

Chapter 7 Flood Hazards

(Hazard Analysis Score = 178)

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Why are Floods a Threat to Beaverton?

The City of Beaverton has a long-standing, historic relationship with flooding, including repetitive flood losses. Due to the City's ongoing growth and development, Beaverton faces potential increased frequency of flooding; development generally removes vegetation and increases impervious surfaces, a combination that increases storm water runoff and velocity.

History of Flooding

Beaverton residents share a statewide concern regarding flood events. According to the National Flood Insurance Program (NFIP), Oregon has 256 **flood-prone communities throughout the state's 36 counties**. That number includes a majority of Oregon's 240 incorporated communities and counties, of which Beaverton is one. Flooding can cause severe damage to public and private property and pose a threat to life and safety. Oregon's largest economic loss from natural disasters resulted from flooding. Damage during the Christmas Flood of 1964 totaled over \$157 million dollars, and 20 Oregonians lost their lives.

In 1996, many rivers and creeks throughout the Willamette River watershed rose to 100-year flood levels (flood levels that have a 1% annual chance of occurring). Washington County sought and received a Presidential Disaster Declaration to obtain federal assistance for its flood recovery effort in February 1996. Fortunately, in Beaverton, the intensity of the storms experienced locally **didn't approach the predicted 100-year flood event potential (1% annual chance of occurring)**. For example, the February event levels were only slightly higher than a 10-year flood event; however, several creeks rose to these levels a number of times over three consecutive days. A November 1996 flood event on Beaverton Creek neared a 10-year flood event (10% annual chance of flooding), and, within the City limits, Fanno Creek flooded to slightly greater than a 50-year event (2% annual chance of flooding). Within Beaverton, this inundation of low-lying areas caused natural gas line regulators to flood, threatening the operations facility of Northwest Natural Gas. Since those events, the company has developed a back-up emergency plan and put backup emergency positions and systems in place.

(Revised 9/2010) The flood season for Beaverton extends from late October through April. Historically, the majority of flooding has occurred in Beaverton during November, December, January, and February, but overall, the times, duration, and extent of flooding in the City is not well documented. The City has considerable areas of development in the floodplain, most of which was developed prior to the establishment of the current floodplain development regulations. Several of these areas have a high potential for redevelopment, as **well as several undeveloped areas in the City's floodplains that have the potential for development**. Flooding will continue to be a lengthy maintenance and cleanup issue for Beaverton. **The City's most recent flooding incident occurred December 2007.**

Beaverton Creek, the most significant stream in the community, drains approximately 36 square miles as it flows northwesterly through the major commercial area of Beaverton. Streams in the City include five tributaries to Beaverton Creek: Erickson Creek (South Fork Beaverton Creek), North Johnson Creek, South Johnson Creek, Hall Creek, Willow Creek, and Cedar

Mill Creek.

Erickson Creek flows northwesterly through central Beaverton and drains 1.7 square miles. South Johnson Creek flows northerly along the Beaverton western corporate limits and has a 3.7-square mile drainage area. Hall Creek, which drains 3.6 square miles, flows westerly, entering Beaverton Creek just upstream of the Hall Boulevard bridge. Willow Creek, which drains 6.2 square miles, flows westerly through the North Section of Beaverton entering the community just south of Highway 26. Fanno Creek, another significant stream, flows westerly to State Highway 217, then southerly through the City to its confluence with the Tualatin River, after draining 32 square miles. Cedar Mill Creek flows northwesterly and has a drainage area of 8.6 square miles.

There are currently six gauging stations in or near Beaverton for Beaverton Creek, Cedar Mill Creek, Ericson Creek, Johnson Creek, and Willow Creek. The largest flood since 1970 on the creeks in the study area occurred in December 1977, which had an estimated recurrence interval of approximately 10 years.

As a mitigation effort, several culverts have been enlarged on Beaverton Creek to decrease the flooding frequencies in the City. The City spends on average 1.5 million dollars each year in capital improvement projects for the retrofit of detention facilities and other storm sewer improvements in older sections of the City; these retrofits are designed to reduce the frequency of and to minimize future flooding events. The City also requires storm water detention for all new developments that are a half-acre in size and greater.

Nonstructural measures are also being utilized in the form of flood hazard zoning ordinances that follow FEMA guidelines for controlling development within the 100-year floodplain to ensure that it is reasonably safe from flooding. Except in the downtown area, all fill below the 100-year flood event elevation in new developments must be balanced by an offsetting cut for each one foot of contour. In the downtown area, while unbalanced fill in the floodplain is allowed, all new buildings must be elevated or flood proofed to two feet above the 100-year flood event.

Flood Losses in Beaverton (Revised 03/2011)

There are a total of 18 flood loss properties in Beaverton that are dispersed throughout the City but concentrations occur near the following locations:

- Highway 217 and Denny Road (Fanno Creek);
- Near 217 between the Beaverton-Hillsdale Highway and Canyon Road (Beaverton Creek); and
- Near the intersection of Murray and Allen Boulevards, along the Johnson Creek corridor.

The potential for property damage from Beaverton Creek flooding is especially severe for several reasons. Inadequate size and moderate grade of the channel causes over-bank flooding during even mild storms. Many culverts and bridges constrict Beaverton Creek flow; additionally, banks that were artificially constricted by farmers in the first half of the last century and the last half of the previous century result in increased upstream flood heights. The potential for property damage is significant due to the extensive commercial and residential

Source - NFIP BureaNet (<http://bsa.nfip.com>)

development within the Beaverton Creek floodplain. The City experiences flooding frequently from rising creeks and streams as well as localized flooding from overtaxed storm water systems.

Fanno Creek, Johnson Creek, Erickson Creek, and Cedar Mill Creek also have flooding problems, though the flood damage potential from these streams is not as prominent as Beaverton Creek. The floodplains have not been extensively developed on these smaller streams except for residential developments that flood frequently in the Cedar Mill Creek basin upstream from the Nike World Headquarters. The frequency of these damaging events has greatly increased because of numerous recent developments upstream in the basin, outside the City limits, which lack any run-off detention or flow mitigation for large storms.

Repetitive Loss Properties (Revised 03/2011)

The National Flood Insurance Program (NFIP) indicates that Beaverton has 3 recorded repetitive loss properties, according to NFIP data dated April 30, 2009. Each of these repetitive loss properties has had two losses apiece having total losses, for building and contents, of \$147,520. None of the properties meet the definition of a Severe Repetitive Loss Property. **There are no “clusters” of repetitive loss properties within the City.**

#	Stream/ Creek	Insured?	Date of Loss	Building Payment	Date of Loss	Building Payment	Total Bldg Payment
1	Fanno	NO	12/02/80	786.53	11/08/80	2,265.31	3,051.84
2	Johnson	NO	11/19/96	7,231.02	02/06/96	6,688.64	13,919.66
3	Upper	YES	11/19/96	19,918.47	02/06/96	15,644.15	35,562.62

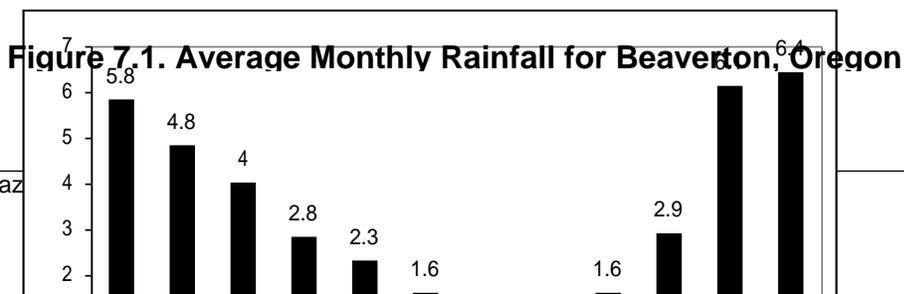
What Factors Create Flood Risk

Flooding occurs when climate or weather patterns, geology, and hydrology combine to create conditions enabling water to flow outside of its usual course. In Beaverton, geographic and climatic conditions combine to create a situation of chronic seasonal flooding.

Precipitation

Flooding is most common from October through April when storms from the Pacific Ocean can bring intense rainfall to the area. The average annual precipitation approximately 39.4 inches, and occurs during these seven wettest months of the year. During this seven-month period, Beaverton receives approximately 81% of its annual precipitation. Snowfall occurs a few days each year, with depths seldom exceeding six inches. Figure 7.1 illustrates the average monthly precipitation that Beaverton receives in inches.

The high level of precipitation during the rainy season saturates the ground, and



often fills Beaverton Creek and its tributaries to bank full conditions. Bank full conditions exist when rivers and streams rise and exceed their channel capacity; any additional water begins to encroach into the surrounding floodplain. The City typically experiences flooding after more than three days of heavy rainfall, which results in saturated conditions and during significant rainfall over short periods of time, typically associated with major storms/thunderstorms.

Geography

Beaverton is located in the Willamette sub-region and Tualatin Valley drainage basin. The drainage basin is approximately 43 miles long and 29 miles wide, and covers an area of 712 square miles. An early settler to the area, Peter Ogden, described the area of the 1800s as “mostly water connected by swamps.” Soils on the valley floor include poorly drained clay soils. These soils often form into wetlands because they are capable of holding water for extended periods of time.

The broad floodplain of the valley can be easily inundated by floodwaters. Wet, rainy season storms move in from the Pacific Ocean, dropping heavy precipitation into the “bowl-shaped” valley. Flooding in the valley becomes a problem when human activities infringe on the natural floodplain.

Soils

Soils in and around Beaverton are silt loams ranging from being nearly level to steep slopes. Drainage characteristics for those soils are poor along the level areas of the Beaverton floodplains. Drainage improves on sloping terrain.

Floodplain Terminology

Floodplain

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe. See the Natural Hazards Map in this plan’s Map Section for Beaverton’s 100-Year Floodplain.

Floodway

The floodway is one of two main sections that make up the floodplain. Floodways are defined only for regulatory purposes; unlike floodplains, floodways do not reflect a recognizable geologic feature or floodwater path. The City uses the NFIP floodway definition, which is “the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto

other properties. The City of Beaverton regulations prohibit development in the floodway, with certain exceptions. Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

Figure 7-2. Floodplain Schematic

Source: Floodplain Management in Missouri. (March 1999) Missouri Emergency Management Agency

Flood Fringe

The Floodway Fringe is the area of the floodplain lying outside the floodway that does not contribute appreciably to the passage of flood water, but serves as a retention area. The flood fringe refers to the outer portions of the floodplain, **beginning at the edge of the floodway and continuing outward. The City's** Development Code provides requirements for commercial and industrial as well as residential uses within the fringe. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the height of the base flood, usually in feet, in relation to the National Geodetic Vertical Datum of 1929, the North American Vertical Datum of 1988, or other datum referenced in the Flood Insurance Study report, or average depth of the base flood, usually in feet, above the ground surface. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie

down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain.

Characteristics of Flooding in Beaverton

Two types of flooding primarily affect Beaverton: urban flooding and riverine flooding. In addition, any low-lying area has the potential to flood. Flooding of developed areas may occur when the amount of rainfall and runoff exceeds a storm water system's (creek, ditch, or storm drain) capability to remove it. Unlike some urban areas, all storm water runoff in Beaverton is directed to the nearest creek or stream. At no point is storm water intentionally directed into the sanitary sewer system.

Urban Flooding

Urbanization of the watershed changes the hydrologic systems of the basin. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb and then slowly release rainfall. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force. The resulting high water volume and turbidity both contribute to erosion of stream banks.

A majority of land within Beaverton is urbanized, and has a high concentration of impervious surfaces that either collect water or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains and catch basins often back up with vegetative debris causing additional, localized flooding.

There are currently numerous areas subject to urban flooding and the potential exists for more as development continues throughout Beaverton. The continual increase of impervious surfaces related to development significantly contributes **to Beaverton's future flood risk as a result of increasing runoff subsequently exceeding the capabilities of existing drainage infrastructure.**

Riverine Flooding

Riverine flooding, the overbank flooding of rivers and streams, is the largest single form of flooding in Beaverton. Streams in the City regularly overflow their banks and inundate low-lying areas. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as **"areas that are inundated by the 100-year flood with flood depths of only 1 to 3 feet."** **These areas are generally flooded by low-velocity sheet flows of water.**

What is the Effect of Development on Floods?

When structures or fill are placed in the floodway, water is displaced. Development raises the base flood elevation by forcing the river to compensate

for the flow space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway, and no fill is removed to compensate, serious problems can arise. Floodwaters inundating the area may expand beyond their historic floodplain areas, possibly resulting in other existing floodplain areas experiencing floodwaters above historic levels.

Local governments must manage development in floodplains and flood ways to assure that any encroachments in the floodway or floodplain are minimized. This can be by cut and fill balance and other methods to prevent the rise of pre-development flood levels. Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention must be paid to development that occurs within the floodway to ensure that structures are prepared to withstand base flood events without exacerbating flood levels.

Development within the floodway is prohibited in City of Beaverton's Development Code, (60.10.15). The following exceptions are allowed, but are subjected to the site development ordinance (B.C. 9.05.005 to 9.05.170):

- A. Storm water outfall pipes and other drainage improvements;
- B. Bridges;
- C. Culverts;
- D. Public utility lines;
- E. Trails or bike paths;
- F. **Roads and other uses identified in the City's Transportation Plan; and**
- G. Grading associated with A through F above.

The City's site development ordinance prohibits encroachments, including fill, new construction, substantial improvements, and other development unless certification by a registered professional engineer or architect is provided demonstrating that encroachments shall not result in any increase in flood levels during the occurrence of the base flood discharge. The city engineer will also deny a permit for development in an area of special flood hazard if the city engineer finds that any of the following circumstances exist:

- The proposed development will diminish the flood carrying capacity of the watercourse;
- The proposed development does not maintain the holding capacity of the site;
- The proposed development will significantly raise the flood surface elevations up or down stream from or adjacent to the site;
- The proposed development will endanger life or property on or off the site;
- Where elevation data is not available either through the Flood Insurance Study or from another authoritative source, proposed construction will not be reasonably safe from flooding. The test of reasonableness is a local judgment and includes use of historical data, high water marks, photographs of past flooding, etc., where available. Failure to elevate at least two feet above grade in these zones may

result in higher insurance rates.

- All necessary permits have not been obtained from those federal, state or local governmental agencies from which prior approval is required.

In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of stormwater management systems to ensure that these runoff waters are dealt with effectively. In Beaverton, this is accomplished by the detention of large storm events to mimic pre-development run-off rates.

How are Flood-Prone Areas Identified? (Revised 03/2011)

Flood maps and Flood Insurance Studies are often used to identify flood-prone areas. The National Flood Insurance Program (NFIP) was established in 1968 **as a means of providing low cost flood insurance to the nation's flood-prone communities.** The NFIP also reduces flood losses through regulations that focus **on building codes and what we have come to know as "sound floodplain management."** Beaverton and Washington County joined the NFIP and implemented the related codes and regulations in 1974. NFIP regulations (44 Code of Federal Regulations (CFR) Chapter 1, Section 60.3) require that all new construction in floodplains must be elevated at or above base flood level. The Oregon Building Code requires new construction to be elevated to one foot above the base flood elevation.

Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent. In Beaverton, all homes and other buildings legally constructed in the floodplain after January 1974 must be mitigated to NFIP standards with the first floor being elevated at least one foot above base flood level, or in the case of non-residential buildings, flood proofed to at least one foot above the base flood level.

The City of Beaverton considers the 100-year (1% annual chance of flooding) flood as the base flood event.

FIRM Maps and Flood Insurance Studies (Revised 03/2011)

Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by the Federal Emergency Management Agency (FEMA), which delineates Special Flood Hazard Areas or floodplains where National Flood Insurance Program regulations apply. The maps are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply. Water surface elevations are combined with topographic data to develop FIRMs. These maps illustrate areas that would be inundated during a 100-year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases they also include base flood elevations (BFEs) and areas located within the 500-year floodplain. Hard copy and electronic copies of the FIRMs are maintained by the City.

Flood Insurance Studies and FIRMs produced for the National Flood Insurance Program (NFIP) provide assessments of the probability of flooding at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s. These studies and maps represent flood risk at the point in time

when FEMA completed the studies. They do not reflect changes within the study area that might affect flooding since the studies. For example, many areas in Beaverton have experienced significant urbanization and changes in hydrology during the past 20 years. The City Engineer and Planning Director have records of subsequent flood studies performed for new developments in areas where the FEMA maps were deficient or with previously unstudied flood hazards. Floodplain maps within most of, but not all of, urban Washington County are being updated and the updates were submitted to FEMA for review in July 2003.

(New 9/2010) This resulted in maps being adopted by FEMA in February of 2005 that incorporated the most current flood study of the Fanno Creek Basin. A County-wide restudy of the Beaverton Creek basin (and other local creeks besides Fanno) was submitted to FEMA in 2006 and produced draft maps sent to the City and Washington County for review in 2007. Comments were sent **back to FEMA's consultants within** their allotted 30 days for local input. The revisions from that process were not returned to the City and County for a second review until August of 2009. The draft maps sent for this review were full of errors and missing labels, which resulted in a third revision being sent for local review in December of 2009. Comments generated from that review were returned to FEMA the first week of January 2010 by City staff. There have been no further updates from FEMA as to when new maps will be completed or ready for local adoption.

Flood Mapping Methods and Techniques (Revised 03/2011)

Although many communities rely exclusively on FIRMs to characterize the risk of flooding in their area, some jurisdictions develop their own flood hazard maps, like Beaverton. They use high-water marks from flood events or aerial photos, in conjunction with the FEMA maps, and all new studies to better reflect the true flood risk for properties within their communities.

The use of GIS (Geographic Information System) is becoming an important tool for flood hazard mapping. FIRM maps can be imported directly into GIS, which then allows for GIS analysis of flood hazard areas. Communities find it particularly useful to overlay flood hazard areas on tax assessment parcel maps. **However, as the original mapping efforts by FEMA in the 1980's did not** contain adequate horizontal controls, any such overlay is subject to significant error. Local communities have found that the only useful mapping information is the water elevation and cross section locations contained in the flood studies. This information can be added to topography maps that more accurately define the areas prone to flood hazard. This allows a community to evaluate the flood hazard risk for a specific parcel during review of a development request.

Community Flood Issues

Development in the floodplains of Beaverton will continue to be at risk from flooding. Flood damage occurs on a regular basis throughout the City. During certain years, property losses resulting from flood damage can be extensive. NFIP payment for 1996 flood damages for all of Washington County was 531 times greater than the three previous years combined.

The single largest impact on communities from flood events is the loss of life

and property. Washington County has experienced millions of dollars in flood damage in the past three decades, with Beaverton's losses reflecting a subtotal of this amount. Property loss from floods strikes both private property and public property. Public sector impacts (e.g., impacts to water and sewer systems, roads, etc.) state-wide resulted in approximately two-thirds of the damage from the 1996 flood events.

In a survey of stakeholders, Clean Water Services (CWS, formerly Unified Sewerage Agency) found that stakeholders desired a greater connection between flood control, water quality, the mitigation of growth impacts, and the effectiveness of land use systems. Many citizens are concerned about the relationship between rapid urban growth and flood damage. While there are no strong sentiments to stop growth, some Beaverton residents are concerned that growth is pushing development into floodplains. CWS manages wastewater treatment and sets minimum standards for surface water management within the urbanized area of Washington County. The City of Beaverton sets higher standards for control of damaging run-off rates from new developments than are used by Clean Water Services for areas outside the current City limits.

Property loss resulting from Flooding Events

The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive flood damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Surface water entering into crawlspaces, basements, or daylight basements is common during flood events, not only in or near floodplains, but also on hillsides and other areas that are far removed from floodplains. Most flood damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). Most of the losses in the 1996 floods were due to saturation damage.

Private property flood issues

In 1996, flood damage to private property totaled one-third of damages statewide. In Beaverton, damage occurred to structures in the floodplain, as well as structures impacted by localized urban flooding, but not necessarily in the FEMA-mapped floodplain. Damage also occurred to structures impacted by landslides caused by heavy precipitation. A high level of flood damage during the 1996 floods occurred to those structures that were constructed prior to the adoption of floodplain management measures required by the National Flood Insurance Program. The concentration of damage clearly demonstrates the success of the mitigation measures required and implemented through the NFIP.

The City of Beaverton regulates floodplain development in the City Code (Chapter 9), the Development Code (Chapter 60), and the City's Engineering Design Manual (Ord. 4060). Flood events also pose a risk to structures outside of identified floodplains. Outside of official floodplains the City also provides drainage standards under the Development Code, Engineering Design Manual and Clean Water Services' Design and Construction standards.

Homes

Housing losses accounted for the largest share of private property damage

during the 1996 flood events. Homes with access to rivers and creeks may be located in areas especially at risk to chronic flooding. Beaverton flood ordinances provide baseline rules governing the construction of homes within identified floodplains. Flood damage problems may continue to arise for homes that were constructed prior to the implementation of the City regulations and the Washington County Floodplain and Drainage Hazard Area Development Standards. Flood damage may also occur to homes constructed according to standards, as the County and City cannot guarantee that adherence will prevent flood damage.

Homes in frequently flooded areas can also suffer damage to septic systems and drain fields. Homes in rural floodplain areas often depend on private sewage treatment systems. Inundation of these systems may result in leakage of wastewater into surrounding areas. In many cases, flooding damage to homes renders them unlivable.

In the wake of the 1996 floods, Washington County received almost \$1.5 million in Disaster Housing Assistance Program funds with a portion of that allotment dedicated to assist Beaverton in its post-flood recovery period. The Federal Government provides disaster funding for people who cannot, or should not, live in their homes because of damage or other disaster related reasons.

Table 7.1 illustrates Washington County's rank as the seventh highest county in the state for total flood damage during the 1996 events, and as the fourth highest county for housing disaster assistance. Housing Assistance funds went primarily to urban counties with high populations and relatively high property values.

Table 7.1. 1996 Oregon County Losses and Housing Program Fund Payments

Source: 1996 Flooding and Landslides and Stream Erosion In the State of Oregon

Manufactured Homes

Statewide, the 1996 floods destroyed 156 housing units. Of those units, 61% were mobile homes and trailers. Many older manufactured home parks are located in floodplain areas. Manufactured homes have a lower level of structural stability than "stick-built" (standard wood frame construction) homes. A stick-built home's foundation and building frame are put together on site as opposed to manufactured homes which are pre-fabricated off site. Manufactured homes in floodplain zones must be anchored to provide additional structural stability during flood events. Because of confusion in the late 1980's resulting from multiple changes in NFIP regulations, there are some communities that do not actively enforce anchoring requirements. Lack of

enforcement of manufactured home construction standards in floodplains can contribute to severe damages from flood events. In all areas of special flood hazards Beaverton's Development Code requires that all new construction and substantial improvements shall be anchored to prevent flotation, collapse, or lateral movement of the structure. Additionally, all manufactured homes must likewise be anchored to prevent flotation, collapse or lateral movement, and shall be installed using methods and practices that minimize flood damage.

Business/Industry

Flood events impact businesses by damaging property and by interrupting business. Flood events can cut off customer access to a business as well as close a business for repairs. The 1996 flood damaged some businesses in Beaverton and caused extensive losses to Washington County's agricultural and nursery-stock industries. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

The Beaverton Creek floodplain includes existing commercial development and potential commercial sites from Millikan Way (near 160th Avenue) to upstream of State Highway 217. Along Fanno Creek, both commercial and residential development sites are in the floodplain from Vermont Street to Scholls Ferry Road where it flows into the City of Tigard.

Public Infrastructure

Publicly owned facilities are a key component of daily life for all citizens of Beaverton. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Government can take action to reduce risk to public infrastructure from flood events, and to craft public policy that reduces risk to private property from flood events.

Buildings and Roads

In the wake of the 1996 flood events, damage to public buildings statewide represented 34% of total public losses. Of particular importance during flood events are critical facilities located in flood hazard areas (i.e., facilities that are critical to government response and recovery activities). During natural hazard events, or any type of emergency or disaster, dependable road connections are critical for providing emergency services. The roads in Beaverton are maintained by multiple jurisdictions depending on ownership and maintenance agreements. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. More than 50% of public assistance appropriations to Washington County following the 1996 floods were to repair damages to the road system. Road networks often traverse floodplain and floodway areas. Transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding.

Bridges

Bridges are key points of concern during flood events for two primary reasons:

- (1) They are often important links in road networks, crossing water courses or other significant natural features; and,
- (2) They can be obstructions in watercourses, inhibiting the flow of water during flood events.

Storm Water System

Local drainage problems are common throughout Beaverton. The City's Operations and Maintenance Department maintains a list of local drainage threats and potential problem areas. The problems often are located where open ditches enter culverts or go underground into storm sewers. In addition, high water tables in some areas can mean wet crawl spaces, yards, and basements following a flooding event because the accumulated water does not drain quickly into a stream or storm sewer. The problem is compounded when ditches and swales near buildings are filled or when debris dumped in them inhibits or prevents the flow of water. Most of the areas where these problems exist were recently annexed by the City and were originally developed when part of unincorporated Washington County. Inadequate maintenance, especially following leaf accumulation in the fall, could contribute to the flood hazard. In Beaverton aggressive leaf removal, catch basin cleaning, and street sweeping programs have all but eliminated these types of flood events in the City limits.

Water/Wastewater Treatment Facilities

Portions of Washington County, including a small percentage of Beaverton are served by the Tualatin Valley Water District. But most of the City is served by **the City's water district. The Beaverton Water District draws the bulk of its** water from the watersheds located on the west side of Washington County and is able to draw from Bull Run as a backup source. The Joint Water Commission (JWC) Water Treatment Plant processes water from Hagg Lake, (routed through Scoggins Creek and the Tualatin River) and Barney Reservoir. The plant faces significant risk during flood events.

During the February 1996 flood events, the JWC Plant was surrounded on all sides by floodwaters. The plant was able to maintain operations by instituting emergency procedures. In 2001, the JWC began developing an emergency operations plan that will assist management during hazard events. **The JWC faced another significant challenge during the 1996 events—treating water with high levels of turbidity (sedimentation).** According to the JWC Plant Operations Manager, **water turbidity during the 1996 events was “something we had never seen before.” The JWC Plant can treat high turbidity levels in the water.** However, the cost of treating the water increases with turbidity levels. High turbidity levels can be attributed to land use practices up stream that result in increased erosion (e.g., vegetation removal and landslides). Changes in land use practices within the watershed could assist in reducing turbidity levels during flood events. The problem with turbidity will also be reduced greatly when a planned pipeline is built from Hagg Lake to the water treatment plant, eliminating the need to use Scoggins Creek/Tualatin River to convey the water from the reservoir to the treatment plant.

Clean Water Services (CWS) operates four wastewater treatment plants in the Tualatin Basin at Durham Creek, Rock Creek, Hillsboro, and Forest Grove. The wastewater treatment plant facilities are located adjacent to the floodplain and were not flooded in 1996. Since the system is built to a target capacity based on a 5-year idealized storm, the volume of water entering the plants during flood events can be problematic. A new wet weather outfall was recently installed at Rock Creek in Beaverton to improve discharge capacity and structures at risk of flooding have been elevated/flood proofed. CWS is working to improve the tightness of the conveyance system to minimize treatment of non-sewage waters. All four wastewater treatment plants have back-up emergency power supplies. Also, the Forest Grove and Hillsboro plants are linked to the Rock

Creek plant, so if there were problems at these smaller facilities, the sewage could be treated at Rock Creek.

Floods and Natural Systems

Maintaining and restoring natural systems can mitigate the impact of flood events on the built environment. Flooding changes the natural environment and hydrology of an affected area. High water can also be beneficial to the natural processes within a floodplain, and can benefit riparian areas.

Parks and Open Space

Current efforts to increase public open space in Beaverton have been paired with the need to restore and preserve natural systems that provide wildlife habitat and help to mitigate flood events. Public parks and publicly owned open spaces can provide a buffer between flood hazards and private property.

Riparian Areas

Riparian areas are important transitional areas, which link water and land ecosystems. Vegetation in riparian areas is dependent on stream processes, such as flooding, and often is composed of plants that require large amounts of water such as willow and cottonwood trees. Healthy vegetation in riparian buffers can reduce streamside erosion. During flood events, high water can cause significant erosion. Well-managed riparian areas can reduce the amount of erosion and help to protect water quality during flood events.

Wetlands

Many floodplain and stream-associated wetlands absorb and store storm water flows, which reduces flood velocities and stream bank erosion. Preserving these wetlands reduces flood damage and the need for expensive flood control devices such as levees. When the storms are over, many wetlands augment summer stream flows by slowly releasing the stored water back to the stream system. Wetlands are highly effective at removing nitrogen, phosphorous, heavy metals, and other pollutants from water. For this reason, artificial wetlands are often constructed for cleaning stormwater runoff and for tertiary treatment (polishing) of wastewater. Wetlands bordering streams and rivers and those that intercept runoff from fields and roads provide this valuable service free of charge.

Water Quality

The Tualatin River and Beaverton Creek are part of a sediment-based system. **High turbidity is part of its “normal” condition due to the dominance of silts and clays on the valley floor.** Streams naturally carry some quantity of sediment (called bed load). When the scouring and deposition of sediments is excessive (i.e., beyond normal bed movement) turbidity becomes a problem in the stream. High flows can generate very high turbidity and suspended solids in the main stem and many of the tributaries. Significant flood events in 1995 and 1996 have increased concern for flood management and control in the watershed.

Title 3: (Metro Code 3.07.310-3.07.370), Water Quality and Flood Management Conservation

The goal of the Stream and Floodplain Protection Plan (Title 3) of Metro **Regional Government’s Framework plan is to protect the region's health and public safety by reducing flood and landslide hazards, controlling soil erosion, and reducing pollution of the region's waterways.** Title 3 implements Oregon Land Use Goals 6: Air, Water, and Land Resources Quality and 7: Areas

Subject to Natural Disasters and Hazards, by protecting streams, rivers, wetlands, and floodplains by avoiding, limiting, or mitigating development impact on these areas.

Title 3 contains performance standards to protect against flooding. The standards limit development in a manner that requires balanced cut and fill, and requires floor elevations at least one foot above the flood hazard standard. The areas subject to these requirements have been mapped and adopted by Metro Council. The areas are the FEMA 100-year floodplain and the area of inundation for the February 1996 flood. Title 3 also contains performance standards related to streams, rivers, and wetlands.

The purpose of these standards is to protect and allow enhancement of water quality. The water quality areas are rivers and streams with a protected vegetated corridor width depending on the slope of the stream and the number of acres drained by the stream. The performance standards require erosion and sediment control, planting of native vegetation on the stream banks when new development occurs, and prohibition of the storage of uncontained hazardous material in water quality areas.

Flood Hazard Assessment

Hazard Identification

Hazard identification is the first phase of flood hazard assessment. Identification is the process of estimating (1) the geographic extent of the floodplain (i.e., the area at risk from flooding), (2) the intensity of the flooding that can be expected in specific areas of the floodplain, and (3) the probability of occurrence of flood events. This process usually results in a floodplain map. Floodplain maps provide detailed public information that can assist planning jurisdictions in making policy and land use decisions. In Beaverton, the City, the Army Corps of Engineers, the Federal Emergency Management Agency (FEMA), and Clean Water Services develop floodplain maps. Each map of the floodplain provides important data for determining the areas that fall within the floodplain. To identify the flood hazard area, or floodplain, Beaverton uses the maps from all three agencies in addition to maps developed over the years by City staff. The map that is used depends upon the specific parcel or area in question, and which map provides the best available data for that area.

Data Sources

In 1980, FEMA mapped the 100-year and 500-year floodplains in Washington County. The County has updated portions of the Corps and FEMA maps through smaller drainage studies throughout the County. The County also provides 25-year floodplain data for Tualatin River tributaries, such as **Beaverton Creek, also referenced as the County's Drainage Hazard Areas.** Clean Water Services (CWS) in partnership with Washington County and several cities is currently in the process of updating floodplain data. It is hoped that the CWS data will become the best available data when it is completed.

Beaverton's GIS Services plays an important role in creating maps using existing data for the purpose of identifying high-risk flood areas. Important to note is the fact that the FEMA floodplain map does not match the City's building footprint maps, creating the erroneous impression that some structures are in

the floodplain while other structures shown outside the floodplain are actually within.

Vulnerability Assessment

Vulnerability assessment is the second phase of flood hazard assessment. It combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. It identifies the number of properties at risk from flooding, and the dollar value of the property at risk. Floodplain data for Beaverton can be used to conduct a preliminary vulnerability assessment for flood and drainage hazard areas.

The floodplains in Beaverton are generally located along Beaverton Creek, Fanno Creek, and its tributaries. There are approximately 750 acres within the 100-year floodplain boundaries in the City's jurisdiction. A total of 845.69 acres of tax lots that lie within the 100-year flood plain in Beaverton. Within the tax lots, there are 320 total structures valued at \$339,537,830. See Table 7.2 for a breakdown of these properties by types of tax lots.

Table 7.2. Vulnerability Assessment for the 100-year Floodplain

Building Code Category	Number of Properties	Assessed Improved Value	Acreage within 100-year floodplain
COMMERCIAL	34	\$78,014,890	103.26
INDUSTRIAL	39	\$126,973,670	226.27
SINGLE FAMILY RESIDENTIAL	199	\$29,201,790	171.75
MULTI-FAMILY RESIDENTIAL	48	\$105,347,480	344.41
TOTAL	320	\$339,537,830	845.69

Source: City of Beaverton GIS, 2003

Risk Analysis

Risk analysis is the third and most advanced phase of a hazard assessment. As such, it builds upon the hazard identification and vulnerability assessment.

A flood risk analysis for Beaverton should include two components:

- (1) The amount of loss to both property and life that may result from a flood event (defined through the vulnerability assessment); and,
- (2) The number of flood events expected to occur over time. Within the broad components of a risk analysis, it is possible to predict the severity of damage from a range of events. For example, a risk analysis can be conducted for both 25-year (smaller storm) floodplains (Drainage Hazard Areas), and 100-year

(larger storm) floodplains. Over time, the Drainage Hazard Areas will flood more often than areas within a 100-year floodplain, exposing properties in Drainage Hazard Areas to a greater risk of flood damage. However, depending on the impacts resulting from a 25-year flood event versus a 100-year flood event, and the amount of life and property exposed to the different hazard events, the level of risk may vary.

Empirical data, such as NFIP insurance claims, can also help establish where risk is greatest, particularly for properties that have had multiple (repetitive) losses.

Flow velocity models can assist in predicting the amount of damage expected from different magnitudes of flood events. The data used to develop these models is based on hydrological analysis of landscape features. Changes in the landscape, often associated with human development, can alter the flow velocity and the severity of damage that can be expected from a flood event. GIS technology and flow velocity models make it possible to map the damage that can be expected from both flood events over time. It is also possible to pinpoint the effects of certain flood events on individual properties.

At the time of publication of this plan, data was insufficient to conduct a full risk analysis for flood events in Beaverton. However, fostering partnerships between the City, Clean Water Service and the State Floodplain Manager will help support development of improved floodplain data for the City. This plan includes recommendations for building partnerships that will support the conducting a future flood risk analysis in Beaverton.

Mitigation Plan Goals and Existing Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Steering Committee, and interviews with both Beaverton and Washington County stakeholders. Goals for this mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Partnerships for Communication and Coordination
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies or organizations. Several personal stakeholder interviews were conducted with several Beaverton agencies to obtain existing mitigation activities information.

City Programs

City of Beaverton Codes

Flood-related goals, actions, and or regulations can be found in Beaverton's Comprehensive Plan, Development Code, City Code, and Engineering Design

Manual.

Floodplain Management (new 03/2011)

The City has been part of the National Flood Insurance Program (NFIP) since 1974. The City has a designated Floodplain Manager, who is a Certified Floodplain Manager (CFM), and performs those duties in conjunction with his responsibilities as an Engineer with Public Works Ops Site Development Inspection Division. The City is in good standing with the NFIP and there is currently no Community Assistance Visits (CAV) or Community Assistance Contacts (CAC) scheduled.

NFIP administration services provided by the City include permit review; plan approvals; construction and building inspection; public notice of floodplain changes; flood map determinations; floodplain information; and GIS products, hydraulic and hydrologic engineering analysis required of projects.

The City of Beaverton's floodplain ordinance exceeds FEMA and State minimum requirements. For example: Cut and fill balance for floodplain encroachment is required, analyzed for each one foot interval to preserve flood storage; except for one area of downtown where unlimited floodway-fringe filling is allowed. One-foot freeboard is required for all areas of the City; two-foot freeboard required in areas of downtown where unbalanced floodplains fill is allowed. City public notice requirements also exceed the state statute requirement.

In Beaverton **there is no single "floodplain permit"**. The floodplain permitting process is a multi-disciplinary review that is incorporated into the Land Use entitlement (planning), Site Development Permit, and Building Permit processes. Each project is evaluated on its own merits under the established code provisions and permit thresholds.

Flood Management Projects

As stated earlier, the City spends approximately \$1.5 million each year on flood **mitigation projects like the ones identified below. A majority of the City's projects** deal with underground detention facilities. Flood management structures (i.e., dams) can assist in regulating flood levels by adjusting water flows upstream of flood-prone areas. The expense and space needs of large water detention projects to mitigate flood damages can be a prohibitive factor for local jurisdictions such as Beaverton. Flood detention and conveyance projects are also potential solutions to flood damage issues. However, detention or conveyance projects may not always be the most cost-effective way to decrease flood damages especially in high frequency or severely flood-prone areas. Individual property mitigation projects within an affected area may be more effective at reducing flood damage, and less expensive than large detention or conveyance projects that may simply shift the problem downstream.

Additional flood control projects may include levees, diversions, and channel modifications. Levees provide a barrier of earth, steel, or concrete erected between the watercourse and the property to be protected. However, levees may result in the displacement of floodwaters to surrounding properties. Diversion channels direct floodwater to a different location, reducing damage to property within the floodplain or floodway. Diversions may protect certain properties; however, water diversion may force flood impacts onto new areas. Channel modifications increase the capacity of a stream or river channel to

carry water. Channel modifications may not be appropriate for sensitive natural systems within riparian areas.

Emergency Management Program

Beaverton's Emergency Management Program coordinates available resources to combat emergencies. The program's goals are to effectively save lives, avoid injury, and minimize economic loss. Today's Emergency Management Program evolved from Civil Defense and Civil Preparedness programs of the 1950s, 60s, and early 70s. Other City departments work in conjunction with the Emergency Management Program. The goal of the program is to develop and maintain the City's ability to prepare for, respond to, recover from, and mitigate against major emergencies and disasters and to minimize loss of life and property, ensure continuity of government, and facilitate rapid recovery.

The City has established an Emergency Management Program consistent with its authority under Oregon Revised Statutes (ORS) 401.305 to 401.335 and City Code 2.01.010 to 2.01.060 (cited as the "Emergency Management Code"). It is organized under the auspices of the City Council and works under the overall supervision of the Mayor. The Emergency Manager is part of the Mayor's Office and is responsible for managing the City's program in all four phases of Emergency Management. The responsibilities of the City's Emergency Manager include:

- Development and maintenance of the City's Response, Recovery, Preparedness, and Mitigation Plans
- Public education and training
- Education and training of City employees
- Establishing procedures to staff and maintain the City's Emergency Operations Center during disasters and emergencies
- Coordination with local, regional, state, and federal jurisdictions and agencies

County Programs

Office of Consolidated Emergency Management

The City of Beaverton's Emergency Management Program is an integral part of the Office of Consolidated Emergency Management (OCEM) in Washington County. OCEM was established in 1995 by an intergovernmental agreement between the City of Beaverton, the City of Hillsboro, the City of Tigard, Washington County, and Tualatin Valley Fire and Rescue. OCEM was formed to improve the level of disaster and emergency preparedness within the boundaries of the participating jurisdictions through increased coordination among OCEM members and among the various emergency service functions provided within each participating jurisdiction.

Washington County Codes

The Community Development Code, Section 421: Floodplain and Drainage Hazard Area Development, was first adopted in November 1973, and became effective in January 1974. The current standards were adopted in 1983, and revised in subsequent years. These standards directed that the 1974 Corps of Engineers maps and the 1980 FEMA Flood Insurance Rate Maps, including the Flood Boundary and Floodway Maps be used to determine the floodplain,

floodway, and Drainage Hazard Areas of Beaverton. These were later changed, most significantly in 1984, 1987, and 2000 as new FIRM maps and Letters of Map Revisions were adopted. All lots of record established after 1974 have buildable area outside of the delineated floodplain or Drainage Hazard Area boundaries. Legal lots of record established prior to 1974 may not have buildable area outside of the floodplain. Any building within the floodplain must adhere to the provisions in Section 421.

Affected Properties

Section 421 provides development guidelines for properties in the floodplain, and properties that are within 250 feet of a delineated floodplain. The floodplain is determined through the use of maps and data from FEMA, Army Corps of Engineers, Washington County, Beaverton, and Clean Water Services. The County policy is to use the most current data available to delineate the floodplain in relation to property lines.

Mitigation Requirements

Section 421 requires the following:

- Landowners must submit a detailed delineation of the floodplain in areas planned for development.
- All fill below flood surface elevation (i.e., in the floodplain) be accompanied by an equal or greater amount of cut on the development site.
- Landowners are allowed to avoid the on-site requirement of the cut and fill rule by developing a drainage master plan for the site, or providing off-site excavation to meet the amount of cut required to balance the fill in the floodplain.
- Construction of a new dwelling in the floodplain is prohibited if the property in question has a suitable site for development that is not in the floodplain.
- All new or improved residences (including manufactured homes), and lots for subdivisions and partitions must be elevated at least 1 foot above base flood elevation.
- All new or improved non-residential buildings must be flood-proofed, or elevated to or above base flood elevation

Regional Surface Water Management

Clean Water Services (CWS) sets minimum surface water management standards for all municipalities in the County, and those urban, unincorporated areas within the urban growth boundary. CWS has adopted surface water standards with respect to flood management while the City of Beaverton has adopted more stringent standards to control and mitigate for flood events. The Surface Water Management Program, in coordination with local jurisdictions, seeks to provide and maintain urban area surface water management facilities, **policies, practices, and controls that protect the public's health, safety, and property.** The program also seeks to conserve, and where possible, enhance and restore, the natural systems of Beaverton Creek and its tributaries. CWS is authorized by State law to set fees and charges for connection to and use of, the public facilities and public services related to surface water management. However, inside the City limits, the City of Beaverton collects all fees and charges for connection to and use of public facilities and services related to

surface water management.

Healthy Streams Plan

Clean Water Services began the development of the Healthy Streams Plan concept in October of 1999, following the listing of winter steelhead and spring Chinook as threatened species under the Endangered Species Act. The purpose of the project is to develop a watershed-based plan that integrates the requirements of the Clean Water Act (CWA) and the Endangered Species Act (ESA) in a manner that promotes overall stream health. The plan will identify and prioritize specific projects, policies, and programmatic changes needed to further improve water quality, manage flooding and floodplains, and provide for aquatic species recovery throughout the Tualatin River Basin. The Healthy Streams Plan has six major components outlined below in chronological order. All components were completed by winter 2002.

Actions

- Watersheds 2000 Inventory (topography, ecological survey, hydrology/hydraulic modeling);
- Fish friendly reviews of existing activities;
- Economic analysis and funding strategy development;
- Public values analysis;
- Programmatic and policy focus areas (impervious cover, vegetated corridors, landscape management, hydrology/hydraulics, storm water pretreatment); and
- Document preparation and final plan approval.

Clean Water Services has been working with project partners in the basin including: Washington County, cities in Washington County including Beaverton, Tualatin Hills Park and Recreation District, Metro, the Soil and Water Conservation District, and the Federal Emergency Management Agency.

Regional Programs

Acquisition and Protection of Open Space in the Floodplain

Public, private, and non-profit organizations have acquired open space within the floodplain. The City of Beaverton, Washington County, Metro, the City of Hillsboro, and the Oregon Wetlands Joint Venture are among the organizations that have acquired floodplain open space in order to protect natural flood hazard mitigation systems and prevent further development in the floodplain. Clean Water Services owns floodplain open space for use in conjunction with wastewater treatment facilities.

State Programs

State of Oregon Floodplain and Floodway Removal/Fill Law

The Oregon Removal/Fill Law, which is administered by the Oregon Division of State Lands, requires a permit for activities that would remove or fill 50 cubic yards or more of material in waters of the state (e.g., streams, lakes, wetlands). Beaverton, Clean Water Services and other partner cities must comply with the removal/fill laws when designing and building facilities, and have related

responsibilities when dealing with private development and other construction projects.

Oregon's Wetlands Protection Program

Oregon's Wetlands Program was created in 1989 to integrate federal and state rules concerning wetlands protection with the Oregon Land Use Planning Program. The Wetlands Program has a mandate to work closely with local governments and the Division of State Lands (DSL) to improve land use planning approaches to wetlands conservation. A Local Wetlands Inventory (LWI) is one component of that program. DSL also develops technical manuals, conducts wetlands workshops for planners, provides grant funds for wetlands planning, and works directly with local governments on wetlands planning tasks.

Oregon Wetlands Joint Venture

The Oregon Wetlands Joint Venture is a coalition of private conservation, waterfowl, fisheries, and agriculture organizations working with government agencies to protect and restore important wetland habitats.

Federal Programs

National Weather Service

The National Weather Service provides flood watches, warnings, and informational statements for rivers throughout Washington County.

National Resources Conservation Service (NRCS), US Department of Agriculture

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource, or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance to clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and generally benefit more than one property.

Federal Emergency Management Agency (FEMA) Programs

The Federal Emergency Management Agency (FEMA) resulted from the consolidation of five federal agencies that were dealing with different types of emergencies. Since then, many states and local jurisdictions have accepted this approach and changed the names of their organizations to include the words "emergency management." Beaverton is one of those local jurisdictions. FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance.

National Flood Insurance Program (NFIP)

Flood insurance is available to citizens in communities that adopt and implement NFIP citing and building standards. The standards are applied to development that occurs within a delineated floodplain, a drainage hazard area, areas subject to inundation during a base flood event, and properties within 250

feet of a floodplain boundary. These areas are depicted on federal Flood Insurance Rate Maps (FIRMS) that are available through Beaverton. Oregon's Department of Land Conservation and Development is the state's NFIP-coordinating agency. NFIP claims data can be helpful in delineating areas where past losses have occurred, especially where there have been repetitive losses. These areas are particularly problematic and in need of mitigation.

The Community Rating System (CRS)

The Community Rating System (CRS) recognizes community floodplain management efforts that go beyond the minimum requirements of the NFIP. Property owners within the City would receive reduced NFIP flood insurance premiums if the City implements floodplain management practices that qualify it for a CRS rating. For further information on the CRS, visit FEMA's website at <http://www.fema.gov/nfip/crs.htm>.

The City of Beaverton was designated a CRS Class 9 community in 1990, 1991, and 1992 with the potential for a better class designation. However, budget constraints and staff layoffs in 1993 eliminated the City from further participation, even though the standards adopted by the City go well beyond the minimum required for participation in the NFIP. (New 9/2010) Key to the decision then and now is the cost associated with meeting and reporting on the compliance with CRS standards, relative to the small percentage of Beaverton's population that would actually benefit from the City's compliance. Currently out of a City with over 36,000 structures, there are only 319 NFIP policies in-force.

Flood Mitigation Action Items (Rev 03/2011)

The flood mitigation action items provide direction on specific activities that organizations and residents in the City of Beaverton can undertake to reduce risk and prevent loss from flood events. There are three short-term and six long-term flood hazard action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

ST-FL#1: Evaluate the requirements for Beaverton to become a participant in the NFIP's Community Rating System (CRS).

- (Completed) The City will not be participating in the CRS.
Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

ST-FL#2: Analyze each repetitive loss property to identify viable mitigation options.

Possible Actions

- (Done) Use insurance claim data from FEMA and OEM to identify properties in the City that have filed more than one National Flood Insurance Program (NFIP) insurance claim. Some properties that have experienced repetitive flood damage may not be enrolled in the NFIP (e.g., properties not in the floodplain, but experiencing damage from urban flooding). Data concerning these properties may be more difficult to obtain;
- Consider identified properties for mitigation activities. Funding for mitigation may be available through FEMA's Hazard Mitigation Grant or

Flood Mitigation Assistance programs;

- Prioritize properties for mitigation activities using a benefit/cost analysis; and
- (In-progress). Map and analyze each repetitive loss property to develop appropriate mitigation actions

Coordinating Organization: City of Beaverton

Internal Partners: Emergency Management, Community Development, Public Works, Economic and Capital Development, Geographic Information System

External Partners: Oregon Emergency Management, Department of Land Conservation and Development, Federal Emergency Management Agency, Natural Resources Conservation Service

Timeline: Ongoing

Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

ST-FL#3: Develop mitigation and preparedness measures for critical public infrastructure and facilities located in flood hazard areas.

Critical facilities fall into two principal categories:

- (1) Buildings, bridges, roadways, or locations vital to emergency response efforts; and
- (2) Facilities that, if damaged, could cause secondary or compound disasters (e.g., sewer and gas lines).

Possible Actions

- Document in database format as well as in maps the critical facilities that are at risk from flood events; and
 1. (New 03/2011) No critical facilities (buildings) are in the 100 year flood plain.
 2. (New 03/2011) The hazard and critical facilities map layers already exist and are used in maps including the maps for this plan..
- Develop strategies to mitigate risk to these facilities, or to utilize alternative facilities should flood events cause damages to the facilities in question.

Coordinating Organization: City of Beaverton

Internal Partners: Geographic Information System, Emergency Management

External Partners: Overhead Utilities Tualatin Valley Water District, Clean Water Services

Timeline: On-going

Plan Goals Addressed: Enhance Emergency Services

LT-FL#1: Develop acquisition and management strategies to preserve open space in the floodplain.

Possible Actions

- Develop a comprehensive strategy for acquiring and managing floodplain open space in Beaverton. Perhaps conduct regional-wide funding search, but keep management of program under local jurisdiction;
- Explore funding for open space acquisition from federal (e.g., FEMA Hazard Mitigation Grant Program), state, regional, and local governments, as well as private and non-profit organizations;
- Develop a regional partnership between flood mitigation organizations;
- Identify sites where environmental restoration work can benefit flood mitigation, fish habitat, and water quality; and
- Work with landowners to develop flood management practices that provide healthy fish habitat.

Coordinating Organization: City of Beaverton

Internal Partners: Community Development, Emergency Management

External Partners: Clean Water Services, Tualatin River Watershed Council, Metro, FEMA, ODFW, Natural Resources Conservation Service, SWCD

Timeline: Ongoing

Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

LT-FL#2: Provide flood event education and outreach to households and businesses.

Possible Actions

- Identify and map vulnerable populations;
- Create flood education and outreach aimed at specific populations (i.e. schools, households, businesses, etc);
- Identify and provide mitigation guidance to owners of properties at risk from flooding;
- Recruit individuals to speak to households, and businesses/employees about flood issues;
- **Develop a “Clean Stream” sponsorship program, using the “Friends of Fanno Creek” model. Erect signage recognizing individuals, households, businesses, and organizations committed to the ongoing care of a waterway section;**
- Integrate a flood hazard component into local watershed education programs;
- Raise awareness level of property owners and developers that impacts upstream result in impacts downstream, and lack of storm water best management practices can result in an increase in flooding events;
- Educate private property owners on restoring natural systems within the floodplain to manage riparian areas and wetlands for flood abatement;
- **Erect “monuments” over piped creeks throughout the City and floodplain elevation markers to bring flood awareness to home and business owners who live near them; and**

- Educate public on the need for them to maintain their private water quality and water detention facilities.

Coordinating Organization: City of Beaverton

Internal Partners: Geographic Information System, Emergency Management

External Partners: Clean Water Services, Tualatin River Watershed Council, Tualatin Riverkeepers, Insurance Information Service of Oregon and Idaho, Washington County, Department of Land Conservation and Development, Oregon Emergency Management

Timeline: Future Plan Cycle

Plan Goals Addressed: Improve Partnerships for Communication and Coordination

LT-FL#3: Enhance data and mapping for floodplain information within the City.

Possible Actions

- Prepare floodplain maps for all local streams not currently mapped on Flood Insurance Rate Maps or County maps. The maps should show the expected frequency of flooding, the level of flooding, and the areas subject to inundation. The maps can be used for planning, risk analysis, and emergency management;
- Maintain maps of covered streams and creeks;
- Identify mapped culverts that historically create flooding problems and target them for retrofitting;
- Prepare an inventory of urban drainage problems;
- Coordinate with local agencies and organizations to obtain flood data and mapping resources;
- Integrate the Capital Improvement Plan process with GIS;
- Include a map layer with arrows to indicate direction of stream/creek flow; and
- Add creek names that are missing and coordinate the naming of unnamed creeks.

Coordinating Organization: City of Beaverton

Internal Partners: Public Works, Economic and Capital Development, Geographic Information System

External Partners: Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District

Timeline: On-going

Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

LT-FL#4: Use storm water and urban design best management practices (BMPs).

Possible Actions

- Reduce effective impervious surfaces that contribute to storm water volume being pumped into existing waterways and exceeding their volume capacity;

- Increase storm water infiltration through installation of porous surfaces to reduce storm water volume;
- Support urban land design practices that improve upon existing infiltration systems and provide infiltration of water rather than creating storm water runoff and increasing hydrologic impacts;
- Abide by adopted design and construction standards for the protection of vegetated corridors;
- Incorporate Metro’s “green street” design principles and educational publications into the urban design process;
- Continue maintenance on storm water system to increase capacity, and
- Identify and map areas where flood probability/frequency can be economically reduced or eliminated.

Coordinating Organization: City of Beaverton
Internal Partner: Community Development, Public Works
External Partners: Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District, Metro
Timeline: Current Plan Cycle
Plan Goals Addressed: Create a Disaster Resistant and Resilient Community

LT-FL#5: Update City code to improve risk reduction and prevention of natural hazard impacts.

Possible Actions

- Remove barriers in City codes and planning regulations that prevent best management practices in urban design;
- Protect critical and essential facilities against flood damage at the time of initial construction;
- Consider increasing regulations for all new fill, grading, and dredging in floodplain areas;
- Regulate to prevent construction of flood barriers which will unnaturally divert flood waters or increase flood hazards;
- Review and update City flood ordinance. Provide additional, more stringent standards designed to encourage sound floodplain management, reduce flood risks, and potentially allow property owners to obtain flood insurance at a lower premium rate;
- Write and implement new code requiring developers to install permeable surfaces to reduce storm water runoff volume and encourage aquifer recharging via increased storm water percolation;
- Consider adopting stricter elevation requirements for development within the floodplain; and
- Develop codes and ordinances to require owners of private water quality and water detention facilities to maintain them so that they can perform their required function and engineered capacity.

Coordinating Organization: City of Beaverton
Internal Partner: Community Development, Public Works, Economic and Capital Development
External Partner: Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District
Timeline: Current plan cycle
Plan Goals Addressed: Create a Disaster Resistant and Resilient Community

LT-FL#6: Create a regional partnership to reduce flood loss across the region.

Possible Actions

- Work flood issues on a regional basis to avoid moving flood problems to other jurisdictions;
- Create a regional process for naming un-named streams; and
- Work with regional partners including the City, Clean Water Services and the State Floodplain Manager to improve floodplain data for the City that will support conducting future full risk analyses in Beaverton.

Coordinating Organization: City of Beaverton
Internal Partner: Community Development, Public Works, Economic and Capital Development, Geographic Information Systems
External Partners: Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District, Washington County, Other Cities
Timeline: Future Plan Cycle
Plan Goals Addressed: Create a Disaster Resistant and Resilient Community, Improve Partnerships for Communication and Coordination

Flood Mitigation Resources

(Revised 03/2011) - See Appendix G: Consolidated Resource Directory.