# FLOOD INSURANCE STUDY

**Notice**
**This preliminary FIS report includes only <u>revised</u> Flood Profiles and Floodway Data tables. See "Notice to Flood Insurance Study Users" page for additional details.**

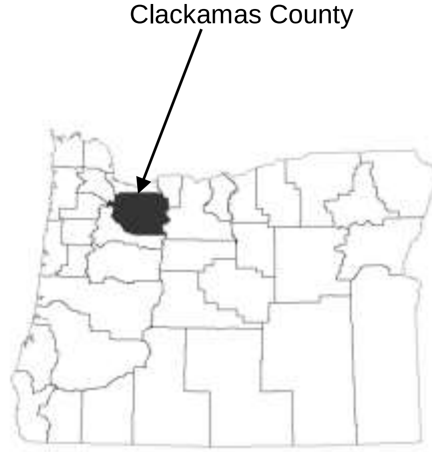
# CLACKAMAS COUNTY, OREGON

## AND INCORPORATED AREAS

## Volume 1 of 3

| Community Name | Community Number |
|---|---|
| BARLOW, CITY OF | 410013 |
| CANBY, CITY OF | 410014 |
| DAMASCUS, CITY OF | 410006 |
| *ESTACADA, CITY OF | 410016 |
| GLADSTONE, CITY OF | 410017 |
| HAPPY VALLEY, CITY OF | 410026 |
| *JOHNSON CITY, CITY OF | 410267 |
| LAKE OSWEGO, CITY OF | 410018 |
| MILWAUKIE, CITY OF | 410019 |
| *MOLALLA, CITY OF | 410020 |
| OREGON CITY, CITY OF | 410021 |
| RIVERGROVE, CITY OF | 410022 |
| SANDY, CITY OF | 410023 |
| WEST LINN, CITY OF | 410024 |
| WILSONVILLE, CITY OF | 410025 |
| CLACKAMAS COUNTY (UNINCORPORATED AREAS) | 415588 |

Clackamas County



*No Special Flood Hazard Areas Identified

Preliminary: March 28, 2016

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
41005CV001B

**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.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

This preliminary FIS report does not include unrevised Floodway Data Tables or unrevised Flood Profiles. These Floodway Data Tables and Flood Profiles will appear in the final FIS report.

Initial Countywide Effective Date: June 17, 2008
Revised Countywide Date: To Be Determined

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# FLOOD INSURANCE STUDY
# CLACKAMAS COUNTY AND INCORPORATED AREAS

## 1.0 INTRODUCTION

### 1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Clackamas County, including the Cities of Barlow, Canby, Damascus, Estacada, Gladstone, Happy Valley, Johnson City, Lake Oswego, Milwaukie, Molalla, Oregon City, Rivergrove, Sandy, West Linn, Wilsonville and the unincorporated areas of Clackamas County (referred to collectively herein as Clackamas 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 44CFR, 60.3.

Please note that the Cities of Rivergrove, Tualatin, and Wilsonville are geographically located in Clackamas and Washington Counties, the City of Milwaukie is geographically located in Clackamas and Multnomah Counties, and the Cities of Lake Oswego and Portland are geographically located in Clackamas, Multnomah, and Washington Counties. The Cities of Lake Oswego, Milwaukie, Rivergrove and Wilsonville are included in their entirety in this FIS report. The Cities of Portland and Tualatin are published separately.

Please note that the Cities of Estacada, Johnson City, and Molalla have no 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) for 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.

The Digital Flood Insurance Rate Map (DFIRM) and FIS report for this countywide study have been produced in digital format. Flood hazard information was converted to meet the FEMA DFIRM database specifications and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community.

## 1.2 Authority and Acknowledgments

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

**Pre-Countywide Analyses**

The hydrologic and hydraulic analyses for the original FIS for the City of Barlow, City of Canby, the unincorporated areas of Clackamas County, City of Lake Oswego, City of Oregon City, City of Rivergrove, and the City of Wilsonville, were performed by James M. Montgomery, Consulting Engineers, Inc., for FEMA, under Contract Nos. H-4583 and H-4582. These studies were completed in December, 1979, January, 1983, November, 1984, March, 1984, June, 1978, November, 1984, and November, 1979, respectively. For the City of Milwaukie, analyses for the original FIS were performed by the United States Army Corps of Engineers (USACE) - Portland District, under contract No. IAA-H-16-75-P019. That study was completed in July, 1978. The USACE-Portland District also completed a channel improvement project in 1983 within the reach of the Tualatin River directly upstream of the City of Rivergrove. The hydrologic and hydraulic analyses for Seely Ditch were performed by Westech Engineering, Inc. These analyses were completed in May, 1985.

**June 17, 2008**
**The Initial Countywide FIS Report**

The hydrologic and hydraulic analyses for Tickle Creek were performed by Ogden Beeman & Associates, Inc., for FEMA, under Contract No. EMS-96-C0-0078-TA04. The Analyses were completed in September, 1998.

Curran-McLead, Inc. submitted data to remove an area of shallow flooding and ponding in the City of Gladstone. A LOMR was issued on October 18, 1996.

The City of Portland submitted data to revise flood hazards on a portion of Johnson Creek in Clackamas County and the City of Milwaukie. A LOMR was issued on December 21, 2000.

Harper Houf Righellis, Inc. performed hydrologic and hydraulic analyses of Kellogg Creek to obtain a LOMR dated March 1, 2001.

Parsons, Brinkerhoff, Quade, and Douglas, Inc. performed hydrologic and hydraulic analyses of the Salmon River in Clackamas County to obtain a LOMR dated August 11, 2005.

The hydrologic and hydraulic analyses for Rock and Richardson Creeks were performed by Pacific Water Resources, Inc., for Clean Water Services (CWS) of Clackamas County, a participant in FEMA's Cooperating Technical Partners (CTP) Program. These studies were completed in June, 2005.

The hydrologic and hydraulic analyses for the Tualatin River Basin were also completed by Pacific Water Resources, Inc., under contract with CWS. This study was completed in December, 2005.

**This Physical Map Revision**

The hydrologic and hydraulic analyses for this study were performed by Strategic Alliance for Risk Reduction (STARR), and DOGAMI for FEMA, under Contract No. HSFEHQ-09-D-0370, task number HSFE10-10-J-00106. The work was completed in June 2013.

Base map information shown on the FIRM was derived from multiple sources in digital format provided by Clackamas County and the USGS produced at a scale of 1:24,000 from National Agricultural Imagery Program mosaic photography dated 2014 or later. The projection used in the preparation of this map is Universal Transverse Mercator (UTM) Zone 10, and the horizontal datum used is North American Datum 1983, GRS 1980 spheroid.

1.3 Coordination

An initial meeting is held with representatives from FEMA, the community, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied or restudied. A final meeting is held with representatives from FEMA, the community, and the study contractor to review the results of the study.

**Pre-Countywide Analyses**

The initial and final meeting dates for previous FIS reports for Clackamas County and its communities are listed in the following table:

Table – 1 – CCO Meeting Dates for Pre-Countywide Study

| Community | FIS Date | Initial Meeting | Final Meeting |
|---|---|---|---|
| Barlow, City of | * | June,1977 | May 28, 1980 |
| Canby, City of | * | October 16, 1979 | July 18, 1983 |
| Clackamas County (Unincorporated Areas) | * | May 9, 1984 | August 21, 1986 |
| Gladstone, City of | * | September 26, 1974 | March 8, 1976 |
| Oswego Lake, City of | * | May 10, 1984 | August 20, 1986 |
| Milwaukie, City of | * | March 5, 1975 | May 17, 1979 |
| Oregon City, City of | * | June, 1977 | October 11, 1978 |
| Rivergrove, City of | * | June, 1977 | August 21, 1986 |
| Sandy, City of | * | * | July 13, 1999 |
| West Linn, City of | * | October 9, 1974 | March 5, 1975 |
| Wilsonville, City of | * | June 1977 | January 29, 1981 |

*Data not available for this FIS

**June 17, 2008**
**The Initial Countywide FIS Report**

The results of the analyses performed for this countywide study were reviewed at the final CCO meeting held on January 18, 2007, and attended by representatives of Clackamas County and FEMA.

**This Physical Map Revision**

The results of this study were reviewed at the final meeting held on ______, and attended by representatives of ___________, All issues and/or concerns raised at the meeting have been addressed.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This FIS covers the geographic area of Clackamas County, Oregon, including the incorporated communities listed in Section 1.1.

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through June, 2013.

Table 2 – Limits of Detailed Study

The following streams were studied by detailed methods in this FIS report:

| Flooding Source | Limit of Study |
| --- | --- |
| Abernethy Creek | From its confluence with the Willamette River to approximately 920 feet upstream of the Redland Road Bridge |
| Clackamas River | From its confluence with the Willamette River to approximately 800 feet downstream of the River Mill powerhouse |
| Clear Creek | From its confluence with the Sandy River to approximately 700 feet upstream of its confluence with Minikanda Creek |
| Dear Creek | From its confluence with Mt. Scott Creek to approximately 350 feet downstream of Interstate Highway 205 |
| Eagle Creek | From its confluence with the Clackamas River to approximately 1,400 feet upstream of Eagle Creek County Road |
| Johnson Creek | From the Portland corporate limits to the Clackamas-Multnomah County line, 950 feet upstream of Southeast Luther Road |
| Kellogg Creek | From its confluence with the Willamette River to approximately 150 feet upstream of Southeast Marel Avenue |
| Milk Creek | From its confluence with the Molalla River to Beaver Creek Road, near Four Corners |
| Molalla River | From its confluence with the Willamette River to 150 feet upstream of the private road southwest of Dickey prairie |

Table 2 – Limits of Detailed Study (continued)

| Flooding Source | Limit of Study |
|---|---|
| Mt. Scott Creek | From its confluence with Kellogg Creek to approximately 550 feet upstream of Interstate Highway 205 |
| Nyberg Slough | From its divergence from the Tualatin River to Nyberg Road |
| Oswego Canal | From its divergence from the Tualatin River to its confluence with Lake Oswego |
| Phillips Creek | From its confluence with Mt. Scott Creek to approximately 600 feet downstream of Southeast 82nd Avenue |
| Pudding River | From its confluence with the Molalla River to U.S. Highway 99 |
| Rock Creek | From its confluence with the Clackamas River upstream to Tillstrom Road |
| Rock Creek Hemrick Road Tributary | From its confluence with Rock Creek to the upstream face of Tillstrom Road |
| Rock Creek North Golf Course Tributary | From its confluence with Rock Creek to the upstream face of 162nd Avenue |
| Rock Creek South Golf Course Tributary | From its confluence with Rock Creek to the upstream face of 162nd Avenue |
| Rock Creek 172nd Avenue Tributary | From its confluence with Rock Creek to a point approximately 1.53 miles upstream of the confluence with Rock Creek |
| Rock Creek Highway 224 Tributary | From its confluence with Rock Creek to the upstream face of Goose Hollow Drive |
| Richardson Creek | From its confluence with the Clackamas River to a point approximately .4 mile upstream of Royer Road |
| Richardson Creek Royer Road Tributary | From its confluence with Richardson Creek upstream to Royer Road |
| Richardson Creek Anderson Road Tributary | From its confluence with Richardson Creek to upstream face if Sunnyside Road |
| Richardson Creek Keller Road Tributary | From it's confluence with Richarson Creek to upstream face of Keller Road |

Table 2 – Limits of Detailed Study (continued)

| Flooding Source | Limit of Study |
| --- | --- |
| Salmon River | From its confluence with the Sandy River to approximately River Mile (R.M.) 0.9 upstream of Cheeney Creek |
| Salmon River North Channel | From its confluence with the Salmon River to its divergence from the Salmon River, near Camp Arrah Wanna |
| Sandy River | From 820 feet upstream of the Clackamas-Multnomah County line to approximately R.M. 21.2, east of Sandy |
| Sandy River | From approximately 150 feet upstream of R.M. 23 to approximately 1,000 feet upstream of Revenue Bridge |
| Sandy River | From approximately 150 feet downstream of R.M. 33 to approximately 2,000 feet southeast of the intersection of Lolo Pass and Muddy Fork Roads |
| Still Creek | From its confluence with the Zig Zag River to approximately 1,600 feet downstream of its confluence with Cool Creek |
| Tickle Creek | From approximately 1,500 feet downstream of Southeast 362nd street upstream to Langens and Road |
| Tualatin River | From its confluence with the Willamette River to approximately 850 feet downstream of R.M. 8, at the Clackamas-Washington County line |
| Willamette River | From the Portland corporate limits near Golf Junction to the Clackamas-Yamhill-Marion county line, 1,200 feet upstream of its confluence with Ryan Creek |
| Zig Zag River | From its confluence with the Sandy River to approximately 2,500 feet northeast of the Bruin Run campground |

The limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

Each FIS report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance flood elevations (the 1-percent-annual-chance flood elevation is also referred to as the Base Flood Elevation (BFE); delineations of the 1-percent-annual-chance floodway. This information is presented on the FIRM and/or in many components of the FIS report, including Flood Profiles and Floodway Data tables.

Figure 1 presents important considerations for using the information contained in this FIS report and the FIRM and is provided in response to changes in format and content.

Figure 1 – FIRM Note to Users

# NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 8 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

PRELIMINARY FIS REPORT: FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

PROJECTION INFORMATION: The projection used in the preparation of the map was Universal Transverse Mercator. The horizontal datum was North American Datum 1983. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM

Figure 1 – FIRM Notes to Users (Continued)

ELEVATION DATUM: Flood elevations on the FIRM are referenced to NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://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

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community.

BASE MAP INFORMATION: Base map information shown on this FIRM was developed and/or compiled in digital format by the Oregon Department of Geology and Mineral Industries (DOGAMI). Data sources include DOGAMI, Oregon Lidar Consortium, Bureau of Land Management, U. S. Geological Survey, and Clackamas County GIS. Base map information was rectified to 3-foot resolution Lidar topographic data acquired in 2002.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

**NOTES FOR FIRM INDEX**

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Clackamas County, Oregon and Incorporated Areas, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 8 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Figure 2 – FIRM Legend

**SPECIAL FLOOD HAZARD AREAS:** *The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.*

| | |
|---|---|
| | Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE) |
| Zone A | The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone. |
| Zone AE | The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone, either at cross section locations or as static whole-foot elevations that apply throughout the zone. |
| Zone AH | The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone. |
| Zone AO | The flood insurance rate zone that corresponds to the areas of 1% 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 hydraulic analyses are shown within this zone. |
| Zone AR | The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood. |
| Zone A99 | The flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone. |
| Zone V | The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone. |
| Zone VE | Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone. |
| | Regulatory Floodway determined in Zone AE. |

| | |
|---|---|
| **OTHER AREAS OF FLOOD HAZARD** | |
| | Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile. |
| | Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone. |
| | Zone X Protected by Accredited Levee: Areas protected by an accredited levee, dike or other flood control structures. See Notes to Users for important information. |
| **OTHER AREAS** | |
| | Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible |
| NO SCREEN | Unshaded Zone X: Areas determined to be outside the 0.2% annual chance floodplain |
| **FLOOD HAZARD AND OTHER BOUNDARY LINES** | |
| | Flood Zone Boundary (white line) |
| | Limit of Study |
| | Jurisdiction Boundary |
| | Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet |
| **GENERAL STRUCTURES** | |
| *Aqueduct*<br>*Channel*<br>*Culvert*<br>*Storm Sewer* | Channel, Culvert, Aqueduct, or Storm Sewer |
| *Dam*<br>*Jetty*<br>*Weir* | Dam, Jetty, Weir |
| | Levee, Dike or Floodwall accredited or provisionally accredited to provide protection from the 1% annual chance flood |
| | Levee, Dike or Floodwall not accredited to provide protection from the 1% annual chance flood. |
| *Bridge* | Bridge |

| | |
|---|---|
| **COASTAL BARRIER RESOURCES SYSTEM (CBRS) AND OTHERWISE PROTECTED AREAS (OPA):** *CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. See Notes to Users for important information.* | |
| **CBRS AREA**<br>**09/30/2009** | Coastal Barrier Resources System Area: Labels are shown to clarify where this area shares a boundary with an incorporated area or overlaps with the floodway. |
| **OTHERWISE**<br>**PROTECTED AREA**<br>**09/30/2009** | Otherwise Protected Area |
| **REFERENCE MARKERS** | |
| 22.0 | River mile Markers |
| **CROSS SECTION & TRANSECT INFORMATION** | |
| B 20.2 | Lettered Cross Section with Regulatory Water Surface Elevation (BFE) |
| 5280 21.1 | Numbered Cross Section with Regulatory Water Surface Elevation (BFE) |
| 17.5 | Unlettered Cross Section with Regulatory Water Surface Elevation (BFE) |
| 8 | Coastal Transect |
| | Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation. |
| | Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping. |
| 513 | Base Flood Elevation Line (shown for flooding sources for which no cross sections or profile are available) |
| **ZONE AE**<br>**(EL 16)** | Static Base Flood Elevation value (shown under zone label) |
| **ZONE AO**<br>**(DEPTH 2)** | Zone designation with Depth |
| **ZONE AO**<br>**(DEPTH 2)**<br>**(VEL 15 FPS)** | Zone designation with Depth and Velocity |

| **BASE MAP FEATURES** | |
|---|---|
| *Missouri Creek* | River, Stream or Other Hydrographic Feature |
| 234 | Interstate Highway |
| 234 | U.S. Highway |
| 234 | State Highway |
| 234 | County Highway |
| MAPLE LANE | Street, Road, Avenue Name, or Private Drive if shown on Flood Profile |
| *RAILROAD* | Railroad |
| | Horizontal Reference Grid Line |
| | Horizontal Reference Grid Ticks |
| + | Secondary Grid Crosshairs |
| Land Grant | Name of Land Grant |
| 7 | Section Number |
| R. 43 W.  T. 22 N. | Range, Township Number |
| $^{42}76^{000m}\mathrm{E}$ | Horizontal Reference Grid Coordinates (UTM) |
| **365000 FT** | Horizontal Reference Grid Coordinates (State Plane) |
| **80° 16’ 52.5”** | Corner Coordinates (Latitude, Longitude) |

Table 3 is a list of the locations where FIRMs for Clackamas County can be viewed. Please note that the maps at these locations are for reference only and are not for distribution. Also, please note that only the maps for the community listed in the table are available at that particular repository. A user may need to visit another repository to view maps from an adjacent community.

Table 3 – Community Map Repositories

| Community | Address | City | State | Zip Code |
|---|---|---|---|---|
| City of Barlow | City Hall<br>106 North Main Street | Barlow | OR | 97013 |
| City of Canby | City Hall<br>182 North Holly Street | Canby | OR | 97013 |
| Clackamas County (Unincorporated Areas) | Clackamas County<br>City Hall<br>320 Warner Milne Road | Oregon City | OR | 97045 |
| City of Damascus | City Hall<br>19920 Southeast Highway 212 | Damascus | OR | 97089 |
| City of Gladstone | City Hall<br>525 Portland Avenue | Gladstone | OR | 97027 |
| City Happy Valley | City Hall<br>12915 Southeast King Road | Happy Valley | OR | 97086 |
| City Lake Oswego | City Hall<br>380 A Avenue | Lake Oswego | OR | 97034 |
| City of Milwaukie | City Hall- Public Works<br>6101 Southeast Johnson Creek Boulevard | Milwaukie | OR | 97206 |
| City of Oregon City | City Hall<br>320 Warner Milne Road | Oregon City | OR | 97045 |
| City of Rivergrove | City Hall<br>5311 Childs Road | Lake Oswego | OR | 97055 |
| City of Sandy | City of Sandy<br>City Hall<br>39250 Pioneer Boulevard | Sandy | OR | 97055 |
| City of West Linn | City Hall<br>22500 Salamo Road | West Linn | OR | 97068 |
| City of Wilsonville | City Hall<br>29799 Southwest Town Center Loop E | Wilsonville | OR | 97070 |

## 2.2 Community Description

Clackamas County is located in northwestern Oregon and is bordered to the west by Washington, Yamhill, and Marion Counties; to the east by Hood River and Wasco Counties; to the north by Multnomah County; and to the south by Marion County.

The county is in the northeastern portion of the Willamette valley. The eastern third of the county is part of Mt. Hood National Forest, extending from the foothills to the crest of the Cascade Range. The Willamette River lies immediately to the west of the county along most of its western boundary, and runs through the northwestern section of the county.

The Willamette Valley was one of the earliest settled areas in the Pacific Northwest. It was frequently visited by fur trappers in the l820s and l830s, and large-scale emigration over the Oregon Trail began in 1843.

Clackamas County was created by the provisional Government Legislative Committee on July 3, 1843, 16 years before Oregon obtained statehood. The county was named for the resident Clackamas Indians. The county boundaries encompass 1,890 square miles, including Oregon City, the county seat.

Most of Clackamas County is within a 1-hour drive of the City of Portland, making it a prime development area. The population of the county has increased rapidly since World War II. In 2000 the population was. 338,391. In 2010 the county population increased to 375,922.

Elevations within the county range from sea level at Milwaukie to 11,235 feet at the peak of Mt. Hood at the eastern county boundary. The average temperature is 65 degrees Fahrenheit (°F) in July and 43°F in January. Annual precipitation ranges from 32 inches to 100 inches.

Main transportation arteries serving Clackamas County include Interstate Highways 5 and 205, U.S. Highway 26, and State Highway 99E.

Abernethy Creek flows for approximately 16 miles through the hills east and north of Oregon City, joining the Willamette River from the east. The total drainage area of Abernethy Creek is 30 square miles.

The Clackamas River flows northwesterly for approximately 70 miles from its headwaters in the Cascade Range, then westerly for 10 miles to its confluence with the Willamette River. The total drainage area of the Clackamas River is 937 square miles.

The Clackamas River experiences a significant overflow during flood events near River Mile (R.M.) 7.6. The overflow follows a 1.2-mile-long natural channel that returns to the Clackamas River at R.M. 5.6.

Clear Creek flows southwesterly from its headwaters in the northeastern corner of the county to its confluence with the Sandy River, north of Zigzag. The total drainage area of Clear Creek is 9.3 square miles.

Deer Creek flows northwesterly to its confluence with Mt. Scott Creek, south of Harmony. The total drainage area of Deer Creek is 1.5 square miles.

Eagle Creek flows northwesterly to its confluence with the Clackamas River near Bonnie Lure. The total drainage area of Eagle Creek is 83.0 square miles.

Henry Creek flows westerly to its confluence with the Zigzag River, near Rhododendron. The total drainage area of Henry Creek is 3.6 square miles.

Johnson Creek flows southwesterly. It has a total drainage area of 54 square miles at its confluence with the Willamette River.

Kellogg Creek flows northwesterly for approximately 4.5 miles from its headwaters to its confluence with the Willamette River. The total drainage area of Kellogg Creek is 16.6 square miles.

Milk Creek flows westerly for 28 miles from its headwaters in the foothills of the Cascade Range to its confluence with the Molalla River. The total drainage area of Milk Creek is 108.0 square miles.

The Molalla River flows northerly for 50 miles from its headwaters near the southern county boundary to its confluence with the Willamette River. The total drainage area of the Molalla River is 878.0 square miles.

Mt. Scott Creek flows westerly from its headwaters to its mouth at Kellogg Creek. The total drainage area of Mt. Scott Creek is 10.2 square miles.

Oswego Canal connects Oswego Lake to the Tualatin River at R.M. 6.7. The canal flows northerly toward the lake for approximately 1.6 miles near the City of Lake Oswego.

Phillips Creek flows 1.5 miles southerly from its headwaters near Harmony Point to its confluence with Mt. Scott Creek, south of Harmony. The total drainage area of Phillips Creek is 2.4 square miles.

The Pudding River is a tributary of the Molalla River, flows northerly, and has a total drainage area of 530.0 square miles.

Rock Creek drains a watershed with a total area of close to 10 square miles and is the lowest contributing sub-basin to the Clackamas River.

Richardson Creek enters the Clackamas River approximately 2 miles upstream of the Rock Creek confluence. Its watershed is less than half the size of the Rock Creek Watershed with a drainage area of little more than 3 square miles. The Salmon River flows southwesterly from its headwaters near Mt. Hood, then northerly to its confluence with the Sandy River near Brightwood. The total drainage area of the Salmon River is 114.4 square miles. The Salmon River North Channel is a 0.4-mile-long overflow channel of the Salmon River that breaks away from the main channel near R.M. 4.8 and rejoins it near R.M. 4.2.

Still Creek flows northwesterly from its headwaters near Government Camp to its confluence with the Zigzag River near Rhododendron. The total drainage area of Still Creek is 23.0 square miles.

The Tualatin River is one of the larger tributaries of the Willamette River. Its basin is bounded by the Coast Range on the west, the Tualatin Mountains on the north and east, and several short mountain ranges on the south. The river flows easterly for more than 75 miles from its headwaters at the eastern edge of the Coast Range to its mouth at the Willamette River, near the City of West Linn. The total drainage area of the Tualatin River is 711 square miles.

The Willamette River, one of the principal rivers in Oregon, drains approximately 11,200 square miles of northwestern Oregon. Originating upstream of the City of Eugene at the confluence of its Middle and Coast Forks, the river flows 187 miles before entering the Columbia River downstream of Portland. Both the Clackamas and Molalla Rivers are tributaries of the Willamette River and are significantly affected by backwater from floods on that river.

The Zigzag River flows southwesterly from its headwaters near Mt. Hood, then northwesterly to its confluence with the Sandy River, near Zigzag. The total drainage area of the Zigzag River is 60 square miles.

The City of Barlow, a residential community on the western edge of Clackamas County, is approximately 18 miles south of Portland. The City of Canby lies approximately 1 mile to the northeast. Barlow is surrounded by unincorporated areas of Clackamas County. The total land area contained within the city limits is 35.39 acres or 0.06 square miles. According to U.S. Census Bureau figures, the population decreased from 140 in 2000 to 135 in 2010.

The topography of the Barlow area is generally level. Any grade in the area is very slight. Soil of the area is well-drained, sandy alluvium on valley terraces. Natural vegetation is coniferous Douglas fir and deciduous willows and alder.

The City of Canby is located in western Clackamas County, approximately 17 miles south of Portland. The City of Canby is completely surrounded by unincorporated Clackamas County. The total land area contained within the corporate limits is approximately 3.77 square miles. According to U.S. Census figures, the population of Canby increased from 12, 790 in 2000 to 15,829 in 2010.

The Willamette River flows along a portion of the northern boundary of Canby. Approximately 9,300 square miles of its drainage area is located upstream from Canby.

The Molalla River flows northerly and forms the western boundary of Canby.

Approximately 71% of the city has been developed. Within the floodplain, there is very little agricultural or urban development; however, the areas are zoned primarily for industrial use. Less than 1% of the total city housing lies within the floodplain.

The topography of the Canby area is generally very level. Any grade is very slight. The soil is a well-drained, sandy alluvium on valley terraces. Natural vegetation is coniferous Douglas fir and deciduous willows and alder.

The City of Damascus is located east of Happy Valley and Interstate 205 and west of Boring; its northern boundary is the Multnomah County line. According to

Oregon Geographic Names, Damascus can date its existence as a community back to 1867, when a post office by that name was established. The original heart of the community is along Oregon Highway 212, which as of 2004 serves as part of the city's southern boundary.

It is part of the North Clackamas School District and the Gresham-Barlow School District.

A 2000 decision by Metro to expand Portland's urban growth boundary into the area prompted some citizens of the community to submit Measure 3-138, a measure on the ballot for the 2004 general election. The initiative's passage resulted in the incorporation of the former unincorporated communities of Damascus and Carver into the City of Damascus, a step which prevents nearby cities from annexing the community. In a special election on September 21, 2005, a city charter was approved by 88 percent of voters.

The City of Gladstone, a rapidly growing suburb of the Portland, Oregon, metropolitan area, is located at the confluence of the Willamette and Clackamas Rivers. The community's commercial development is primarily a strip along Highway 99E, which extends north and south through the city and was for many years the main access to Willamette Valley. Now, the city is bypassed by HighwayI-205. Nearly all of the residential development extends eastward from Highway 99E. West of the highway, low-lying river frontage is used for agricultural and recreational purposes.

Gladstone's population has grown dramatically in recent years. According to the 2010 U.S. Census the population was 11, 497.

The climate consists of warm, dry summers and mild, wet winters. Temperatures are usually moderate, ranging from an average monthly minimum in January of 33°F to an average monthly maximum in July of 82°F. The average annual precipitation is 45.3 inches, with 86 percent of precipitation occurring form October to May.

The Willamette and Clackamas Rivers form Gladstone's corporate boundaries on the west and south. Willamette River, a tributary to the Columbia River, drains 11,200 square miles and has its origin at the confluence of its Middle and Coast Forks near Eugene, Oregon. Clackamas River, a tributary to Willamette River, drains 937 square miles and originates high in the Cascade Mountains.

Gladstone's 100-year floodplain is relatively undeveloped, except for a few residences and farms in the reach of Clackamas River upstream of Highway I-205. A 500-year flood would inundate a much larger area, including many residences on the east side of Highway 99E and a mobile home complex, apartments, a golf course and various businesses on the west side of the highway.

The City of Happy Valley is a city in Clackamas County, just east of Damascus. It has a total area of 2.7 square miles. The population was 13,903 at the 2010 Census. Happy Valley is part of the North Clackamas School District. Happy Valley was originally called Christilla Valley, named after its first residents, Christian and Matilda Deardorff. The city was officially incorporated in 1965. It remained a small community until the late 1990s, when urbanization of the surrounding area became inevitable. Happy Valley became one of the fastest-growing cities in Oregon.

The City has a mayor, along with four other city council members. There is also a planning commission, as well as a Park Advisory/Urban Forestry Commission and Citizen Traffic and Public Safety Committee.

Mount Scott, and extinct volcano that is part of the Boring Lava Field, is the highest point in Happy Valley, at 1,050 feet.

The City of Lake Oswego is located in the northwestern corner of Clackamas County, Oregon. It shares its northern boundary with of the City of Portland. There are 15.6 square miles (10,000 acres) within Lake Oswego's urban growth boundary. As of the 2010 census, the city had a total population of 36,619.

The Willamette River forms the eastern boundary of the City of Lake Oswego. Approximately 11,105 square miles of its drainage area are upstream of the City of Lake Oswego.

The Tualatin River flows easterly along the southern corporate limits of the city to its mouth at the Willamette River southeast of Lake Oswego. Approximately 690 square miles of its drainage area are upstream of the City of Lake Oswego. Oswego Lake is impounded by Oswego Dam, which is operated by the Lake Oswego Corporation for recreation and hydropower. Oswego Lake, which covers 0.7 square mile, divides the community into northern and southern sections. Blue Heron Bay, Lakewood Bay, and West Bay are extensions of the Lake. Oswego Creek drains the lake from Oswego Dam to the Willamette River. Oswego Canal flows northerly for approximately 1.6 miles and connects Oswego Lake to the Tualatin River at River Mile (R.M.) 6.7.

The comprehensive plan for the city is based on the urban growth boundary, which includes areas outside the corporate limits that are to be annexed in the future. As of 1987, a total of 15.6 square miles (10,000 acres) of land are located within the city's urban growth boundary. Sixty-five percent of this area has been developed. The area within the Willamette River flood plain is zoned for heavy industry, with 87.9 percent of that land actually developed for heavy industrial use. Development in the Tualatin River flood plain is completely residential.

The Tualatin Valley is generally flat or gently sloping. Soils in the area have poor drainage characteristics. Trees, grass and shrubs are the dominant vegetation.

The City of Milwaukie is located in the northwest corner of Clackamas County, along the Clackamas and Multnomah County line. It is situated immediately southeast of Portland, on the east bank of the Willamette River. Milwaukie's 2010 population was 20,291, down from the 2000 population of 20,490.

The Willamette River flows north along the western corporate limits. Upstream of Milwaukie, it drains approximately 11,130 square miles of central Oregon.

Johnson Creek drains a highly urbanized area northeast of Milwaukie. It has a total drainage area of 54 square miles, of which 45 square miles contribute directly to Johnson Creek runoff. The remaining 9 square miles drain into a depression upstream of the study area.

Kellogg Creek flows northwesterly along Milwaukie's southern corporate limits and has a drainage area of 16.6 square miles.

Commercial and industrial areas are primarily located in the southern and western portions of Milwaukie, while residential development is spread throughout the community. Milwaukie's central business district is located along Southeast McLoughlin Boulevard, near the Willamette River. Development within the flood plains include industrial sites along Johnson Creek and scattered business and residential structures along Willamette River and Johnson and Kellogg Creeks. Residential development has also occurred in a flood-prone depression near Southeast 46th Avenue and Southeast King Road.

The City of Oregon City is situated in the upper northwest corner of Clackamas County. The City of Gladstone is directly north of Oregon City on the opposite side of the Clackamas River, and West Linn is directly northwest of Oregon City on the opposite side of the Willamette River.

Oregon City is located on the southeast periphery of the Portland, Oregon, metropolitan urban area. The total land area contained within the corporate limits is 8.4 square miles. According to U.S. Census figures, the population increased from 8,000 in 1960 to 14,100 in 1977, to 31,859 in 2010.

The Willamette River flows northerly through Oregon City and forms its western corporate limits. Approximately 10,100 square miles of its drainage area are upstream of Oregon City.

The Clackamas River flows westerly and forms part of the northern corporate limits of Oregon City.

Abernethy Creek, also a tributary of the Willamette River, flows westerly through Oregon City. It extends approximately 16 miles and has a total drainage area of 30 square miles.

Approximately 70% of the city has been developed. Within the floodplains studied, development is mainly commercial as well as light and heavy industry. Less than 1% of the total city housing lies within the floodplain.

Oregon City is located along a gorge of the Willamette River. Development began adjacent to the river and progressed up and away from the river. The topography has formed a lower commercial-industrial area, an intermediate area with mixed commercial-residential development and an upper area that is predominantly residential.

Other than the rocky broken ground in the southeast portion of the city, the soil is typically silt loam or clay loam which naturally supports deciduous trees and shrubs, with a mix of coniferous trees.

The City of Rivergrove is a southern suburb of Portland, in the northwestern corner of Clackamas County. The total land area contained within the corporate limits is 0.18 square mile. According to the U.S. Census Bureau figures, the population decreased from 324 in 2000 to 289 in 2010. Development within the

Tualatin River basin is mainly residential. 55% of the housing in the city lies within the floodplain.

Located in the Tualatin Valley, the topography of Rivergrove is relatively flat and gently sloping. Soils in the area have poor drainage characteristics. Trees, grass, and shrubs are the predominant vegetation.

The City of Sandy is located in the Willamette Valley. The Willamette Valley was one of the earliest settled areas in the Pacific Northwest. It was frequently visited by fur trappers in the 1820's and 1830s, and large-scale emigration over the Oregon Trail began in 1843. Sandy's first post office was established in 1873 and the village became an incorporated City in 1913.

As of 2010, the City of Sandy had a population of 9, 570, and is located on the Mt. Hood Highway (U.S. Highway 26), midway between Portland and Mt. Hood.

Residents of the City enjoy a mild climate, clean air, good water, beautiful scenic views in a country setting, and all the advantages of small-town living while being only 45 minutes from the urban amenities of downtown Portland.

Though the City of Sandy's heritage was logging and saw milling, today's economic activity ranges from light industrial manufacturing to service businesses. Many Sandy residents commute to jobs in nearby Portland. Agricultural crops in the surrounding area are primarily nursery stock and a variety of berries.

U.S. Highway 26 remains a major thoroughfare for travelers and for commerce. Agriculture is central to the area's economic stability, and industrial activity is increasing.

The City of West Linn, a rapidly growing suburb of Portland, is located at the confluence of the Willamette and Tualatin Rivers. The city stretches for 6 miles along the west bank of the Willamette River in an area characterized by rolling hills and random development. Several concentrations of residential development occur throughout the area. Commercial development is centered near the Oregon City-West Linn Bridge, and an industrial district fronts on Willamette River upstream of the bridge. Major industries located at one time there included a paper mill and a hydroelectric plant adjacent to Willamette Falls. At Willamette Falls, a navigational lock enables river traffic to bypass the 45-foot falls. Highway transportation is provided by State Highway 43 and I-205.

Settlement of the West Linn area, once known as Robins Nest, began in 1840. In 1850, the legislature named the area Linn City. In 1923, the area was incorporated under the name West Linn.

The population of West Linn grew dramatically in the mid-1900s and continues to do so today. According to census of 2010, there were 25,109 inhabitants.

The City of Wilsonville is situated in the northwestern corner of Clackamas County and the southeastern corner of Washington County, in northwestern Oregon. Oregon City is approximately 9 miles northeast of Wilsonville, and the City of Canby lies approximately 5 miles southeast. Wilsonville is bordered by unincorporated areas of Clackamas County on all sides except the north where it borders unincorporated Washington County. The total land area contained within the corporate limits is 5.92 square miles. The population of Wilsonville increased from 1,009, when it was incorporated in 1969, to 2,040 in 1977. According to U.S. Census Bureau figures, Wilsonville had a 2000 population of 13,991, and grew to 19,509 at the 2010 census.

Seely Ditch, which flows southerly, is a minor tributary of the Willamette River. It extends approximately 5.2 miles from its origin to Willamette River. The total drainage area of Seely Ditch is 8.2 square miles.

Boeckman Creek, also a tributary of the Willamette River, flows southerly through Wilsonville. It extends approximately 4.2 miles and has a total drainage area of approximately 2.0 square miles.

Corral Creek, also a tributary flowing southeasterly to the Willamette River, is 6.8 miles long and has a total drainage area of 10.9 square miles.

Approximately 19 percent of the city has been developed. Within, the flood plains studied, development is residential, commercial, and light industrial.

The terrain in the Wilsonville area is generally flat, with slopes of less than 3 percent. There are some areas of low, gently rolling hills. Soil consists of a large deposit of lacustrine gravel (bouldry pebble and cobble gravel in silt and coarse sand) for approximately 1 mile north of Willamette River. A young alluvium (sand and clay) has been deposited over Willamette silt (unconsolidated sediments, silt, and fine sand) along stream banks and floodplain areas. A wide variety of trees is common in the area. This includes ash, cottonwood, maple, willow, dogwood, oak, Douglas fir, hemlock, cedar, sycamore, and poplar. A variety of grasses and smaller plants forms the understory. Undergrowth, bushes, and trees are especially dense along the Willamette River, Boeckman Creek, and Seeley Ditch.

## 2.3 Principal Flood Problems

Historically, flooding within Clackamas County normally occurs from October through April. Cyclonic winter storms from the Pacific Ocean sometimes produce intense rainfall on drainage basins of the Pacific Northwest. When these storm fronts move in a downstream direction, greater discharges are produced. If this condition is accompanied by rapid snowmelt and frozen ground in the upper watersheds, large floods can result.

Floods in the study area are normally widespread rather than limited to a few streams. Because of longer travel times between the upstream headwaters and the study area, crests on larger rivers occur several days later than those on some of the smaller tributaries. For example, the Willamette River remains above the bankfull stage for approximately 10 days following a major flood, whereas most tributaries recede to within their banks in 4 or 5 days. The Tualatin River is an exception because there is considerable ponding in the middle and lower reaches.

The February, 1996 flood on the Tualatin River produced the highest flows ever recorded, with an estimated 84-year return period and an annual probability of recurrence of 1.2%. However, for almost all of the smaller urbanized Tualatin River tributaries that were studied, the November 1996 flood is thought to be the largest flood ever observed with an estimated 25-year return period and an annual probability of recurrence of 4%. Other major floods have occurred on the

Tua1atin River. Prior to the floods of 1996, a flood occurred on January 18, 1974, and had peak discharge of 21,400 cfs. On December 23, 1933, a flood occurred that had a recorded flow of 23,300 cfs at the West Linn gage and 6,000 cfs at the Oswego Canal gage.

A number of major floods have occurred on the Willamette River. The largest recent flood occurred as the result of a December 1964 storm that dropped 6 to 10 inches of rainfall over the watershed and caused the freezing level to rise to the 10,000-foot elevation. A peak discharge of 403,000 cubic feet per second (cfs) for this flood was observed on December 24, 1964, at the Wil1amette Locks Upper Gage in Oregon City. This discharge exceeded the projected 100-year (1-percent-annual-chance) floodflow of 341,000 cfs. The flood of December 1861 is believed to be the greatest historical flood, with a peak discharge at the same gaging station estimated at 590,000 cfs.

The second largest historical flood, in 1890, had an estimated discharge of 510,000 cfs. Both floods exceeded the 500-year (0.2-percent-annual-chance) floodflow of 469,000 cfs. The January 9, 1923, peak discharge of 357,000 cfs and the January 3, 1943, peak discharge of 324,000 cfs are the fourth and fifth largest recorded floods, for the Wi11amette River at the Wi11amette Locks Upper Gage.

Major floods have also occurred on the Mo1a11a River. The largest recorded flood at the gage near Canby occurred on December 22, 1964, and had a peak discharge of 43,600 cfs. Other major floods on the Molal1a River occurred in January 1972 and January 1974, and had peak discharges of 36,200 cfs and 31,200 cfs, respectively. The estimated 1-percent-annual-chance flood discharge for the Mo1a1la River at the gaging station near Canby is 41,200 cfs.

The largest recorded flood on the Clackamas River at the gage near the City of Clackamas occurred on December 22, 1964, and had a peak discharge of 120,000 cfs. The estimated 1-percent-annual-chance flood discharge at this point is 110,000 cfs.

Industrial, commercial, and residential developments in the flood plains of the streams studied are found only near the incorporated communities in the northwestern corner of the county. Elsewhere, the flood plains are generally devoted to agricultural use.

City of Barlow

Major floods have occurred on the Pudding River. The largest recorded flood at the gaging station at Aurora occurred on December 23, 1964, with a peak discharge of 26,200 cfs. This discharge is less than the estimated 1%-annual-chance flow of 30,100 cfs. Other major floods on Pudding River occurred in December, 1937 and February, 1949, with peak discharges of 25,400 cfs and 22,200 cfs, respectively.

City of Canby

The major developed area of the City of Canby lies almost entirely above the historic high-water levels of Willamette and Molalla Rivers. The flood damages that have occurred within the city have been limited to agricultural lands in the

Willamette and Molalla River flood plains. High channel velocities on Molalla River have caused erosion and, in some cases, channel migration.

City of Gladstone

Floods in Gladstone are caused by bank overflow from both the Willamette and Clackamas Rivers and to a lesser extent, by ponding resulting from local storm runoff. The annual flood season extends from October through April, the period of the greatest storm activity. Major riverine floods usually result from intense rainfall augmented by snowmelt.

Many large floods have occurred on the Willamette and Clackamas Rivers in the past. Severe floods of approximately 100-year frequency occurred on both streams in December 1964; however, Gladstone experienced only moderate damages, mainly because the areas susceptible to flooding were generally known and development was avoided. The regulated peak flow of the Willamette River during that flood was 435, 00 cfs, while Clackamas River peaked at 120,000 cfs. Floods on Clackamas River and Willamette River usually occur together, although Clackamas River crests 1 to 2 days prior to Willamette River.

City of Lake Oswego

Flooding on Oswego Canal is a result of overflow from the Tualatin River.The flood of February 1996 caused extensive property damage within the City of Lake Oswego, particularly areas affected by unusually high flooding from the Willamette and Tualatin Rivers. Flooding along the rivers was understandable, but many people were surprised at the extensive flooding of areas along the Oswego Canal and the shore of Oswego Lake (including portions of downtown Lake Oswego along McVey and State Streets) when a significant volume of floodwater spilled from the Tualatin River over the canal headgate and through the Tualatin River Overflow to Rivergrove, flooding the Oswego Canal and overwhelming the capacity of the Oswego Lake Dam. The resulting lake level was almost 4 feet higher than normal high water.

City of Milwaukie

The largest flood this century on Willamette River occurred in December 1964. The peak discharge in the vicinity of Milwaukie was 440,000 cubic feet per second (cfs), with an estimated recurrence interval of 120 years. Business and residential areas along Willamette River, as well as the city's sewage treatment plants, were inundated. Willamette River backwater extended approximately 1 mile up both Johnson and Kellogg Creeks, flooding industrial and residential areas along those streams. Figure 2 shows flooding in December 1964. Other large floods on Willamette River occurred in January 1923 (421,000 cfs) and January 1943 (367,000 cfs).

Flood discharges above 2,000 cfs have been recorded four times on Johnson Creek since the USGS established a stream gage at Sycamore, approximately 9 miles upstream of Milwaukie, in 1940. The largest discharge, 2,620 cfs, occurred in December 1964. That flood had an estimated recurrence interval of only 15 years. Additional discharges greater than 2,000 cfs were 2,220 cfs in January 1969, 2,180 cfs in November 1960, and 2,110 cfs in February 1949. Those floods caused minor damages in Milwaukie. Several bridges present severe restrictions to flow, which result in localized increases in flood heights.

The largest discharge on Kellogg Creek also occurred in December 1964. There are no stream gages on Kellogg Creek, but it was estimated that the December 1964 flood had a discharge of 1,570 cfs and a recurrence interval of 25 years. That flood caused little damage along Kellogg Creek, outside of the area affected by the Willamette River backwater. There are no constrictions on Kellogg Creek that aggravate flooding problems in Milwaukie.

Flooding from Mount Scott Creek, a tributary to Kellogg Creek, has occurred near the intersection of Rusk and Lake Roads. There are no recorded discharges on Mount Scott Creek, but it was estimated that the peak discharge in December 1964 was 1,160 cfs. There was minor residential flooding along Mount Scott Creek during that flood.

Local ponding has occurred in the depression near Southeast 46th Avenue and Southeast King Road, but it has been limited to the flooding of streets and has not involved any structures. Runoff from approximately 450 acres is trapped in the depression.

Major floods have occurred on the Clackamas River. The largest recorded flood at the gage near Oregon City occurred on December 22, 1964, with a peak discharge of 120,000 cfs. Other major floods on the Clackamas River occurred in March 1931, January 1923, and November 1960, with peak discharges of 82,000 cfs, 80,000 cfs and 73,000 cfs, respectively. The estimated 1%-annual-chance discharge for the Clackamas River at the gaging station near Oregon City s is 110,000 cfs.

Oregon City has sustained damage from flooding of the Willamette and Clackamas Rivers. The 1861 Willamette River flood inundated the main streets of Oregon City with 4 feet of water. Although the 1890 Willamette River flood had a smaller discharge than the 1861 flood, water from the later flood rose to a level 2.1 feet above the earlier flood, due to the presence of buildings along the river which reduced the channel capacity in Oregon City. The December 1964 flood also caused extensive damage in Oregon City. Waterfront industry and shopping areas along the Willamette and Clackamas Rivers received significant damage from this flood.

Major floods have occurred on the Tualatin River.  The largest recent flood occurred on February 10, 2006, with a peak discharge of 26,400 cfs. The estimated 1-%- annual-chance flow at the West Linn gage on the Tualatin River is 23,455 cfs.

Since 1979 when the original approximate study of Tickle Creek in the City of Sandy was performed, the City has annexed new areas along the creek. Development is progressing at a rapid pace as evidenced by newly constructed roads and new subdivisions.

One unnamed tributary along Tickle Creek, an urban creek, is confined to culverts of irregular sizes in many places. The unnamed tributary causes flooding problems of approximately 6 inches in places where it daylights, but the water does not presently threaten any living spaces and is primarily nuisance flooding of some streets. City planners are concerned about the flows and flooding increasing due to the increasing development and larger areas of impermeable ground.

The largest flood of historical record on Willamette River occurred in December, 1861, with an estimated flow of 590,000 cfs at West Linn. Many large floods have occurred since then. The next 5 largest floods, in order of descending magnitude, occurred in February 1890, December 1964, January 1923, January 1943, and December 1955. The Willamette River flood of December 1964, had it not been regulated by upstream storage projects, would have been approximately equal to the 1861 flood. The December 1964 flood reached approximately a 1-%-annual-chance magnitude and had a peak flow at West Linn of 403,000 cfs. A corresponding crest elevation of 70.1 feet MSL, 1947 adjustment, was recorded at the Willamette Falls upper gage. The December 1964 flood caused considerable damage to the study area. The paper mill on Moores Island and those low-lying residences were especially hard hit.

Floods have been observed on Seely Ditch, and Boeckman and Corral Creeks; however, there are no gaging stations on these streams, and as a result, no records of major floods are available.

Flooding in the Lower Columbia-Sandy Watershed in Clackamas County occurs along the banks of Sandy River and its tributaries, including Salmon and Zigzag Rivers, and Clear, Cedar, Henry, and Still Creeks. Flooding typically occurs from October through April, exacerbated by intense rainfall from winter storms.

The Sandy River is Clackamas County's main source of riverine flooding, and there have been at least four floods since 1861 that have been estimated to have exceeded the 1% annual chance flood. The Sandy River is a dynamic channel that drains the western flank of Mount Hood, and storm events combined with snowmelt from its upper reaches can cause extensive flooding and channel migration.

Flooding in the upper Sandy River area is due to channel aggradation and movement, debris in the waterways, heavy rainfall, and snowmelt. Dynamic and augmented streams in developed areas can cause major property and environmental damage.

Cedar Creek floods during the winter months due to increased rainfall, upstream snowmelt, and riverine debris interacting with flood control structures.

The main areas of flooding in the Zigzag River area are those where development has caused the river to be constrained, thus creating a conflict between developed areas and peak flow. These streams flood frequently.

Flooding in the Salmon River area is largely due to riverine structures, particularly bridges, restricting the river flows and rendering existing peak flow data inaccurate.

The main areas of flooding in the Zigzag River area are those where development has caused the river to be constrained, thus creating a conflict between developed areas and peak flow. These streams flood frequently.

The main areas of flooding in the Zigzag River area are those where development has caused the river to be constrained, thus creating a conflict between developed areas and peak flow. These streams flood frequently.

## 2.4 Flood Protection Measures

Levees exist in the study areas that provide the county with some degree of protection against flooding. However, it has been ascertained that some of these levees may not protect the community from rare events such as the 1-percent-annual-chance flood. The criteria used to evaluate protection against the 1-percent-annual-chance flood are 1) adequate design, including freeboard, 2) structural stability, and 3) proper operation and maintenance. Levees that do not protect against the 1-pecent-annual-chance flood are not considered in the hydraulic analysis of the 1-percent-annual-chance floodplain.

Other levees may exist within Clackamas County. Levees not identified in this section are not known to have the necessary features to provide protection from a flood with a 1-percent chance of annual occurrence.

Willamette River flood stages have been reduced significantly by 14 storage projects operated by the USACE. These projects have been placed in operation since 1942 and provide a total flood-storage capacity of 1.7 million acre-feet. Three more reservoirs are authorized and are in preliminary planning stages as of 2005.

The Tualatin River basin has one multipurpose storage project available for flood control. Henry Hagg Lake Project, constructed by the U.S. Bureau of Reclamation, began operation during the 1974—75 flood seasons. It provides 30,000 acre-feet of flood storage, starting in November of each year. The flood-storage capacity is reduced as the winter flood season terminates, and the reservoir is filled each spring in anticipation of the summer irrigation demand. The effect of the Henry Hagg Lake Project on flood storage has been considered in the calculation of water-surface profiles for the segment of the Tualatin River near the City of Lake Oswego. Located approximately 50 miles upstream, this storage facility is distant enough that the effect it would have on the 1- and 0.2-percent-annual-chance floods is negligible. The U.S. Bureau of Reclamation has completed a draft feasibility study of two alternative storage projects on the Tualatin River near the Town of Gaston that could provide additional flood storage in the Tualatin River basin. Those projects, however, are still in the planning stages and are not reflected in this study.

There are no flood control structures on Johnson, Kellogg, or Mount Scott Creeks. In an effort to reduce flood losses, The City of Milwaukie has established a flood hazard zoning ordinance that requires planning commission approval for building permits within the 1%-annual-chance flood plain. When reviewing a building permit application, the planning commission considers such factors as the danger to life and property due to increased flood heights or velocities caused by encroachments, the ability of water supply and sanitation systems to prevent unsanitary conditions, and the availability of alternative locations not subject to flooding.

Regulatory measures have been adopted by the City of Oregon City to guide new development in the floodplain consistent with the hazards involved (Reference 11). Finished floors must be at least 2 feet higher than the 1%-annual-chance flood, and development within the floodway which would hinder flow is not permitted.

Regulatory measures have been adopted by the City of Rivergrove to guide new development in the floodplain consistent with the hazards involved. New residential development must be adequately protected from flooding, and development within the floodway that would hinder flow is not permitted.

In West Linn, Levees provide flood protection for industrial waste lagoons on the left bank, upstream of Willamette Falls. Those levees, although constructed above 500-year flood levels, are not recognized by the National Flood Insurance Program consequently are not reflected on the Flood Insurance Rate Map. West Linn has also adopted land use regulatory measures to guide new development in the floodplain consistent with the hazard involved. Current ordnances require that building foundations be at least 1 foot higher than the 1%-annual-chance flood.

Regulatory measures have been adopted by the City of Wilsonville to prevent construction within 5 feet of the 1%-annual-chance flood elevation on the Willamette River in Wilsonville.

River stage forecasting for Clackamas County is the responsibility of the Portland River Forecast Center, National Weather Service. Forecasts and flood warnings prepared by the center are disseminated through Clackamas County Emergency Services, radio, television, and other news media. Forecasts are prepared for the USGS gages on the Clackamas River near Clackamas and on the Tualatin River at West Linn. Forecasts are also prepared for the USACE gages above and below Willamette Falls on the Willamette River.

## 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 1-percent-annual-chance (100-year) flood 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.

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 exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 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.

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The flood peak discharges used for mapping the flooding along the main stem of the Tualatin River including the Tualatin River Overflow to Rivergrove and the Oswego Canal were based on a flood frequency analysis of historic gaged annual peak flows after accounting for the effect of the upstream regulation at Hagg Lake. Flow losses observed at the Tualatin River Overflow to Rivergrove and the Oswego Canal were considered at downstream locations along the Tualatin River. A stream gage on Oswego Canal has been maintained by USGS since 1928 to measure outflow from the Tualatin River. The flood peak discharges for mapping the flooding along the tributary waterways of the Tualatin River were based on HEC-HMS hydrologic modeling of these watersheds. The Tualatin River basin study included a new analysis of lake levels, inflow, and outflow for Lake Owego.

Peak discharge-frequency relationships for Abernethy, Deer, Kellogg, Mt. Scott, and Phillips Creeks were developed by a regional hydrologic analysis using previously computed discharge-frequency information and statistical analyses of recorded runoff data for other nearby streams. Because there are no long-term gaging stations on these streams, the hydrologic analysis could not be based on the statistical approach that was used for streams with gage data. The regional analysis was performed using discharge-frequency curves developed by the USACE. The curves were adjusted slightly on the basis of the discharge-frequency curves for Johnson Creek, at the Sycamore gaging station.

Clackamas River discharge-frequency data (Reference 14) were based on records from the USGS gaging station at R.M. 4.9. Those records have been continuous since October 1962, the date of installation. Another gage, at Estacada (at R.M. 23.1), has had a continuous record since 1908. Flood data before 1962 were extrapolated by correlation with the Estacada gage.

Discharge-frequency data for the following streams were developed using methodology developed by USGS (Reference 9). Clear Creek, Eagle Creek, Henry Creek, Milk Creek, Salmon River, Sandy River, Still Creek, and Zigzag River. The 10-, 50-, and 1-percent-annual-chance flood discharge frequencies were obtained using this methodology, whereas the .2%-annual-chance flood discharge frequencies were determined by extrapolating the lower recurrence interval data on a log-probability plot.

The peak discharges for floods on the Molalla and Willamette Rivers and Johnson Creek were determined by statistical analysis of river-gage records, using the standard log Pearson. Type III method as outlined by the U.S. Water Resources Council.

Molalla River discharge-frequency data were based on records from the USGS gaging stations at Goods Bridge, near Canby (No. 14200000), and above Pine Creek near Wilhoit (No. 14198500) (Reference 16). The records for these two gages are continuous from the times that records were first kept, October 1929 and October 1936, respectively. The Goods Bridge gage, was discontinued in May 1979. The Pine Creek gage is still in operation.

Peak discharges for the Willamette River were based on stage-frequency curves for gages at Willamette Falls Locks and Wilsonville, (References 17 and 18, respectively). The flows were derived by correlation of stream flow records (Reference 19) and the discharge frequency curve (Reference 20) for the gage upstream of the study area at the City of Salem, Oregon.

Willamette River stages were first recorded in 1879, at the Portland Morrison Bridge, by the U.S. Weather Bureau (Reference 21). The gages at Willamette Falls Locks and Salem have also had long periods of record, dating back to 1915 and 1909, respectively. The gage at Wilsonville was established in 1948. Willamette Falls Locks gage is operated by the USACE, and the other gages are operated by the USGS.

Flows into Nyberg Slough and Salmon River North Channel were determined through divided flow analyses using rating curves developed for the hydraulic analysis. Discharge-frequency data for the Pudding River were obtained from a 1970 USACE Flood Plain Information report.

The discharge-frequency data for Tickle Creek were developed using a set of USGS regional regression equations that relate basin characteristics to streamflow characteristics for western Oregon. Using the size of the drainage area and the regression equations, the discharges at two locations in the study reach were determined for the various flood events.

The June 2005 hydrologic study of Rock and Richardson Creek, which was performed by Pacific Water Resources, Inc. (PWR), was developed using USGS regional regression equations. The 10-, 2-, and 1-percent-annual-chance flood discharge frequencies were obtained using the USGS developed equation. PWR extended the equation to estimate values for the 0.2-percent chance flow.

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 4. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Several sections of the Sandy River in Clackamas County rely on effective hydrologic analysis from the previous Flood Insurance Study. For these sections, discharge-frequency data was developed using methodology developed by USGS (USGS 1979). The 10-, 50-, and 1-percent-annual-chance flood discharge frequencies were obtained using this methodology, whereas the .2%-annual-chance flood discharge frequencies were determined by extrapolating the lower recurrence interval data on a log-probability plot.

**This Physical Map Revision**

For the updated Sandy River watershed analysis, any years with maximum value discharges in April-September were analyzed to determine if there was a separate population within the data. This was not the case for the gages within the Sandy River watershed. Either all annual peak flood events occurred in the winter season, October-March, or there were a small number of years where the annual maximum occurred in the spring season, April-September, and therefore observations were not in the magnitude of the period of record maximum. The exception was the Sandy River where 10 years of the 99 years of recorded annual flood peaks occurred outside of the winter season. Again, the annual maxima did not approach the magnitude of the period of record observed peaks. This proved to have minimal affect on the outcome of the statistical analysis.

Salmon River had two separate gages with similar drainage areas, and slightly different periods of record. To determine the discharges for the Salmon River, the two weighted discharges were weighted with each other to produce a single discharge- drainage area relationship to be used for the Salmon River. This relationship was applied to the Salmon River only.

Eight USGS gages within the Sandy River watershed were used to develop discharges along the study reaches, seven of which are in Clackamas County: USGS gage 14131400 Zigzag River near Rhododendron Oregon (USGS, 2011c), USGS gage 14135000 Salmon River at Welches Oregon (USGS, 2011d), USGS gage 14135500 Salmon River at Boulder Creek near Brightwood Oregon (USGS, 2011e), USGS gage 14137000 Sandy River upstream of Marmot Dam (USGS, 2011f), USGS gage 14140000 Bull Run River near Bull Run, Oregon (USGS, 2011g), USGS gage 14141500 Little Sandy River near Bull Run, Oregon (USGS, 2011h), and USGS gage 14142500 Sandy River below Bull Run River (USGS, 2011i).

The gage data was analyzed by Bulletin 17B (WRC 1981) methodology and the log-Pearson Type III distribution, using the USGS PeakFQ computer program (Flynn, et al, 2006). The Sandy River gage (14137000), discharges below 5,000 cubic feet per second (cfs) were considered to be outliers, based on information provided in the USGS regional regression equation report for Oregon. Additionally, the State of Oregon has a specific mean square error value of 0.112 which was used in the PeakFQ program.

Based on historical data, and USGS documentation, October-March is the winter storm season. The USGS investigated the seasonal occurrence of 9,372 observed peak discharges for western Oregon (Cooper, 2005). The peak discharges were grouped by season, with winter defined as November through March (rain or rain on snow) and spring as April through June (snowmelt). The data clearly demonstrated that the majority of annual peak floods occur in the winter season (93.5 percent) with only 6.2 percent occurring in the spring season (see Cooper, 2005, Table 1.).

The 24-hour rainfall depths were based on the Oregon Department of Transportation's precipitation-frequency analysis for 24-hour precipitation for Oregon (ODOT, 2008). The total rainfall depths were distributed following a Natural Resource Conservation Service (NRCS) Type 1A storm distribution.

The rainfall losses were estimated using the NRCS approach presented in Technical Release 55. A curve number was determined for each sub-basin based on the soil type, hydrologic soil group, and land use.

Sub-basin response for Cedar Creek and Sandy River were estimated using methodology described in U.S. Geological Survey Water Investigations Report 80-689 (USGS, 1980). The lag time ($t_L$) was used to transform the unit hydrograph for a sub-basin to a hydrograph of direct runoff for the estimate of peak discharge. The lag time was based on the channel being considered fully developed (F) or natural (N).

Sub-basin reach routings were estimated using the Muskingum-Cunge Method.

One storage areas was modeled in the analysis. The storage area was routed based on stage-discharge outlet relationships and stage-storage relationships. The outlet structure information was provided by the City of Gresham.

Peak discharge-drainage area relationships for the streams studied by detailed methods in Clackamas County are shown in Table 4**,** "Summary of Discharges."

Table 4 - Summary of Discharges

Peak Discharges (cubic feet per second)

| Flooding Source and Location | Drainage Area (square miles) | 10-Percent-Annual-Chance | 2-Percent-Annual-Chance | 1-Percent-Annual-Chance | 0.2-Percent-Annual-Chance |
|---|---|---|---|---|---|
| Abernethy Creek | | | | | |
| At mouth | 30.0 | 2,460 | 3,930 | 4,560 | 6,660 |
| Cedar Creek | 14.54 | 1,678 | 2, 360 | 2, 608 | 3, 230 |
| Clackamas River | 937.0 | 65,000 | 95,000 | 110,000 | 145, 000 |
| At mouth | 683.0 | 46, 900 | 68, 900 | 78,700 | 102, 800 |
| Clear Creek | 9.3 | * | * | 1,705 | * |
| At mouth | | | | | |
| Deer Creek | 1.5 | 130 | 220 | 285 | 405 |
| At mouth | | | | | |
| Henry Creek | 3.6 | 500 | 800 | 900 | 1,200 |
| At Mouth | | | | | |
| Johnson Creek | 54.0 | 1,900 | 2,600 | 2,900 | 3,390 |
| At Mouth | 49.0 | 1, 870 | 2, 590 | 2, 270 | 3, 080 |
| Upstream study limits | | | | | |
| Kellogg Creek | | | | | |
| At mouth | 16.6 | 1,290 | 1780 | 1,900 | 2,500 |
| Upstream of confluence with Mt. Scott Creek | 2.8 | * | * | * | * |
| Milk Creek | | | | | |
| At mouth | 108.0 | 8, 100 | 12, 100 | 14,000 | 18,900 |
| Upstream of confluence with Cedar Creek | 67.7 | 6,200 | 9,200 | 10,600 | 14,100 |
| Molalla River | | | | | |
| At mouth | 878.0 | 47,000 | 63,500 | 73,000 | 97,000 |
| At confluence with Pudding River | 346.0 | 25,000 | 36,000 | 41,200 | 54,500 |
| Upstream of confluence with Milk Creek | 215.0 | 20,100 | 29,00 | 33,000 | 43,000 |

*Not calculated for this FIS project

Table 4 - Summary of Discharges

Peak Discharges (cubic feet per second)

| Flooding Source and Location | Drainage Area (square miles) | 10-Percent-Annual-Chance | 2-Percent-Annual-Chance | 1-Percent-Annual-Chance | 0.2-Percent-Annual-Chance |
|---|---|---|---|---|---|
| Mt. Scott Creek | | | | | |
| At mouth | 10.2 | 940 | 1,300 | 1,440 | 1,750 |
| Oswego Canal | | | | | |
| At Bryant Road | * | 250 | 2,700 | 5,700 | 12,500 |
| At divergence from Tualatin River | * | 250 | 1,600 | 2,800 | 6,200 |
| Phillips Creek | | | | | |
| At mouth | 2.4 | 210 | 270 | 310 | 370 |
| Pudding River | | | | | |
| At mouth | 530.0 | * | * | 32,000 | * |
| Richardson Creek | | | | | |
| Upstream of Confluence with Clackamas River | 4.2 | 466 | 618 | 677 | 761 |
| Downstream of Confluence with Richardson Creek Anderson | 3.5 | 353 | 522 | 571 | 641 |
| Downstream of Confluence with Richardson Creek Royer Road Tributary | 2.3 | 259 | 346 | 376 | 423 |
| Richardson Creek Royer Road Tributary Upstream of Confluence with Richardson Creek | 0.8 | 95 | 128 | 138 | 155 |
| Richardson Creek Anderson Road Tributary Upstream of Confluence with Richardson Creek | 0.7 | 87 | 118 | 127 | 143 |
| Richardson Creek Keller Road Tributary Upstream of Confluence with Richardson Creek | 0.4 | 45 | 61 | 65 | 73 |

*Not calculated for this FIS project

Table 4 - Summary of Discharges

Peak Discharges (cubic feet per second)

| Flooding Source and Location | Drainage Area (square miles) | 10-Percent-Annual-Chance | 2-Percent-Annual-Chance | 1-Percent-Annual-Chance | 0.2-Percent-Annual-Chance |
|---|---|---|---|---|---|
| Rock Creek Upstream of Confluence with Clackamas River | 10.3 | 1,071 | 1,408 | 1,155 | 1,747 |
| Rock Creek South Golf Course Tributary Downstream of Confluence with Rock Creek | 7.4 | 787 | 1,038 | 1,143 | 1,284 |
| Rock Creek North Golf Course Tributary Downstream of Confluence with Rock Creek | 6.2 | 669 | 883 | 971 | 1091 |
| Rock Creek | 5.4 | 586 | 775 | 850 | 955 |
| Hemrick Road Tributary At Private road | 2.4 | 271 | 361 | 393 | 442 |
| Rock Creek Hemrick Road Tributary Upstream of Confluence with Rock Creek | 2.1 | 240 | 320 | 348 | 391 |
| Rock Creek North Golf Course Tributary Upstream of Confluence with Rock Creek | 0.5 | 58 | 79 | 85 | 95 |
| Rock Creek South Golf Course Tributary Upstream of Confluence with Rock Creek | 0.4 | 54 | 73 | 78 | 88 |
| Rock Creek 172nd Avenue Tributary Upstream of Confluence with Rock Creek | 0.6 | 80 | 108 | 116 | 130 |

*Not calculated for this FIS project

## Table 4 - Summary of Discharges (continued)

Peak Discharges (cubic feet per second)

| Flooding Source and Location | 1-Percent-Annual-Chance | 0.2-Percent-Annual-Chance | Flooding Source and Location | Drainage Area (square miles) | 10-Percent-Annual-Chance |
|---|---|---|---|---|---|
| Rock Creek<br>Highway 224 Tributary<br>Upstream of Confluence with Rock Creek | 0.8 | 101 | 136 | 147 | 165 |
| Salmon River | 88 | 6,903 | 10,504 | 12,039 | 16,085 |
| Salmon River (Upstream of confluence with Cheeney Creek) | 115 | 9,070 | 13,800 | 15,818 | 21,133 |
| Sandy River (At Mouth) | 502 | 51,668 | 74,628 | 85,139 | 112,342 |
| Sandy River (At Dabney Park) | 483 | 49,672 | 71,742 | 81,853 | 107,994 |
| Sandy River (Downstream of Confluence with Bull Run) | 436 | 44,742 | 64,615 | 73,737 | 97,256 |
| Sandy River (Upstream of confluence with Alder Creek) | 248.9 | 25,940 | 39,538 | 46,090 | 63,291 |
| Sandy River (Upstream of confluence with Clear Creek) | 41.1 | 4,407 | 6,357 | 7,182 | 9,353 |
| Seeley Ditch<br>At Confluence with Willamette<br>River At Wilsonville Road | 8.2<br>* | 493<br>398 | 706<br>516 | 777<br>587 | 950<br>730 |
| Still Creek | 22.8 | 2,527 | 3,603 | 4,030 | 5,134 |

*Not calculated for this FIS project

Table 4 - Summary of Discharges (continued)

Peak Discharges (cubic feet per second)

| Flooding Source and Location | 1-Percent-Annual-Chance | 0.2-Percent-Annual-Chance | Flooding Source and Location | Drainage Area (square miles) | 10-Percent-Annual-Chance |
|---|---|---|---|---|---|
| Tickle Creek | | | | | |
| At downstream study limit (Approximately 2,600 feet downstream of northeast 362nd Street) | 3.9 | 368 | 549 | 633 | 807 |
| Upstream of confluence with Unnamed Tributary (Highway 211) | 1.7 | 176 | 236 | 303 | 388 |
| Tualatin River | | | | | |
| At mouth | 706.0 | 15,750 | 24,200 | 27,900 | 36,000 |
| Downstream of overflow through Rivergrove | 698 | 16,000 | 25,800 | 30,700 | 42,200 |
| Downstream of confluence with Nyberg Slough | 698.0 | 16,000 | 26,900 | 33,600 | 48,500 |
| Tualatin River overflow to Rivergrove | * | * | 1,100 | 2,900 | 6,300 |
| Willamette River | | | | | |
| At Milwaukie | 11,130 | 251,000 | 329,000 | 375,000 | 495,000 |
| At Willamette Locks Upper Gage | 10,100 | 219,000 | 295,000 | 341,000 | 469,000 |
| At Fish Eddy | 9,300 | 209,200 | 284,200 | 328,000 | 457,000 |
| At downstream of Wilsonville Corporate Limits | 8,400 | 178,000 | 250,000 | 287,000 | 420,000 |
| Zigzag River (At Mouth) | 59.1 | 6,256 | 9,066 | 10,283 | 13,503 |
| Zigzag River (At confluence with Still Creek) | 30.2 | 3,287 | 4,717 | 5,305 | 6,840 |

*Not calculated for this FIS project

## 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 FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data Table in the 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.

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The hydraulic analyses for Johnson Creek and portions of Clackamas River, Kellogg Creek, and Willamette River were obtained from USACE-Portland District.

Water-surface elevations (WSELs) of the selected recurrence intervals along the streams studied by detailed methods of the original studies were computed using the USACE HEC-2 step-backwater computer program. Cross sections were obtained photogrammetrically from aerial photographs at a photographic scale of approximately1:10,20.

WSELs of Oswego Canal, Rock Creek and its tributaries, Richardson Creek and its tributaries, Tickle Creek, the Tualatin River, and Tualatin River Overflow to Rivergrove, were determined with the use of the USACE HEC-RAS program. Cross sections were field surveyed and supplemented with topographic maps in the overbank areas. The below-water sections were obtained by hydrographic survey. Bridge dimensions and elevations were obtained from design drawings and field measurements.

Cross section data for the Pudding River were obtained from the USACE. For Henry Creek, Still Creek and the Zigzag River, surveyed cross sections were utilized in the hydraulic analysis.

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 FIRM.

Manning's "n" roughness values used in the hydraulic computations were generally chosen by engineering judgment and based on field observations of the streams and flood plain areas and comparisons with previous studies. In the case of the Clackamas, Molalla, and Willamette Rivers, roughness values were calibrated using stage-discharge information at gaging stations. For other streams that crossed gaging locations, the hydraulic analyses were compared to available stage-discharge information, but no calibrations of roughness values were warranted.

Roughness values used for the main channel of Rock Creek and its tributaries range from 0.02 to 0.09 and were estimated to be 0.06 for Richardson Creek and its tributaries. Overbank roughness values range from 0.02 to 0.20 for Rock Creek and its tributaries and from 0.04 to 0.10 for Richardson Creek and its tributaries.

Roughness values were estimated at 0.1 in the channel and 0.6 to 0.1 in the overbank areas for the Tualatin River study (including Oswego Canal and Tualatin River Overflow to Rivergrove). Roughness values for the Willamette River were verified by comparing computed profiles with high-water marks from known discharges for the December 1964 flood. Channel roughness values for the Molalla River were verified using high-water marks at Goods Bridge. Clackamas River roughness values were verified using the rating curve for the gage at Estacada.

The Willamette River backwater model from Fish Eddy to R.M. 41.4 was first adjusted by modeling the 1964 flood and matching the elevations obtained at R.M.s 34.4, 38.5, and 41.4 to the high-water marks at these three locations. Because the elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods are known from the gage records at the Wilsonville gage (R.M. 38.5), successive starting WSELs were approximated at Fish Eddy to obtain the known elevations at the gage for each of the flood frequencies.

Starting WSELs for Abernethy Creek, Clear Creek, Eagle Creek, Henry Creek, Milk Creek, Molalla River, Phillips Creek, Salmon River, Sandy River, Still Creek, and Zigzag River were based on slope-area calculations. Starting WSELs for the Clackamas River, Johnson Creek and Kellogg Creek were based on confluence elevations with Willamette River. Starting WSELs for Deer Creek were based on elevations at the confluence with Mt. Scott Creek. Starting WSELs for Mt. Scott Creek were based on elevations at the confluence with Kellogg Creek. Starting WSELs for both the upstream and downstream elevations of Nyberg Slough were obtained from a known WSEL. Starting WSELs for the Pudding River were based on elevations at the confluences with the Molalla and Willamette Rivers. The starting WSELs for the Salmon River North Channel were obtained from Salmon River profile elevations at the entrance of the overflow channel.

Starting WSELs for Oswego Canal, the Tualatin River, and Tualatin River Overflow to Rivergrove were based on Normal Depth calculations.

The starting WSELs for Rock Creek and Richardson Creek were determined by normal depth analysis. Starting WSELs for their tributaries were calculated by HEC-RAS considering backwater from the main stem.

The hydraulic analyses for Henry Creek resulted in the computation of shallow1-percent chance flooding outside the channel, with depths of less than 1 foot.

Near Cross Section A on Milk Creek, the 1-percent-annual-chance flood overtops Canby Mulino Road, resulting in shallow flooding in the northern overbank of the river, extending westerly across the Southern Pacific Railroad tracks.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail. The exception to this is a structure found on a private road along Rock Creek. This multiple-culvert structure was found to have a broken pipe joint on one culvert, a collapsed bank blocking a second pipe, and a third unobstructed pipe. This culvert system was modeled with obstructions in-place.

**This Physical Map Revision**

WSELs of the 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance floods for Cedar Creek and Sandy River in Clackamas County were estimated using of the USACE, HEC-RAS 4.1.0 computer, program (HEC, 2010). Cross sectional geometries for the detailed analysis of these streams were comprised of field run survey data and a digital terrain model (DTM) generated from Light Detection and Ranging (LIDAR) data collected by the Oregon Department of Geology & Mineral Industries (DOGAMI) in 2011 (DOGAMI 2011). Surveyed channel sections were transferred upstream and downstream to LIDAR generated cross sections and were blended with the LIDAR data to create a consistent channel profile. Floodway encroachment stations were established, first using Method 4. The Method 4 encroachment stations were imported and the Method 1 encroachment analysis was then executed to create the final floodway.

Roughness coefficients are provided in Table. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Manning's Roughness were determined based on surface conditions in the channel and on the overbanks based on site visit, aerial photography and photographs. Manning's roughness used in the modeling is summarized in Table 5.

Table – 5 Roughness Coefficients Manning's "n" Values

| Stream | Channel "n" | Overbank "n" |
|---|---|---|
| CEDAR CREEK | 0.045-0.050 | 0.350-0.120 |
| CLEAR CREEK | 0.050-0.060 | 0.120 |
| HENRY CREEK | 0.040 | 0.040 |
| SALMON RIVER (AND SPLITS) | 0.050-0.060 | 0.050-0.100 |
| SANDY RIVER | 0.030-0.120 | 0.035-0.120 |
| SANDY RIVER - SPLIT A | 0.050 | 0.100-0.120 |
| SANDY RIVER - SPLIT B | 0.060 | 0.060-0.120 |
| SANDY RIVER - SPLIT C | 0.055 | 0.100-0.120 |
| STILL CREEK | 0.045-0.055 | 0.080-0.120 |
| ZIGZAG RIVER (AND SPLIT) | 0.050-0.065 | 0.070-0.100 |

The profile baselines depicted on the FIRM represent the hydraulic modeling baselines that match the flood profiles on this FIS report. As a result of improved topographic data, the profile baseline, in some cases, may deviate significantly from the channel centerline or appear outside the Special Flood Hazard Area.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

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 in use for newly created or revised FIS reports and FIRMs was NGVD. With the finalization of North American Vertical Datum (NAVD), many FIS reports and FIRMs are being prepared using NAVD as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD. Structure and ground elevations in the community must, therefore, be referenced to NAVD. It is important to note that adjacent communities may be referenced to NGVD. This may result in differences in Base Flood Elevations (BFEs) across the corporate limits between the communities. Some of the data used in this study were taken from the prior effective FIS reports and adjusted to NAVD. The average conversion factor that was used to convert the data in this FIS report to NAVD was calculated using the National Geodetic Survey's (NGS) VERTCON online utility.

For additional information regarding conversion between NGVD and NAVD, visit the NGS website at www.ngs.noaa.gov, or contact the NGS 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

Table 6 – Vertical Datum Conversions

| Quadrangle Name | Quadrangle Corner | Latitude | Longitude | Conversion from NGVD29 to NAVD88 (feet) |
|---|---|---|---|---|
| Cherryville | NE | 45.375 | -122.125 | 3.461 |
| Estacada | NE | 45.375 | -122.250 | 3.490 |
| High Rock | NE | 45.250 | -121.875 | 3.624 |
| Rhododendron | NE | 45.375 | -121.875 | 3.556 |
| Wildcat Mountain | NE | 45.375 | -122.000 | 3.473 |
| Three Lynx | NE | 45.250 | -122.000 | 3.727 |

Average Conversion from NGVD29 to NAVD88 = 3.555 (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 FIRM 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 this map, please contact the 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. Therefore, each FIS provides 1-percent-annual-chance (100-year) flood elevations and delineations of the 1- and 0.2-percent-annual-chance (500-year) floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Table, and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local 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 flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance 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. Between cross sections, the boundaries were interpolated using topographic maps at scale of 1:4,800, with a contour interval of 5 feet.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards Zones A, AE, AH, 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 FIRM (Exhibit 2).

## 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 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 floodways presented in this FIS report and on the FIRM 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 have been tabulated for selected cross sections (Table 7). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

| 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) |
| A | 1,369 | 71 | 246 | 10.6 | 391.3 | 391.3 | 391.3 | 0.0 |
| B | 2,317 | 66 | 241 | 10.8 | 441.8 | 441.8 | 441.8 | 0.0 |
| C | 4,588 | 64 | 295 | 8.8 | 555.2 | 555.2 | 555.3 | 0.1 |
| D | 4,686 | 74 | 431 | 6.1 | 558.3 | 558.3 | 558.4 | 0.1 |
| E | 5,827 | 70 | 246 | 10.6 | 587.1 | 587.1 | 587.1 | 0.0 |
| F | 6,063 | 57 | 229 | 11.4 | 596.5 | 596.5 | 596.5 | 0.0 |
| G | 7,200 | 64 | 237 | 11.0 | 621.4 | 621.4 | 621.4 | 0.0 |
| H | 8,298 | 74 | 313 | 8.3 | 645.8 | 645.8 | 645.9 | 0.1 |
| I | 8,566 | 145 | 589 | 4.4 | 649.4 | 649.4 | 649.5 | 0.1 |
| J | 9,579 | 102 | 393 | 6.6 | 659.2 | 659.2 | 659.7 | 0.5 |
| K | 10,904 | 106 | 318 | 8.2 | 672.5 | 672.5 | 672.8 | 0.3 |
| L | 11,905 | 79 | 353 | 7.4 | 683.3 | 683.3 | 684.3 | 1.0 |
| M | 12,224 | 80 | 400 | 6.5 | 687.1 | 687.1 | 687.9 | 0.8 |
| N | 14,069 | 63 | 276 | 9.5 | 708.1 | 708.1 | 708.7 | 0.6 |
| O | 14,387 | 81 | 353 | 7.4 | 712.4 | 712.4 | 712.7 | 0.3 |
| P | 15,461 | 111 | 354 | 7.4 | 729.7 | 729.7 | 730.1 | 0.4 |
| Q | 15,956 | 82 | 459 | 5.7 | 740.3 | 740.3 | 741.2 | 0.9 |
| R | 16,424 | 87 | 268 | 9.7 | 747.0 | 747.0 | 747.0 | 0.0 |
| S | 17,292 | 48 | 217 | 12.0 | 765.9 | 765.9 | 766.0 | 0.1 |
| T | 18,127 | 49 | 232 | 11.2 | 783.2 | 783.2 | 783.5 | 0.3 |
| U | 19,258 | 52 | 223 | 11.7 | 811.5 | 811.5 | 811.5 | 0.0 |
| V | 20,204 | 86 | 267 | 9.8 | 834.0 | 834.0 | 834.1 | 0.1 |

[1] Stream distance in feet confluence with Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: CEDAR 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) |
| A | 70 | 41 | 210 | 9.9 | 1,453.9 | 1,449.8 | 1,450.3 | 0.5 |
| B | 714 | 41 | 214 | 9.7 | 1,464.1 | 1,464.1 | 1,464.6 | 0.5 |
| C | 1,268 | 39 | 235 | 8.9 | 1,474.8 | 1,474.8 | 1,475.3 | 0.5 |
| D | 1,433 | 41 | 298 | 7.0 | 1,477.5 | 1,477.5 | 1,478.0 | 0.5 |
| E | 1,576 | 28 | 185 | 11.3 | 1,478.9 | 1,478.9 | 1,479.6 | 0.7 |
| F | 2,000 | 52 | 264 | 7.9 | 1,488.2 | 1,488.2 | 1,488.5 | 0.3 |
| G | 2,665 | 64 | 314 | 6.6 | 1,496.6 | 1,496.6 | 1,496.8 | 0.2 |
| H | 3,196 | 51 | 223 | 9.3 | 1,504.1 | 1,504.1 | 1,504.4 | 0.3 |
| I | 3,897 | 36 | 220 | 9.5 | 1,521.8 | 1,521.8 | 1,521.9 | 0.1 |
| J | 4,528 | 47 | 225 | 9.3 | 1,531.8 | 1,531.8 | 1,532.6 | 0.8 |
| K | 5,345 | 50 | 235 | 8.9 | 1,548.3 | 1,548.3 | 1,549.0 | 0.7 |
| L | 6,017 | 35 | 183 | 11.4 | 1,564.3 | 1,564.3 | 1,564.4 | 0.1 |
| M | 6,698 | 44 | 196 | 10.6 | 1,582.5 | 1,582.5 | 1,582.5 | 0.0 |
| N | 7,242 | 30 | 180 | 11.6 | 1,596.9 | 1,596.9 | 1,597.6 | 0.7 |
| O | 7,780 | 32 | 159 | 10.7 | 1,613.1 | 1,613.1 | 1,613.5 | 0.4 |
| P | 8,336 | 36 | 168 | 10.1 | 1,627.3 | 1,627.3 | 1,627.6 | 0.3 |
| Q | 8,453 | 63 | 292 | 5.8 | 1,631.7 | 1,631.7 | 1,631.7 | 0.0 |
| R | 8,547 | 50 | 255 | 6.7 | 1,632.3 | 1,632.3 | 1,632.4 | 0.1 |
| S | 9,130 | 53 | 219 | 7.8 | 1,640.2 | 1,640.2 | 1,640.3 | 0.1 |
| T | 9,647 | 38 | 210 | 8.1 | 1,645.4 | 1,645.4 | 1,645.8 | 0.4 |
| U | 10,028 | 48 | 243 | 7.0 | 1,648.9 | 1,648.9 | 1,649.6 | 0.7 |

[1] Stream distance in feet confluence with Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: CLEAR 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) |
| V | 10,117 | 43 | 271 | 6.3 | 1,650.1 | 1,650.1 | 1,650.7 | 0.6 |
| W | 10,189 | 96 | 444 | 3.8 | 1,651.0 | 1,651.0 | 1,651.4 | 0.4 |
| X | 10,692 | 39 | 219 | 7.8 | 1,655.9 | 1,655.9 | 1,656.7 | 0.8 |
| Y | 11,242 | 39 | 199 | 8.6 | 1,661.7 | 1,661.7 | 1,662.4 | 0.7 |
| Z | 11,628 | 43 | 192 | 8.9 | 1,668.3 | 1,668.3 | 1,668.5 | 0.2 |
| AA | 11,762 | 49 | 291 | 5.9 | 1,671.5 | 1,671.5 | 1,671.9 | 0.4 |
| AB | 11,881 | 31 | 175 | 9.7 | 1,671.9 | 1,671.9 | 1,672.4 | 0.5 |
| AC | 12,305 | 69 | 220 | 7.7 | 1,680.0 | 1,680.0 | 1,680.0 | 0.0 |
| AD | 12,814 | 73 | 222 | 7.7 | 1,688.4 | 1,688.4 | 1,689.4 | 1.0 |
| AE | 13,417 | 56 | 226 | 7.6 | 1,705.7 | 1,705.7 | 1,706.6 | 0.9 |
| AF | 13,988 | 38 | 175 | 9.8 | 1,717.8 | 1,717.8 | 1,718.4 | 0.6 |
| AG | 14,057 | 39 | 297 | 5.7 | 1,722.4 | 1,722.4 | 1,722.4 | 0.0 |
| AH | 14,089 | 63 | 400 | 4.3 | 1,722.7 | 1,722.7 | 1,722.7 | 0.0 |
| AI | 14,920 | 65 | 215 | 7.9 | 1,746.5 | 1,746.5 | 1,747.5 | 1.0 |
| AJ | 15,564 | 21 | 137 | 12.5 | 1,762.9 | 1,762.9 | 1,763.7 | 0.8 |
| AK | 16,263 | 23 | 127 | 13.4 | 1,790.7 | 1,790.7 | 1,790.8 | 0.1 |

[1] Stream distance in feet confluence with Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: CLEAR 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) |
| A | 275 | 139 | 1,282 | 12.3 | 1,025.5 | 1,023.3 | 1,023.8 | 0.5 |
| B | 2,165 | 133 | 1,677 | 9.4 | 1,047.8 | 1,047.8 | 1,047.8 | 0.0 |
| C | 2,772 | 146 | 1,404 | 11.3 | 1,050.5 | 1,050.5 | 1,050.7 | 0.2 |
| D | 3,131 | 146 | 1,319 | 12.0 | 1,053.2 | 1,053.2 | 1,053.4 | 0.2 |
| E | 3,624 | 143 | 1,636 | 9.7 | 1,060.2 | 1,060.2 | 1,060.2 | 0.0 |
| F | 3,872 | 169 | 1,816 | 8.7 | 1,061.6 | 1,061.6 | 1,061.6 | 0.0 |
| G | 4,727 | 178 | 1,550 | 10.2 | 1,064.7 | 1,064.7 | 1,065.1 | 0.4 |
| H | 5,136 | 175 | 1,526 | 9.6 | 1,067.5 | 1,067.5 | 1,067.5 | 0.0 |
| I | 6,087 | 146 | 1,389 | 10.5 | 1,072.8 | 1,072.8 | 1,073.4 | 0.6 |
| J | 7,103 | 138 | 1,282 | 11.4 | 1,080.8 | 1,080.8 | 1,081.2 | 0.4 |
| K | 8,045 | 174 | 1,628 | 9.0 | 1,088.6 | 1,088.6 | 1,089.2 | 0.6 |
| L | 10,229 | 81 | 1,131 | 12.9 | 1,106.3 | 1,106.3 | 1,106.5 | 0.2 |
| M | 10,422 | 148 | 1,950 | 7.5 | 1,108.7 | 1,108.7 | 1,109.2 | 0.5 |
| N | 11,209 | 124 | 1,071 | 13.7 | 1,113.8 | 1,113.8 | 1,114.3 | 0.5 |
| O | 12,307 | 122 | 1,419 | 10.3 | 1,123.6 | 1,123.6 | 1,124.6 | 1.0 |
| P | 13,413 | 85 | 952 | 15.4 | 1,131.2 | 1,131.2 | 1,132.2 | 1.0 |
| Q | 14,816 | 156 | 1,401 | 10.5 | 1,147.6 | 1,147.6 | 1,148.2 | 0.6 |
| R | 15,857 | 148 | 1,378 | 10.6 | 1,155.5 | 1,155.5 | 1,155.8 | 0.3 |
| S | 17,023 | 126 | 1,151 | 12.7 | 1,165.1 | 1,165.1 | 1,165.5 | 0.4 |
| T | 18,182 | 89 | 1,084 | 13.5 | 1,176.1 | 1,176.1 | 1,176.6 | 0.5 |
| U | 19,410 | 112 | 1,151 | 12.3 | 1,187.7 | 1,187.7 | 1,188.2 | 0.5 |

[1]Distances are measured in feet upstream of the confluence of Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: SALMON 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) |
| V | 20,978 | 147 / 0 | 1,232 | 11.5 | 1,202.3 | 1,202.3 | 1,203.1 | 0.8 |
| W | 22,418 | 142 / 0 | 1,342 | 10.6 | 1,214.2 | 1,214.2 | 1,214.9 | 0.7 |
| X | 22,768 | 162 / 0 | 1,382 | 9.9 | 1,217.1 | 1,217.1 | 1,217.9 | 0.8 |
| Y | 23,322 | 145 / 0 | 1,141 | 12.0 | 1,222.2 | 1,222.2 | 1,222.3 | 0.1 |
| Z | 23,997 | 110 / 0 | 1,079 | 12.7 | 1,228.9 | 1,228.9 | 1,229.7 | 0.8 |
| AA | 24,477 | 100 / 0 | 1,025 | 13.3 | 1,234.0 | 1,234.0 | 1,234.4 | 0.4 |
| AB | 24,648 | 142 / 0 | 1,328 | 10.7 | 1,236.5 | 1,236.5 | 1,237.1 | 0.6 |
| AC | 25,962 | 121 / 0 | 1,223 | 11.6 | 1,247.9 | 1,247.9 | 1,248.7 | 0.8 |
| AD | 26,860 | 126 / 0 | 1,267 | 11.2 | 1,254.5 | 1,254.5 | 1,255.0 | 0.5 |
| AE | 27,909 | 134 / 0 | 1,305 | 10.9 | 1,262.5 | 1,262.5 | 1,262.7 | 0.2 |
| AF | 28,883 | 177 / 0 | 1,470 | 9.6 | 1,269.2 | 1,269.2 | 1,269.5 | 0.3 |
| AG | 30,279 | 316 / 0 | 1,914 | 7.2 | 1,280.8 | 1,280.8 | 1,281.8 | 1.0 |
| AH | 31,471 | 421 / 0 | 2,059 | 6.7 | 1,289.5 | 1,289.5 | 1,290.1 | 0.6 |
| AI | 32,562 | 192 / 0 | 1,363 | 11.3 | 1,297.9 | 1,297.9 | 1,298.5 | 0.6 |
| AJ | 32,613 | 195 / 0 | 1,646 | 9.2 | 1,299.8 | 1,299.8 | 1,300.4 | 0.6 |
| AK | 32,804 | 246 / 0 | 1,674 | 8.2 | 1,300.4 | 1,300.4 | 1,301.3 | 0.9 |
| AL | 33,539 | 265 / 0 | 1,487 | 9.3 | 1,307.4 | 1,307.4 | 1,307.7 | 0.3 |
| AM | 34,163 | 224 / 0 | 1,315 | 10.5 | 1,312.4 | 1,312.4 | 1,313.4 | 1.0 |

[1]Distances are measured in feet upstream of the confluence of Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: SALMON 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) |
| AN | 34,812 | 128 / 0 | 1,100 | 12.5 | 1,320.0 | 1,320.0 | 1,320.5 | 0.5 |
| AO | 35,658 | 148 / 0 | 1,157 | 11.9 | 1,329.4 | 1,329.4 | 1,330.0 | 0.6 |
| AP | 36,365 | 81 / 0 | 1,066 | 12.9 | 1,338.0 | 1,338.0 | 1,338.5 | 0.5 |
| AQ | 36,605 | 91 / 0 | 1,090 | 12.7 | 1,339.6 | 1,339.6 | 1,340.6 | 1.0 |
| AR | 36,893 | 85 / 0 | 1,001 | 13.8 | 1,342.1 | 1,342.1 | 1,343.1 | 1.0 |
| AS | 37,069 | 100 / 0 | 1,187 | 11.6 | 1,345.1 | 1,345.1 | 1,345.7 | 0.6 |
| AT | 37,311 | 83 / 0 | 814 | 11.8 | 1,347.2 | 1,347.2 | 1,347.5 | 0.3 |
| AU | 37,456 | 78 / 0 | 737 | 13.0 | 1,347.8 | 1,347.8 | 1,348.7 | 0.9 |
| AV | 37,933 | 83 / 0 | 650 | 12.3 | 1,353.4 | 1,353.4 | 1,354.3 | 0.9 |
| AW | 38,645 | 92 / 0 | 656 | 12.2 | 1,363.7 | 1,363.7 | 1,364.2 | 0.5 |
| AX | 38,891 | 128 / 0 | 848 | 14.4 | 1,369.1 | 1,369.1 | 1,369.2 | 0.1 |
| AY | 39,263 | 147 / 0 | 986 | 12.3 | 1,375.4 | 1,375.4 | 1,376.3 | 0.9 |
| AZ | 40,215 | 124 / 0 | 978 | 12.4 | 1,389.9 | 1,389.9 | 1,390.3 | 0.4 |
| BA | 41,312 | 104 / 0 | 916 | 13.3 | 1,403.0 | 1,403.0 | 1,403.2 | 0.2 |
| BB | 42,144 | 95 / 0 | 869 | 14.0 | 1,413.2 | 1,413.2 | 1,413.5 | 0.3 |

[1]Distances are measured in feet upstream of the confluence of Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: SALMON 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) |
| A | 179 | 0 | * | * | 1,348.1 | 1,348.1 | 0.0 | 0.0 |
| B | 392 | 0 | * | * | 1,351.5 | 1,351.5 | 0.0 | 0.0 |
| C | 440 | 0 | * | * | 1,354.3 | 1,354.3 | 0.0 | 0.0 |
| D | 855 | 0 | * | * | 1,356.6 | 1,356.6 | 0.0 | 0.0 |
| E | 1,486 | 0 | * | * | 1,367.5 | 1,367.5 | 0.0 | 0.0 |

[1]Distances are measured in feet upstream of the confluence of Salmon River

*Data not available

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: SALMON RIVER - EAST ABERNETHY SPLIT**

| 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) |
| A | 190 | 93 | 229 | 10.4 | 1,348.3 | 1,348.3 | 1,348.4 | 0.1 |
| B | 794 | 56 | 96 | 9.2 | 1,359.4 | 1,359.4 | 1,360.2 | 0.8 |
| C | 1,148 | 57 | 105 | 12.7 | 1,363.8 | 1,363.8 | 1,364.1 | 0.3 |

[1]Distances are measured in feet upstream of the confluence of Salmon River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: SALMON RIVER - EAST ISLAND SPLIT**

| 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) |
| A | 278 | 75 | 403 | 0.7 | 1,217.3 | 1,217.3 | 1,218.3 | 1.0 |
| B | 880 | 33 | 456 | 2.2 | 1,217.4 | 1,217.4 | 1,218.3 | 1.0 |
| C | 1,578 | 39 | 331 | 5.2 | 1,221.3 | 1,221.3 | 1,221.4 | 0.1 |
| D | 2,594 | 19 | 720 | 4.7 | 1,229.5 | 1,229.5 | 1,230.1 | 0.6 |

[1]Distances are measured in feet upstream of the confluence of Salmon River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: SALMON RIVER - EAST METSGER ISLAND SPLIT**

| 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) |
| A | 820 | 197 | 3,833 | 17.7 | 196.5 | 196.5 | 196.5 | 0.0 |
| B | 1,470 | 205 | 5,687 | 11.9 | 204.2 | 204.2 | 205.2 | 1.0 |
| C | 2,310 | 210 | 5,335 | 12.7 | 210.0 | 210.0 | 210.3 | 0.3 |
| D | 3,020 | 215 | 4,501 | 15.1 | 213.9 | 213.9 | 214.5 | 0.6 |
| E | 3,760 | 221 | 4,154 | 16.3 | 219.5 | 219.5 | 220.5 | 1.0 |
| F | 4,410 | 224 | 4,553 | 14.9 | 223.5 | 223.5 | 224.4 | 0.9 |
| G | 5,720 | 231 | 5,954 | 11.4 | 229.5 | 229.5 | 230.2 | 0.7 |
| H | 6,460 | 232 | 4,649 | 14.6 | 231.5 | 231.5 | 232.0 | 0.5 |
| I | 7,390 | 240 | 6,095 | 11.1 | 239.3 | 239.3 | 240.3 | 1.0 |
| J | 8,000 | 240 | 3,738 | 18.2 | 240.0 | 240.0 | 240.0 | 0.0 |
| K | 9,060 | 252 | 6,119 | 11.1 | 251.5 | 251.5 | 251.7 | 0.2 |
| L | 10,460 | 258 | 3,884 | 12.7 | 257.5 | 257.5 | 258.4 | 0.9 |
| M | 10,760 | 261 | 3,848 | 12.8 | 261.0 | 261.0 | 261.0 | 0.0 |
| N | 11,490 | 264 | 2,876 | 17.2 | 264.2 | 264.2 | 264.2 | 0.0 |
| O | 11,960 | 271 | 4,348 | 11.4 | 270.9 | 270.9 | 270.9 | 0.0 |
| P | 12,470 | 273 | 4,242 | 11.6 | 272.5 | 272.5 | 273.3 | 0.8 |
| Q | 12,780 | 275 | 4,676 | 10.6 | 274.6 | 274.6 | 275.2 | 0.6 |
| R | 13,940 | 281 | 4,230 | 11.7 | 280.1 | 280.1 | 280.6 | 0.5 |
| S | 14,610 | 286 | 3,995 | 12.4 | 285.9 | 285.9 | 285.9 | 0.0 |
| T | 15,740 | 297 | 4,513 | 10.9 | 297.0 | 297.0 | 297.1 | 0.1 |
| U | 16,270 | 304 | 6,689 | 7.4 | 303.2 | 303.2 | 304.0 | 0.8 |

[1]Stream Distance in feet above Multnomah-Clackamas County Boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: SANDY 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) |
| V | 17,550 | 312 | 3,439 | 14.4 | 312.4 | 312.4 | 312.4 | 0.0 |
| W | 18,270 | 320 | 5,926 | 8.3 | 319.8 | 319.8 | 320.0 | 0.2 |
| X | 18,630 | 321 | 5,578 | 8.9 | 320.4 | 320.4 | 320.6 | 0.2 |
| Y | 19,100 | 322 | 3,348 | 14.7 | 321.5 | 321.5 | 321.8 | 0.3 |
| Z | 19,740 | 327 | 3,736 | 13.2 | 326.2 | 326.2 | 326.6 | 0.4 |
| AA | 20,300 | 329 | 2,636 | 18.7 | 329.0 | 329.0 | 329.0 | 0.0 |
| AB | 20,690 | 335 | 3,697 | 13.4 | 334.2 | 334.2 | 334.6 | 0.4 |
| AC | 21,010 | 337 | 3,680 | 13.4 | 336.8 | 336.8 | 336.8 | 0.0 |
| AD | 22,370 | 344 | 3,158 | 15.6 | 343.7 | 343.7 | 344.4 | 0.7 |
| AE | 23,030 | 350 | 5,147 | 9.6 | 349.9 | 349.9 | 350.4 | 0.5 |
| AF | 33,360 | 425 | 3,778 | 12.4 | 424.7 | 424.7 | 424.9 | 0.2 |
| AG | 34,140 | 429 | 3,862 | 12.2 | 428.9 | 428.9 | 429.4 | 0.5 |
| AH | 35,050 | 434 | 5,096 | 9.2 | 434.0 | 434.0 | 434.4 | 0.4 |
| AI | 35,780 | 438 | 2,879 | 16.3 | 436.5 | 436.5 | 437.5 | 1.0 |
| AJ | 37,040 | 447 | 3,640 | 12.9 | 446.7 | 446.7 | 447.0 | 0.3 |
| AK | 38,000 | 463 | 4,060 | 11.6 | 462.8 | 462.8 | 463.3 | 0.5 |
| AL | 38,440 | 468 | 5,292 | 8.9 | 467.2 | 467.2 | 468.0 | 0.8 |
| AM | 39,020 | 469 | 5,313 | 8.8 | 468.3 | 468.3 | 469.2 | 0.9 |
| AN | 86,000 | 289 | 3,801 | 13.3 | 821.6 | 821.6 | 821.7 | 0.1 |
| AO | 88,237 | 244 | 2,992 | 16.9 | 837.5 | 837.5 | 837.5 | 0.0 |
| AP | 88,946 | 173 | 4,728 | 10.7 | 854.3 | 854.3 | 854.4 | 0.1 |

[1] Stream Distance in feet above Multnomah-Clackamas County Boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: SANDY 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) |
| AQ | 90,086 | 223 | 2,788 | 16.5 | 856.2 | 856.2 | 856.7 | 0.5 |
| AR | 91,153 | 206 | 2,685 | 17.2 | 867.3 | 867.3 | 867.6 | 0.3 |
| AS | 92,098 | 424 | 3,367 | 13.7 | 876.2 | 876.2 | 876.2 | 0.0 |
| AT | 93,002 | 769 | 5,788 | 8.0 | 886.1 | 886.1 | 886.2 | 0.1 |
| AU | 94,116 | 545 | 3,833 | 12.0 | 895.3 | 895.3 | 895.7 | 0.4 |
| AV | 95,153 | 650 | 4,255 | 10.8 | 904.2 | 904.2 | 904.4 | 0.2 |
| AW | 96,319 | 590 | 4,320 | 10.7 | 913.8 | 913.8 | 914.2 | 0.4 |
| AX | 97,195 | 969 | 6,179 | 7.5 | 920.5 | 920.5 | 920.6 | 0.1 |
| AY | 98,205 | 613 | 4,510 | 10.2 | 929.2 | 929.2 | 929.4 | 0.2 |
| AZ | 98,961 | 472 | 4,079 | 11.3 | 935.6 | 935.6 | 935.9 | 0.3 |
| BA | 100,174 | 463 | 4,118 | 11.2 | 942.8 | 942.8 | 943.7 | 0.9 |
| BB | 101,284 | 600 | 4,405 | 10.5 | 952.5 | 952.5 | 952.7 | 0.2 |
| BC | 102,348 | 400 | 3,938 | 11.7 | 961.3 | 961.3 | 962.0 | 0.7 |
| BD | 103,172 | 444 | 4,149 | 11.1 | 966.9 | 966.9 | 967.5 | 0.6 |
| BE | 105,211 | 139 | 2,439 | 18.9 | 985.1 | 985.1 | 985.9 | 0.8 |
| BF | 106,401 | 494 | 4,652 | 9.9 | 995.0 | 995.0 | 995.0 | 0.0 |
| BG | 107,322 | 605 | 3,883 | 11.9 | 999.7 | 999.7 | 999.7 | 0.0 |
| BH | 108,420 | 369 | 3,383 | 13.6 | 1,011.5 | 1,011.5 | 1,011.6 | 0.1 |
| BI | 109,390 | 350 | 4,020 | 11.5 | 1,021.0 | 1,021.0 | 1,021.2 | 0.2 |
| BJ | 112,150 | 501 | 3,699 | 6.1 | 1,043.2 | 1,043.2 | 1,043.3 | 0.1 |
| BK | 113,681 | 587 | 2,677 | 8.4 | 1,056.0 | 1,056.0 | 1,056.0 | 0.0 |

[1] Stream Distance in feet above Multnomah-Clackamas County Boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

## FLOODWAY DATA

**FLOODING SOURCE: SANDY RIVER-SALMON 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) |
| BL | 115,743 | 283 | 2,086 | 12.8 | 1,079.1 | 1,079.1 | 1,079.5 | 0.4 |
| BM | 115,874 | 352 | 4,532 | 5.0 | 1,085.7 | 1,085.7 | 1,086.5 | 0.8 |
| BN | 116,798 | 168 | 1,529 | 14.7 | 1,088.8 | 1,088.8 | 1,089.0 | 0.2 |
| BO | 117,716 | 217 | 1,817 | 12.3 | 1,100.0 | 1,100.0 | 1,100.0 | 0.0 |
| BP | 118,656 | 203 | 1,895 | 11.8 | 1,110.7 | 1,110.7 | 1,111.3 | 0.6 |
| BQ | 120,646 | 341 | 2,200 | 10.2 | 1,135.1 | 1,135.1 | 1,135.8 | 0.7 |
| BR | 121,593 | 264 | 1,947 | 11.5 | 1,145.1 | 1,145.1 | 1,145.3 | 0.2 |
| BS | 122,783 | 277 | 2,026 | 11.1 | 1,158.8 | 1,158.8 | 1,158.8 | 0.0 |
| BT | 123,787 | 503 | 2,205 | 10.2 | 1,170.8 | 1,170.8 | 1,170.8 | 0.0 |
| BU | 124,818 | 770 | 3,721 | 6.0 | 1,183.3 | 1,183.3 | 1,183.7 | 0.4 |
| BV | 126,926 | 190 | 1,699 | 13.2 | 1,209.5 | 1,209.5 | 1,210.2 | 0.7 |
| BW | 127,831 | 217 | 2,003 | 11.2 | 1,220.8 | 1,220.8 | 1,221.1 | 0.3 |
| BX | 128,866 | 336 | 2,127 | 10.5 | 1,230.4 | 1,230.4 | 1,230.6 | 0.2 |
| BY | 129,929 | 543 | 2,312 | 9.7 | 1,244.2 | 1,244.2 | 1,244.9 | 0.7 |
| BZ | 130,887 | 302 | 2,228 | 10.1 | 1,257.0 | 1,257.0 | 1,257.3 | 0.3 |
| CA | 132,230 | 668 | 2,833 | 7.9 | 1,272.9 | 1,272.9 | 1,273.0 | 0.1 |
| CB | 133,244 | 310 | 1,949 | 11.5 | 1,285.8 | 1,285.8 | 1,285.9 | 0.1 |
| CC | 134,151 | 278 | 2,186 | 10.3 | 1,297.4 | 1,297.4 | 1,297.7 | 0.3 |
| CD | 135,238 | 146 | 1,464 | 15.3 | 1,314.6 | 1,314.6 | 1,315.3 | 0.7 |
| CE | 137,095 | 174 | 1,788 | 12.5 | 1,341.7 | 1,341.7 | 1,341.8 | 0.1 |
| CF | 138,314 | 184 | 1,578 | 14.2 | 1,355.1 | 1,355.1 | 1,355.5 | 0.4 |

[1] Stream Distance in feet above Multnomah-Clackamas County Boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: SANDY 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) |
| CG | 140,150 | 185 | 1,624 | 13.8 | 1,383.8 | 1,383.8 | 1,383.9 | 0.1 |
| CH | 140,729 | 174 | 1,314 | 8.5 | 1,392.2 | 1,392.2 | 1,392.6 | 0.4 |
| CI | 141,388 | 147 | 817 | 13.7 | 1,400.8 | 1,400.8 | 1,400.8 | 0.0 |
| CJ | 143,347 | 98 | 827 | 13.5 | 1,439.0 | 1,439.0 | 1,439.1 | 0.1 |
| CK | 144,199 | 100 | 1,026 | 10.9 | 1,455.9 | 1,455.9 | 1,456.0 | 0.1 |
| CL | 144,498 | 84 | 666 | 10.8 | 1,458.7 | 1,458.7 | 1,458.9 | 0.2 |
| CM | 144,809 | 154 | 905 | 7.9 | 1,462.7 | 1,462.7 | 1,462.7 | 0.0 |
| CN | 145,462 | 124 | 696 | 10.3 | 1,475.7 | 1,475.7 | 1,475.8 | 0.1 |
| CO | 146,295 | 128 | 765 | 9.4 | 1,491.7 | 1,491.7 | 1,491.9 | 0.2 |
| CP | 146,730 | 145 | 664 | 10.8 | 1,501.0 | 1,501.0 | 1,501.1 | 0.1 |
| CQ | 147,171 | 192 | 862 | 8.3 | 1,511.7 | 1,511.7 | 1,511.8 | 0.1 |
| CR | 148,411 | 229 | 675 | 10.6 | 1,532.9 | 1,532.9 | 1,532.9 | 0.0 |
| CS | 149,189 | 313 | 866 | 8.3 | 1,548.8 | 1,548.8 | 1,548.9 | 0.1 |
| CT | 149,781 | 158 | 757 | 9.5 | 1,559.9 | 1,559.9 | 1,560.0 | 0.1 |
| CU | 150,646 | 136 | 573 | 10.2 | 1,576.2 | 1,576.2 | 1,576.4 | 0.2 |
| CV | 151,163 | 91 | 427 | 13.6 | 1,586.9 | 1,586.9 | 1,586.9 | 0.0 |
| CW | 152,203 | 157 | 697 | 10.3 | 1,608.2 | 1,608.2 | 1,608.4 | 0.2 |
| CX | 152,992 | 129 | 776 | 9.3 | 1,622.0 | 1,622.0 | 1,622.2 | 0.2 |
| CY | 154,057 | 187 | 848 | 8.5 | 1,645.2 | 1,645.2 | 1,645.3 | 0.1 |
| CZ | 155,207 | 130 | 596 | 12.1 | 1,667.3 | 1,667.3 | 1,667.3 | 0.0 |
| DA | 157,077 | 232 | 919 | 7.8 | 1,710.4 | 1,710.4 | 1,710.5 | 0.1 |

[1] Stream Distance in feet above Multnomah-Clackamas County Boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: SANDY 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) |
| DB | 158,353 | 207 | 720 | 10.0 | 1,736.4 | 1,736.4 | 1,736.4 | 0.0 |
| DC | 159,435 | 153 | 776 | 9.3 | 1,761.6 | 1,761.6 | 1,762.0 | 0.4 |
| DD | 160,231 | 131 | 618 | 11.6 | 1,782.9 | 1,782.9 | 1,783.0 | 0.1 |
| DE | 161,182 | 93 | 535 | 13.4 | 1,809.3 | 1,809.3 | 1,809.4 | 0.1 |
| DF | 162,146 | 94 | 609 | 11.8 | 1,839.1 | 1,839.1 | 1,839.5 | 0.4 |
| DG | 163,331 | 124 | 709 | 10.1 | 1,872.8 | 1,872.8 | 1,873.0 | 0.2 |

[1]Stream Distance in feet above Multnomah-Clackamas County Boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: SANDY 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) |
| A | 384 | 90 | 204 | 6.6 | 1,580.6 | 1,580.6 | 1,580.8 | 0.2 |
| B | 785 | 206 | 260 | 5.2 | 1,589.2 | 1,589.2 | 1,589.4 | 0.2 |

[1]Stream distance in feet above confluence with Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: SANDY RIVER SPLIT B**

| 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) |
| A | 135 | 56 | 315 | 12.8 | 1,574.4 | 1,572.6 | 1,572.8 | 0.2 |
| B | 721 | 53 | 328 | 12.3 | 1,587.1 | 1,587.1 | 1,587.3 | 0.2 |
| C | 851 | 58 | 311 | 13.0 | 1,590.6 | 1,590.6 | 1,590.6 | 0.0 |
| D | 918 | 46 | 367 | 11.0 | 1,592.9 | 1,592.9 | 1,592.9 | 0.0 |
| E | 1,479 | 49 | 378 | 10.7 | 1,604.6 | 1,604.6 | 1,605.2 | 0.6 |
| F | 2,179 | 43 | 441 | 9.4 | 1,622.9 | 1,622.9 | 1,622.9 | 0.0 |
| G | 2,767 | 51 | 322 | 12.6 | 1,636.4 | 1,636.4 | 1,637.2 | 0.8 |
| H | 3,699 | 71 | 400 | 10.1 | 1,659.8 | 1,659.8 | 1,659.9 | 0.1 |
| I | 4,648 | 144 | 412 | 9.8 | 1,685.5 | 1,685.5 | 1,685.5 | 0.0 |
| J | 5,486 | 66 | 384 | 10.5 | 1,705.9 | 1,705.9 | 1,706.1 | 0.2 |
| K | 6,343 | 63 | 506 | 8.0 | 1,722.1 | 1,722.1 | 1,722.5 | 0.4 |
| L | 6,886 | 59 | 566 | 7.1 | 1,726.3 | 1,726.3 | 1,727.1 | 0.8 |
| M | 7,013 | 54 | 356 | 11.3 | 1,726.8 | 1,726.8 | 1,727.6 | 0.8 |
| N | 7,049 | 76 | 1,166 | 5.3 | 1,730.2 | 1,730.2 | 1,730.3 | 0.1 |
| O | 7,246 | 105 | 1,509 | 2.7 | 1,731.0 | 1,731.0 | 1,731.0 | 0.0 |
| P | 7,838 | 80 | 639 | 6.3 | 1,731.5 | 1,731.5 | 1,731.8 | 0.3 |
| Q | 8,509 | 99 | 800 | 5.0 | 1,735.8 | 1,735.8 | 1,736.3 | 0.5 |
| R | 9,205 | 95 | 1,062 | 7.2 | 1,740.1 | 1,740.1 | 1,740.2 | 0.1 |
| S | 10,162 | 100 | 752 | 5.8 | 1,748.4 | 1,748.4 | 1,748.9 | 0.5 |
| T | 11,059 | 173 | 728 | 6.1 | 1,756.0 | 1,756.0 | 1,756.1 | 0.1 |
| U | 12,246 | 186 | 1,235 | 3.9 | 1,768.8 | 1,768.8 | 1,769.8 | 1.0 |

[1]Distances are measured in feet upstream of the confluence of Zigzag

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: STILL 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) |
| V | 13,295 | 142 | 755 | 5.3 | 1,781.0 | 1,781.0 | 1,781.6 | 0.6 |
| W | 14,188 | 80 | 567 | 7.1 | 1,794.8 | 1,794.8 | 1,795.5 | 0.7 |
| X | 15,030 | 63 | 603 | 6.7 | 1,807.9 | 1,807.9 | 1,808.6 | 0.7 |
| Y | 15,446 | 54 | 585 | 8.1 | 1,814.8 | 1,814.8 | 1,815.5 | 0.7 |

[1]Distances are measured in feet upstream of the confluence of Zigzag

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

## FLOODWAY DATA

**FLOODING SOURCE: STILL 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) |
| A | 24,093 | 23 | 75 | 8.5 | 697.5 | 697.5 | 698.0 | 0.5 |
| B | 24,958 | 52 | 105 | 6.1 | 715.4 | 715.4 | 715.5 | 0.1 |
| C | 25,463 | 24 | 67 | 9.5 | 731.9 | 731.9 | 732.0 | 0.1 |
| D | 26,588 | 27 | 76 | 8.3 | 750.1 | 750.1 | 750.1 | 0.0 |
| E | 27,708 | 23 | 68 | 9.3 | 772.8 | 772.8 | 773.1 | 0.3 |
| F | 28,163 | 24 | 73 | 8.7 | 782.9 | 782.9 | 783.1 | 0.2 |
| G | 29,163 | 34 | 221 | 2.9 | 802.8 | 802.8 | 802.8 | 0.0 |
| H | 30,063 | 50 | 236 | 4.0 | 811.7 | 811.7 | 812.6 | 0.9 |
| I | 30,503 | 32 | 72 | 8.8 | 819.1 | 819.1 | 819.1 | 0.0 |
| J | 30,628 | 115 | 369 | 2.8 | 823.2 | 823.2 | 823.9 | 0.7 |
| K | 30,953 | 80 | 196 | 5.3 | 823.1 | 823.1 | 824.1 | 1.0 |
| L | 32,598 | 32 | 82 | 7.7 | 858.7 | 858.7 | 859.0 | 0.3 |
| M | 33,108 | 33 | 81 | 7.8 | 867.9 | 867.9 | 868.0 | 0.1 |
| N | 33,952 | 30 | 72 | 8.8 | 889.8 | 889.8 | 889.0 | 0.0 |
| O | 35,093 | 29 | 43 | 7.0 | 913.7 | 913.7 | 913.7 | 0.0 |
| P | 35,533 | 31 | 44 | 6.8 | 925.8 | 925.8 | 925.8 | 0.0 |
| Q | 36,343 | 49 | 288 | 1.0 | 954.4 | 954.4 | 954.5 | 0.1 |
| R | 37,218 | 32 | 45 | 6.8 | 974.1 | 974.1 | 974.1 | 0.0 |
| S | 38,093 | 30 | 44 | 6.9 | 999.1 | 999.1 | 999.1 | 0.0 |

[1]Distances are measured in feet upstream from a point located 575 feet

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

## FLOODWAY DATA

**FLOODING SOURCE: TICKLE 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) |
| A | 339 | 312 | 1,117 | 9.2 | 1,387.5 | 1,386.6 | 1,387.6 | 1.0 |
| B | 618 | 199 | 791 | 13.0 | 1,391.6 | 1,391.6 | 1,392.3 | 0.7 |
| C | 995 | 132 | 998 | 10.3 | 1,400.6 | 1,400.6 | 1,400.6 | 0.0 |
| D | 2,096 | 224 | 1,134 | 9.1 | 1,417.4 | 1,417.4 | 1,417.8 | 0.4 |
| E | 3,079 | 175 | 1,088 | 9.5 | 1,431.9 | 1,431.9 | 1,432.7 | 0.8 |
| F | 3,651 | 133 | 897 | 11.5 | 1,439.9 | 1,439.9 | 1,440.6 | 0.7 |
| G | 4,481 | 109 | 803 | 12.8 | 1,455.1 | 1,455.1 | 1,455.4 | 0.3 |
| H | 5,139 | 303 | 1,262 | 8.2 | 1,464.1 | 1,464.1 | 1,465.0 | 0.9 |
| I | 5,328 | 191 | 691 | 10.5 | 1,466.4 | 1,466.4 | 1,466.7 | 0.3 |
| J | 6,186 | 112 | 630 | 11.5 | 1,483.6 | 1,483.6 | 1,484.3 | 0.7 |
| K | 6,574 | 123 | 794 | 9.1 | 1,489.7 | 1,489.7 | 1,490.2 | 0.5 |
| L | 7,091 | 125 | 811 | 12.7 | 1,496.7 | 1,496.7 | 1,497.2 | 0.5 |
| M | 8,139 | 123 | 801 | 12.8 | 1,514.4 | 1,514.4 | 1,514.4 | 0.0 |
| N | 9,010 | 115 | 765 | 13.4 | 1,529.0 | 1,529.0 | 1,529.1 | 0.1 |
| O | 10,271 | 129 | 924 | 11.1 | 1,553.7 | 1,553.7 | 1,554.5 | 0.8 |
| P | 11,175 | 87 | 722 | 12.8 | 1,567.9 | 1,567.9 | 1,568.6 | 0.7 |
| Q | 11,432 | 76 | 870 | 10.6 | 1,574.4 | 1,574.4 | 1,574.5 | 0.1 |
| R | 11,625 | 64 | 427 | 12.4 | 1,576.1 | 1,576.1 | 1,576.7 | 0.6 |
| S | 11,850 | 62 | 480 | 11.1 | 1,581.6 | 1,581.6 | 1,581.6 | 0.0 |
| T | 12,605 | 69 | 480 | 11.1 | 1,600.9 | 1,600.9 | 1,600.9 | 0.0 |
| U | 13,342 | 70 | 504 | 10.5 | 1,617.4 | 1,617.4 | 1,618.1 | 0.7 |

[1]Distances are measured in feet upstream of the confluence of Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: ZIGZAG 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) |
| V | 14,099 | 42 | 412 | 12.9 | 1,645.0 | 1,645.0 | 1,645.1 | 0.1 |
| W | 14,957 | 57 | 420 | 12.6 | 1,667.9 | 1,667.9 | 1,668.7 | 0.8 |
| X | 16,000 | 58 | 418 | 12.7 | 1,699.9 | 1,699.9 | 1,700.7 | 0.8 |
| Y | 17,121 | 78 | 477 | 11.1 | 1,728.9 | 1,728.9 | 1,729.5 | 0.6 |
| Z | 18,274 | 67 | 453 | 11.7 | 1,755.4 | 1,755.4 | 1,755.9 | 0.5 |
| AA | 19,359 | 79 | 501 | 10.6 | 1,783.0 | 1,783.0 | 1,783.4 | 0.4 |
| AB | 20,323 | 56 | 426 | 12.5 | 1,807.8 | 1,807.8 | 1,808.3 | 0.5 |
| AC | 21,392 | 65 | 411 | 12.9 | 1,838.1 | 1,838.1 | 1,838.4 | 0.3 |
| AD | 22,348 | 50 | 268 | 13.1 | 1,874.8 | 1,874.8 | 1,874.9 | 0.1 |
| AE | 23,196 | 46 | 313 | 11.2 | 1,898.6 | 1,898.6 | 1,899.2 | 0.6 |
| AF | 23,665 | 77 | 431 | 8.2 | 1,912.2 | 1,912.2 | 1,913.1 | 0.9 |
| AG | 23,811 | 65 | 402 | 8.7 | 1,918.5 | 1,918.5 | 1,918.5 | 0.0 |
| AH | 24,053 | 30 | 254 | 13.8 | 1,924.1 | 1,924.1 | 1,924.9 | 0.8 |
| AI | 24,555 | 44 | 320 | 11.0 | 1,937.9 | 1,937.9 | 1,938.2 | 0.3 |
| AJ | 25,728 | 68 | 312 | 11.3 | 1,972.9 | 1,972.9 | 1,973.2 | 0.3 |
| AK | 26,827 | 36 | 256 | 13.7 | 2,010.1 | 2,010.1 | 2,010.5 | 0.4 |
| AL | 27,646 | 41 | 272 | 12.9 | 2,036.4 | 2,036.4 | 2,036.9 | 0.5 |
| AM | 28,776 | 39 | 273 | 12.9 | 2,075.7 | 2,075.7 | 2,075.9 | 0.2 |
| AN | 29,801 | 40 | 257 | 13.7 | 2,108.6 | 2,108.6 | 2,108.6 | 0.0 |
| AO | 30,844 | 62 | 304 | 11.5 | 2,142.9 | 2,142.9 | 2,143.9 | 1.0 |
| AP | 32,012 | 50 | 268 | 13.1 | 2,191.6 | 2,191.6 | 2,192.0 | 0.4 |

[1]Distances are measured in feet upstream of the confluence of Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

# FLOODWAY DATA

**FLOODING SOURCE: ZIGZAG 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) |
| AQ | 32,349 | 45 | 346 | 10.2 | 2,207.6 | 2,207.6 | 2,207.6 | 0.0 |
| AR | 33,014 | 45 | 260 | 13.5 | 2,234.2 | 2,234.2 | 2,234.4 | 0.2 |
| AS | 34,050 | 46 | 278 | 12.6 | 2,275.5 | 2,275.5 | 2,275.9 | 0.4 |
| AT | 35,264 | 38 | 245 | 14.4 | 2,320.3 | 2,320.3 | 2,320.3 | 0.0 |
| AU | 36,144 | 60 | 329 | 10.7 | 2,348.2 | 2,348.2 | 2,348.9 | 0.7 |
| AV | 37,255 | 60 | 327 | 10.8 | 2,393.1 | 2,393.1 | 2,393.7 | 0.6 |
| AW | 38,517 | 35 | 251 | 14.0 | 2,456.2 | 2,456.2 | 2,456.3 | 0.1 |

[1]Distances are measured in feet upstream of the confluence of Sandy River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: ZIGZAG 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) |
| A | 123 | 135 | 725 | 4.2 | 1,466.7 | 1,466.7 | 1,467.3 | 0.6 |
| B | 610 | 113 | 336 | 9.0 | 1,471.3 | 1,471.3 | 1,471.6 | 0.3 |
| C | 1,317 | 125 | 590 | 5.1 | 1,482.2 | 1,482.2 | 1,483.0 | 0.8 |
| D | 1,919 | 102 | 339 | 9.0 | 1,490.0 | 1,490.0 | 1,490.2 | 0.2 |

[1]Distances are measured in feet upstream of the confluence of Zigzag

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OREGON AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOODING SOURCE: ZIGZAG RIVER SIDE CHANNEL**

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 WSEL 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 3.

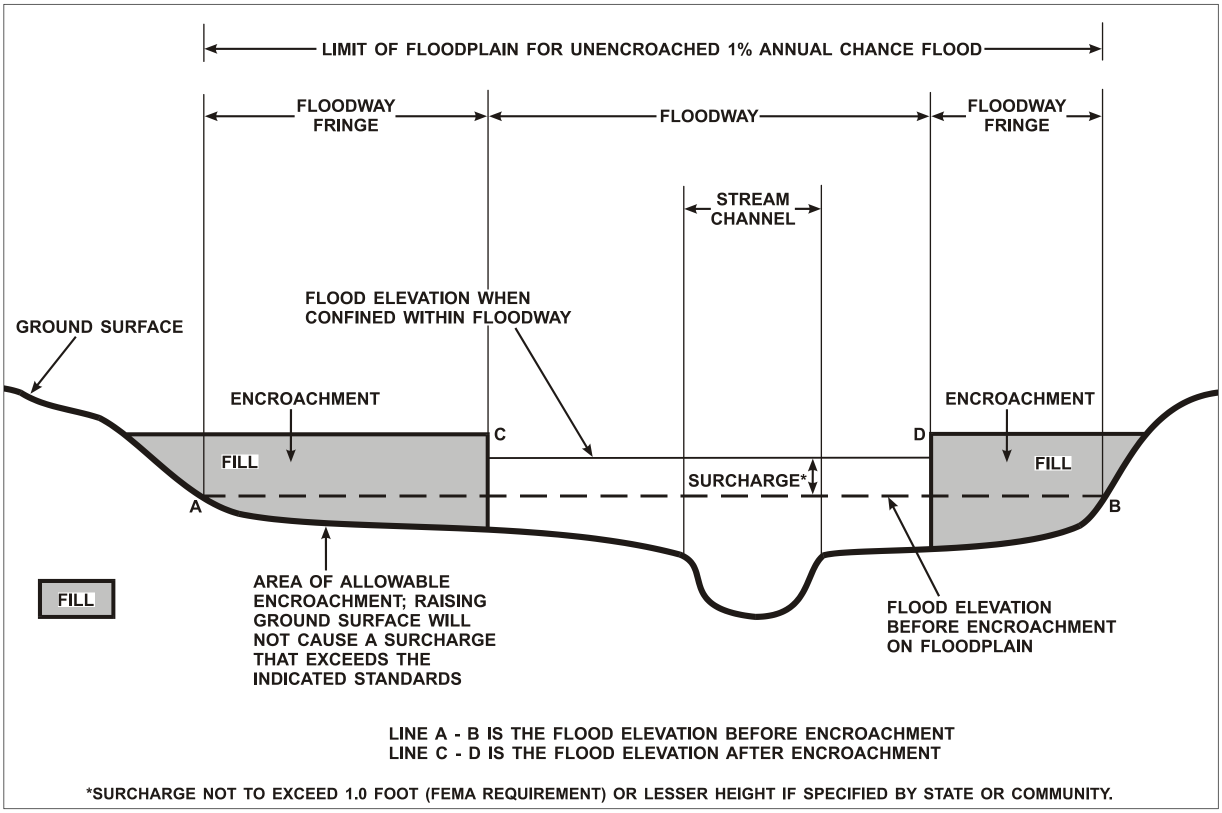


Figure 3 - Floodway Schematic

## 4.3 Base Flood Elevations

Areas within the community studied by detailed engineering methods have BFEs established in AE and VE Zones. These are the elevations of the 1-percent-annual-chance (base flood) relative to NAVD. In coastal areas affected by wave action, BFEs are generally maximum at the normal open shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in BFEs have been shown in 1-foot increments on the FIRM. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. BFEs shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is elevated to or above the BFE in AE and VE Zones.

## 5.0 INSURANCE APPLICATIONS

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

Zone A

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

Zone AE

Zone AE is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance risk 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 base flood depths are shown within this zone.

## 6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance risk 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 FIRM presents flooding information for the entire geographic area of Clackamas County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide FIRM 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 8.

| COMMUNITY NAME | INITIAL IDENTIFICATION | FLOOD HAZARD BOUNDARY MAP REVISION DATE | FIRM EFFECTIVE DATE | FIRM REVISION DATE |
|---|---|---|---|---|
| Barlow, City of | January 10,1975 | | May 5, 1981 | None |
| Canby, City of | November 16, 1973 | November 28, 1975 | June 15, 1984 | None |
| Damascus, City of | March 1, 1978 | | March 1, 1978 (Clackamas County) | |
| [1]Estacada, City of | N/A | | N/A | |
| Gladstone, City of | April 5, 1974 | June 25, 1976 | March 15, 1977 | |
| [1]Johnson City, City of | N/A | | December 4, 1979 | |
| Lake Oswego, City of | June 14, 1974 | June 11, 1976<br>May 25, 1982 | August 4, 1987<br>N/A | |
| Milwaukie, City of | April 5, 1974 | June 25, 1976 | June 18, 1980 | |
| [1]Molalla, City of | N/A | | N/A | |
| Oregon City, City of | December 28, 1973 | June 4, 1976 | February 15, 1980 | |
| Rivergrove, City of | December 6, 1974 | April 22, 1977 | August 4, 1987 | |
| Sandy, City of | April 12, 1974 | April 12, 1974 | December 11, 1979 | December 11, 1979 |
| West Linn, City | December 17, 1973 | August 20, 1976 | March 15, 1977 | |
| Wilsonville, City | March 29, 1974 | August 6, 1976 | January 6, 1982 | |
| Clackamas County (Unincorporated Areas) | March 1, 1978 | N/A | March 1, 1978 | August 4, 1987<br>July 19, 2000 |

[1]No special flood hazard areas identified

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY AND INCORPORATED AREAS**

**COMMUNITY MAP HISTORY**

Table 9 - Listing of NFIP Jurisdictions

| Community | CID | HUC-8 Sub-Basin(s) | Located on FIRM Panel(s) | If Not Included, Location of Flood Hazard Data |
|---|---|---|---|---|
| City of Barlow | 410013 | * | 41005C0263D, 41005C0264D, 41005C0505D | |
| City of Canby | 410014 | * | 41005C0264D, 41005C0266D, 41005C0268D, 41005C0268D, 41005C0505D, 41005C0510D | |
| City of Damascus | 410006 | * | 41005C0042D, 41005C0045D, 41005C0053D, 41005C0060D, 41005C0061D, 41005C0062D, 41005C0063D, 41005C0064D, 41005C0070D | |
| City of Estacada[1] | 410016 | * | 41005C0330D, 41005C0340D | |
| City of Gladstone | 410017 | * | 41005C0038D, 41005C0039D, 41005C0276D | |
| City of Happy Valley | 410026 | * | 41005C0029D, 41005C0033D, 41005C0034D, 41005C0037D, 41005C0041D, 41005C0042D, 41005C0053D, 41005C0061D | |
| City of Johnson[1] | 410267 | * | 41005C0037D, 41005C0039D | |
| City of Lake Oswego | 410018 | * | 41005C0011D, 41005C0012D, 41005C0013D, 41005C0014D, 41005C0016D, 41005C0017D, 41005C0018D, 41005C0019D, 41005C0025D | |
| City of Milwaukie | 410019 | * | 41005C009D, 41005C0017D, 41005C0028D, 41005C0029D, 41005C0036D, 41005C0037D | |

[1]No Special Flood Hazard Areas Identified

*Data not available for this study

Table 9 - Listing of NFIP Jurisdictions

| Community | CID | HUC-8 Sub-Basin(s) | Located on FIRM Panel(s) | If Not Included, Location of Flood Hazard Data |
|---|---|---|---|---|
| City of Molalla[1] | 410020 | * | 41005C0540D, 41005C0545 | |
| City of Oregon City | 410021 | * | 41005C0038D, 41005C0039D, 41005C0257D, 41005C0259D, 41005C0276D, 41005C0277D, 41005C0278D, 41005C0279D, 41005C0285D, 41005C0290D | |
| City of Sandy[1] | 410023 | * | 41005C0091D, 41005C0092E, 41005C0093D, 41005C0094E, 41005C0113E | |
| City of Rivergrove | 410022 | * | 41005C0013D | |
| City West Linn | 410024 | * | 41005C0018D, 41005C41005C0019D, 41005C0038D, 41005C0257D, 41005C0259D, 41005C0260D, 41005C0276D | |
| City Wilsonville | 410025 | * | 41005C0234D, 41005C0241D, 41005C0242D, 41005C0250D, 41005C0253D, 41005C0261D | |

[1] No Special Flood Hazard Areas Identified

*Data not available for this study

Table 9 - Listing of NFIP Jurisdictions

| Community | CID | HUC-8 Sub-Basin(s) | Located on FIRM Panel(s) | If Not Included, Location of Flood Hazard Data |
|---|---|---|---|---|
| Clackamas County (Unincorporated Areas) | 415588 | * | 41005C0080D, 41005C0085E, 41005C0090D, 41005C0091D, 41005C0092E, 41005C0093D, 41005C0094E, 41005C0105E, 41005C0110D, 41005C0113E, 41005C0115E, 41005C0120E, 41005C0140E, 41005C0145E, 41005C0165D, 41005C0170E, 41005C0335D, 41005C0375D, 41005C0381D, 41005C0382E, 41005C0400D, 41005C0401E, 41005C0402E, 41005C0403E, 41005C0404E, 41005C0406E, 41005C0407E, 41005C0408E, 41005C0409E, 41005C0415E, 41005C0450D | |

[1] No Special Flood Hazard Areas Identified

*Data not available for this study

## 7.0 OTHER STUDIES

This report either supersedes or is compatible with all previous studies on streams studied in this report and should be considered authoritative for purposes of the NFIP.

## 8.0 LOCATION OF DATA

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

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