

## **CHAPTER 9. WATERSHED CONDITION SUMMARY**

### **9.1 Introduction**

Summarizing current conditions within the watershed helps to identify the impacts of current and past resource management on aquatic and riparian resources. Through this summarization, we provide information needed to create a decision-making framework to help identify activities that will protect and improve water quality and the condition of aquatic and riparian habitats. Following is a summary of key findings and data gaps regarding watershed condition from the primary components of this watershed assessment, including fisheries, fish habitat, hydrology, water use, sediment sources, and water quality.

### **9.2 Fisheries**

There are data available on the status of fisheries in the North Santiam River system, although data specific to the Middle or Lower Reach are more limited. Anadromous salmonid distribution is now confined to the area downstream of the Big Cliff Dam, which is at the upper extent of the Middle Reach subwatershed.

Spring chinook are found throughout the Middle and Lower Reaches below Detroit Dam. Spring chinook historically spawned in the tributaries that drained the Cascades and probably reared in the lower tributaries and mainstem riparian areas and marshes. The riparian forests and most of the marshlands have been removed. The mainstem river has been channelized, eliminating many secondary channels and backwater areas. Substantial spring chinook rearing areas have been lost.

Since 1996, spring chinook counts at the Bennett Dams on the North Santiam River have increased, perhaps in response to more favorable ocean conditions. ODFW (1995) concluded, however, that wild spring chinook populations in the Willamette Basin on the whole have declined as compared with historic levels, in large part because dams blocked access to spawning areas and/or inundated spawning areas, adult holding pools in tributaries have decreased, juvenile rearing capacity has decreased throughout the basin, and also because of mixed-stock fisheries. Factors thought to be especially important in the North Santiam watershed include the elimination of much of the natural spawning beds due to the construction of Detroit and Big Cliff Dams (and perhaps also the diversion dam at Stayton Island which can

restrict fish passage), water flow and temperature conditions below the dams, and degradation of spawning and rearing habitat conditions.

The recreational catch of spring chinook salmon has been indexed from annual hatchery returns of salmon/steelhead punch cards which represent a portion of escapement. These catch estimates indicate a generally decreasing trend from 1968 to 1980, with generally stable to increasing returns since 1980. The recreational catch of spring chinook in the North Santiam River (including the Lower and Middle Reaches, and the Little North Santiam sub-basin) averaged about 1,000 fish since 1981. Although annual variability is high, the present level of harvest appears relatively stable.

Fall chinook were introduced to the North Santiam River. ODFW began spawning survey counts of fall chinook on the Santiam River in 1969 and data are available through 1994. Estimates declined from a high of about 19,000 fish in 1974 to less than 5,000 fish in 1988.

In the Lower and Middle Reaches of the North Santiam River, steelhead include both winter-run and summer-run fish. There is a native late-run winter steelhead population, and two introduced steelhead populations, early-run winter steelhead and summer steelhead. Although data specific to the Lower and Middle Reaches are scarce, the entire Santiam River watershed has produced about 60 percent of the wild steelhead in the Willamette Basin above Willamette Falls. Steelhead production in the Lower and Middle Reaches is less than pre-dam levels, but continues to be an important component of the steelhead production for the Willamette Basin. Wild steelhead catch and release regulations were implemented for the entire Willamette Basin in 1994.

The abundance of steelhead spawners in the North Santiam River remained relatively stable in the 1970s and 1980s, but declined in the 1990s. North Santiam River winter steelhead spawning counts for the period 1980 through 1997 showed a generally declining trend (Figure 7.7). Since 1991, the total estimate has generally been below 2,000 fish. However, 2001 was a particularly strong year for winter steelhead, and as of June, 2001 the runs for steelhead were well over 4,000 fish, according to ODFW fish biologists.

Steelhead populations have been affected by freshwater habitat degradation. In the past, stream systems were structurally complex, with large in-stream wood, flood plains, beaver ponds, braided channels, marshes and bogs. Human activities have altered these ecosystems, particularly by reducing their complexity and removing components that were essential to

steelhead production. Logging and road construction have had widespread impacts on steelhead, and are believed to have affected most populations, including those in the Lower and Middle Reaches. In addition, lost habitat from dam construction, passage over small irrigation dams, and lack of adequate fish screens on diversion ditches are believed to pose problems for steelhead in the Santiam system.

Winter steelhead use much of the Lower and Middle Reaches, but they are confined to the area below Detroit Dam (Figures 7.8 and 7.9; Table 7.3). They utilize many of the smaller tributaries for spawning and rearing, including Stout Creek, Rock Creek, and Mad Creek. Winter steelhead production is enhanced in structurally complex streams with large in-stream wood, flood plains, beaver ponds, braided channels, marshes, and bogs.

Summer steelhead utilize the same mainstem river habitat as winter steelhead in this basin, but their use of the tributary streams is more restricted (Figures 7.8 and 7.9; Table 7.4). Although summer steelhead are not indigenous to the North Santiam River, hatchery summer steelhead have produced a major recreational fishery in the Willamette Valley. The introduction of hatchery summer steelhead into some of the drainage systems, however, including the Santiam River, may have contributed to declines of native winter steelhead (ODFW 1995, Chilcote 1998).

Coho are not native to the study area. Hatchery coho were stocked extensively between 1958 and 1982, at which time the stocking program was discontinued due to low program success and concern for the impact on native fish. In the North Santiam River system, coho salmon are only known to utilize the lower section (about 4.4 miles) of Stout Creek (Figure 7.10). The mainstem North Santiam River, up to Stout Creek, is used for migration. None of the Middle Reach appears to be used by this species. Data on the returns of hatchery coho for the North Santiam River are not available, although the population in Stout Creek has remained self-sustaining since the termination of stocking. Population surveys have not been conducted in the Lower and Middle Reaches, and the exact size of the population is unknown, although it is expected to be relatively small.

Cutthroat trout distributions have not been mapped by ODFW, but cutthroat trout inhabit virtually the entire drainage, to the headwaters of most tributaries until gradient becomes too steep (Wayne Hunt, ODFW, pers. comm., December, 1995). Resident populations were documented by ODFW (1995) in Stout Creek above the falls, Ayers Creek, and Shelburg Creek.

A fluvial cutthroat population was identified in the mainstem North Santiam River below the barriers. Systematic abundance estimates are not available for most resident and fluvial cutthroat populations. Anecdotal information suggests that they remain relatively abundant.

### **9.3 Aquatic and Riparian Habitats**

Habitat survey data collected by ODFW provide the best available source of information for assessing the present status of the freshwater habitat within the study area, but data are only available for a small percentage of the overall stream resource. Since 1996, three creeks have been surveyed in the Middle Reach, but none have been surveyed in the Lower Reach. In the three streams surveyed, the pool frequency for the majority of the reaches fell in the moderate category. Less than a fifth of the surveyed stream reaches were in the desirable category and one reach of Mad Creek was rated as undesirable. Just over half of the stream reaches were also in the moderate category based on the percent of area of the stream reach in pools, and the remainder were rated as undesirable (Table 8.2). In general, the depth of pools was moderate; pool depth was desirable for two stream reaches and undesirable for one stream reach. Gravel conditions in riffles demonstrated generally moderate conditions, although three reaches of Mad Creek were rated as undesirable (Table 8.2).

Overall, the majority of the reaches surveyed throughout the Middle Reach had moderate stream habitat conditions and there were no stream reaches that were consistently rated as desirable, suggesting a need for improvement (Table 9.1). In general, stream habitat conditions were much better in the four lower reaches than in the three upper reaches of Mad Creek. In Rock Creek, conditions were slightly better in the second reach than in the first or third reach. (See Figure 8.1 for locations of these surveyed reaches.)

In general, LWD conditions in the surveyed streams were less than desirable. In particular, the density of key pieces of LWD was predominantly rated as undesirable. In only one of eleven surveyed stream reaches (Reach 5 of Mad Creek) was the density of key pieces rated as desirable (Table 8.3). The volume of LWD was rather evenly distributed among the desirable, moderate, and undesirable categories. LWD conditions in the first three reaches of Mad Creek and the first reach of Rock Creek were consistently rated undesirable in terms of the total number of pieces, the volume of the pieces, and the number of key pieces per 100 m of stream. The fifth

Table 9.1. Stream morphologic conditions in the North Santiam River watershed. Data were collected by ODFW.							
Subwatershed	Stream Miles	Fish Use <sup>1</sup>	Miles Surveyed <sup>2</sup>	Pool Frequency <sup>3</sup>	Percent Pools <sup>3</sup>	Residual Pool Depth <sup>3</sup>	Gravel <sup>3</sup>
<b>Lower Reach</b>							
Bear Branch	42	FC,SC,WS,SS	NA	NA	NA	NA	NA
Chehulpum Creek	47	FC,SC,WS,SS	NA	NA	NA	NA	NA
Marion Creek	47	FC,SC,WS,SS	NA	NA	NA	NA	NA
Stout Creek	17	FC,SC,WS,SS	NA	NA	NA	NA	NA
Valentine/Trask Creek	30	FC,SC,WS,SS	NA	NA	NA	NA	NA
<b>Lower Reach Total</b>	<b>183</b>						
<b>Middle Reach</b>							
Fox Valley	56	SC,WS,SS	NA	NA	NA	NA	NA
Mad Creek	31	SC,WS,SS	5.1 (7)	10.2	11.4	0.6	18.1
Rock Creek	45	SC,WS,SS	9.6 (3)	9.5	12.4	0.7	19.0
Sevenmile Creek	51	SC,WS,SS	3.1 (1)	11.5	8.2	0.6	31.0
<b>Middle Reach Total</b>	<b>183</b>						
<b>Watershed Total</b>	<b>366</b>						
<sup>1</sup> FC=fall chinook, SC=spring chinook, WS=winter steelhead, SS=summer steelhead <sup>2</sup> Number in parentheses is the number of reaches in that subwatershed. <sup>3</sup> Subwatersheds were assigned categories (desirable, moderate, undesirable) based on the most prevalent category among all reaches surveyed in that subwatershed. The categories were based on how the data compared to ODFW habitat benchmarks.  NA = Not surveyed by ODFW							
	= Desirable			= Undesirable			= Moderate

reach of Mad Creek and the second reach of Rock Creek exhibited the best LWD conditions of the surveyed stream reaches (Table 8.3).

Riparian vegetation was categorized as having a high, moderate, or low potential for large woody debris recruitment to stream channels. Vegetation classes defined as coniferous or mixed in the large size class (>24 inch dbh) had a high potential for LWD recruitment. Coniferous or mixed vegetation in the medium size class (12-24 inch dbh), and hardwoods in the medium to large class, had moderate potential for LWD recruitment (Table 8.7).

Recruitment potential of LWD from the riparian zone was identified based on the size and species of trees in the riparian zone and their distance from the streambank, according to the OWEB methodology. This analysis provides a coarse-screening of the overall condition of LWD recruitment potential throughout the watershed. The potential for LWD recruitment for the surveyed stream lengths was very low (Figures 8.4, 8.5). In all subwatersheds, the majority

of the riparian vegetation along surveyed streams was in the low LWD recruitment category (Tables 8.8, 9.2). Marion Creek subwatershed had the highest percentage of low LWD recruitment (95 percent), while the smallest percentage was in Fox Valley (73 percent). Moderate LWD recruitment potential conditions were uncommon in the Lower and Middle Reaches. The highest percentage of stream length in the moderate LWD recruitment class was found in the Fox Valley subwatershed (26 percent), while the lowest was Marion Creek (4.5 percent). High potential for LWD recruitment was rare in the study area (Table 8.8). LWD recruitment potential was marginally better in the Middle Reach than in the Lower Reach.

Shade conditions determined from aerial photographs were rather evenly distributed among the low, moderate, and high categories (Table 8.9). Only the Rock Creek subwatershed showed more than half of the stream reach in the high shade category, whereas more than half of the stream reach in Fox Valley was rated as low. Overall, shade conditions were considerably better in the Middle Reach than the Lower Reach (Table 9.2). Riparian conifer conditions were low in most reaches, suggesting that much of the shading is provided by hardwood species such as alder and maple. These relatively short-lived hardwoods do not contribute high quality LWD to the stream system. Shading conditions were worst in Fox Valley and Sevenmile Creek and best in Rock Creek (Figure 8.7). Shade conditions along the mainstem river were only desirable in a few short segments of the upper part of the Middle Reach.

The Middle Reach has an average stream crossing density of 3.6 stream crossings per square mile, and the Lower Reach has an average stream crossing density of 1.9 stream crossings per square mile, based on ODF/BLM data for publicly-owned forest land. Stream crossing densities were highest in the Sevenmile Creek and Fox Valley subwatersheds (4.5 and 4.1 crossings per square mile, respectively). Only about 10 percent of the culverts in the study area (55 culverts of 542 road/stream crossings) have been surveyed for potential fish passage barriers and 53 percent of those surveyed were judged by ODFW to be impassable (Figures 8.8 and 8.9, Table 8.10). Culverts have not been surveyed in the Rock Creek subwatershed, and very few culverts have been surveyed in the Stout Creek, Marion Creek, or Chehulpum Creek subwatersheds (Tables 8.10, 9.3). All other subwatersheds contained some impassable culverts.

Several dams constitute fish passage barriers in the Lower and Middle Reaches, and their locations are shown in Figures 8.8 and 8.9. Chinook salmon have been found above these dams, however, suggesting they are not complete fish passage barriers.

Table 9.2. Riparian and in-stream LWD conditions in the North Santiam River watershed.

Subwatershed	Str Length (mi)	Fish Use <sup>1</sup>	Miles Surveyed <sup>2</sup>	Riparian Recruitment <sup>3</sup>	Riparian Shade <sup>4</sup>	In-stream LWD		
						Pieces	Volume	Key Pieces
<b>Lower Reach</b>								
Bear Branch	42	FC,SC,WS,SS	NA	Poor	Low	NA	NA	NA
Chehulpum Creek	47	FC,SC,WS,SS	NA	Poor	Low	NA	NA	NA
Marion Creek	47	FC,SC,WS,SS	NA	Poor	Low	NA	NA	NA
Stout Creek	17	FC,SC,WS,SS	NA	Poor	Low	NA	NA	NA
Valentine/Trask Creek	30	FC,SC,WS,SS	NA	Poor	Low	NA	NA	NA
<b>Lower Reach Total</b>	<b>183</b>							
<b>Middle Reach</b>								
Fox Valley	56	SC,WS,SS	NA	Poor	Low	NA	NA	NA
Mad Creek	31	SC,WS,SS	5.1 (7)	Poor	High	106	195	8
Rock Creek	45	SC,WS,SS	9.6 (3)	Poor	High	45	89	4
Sevenmile Creek	51	SC,WS,SS	3.1 (1)	Poor	Moderate	26	38	1
<b>Middle Reach Total</b>	<b>183</b>							
<b>Watershed Total</b>	<b>366</b>							

<sup>1</sup> C=coho, FC=fall chinook, WS=winter steelhead, SS=summer steelhead, SC=spring chinook, CH=chum  
<sup>2</sup> Number in parentheses is the number of reaches in that subwatershed.  
<sup>3</sup> Subwatersheds were assigned categories (good, moderate, poor) based on the most prevalent category among all reaches surveyed in that subwatershed. The categories were based on how the data compared to ODFW habitat benchmarks.  
<sup>4</sup> From aerial photo interpretation conducted by E&S Environmental Chemistry, Inc.

NA = Not surveyed by ODFW

Table 9.3 Fish passage conditions in the North Santiam River watershed based, on ODFW data.						
Subwatershed	Stream Length (mi)	Fish Use <sup>1</sup>	Miles Fish Use	Surveyed Culvert Data		
				# Surveyed	# Known Impassable Culverts	# Road/ Stream Crossings
<b>Lower Reach</b>						
Bear Branch	42	FC,SC,WS,SS	20.9	12	3	46
Chehulpum Creek	47	FC,SC,WS,SS	30.2	4	2	59
Marion Creek	47	FC,SC,WS,SS	16.7	4	0	52
Stout Creek	17	FC,SC,WS,SS	4.3	1	0	22
Valentine/Trask Creek	30	FC,SC,WS,SS	12.1	8	5	41
<b>Lower Reach Total</b>	<b>183</b>			<b>29</b>	<b>10</b>	<b>220</b>
<b>Middle Reach</b>						
Fox Valley	56	SC,WS,SS	11.5	10	6	115
Mad Creek	31	SC,WS,SS	7.4	9	6	48
Rock Creek	45	SC,WS,SS	4.9	0	0	91
Sevenmile Creek	51	SC,WS,SS	5.0	7	7	68
<b>Middle Reach Total</b>	<b>183</b>		<b>28.8</b>	<b>26</b>	<b>19</b>	<b>322</b>
<b>Watershed Total</b>	<b>366</b>			<b>55</b>	<b>29</b>	<b>542</b>

<sup>1</sup> FC=fall chinook, SC=spring chinook WS=winter steelhead, SS=summer steelhead

The present condition of freshwater habitat in the Lower and Middle Reaches of the North Santiam River Watershed has been heavily influenced by human activities and natural phenomena that have occurred over an extended period of time. Several events and practices have severely disturbed the watershed, the most significant of which have included dam construction, channelization, diking, bank stabilization, flood plain development, logging, and gravel removal.

In-channel structures and activities associated with streambank stabilization and flood control can adversely affect aquatic organisms and their associated habitats by changing the physical character of the stream channel. Additional work will be necessary to identify locations of channel modifications. Currently, limited data exist regarding the specific locations of channel modifications and historical channel disturbances. It is known, however, that large

segments of the banks of the mainstem North Santiam River were diked and stabilized. This has been most prevalent throughout the Lower Reach. Bank stabilization through the creation of revetments has helped to reduce property damage during high flow periods and has protected agricultural land and developed areas from flood damage. However, river bank armoring has also greatly diminished the amount and quality of off-channel and backwater habitat that is very important to many species of aquatic biota, including juvenile salmonid fish and the endangered Oregon chub.

The USACE mapped revetments along the mainstem of the Santiam and North Santiam River in the Lower Reach, which we have digitized in a GIS coverage (Figure 8.8). Unfortunately, no mapped data exist for the Middle Reach. The greatest length of stabilized streambank occurs in the lower portions of the Lower Reach. The locations of existing dikes have not been systematically mapped or studied.

#### **9.4 Hydrology**

Some examples of human activities that affect watershed hydrology are dam construction and operation, diking, bank stabilization, timber harvesting, urbanization, conversion of forested land to agriculture and agricultural land to urban, and construction of road networks. The focus of the hydrologic analysis component of this assessment is to evaluate the potential impacts from land and water use on the hydrology of the watershed (WPN 1999). It is important to note, however, that this assessment only provides a screening for potential hydrologic impacts based on current land use activities in the watershed. Identifying and quantifying specific activities that are actually affecting the hydrology of the watershed would require a more in-depth analysis and is beyond the scope of this assessment.

Construction and operation of Detroit and Big Cliff Dams have had significant impacts on the hydrology of the mainstem river. In particular, both peak flow and low flow conditions have been moderated. Peak flows now tend to be lower and low flows higher than pre-dam conditions. In addition to modification of downstream flows, effects of the dams on fisheries include temperature changes in the reservoirs and downstream, blockage of fish passage, and loss of spawning and rearing habitat (USACE 1980). Modification of flow conditions has also had negative impacts on hydrogeomorphic function, recruitment of LWD, and sediment

transport, especially in the lower reaches and the floodplain (Rick Hayes, USACE, pers. comm., May 2001).

There are steep headwater streams in some of the upper tributaries within the study area. However, the hydrology of the study area is mainly dominated by medium-to-low-gradient reaches, including the mainstem of the North Santiam River. Peak flows are, and have always been, controlled by rain events and snowmelt. Most of the discharge in the lower reach of the river originates in the upper watershed (above the study area). The hydrology is often quite flashy; discharge can increase from baseflow to over 10,000 cfs in less than 24 hours. Present-day hydrology is strongly influenced by the dams. The effects on hydrology of other land use activities within the watershed are small in comparison with the effects of the dams.

The largest known floods produced an estimated 65,000 cfs in 1861, 53,000 cfs in 1890, and 41,000 cfs in 1945 at Detroit. The high flows during the major flood events of 1964 and 1996 were two to three times higher than the typical peak flows generally observed since dam construction (Figure 3.5). It should be noted, however, that the peak flows during these two storms were not particularly unusual in comparison with discharge records prior to dam construction. For example, during the period 1921 to 1953, there were 30 peak flows in excess of 25,000 cfs. In contrast, during the considerably longer period of record for post-dam construction (1953 to 1999), there were only three recorded flows that were greater than 25,000 cfs (two in 1964 and one in 1996). Similarly, there were three peak flows recorded prior to dam construction that were higher than the 1996 flood, and eight that were higher than the 1964 flood.

Past clearcutting has increased the Water Available for Runoff (WAR) in the watershed, with the magnitude of the effect proportional to the percent of the area that was cut and how recently the cutting occurred. Bureau of Land Management (1997) estimated that the magnitude of effect for large flooding events (50+ and 100+ year return intervals) in subbasins of the Little North Santiam River were less than about 12 percent increase in WAR due to clearcutting. Because only 17.5 percent of the study area is in industrial forestry land use, the overall impact of such effects within the study area is expected to be small.

Only 0.5 percent of the Middle Reach North Santiam River watershed is in agricultural land use. There is, therefore, little potential for agriculture to impact hydrology to any significant extent. In contrast, 40 percent of the Lower Reach is in agricultural land use, which is

concentrated in the lower three subwatersheds (Marion Creek, 68 percent; Chehulpum Creek, 64 percent; Bear Branch, 42 percent). In these subwatersheds, agricultural land use can have a substantial impact on runoff. The importance of this effect is dampened to some extent, however, by the fact that these are the same three subwatersheds that receive the lowest precipitation amounts (averaging only 61 percent of the overall average for the combined Lower and Middle Reaches; Table 3.1).

Other factors associated with agricultural land use that may have impacted the hydrology of the North Santiam River watershed include draining and ditching of wetlands and disconnection of the floodplain. Agricultural and urban land uses are concentrated in the lower elevations of the watershed, generally in the floodplains of the North Santiam and Santiam Rivers. Historically, these floodplains contained extensive wetland areas that trapped sediments and accumulated plant material, resulting in rich fertile soils. Disconnecting part of the floodplain from the rivers has likely resulted in the loss of flood attenuation capacity, increased peak flows, down-cutting of channels, and increased flow velocities.

The potential for increased peak flow for agricultural and range lands in the Lower and Middle Reaches was classified in the low and moderate ranges only. Sensitivity of range lands to peak flow enhancement occurs only when the hydrologic condition is poor (Table 3.4). Poor hydrologic condition occurs when there is <50 percent ground cover with no mulch or the land is heavily grazed. For agricultural lands, straight row crops had the largest percentage of runoff values (53 percent) classified in the moderate range for potential peak flow enhancement. These results suggest that efforts to reduce the impacts of agricultural land use on hydrology should be focused primarily on straight row treatment types, row crops, and increasing the practice of leaving a crop residue cover.

According to GIS calculations for the ODF fire roads coverage, all of the subwatersheds in the Lower and Middle Reaches of the North Santiam River watershed were considered to have a low potential impact on hydrology from the density of forest roads. Other hydrologic impacts may have occurred in response to forest fires. Urban and residential development results in soil compaction and reduced opportunity for precipitation to infiltrate into soils. Because only 4.6 percent of the study area is in urban land use, the overall impact of such factors is expected to be small.

## 9.5 Water Use

Total water rights on the North Santiam system include allocations for nonconsumptive hydroelectric power generation and fish and wildlife. Industrial, agricultural, municipal, and miscellaneous water users also hold consumptive rights to use substantial amounts of water from the system. In-stream water rights, established by the Oregon Water Resources Department for the protection of fisheries, aquatic life, and pollution abatement, remain junior to most other water rights in the watershed.

It is difficult to obtain an accurate representation of water rights and use in the North Santiam watershed. Water rights information is available from OWRD, the City of Salem, and the Santiam Water District. Care must be taken to avoid any duplication of water rights records when combining information from different sources. Piecing together the puzzle can become a difficult task when one inevitably runs into contradictory information from separate sources. It is the combination of these factors that contributes to the difficulties encountered when trying to paint a clear and accurate picture of water rights and use for one or many Water Availability Basins in the watershed.

The largest amounts of water appropriated in the North Santiam River watershed are for irrigation and municipal use (Table 4.3). Most of this water is appropriated in the lower elevations of the North Santiam River watershed (North Santiam River at the mouth of the subwatershed) and is used for a variety of agricultural purposes and to provide water to Salem and to the small communities along the lower North Santiam River (Figures 4.1 to 4.4).

The Lower and Middle Reaches of the North Santiam watershed contain a total of 1,196 points of diversion (PODs), 997 in the Lower Reach and 199 in the Middle Reach. Associated with these PODs are at least 1,063 separate water rights. The majority of PODs (76 percent) are associated with irrigation water rights. About 35 percent of the consumptive water use (excluding power rights) is associated with municipal water rights and 44 percent is associated with irrigation water rights.

Agricultural, municipal, and domestic water supplies can have large impacts on in-stream flows, especially during low flow months (July through October). The City of Salem, which resides outside the North Santiam River watershed, draws its domestic water from the North Santiam River at Stayton. During dry seasons, domestic water use, combined with irrigation withdrawals in the lower elevations of the watershed, may significantly reduce stream flows.

The communities of Idanha, Gates, Mill City, Stayton, Turner and Jefferson also divert their water supplies from the Lower or Middle Reach of the river.

Based on current water availability model outputs (OWRD website), there is moderate concern for dewatering in the North Santiam River watershed at the mouth, with water loss ranging between 24 percent and 35 percent of the predicted in-stream flows for the months of July through October (Table 4.6). The overall dewatering potential was high (65 percent and 55 percent in August and September, respectively) in Stout Creek. In the other Water Availability Basins (North Santiam River above Little North Santiam River, Rock Creek, and Mad Creek), the average percent withdrawal was less than or equal to 2 percent of in-stream flows 50 percent of the time (Table 9.4). Consequently, it is likely that water withdrawals from the North Santiam River and its tributaries are having some impact on current in-stream flows, but the impacts are generally moderate and are primarily in Stout Creek and the lower reaches of the river.

Table 9.4. Dewatering potential and associated beneficial uses of water in the North Santiam River watershed.				
Subbasin	Fish Use <sup>1</sup>	Average Percent withdrawn <sup>2</sup>	Dominant Water Use	Dewatering Potential <sup>3</sup>
<b>Lower Reach</b>				
Santiam River at mouth	FC,SC,WS,SS, CTT	53.1	Agriculture/Irrigation	High
Santiam River above Morgan Creek	FC,SC,WS,SS, CTT,OC	52.7	Agriculture/Irrigation	High
North Santiam River at mouth	FC,SC,WS,SS, CTT,OC	26.6	Power	Moderate
Stout Creek at mouth	FC,SC,WS,SS, CTT	38.8	Agriculture/Irrigation	High
<b>Middle Reach</b>				
North Santiam River above Little North Santiam River	SC,WS,SS,CTT	2.0	Fish/Wildlife	Low
Rock Creek at mouth	SC,WS,SS,CTT	0.0	Recreation	Low
Mad Creek at mouth	SC,WS,SS,CTT	0.2	Agriculture/Irrigation	Low
<sup>1</sup> FC=fall chinook, SC=spring chinook, WS=winter steelhead, SS=summer steelhead, CTT=cutthroat trout, OC=Oregon chub <sup>2</sup> Average of low flow months (June, July, August, September, October). <sup>3</sup> Greater than 30% is high, 10 to 30% is moderate, and less than 10% is low.				

However, any time water is appropriated for out-of-stream use, there is a potential for some effects on the in-stream habitats to occur during periods of very low flow.

ODFW identified two tributary streams to the North Santiam River that occur within the study area as high priorities for in-stream water rights: Rock Creek and Mad Creek. The Little North Santiam River is also included in that list. Although data obtained from OWRD suggest that there is low dewatering potential for Mad and Rock Creeks (Table 4.6), these data do not account for in-stream water rights implemented for the protection of fish habitat. Oregon Water Resources Department flow estimates for both Rock Creek and Mad Creek suggest that flows are insufficient to support additional water appropriations on these streams (Table 4.8) when in-stream water rights are accounted for.

## 9.6 Sediment Sources

Prior to construction of the dams, some sediment originating at the higher elevations was deposited in the Lower and Middle Reaches. Construction of the dams blocked transport of sediment from almost 60 percent of the North Santiam watershed. It is likely that the blocked area previously contributed an even larger percentage of the total sediment load because of steeper slopes, higher sediment transport rates, and higher precipitation (c.f., NMFS 2000a). Consequently, there is less sediment in the stream system below Big Cliff Dam today than there was prior to human settlement, and most of it originates from within the Lower and Middle Reaches and from the Little North Santiam River.

Upland processes that deliver sediment to the stream system include landslides and surface erosion. In lowland streams and rivers, erosion occurs principally as streambank erosion, which often causes significant losses of riparian agricultural land. In this watershed, slope instability, road instability, streambank erosion, and rural road runoff are probably the most significant sediment sources. In addition, wildfires can alter soil conditions, setting the stage for increased rates of erosion.

Sediment movement is generally episodic, with most erosion and downstream soil movement occurring during large storm events. Super-saturated weak soils on steep slopes lose cohesion, and cause landslides and debris flows. Extremely high flows are usually associated with rain-on-snow events, which occur when snowpack is melted by warm rain, rapidly releasing a large volume of water. However, the Detroit and Big Cliff Dams attenuate the effects of high

flows from upstream of the study area and trap sediment and woody debris, so the effects of large storm events on the mainstem of the North Santiam River in the study area have been reduced since pre-dam times.

In the Middle Reach, slope instability, road instability, and rural road runoff are likely the most significant sediment sources. In the Lower Reach, most erosion is likely to originate from earthflows, streambank erosion and surface erosion from crop lands. Because agricultural areas predominate in the Lower Reach, bank erosion might be a significant sediment source in that area.

Unfortunately, there is not much information regarding the locations of landslides in the Lower and Middle Reaches. ODFW surveys were conducted in the summers of 1995 and 1996 on three streams in the Middle Reach: Mad Creek, Rock Creek, and Sevenmile Creek. No surveys occurred in the Lower Reach subwatershed. Two landslides were recorded on Mad Creek, 16 on Rock Creek, and 19 on Sevenmile Creek (Table 5.1, Figure 5.3).

ODF created debris flow hazard maps in 1996 to characterize the future potential for landslide activity, based on watershed features such as slope, soils, and geology. Only 0.3 percent of the Lower Reach and 8 percent of the Upper Reach are in the high debris flow activity zone (Figures 5.1 and 5.2). If both the high and moderate risk categories are included, only 5 percent of the Lower Reach is located within the debris flow activity zone. In contrast, 47 percent of the Middle Reach is within the debris flow activity zone, and most of that land is found within the Sevenmile Creek and Rock Creek subwatersheds. Nearly 70 percent of each of those subwatersheds showed moderate or high debris flow hazard (Table 5.2).

Slumps and earthflows are common on some less steep slopes (i.e., 15-60 percent) in the lower portion of the watershed, especially in the hydrothermally altered igneous rock units and in volcanic tuffs and breccias (Keith Mills, ODF, communication to Watershed Council, 2001). Most of these slow-moving landslides have not been mapped, although they can be major sources of sediment to the river. These earthflows are believed to be an important source of high turbidity when it occurs in the North Santiam River. Aerial photo analysis could be used to describe the distribution and extent of such landslides.

Based on the predominantly gentle terrain, moderate annual precipitation, and small area of high debris flow hazard, we would expect that road-related landslides are relatively uncommon in the study area, except possibly in the Rock Creek and Sevenmile Creek subwatersheds of the

Middle Reach. Rural roads are a common feature of this watershed, however, and some are present on steep slopes in the Middle Reach. Unfortunately, data regarding road-related landslides in the study area are incomplete. Much of the steep, roaded terrain in the study area exists on private lands.

In order to get a general sense of the density of culverts in the study area, we conducted a GIS-based analysis of road-stream crossings. This was based on 1:24,000 scale road and stream maps, which are known to omit many features, although undoubtedly there are not culverts at all mapped road-stream crossings. We found an average density of 2.7 crossings per square mile in the study area, with a much higher density in the Middle Reach (3.6) than the Lower Reach (1.9). The highest density was in Sevenmile Creek, with 4.5 crossings per square mile. The second highest density was in the Fox Valley subwatershed, with 4.1 crossings per square mile. The lowest density was 1.7 crossings per square mile in the Chehulpum Creek subwatershed (Table 5.4).

Road data were used to assess potential sediment contribution from road runoff. The OWEB method for assessing road runoff involves identifying roads within 200 ft. of streams, and on slopes greater than 50 percent. The density of roads within 200 ft of a stream (irrespective of slope steepness) was highest in the Fox Valley subwatershed, at 0.36 miles of road per mile of stream, whereas the lowest road density within 200 ft of a stream was in the Bear Branch subwatershed at 0.17 mi/mi. Very few roads in the study area are both within 200 feet of a road and on a slope gradient greater than 50 percent, based on GIS analysis (Table 5.5). The Sevenmile Creek subwatershed had the greatest length of road near streams and on steep slopes (2 miles), but Bear Branch, Fox Valley, and Marion Creek subwatersheds had no roads that were both on steep slopes and near streams.

Data are incomplete for road surface type and frequency of use in this watershed. Surface type is unknown for the majority of the roads, and frequency of use is absent for all except major highways. In the Lower Reach, many of the roads are paved and publicly owned, whereas in the Middle Reach, many are privately owned roads for the purpose of forest management, and data are lacking or unavailable. Cooperation with private landowners to complete the road condition database would make it possible to more precisely determine the impact of road runoff on stream sediment supply.

In the Middle Reach, ODFW stream habitat surveys recorded streambank erosion for Mad Creek, Rock Creek, and Sevenmile Creek (Figure 5.3). The specific locations of erosion were not mapped, but rather the percentage of actively eroding streambank per ODFW-defined stream reach was estimated in the field. Actively eroding streambank was the highest in Sevenmile Creek, at 29 percent. The lower three reaches of Mad Creek also had high rates of bank erosion, with an average of 21 percent. The overall average percentage of streambank erosion for Mad Creek was 12 percent. Rock Creek had the lowest average proportion of actively eroding streambank, at 6.2 percent (Table 5.1).

## 9.7 Water Quality

The North Santiam River Watershed Council collected temperature data at 30-minute intervals during the summer of 2000. They found that 14 of the 15 continuous monitoring sites with valid data exceeded the 17.8° C temperature criterion based on the 7-day statistic (the 7-day moving average of the daily maximum temperature; Sandberg 2001). The results of the summer 2000 continuous monitoring are summarized in Table 6.10. These data suggest that both the North Santiam River and the Santiam River are impaired with respect to temperature, confirming their inclusion on the 303(d) list of water quality impaired water bodies.

The operation of Detroit and Big Cliff Dams influences the temperature of river water, with different effects depending on the time of year (Figure 7.3). The average water temperature below the dams is 3° to 5° C colder than inflowing water between mid-June and the end of August. However, during the period September through November, water below the reservoirs is generally 3° to 6° C warmer than above the reservoirs. This increase in temperature in the fall is believed to negatively affect the survival of juvenile chinook salmon hatched from eggs deposited below the dams (NMFS 2000a, USACE 1988).

Although turbidity is generally low in the North Santiam River below the dams, due largely to sediment deposition in Detroit Reservoir (Bates 1998), the North Santiam River carried a very high level of turbidity following the February 1996 floods. This condition persisted for months after the floods and caused significant problems related to the drinking water supply for Salem, which is diverted from the river near Stayton. The primary cause of the persistent turbidity was smectite clays, which have extremely small particle size and are scattered throughout the watershed (Bates et al. 1998).

DEQ routinely monitors water quality at the most downstream bridge in the watershed, the North Santiam River at Greens Bridge. Water quality at this site represents the cumulative effects of upstream nonpoint and point sources of pollution. Water quality in the North Santiam River is occasionally impacted by moderately high levels of fecal coliform bacteria and biochemical oxygen demand. This indicates the introduction of organic materials to the water. High levels of fecal coliform bacteria can be associated with the presence of untreated human or animal waste. These high concentrations occur primarily in the wet fall, winter, and spring seasons, suggesting runoff from fields, ditches, and storm drains carrying organic material to streams and rivers. Due to the low frequency and low severity of these impacts, water quality in the North Santiam River is generally excellent throughout the year (Table 6.12).

The most serious impairment noted in the North Santiam River occurs with respect to temperature, which suggests that some beneficial uses may not be protected in the study area. The beneficial uses that may be sensitive to water temperature include:

- Anadromous fish passage,
- Salmonid fish rearing,
- Salmonid fish spawning,
- Resident fish and aquatic life,
- Fishing and hunting, and
- Wildlife.

Data from EPA, ODEQ, and the watershed council indicate no impairment of water quality in the Lower and Middle reaches of the North Santiam River above the confluence with the South Santiam River, based on water quality assessment screening criteria. There are instances, however, when the screening criteria are exceeded. Water quality data collected by the City of Salem in the Middle and Upper Reaches of the North Santiam River exhibit fewer measurements in excess of the criteria than in the Lower Reaches. For some constituents (for example nitrogen), there appears to be an increasing trend in concentration with distance downstream (Table 6.13). Monitoring results suggest that there is a progressive deterioration in water quality through the length of the river. While changes in some constituents are to be expected, the nature of the changes in nutrients, bacteria, and organic contaminants suggest that there are sources of these constituents in the watershed that may be adversely affecting water quality.