CHAPTER 4: BASIN CHARACTERIZATION

The following description of Salmon Creek Basin lays the groundwork for understanding the basin's flooding problems and how best to address flooding impacts. The following characterization is based on data collected from 1999 to the date of this report. Comprehensive monitoring data is unavailable for flooding that occurred before 1999, therefore, other environmental conditions might have contributed to flooding in the past and may be a factor in future flooding.

4.1 BASIN OVERVIEW

Salmon Creek Basin is located in Thurston County, Washington, just south of the Olympia Regional Airport and the Tumwater City limits. The area of the basin is defined by the surface and groundwater sources that contribute to recharge of Salmon Creek. The basin encompasses approximately 7,500 acres (or 12 square miles). Salmon Creek Basin features a flat glacial outwash plain with low-lying areas that are prone to flooding during periods of prolonged above-average rainfall.

The basin boundary approximately encloses Littlerock Road on the west, the Tumwater City limits on the north, 113th Ave on the south, and just past Brooks Lane to the east (Fig, 3-2, Appendix E). Basin maps have been modified in recent years because of changes discovered during technical studies of groundwater and surface water flows in the basin. The current Salmon Creek Basin boundaries are based on aerial photography, topographic mapping, subsurface hydrogeologic information, and ground verification. (For detailed information, see the Phase I study.)

4.2 HYDROLOGY

The term "hydrology" refers to the properties, distribution and circulation of water on and below the earth's surface and in the atmosphere. Topography, geology, climate, surface water features, and groundwater characteristics all play a part in determining Salmon Creek Basin's hydrology and in understanding the basin's flooding problems.

4.2.1 Topography

The topography of Thurston County is characterized by low hills on the northwest and southeast, separated by a broad, flat plain that trends northeast-to-southwest. The hills generally lie at elevations of 300 to 400 feet above sea level. The plain lies at elevations between approximately

180 and 200 feet above sea level and includes Salmon Creek Basin. The plain is incised by the Deschutes River Valley, which lies east of Salmon Creek Basin at an elevation of approximately 100 feet. To the west are Black Lake and Black River; Black Lake drains mostly northward through Black Lake Ditch to Capital Lake, at the mouth of the Deschutes drainage basin. The Black River drains southward, but it is not incised as deeply as the Deschutes River.

Salmon Creek Basin slopes gently to the southwest, toward the Black River. Near the confluence of Salmon Creek and the Black River, the terrain becomes slightly more steep down to the river's floodplain. In this vicinity, the Black River has a very slow velocity. Data gathered from the hydrologic analysis indicate that the horizontal hydraulic gradient within the central Salmon Creek Basin is very low. The central reach of Salmon Creek drops only 30 feet over 4 miles (0.014%).

The natural boundaries of the basin have been modified due to filling for property development and road construction, particularly along Littlerock Road. For example, a Department of Interior 1883 survey of the County identifies an unnamed stream north of what is now 93rd Avenue that emptied into Black Lake. USGS maps from 1944 show the same area with the location of Littlerock Road. Following property development and development of the road system, surface water that historically drained into this unnamed stream was diverted into Salmon Creek, increasing the creek's volume.

Though the topography varies enough that fifteen sub-basins were identified (Figure 4-1, Appendix E), the basin is basically flat and does a poor job of draining surface water. The flat topography is a key element in understanding why flooding occurs, however, the geology and soils are also important factors in the basin's hydrology.

4.2.2 Geology and Soils

Glacial ice from Canada advanced over the Puget Sound Region at least 6 times during the last 2 million years. The advance and retreat of glacial ice has strongly influenced the topography of the entire region including Salmon Creek Basin. The most recent ice advance reached its maximum extent just south of Olympia approximately 14,500 years ago. Over the area now occupied by Seattle, the ice was approximately 3,300 feet thick and thinned to approximately 1,000 feet near the area now occupied by Olympia (Waitt and Thorson 1983). The advancing ice deposited and compacted a layer of silt, sand and gravel that is very dense. As the ice melted, the sand and gravel trapped within the ice was deposited near the ground surface over much of the area now occupied by Thurston County, thus accounting for the very permeable soils that cover most of Salmon Creek Basin.

According to the USDA Soil Survey of Thurston County, Salmon Creek Basin soils consist mainly of two types of glacial upland soils: the Spanaway-Nisqually Association and the Alderwood-Everett Association (USDA 1990). The soil types may be grouped by their parent material such as till or outwash, or their degree of saturation as defined below. The acreage of each soil type for each Salmon Creek sub-basin is presented in Table 4-1.

Impervious Surface	Impervious surfaces are hard, non-permeable areas such as paved roads or rooftops which contribute to surface water runoff.

Saturated Soil	Saturated soils form in surface depressions from accumulated plant material, or a mixture of glacial silt and accumulated plant matter. Saturated soils, including silty loams, silty clays, infiltrate little or no stormwater. Saturated soils indicate the presence of existing or former wetlands.

Outwash Soil	Outwash refers to sand and gravel deposited by streams issuing from melting glacial ice. Sandy outwash soils erode easily, and gravelly or rocky outwash soils tend to resist erosion. Outwash soils are usually deeper and better drained than till soils, but their permeability varies widely depending on the degree of compaction and the presence of silt.

Till Soil	Till is deposited by advancing or retreating glacial ice. Glaciers carry a poorly sorted mixture of sand, silt, and clay. When deposited by advancing glacial ice, the weight of the glacier compacts this material into till or what is locally called "hardpan". Soils derived from till tend to have low permeability, so most stormwater runs off, instead of infiltrating. Till soils are moderately erosion-resistant.

Table 4-1 Surface Soil Type by Sub-basin

SUB-BASIN	*TILL SOIL (acres)*	*OUTWASH SOIL (acres)*	*SATURATED SOIL (acres)*	*IMPERVIOUS SURFACE (acres)*	*TOTAL (acres)*
SC1	32	349	129	25	**535**
SC2	103	443	386	36	**968**
SC3	0	261	12	16	**289**
SC4	47	143	74	45	**309**
SC5	6	13	49	4	**72**
SC6	75	484	150	63	**772**
SC7	379	791	290	49	**1,509**
SC8	60	157	121	19	**357**
SC9	12	275	6	23	**316**
SC10	0	271	69	20	**360**
SC11	0	495	103	51	**649**
SC12	7	511	125	103	**746**
SC13	2	156	71	38	**267**
SC14	0	41	0	3	**44**
*SCR**	0	159	4	101	**264**
TOTALS	**723**	**4,549**	**1,587**	**598**	*7,457*

Source: Thurston GeoData Center
*Refers to the Salmon Creek recharge area

In Salmon Creek Basin, the predominance of outwash soils at the surface means that rain water infiltrates quickly in most parts of the basin. In years of average or below-average rainfall, rain water typically soaks into the ground and no flooding occurs. However, below the ground, soil conditions are such that this capacity for infiltration is limited.

4.2.3 Below Surface Soils and Groundwater

Groundwater is generally defined as water that is found under the earth's surface in the spaces between soil or rock grains and in fractures. The area where water fills these spaces is referred to as the saturated zone, and the top of this zone is called the water table. The water table may be deep or shallow and may rise or fall depending on many factors. Rains or melting snow may cause the water table to rise. For example, hydrographs (groundwater-level trends over time) for wells monitored from December through March of 1998-99 and 1999-2000, show that groundwater elevations increased 3 to 11 feet (URS 2001b). Likewise, an extended period of dry weather may cause the water table to fall.

Groundwater is stored in, and moves through, layers of soil, sand and rocks called aquifers. Aquifers typically consist of permeable materials such as gravel, sand, sandstone, or fractured rock. Less permeable materials such as till and glacial lake deposits are considered aquitards. Water flow through aquitards is usually relatively slow, and aquitards may form a confining layer for aquifers.

Salmon Creek Basin is characterized by a series of glacially derived materials that form aquifers, and aquitards. (URS Corp 2001b). The first geologic layer, the upper aquifer, is 25- to 50-feet thick and consists of well-sorted, loose sand and gravel. This layer rapidly accepts and stores water. As a result, little precipitation leaves the basin as surface runoff. Below the layer lies a second layer of dense, compacted sand and gravel, mixed with silts and clays (commonly referred to as "hardpan" or "glacial till"). This hardpan layer is not very porous and generally slows the downward flow of water from the upper aquifer. The hardpan layer typically ranges from 5 to 50 feet, however, its thickness and permeability vary substantially, and it may be absent in some areas. Figure 4-2 (Appendix E) shows these layers in a cross-section of land that includes Salmon Creek Basin. The Salmon Creek Basin portion of the cross-section is based on well logs from wells located along a line from 107th Avenue near Salmon Creek, heading northeast to the intersection of Kimmie and 83rd Avenue.

Once rainwater fills the upper aquifer during prolonged wet periods, the water builds up on the surface of the land. (In sub-basin SCR, the Salmon Creek Recharge area, some of the rising groundwater moves laterally, below the surface, into adjacent sub-basins.) Whether or not this filling of the upper aquifer and resultant flooding occur depends largely on climatic conditions.

4.2.4 Climate

Salmon Creek Basin has a marine warm-temperate climate, with relatively warm, dry summers and typically mild, rainy winters. During a typical year, average temperatures range from a low of 31.4 °F in January, to a high of 77°F in July and August. In 1997, 1998 and 1999, the average high temperatures for July and August ranged from 62°F to 65°F according to information recorded by NOAA at the Olympia Regional Airport.

Precipitation (mostly as rainfall) averaged 51 inches per calendar year between 1951 and 1980 at the Olympia Airport (Drost 1999). Approximately 70 percent of this precipitation occurred during October through March. Annual precipitation can vary substantially. For example, annual precipitation at the Olympia Airport between 1950 and 1961 varied between 38 and 67 inches per year. Average (normal) snow depth for Thurston County is just over 1.5 inches per year.

Precipitation was exceptionally high in Western Washington at the end of the 20th century. During the calendar year:

- 1996, total precipitation was 62.6 inches, 11.6 inches above average.
- 1997, total precipitation was 68.2 inches, 17.2 inches above average.
- 1998, total precipitation was 46.0 inches, 5.0 inches below average.
- 1999, total precipitation was 72.0 inches, 21.8 inches above average (URS Corp. 2001b).

Generally, when the basin experiences two successive years of above-average rainfall, accompanied by wet springs and cool, mild summers, the upper aquifer fills and overflows into low lying areas. Since the land is virtually flat, standing water can remain on the surface for months. The most recent flooding event was observed during the wet seasons of 1996/97 and 1998-99.

4.2.5 Recent and Future Flooding

During the most recent flooding events, groundwater surfaced and formed lake-like conditions that covered several acres on some properties. A depth-to-groundwater map (Fig. 4-3, Appendix E) shows the approximate distance between the surface of the land and the high water table during the winter of 1999. Areas on the map showing "depth-to-groundwater <0" are areas where water was on or close to the surface.

Basin planning efforts focused on the areas where flooding posed major problems for local residents. Figure 4-4 (Appendix E) depicts these selected flood areas for the spring of 1999, but does not show all the areas where water was at the surface (such as wetlands). Wetlands in Salmon Creek Basin are shown on Figure 4-5 (Appendix E).

Table 4-2 below lists the sub-basins that had significant flooding in the spring of 1999. The "total flooded area" is the number of acres covered by floodwaters for each sub-basin. For example, the number for sub-basin SC6 (12.32 acres) represents many separate flooded areas within that sub-basin, the total area of which equals 12.32 acres. Within that sub-basin the largest of those separate flooded areas (i.e. the "largest contiguous flooded area" within sub-basin SC6) was 6.47 acres. Although the chart depicts flooded and contiguous-flooded areas, the actual *height* of the flooding (depth of water) varied widely within each sub-basin.

Table 4-2 Spring 1999 Flooded Areas

Sub-basin Name	Total Flooded Area (acres)	Largest Contiguous Flooded Area (acres)
SC2	0.10	0.09
SC6	12.32	6.47
SC7	6.19	4.09
SC9	216.88	113.42
SC10	62.67	60.42
SC11	128.16	58.13
SC12	46.64	21.27
SC13	71.69	65.40
SC14	1.71	1.16
SCR	7.93	3.90

Source: Thurston Geodata Center

In order to help visualize the high volume of water involved in the basin's flooding problem, Fig. 4-6 (Appendix E) was created. In Fig. 4-6, water volume has been depicted in terms of "football fields covered with four feet of water." (This is easier to visualize than 1,346,493 gallons of water.)

As shown in Figure 4-6, if the goal of a drainage project in the west basin (west of I-5) were to lower floodwater to the surface of the ground, the project would have to remove a volume of water equaling 554 football fields covered in four feet of water. This is equal to 17,125 acre feet. (In the east basin, it would be 49 football fields covered in four feet of water, or 1,514 acre feet.) If the project's goal were to lower the water level to below septic drain fields, it would have to remove a volume of water in the west basin equal to 833 football fields covered in four feet of water. This is equal to 25,750 acre feet. (In the east basin it would be 94 football fields, or 2,905 acre feet.)

The heavy levels of rainfall that caused flooding in 1999 will occur again. On average, flooding occurs in Salmon Creek Basin every 20 years. The flooding in 1999 was the worst flooding observed in fifty years, based on records. It is also possible that, in the future, Salmon Creek Basin will experience even worse flooding than the recorded levels of 1999.

4.2.6 Surface Water Drainages

Water moves out of the basin primarily through ditches and stream (as well as through evapotranspiration and other natural processes.) The principal surface-water drainages in Salmon Creek Basin are shown on Figure 3-2 (Appendix E). They include:

- Salmon Creek/Hopkins Ditch, in the central portion of the basin, which drains southwestward to the Black River;
- Hickman Sub-Area Drainage Improvement Project (on maps referred to as Hickman Ditch) in the northwestern portion of the basin, which drains west and south into Salmon Creek; and
- Associated minor tributaries and constructed ditches.

Salmon Creek and Hopkins Ditch are the primary, year-round surface water features within Salmon Creek Basin. Various ponds, lakes, and wetlands are also present year-round.

Salmon Creek and Hopkins Ditch are names applied to a continuous set of surface drainages in the south part of the basin, running from the South Union area east of I-5 to the Black River. The total length of the watercourse is approximately 12 miles, plus tributary ditches. The Hopkins Ditch portion has been the subject of drainage ditch improvements since around the turn of the century, with the first assessments for the Hopkins Drainage District collected in 1902. The average discharge of the Salmon Creek/Hopkins Ditch system during the 13-month study period was 18.2 cubic feet per second (cfs) of water near the mouth of the creek, where it crosses Littlerock Road, and 2.1 cfs in the upper basin, where it crosses Tilley Road. (URS Corp. 2001b)

Despite a natural stream and two functioning ditch systems that drain parts of the basin, when prolonged wet periods occur and the upper aquifer fills up, the volume of water that spreads over low areas is too great, and the land is too flat for the water to be drained quickly enough to prevent flooding.

4.2.7 Conclusion

Salmon Creek Basin is naturally prone to flooding because of geology and topography. Most of the basin is covered by a very permeable layer of well-sorted, loose sand and gravel. This layer rapidly accepts and stores water. Below the layer lies a second layer of dense, compacted sand and gravel, mixed with silts and clays (commonly referred to as "hardpan" or "glacial till"). This hardpan layer is not very porous and generally slows the downward flow of water from the upper aquifer. The basin also has little slope; the ground surface drops only 30 feet over four miles.

Generally, when the region experiences prolonged periods of above-average rainfall, accompanied by wet springs and cool, mild summers, the upper aquifer fills and overflows into low lying areas. Since the land is virtually flat, and surface drainage is slow, standing water can remain on the surface for months. The Hopkins Ditch system (approximately nine miles) and the newly-reconstructed Hickman Sub-Area Drainage Improvement Project both help reduce the onset and duration of flooding, but the high volume of water during the worst flooding events overwhelms these systems.

On average, flooding occurs in Salmon Creek Basin every 20 years. It is also possible that, in the future, Salmon Creek Basin will experience even worse flooding than the recorded levels of 1999. Since it is highly likely that periodic flooding in Salmon Creek Basin will re-occur in the future, and perhaps at a greater magnitude than previously observed, it is important to continue groundwater monitoring efforts to provide early warning to residents in the event of imminent flooding. Also, to ensure a better-coordinated response to flooding, the Salmon Creek Emergency Preparedness and Response Plan should be incorporated into Thurston County's Office of Emergency Management's plans for notifying residents. In addition, flood protection standards should be maintained to protect future development from flooding impacts.

Related recommendations

- Thurston County should continue to monitor groundwater levels and provide early warning to residents when flooding appears imminent.
- Thurston County should Incorporate the Salmon Creek Emergency Preparedness and Response Plan as an appendix to the Office of Emergency Management's Comprehensive Emergency Management Plan.
- Thurston County should continue to enforce Flood Plain Building Standards for new development.
- Thurston County should adopt standards requiring owners of new wells in flooding areas to install well casings that extend above the anticipated flood elevation.
- Thurston County should continue to require the current Critical Areas Ordinance for High Groundwater Hazard and High Groundwater Buffer areas.

See Chapter 7 for details.

4.3 LAND COVER AND LAND USE

4.3.1 Existing Land Cover

Land cover is usually an important factor in a basin's hydrology. This is because areas covered with forests absorb and evapo-transpirate huge volumes of water, and areas covered with impervious surfaces prevent infiltration during rainfall. However, in Salmon Creek Basin, land cover is not the most important factor influencing whether or not the basin floods. The most significant cause of flooding in the basin is the rising water table caused by high precipitation. Flooding can occur regardless of the amount of impervious surface in the basin, but build-out would increase flood stages and probably extend flood durations.

Development can also cause rainwater to "mound" underneath the ground. Simply put, this occurs when rainwater that would normally soak into the ground over a wide, open area is forced to infiltrate in a narrower area (for example, through a stormwater pond). The collection and infiltration of water at one central point causes water to "point load" underground, causing water to mound under the infiltration area. This mounding effect can reduce infiltration, cause flooding at the site, and cause water levels to rise on adjacent properties.

Related recommendation

☛ Thurston County and the City of Tumwater should permanently adopt stormwater standards for new development and redevelopment that are technically equivalent to the Interim Stormwater Standards for the Salmon Creek Basin.

See Chapter 7 for details.

The Interim Stormwater Standards for Salmon Creek Basin address this issue by requiring developers to prevent water from mounding near property lines and demonstrate performance under flooded conditions equal to those of spring 1999. (The interim standards are set forth in an amendment to the 1994 Drainage Design and Erosion Control Manual.)

Existing land cover in Salmon Creek Basin can be seen in Figure 4-7, (Appendix E, Aerial Photo) and is categorized in Table 4-3. Currently, the largest categories include forests (approximately 38%) and pastures (approximately 51%). Despite the relatively small percentage of impervious surface (approximately 7%), Salmon Creek Basin experiences significant flooding during prolonged wet seasons. This is due to the unique geology and topography of the basin as explained in the previous section.

Table 4-3 Existing Land Cover in Salmon Creek Basin per Sub-basin (in acres)

Sub-basin	Forest	Pastures	Lawns	Open Water	Gravel Mines	Impervious Surfaces	Total
SC1	250	256	4	0	0	25	**535**
SC2	439	487	1	9	5	27	**968**
SC3	109	162	2	0	0	16	**289**
SC4	132	126	5	5	0	41	**309**
SC5	6	58	4	0	0	4	**72**
SC6	174	498	28	0	9	63	**772**
SC7	684	763	13	0	0	49	**1,509**
SC8	184	153	1	13	0	6	**357**
SC9	70	216	7	8	0	15	**316**
SC10	98	224	18	0	0	20	**360**
SC11	337	239	17	6	5	45	**649**
SC12	232	399	11	11	0	93	**746**
SC13	36	164	29	0	0	38	**267**
SC14	0	39	2	0	0	3	**44**
SCR[1]	97	47	19	0	0	101	**264**
Total	**2,848**	**3,831**	**161**	**52**	**19**	**546** [2]	**7,457**

Source: Thurston Geodata Center
1Refers to the Salmon Creek recharge area
2 This figure differs from the impervious surface figure of 598 in Table 4-1 due to different methodologies used for calculating impervious surface.

4.3.2 Future Land Cover

Future land cover could be influenced by many factors including climate conditions, possible changes in land use regulations, choices made by private landowners, natural disasters, and social/economic conditions.

4.3.3 Existing Land Use

In Salmon Creek Basin, existing land use is described by current zoning designations, as shown in Figure 4-8 (Appendix E) and below:

Rural Residential/Resource:	1 unit per five acres
Rural Residential:	1 unit per two acres
Low Density Residential (Single Family):	4-7 units per acre
Medium Density Residential (both Single and Multi-family):	6-15 units per acre
Commercial, Industrial, Government	

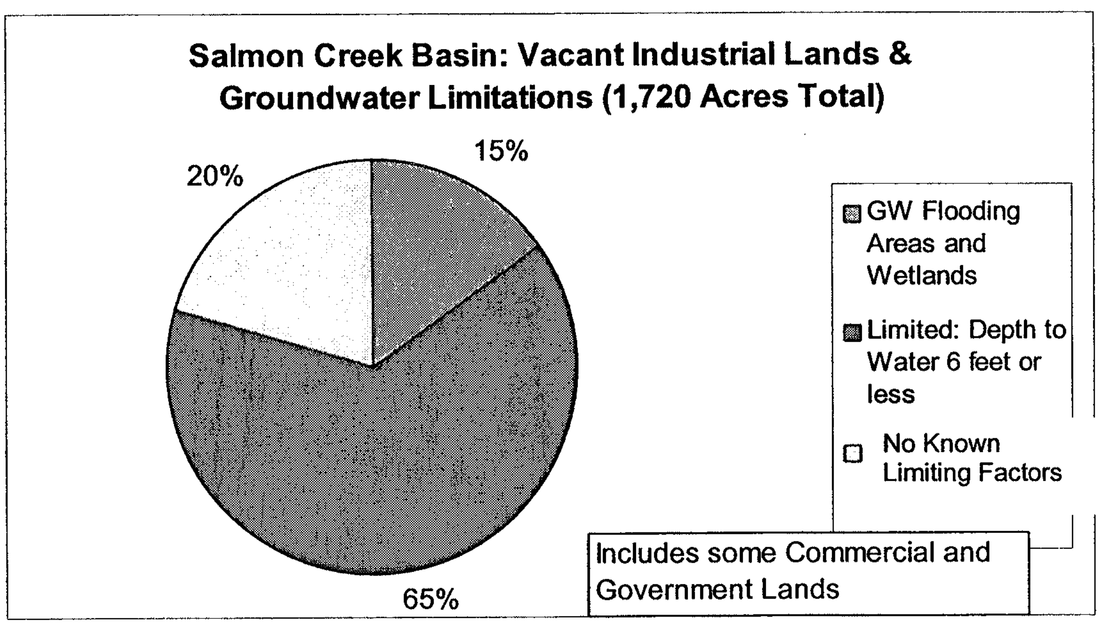
Comparing Figure 4-7 (Aerial Photo) to Fig. 4-8 (Zoning Designations), it is clear that Salmon Creek Basin is nowhere near a full build-out condition. It appears as if there is ample opportunity for future development, however, high groundwater conditions in Salmon Creek Basin pose some limitations to future growth, limitations which have an impact on future land use decisions.

4.3.4 Future Land Use

Future land use, as envisioned by Thurston County and the City of Tumwater, is described by current zoning designations as shown in Figure 4-8 (Appendix E). In Tumwater's Urban Growth Area (UGA), future land uses under current zoning are mainly industrial and low density residential (4-7 units per acre). There are significant quantities of currently vacant land in both of these zoning categories; however, some of these areas are subject to limitations due to high groundwater conditions or proximity to wetlands and floodplains (Fig. 4-9, Appendix E).

As shown in Figure 4-10, 15% of the vacant land zoned as "commercial/industrial/government" is located in high groundwater hazard or wetland areas, where, under the current Critical Areas Ordinance, development is prohibited. Another 65% of vacant land zoned for commercial/industrial/government uses is located in the 0-6 feet depth-to-water area where, under the interim standards of the 1994 Drainage Design and Erosion Control Manual, development potential may be limited by the site's ability to manage stormwater runoff.

Figure 4-10 Vacant Industrial Lands & Groundwater Limitations

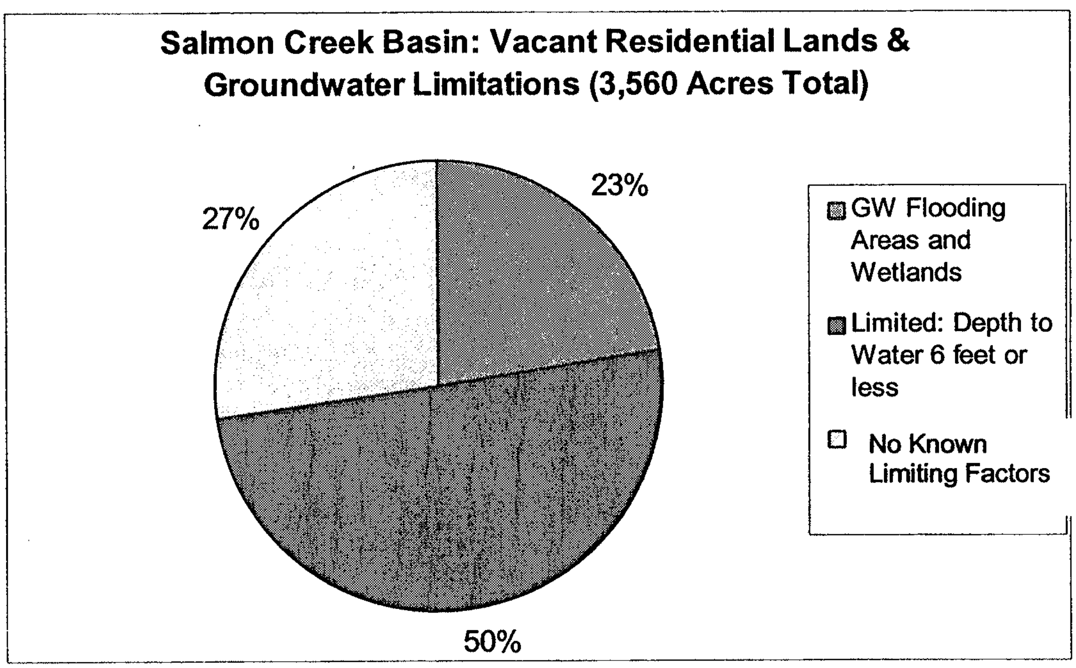


Local state, and federal laws require that new development and redevelopment manage stormwater to protect water quality, protect property, and minimize downstream impacts such as flooding, erosion, and aquatic habitat degradation. Stormwater management typically means that stormwater runoff generated by a developed site will be managed through infiltration, detention, retention, or a combination thereof.

If the site is limited by poor soils or high groundwater elevations, infiltration may not be practical. Similarly, if detention facilities are inundated by high groundwater or surface flooding, it will not be possible to detain and then discharge stormwater offsite. Finally, retention facilities are limited by the same factors as detention facilities with an additional disadvantage: Retention involves onsite storage of large storm events over extended periods of time. This requires that large areas be dedicated to stormwater retention facilities which, in turn, reduces the area available for building, parking and other site amenities. This reduction in building area may make development impractical in some locations.

Residentially zoned lands are also subject to limitations due to high groundwater conditions in the basin. (Fig. 4-11) About 23 percent of vacant land zoned for residential use appears unsuitable for development due to flooding or wetlands. Another 50% may have limitations due to a high groundwater table less than 6 feet from the surface. This leaves only 27% of residential vacant lands with no potential groundwater-associated development limitation.

Figure 4-11 Vacant Residential Lands & Groundwater Limitations



In summary, approximately 80% of the vacant land zoned for commercial, industrial and government uses in Salmon Creek Basin may be limited by surface flooding, high groundwater, and/or other limiting factors. This high percentage does not necessarily mean that immediate future development patterns in Tumwater's UGA will be significantly changed. This is due to the fact that projections by Thurston Regional Planning Commission (TRPC) indicate that 96% of the currently vacant industrial-zoned land in the Tumwater UGA is anticipated to remain undeveloped in 2025. However, though the industrial/commercial expansion rate may be slow in Salmon Creek Basin at this point in time, the drainage problems and the limitations for development remain. Commercial and industrial zoning districts may not realize their development potential due to these limiting factors.

Similarly, nearly 75% of vacant land zoned for residential uses may have some limitation for development due to high groundwater conditions. Under current regulations, low intensity land uses such as low density residential, will likely be less vulnerable to flooding. However, achieving urban levels of residential density (4-7 units/acre) may be problematic in areas with high groundwater limitations.

If Salmon Creek Drainage Basin were allowed to fully develop as planned, any new structures placed in localized depressions could experience flooding. For the four sub-basins that experienced the worst flooding in 1999, a full build-out would increase flooding elevations by less than 18 inches.

Table 4-4 Change in flood levels under full build-out conditions

Monitoring location (See maps in Appendix E)	**Sub-Basin Name**[1]	**Existing Watershed Condition**	**Fully Developed Watershed, current zoning**
A	SC9	175.4	176.7
B	SC10	186.0	186.0
C	SC11	186.9	187.5
D	SC13	192.3	192.7

[1]There were no measurable changes for sub-basins SC1-8, SC12, 14, SCR
Source: URS Tech Memo, 2002a

4.3.5 Conclusion

Due to hydrogeologic conditions, Salmon Creek Basin will likely continue to flood during prolonged wet periods. New development can increase flooding problems by placing new structures in harm's way as well as by increasing runoff, reducing evapotranspiration, and concentrating recharge.

The areas of known high groundwater will continue to be regulated by the Critical Areas Ordinance and (if interim standards are adopted permanently) by the 1994 Drainage Design and Erosion Control Manual, both of which will likely restrict the scope of any development, and/or make some development economically unfeasible. If this is the case, then zoning regulations for the Tumwater UGA should be amended so that future land use is more consistent with what is known about high groundwater conditions in Salmon Creek Basin. Also, property values, in cases where high groundwater conditions restrict a property's development potential, should be reassessed.

Large, regional infiltration/recharge facilities (such as a LOTT reclaimed water facility) would be subject to standards set by the Critical Areas Ordinance and the Drainage Design and Erosion Control Manual. At the time this publication went to press, LOTT was working on a conceptual plan to discharge reclaimed water to the Deschutes Watershed at a future time. (See Fig. 4-12, Appendix E.) The Department of Ecology, in issuing LOTT's permit for a Budd Inlet reclaimed water plant, states: "No reclaimed water shall be used or discharged in a drainage basin or adjacent to that basin such that the reclaimed water would cause or significantly contribute to groundwater flooding in the basin."

Related recommendations

☛ Tumwater and Thurston County should re-evaluate the feasibility of supporting urban-level development in areas subject to high groundwater (surface flooding and groundwater less than 6 feet from the surface.) Industrial land supply and anticipated demand in the Tumwater UGA should be considered in this evaluation. Revisions in land-use designations and development standards should be incorporated into the 1995 Tumwater-Thurston County Joint Plan.

☛ The Thurston County Assessor's Office should consider all restrictions that limit development when performing the annual re-assessment of properties.

See Chapter 7 for details.

4.4 FISH SPECIES AND HABITAT

While this basin plan is focused primarily on solving/mitigating flooding problems, any recommended action must be consistent with laws and policies that protect aquatic species. Several fish species of concern are present in Salmon Creek Basin.

4.4.1 Olympic Mud Minnow

The Olympic Mud Minnow (Umbridae Novumbra), is usually found in slow-moving streams, wetlands and ponds. Within these habitats, mud minnows require a muddy bottom, little or no water flow and abundant vegetation, making Hopkins Ditch with its low gradient, slow moving waters and adjacent wetlands ideal mud minnow habitat. Spawning occurs over an extended period from late November to June. Mud minnows are completely dependent on healthy wetlands for their survival. Because of this, and the mud minnow's very restricted range and continuing loss of wetlands, Washington Department of Fish and Wildlife (WDFW) believes the mud minnow is vulnerable and likely to become threatened or endangered in a significant portion of its range without cooperative management (Mongillo and Hallock, 1999). The mud minnow is therefore on the state sensitive species list, but is not considered threatened or endangered.

WDFW biologists suggest mud minnow populations in Hopkins Ditch/ Salmon Creek are stable, and can be protected providing that ditch maintenance activities take into account the mud minnow spawning, rearing and habitat requirements. WDFW biologists suggest that ditch maintenance activities be accomplished in mid-summer to mid-fall to avoid mud minnow spawning and rearing times. Furthermore, ditch maintenance activities should not completely denude the ditch of vegetation or remove all muddy substrates vital to mud minnow habitat.

4.4.2 Coho Salmon

Coho salmon (Oncorhynchus kisutch) are present in the Salmon Creek system. After spending up to 18 months at sea, the 3-5 year old adults migrate late in the season and over a prolonged period. Often they school at the mouths of rivers and move up when fall rains increase river flow. Generally, a coho will not travel more than 150 miles up river from the sea or lake. Spawning takes place anywhere between October and January. After the female prepares the redd she will lay approximately 2500 eggs, guarding them until she dies a few days later. The fry emerge from early March to late July, and although some will migrate almost immediately, most remain at least one year in fresh water lakes, wetlands, or streams.

Coho Salmon use approximately 1.3 miles (roughly the length of the creek from the mouth at the Black River to its headwaters where it joins Hopkins Ditch) of Salmon Creek for spawning and rearing. Coho Salmon in Salmon Creek Basin are considered to be part of the Lower Columbia River/Southwest Washington Ecologically Significant Unit (ESU). This ESU exhibits two run timings: one with spawning in early December throughout the Chehalis River Basin, and late, with spawning in early January and February in lower Chehalis River tributaries. Hiss and Knudsen (1992) suggest that the normal run is composed of a mixture of wild and hatchery fish, and the late run is virtually all wild fish.

Based on a 2003 draft report issued by NOAA Fisheries Biological Review Team, it appears that the Coho stocks in the Chehalis River Basin are healthy and that Coho Salmon in the Chehalis River Basin are not presently being considered for listings as a threatened or endangered species. (NOAA 2003) They will, however, remain a candidate species. As such, federal law does not require that a project applicant or action agency consult with federal agencies unless the applicant or action agency volunteers to do so. (NMFS 1998)

4.4.3 Steelhead

Steelhead (Oncorhynchus Mykiss) spawn in the spring. They generally prefer fast water in small-to-large mainstem rivers, and medium-to-large tributaries. In streams with steep gradient and large substrate, they spawn between the steep areas, where the water is faster and the substrate is small enough to dig into. Records indicate that Steelhead use Salmon Creek from the .1-mile to the 1.3-mile point for spawning and rearing (Streamnet 2003).

4.5 CONCLUSION OF CHAPTER 4

Salmon Creek Basin is naturally prone to flooding because of its geology and flat topography. The Hopkins Ditch system (approximately nine miles) and the newly-reconstructed Hickman Sub-Area Drainage Improvement Project both help reduce the onset and duration of flooding, but cannot eliminate flooding during exceptionally wet years. Salmon Creek Basin will likely continue to flood during prolonged wet periods. New development can increase flooding problems by placing new structures in harm's way as well as by increasing runoff, reducing evapotranspiration, and concentrating recharge.

The areas of known high groundwater will continue to be regulated by the Critical Areas Ordinance and (if interim standards are adopted permanently) by the 1994 Drainage Design and Erosion Control Manual, both of which will likely restrict the scope of any development, and/or make some development economically unfeasible.

If this is the case, zoning regulations for the Tumwater UGA should be amended so that future land use is more consistent with what is known about high groundwater conditions in Salmon Creek Basin. Also, property values should be reassessed in cases where high groundwater conditions restrict a property's development potential.

Coho salmon and steelhead use Salmon Creek for spawning and rearing; the creek and Hopkins Ditch provide habitat for the Olympic Mud Minnow as well, however none of these fish is listed as a threatened or endangered species.