridges. Debris accumulations in the creek channel at 12th and 14th Avenues have also caused shallow flooding in this vicinity.

Flooding has occurred along Taylor Creek in the City of Sweet Home when flows have exceeded the capacity of the culverts along 10th Avenue. This flooding has caused little damage, as it generally inundates only 10th Avenue and the adjacent yards.

In the vicinity of Sweet Home, Wiley Creek has flooded low areas downstream of the U.S. Highway 20 bridge, but damage has been slight because of the lack of development in the floodplain.

The unincorporated areas of the county are nearly all agricultural lands or timberlands. Flood damage in those areas would be limited to farm crops, farm buildings and residences, and erosion of croplands. Very little development in the floodplain has occurred in the unincorporated areas. Flood damage, therefore, is minimal.

2.4 Flood Protection Measures

Approximately 50 percent of the Willamette River drainage area above Albany is controlled by eight flood-storage projects. These projects are Cougar, Blue River, Fern Ridge, Dorena, Cottage Grove, Hills Creek, Lookout Point, and Fall Creek. The eight reservoir projects control the runoff from 2,115 square miles of the 4,840 square miles of drainage area on the Willamette River upstream of Albany with 1,100,000 acre-feet of flood-control storage. The reduction during the December 1964 flood was from an estimated natural flow of 320,000 cfs to an observed 186,000 cfs at the Albany gaging station with an estimated stage reduction of 6.3 feet. The estimated flow-stage reductions for the 1- and 0.2-percent annual chance floods at Albany are 135,000 cfs/5.9 feet and 160,000 cfs/6.3 feet, respectively (Reference 12).

Seven of the eight multiple-purpose storage projects on the Willamette River tributaries listed above are located upstream of the City of Harrisburg. It is estimated that had the present system been in operation, the 1945 flood peak at Harrisburg could have been reduced from the observed 210,000 cfs to 100,000 cfs, the 1948 peak from 163,000 cfs to 75,000 cfs, and the 1953 peak from 149,000 cfs to 70,000 cfs. With five of the seven storage projects in operation during the 1964 flood, the peak discharge was reduced from an estimated natural peak of more than 250,000 cfs to the observed peak of 125,000 cfs.

Fifty-two percent of the runoff from the drainage area of the Santiam River upstream of Jefferson, Oregon, is controlled by three multipurpose projects: Green Peter, Foster, and Detroit. Those projects control the runoff from 932 square miles of the 1,790 square miles of drainage area on the Santiam River basin upstream of Jefferson, Oregon. The combination of these multipurpose projects reduce the 1-percent annual chance flood from an estimated natural 245,000 cfs on the Santiam River at Jefferson, Oregon, to 160,000 cfs. The estimated stage reduction for the 1-percent annual chance flood is 2.6 feet at Jefferson. The estimated discharge/stage reduction for the 0.2-percent annual chance flood is 90,000 cfs/2.1 feet at Jefferson (Reference 12).

The Green Peter and Foster projects provide 270,000 acre-feet of flood-control storage in the South Santiam River drainage basin. These projects reduce a 1-percent annual chance flood from an estimated natural (unregulated) 103,000 cfs on the South Santiam River at Waterloo, Oregon, to 44,000 cfs. The estimated stage reduction for the 1-percent annual chance flood is 9.2 feet at Waterloo. The estimated discharge/stage reduction for the 0.2-percent annual chance flood is 48,000 cfs/5.6 feet at Waterloo (Reference 12). In the City of Lebanon, the likelihood of flooding along the Lebanon-Santiam Canal have substantially lessened as a result of these projects.

The Detroit multiple-purpose storage project on the North Santiam River is located upstream of the Cities of Lyons and Mill City. Detroit Reservoir became operational in 1953 and provides 300,000 acre-feet of flood control storage. It has reduced the expected 100-year flood peak at Mehama gage from 115,000 to 52,000 cfs.

Numerous bank stabilization projects are located on the Willamette, Santiam, North Santiam, South Santiam, and Calapooia Rivers, and Thomas Creek. Those revetments aid in the control of floodwaters by routing floodwaters more efficiently and by protecting eroding banks in flood-prone areas.

Approximately 4 miles downstream of Brownsville, Sodom Ditch, a bypass channel, diverts a major portion of flow from the Calapooia River during periods of high flow to alleviate flooding. Flow into Sodom Ditch is controlled by a concrete diversion structure near the entrance to the channel.

Periwinkle Creek has been improved upstream of Pacific Boulevard (in Albany) to Interstate Highway 5 through a U.S. Soil Conservation Service channelization project which was designed to carry 1-percent annual chance flood flows (Reference 13).

Parts of Truax and Burkhart Creeks downstream of Scravel Hill Road, and the Burkhart-Truax Diversion Channel have undergone channel improvements. Most of the Cox Creek channel downstream of State Highway 20, including the 2-mile reach from Interstate Highway 5 upstream to Tallman Road has had channelization project improvements (Reference 14). The channelization projects were designed to contain 1-percent annual chance discharges.

Waverly Lake and Swan Lake are two artificial lakes in the Cox Creek detailed study reach that were originally excavated as a materials source by the Oregon Department of Transportation (ODOT) for interstate freeway construction. The two lakes have minimal storage capacity, and both ODOT and the USACE have concluded that these impoundments provide no flood control for the 10-, 2-, 1-, and 0.2-percent annual chance floods on Cox Creek.

Lebanon has a continuing program of channel improvement and maintenance along Cox Creek. Past improvements have included channel clearing and the increase of culvert capacities. Due to these improvements, the effect of 1-percent annual chance flooding on Cox Creek has been reduced to the extent that flood waters will be completely confined to the channel within the limited detailed study area.

River forecasting for the streams in Linn County is the responsibility of the National Oceanic and Atmospheric Administration, National Weather Service, Portland River Forecast Center. River stage forecasts and flood warnings are issued by the Portland River Forecast Center, River District Office, and are available during the flood season (October through March) for Willamette River at Albany. Weather forecasts are storm warnings for the study area are prepared and disseminated by the Portland Weather Service Forecast Office, located at Portland International Airport.

The floodplain along South Santiam River between Clark Mill Road and 18th Avenue, as shown in a USACE report (Reference 15), has been zoned as an open land-use area where new development is prohibited.

There are no flood control structures on Ames Creek, Burkhart Creek, the Calapooia River, Cox Creek, Peters Ditch, Taylor Creek, Thomas Creek, Truax Creek, and Wiley Creek.

The Cities of Albany, Brownsville, Harrisburg, Lyons, Mill City, Millersburg, Scio, Sweet Home, Tangent, and Waterloo, and Linn County participate in the National Flood Insurance Program and each have a floodplain ordinance approved by FEMA for controlling development in flood hazard areas.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

Stream gage records for the Willamette River were statistically analyzed utilizing the standard log-Person Type III distribution as outlines by the U.S. Water Resources

Council (Reference 16). Natural discharge-frequency curves were developed for the USGS gaging on the Willamette River at Albany (gage No. 14174000) from 1893 to 1976 and at Harrisburg (gage No. 14166000). Regulated discharge-frequency curves were then prepared using USACE flood-routing computations to take into account upstream storage projects. The regulated discharge-frequency curve was then used to obtain discharge values for the selected recurrence intervals used in this FIS.

Calapooia River stream gage records were statistically analyzed utilizing the standard log-Pearson Type III distribution (Reference 16). Discharge-frequency curves were developed for the USGS gages on the Calapooia River at Albany (gage No. 14173500) and at Holley (gage No. 14172000), utilizing data from 1936-1977 and 1941-1977, respectively. The discharges calculated at the gage near Albany, however, were higher than expected. More representative discharges were obtained when graphical techniques were applied to the gage and were, therefore, used for this study.

Stream gage records for the Santiam, North Santiam, and South Santiam Rivers were statistically analyzed utilizing the standard log-Pearson Type III distribution as outlined by the U.S. Water Resources Council (Reference 16) to determine peak discharges in the study area. Natural discharge-frequency curves were developed for the USGS gages on the Santiam River at Jefferson (gage No. 14189000), on the North Santiam River at Mehama (gage No. 14283000), and on the South Santiam River at Waterloo (gage No. 14187500) using data from 1924 to 1965. A regulated discharge-frequency curve for each of the locations was then prepared using existing USACE flood-routing computations to take upstream storage projects into account. The regulated discharge-frequency curves were then used to obtain discharge values for the selected recurrence intervals used in this study.

The regulated discharge-frequency curves (References 17 and 18) for the North Santiam River at Mehama, (gage No. 14183000), and Detroit project were used to determine discharges for the City of Lyons. The discharge-frequency curve for Little North Santiam River (gage No. 14182500) (Reference 19), was also used to compute discharges considered in the hydrologic analyses. Two hydrologic conditions were analyzed to determine North Santiam River peak flows for the City of Lyons study area. The first condition was used downstream of the confluence with the Little North Santiam River. For that condition, peak North Santiam River flows occur from the Little North Santiam River peak discharges plus simultaneous contributions from Detroit project regulated discharges and local inflow between the dam and the study area. The second condition was used for areas located upstream of the Little North Santiam River. North Santiam River discharges for that portion of the study reach would peak after the storm subsided. At that time, the Detroit project would increase outflow discharges to lower its reservoir.

The North Santiam River flows at Mill City study area were adjusted for the change in flows between Detroit Dam and the study area based on a log-Pearson Type III frequency analysis of inflow per square mile (Reference 16).

Stream gage records for Thomas Creek were statistically analyzed using standard log-Pearson Type III analysis and two-station corrections, as outlined by the U.S. Water Resources Council (Reference 16). A discharge-frequency curve was developed for the USGS gage on Thomas Creek, located approximately 4 miles east of Scio (gage No. 14188800) using data from 1963 to 1977. That discharge-frequency curve was adjusted by correlation with the USGS gage on the Little North Santiam River (gage No.

14182500) for the period of 1932 to 1977. The adjusted discharge-frequency curve is the basis for discharge values for the selected recurrence intervals used in this study.

Flooding in the vicinity of the City of Scio is complicated by its flat terrain and the fact that significant amounts of flood flow leave Thomas Creek upstream of Scio and flow away from the main floodwaters around the north and south sides of the city and return downstream to Thomas Creek. Thomas Creek discharges were adjusted to represent, as accurately as possible, the complicated and unpredictable flow patterns around Scio.

There are no streamflow gages on Ames Creek, Cox Creek, North Lake Creek, Oak Creek, Peters Ditch, and Truax Creek. Peak discharge-frequency estimates for selected recurrence intervals for these streams were derived using the procedure outlined by the USACE in Procedures for Determination of Maximum Annual Flood Peak and Volume Frequencies for Portland District, February 1969 (Reference 20) This is a regional procedure using multiple-regression analysis to determine discharges of an ungaged basin for selected recurrence intervals using the drainage area and normal annual precipitation.

Flow frequencies for Cox Creek in the City of Albany were based on statistical analysis of a USGS crest gage (No. 14174100) using data from 1953 to 1968. The data were analyzed in accordance with criteria outlines in Bulletin No. 17B (Reference 21).

Local officials indicate that Cox Creek flooding may have been accentuated in December 1964 by interbasin flooding from the South Santiam River. In particular, the collapse of the cofferdam at Green Peter dam site accentuated flooding in Lebanon, and sent water northwest into Albany. Review of topographic maps, however, indicates that Burkhart Creek and possibly Truax Creek may have intercepted this interbasin flood flow. In addition, the USGS crest gage for Cox Creek measured only a peak flow of 1,070 cfs for the December 1964 flood (a 25-year recurrence interval flood). This is only slightly larger than a peak flow of 985 cfs (a 20-year recurrence interval flood) that was measured in 1961 for a flood that included no interbasin flooding. Completion of the Green Peter and Foster projects in 1966 have significantly reduced downstream flood elevations in the South Santiam River, and have minimized this possible threat of interbasin flooding.

Approximate 100-year flood discharges were developed for Taylor and Wiley Creeks. Stream gage records for Wiley Creek near Sweet Home (USGS gage No. 14187100), from 1948 to 1973, were statistically analyzed to determine the discharge. The regional procedure (Reference 20) was used on Taylor Creek.

Discharges for the Burkhart Creek approximate study was not determined because the flood-prone areas for this stream was previously determined by the U.S. Soil Conservation Service (Reference 22).

Peak discharge-drainage area relationships for each stream studied in detail are shown in Table 6, “Summary of Discharges”.

Table 6. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
Ames Creek					
At mouth	11	1,150	1,820	2,125	2,800
Calapooia River					
At Albany	372	26,500	33,800	35,500	38,500
At Brownsville Bridge	153	15,000	20,000	22,000	26,300
At Holley	105	10,300	14,700	16,600	21,300
Calapooia River Split Flow					
At Confluence with Oak Creek	--[1]	--[1]	--[1]	4,900	--[1]
Cox Creek					
Near Albany	10.3	900	1,220	1,360	1,690
At Tangent Street	1.4	87	--[1]	141	--[1]
North Lake Creek					
At Mouth	2.2	135	190	220	280
Oak Creek					
At Mouth	47	3,750	3,950	4,450	5,700
At Lebanon	17	900	1,285	1,460	1,875
Peters Ditch					
At Mouth	4	670	930	1,050	1,300
Richardson Gap Road	1.9	320	435	490	620
Santiam River					
At Jefferson	1,790	89,500	134,000	158,000	231,000
North Santiam River					
At Confluence with Santiam River	736	33,000	48,000	57,000	100,000
At Mehama	665	29,000	41,000	48,000	72,000
At Mehama	665	28,000	43,000	52,000	93,000
Upstream of Little North Santiam River	553	15,500	24,800	32,250	58,200

[1] Data Not Available

Table 6. Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
North Santiam River (continued)					
At Mill City	524	13,200	18,900	24,700	44,300
South Santiam River					
At Lebanon Highway Bridge	690	25,000	40,500	51,000	87,500
At Waterloo	640	21,500	34,000	44,000	84,000
At Foster Project	494	18,500	23,500	30,000	50,000
Thomas Creek					
At Gage Near Scio	109	14,050	20,900	24,000	31,900
Truax Creek					
At Mouth	8	470	670	760	980
Willamette River					
At Albany (USGS Gage # 14174000)	4,840	117,000	172,000	200,000	272,000
At Harrisburg	3,420	81,000	107,000	123,000	182,000

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in this FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Water-surface profiles for the portion of the Willamette River within Linn County, except for the reach at Albany, were determined from hydraulic rating curves. Those curves were based on crest gages established in 1964 and high-water marks recorded at the crest gages. High-water marks for the January 1943 flood were used to complete the profile determination. The remaining reach of the Willamette River through Albany was analyzed using the USACE HEC-2 step-backwater computer program (Reference 23).

The detailed-study reaches of the Santiam and North Santiam Rivers upstream of I-5 were also analyzed using the HEC-2 step-backwater program. Those study reaches, except for a small Segment near the City of Lyons, used data previously prepared for the Marion County Flood Insurance Study (Reference 24). The North Santiam River detailed-study reach near Lyons was analyzed by the USACE for this study.

The Calapooia River hydraulic analysis was performed using the USACE HEC-2 step-backwater computer program (Reference 23). The Calapooia River hydraulic model and 1-percent annual chance (100-year) water-surface profile were originally prepared for the Albany Flood Plain Information report (Reference 25) and Brownsville Flood Plain Information report (Reference 26). The Albany study reach cross section data are a combination of 1962 and 1978 field surveys and elevations from topographic maps (Reference 27) Cross section data for the Brownsville reach is a combination of 1973 field surveys and 1972 aerial surveys for the Brownsville Flood Plain Information report (Reference 25). The channel portion of each section was field surveyed and the overbank portions were obtained photogrammetrically. All bridges, dams, and culvers were field checked to obtain elevation data and structural geometry. Additionally, the Calapooia River from upstream of Highway 99E to approximately 2 miles downstream of Brownsville was studied using crest-stage gage records to compute rating curves for flood profile determination.

Hydraulic analyses for the remaining streams studied in detail were performed using the UASCE HEC-2 step-backwater computer program (Reference 23). Cross section data used in the program were obtained from a number of sources. Cross sections are composites of data from USACE field surveys, city topographic maps, and USGS topographic information. Cross section data for the South Santiam River were obtained from the USACE who originally surveyed the area for the Lebanon Flood Plain Information report (Reference 28) and the Sweet Home Flood Plain Information report (Reference 14). North Lake Creek cross section data are from 1976 field surveys. Cross section data for Thomas Creek and Peters Ditch are a combination of 1978 field and aerial surveys. The channel portion of each cross section was field surveyed and the overbank portions were obtained from orthophoto topographic maps (Reference 28). Cross sections of remaining detailed study reaches not listed above were surveyed by the

USACE in November 1978 through February 1979. The underwater portions of Willamette River cross sections were taken from conditional surveys. The above-water portions of cross sections for the Santiam River and the North Santiam River near Stayton were taken by digitizing ground elevations from aerial photographs. The remainder of the North Santiam River above-water cross sections were taken using field-surveying methods. All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Insurance Rate Map.

Hydraulic roughness values (Manning's "n") for the channel and overbanks were first estimated from field observation. The "n" values were then adjusted to match high-water marks where available. The "n" values are shown in Table 7 for all streams studied in detailed using the HEC-2 computer model.

Table 7. Range of Manning's Roughness Values

Flood Source	Main Channel	Overbank
Ames Creek	0.050-0.100	0.060-0.100
Calapooia River	0.037-0.055	0.060-0.160
Calapooia River Split Flow	0.070	0.120-0.200
Cox Creek	0.035-0.085	0.065-0.120
North Lake Creek	0.050	0.060-0.080
Oak Creek	0.045-0.062	0.040-0.095
Peters Ditch	0.045-0.050	0.075-0.120
Santiam River	0.032-0.035	0.045-0.070
North Santiam River	0.030-0.060	0.075-0.200
South Santiam River	0.030-0.040	0.050-0.110
Thomas Creek	0.030-0.055	0.069-0.150
Truax Creek	0.050-0.070	0.060-0.200
Willamette River	0.025-0.045	0.041-0.250

For all streams studied using the HEC-2 backwater program, starting water-surface elevations were obtained by normal-depth analysis. Flood profiles were drawn showing computed water-surface elevations for floods of selected recurrence intervals.

The starting water-surface elevations for the Santiam and North Santiam Rivers were determined from flood profiles (Reference 9) and normal-depth analysis. The profiles match within 0.5 foot the stage-discharge curve (Reference 30) for the USGS gaging station at Jefferson. High-water marks and crest-stage data were available for this reach, but changed conditions and difficulty in precisely locating the measurements made matching within less than 1 foot impractical.

The starting water-surface elevations for the North Santiam River at Stayton were determined by normal-depth analysis. Several cross sections were included downstream of the start of the detailed study to dissipate any errors in the starting elevations. High-water marks for the North Santiam River floods of 1945 and 1964, available from the

USACE, Portland District, could be used for only approximately calibrating the profiles because of changed conditions.

The starting water-surface elevations for the North Santiam River at the City of Lyons were obtained from a hydraulic analysis performed for the Linn County Flood Insurance Study (Reference 11). Flood profiles were calibrated to the Mehama gage rating curve and were drawn to reflect the highest computed water-surface elevations of the two hydrologic conditions.

The starting water-surface elevations for the North Santiam River at Mill City and Gates were determined by flood profiles (Reference 9) and normal-depth analysis.

The starting water-surface elevation for the North Santiam River at Idanha was the maximum pool elevation for the reservoir behind Detroit Dam. The profiles match within 0.5 foot of the stage-discharge curve for the USGS gaging station at Idanha (Reference 31).

Channel cross sections for Cox Creek were field surveyed and a planametric topographic map was provided by the City of Albany. The Cox Creek topographic map, dated 1975, has a scale of 1 inch equal to 100 feet and a contour interval of 2 feet (Reference 32). Cross sections of the channel and overbank areas were determined by a combination of field survey and photogrammetry methods. Field surveys were taken of the channel area and at least 50 feet to each side of the channel. Those field surveys were conducted in April 1987. All bridges, culverts, and weir structures were surveyed to obtain elevation data and structural geometry.

The hydraulic analysis for Cox Creek was slightly complicated by the presence of three weir structures along the study reach. The first weir structure is located at RM 0.39, and is adjacent to the Teledyne Wah Chang Research Facility. It is a low-head weir structure that measures about 5 feet vertically from streambed to spillway crest, and forms a 200-foot long impoundment. The second structure is located at the Salem Avenue Bridge (RM 0.59), and forms the Waverly Lake impoundment. A USGS crest gage operated at this weir structure during the period 1953 through 1968. A rating curve is no longer available from the USGS, but USGS-measured weir coefficients are still available for this hydraulic structure. The measured weir coefficients were used to develop a rating curve for this weir structure for input into the HEC-2 computer model. The third weir structure is located upstream at RM 0.89 and forms the Swan Lake impoundment. A rating curve is no longer available for the Swan Lake weir structure, but USGS-measured weir coefficients are also available for this weir structure. Again, the measured weir coefficients were used to develop a rating curve for input into the HEC-2 computer model.

For the downstream segments of Oak Creek and Calapooia River Split Flow, where elevations are influenced by the Calapooia River, no profiles are shown. For the downstream segment of the Calapooia River, where elevations are influenced by the Willamette River, no profiles are shown.

The 100-year split-flow flooding from the Calapooia River breaks out between Belmont and 53rd Avenues and flows into Oak Creek west of Pacific Boulevard before returning to the Calapooia River.

The stationing of cross sections and physical features on the South Santiam River, as shown on the flood profiles, is based on previously established river miles. Because a river mile is not necessarily equal to a statute mile, stream distances will not always agree between maps and profiles.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Approximate-study reaches were evaluated using existing topography, accounts of past flooding, post-flood aerial photography, approximate hydraulic calculations, field inspections, and engineering judgment.

Because of difficulties in determining contributing drainage areas, overflows between basins, and channel controls throughout the watersheds, no discharges were calculated for Muddy Creek, Camous Creek, and Lake Creek at Harrisburg.

For Crabtree Creek, the USGS stream gage rating curve was analyzed and an estimated 1-percent annual chance flood profile was prepared (based on low-water elevations taken from the USGS topographic maps and flood stages estimated at multiple location correlated to the flood stage of the gage). Those estimated flood elevations were transferred to the topographic map, and flooded areas were prepared based on these elevations and refined based on post-flood aerial photographs, dated April 1961, March 1964, February 1965, and August 1966.

A similar procedure was used for the other approximate-study areas with some modification; that is, no flood profiles were estimated. For Thomas and Oak Creeks, the flooded-area delineations in the detailed-study reaches were used to start and extend the flooded areas into the approximate-study reaches, and post-flood aerial photographs were used to refine those flooded areas.

For that portion of Cox Creek studied by approximate methods, the boundary of the 1-percent annual chance flood as prepared from information furnished by the City of Lebanon, local residents, and field observations. The approximate flood limits along Lebanon-Santiam Canal were obtained from the Lebanon Flood Plain Information report (Reference 28).

Floodwaters from Karks Slough, located northeast of Lebanon, originate from the main channel of the South Santiam River outside of the Lebanon corporate limits and return to the main channel farther downstream. Elevations in the area of Marks Slough were interpolated from a topographic map assuming a uniform gradient (Reference 33).

The floodplain south of State Highway 228 and between Linn Way and Ash Street north of the Calapooia River is subject to 1-percent annual chance shallow flooding with depths of less than 1 foot. Floodwater from the Calapooia River overtops the highway to the south and the railroad to the north and spreads out in a thin sheet along an indeterminate flow path.

A zone of shallow 1-percent annual chance flooding resulting from overflow from Ames Creek, bounded approximately by the Burlington Northern Railroad to the north and by

15th Avenue to the east, was determined from historic flood records and interviews with local residents.

Slope-area and culvert-flow calculations were made to estimate the extent of flooding for the approximate study areas.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRMs are referenced to NAVD 88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the NGVD and the NAVD, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
(301) 713-4172 (fax)

The conversion factor from NGVD 29 to NAVD 88 for all flooding sources in Linn County is +3.38 feet.

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and the FIRMs for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description and/or location information for benchmarks shown on the FIRMs, please contact information services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent annual-chance floodplain data, which may include a combination of the following: 10-, 2-,1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains; and 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section.

Floodplain boundaries were interpolated between cross sections using topographic maps at scales of 1:24,000 (Reference 33), 1:4,800 (Reference 34), and 1:4,800 and 1:6,000 (Reference 35), with contour intervals of 5 and 10 feet.

For portions of the South Santiam River near Lebanon, the 1- and 0.2-percent annual chance floodplain boundaries were taken from areport prepared by the USACE (Reference 28).

Within the City of Albany, the floodplain boundaries were interpolated between cross sections using topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (Reference 36). This information was then transferred to topographic maps enlarged to a scale of 1:4,800, with a contour interval of 5 feet (Reference 33). Planametric topographic maps at a scale of 1:1,200 with a contour interval of 2 feet were used to show the flooding on Cox Creek (Reference 32).

The 1-percent-annual-chance floodplain boundaries along the Willamette River, from approximately 5.5 miles downstream of the confluence of the Calapooia River to approximately 1.5 miles upstream of the confluence with the Calapooia River were revised to incorporate more detailed topographic information on July 7, 1999. In addition, a portion of the unincorporated areas of Benton County was annexed by the City of Albany in 1991. Topographic maps at a scale of 1:1,200 (Reference 37) were used to produce the revised 1- and 0.2-percent annual chance floodplain boundary delineations.

For each stream studied in detail within the City of Harrisburg, the boundaries of the 1- and 0.2-percent annual chance floods have been delineated using the flood elevations obtained from stage-discharge curves, as discussed in Section 3.2, and topographic maps at a scale of 1:1,200, with a contour interval of 2 feet (Reference 38).

Floodplain boundaries for the North Santiam River at Lyons were interpolated between cross sections, the boundaries were interpolated using topographic maps at an approximate scale of 1:63,360, with a contour interval of 40 feet (Reference 39), stereo-photos enlarged to a scale of 1:12,000 (Reference 40), and City of Lyons Storm Drainage Plan (Reference 7).

Floodplain boundaries for the North Santiam River near Mill City were interpolated between cross sections, the boundaries were interpolated using stereophotos at a scale of 1:12,000 (Reference 41).

In the vicinity of Scio, floodplain boundaries were interpolated between cross sections using orthophoto topographic maps at a scale of 1:4,800, with a contour interval of 5 feet (Reference 28).

In the City of Sweet Home, the floodplain boundaries were interpolated between cross sections using orthophoto topographic maps at a scale of 1:6,000, with a contour interval of 5 feet (Reference 41), for South Santiam River, and using a topographic map at a scale of 1:2,400, with a contour interval of 2 feet for Ames Creek (Reference 42),.

Portions of the approximate 1-percent annual chance floodplain boundaries were extracted from floodplain mapping published by the U.S. Soil Conservation Service (Reference 22). The approximate 100-year floodplain boundaries were delineated using available USGS topographic information and post flood photographs.

In the City of Lebanon, the approximate 1-percent annual chance flood boundaries were delineated using a topographic map at a scale of 1:24,000 with a contour interval of 10 feet, in conjunction with previously determined elevations (Reference 33).

In the vicinity of Harrisburg, areas studied by approximate 1-percent annual chance floodplain boundaries were delineated using information furnished by the City of Harrisburg, the Linn County Planning Department, and the U.S. Soil Conservation Service, as well as by field observations. The approximate 100-year flood boundaries were delineated on the same maps that were used for the detailed flood boundaries (Reference 38).

In the vicinity of Scio, flood boundaries in shallow flooding areas were based on estimated depth and delineated on orthophoto topographic maps (Reference 29). Approximate 100-year floodplain boundaries were delineated using the same mapping.

In the City of Sweet Home, areas of shallow 1-percent annual chance flooding adjacent to Ames Creek and for the approximate studies of the South Santiam River, Taylor Creek, and Wiley Creek, the 100-year flood boundaries were prepared from information furnished by the City of Sweet Home, local residents, aerial photographs, and field observations, and by using the methods described in Section 3.2. These boundaries were delineated on the topographic maps (Reference 43) for the area of shallow flooding and for Taylor Creek, and were delineated on the orthophoto topographic maps (Reference 42) for the South Santiam River and Wiley Creek.

Approximate flood boundaries for Foster Reservoir were taken from the Flood Hazard Boundary Map (Reference 4).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the Flood Insurance Rate Map. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, and AO), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the Flood Insurance Rate Map (FIRM).

Countywide Update

The initial countywide FIS update was completed in September 29, 2010 by WEST Consultants, Inc. for FEMA under Contract No. EMS-2001-CO-0068.

This update combined the Flood Insurance Rate Maps and Flood Insurance Study reports for Linn County and incorporated communities into the countywide format. Under the countywide format, FIRM panels were produced using a single layout format for the entire area within the county, instead of separate layout formats for each community. The single-layout format facilitates the matching of adjacent panels and depicts the flood-hazard area within the entire panel border, even in areas beyond a community's corporate boundary line. In addition, under the countywide format a single FIS report provides all associated information and data for the entire county area.

As part of the countywide update the format of the map panels were changed. Previously, flood-hazard information was shown on both FIRMs and Flood Boundary and Floodway Maps (FBFMs). In the new format, all base flood elevations, cross sections, zone designations, and floodplain and floodway boundary delineations are shown on the FIRM; the FBFM has been eliminated. Some of the flood insurance zone designations were changed to reflect the new format. Areas previously shown as numbered Zone A were changed to Zone AE. Areas previously shown as Zone B were changed to Zone X (shaded). Areas previously shown as Zone C were changed to Zone X (unshaded). In addition, all Flood Insurance Zone Data Tables were removed from the

All flood elevations shown in this FIS report and on the FIRM panels were converted from NGVD 29 to NAVD 88. The conversion factor is +3.38 feet.

The floodplain boundaries of the detailed study areas were revised with new topographic mapping ; Oak Creek, Calapooia River, and Willamette River with contour interval of 2 feet and 5 feet (References 45 and 46), North Santiam River with contour interval of 2 feet and 5 feet (References 46 and 47), Cox Creek and Truax Creek with a contour interval of 2 feet (Reference 45), North Lake Creek and Santiam River, and with a contour interval of 5 feet (Reference 46), and Ames Creek with a contour interval of 2 feet (Reference 48).

Approximately 21 miles of the South Santiam River floodplain boundaries, from River Mile 14.57 to River Mile 35.78, were revised using topographic mapping with a contour interval of 2 feet and 5 feet (References 46, 48, and 49).

The remaining floodplain boundaries were digitized from the effective FIRM and Floodway panels. Where new topographic mapping was available, approximate Zone A areas were refined with a contour interval of 2 feet and 5 feet (References 45, 46, 48, and 49). Where applicable, the contour data was used to adjust the flood hazard areas to more accurately match the topography. In addition, aerial photography was used to adjust floodplain boundaries where appropriate (Reference 50).

LOMR 06-10-B494P, a Willamette River BFE correction within the City of Albany, has been incorporated into the FIRM.

In accordance with FEMA Procedure Memorandum 36 (Reference 51), profile baselines have been included in all areas of detailed study. Profile baselines are shown in the location of the original stream centerline or original profile baseline without regard to the adjusted floodplain position on the new base map. This was done to maintain the relationship of distances between cross sections along the profile baseline.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies. The results of the floodway computations at selected stream cross sections are shown Table 8, “Floodway Data”.

The floodways presented in this study were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections. In cases where the floodway and 1-percent-annual chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.
The computation of floodways was not within the scope of this study for the following areas studied in detail: Calapooia River between Tangent and Brownsville; Calapooia River upstream of Brownsville Diversion Dam; North Santiam River at Lyons; Oak Creek at Lebanon; South Santiam River; Thomas Creek and Peters Ditch at Scio; and Willamette River, except in the vicinity of Albany and Millersburg.

A floodway was determined for the Willamette River from River Mile 159.7 to River Mile 160.4 along the east bank only. Discharges were determined by normal depth calculations for the main channel and the east overbank for two cross sections. Encroachment stations were determined by assuming that all discharge elimination from the east overbank would flow in the main channel and not in the west overbank. As agreed between the study contractor and FEMA, no floodway was determined upstream of River mile 160.4 because most of the flow is this area is conveyed within the channel banks.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.

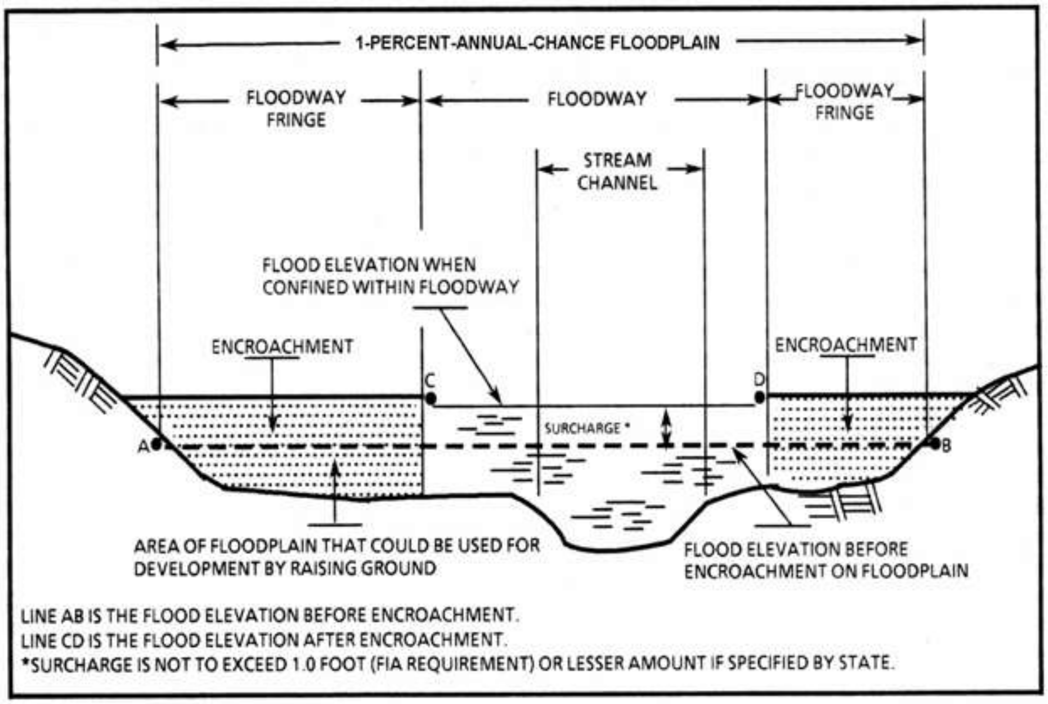

Figure 1. Floodway Schematic

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Ames Creek								
A	0.141	74	545	3.9	512.0	512.0	512.3	0.3
B	0.160	46	261	8.1	512.0	512.0	512.3	0.3
C	0.200	44	229	9.3	513.5	513.5	514.3	0.8
D	0.290	69	372	5.7	520.4	520.4	521.4	1.0
E	0.320	65	312	6.8	523.2	523.2	523.7	0.5
F	0.331	28	186	11.4	524.3	524.3	524.4	0.1
G	0.380	85	545	3.9	529.9	529.9	529.9	0.0
H	0.431	20	214	9.9	529.9	529.9	530.9	1.0
I	0.460	80	430	4.9	533.8	533.8	534.0	0.2
J	0.530	96	496	4.3	535.5	535.5	536.3	0.8
K	0.585	97	574	3.7	537.0	537.0	537.8	0.8
L	0.650	48	246	8.6	539.8	539.8	540.5	0.7
M	0.675	46	244	8.7	543.1	543.1	543.5	0.4
N	0.740	60	490	4.3	545.7	545.7	546.1	0.4
O	0.810	52	410	5.2	546.2	546.2	547.0	0.8
P	0.827	24	206	10.3	546.4	546.4	546.9	0.5
Q	0.865	59	530	4.0	548.7	548.7	549.3	0.6
R	0.895	148	1,637	1.3	554.0	554.0	554.9	0.9
S	0.917	160	1,011	2.1	554.0	554.0	554.9	0.9
T	1.072	81	546	3.9	554.5	554.5	555.3	0.8
U	1.153	58	400	5.3	555.9	555.9	556.6	0.7
V	1.270	39	316	6.7	559.1	559.1	559.9	0.8
W	1.393	32	253	8.4	562.3	562.3	563.3	1.0
X	1.427	80	541	3.9	564.3	564.3	564.6	0.3
Y	1.600	79	421	5.0	566.2	566.2	567.1	0.9
Z	1.80	85	513	4.1	571.3	571.3	572.0	0.7
AA	1.94	103	385	5.5	574.9	574.9	575.5	0.6

[1] Miles above mouth

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR AND INCORPORATED AREAS

FLOODWAY DATA

AMES CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Calapooia River								
A	2.35	2,245	15,543	2.3	208.1	204.5[2]	205.2	0.7
B	2.68	1,151	13,930	2.5	208.3	205.5[2]	206.3	0.8
C	2.84	1,172	4,414	8.0	208.4	205.7[2]	206.5	0.8
D	3.23	1,335	16,668	2.1	209.1	209.1	209.7	0.6
E	4.36	690	6,809	4.2	212.4	212.4	213.0	0.6
F	4.79	750	6,675	4.3	214.0	214.0	214.6	0.6
G	5.41	1000	10,915	2.6	216.3	216.3	216.9	0.6
H	5.88	1,800	17,453	1.6	217.0	217.0	217.6	0.6
I	6.28	1,950	11,350	2.9	217.7	217.7	218.3	0.6
J	7.28	2,286	11,776	2.8	221.8	221.8	222.4	0.6
K	7.69	2,444	19,559	1.7	222.8	222.8	223.5	0.7
L	8.26	2,828	20,645	1.6	223.7	223.7	224.5	0.8
M	8.74	2,200	11,080	3.0	225.1	225.1	225.7	0.6
N	9.13	1,800	11,971	2.7	227.1	227.1	227.6	0.5
O	9.75	1,300	11,867	2.7	229.1	229.1	229.9	0.8
P	9.95	326	3,962	8.2	229.5	229.5	230.4	0.9
Q-AA[3]								

[1] Miles above mouth [2]Elevation computed without consideration of influence from Willamette River [3]No floodway computed for these cross sections

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

CALAPOOIA RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Calapooia River (Con't)								
AB	32.13	530	4,468	4.9	312.4	312.4	312.8	0.4
AC	32.50	1,013	8,122	2.7	314.2	314.2	314.6	0.4
AD	33.22	329	1,974	11.2	318.4	318.4	318.4	0.0
AE	33.80	1,028	6,474	3.4	328.2	328.2	329.1	0.9
AF	34.05	750	3,109	7.1	330.2	330.2	331.1	0.9
AG	34.12	747	4,176	5.3	333.3	333.3	333.5	0.2
AH	34.42	761	5,609	3.9	335.3	335.3	336.2	0.9
AI	34.67	689	3,791	5.8	336.7	336.7	337.5	0.8
AJ	34.86	517	4,936	4.5	339.5	339.5	340.5	1.0
AK	35.13	553	4,770	4.6	340.7	340.7	341.7	1.0
AL	35.62	388	2,411	9.1	345.4	345.4	345.6	0.2
AM	36.13	555	4,382	5.0	355.0	355.0	355.4	0.4
AN	36.73	483	3,046	7.1	363.0	363.0	363.3	0.3
AO	37.36	670	3,792	5.7	374.7	374.7	374.8	0.1
AP	37.72	759	3,122	6.9	381.0	381.0	381.7	0.7
AQ	38.25	827	4,181	5.1	387.9	387.9	388.3	0.4
AR-BN[2]								

[1] Miles above mouth [2]No floodway computed for these cross sections

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

CALAPOOIA RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Calapooia River Split Flow								
A	0.88	600	4,013	1.7	211.4	210.6[2]	211.4[2]	0.8
B	1.49	632	3,159	1.6	212.7	212.7	213.5	0.8
C	1.62	472	3,512	1.4	214.2	214.2	214.9	0.7
D	1.73	649	3,151	1.4	215.6	215.6	216.3	0.7
E	1.79	796	5,674	0.9	216.3	216.3	217.0	0.7
F	2.06	1,638	10,148	0.5	216.7	216.7	217.4	0.7
G	2.38	1,424	7,282	0.7	217.3	217.3	217.9	0.6

[1] Miles above confluence with Calapooia River [2]Elevation computed without consideration of influence from Calapooia River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

CALAPOOIA RIVER SPLIT FLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Cox Creek								
A	50	30	253	5.4	202.8	178.0[2]	178.0	0.0
B	1060	48	252	5.4	202.8	188.1[2]	188.1	0.0
C	1370	74	430	3.2	202.8	190.1[2]	190.1	0.0
D	1950	55	235	5.8	202.8	192.7[2]	192.7	0.0
E	2010	125	301	4.5	202.8	195.3[2]	195.3	0.0
F	2320	47	269	5.1	202.8	197.3[2]	197.4	0.1
G	2390	72	400	3.4	202.8	197.9[2]	198.0	0.1
H	2430	71	372	3.7	202.8	198.0[2]	198.1	0.1
I	3060	56	604	2.3	202.8	199.8[2]	919.8	0.0
J	3120	70	269	5.1	206.1	206.1[2]	206.1	0.0
K	4170	97	378	3.6	206.4	206.4[2]	206.4	0.0
L	4320	39	216	6.3	206.6	206.6[2]	206.6	0.0
M	4660	50	352	3.9	208.9	208.9[2]	209.1	0.2
N	4720	51	223	6.1	214.5	214.5[2]	214.5	0.0
O	5640	33	203	6.7	214.8	214.8[2]	214.8	0.0
P	5700	33	169	8.1	216.6	216.6[2]	216.7	0.1
Q	7010	37	236	5.8	217.8	217.8[2]	217.8	0.0
R	1790	38	198	6.9	218.4	218.4[2]	218.4	0.0
S	7280	38	214	6.4	218.9	218.9[2]	218.9	0.0
T	7400	45	243	5.6	219.5	219.5[2]	219.5	0.0

[1]Feet above mouth [2]Elevation computed without consideration of influence from Willamette River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR AND INCORPORATED AREAS

FLOODWAY DATA

COX CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
HARDER LANE OVERFLOW								
A	322	224	871	0.5	200.5	200.5	201.4	0.9
B	824	101	571	1.1	200.8	200.8	201.6	0.8
C	1,576	99	796	0.8	201.3	201.3	202.0	0.7

[1] Feet above convergence with Thornton Lakes Overflow

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

HARDER LANE OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
North Santiam River								
A	64,030	2,655[2]	28,819	2.3	235.2	235.2	236.1	0.9
B	66,280	2,649[2]	23,434	2.8	236.3	236.3	237.2	0.9
C	69,360	2,266[2]	14,095	4.7	240.0	240.0	240.8	0.8
D	70,940	1,736[2]	7,378	9.1	245.5	245.5	245.9	0.4
E	72,470	2,550[2]	12,106	5.5	250.2	250.2	251.1	0.9
F	73,900	1,643[3]	9,114	7.3	252.6	252.6	253.3	0.7
G	75,600	615[3]	5,975	11.2	255.8	255.8	256.6	0.8
H	76,825	588[3]	6,912	9.7	259.0	259.0	259.8	0.8
I	77,335	405[3]	4,826	13.8	259.1	259.1	260.0	0.9
J	139,480	2,977[3]	9,769	6.4	413.9	413.9	414.9	1.0
K	142,090	3,752[3]	18,217	3.5	422.5	422.5	422.5	0.0
L	143,450	3,368[3]	8,705	7.2	425.3	425.3	425.7	0.4
M	145,110	3,358[3]	14,364	4.4	432.8	432.8	433.4	0.6
N	146,620	2,085[3]	7,934	7.9	437.1	437.1	437.8	0.7
O	147,990	1,547[3]	9,590	6.6	443.3	443.3	443.9	0.6
P	149,070	1,539[3]	7,858	8.0	446.0	446.0	446.2	0.2
Q	150,790	2,227[3]	14,987	4.2	452.2	452.2	453.2	1.0
R	152,580	2,950[3]	12,247	5.1	457.5	457.5	457.5	0.0
S	154,540	3,936[3]	7,705	8.2	466.1	466.1	466.2	0.1
T	155,630	3,589[3]	12,385	5.1	472.1	472.1	472.4	0.3
U	157,150	1,874[3]	7,281	8.7	478.3	478.3	478.8	0.5
V	158,490	2,603[3]	12,508	5.0	483.5	483.5	483.5	0.0
W	159,840	2,171[3]	7,844	8.0	486.7	486.7	486.7	0.0
X	161,090	2,139[3]	9,611	6.6	493.1	493.1	493.6	0.5
Y	162,540	2,793[3]	15,866	4.0	498.5	498.5	498.6	0.1
Z	163,850	3,431[3]	14,966	4.2	501.7	501.7	501.7	0.0

[1] Feet above mouth of Santiam River [2]Width lies entirely outside county limits [3]Width extends beyond county limits

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR AND INCORPORATED AREAS

FLOODWAY DATA

NORTH SANTIAM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
North Santiam River (Con't)								
AA-AF[2]								
AG	241,000	389[3]	1,938	12.7	770.4	770.4	770.4	0.0
AH	242,390	310[3]	2,658	9.3	777.7	777.7	777.7	0.0
AI	244,970	273[3]	2,369	10.4	785.3	785.3	785.3	0.0
AJ	247,160	256[3]	2,262	10.9	793.1	793.1	793.1	0.0
AK	249,160	112[3]	1,658	14.9	805.4	805.4	805.4	0.0
AL	249,335	255[3]	3,001	8.2	808.7	808.7	808.7	0.0
AM	251,550	323[3]	1,848	13.3	816.6	816.6	816.6	0.0
AN	253,110	230[3]	2,385	10.3	827.1	827.1	827.1	0.0
AO	254,930	248[3]	2,530	9.8	833.3	833.3	833.3	0.0
AP	256,730	239[4]	2,696	9.2	838.2	838.2	838.2	0.0
AQ	258,230	191[3]	1,665	14.8	842.3	842.3	842.3	0.0
AR	259,980	240[3]	2,617	9.1	852.7	852.7	852.7	0.0
AS	262,220	210[3]	1,539	15.4	860.6	860.6	860.6	0.0
AT	263,960	200[3]	2,367	10.0	872.5	872.5	872.5	0.0
AU	265,630	180[3]	1,701	14.0	879.8	879.8	879.8	0.0
AV	267,630	291[3]	2,743	8.7	890.4	890.4	890.4	0.0
AW	269,190	118[3]	1,611	14.8	900.8	900.8	900.8	0.0
AX	272,940	224[3]	1,867	12.7	916.5	916.5	916.5	0.0
AY	275,300	197[3]	2,414	9.8	926.6	926.6	926.6	0.0
AZ	276,630	237[3]	1,620	14.7	933.0	933.0	933.0	0.0

[1] Feet above mouth of Santiam River [2] No floodway computed for these cross sections [3] Width extends beyond county limits

[4] Width lies entirely outside county limits

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**LINN COUNTY, OR
AND INCORPORATED AREAS**

FLOODWAY DATA

NORTH SANTIAM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
North Santiam River (Con't)								
BA	370,040	168[3]	2,033	13.2	1,591.4	1,591.4	1,591.4	0.0
BB	371,970	186[2]	1,747	15.3	1,606.9	1,606.9	1,606.9	0.0
BC	373,670	166[3]	1,778	15.1	1,623.5	1,623.5	1,623.5	0.0
BD	375,050	214[3]	1,915	14.0	1,637.8	1,637.8	1,637.8	0.0
BE	376,500	214[3]	1,882	14.2	1,655.1	1,655.1	1,655.1	0.0
BF	378,080	449[3]	2,811	9.5	1,678.7	1,678.7	1,678.7	0.0
BG	383,760	222[3]	1,742	15.4	1,748.6	1,748.6	1,748.6	0.0
BH	385,650	370[3]	2,283	11.7	1,770.9	1,770.9	1,770.9	0.0
BI	387,740	197[3]	1,740	15.4	1,795.0	1,795.0	1,795.0	0.0

[1] Feet above mouth of Santiam River [2] Width lies entirely outside county limits [3] Width extends beyond county limits

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR AND INCORPORATED AREAS

FLOODWAY DATA

NORTH SANTIAM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Oak Creek								
A	0.313	79	573	5.8	212.3	210.1[2]	210.5[2]	0.4
B	0.573	82	652	5.1	213.1	213.1	213.4	0.3
C	0.673	650	2,470	1.4	214.3	214.3	214.7	0.4
D	1.01	900	1,912	1.8	216.8	216.8	217.0	0.2
E	1.42	1,500	2,526	1.3	220.9	220.9	220.9	0.0
F	1.67	401	1,325	2.3	223.1	223.1	223.3	0.2
G	2.07	284	1,424	2.1	227.1	227.1	228.0	0.9
H	2.51	500	818	3.7	232.3	232.3	232.4	0.1
I	3.30	368	1,795	1.7	239.1	239.1	240.0	0.9
J	3.71	167	1,788	1.7	242.9	242.9	243.4	0.5
K	3.95	296	1,198	2.6	244.1	244.1	244.8	0.7
L	4.35	415	1,724	1.8	248.1	248.1	249.0	0.9
M	5.24	700	1,581	1.9	257.5	257.5	257.7	0.2
N	5.58	350	1,650	1.8	260.2	260.2	260.9	0.7
O-V[3]								

[1] Miles above confluence with Calapooia River Split Flow
[2] Elevation computed without consideration of influence from Calapooia River
[3] No floodway computed for these cross sections

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR AND INCORPORATED AREAS

FLOODWAY DATA

OAK CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
QUARRY ROAD EAST OVERFLOW								
A	725	69	334	0.7	200.3	200.3	201.1	0.8
B	1,079	90	401	0.6	200.3	200.3	201.1	0.8

[1]Feet above convergence with Thornton Lakes Overflow

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

QUARRY ROAD EAST OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Santiam River								
A	31,680	8,030	51,006	3.1	204.9	204.9	205.9	1.0
B	32,430	9,096	60,571	2.6	207.3	207.3	208.3	1.0
C	35,530	5,146	22,994	6.9	209.1	209.1	209.7	0.6
D	39,080	4,025	28,000	5.7	212.9	212.9	213.9	1.0
E	42,010	4,267	28,872	5.5	217.8	217.8	218.8	1.0
F	45,590	6,758	65,667	2.4	220.3	220.3	221.2	0.9
G	49,030	5,356	43,606	3.6	221.5	221.5	222.4	0.9
H	50,930	4,378	17,936	8.9	222.9	222.9	223.7	0.8
I	52,800	2,285	20,827	7.6	227.1	227.1	227.4	0.3
J	56,085	2,006	24,849	6.4	231.2	231.2	232.1	0.9
K	58,005	2,511	33,936	4.7	232.5	232.5	233.4	0.9
L	59,555	2,919	32,164	4.9	233.0	233.0	233.9	0.9
M	61,080	3,096	32,819	4.8	233.8	233.8	234.7	0.9

[1] Feet above mouth of Santiam River [2]Width extends beyond county limits

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

SANTIAM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
THORNTON LAKES EAST OVERFLOW								
A	757	250	1,695	0.4	202.8	202.8	203.7	0.9
B	1,319	268	1,189	0.5	202.8	202.8	203.7	0.9
C	2,659	191	379	1.6	203.4	203.4	204.2	0.8

[1]Feet above convergence with Thornton Lakes Overflow

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

THORNTON LAKES EAST OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
THORNTON LAKES OVERFLOW								
A	5,593	494	5,518	1.0	200.1	200.1	200.9	0.8
B	7,094	430	3,289	1.7	200.2	200.2	201.1	0.9
C	8,202	360	2,177	2.3	200.6	200.6	201.4	0.8
D	9,041	138	1,290	3.9	201.0	201.0	201.8	0.8
E	9,815	140	2,325	2.4	201.4	201.4	202.3	0.9
F	10,175	156	2,757	2.0	201.5	201.5	202.3	0.8
G	10,945	196	3,307	1.7	201.5	201.5	202.4	0.9
H	12,522	274	5,428	1.0	202.8	202.8	203.7	0.9
I	13,921	320	6,583	0.8	202.8	202.8	203.7	0.9
J	14,917	217	4,564	1.1	202.8	202.8	203.7	0.9
K	15,981	230	2,289	2.2	202.9	202.9	203.8	0.9
L	17,210	375	2,356	2.1	204.2	204.2	204.9	0.7
M	17,481	114	915	0.7	204.5	204.5	205.2	0.7

[1]Feet above convergence with Willamette River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

THORNTON LAKES OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
THORNTON LAKES WEST OVERFLOW								
A	191	351	3,049	1.4	204.4	204.4	205.1	0.7
B	758	286	2,567	1.7	204.7	204.7	205.3	0.6

[1]Feet above convergence with Thornton Lakes Overflow

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

THORNTON LAKES WEST OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Truax Creek								
A	0.23	40	155	4.9	201.4	191.4[2]	191.4[2]	0.0
B	0.33	76	337	2.3	201.4	200.1[2]	200.1[2]	0.0
C	0.53	60	315	2.4	203.6	203.6	203.6	0.0
D	0.56	53	654	1.2	208.8	208.8	209.3	0.5
E	0.64	43	845	0.9	208.9	208.9	209.4	0.5
F	0.817	25	337	2.3	213.4	213.4	213.9	0.5
G	0.868	62	668	1.1	213.6	213.6	214.1	0.5

[1] Miles above confluence with Second Lake outlet [2] Elevation computed without consideration of influence from Willamette River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR AND INCORPORATED AREAS

FLOODWAY DATA

TRUAX CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Willamette River								
A[2]								
B	114.36	3435/2,000[3]	43,320	4.6	197.0	197.0	197.6	0.6
C	115.11	4,020/270[3]	43,798	4.6	197.9	197.9	198.6	0.7
D	116.01	4,900/2,400[3]	51,244	3.9	199.3	199.3	199.8	0.5
E	116.99	3,369/579[3]	72,006	2.8	201.1	201.1	202.1	1.0
F	117.58	4,308/358[3]	82,986	2.5	202.7	202.7	203.7	1.0
G	118.27	3,639/379[3]	70,821	2.8	203.4	203.4	204.4	1.0
H	118.92	2,481/361[3]	44,263	4.5	204.4	204.4	205.4	1.0
I	120.99	5460/3670[3]	66,485	2.7	207.9	207.9	208.8	0.9
J-S[2]								

[1] Miles above mouth [2]No floodway computed for these cross sections [3]Width/width within county limits

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

WILLAMETTE RIVER

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to the community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base (1-percent-annual-chance) flood elevations (BFEs) or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the Flood Insurance Study by detailed methods. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

Table 9 lists the flood insurance zones that each community is responsible for regulating.

Table 9. Flood Insurance Zones Within Each Community

Community	Flood Zone(s)
Albany, City of	A, AE, X
Brownsville, City of	AE, X
Harrisburg, City of	AE, X
Lebanon, City of	A, AE, X
Linn County Unincorporated Areas	A, AE, AO, D, X
Lyons, City of	AE, X
Mill City, City of	AE
Millersburg, City of	A, AE, X
Scio, City of	A, AE, AO, X
Sweet Home, City of	A, AE, X
Tangent, City of	A, AE, X
Waterloo, City of	AE

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The countywide Flood Insurance Rate Map presents flooding information for the entire geographic area of Linn County. Previously, Flood Insurance Rate Maps were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide Flood Insurance Rate Map also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps, where applicable. Historical data relating to the maps prepared for each community are presented in Table 10, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Albany, City of	February 22, 1974	February 11, 1977 April 4, 1978	April 3, 1985	July 16, 1987 March 16, 1989 July 7,1999
Brownsville, City of	December 7, 1973	December 19, 1975 February 11, 1977	August 17, 1981	----
*,**Halsey, City of	----	----	----	----
Harrisburg, City of	March 1, 1974	June 25, 1976	February 3, 1982	----
Lebanon, City of	November 30, 1973	June 11, 1976	July 2, 1981	September 1, 1983
Linn County (Unincorporated Areas)	December 6, 1977	----	September 29, 1986	----
Lyons, City of	March 8, 1974	November 21, 1975 April 8, 1977	December 15, 1981	----
Mill City, City of	December 17, 1973	----	March 1, 1979	----
Millersburg, City of	January 24, 1978	----	June 15, 1982	----
Scio, City of	November 22, 1974	----	August 1, 1984	----
**Sodaville, City of	----	----	----	----
Sweet Home, City of	January 23, 1974	January 16, 1976	March 1, 1982	----
Tangent, City of	June 25, 1976	June 6, 1978	May 17, 1982	----
*,**Waterloo, City of	----	----	----	----

*No Special Flood Hazard Areas Identified
**This community did not have a FIRM prior to the first countywide FIRM for Linn County

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINN COUNTY, OR
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

In 1970, the SCS prepared a report for Linn County (Reference 22). This FIS supersedes the SCS report.

A Flood Hazard Boundary Maps were published for unincorporated areas of Linn County (Reference 44), Albany (References 52), Brownsville (Reference 53). Lebanon (Reference 54), Millersburg (Reference 55), Scio (Reference 56). Sweet Home (Reference 57), and Tangent (Reference 58). This study represents a more detailed analysis and, therefore supersedes the Flood Hazard Boundary Map. Flood Hazard Boundary Maps for the adjacent unincorporated areas of Deschutes County (Reference 59) and Jefferson County (Reference 60) are in agreement with this study.

USACE reports for Brownsville (Reference 26), Marion County (Reference 9), Corvallis and Philomath (Reference 61), Harrisburg (Reference 62), and Albany (Reference 25) included profiles for the Willamette, Santiam, North Santiam, and Calapooia Rivers; Calapooia River Split Flow, and Oak Creek. The 1-percent annual chance (100-year) flood profiles for those streams show little variation from the Flood Insurance Study, except for Willamette River. The 100-year flood discharge for the Willamette River used in the UASCE reports for Albany and Harrisburg was revised for this Flood Insurance Study. This revision is a result of the inclusion of additional years of streamflow records in the frequency analysis and reducing the estimate of the amount of upstream and tributary reservoir storage capacity. The revised discharge produced a 100-year flood profile that is approximately 1 to 2 feet higher in the vicinity of Albany and approximately 0.5 foot lower in the vicinity of Harrisburg than the respective USACE report profiles.

For the South Santiam River in the vicinity of Lebanon and Sweet Home, the 1-percent annual chance flood profile presented in this study is from 0- to 2-feet lower than the Flood Plain Information report for Lebanon (Reference 28) and Sweet Home (Reference 15). This difference resulted from lower discharges based on additional years of stream-flow record and from using the November 1963 flood to determine channel roughness values, rather than the larger December 1964 flood that was used in the earlier report. The lower water-surface profile did not result in any change in the flooded area.

In 1968, the USACE prepared floodplain mapping (Reference 9) that included Lyons. The 1-percent annual chance flood profile presented in this study is 0 to 2 feet higher than the USACE report profile. The increase in expected flood heights is the result of the more detailed hydraulic analysis conducted for this study. The city Storm Drainage Plan (Reference 7) also provides information on potential flood hazards.

Flood Insurance Studies/Flood Insurance Rate Maps have been produced for the Cities of Albany (Reference 63), Brownsville (Reference 64), Corvallis (Reference 65), Gates (Reference 66), Harrisburg (Reference 67), Idanha (Reference 68), Lebanon (Reference 69), Lyons (Reference 70), Mill City (Reference 71), Millersburg (Reference 72), Scio (Reference 73), Sweet Home (Reference 74), and Tangent (Reference 75). With the exception of those areas affected by the revised Willamette River hydrology, those studies are in general agreement with this study.

This Flood Insurance Study matches those published for the unincorporated areas of Marion County (Reference 24), Polk County (Reference 76), Lane County (Reference 77), and Benton County (Reference 78).

The Flood Hazard Boundary Map for the unincorporated areas of Linn County, Oregon (Reference 44), served as the source for the approximate flood boundaries for Foster Reservoir.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA, Mitigation Division, Federal Regional Center, 130 228th Street, SW, Bothell, Washington 98021-9796.

9.0 BIBLIOGRAPHY AND REFERENCES

1. Secretary of State, Oregon Blue Book, 1979-1980, February 1979

2. U.S. Department of Commerce, Bureau of the Census, 1980 Census of Population, December 1981

3. U.S. Department of Commerce, Bureau of the Census website, http://www.census.gov/, 2010

4. Pacific Northwest River Basins Commission, Climatological Handbook, Temperature, Volume 1, 1969

5. Portland State University, Population Estimates: Oregon Counties and Incorporated Cities, July 1977

6. State of Oregon, Department of Economic Development, Oregon Community Profiles, Salem, Oregon

7. City of Lyons, Oregon, Storm Drainage Plan, December 1975

8. U.S. Department of the Interior, Geological Survey, National Water Information System website, Peak Streamflow for Oregon, USGS Gage 14174000, Willamette River at Albany Oregon http://nwis.waterdata.usgs.gov/or/nwis/peak/?site_no=14174000&amp

9. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Willamette River and Tributaries in Marion and Polk Counties, Volumes I and II, Portland, Oregon, June 1968

10. U.S. Department of the Interior, Geological Survey, Water Resources Data for Oregon, 1972

11. Federal Emergency Management Agency, Flood Insurance Study, Linn County, Oregon (Unincorporated Areas), September 29, 1986

12. Pacific Northwest River Basins Commission, Willamette Basin Task Force, Willamette Basin Comprehensive Study of Water and Related Land Resources, 1969

13. Kramer, Chine, Mayo, Inc., Drainage Management Plan, Salem, Oregon, July 1979

14. U.S. Soil Conservation Service, Watershed Work Plan, Grand Prairie Watershed, Linn County, Oregon, October 1969

15. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, City of Sweet Home, Oregon, June 1974

16. U.S. Water Resources Council, “Guidelines for Determining Flood Flow Frequency,” Bulletin No. 17A, June 1977

17. U.S. Department of the Army, Corps of Engineers, Portland District, Cumulative Frequency Curve, North Santiam at Mehama, January 25, 1979

18. U.S. Department of the Army, Corps of Engineers, Portland District, Cumulative Frequency Curve, Detroit Dam on Santiam River, Oregon, December 1978

19. U.S. Department of the Army, Corps of Engineers, Portland District, Cumulative Frequency Curve, Little North Santiam River Near Mehama, Oregon, December 1978

20. U.S. Department of the Army, Corps of Engineers, Portland District, Procedures for Determination of Maximum Annual Flood Peak and Volume Frequency for Portland District, Report No. 2, February 1969

21. U.S. Department of the Interior, Geological Survey, Interagency Advisory Committee on Water Data, Office of Water Data Coordination, Hydrology Subcommittee, ,”Guidelines for Determining Flood Flow Frequency”, Bulletin No. 17B September 1981, revised March 1982

22. U.S. Department of Agriculture, Soil Conservation Service, Flood Plain Areas, Linn County, Oregon, 1970

23. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, November 1976, updated October 1977

24. Federal Emergency Management Agency, Flood Insurance Study, Marion County, Oregon (Unincorporated Areas), 1979

25. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Albany, Oregon, June 1971

26. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Brownsville, Oregon, July 1974

27. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: Tangent and Riverside, Oregon (1969), Photorevised (1975)

28. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Lebanon, Oregon, June 1973

29. U.S. Department of the Army, Corps of Engineers, Portland District, Orthophoto Topographic Maps, Scale 1:4,800, Contour Interval 5 feet: Scio, Oregon, March 1980; revised November 1982

30. U.S. Department of the Interior, Geological Survey, Water Resources Division, Description of Gaging Station and Rating Table for Santiam River at Jefferson, Oregon (No. 14189000), Portland, Oregon, March 19, 1973

31. U.S. Department of the Interior, Geological Survey, Water Resources Division, Description of Gaging Station and Rating Table for North Santiam River Below Boulder Creek Near Detroit, Oregon (No. 141780.00), Portland, Oregon, November 9, 1966

32. City of Albany, Public Works Department – Engineering, Planametric Topographic Maps, Contour Interval 2 feet, Scale 1:1,200, Date of Photography, 1975, Sheets 362/1331, 364/1331, 366/1328, 366/1331

33. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Intervals 5 and 10 feet: Albany, Oregon (1970); Corvallis, Oregon (1956); Crabtree, Oregon (1970); Halsey, Oregon (1969); Harrisburg, Oregon (1969); Junction City, Oregon (1967); Lebanon, Oregon (1969); Lewisburg, Oregon (1970); Monroe, Oregon (1969); Onehorse Slough, Oregon; Peoria, Oregon (1969); Riverside, Oregon (1969); Tangent, Oregon (1969)

34. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Insurance Work Maps (Aerial photos), Scale 1:4,800: North Santiam River (1980); Oak Creek – At Lebanon (1980); Santiam River (1980)

35. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Insurance Work Maps (Orthophoto Topography Maps), Scales 1:4,800 and 1:6,000, Contour Interval 5 Feet: Calapooia River – U.S. 99E to Holley (November 1972); South Santiam River – Waterloo to Foster Lake (July 1972); Thomas Creek and Peters Ditch – Scio (October 1978)

36. City of Albany Public Works Department, Topographic Maps, Scale 1:2,400, Contour Interval 2 Feet: Albany, Oregon (1976)

37. Geographic Information Systems, Albany, Oregon, City of Albany, North Albany & Vicinity, Topographic Maps, Scale 1:1,200, Contour Interval 2 feet, Photo Date April and May 1994

38. Schaudt, Stemm, and Walter, Incorporated, Orthophoto Contour Map, Scale 1:1200, Contour Interval 2 feet: City of Harrisburg, Linn County, Oregon (1978)

39. U.S. Department of the Interior, Geological Survey, 15-Minute Series Topographic Map, Scale 1:62,500, Contour Interval 40 feet: Lyons, Oregon (1951)

40. Western Aerial Contractors, Stereophotos, Lyons, Oregon, Scale 1:48,000, April 3, 1976

41. CH2M HILL, Inc. Stereophotos of North Santiam River Detailed Study Area, Scale 1:12,000, Portland, Oregon, August 27, 1976

42. U.S. Department of the Army, Corps of Engineers, Portland District, Orthophoto Topographic Maps, Scale 1:6000, Contour Interval 5 feet: South Santiam River, Waterloo to Foster Lake, July 1972

43. City of Sweet Home, Oregon, Department of Public Works, Topographic Map, Scale 1:2400, Contour Interval 2 feet, Sweet Home, Oregon, 1970

44. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Linn County, Oregon (Unincorporated Areas), Scale 1:24,000, Revised December 6, 1977

45. City of Albany , Topographic Data, Contour Interval 2 feet, Albany, Oregon, 2006

46. Linn County, Topographic Data, Contour Interval 5 feet, Linn County, Oregon, 1996

47. City of Mill City, Topographic Data, Contour Interval 2 feet, Mill City, Oregon, 2001

48. City of Sweet Home, Topographic Data, Contour Interval 2 feet, Sweet Home, Oregon, 2006

49. Linn County, Topographic Data, Contour Interval 2 feet, Urban Areas of Linn County, 1996

50. U.S. Department of Agriculture, Farm Service Agency, National Agriculture Imagery Program, Stable Base Aerial Photography, Scale 1:40,000, Linn and Benton County, 2005

51. U.S. Department of Homeland Security, Federal Emergency Management Agency, Procedural Memorandum No. 36 – Profile Baselines on Digital Flood Insurance Rate Maps with Orthophoto Bases, Washington, D.C. July 5, 2005

52. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Albany, Oregon, Scale 1:12,000, April 1978

53. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Brownsville, Linn County, Oregon, Scale 1:7200, December 1973

54. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Lebanon, Oregon, Scale 1:800, November 1973, (Revised June 1976)

55. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Millersburg, Oregon, Scale 1:12,000, January 1978

56. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Scio, Linn County, Oregon, Scale 1:7,200, November 22, 1974

57. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Sweet Home, Oregon, Scale 1:6000, January 23, 1974, Revised January 16, 1976

58. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Tangent, Linn County, Oregon, Scale 1:9600, Revised June 6, 1978

59. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Deschutes County, Oregon (Unincorporated Areas), Scale 1:24,000, Revised September 6, 1977

60. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Jefferson County, Oregon (Unincorporated Areas), Scale 1:24,000, Revised July 26, 1977

61. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Corvallis and Philomath, Oregon, March 1971

62. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Harrisburg, Oregon, December 1972

63. Federal Emergency Management Agency, Flood Insurance Study, City of Albany, Linn County, Oregon, 1984

64. Federal Emergency Management Agency, Flood Insurance Study, City of Brownsville, Oregon, 1981

65. Federal Emergency Management Agency, Flood Insurance Study, City of Corvallis, Oregon, 1979

66. Federal Emergency Management Agency, Flood Insurance Study, City of Gates, Oregon, 1979

67. Federal Emergency Management Agency, Flood Insurance Study, City of Harrisburg, Oregon, 1982

68. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Idanha, Oregon, Revised March 1979

69. Federal Emergency Management Agency, Flood Insurance Study, City of Lebanon, Oregon, Revised 1983

70. Federal Emergency Management Agency, Flood Insurance Study, City of Lyons, Oregon, 1981

71. Federal Emergency Management Agency, Flood Insurance Study, City of Mill City, Oregon, 1979

72. Federal Emergency Management Agency, Flood Insurance Study, City of Millersburg, Oregon, June 15, 1982

73. Federal Emergency Management Agency, Flood Insurance Study, City of Scio, Oregon, 1984

74. Federal Emergency Management Agency, Flood Insurance Study, City of Sweet Home, Oregon, 1982

75. Federal Emergency Management Agency, Flood Insurance Study, City of Tangent, Oregon, 1982

76. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Polk County, Oregon (Unincorporated Areas), 1978

77. Federal Emergency Management Agency, Flood Insurance Study, Lane County, Oregon (Unincorporated Areas), 1985

78. Federal Emergency Management Agency, Flood Insurance Study, Benton County, Oregon (Unincorporated Areas), 1986

10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To assure that any user is aware of all revisions, it is advisable to contact the community repository of flood-hazard data located at the address listed below. Please refer to the Linn County, Oregon FIRM Map Index (41019CIND0B) for other community repositories within Linn County.

Linn County Planning and Building Department
Courthouse Building, Room 114
Albany, OR 97321

Table 11 summarizes the flooding sources updated since the original study was completed.

Table 11. Revised Study Descriptions

Flooding Source	Community	Limits of Study	Revision Date	Panel No.
Willamette River	City of Albany	From Approximately 2,100 feet downstream of Lyon Street	September 8, 2006	41043C0213G
Willamette River	City of Albany	From the convergence with Thornton Lakes Overflow to approximately 2.2 miles upstream of the Southern Pacific Railroad	December 8, 2016	41043C0200H 41043C0211H 41043C0212H 41043C0213H 41043C0214H
Harder Lane Overflow	City of Albany	From the convergence with Thornton Lakes Overflow to the divergence from Thornton Lakes Overflow	December 8, 2016	41043C0211H 41043C0213H
Quarry Road East Overflow	City of Albany	From approximately 480 feet upstream of the convergence with Thornton Lakes Overflow to the divergence from Harder Lane Overflow	December 8, 2016	41043C0211H
Quarry Road West Overflow	City of Albany	From approximately 1,420 feet upstream of the convergence with Thornton Lakes Overflow to the divergence from Thornton Lakes School Overflow	December 8, 2016	41043C0211H 41043C0213H

Flooding Source	Community	Limits of Study	Revision Date	Panel No.
Thornton Lakes East Overflow	City of Albany	From the convergence with Thornton Lakes Overflow to just upstream of U.S. Highway 20	December 8, 2016	41043C0200H 41043C0213H
Thornton Lakes Overflow	City of Albany	From approximately 3,750 feet upstream from the convergence with Willamette River to just upstream of U.S. Highway 20	December 8, 2016	41043C0200H 41043C0211H 41043C0213H
Thornton Lakes School Overflow	City of Albany	From the convergence with Thornton Lakes Overflow to the divergence from Thornton Lakes Overflow	December 8, 2016	41043C0213H
Thornton Lakes West Overflow	City of Albany	From the convergence with Thornton Lakes Overflow to just upstream of U.S. Highway 20	December 8, 2016	41043C0200H

10.1 First Revision (December 8, 1016)

a. Authority and Acknowledgments

The redelineation of the Willamette River and the hydraulic and hydrologic analyses for Harder Lane Overflow, Quarry Road East Overflow, Quarry Road West Overflow, Springhill Drive East Overflow, Springhill Drive Middle Overflow, Springhill Drive West Overflow, Thornton Lakes East Overflow, Thornton Lakes Overflow, Thornton Lakes School Overflow, and Thornton Lakes West Overflow, were performed by AMEC Environment and Infrastructure, Inc., for FEMA.

The partial countywide map revision was performed by the Strategic Alliance for Risk Reduction (STARR) for FEMA under Contract No. HSFEHQ-09-D-0370.

b. Coordination

A final meeting was held January 24, 2014, with representatives from FEMA, Oregon Department of Land Conservation and Development, and the communities to review the results of the study.

c. Scope of Study

The purpose of this revision is to incorporate updated analyses of the Thornton Lakes Overflow system and the Willamette River. Although the 1-percent-annual-chance flood has not been modified for this revision, FLO2D (Reference 1) was used to refine the floodplain mapping and BFE delineations on the West Bank of the Willamette River from the confluence with Thornton Lakes Overflow to approximately 2.2 miles upstream of the Southern Pacific Railroad. The Thornton Lakes Overflow system includes the following streams, studied by detailed methods for this revision:

- Harder Lane Overflow
- Quarry Road East Overflow
- Quarry Road West Overflow
- Springhill Drive East Overflow
- Springhill Drive Middle Overflow
- Springhill Drive West Overflow
- Thornton Lakes East Overflow
- Thornton Lakes Overflow
- Thornton Lakes School Overflow
- Thornton Lakes West Overflow

This revision primarily covers the geographic area of the City of Albany within Linn and Benton Counties, Oregon. The new analyses incorporate high ground that exists within the Willamette River floodplain in the vicinity of the City of Albany in Linn and Benton Counties, Oregon.

d. Hydrologic Analyses

Discharges through the Thornton Lakes System were estimated by balancing the hydraulics at each junction and matching water surface elevations with the Willamette River.

Peak discharge-drainage area relationships for each stream studied in detail for the revision are shown in Table 12:

Table 12 – Summary of Discharges for Revised Study

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
HARDER LANE OVERFLOW					
Approximately 165 feet upstream of the convergence with Thornton Lakes Overflow	*	**	20	390	*
Approximately 1,815 feet upstream of the convergence with Thornton Lakes Overflow	*	**	20	620	*
QUARRY ROAD EAST OVERFLOW					
Approximately 880 feet upstream of the convergence with Thornton Lakes Overflow	*	**	**	230	*
QUARRY ROAD WEST OVERFLOW					
Approximately 1,175 feet upstream of the convergence with Thornton Lakes Overflow	*	**	**	80	*
SPRINGHILL DRIVE EAST OVERFLOW					
At confluence with Springhill Drive Middle Overflow	*	*	*	15	*
SPRINGHILL DRIVE MIDDLE OVERFLOW					
At confluence with Springhill Drive West Overflow	*	*	*	20	*
At confluence of Springhill Drive East Overflow	*	*	*	15	*

*Data not available

**No flow exists for this reach for the selected flood event

Table 12 – Summary of Discharges for Revised Study (continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
At confluence of Springhill Drive East Overflow	*	*	*	15	*
SPRINGHILL DRIVE WEST OVERFLOW					
Approximately 2,185 feet downstream of the Southern Pacific Railroad Bridge	*	*	*	240	*
At confluence of Springhill Drive Middle Overflow	*	*	*	220	*
THORNTON LAKES EAST OVERFLOW					
Approximately 3,035 feet upstream of the convergence with Thornton Lakes Overflow	*	**	**	620	*
THORNTON LAKES OVERFLOW					
Approximately 7,275 feet upstream of the convergence with Williamette River	*	560	1,230	5,350	*
Approximately 7,990 feet upstream of the convergence with Williamette River	*	560	1,210	4,960	*
Approximately 9,150 feet upstream of the convergence with Williamette River	*	560	1,210	5,023	*

*Data not available
**No flow exists for this reach for the selected flood event

Table 12 – Summary of Discharges for Revised Study (continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
THORNTON LAKES OVERFLOW *(continued)*					
Approximately 11,700 feet upstream of the convergence with Williamette River	*	560	1,230	5,543	*
Approximately 13,710 feet upstream of the convergence with Williamette River	*	560	1,230	5,560	*
Approximately 17,025 feet upstream of the convergence with Williamette River	*	560	1,230	4,940	*
Approximately 17,750 feet upstream of the convergence with Williamette River	*	536	770	640	*
THORNTON LAKES SCHOOL OVERFLOW					
Approximately 2,405 feet upstream of the convergence with Thornton Lakes Overflow	*	**	**	17	*
THORNTON LAKES WEST OVERFLOW					
Approximately 1,250 feet upstream of the convergence with Thornton Lakes Overflow	*	24	460	4,300	*

*Data not available
**No flow exists for this reach for the selected flood event

e. Hydraulic Analyses

Ground points were surveyed across each cross section. Sections were surveyed across most of the floodplain including wetted areas and steep, densely vegetated areas where LiDAR (Reference 80) was expected to be unsatisfactory. Many of these sections crossed overflow paths where there was no defined channel. These points were supplemented with 1-foot LiDAR contours (Reference 2), and the two data sources were merged at each cross section by an experienced hydraulic engineer. Additional survey measurements were made at bridges and culverts. Hydraulic engineers also interpolated a select group of cross-sections by combining LiDAR ground contours at the new cross-sections with interpolated or copied survey section points from nearby cross sections that were judged to be representative.

Boundary conditions for the Thornton Lakes System were estimated by balancing the hydraulics at each junction and matching water surface elevations with the Willamette River.

Flood profiles for the selected recurrence intervals were computed using the U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC) computer program, HEC-RAS, Version 4.1.0 (Reference 3).

Channel roughness values (Manning's "n") used in the hydraulic computations were mapped by engineers based on professional judgment using field reconnaissance and aerial photographs. The values were varied horizontally across each cross section. The values are summarized in the following table:

HEC-RAS n-Value	**Description of Land Cover**
0.020	Paved
0.025	Gravel
0.028	Open Water
0.030	Lawn
0.040	Field/Pasture
0.045	Orchard
0.070	Brush
0.100	Trees/Closed Canopy
0.120	Suburb

f. Floodplain Boundaries

For Harder Lane Overflow, Quarry Road East Overflow, Quarry Road West Overflow, Springhill Drive East Overflow, Springhill Drive Middle Overflow, Springhill Drive West Overflow, Thornton Lakes East Overflow, Thornton Lakes Overflow, Thornton Lakes School Overflow, Thornton Lakes West Overflow and the west bank of the Willamette River, floodplain boundaries were interpolated between cross sections using LiDAR topographic data, with a contour interval of one foot (Reference 2).

g. Floodways

No floodway was computed for Quarry Road West Overflow, Springhill Drive East Overflow, Springhill Drive Middle Overflow, Springhill Drive West Overflow, and Thornton Lakes School Overflow.

h. Bibliography and References

1. FLO-2D Software, Inc., FLO-2D, Version 2009, Nutrioso, Arizona, 2009.

2. Oregon LiDAR Consortium and Oregon Department of Geology and Mineral Industries, LiDAR Data for USGS Quadrangle 44123F1 and 44123F2, Contour Interval: 1 foot, July 22, 2009.

3. Hydrologic Engineering Center, HEC-RAS River Analysis System, Version 4.1.0, U.S. Army Corps of Engineers, Davis, California, January 2010.