Section 4

Middle Snake River Implementation Area

4.1 Overview of the Middle Snake River Implementation Area

Much of the description of the Middle Snake River subbasin is taken from the Draft Middle Snake Subbasin Summary (NPPC 2001). The Middle Snake lies within a canyon cut through the Columbia plateau. Several small tributaries with perennial water flow that likely contain fish populations are included in this subbasin. Some of these streams drain the north side of the Snake River in Whitman County (e.g., Alkali Flat Creek, Penawawa, Almota, Wawawai and Steptoe Canyon creeks). Others drain from the south, primarily in Garfield County (Alpowa, Deadman and Meadow creeks). The two dams on the Middle Snake River include Lower Granite and Little Goose Dams. Lower Granite is the longest reservoir, whereas Little Goose has the largest surface area in the middle and Middle Snake River.

As described further in Section 7, the geology of the region is composed mainly of lava flows covered by wind-blown silt (loess) deposits. In areas where the Snake River has cut canyons, the dark basalt rock is a primary surface feature. Many of the soils of the Snake River Plateau are light and highly erodible, resulting in heavy sediment loads in the river, especially during the spring runoff season. The current topography of the region results from a combination of erosion and underlying structural deformation of the basalt.

Approximately 5% of the Snake River's total drainage area is located downstream of its confluence with the Clearwater River at Lewiston, Idaho, and this region is relatively arid compared to the Snake River's upstream drainage areas. Therefore, only a relatively small amount of runoff occurs along the Middle Snake River downstream of the Clearwater River confluence.

Unlike many reaches of the Columbia-Snake River System, much of the Middle Snake River is not paralleled by highways, however railroad embankments occupy areas that otherwise might have been suitable for riparian vegetation.

Agriculture in the subbasin is dominated by non-irrigated farming in the uplands, irrigated farming in the lower valleys, and cattle ranching. The majority of the farmland is non-irrigated. Winter wheat, spring grain, peas, and bluegrass seed are the major non-irrigated crops grown in the uplands of the subbasin. Hay, small grains, and pasture are irrigated crops grown in the bottomlands near Alpowa Creek. Livestock grazing is the second largest land use in the subbasin. Grazing occurs predominantly in areas too steep, stony, shallow, or frequently flooded for farming. In general, little forestry activity occurs in the subbasin. Timber harvest occurs on portions of the forested upper watershed, but this area is relatively small. The Lewiston-Clarkston area and the area near the mouth of the Snake represent significant industrial, commercial, and residential development in the subbasin (NPPC 2001).

Lands adjacent to the Middle Snake River are primarily privately owned; public lands adjacent to the reservoirs are managed by the Army Corps of Engineers, and a few isolated parcels are owned by the State (NPPC 2001).

4.2 Surface Water Resources

The Middle Snake River Implementation Area is located in Asotin, Garfield, Whitman and Columbia Counties, with the Middle Snake River as the major stream reach. The major tributaries to the Snake River located on the north side in Whitman County include Steptoe Canyon, Wawawai, Almota, Penawawa, and Alkali Flat creeks. On the south side of the Snake River, primarily in Garfield County, major tributaries include Alpowa, Deadman, and Meadow creeks.

The Middle Snake River mainstem extends from the Oregon and Washington boundary to the Palouse River, and is impounded by Little Goose Dam (RM 70) and Lower Granite Dam (RM42). The backwater from Lower Granite Dam extends upstream to Asotin, Washington (RM 146) (Bartels, et.al, 2001, unpublished work).

Little is known about most of the tributaries to the Snake River in this reach, but there has been a recent effort by various agencies to obtain more information. The tributaries with most information are Alpowa Creek, Deadman Creek, and Meadow Creek.

Alpowa Creek is a fourth order tributary to the Snake River with its headwaters originating in the Blue Mountains, continuing east into the Snake River at Lower Granite Lake, about seven miles west of Clarkston, Washington. The major tributaries to Alpowa Creek include Page, Pow Wah Kee Gulch, Clayton Gulch, and Stember creeks (Bartels, et.al, 2001, unpublished work).

Deadman and Meadow Creeks flow from springs in the Palouse hills south of the Snake River, and enter the Snake River at RM 83, near State Route 127 (Kuttel, 2002).

This section provides an analysis of available gauging station data, a description of the available instream flow studies for the Middle Snake River Mainstem Implementation Area, a discussion of instream flow legal requirements, and identification of instream flow needs.

4.2.1 Gauging Data and Stream Flows

Measurement of stream flows with gauging stations has been occurring in the Middle Snake River Mainstem Implementation Area since 1915 when gauging stations were installed on the Snake River near Clarkston, Washington.

The data most useful to watershed planning efforts has been compiled by the United States Geological Survey (USGS). Historically, USGS has operated gauging stations recording stream flows on a daily basis or peakflows over various time periods in this area.

The Washington State University (WSU) Department of Biological Systems and Center for Environmental Education began an extensive water quality monitoring program in the Pataha

Implementation Area in 1998 to determine the effects of existing conservation practices that had been installed to reduce erosion and sediment delivery into Pataha Creek. As part of this monitoring program, spot stream flow measurements were collected at various locations along Alpowa, Deadman, and Meadow creeks. These spot measurements can be useful for specific research or management activities, and in the long run provide a fairly representative record of stream flow even though the record is not continuous.

In support of the watershed planning efforts in the Middle Snake River Basin, the Washington Department of Ecology (Ecology) and the Asotin County Public Utility District proposed to install additional gauging locations in WRIA 35. These monitoring stations are either telemetry or manual stage height stations. Telemetry stations record the stage height every fifteen minutes and data is then imported into Ecology's stream flow database, providing a continuous record of stream flow. Manual stage height stations record the river stage height 6 to 8 times a year, which can then be converted to instantaneous stream flow using a rating table or flow curve.

Ecology also operates water quality monitoring stations that are either long-term or basin stations. Long-term stations are monitored every water year (October 1 till September 30), whereas basin stations are monitored for one water year and sometimes returning every five years. Grab samples are taken usually once or twice a month and stream flow, when recorded, is either estimated or measured. Ecology water quality monitoring stations do not provide a continuous record of stream flow.

General Stream Gauging Locations

Historically, the USGS has operated nineteen (19) stream flow gauging stations in the Middle Snake River Implementation Area over various time periods (see Table 4-1). Four (4) stations, USGS gauges 13334300, 13343500, and 13343600 on the Snake River and USGS gauge 13343800 on Meadow Creek, have recorded stream flows on a daily basis. Of these, only gauge 13334300 remains in operation today as a real-time station. Eight (8) stations, USGS gauges 13335200, 13343450, 13343510, 13343520, 13343620, 13343660, 13343700, and 13343790, recorded only peak flows; none of these remain in operation today. Four (4) stations, USGS 13343590, 13343595, 13343855, and 13343860, are real-time stations located at Lower Granite Dam and Little Goose Dam, but no information is available at these sites from USGS. However, the United States Army Corp. of Engineers (USACE) has been recording stream flow at these two dams since the 1970's (see Table 4.2-2), and still continues to this day. The remaining 3 stations, USGS gauges 13343220 and 13343505 are located on the Snake River, and 13343400 on Dry Creek; however, no data is available at these locations. The locations of the gages are shown on Exhibit 4-1 and listed in Table 4.2-1.

USGS gauge 13343600 is located below Lower Granite Dam on the Snake River and recorded daily stream flow from 1978 to 1985. Given its location in the immediate vicinity of the USACE reporting site at the same dam, and the correspondence of its data with the USACE reporting site, data from this USGS site is not included in this stream flow analysis.

The WSU Monitoring Program collected stream flow data at five locations on Alpowa, Deadman and Meadow creeks. These locations are shown on Exhibit 4-1 and listed in Table 4.2-3.

Ecology has proposed six additional stream flow gauging locations in the Middle Snake River Implementation Area (Table 4-3). Of which, four telemetry gauges have been installed at Alpowa Creek (35K050), Almota Creek (35L050), and Deadman Creek (35M060 and 25M100) in 2003; and 1 manual stage height station was installed at Meadow Creek (35N050). At the time of this report, the remaining station at Penawawa Creek would not likely be installed (Joe Lemire, personal communication, 2004). Data from all the Ecology stream flow gauging stations are stage heights and conversion tables have not yet been developed for these sites (Jim Peterson, personal communication, 2003). Therefore, data from these Ecology stream flow gauging locations are not included in this stream flow analysis.

Ecology also operates 3 water quality monitoring stations, 35A100, 35A150, and 35A200, at various locations along the Snake River. Ecology 35A100 and 35A200 are basin stations with monthly grab samples taken over a few years in the late 1970's. Ecology 35A100 and 35A200 are located in the immediate vicinity of the USACE LGR reporting site on the Snake River at Lower Granite Dam, and USGS 13334300 gauge on the Snake River near Anatone, respectively. Given that there is limited record available at these sites, the proximity to USACE LGR reporting site and USGS gauge 13335050, and the correspondence of the Ecology data with that of the USACE LGR reporting site and USGS gauge 13335050, data from these Ecology sites are not included in this stream flow analysis. Ecology 35A150 is a long-term basin near Clarkston on the Snake River, located just outside the implementation area, with monthly stream flow records from 1991 through 2001.

The locations of the Ecology gages are shown on Exhibit 4-1 and listed in Table 4.2-4.

Although the data collected from the Ecology and WSU sites are limited at this time, the period of record will continue to expand for these sites. These will be useful in monitoring and evaluating flow enhancement activities under an adaptive management approach.

INSERT EXHIBIT 4-1 (Map showing all gauges/monitoring stations)

Table 4.2-1
USGS Gauging Stations[1]

Site Number	Site Name	Period of Record	Data Type	Count
13334300	SNAKE RIVER NEAR ANATONE, WASH.	1992 – Current 1958 – 2002 1959 – 2002 1989	Real-time Peak stream flow Daily stream flow Water quality	 44 16,142 2
13335200	CRITCHFIELD DRAW NEAR CLARKSTON, WASH.	1959 – 1976	Peak stream flow	18
13343220	SNAKE RIVER AT RM 137.17 AT CLARKSTON, WASH.	No data available	-	-
13343400	DRY CREEK NEAR CLARKSTON, WASH.	No data available	-	-
13343450	DRY CREEK AT MOUTH NEAR CLARKSTON, WASH.	1963 – 1977	Peak stream flow	15
13343500	SNAKE RIVER NEAR CLARKSTON, WASH.	1894 – 1972 1915 – 1973 1966 – 1972	Peak stream flow Daily stream flow Water quality	52 18,791 81
13343505	SNAKE RIVER ABOVE ALPOWA CREEK NEAR ANATONE, WASH.	No data available	-	-
13343510	ALPOWA CREEK AT PEOLA, WASH.	1971 – 1977	Peak stream flow	7
13343520	CLAYTON GULCH NEAR ALPOWA, WASH.	1961 – 1976	Peak stream flow	16
13343590	LOWER GRANITE LK FOREBAY AT LOWER GRANITE DAM, WASH.	No data available	Real-time	-
13343595	SNAKE RIVER (RIGHT BANK) BL LOWER GRANITE DAM, WASH.	No data available	Real-time	-
13343600	SNAKE RIVER BELOW LOWER GRANITE DAM	1979 – 1985 1978 – 1985 1975 – 1978	Peak stream flow Daily stream flow Water quality	7 2,557 35
13343620	SOUTH FORK DEADMAN CREEK TRIBUTARY NEAR PATAHA, WASH.	1961 – 1976	Peak stream flow	16
13343660	SMITH GULCH TRIBUTARY NEAR PATAHA, WASH.	1955 – 1974	Peak stream flow	20
13343700	BEN DAY GULCH TRIBUTARY NEAR POMEROY, WASH.	1961 – 1969	Peak stream flow	9
13343790	MEADOW CREEK TRIBUTARY NEAR CENTRAL FERRY, WASH.	1970 – 1977	Peak stream flow	9
13343800	MEADOW CREEK NEAR CENTRAL FERRY, WASH.	1964 – 1978 1963 – 1974 1964 – 1967	Peak stream flow Daily stream flow Water quality	15 4,171 61
13343855	LAKE BRYAN FOREBAY AT LITTLE GOOSE DAM, WASH.	No data available	Real-time	-
13343860	SNAKE RIVER BELOW LITTLE GOOSE DAM, WASH.	No data available	Real-time	-

[1] Source: USGS, 2003.

Table 4.2-2
United States Army Corp. of Engineers Reporting Stations[1]

Site ID	Location	Period of Record	Count
LGR	SNAKE RIVER AT LOWER GRANITE DAM	1976 – 2002	10,441
LGS	SNAKE RIVER AT LITTLE GOOSE DAM	1971 – 2002	12,298

[1] Source: USACE and Fish Passage Center, 2003.

Table 4.2-3
Washington State University Monitoring Stations[1]

Site ID	Location	Period of Record	Count
Alpowa 1	ALPOWA CREEK AT WILSON'S BANNER RANCH	2003	12
DeadmanL	DEADMAN CREEK AT WILLOW GULCH BRIDGE	2003	11
DeadmanU	DEADMAN CREEK AT GOULD CITY	2003	12
MeadowL	MEADOW CREEK AT CONC. BRIDGE ADJ. TO SR127/MEADOW CREEK RD INTERSECTION	2003	11
MeadowU	MEADOW CREEK AT BEN DAY GULCH BRIDGE	2003	11

[1] Source: Washington State Department of Biological Systems Engineering, 2003.

Table 4.2-4
Washington Department of Ecology Monitoring Stations

Station	Station Type	Site Name	River Mile	Period of Record	Data Type	Count
35K050[1]	Stream flow	ALPOWA CREEK AT MOUTH		2003	Telemetry	61[3]
35L050[1]	Stream flow	ALMOTA CREEK AT MOUTH		2003	Telemetry	57[3]
35M060[1]	Stream flow	DEADMAN CREEK NEAR MOUTH		2003	Telemetry	61[3]
35M100[1]	Stream flow	DEADMAN CREEK NEAR GOULD CITY		2003	Telemetry	60[3]
35N050[1]	Stream flow	MEADOW CREEK AT MOUTH		2003	Manual Stage Height	4
	Stream flow	PENAWAWA CREEK NEAR MOUTH		Not installed at this time[2]	Manual Stage Height	-
35A100[1]	Water Quality	SNAKE RIVER BELOW LOWER GRANITE DAM	106.5	1977 – 1978	Basin	12
35A150[1]	Water Quality	SNAKE RIVER AT INTERSTATE BRIDGE	139.6	1961 – 1969; 1990 – Current	Long-term	128
35A200[1]	Water Quality	SNAKE RIVER NEAR ANATONE	167.4	1972 – 1979	Basin	149

[1] Source: Ecology, 2003.
[2] Source: Jim Peterson, personal communication, 2003.
[3] Count as of 12/9/03.

Summary of Existing Data

Within the Middle Snake River Implementation Area, the most useful gauging data for analyzing stream flows is summarized in Table 4.2-5:

- USGS, USACE, Ecology and WSU monitoring sites with stream flow data
- Potential value and limitations of these data for characterizing stream flows
- Volume of stream flow passing this gage in an average year.

The complete stream flow USGS, USACE, and Ecology records for Snake River are summarized in Exhibits 4-2 through 4-6. The complete stream flow record for USGS gauge at Meadow Creek is summarized in Exhibit 4-7.

The USGS and USACE monitoring locations for the Snake River are daily readings of stream flow, whereas Ecology recorded stream flow data once a month over the period of record. The USGS gauge at Meeadow Creek also recorded stream flow data daily.

The average monthly stream flows observed for the USGS, USACE, and Ecology monitoring stations for Snake River and Meadow Creek over the period of record, and calculated 10% and 90% exceedance flows are summarized in Exhibits 4-8 through 4-13.

The exceedance flows were calculated from the average monthly flows for the full period of record. The 10% exceedance flow represents the flow that would be exceeded an average of only 10% of the time, and the 90% exceedance flow would be exceeded an average of 90% of the time. Although there are different standards depending on the application or analysis, the 10% exceedance flow could be considered to represent average high flows and the 90% exceedance flow to be low average flows.

Table 4.2-5
Stream Flow Data: Middle Snake River Implementation Area[1]

Gauge	Type of data	Site Name and Potential Planning Value	Period of Record	Volume[2] (afy)
SNAKE RIVER MAINSTEM				
USGS 13334300	Daily	SNAKE RIVER NEAR ANATONE, WASH.	1958 – Current	25,517,900
Ecology 35A150	Spot data	SNAKE RIVER AT INTERSTATE BRIDGE	1961 – 1969; 1990 – Current	25,386,048
USGS 13343500	Daily	SNAKE RIVER NEAR CLARKSTON, WASH.	1928 – 1959	36,429,975
USACE LGR	Daily	SNAKE RIVER AT LOWER GRANITE DAM	1976 – 2002	35,778,164
USACE LGS	Daily	SNAKE RIVER AT LITTLE GOOSE DAM	1971 – 2002	36,829,312
ALPOWA CREEK AND TRIBUTARIES				
USGS 13343510	Peak flow	ALPOWA CREEK AT PEOLA, WASH.	1971 – 1977	-
WSU Alpowa 1	Spot data	ALPOWA CREEK AT WILSON'S BANNER RANCH	2003	-
USGS 13343520	Peak flow	CLAYTON GULCH NEAR ALPOWA, WASH.	1961 – 1976	-
MEADOW CREEK AND TRIBUTARIES				
USGS 13343800	Daily	MEADOW CREEK NEAR CENTRAL FERRY, WASH.	1963 – 1974	2,372
WSU MeadowL	Spot data	MEADOW CREEK AT CONC. BRIDGE ADJ. TO SR127/MEADOW CREEK RD INTERSECTION	2003	-
WSU MeadowU	Spot data	MEADOW CREEK AT BEN DAY GULCH BRIDGE	2003	-
DEADMAN CREEK AND TRIBUTARIES				
USGS 13343620	Peak flow	SOUTH FORK DEADMAN CREEK TRIBUTARY NEAR PATAHA, WASH.	1961 – 1976	-
WSU DeadmanL	Spot data	DEADMAN CREEK AT WILLOW GULCH BRIDGE	2003	-
WSU DeadmanU	Spot data	DEADMAN CREEK AT GOULD CITY	2003	-

[1] Sources: USGS, 2003; Ecology, 2003; USACE and Fish Passage Center, 2003; and Washington State University Department of Biological Systems Engineering, 2003.
[2] Total volume of stream flow passing the gage in an average flow year in acre-feet/yr.

Insert Exhibit 4-2

Insert Exhibit 4-3

Insert Exhibit 4-4

Insert Exhibit 4-5

Insert Exhibit 4-6

Insert Exhibit 4-7

Insert Exhibit 4-8

Insert Exhibit 4-9

Insert Exhibit 4-10

Insert Exhibit 4-11

Insert Exhibit 4-12

Insert Exhibit 4-13

The following summarizes the available data, and seasonal and long-term trends suggested by the data, for each of the streams in this Implementation Area:

Middle Snake River Mainstem:

The USGS gauges along Snake River suggest that the general stream flow pattern of Snake River coincides with spring snowmelt. The long-term trend for base flows over the period of record is generally stable and consistent. The data suggests a pattern of a period of 4 to 7 years of average peak flows followed by another period of 4 to 7 years of high peak flows that are often double the average peak flows. High variability in peak stream flow is due to year-to-year variations in the volume and stability of the snowpack and climate variability. Stream flow patterns do not appear to be influenced by the operation of Little Goose and Lower Granite dams.

Snake River from Oregon-Washington border to Clearwater River Confluence

- The records from USGS gauge 13334300 (Exhibits 4-2 and 4-8) located near Anatone, Washington, indicate a mean annual flow of about 35,300 cfs, a normal low flow of about 19,500 cfs between August and October, and a normal high flow of 62,100 cfs between April and June. Average late summer flows are about 31 percent of the average spring flows. The total annual stream flow volume in this reach is about 25,517,900 acre-feet per year. The monitoring station from Ecology 35A150 (Exhibits 4-3 and 4-9), located near Clarkston, Washington, also indicates similar stream flow quantities as anticipated since contributions from Couse, Tenmile and Asotin creeks (see Section 3) are small in comparison to Snake River mainstem flows.

Snake River from Clearwater River Confluence to Alpowa Creek Confluence

- The records from USGS gauge 133343500 (Exhibits 4-4 and 4-10) indicate a mean annual flow of about 50,300 cfs, a normal low flow of about 20,200 cfs in August and September, and a normal high flow of 119,300 cfs in May and June. Average late summer flows are about 17 percent of the average spring flows. The total annual stream flow volume in this reach is about 36,430,000 acre-feet per year. The increase in flow is due to contributions from Clearwater River from Idaho.

Snake River from Alpowa Creek Confluence to Little Almota Creek Confluence

- The records from USACE reporting site at Lower Granite Dam (Exhibits 4-5 and 4-11) indicate a mean annual flow of about 49,460 cfs, a normal low flow of about 25,770 cfs between August and November, and a normal high flow of 98,750 cfs in May and June. Average late summer flows are about 26 percent of the average spring flows. The total annual stream flow volume in this reach is about 35,778,200 acre-feet per year.

Snake River from Little Almota Creek Confluence to Deadman Creek Confluence

- No gauging information is available for this stream reach.

Snake River from Deadman Creek Confluence to Tucannon River Confluence

- The records from USACE reporting site at Little Goose Dam (Exhibits 4-6 and 4-12) indicate a mean annual flow of about 50,900 cfs, a normal low flow of about 26,270 cfs between August and November, and a normal high flow of 103,940 cfs in May and June.

Average late summer flows are about 25 percent of the average spring flows. The total annual stream flow volume in this reach is about 36,829,300 acre-feet per year.

Snake River from Tucannon River Confluence to Palouse River Confluence

- No gauging information is available for this stream reach.

Alpowa Creek and its tributaries:

Limited stream flow data is available for this creek. USGS gauge 13343510 recorded peak stream flows at Peola, Washington for some winter months between 1971 and 1977. The flows recorded ranged from 0.10 cfs on March 6, 1977 to 11.0 cfs on February 7, 1972 and January 15, 1974. WSU monitoring at Alpowa Creek below Pow Wah Kee Gulch recorded a flow of 5.3 cfs in October 1999, and 5.6 cfs in July and August 2000 (Kuttel, 2002). The flows recorded between February and April 2003 at this location ranged from 13-24.3 cfs. The lowest flow recorded in September 2003 was 4.8 cfs (WSU, 2003).

USGS gauge 13343520 at Clayton Gulch, a tributary to Alpowa Creek, recorded peak stream flows for some winter and summer months between 1961 and 1976. The flows recorded ranged from 25 cfs on January 23, 1970 to 298 cfs on February 3, 1963.

There is insufficient data to determine seasonal or long-term trends for Alpowa Creek and its tributaries.

Steptoe Canyon Creek and its tributaries:

No gauging information is available for this creek. WDFW recorded at RM 1.0 of Steptoe Canyon Creek flows of 1.22 cfs on April 18, 2001; 0.16 cfs on July 9, 2001; and 0.65 cfs on October 18, 2001 (Kuttel, 2002).

Wawawai Creek and its tributaries:

No gauging information is available for this creek. WDFW recorded at RM 1.0 of Wawawai Creek flows of 0.43 cfs on October 18, 2001 (Kuttel, 2002).

Almota Creek and its tributaries:

No gauging information is available for this reach. WDFW recorded at RM 1.0 of Almota Creek flows of 0.92 cfs on September 18, 2001. At RM 0.1 of Almota Creek, flows were recorded at 3.99 cfs on April 24, 2001; 0.86 cfs on July 9, 2001; 0.85 cfs on September 18, 20001, and 1.65 cfs on October 18, 2001. At RM 0.1 on Little Almota Creek, flows were recorded at 1.07 on April 24, 2001; 0.53 cfs on July 9, 2001; 0.64 cfs on September 18, 2001, and 0.66 cfs on October 18, 2001 (Kuttel, 2002).

Penawawa Creek and its tributaries:

No gauging information is available for this creek.

Deadman Creek and its tributaries:

Deadman Creek from North and South Forks Confluence to Confluence with Meadow Creek

- Limited stream flow data is available for this reach. WSU monitoring at the North and South Forks (DeadmanU) confluence recorded a low flow of 2.49 cfs on August 5, 2003 and a high flow of 9.33 cfs on April 1, 2003. Near the mouth confluence with Meadow Creek (DeadmanL) , WSU recorded 1.5 cfs on August 5, 2003 and 13.89 cfs on February 3, 2003 (WSU, 2003). WDFW recorded flows of 2.55 cfs in July 2001 on upper Deadman Creek, and 3.5 cfs and 4.0 cfs in July and August 2001 on lower Deadman Creek (Kuttel, 2002).

Deadman Creek from Meadow Creek to Snake River

- No gauging information is available for this stream reach.

North Deadman Creek from Headwaters to North and South Forks Confluence

- Limited stream flow data is available for this reach. WSU recorded high flows of 4.8 cfs in February 1999 and 31 cfs in late June 1999, and low flows of 1.9 cfs in November 1999 and 1.5 cfs in October 2000. WDFW recorded 3 cfs in August 2001 (Kuttel, 2002).

- **South Deadman Creek from Headwaters to North and South Forks Confluence**
- Limited stream flow data is available for this reach. USGS gauge 13343620 recorded peak stream flows near Pataha, Washington for some winter months between 1961 and 1976. The flows recorded ranged from 0.5 cfs on January 23, 1970 to 91 cfs on January 6, 1961. A flow of 192 cfs was also recorded on September 13, 2003 at this site.

- WSU recorded high flows of 3.6 cfs in February 1999 and 27 cfs in late June 1999, and low flows of 0.4 cfs in September 1999 and 0.5 cfs in September 2000. WDFW recorded 0.75 cfs in September 2001 (Kuttel, 2002).

Meadow Creek from Headwaters to Deadman Creek Confluence

- USGS gauge 13343800 (Exhibits 4-7 and 4-13) suggests that the general stream flow pattern of Meadow Creek coincides with winter precipitation. The long-term trend for base flows over the period of record is generally stable and consistent. Peak flows, occurring mostly in winter, vary from year to year, but are generally consistent. High variability in peak stream flow is due to year-to-year variations in the volume of precipitation.

- The records from USGS gauge 13343800, located near the mouth of Meadow Creek, indicate a mean annual flow of about 3.3 cfs, a normal low flow of 1.4 cfs between June and October, and a normal high flow of 6.6 cfs between December and February. Average late summer flows are about 21 percent of the average winter flows. The total annual stream flow volume in this reach is about 2,370 acre-feet per year. The flows recorded by WDFW in April 2001 and August 2001 on Meadow Creek, and by WSU between February and November 2003 near the mouth of Meadow Creek, are consistent with the USGS records (Kuttel, 2002 and WSU, 2003).

- WSU also recorded flows further upstream on Meadow Creek at the confluence with Ben Day Gulch. The flows recorded between February and November 2003 at this location ranged from 0.3-1.25 cfs (WSU, 2003).

Alkali Flat Creek and its tributaries:

No gauging information is available for this creek.

Adequacy of Existing Data

The following summarizes the usefulness of the available data for quantifying the stream flow entering or originating within the Middle Snake River Implementation Area:

Middle Snake River Mainstem:

Snake River from Oregon-Washington border to Clearwater River Confluence

- The stream flow in this reach can be estimated using USGS gauge 1334300 and Ecology water quality monitoring site 35A150. Instantaneous stream flow contributions from Couse and Tenmile creeks may be determined by converting the manual stage height data collected by Ecology at stream flow monitoring sites 35H050 and 35J050, respectively. Contributions from Asotin Creek can be estimated using USGS gauge 13335050 (Section 3).

Snake River from Clearwater River Confluence to Alpowa Creek Confluence

- The stream flow in this reach can be estimated using USGS gauge 13343500. Contributions from Clearwater River can be estimated using USGS gauge 13343000, located on Clearwater River near Lewiston, Idaho. (Data from this gauge has not been analyzed).

Snake River from Alpowa Creek Confluence to Little Almota Creek Confluence

- The stream flow in this reach can be estimated using USACE reporting site at Lower Granite Dam. Contributions from Alpowa Creek can be estimated by using WSU monitoring location on Alpowa Creek, and from Ecology telemetry station (35K050) at the mouth of Alpowa Creek. Contributions from Steptoe Canyon and Wawawai Creeks are not known.

Snake River from Little Almota Creek Confluence to Deadman Creek Confluence

- No stream flow gauging stations have been installed in this stream reach. Contributions from Almota Creek can be determined from Ecology telemetry station (35L050). Contributions from Penawawa Creek are not known.

Snake River from Deadman Creek Confluence to Tucannon River Confluence

- The stream flow in this reach can be estimated using USACE reporting site at Little Goose Dam. Contributions from Deadman Creek can be estimated by using Ecology telemetry station (35M060). Contributions from Meadow Creek can be estimated by using USGS 13343800. Contributions from Alkali Flat Creek are not known.

Snake River from Tucannon River Confluence to Palouse River Confluence

- No stream flow gauging stations have been installed in this stream reach.

Alpowa Creek and its tributaries:

An Ecology telemetry station (35K050) has been installed near the mouth of Alpowa Creek. Continuous stream flow records will be available as more data is collected and a conversion table is developed. Currently, WSU also monitors stream flow on a monthly basis below Pow Wah Kee Gulch (Alpowa 1). Instantaneous stream flow contributions from Clayton Gulch can be determined using USGS gauge 13343520.

Steptoe Canyon Creek and its tributaries:

No stream flow gauging stations have been installed in this creek.

Wawawai Creek and its tributaries:

No stream flow gauging stations have been installed in this creek.

Almota Creek and its tributaries:

An Ecology telemetry station (35L050) has been installed near the mouth of Almota Creek. Continuous stream flow records will be available as more data is collected and a conversion table is developed.

Penawawa Creek and its tributaries:

An Ecology manual stage height station was planned for installation near the mouth of Penawawa Creek. However, the based on conversations with the Ecology contractor at the time of this report, this gauge will not likely be installed (Joe Lemire, personal communication, 2004).

Deadman Creek and its tributaries:

Deadman Creek from North and South Forks Confluence to Snake River

- Instantaneous stream flow in this reach can be estimated from WSU monitoring locations on Deadman Creek at Gould City, Washington (DeadmanU) and at Willow Gulch Bridge (DeadmanL). Ecology telemetry stations have also been installed near Gould City (35M100) and near the mouth of Deadman Creek (35M060). Continuous stream flow records will be available as more data is collected and a conversion table is developed.

Deadman Creek from Meadow Creek to Snake River

- No stream flow gauging stations have been installed in this stream reach.

North Deadman Creek from Headwaters to North and South Forks Confluence

- No stream flow gauging stations have been installed in this stream reach.

South Deadman Creek from Headwaters to North and South Forks Confluence

- No new stream flow gauging stations have been installed in this reach. USGS gauge 13343620 recorded peak flow for some months from 1961 to 1976.

Meadow Creek from Headwaters to Deadman Creek Confluence

- The stream flow leaving this reach can be estimated primarily using USGS gauge 13343800. The WSU monitoring location (MeadowL) and Ecology manual stage height station (35N050) located near the mouth of Meadow Creek also provides instantaneous stream flow data. Instantaneous stream flow further upstream can be estimated by using the WSU monitoring location (MeadowU) located at Ben Day Gulch.

Alkali Flat Creek and its tributaries:

No stream flow gauging stations have been installed in this creek.

4.2.2 Instream Flow Requirements

A listing of specific flow requirements is presented in this subsection. The general discussion on instream flows and instream flow studies are presented in Section 9. The Middle Snake River subbasin currently has no instream flow requirements, however, there are seven surface water source limitations (SWSL). A description of the SWSLs are shown in Table 4.2-6.

Table 4.2-6
Surface Water Source Limitations in the Middle Snake River Subbasin

Stream Name	Type	Location	Documentation Basis
Alkali Flat Creek	Low Flow - .05 cfs	Township 13N, Range 38E, Section 08	Letter from Fisheries, Oct. 28, 1955; Nov. 15, 1957; Apr. 18, 1952 – Letter from Game, Apr. 24, 1952; Dec. 15, 1971; Mar. 29, 1971 5899 (appl. 8661).
Alpowa Creek	Closure/Adjudication	Township 11N, Range 45E, Section 20	Adjudication Decree, Mar. 26, 1923
Deadman Creek	Adjudication	Township 13N, Range 40E, Section 09	Adjudication Decree, Jan. 24, 1929
Meadow Gulch Creek	Adjudication	Township 13N, Range 40E, Section 15	Adjudication Decree, June 6, 1922

Table 4.2-6 Surface Water Source Limitations in the Middle Snake River Subbasin			
Stream Name	**Type**	**Location**	**Documentation Basis**
Penawawa Creek	Closure	Township 14N, Range 41E, Section 17	Letter from Fisheries, June 17, 1952; Closure initiated June 17, 1952; Closure lifted Feb. 14, 1963 - Letter from Game, May 17, 1962; Feb. 14, 1963
South Meadow Creek	Bypass Flow	Township 12N, Range 43E, Section 29	Letter from Fisheries, Aug. 12, 1952 – Bypass sufficient water for stock grazing
WaWaWai Caynon	Adjudication	Township 13N, Range 43E, Section 03	Adjudication Decree Mar 3, 1931

No instream flow studies have been conducted in the Middle Snake River subbasin.

4.3 Water Demand Projections

This section includes the demand projections for the Middle Snake River subbasin. A general discussion of water use is included in Section 2. In general, there are five major categories of water users identified in the Middle Snake River subbasin. These are: (i) major public water systems (Clarkston urban area – Asotin PUD); (ii) small public water systems (small system less than 500 connections); (iii) self-supplied commercial/industrial users (primarily in the Clarkston urban area, but not supplied by Asotin PUD); (iv) individual household wells; and (v) agricultural water users. Although Clarkston has relatively significant water demand, pasture and rangeland, cropland, and forestland are the predominant land uses within the Middle Snake River subbasin, and the most significant water use is associated with agricultural use (including stock watering and pastures).

A summary of principal water demands for municipal and rural residential needs, along with agricultural demands are outlined in the subsections below.

4.3.1 Municipal and Rural Residential Demand

Planning for future water supply needs requires projection of long-term demand to quantify probable water resource requirements. For watershed planning, quantifying current and projected diversions for domestic, commercial, and industrial uses is essential to determine the distribution of instream and out-of-stream water resources and demands. For municipalities, such forecasts guide the sizing and identification of long-range supply facilities.

The method for conducting the demand projections is described in the Asotin Creek Implementation Area section under Section 3.3.1. As described in that section, the demand projection is based on the population and per capita demand derived from the DOH formula. The population forecasts described in Section 2.4 is used as the basis for the demand projections.

For convenience the population projections for Middle Snake River subbasin is repeated below in Table 4.3-1 and the per capita demand is repeated in Table 4.3-2.

Table 4.3-1
Population Projections for Middle Snake Subbasin

	Clarkson Urban Area	Rural Asotin Co.	Rural Columbia Co.	Rural Garfield Co.	Rural Whitman Co.
1990	16,096	-	-	-	-
1995	17,447	-	-	-	-
2000	18,661	432	479	815	945
2005	19,629	380	470	819	946
2010	20,597	429	470	819	952
2015	21,565	406	470	819	948
2020	22,643	373	470	819	948
2025	23,797	264	470	819	948

Table 4.3-2
Average Rainfall and Per Capita Residential Demand

	Asotin County	City of Asotin	Columbia County	Garfield County	Whitman County
Average Rainfall (inches/year)(1)	14.4	13.3	25.3	16.3	18.1
Average per Capita Demand (gallons) (1)	300.9	320.6	206.7	276.3	257.3

(1) Rounded to the nearest tenth.

Using sub-basin populations forecasts shown in Table 4.3-1 and per capita demand shown in Table 4.3-2 the planning unit projected average day demand for residential connections through 2025. The results of this calculation for the Middle Snake River subbasin are provided in Table 4.3-3 in gallons per day and in Table 4.3-4 in acre feet per year.

Table 4.3-3 Average Day Demand Projections for Middle Snake Subbasin					
Year	**Clarkson Urban Area**	**Rural Asotin Co.**	**Rural Columbia Co.**	**Rural Garfield Co.**	**Rural Whitman Co.**
1990	4,183,562	-	-	-	-
1995	4,534,704	-	-	-	-
2000	4,850,239	47,816	10,235	135,636	243,057
2005	5,101,835	42,077	10,043	136,407	243,328
2010	5,353,431	47,489	10,043	136,407	244,987
2015	5,605,027	44,964	10,043	136,407	243,791
2020	5,885,084	41,320	10,043	136,407	243,791
2025	6,185,282	29,209	10,043	136,407	243,791

Units in Gallons per day

Table 4.3-4 Average Annual Volume Projection for Middle Snake Subbasin (acre feet per year)					
	Clarkson Urban Area	**Rural Asotin Co.**	**Rural Columbia Co.**	**Rural Garfield Co.**	**Rural Whitman Co.**
1990	4,690	-	-	-	-
1995	5,083	-	-	-	-
2000	5,437	54	11	152	272
2005	5,719	47	11	153	273
2010	6,001	53	11	153	275
2015	6,283	50	11	153	273
2020	6,597	46	11	153	273
2025	6,934	33	11	153	273

Units in acre feet per year

Demand projections for the Clarkson urban area provided by the Asotin PUD did not distinguish between demand types (e.g. residential versus commercial and industrial). Therefore, Clarkson urban demands represent *total* system demand, whereas demands for the other areas represent residential demands.

Residential demand is projected to increase from 2000 to 2025 by approximately 16.7% which equates to an annual average of approximately 0.7%. The increase is due, in small part, to projected demand increases in the cities of Asotin and Pomeroy and, in large part, to the Clarkson urban area which is slated for an increase of 105 acre-feet per year from 2000 to 2025 as a result of forecasted population increases during this time.

As discussed with the Asotin subbasin (Section 3.3.1), the portion of the projected demand associated with surface water versus ground water was not done for the Level 1 assessment.

However, based on a comparison of the water rights for non-irrigation purposes (see Section 4.4), ground water use is higher on annual basis than surface water use in the subbasin. This is because the Clarkston urban area, which includes the municipal and self-supplied commercial/industrial users, relies on ground water as their source, and most of the large agricultural irrigation utilizes ground water as the source of water. Furthermore, most individual household users use wells for water supply. Based strictly on the water rights ratios, it is estimated that ground water use accounts for over 95 percent of the source of water for non-irrigation use in the Middle Snake River subbasin.

4.3.2 Agricultural Demand

A general discussion on agricultural water use and measurement is provided in Section 3.3.2. That section also includes a description of the methods used to estimate agricultural water use in the basin. This section includes the findings of that analysis for the Middle Snake River subbasin.

A total 391 acres of cropland are currently irrigated with surface diversions in the Middle Snake Subbasin[1]. Primary crops include grass hay, alfalfa hay, grain and orchards. Diversions generally take place from early May through August[2]. These diversions are primarily located on Alkaki Flat Creek and Alpowa Creek, with smaller diversions from Deadman, Almota, and Meadow Creeks. The extent and impact of stock watering use was not estimated.

Table 4.3-5 provides estimates of agricultural water usage in the Middle Snake Subbasin. Irrigation values were calculated based on the number of acres devoted to each crop type and the estimated amount of water applied to these crops annually.

Table 4.3-5
Agricultural Water Use by Crop in the Middle Snake Subbasin

Irrigated Crop	Acreage (Middle Snake Subbasin)*	Estimated Water Use per Acre (afy)	Estimated Total Annual Irrigation (afy)
Hay (Grass)	50	2.0	100
Hay (Alfalfa)	50	2.5	125
Grain	221	2.2	486
Orchard	70	2.8	196
TOTALS	391	n/a	907

** Data provided by Pomeroy Conservation District*
***Estimates from AgriMet ET data from the Legrow, Washington weather station, May – August, 2003.*

The irrigated acreages associated with the water rights in the subbasin are summarized in Table 4.3-6 below. Possessing a water right does not mean that it is currently beneficially used. Surface water rights from the Snake River have been excluded from this table; however, there

[1] Personal communication with Duane Bartels, District Manager, Pomeroy Conservation District, February 2004
[2] Personal communication with Duane Bartels, February 2004

are some relatively large ground water rights that are included located adjacent to the Snake River and in the City of Clarkston.

Table 4.3-6 Irrigation Water Right Summary in the Middle Snake Subbasin			
Purpose	**Acreage**	**Instantaneous Flow (cfs)**	**Annual Volume (afy)**
Surface – Primary	471	9.98	1,400
Surface - Supplemental	140	2.49	380
Ground – Primary	3,125	58.06	16,766
Ground - Supplemental	122	1.81	445
Primary Totals	3,596	68.04	18,166

** Data compiled from DOE WRATS database, no warranties to accuracy are implied.*

Due to the amount of land in the Subbasin suitable and available for cultivation and the uncertainty of agricultural crop markets, agricultural activity in the Subbasin is not likely to increase in the future[3]. Irrigation systems consist of hand or wheel lines with the exception of one big gun system. These are relatively simplistic irrigation systems, with an estimated 65% field application efficiency[4]. These systems are deemed most appropriate for the landscape and conditions in the Subbasin; thus upgrades of irrigation practices to increase efficiency are not likely to significantly decrease the amount of water currently being diverted for irrigation[5]. For these reasons, and in an effort to include conservative estimates in this Level 1 Assessment, it is anticipated that agricultural water use in the Middle Snake Subbasin will remain constant. However, changes in irrigation timing or use of storage to collect water for use during the dry summer months could potentially impact stream flows in the Subbasin.

4.4 Water Rights and Claims

Section 2.9 includes a general discussion of the water rights and claims status for the WRIA 35 watershed as a whole. This section includes a subbasin-specific summary of the types of use and the estimated quantities of water rights for the Middle Snake River subbasin.

In order to derive the subbasin-specific water rights, all of the water rights were mapped based on their location per the township-range-section description in the WRATS database (refer to Section 2.9). The same analysis as conducted to prepare Tables 2.8-1 and 2.8-3 was used, except that only those water rights within the Middle Snake River subbasin were included in the evaluation. Tables 4.4-1 and 4.4-2 include summaries of the types of use and associated quantities for surface and ground water permitted and certificated water rights, respectively. Water rights with irrigation being one of the purposes of use accounts for over 55 percent of the total annual water rights allocated. Ground water is the predominant source of water in the

[3] Personal communication with Duane Bartels, February 2004
[4] Washington State University, 1985, Washington State Irrigation Guide
[5] Personal communication with Duane Bartels, February 2004

subbasin, with over 80 percent of the water rights in terms of annual volume quantities having ground water as a source.

Table 4.4-1
Summary of Surface Water Rights[1] for Middle Snake River Subbasin

Purpose of Use	Number of Records	Annual Quantity, Qa (afy)	Instantaneous Quantity, Qi (cfs)
IR	35	4,313.73	26.77
ST	6	6.00	0.12
DS IR ST	2	54.70	0.30
CI EN FR	1	100.00	0.80
CI IR ST	1	31.60	0.15
DS	1	2.00	0.03
DS IR	1	120.00	0.41
DS ST	1	2.00	0.02
FS	1	1.38	5.56
FS IR ST	1	50.00	0.12
IR ST	1	56.00	0.15
RE ST	1	2.00	0.02

NOTES:
1 The detailed summary by Purpose of Use only includes data pertaining only to water right permits and certificates, as listed in the Department of Ecology Water Rights Application Tracking System (WRATS) database (February 4, 2004). Quantities of water associated with claims and water right applications are not included in this table. There are no annual or instantaneous quantities associated with water right applications, because they are not appropriated rights since they have not yet been approved.

- ***CI***--*Commercial and Industrial Manufacturing*
- ***DG***--*Domestic General (use of water for all domestic uses not specifically defined in the water right record or not defined by the other specific domestic use categories.*
- ***DS***--*Domestic Single (one dwelling with lawn and garden, up to one-half acre)*
- **EN**--Environmental Quality
- **FR**--Fire Protection
- **FS**--Fish Propagation
- ***IR***--*Irrigation*
- ***MU***--*Domestic Municipal*
- ***RE***--*Recreational*
- ***ST***--*Stock Watering*

Table 4.4-2
Summary of Ground Water Rights[1] for Middle Snake River Subbasin

Purpose of Use	Number of Records	Annual Quantity, Qa (afy)	Instantaneous Quantity, Qi (gpm)
IR	38	7053.26	16043
DS IR	25	849.51	1730
DM IR	13	769.8	1480
DM	10	125.32	360
DS IR ST	7	910.9	822
CI DM	4	2330	2730
DS	4	13	38.5
CI DM IR	3	763.86	620
CI DS	3	329	740
DM IR ST	3	61.4	205
CI	2	34.5	570
DS PO	2	967.8	600
IR ST	2	135.6	330
CI DG DS EN FR ST	1	30	50
CI DM FR	1	171	200
CI DM FS IR	1	292.29	300
DG RW	1	15.35	220
DM FR IR	1	60.26	125
DM HE	1	3	45
DS FP IR ST	1	23	100
DS FR	1	2	20
DS FR IR	1	38.9	30
FR IR ST	1	85	100
HE IR	1	71	250
IR MU	1	5600	3500
MU	1	730	900

NOTES:
(1) The detailed summary by Purpose of Use only includes data pertaining only to water right permits and certificates, as listed in the Department of Ecology Water Rights Application Tracking System (WRATS) database (February 4, 2004). Quantities of water associated with claims and water right applications are not included in this table. There is no feasible means of evaluating the validity, or documenting the amount of, water associated with claims. There are no annual or instantaneous quantities associated with water right applications, because they are not appropriated rights, since they have not been approved.

- ***CI***--*Commercial and Industrial Manufacturing*
- ***DG***--*Domestic General*
- ***DM***--*Domestic Multiple*
- ***DS***--*Domestic Single*

- ***EN***--*Environmental Quality*
- ***FR***--*Fire Protection*
- ***FS***--*Fish Propagation*
- ***HE***--*Heat Exchange*
- ***IR***--*Irrigation*
- ***MU***--*Domestic*
- ***PO***--*Power*
- ***ST***--*Stock Watering*

4.5 Surface Water Quality

Various degrees of water quality impairment can restrict the beneficial uses of surface and ground water for the purposes of recreational, drinking, industrial, and agricultural uses, as well as for fish habitat. This section includes a discussion of surface water quality in the Middle Snake Implementation Area. Water quality parameters and regulations are discussed in Sections 3.5.1 and 3.5.2 respectively. Ground water quality is discussed basin-wide in the ground water section (Section 7.6) since it is impractical to describe ground water strictly within the boundaries of individual subbasins.

4.5.1 Surface Water Quality Criteria and 303(d) List

The State of Washington recently adopted revised surface water quality standards on June 25, 2003. However, the changes must be reviewed and adopted by EPA and other federal agencies before they go into effect. Key changes applicable to the study area include a focus on pollution prevention, targeting (1) temperature requirements, (2) new criteria for ammonia, and (3) classifying fresh waters by actual use rather than by class. While these revisions do not change the general process to achieve water quality standards, the mechanics of that process and the goals for specific water bodies will change.

Under the revised water quality standards for Washington, surface waters of the state are assigned to be protected for certain designated uses and the water quality criteria associated with them, as described in WAC 173-201A-200. Use designations for waters of the state are described in WAC 173-201A-600. The designated uses and water quality standards assigned to the segment of the Snake River within the Middle Snake Implementation Area, including all tributaries are described in Table 4.5-1.

The 1998 and 2002 303(d) listed streams and impaired waters within the Middle Snake Implementation Area are summarized in Table 4.5-2 and are illustrated in Exhibit 4.5-1 and 4.5-2, respectively. The 303(d) lists are developed based on monitoring data collected by Ecology as well as information and data submitted to Ecology by other entities. All data is checked for accuracy and compliance with established QA/QC procedures prior to establishing the listings.

The Snake River within WRIA 35 has been listed on the 1998 and 2002 303(d) list of impaired waters for temperature, pH, dissolved oxygen, total dissolved gas (TDG), and toxics. Ecology, together with the Idaho Department of Environmental Quality, the Oregon Department of

Environmental Quality, and the EPA, formed a workgroup to develop the Temperature and TDG TMDLs.

Ecology prepared the *Total Maximum Daily Load for the Middle Snake River Total Dissolved Gas* (Pickett and Harold, 2003) as a result of the 1998 303(d) listing. Approval was received from EPA on October 1, 2003. The TMDL set TDG loading capacities at the four hydroelectric dams in the Middle Snake River in terms of percent saturation for fish passage spills, and in terms of excess pressure above ambient conditions during non-fish passage conditions. These conditions must be met within compliance areas specified by a distance below the spillway, as described in the TMDL.

The *Preliminary Draft Columbia/Snake Mainstem Temperature TMDL* (EPA 2002) was prepared by EPA in 2002 and was scheduled to be released for public comment in the fall of 2002. This release of the draft has since been delayed to allow necessary discussions and information exchange. EPA will post a release date on their website in 2004.

Table 4.5-1
Water Quality Standards: All Waterbodies in the Middle Snake Implementation Area

Designated Uses	Water Quality Standards[5]	
▪ Salmon and trout spawning, non-core rearing, and migration ▪ Primary Contact Recreation ▪ Domestic, Industrial, Agricultural and Stock water supply ▪ Wildlife habitat, harvesting, commerce/ navigation, boating and aesthetics	**Temperature**, 7-day average of daily max.	17.5°C (63.5°F)
	Dissolved Oxygen, 1-day min.	8.0 mg/L
	Turbidity[1] Background Turbidity ≤ 50 NTU: Background Turbidity > 50 NTU:	< 5 NTU over background < 10% increase
	Total Dissolved Gas[2]	< 110% saturation
	pH[3]	6.5 – 8.5, variation of < 0.5
	Fecal coliform[4]	< 100 colonies/100mL

Source: WAC 173-201A.
Notes:
[1] Turbidity is measured in Nephelometric Turbidity Units (NTU). Ecology may allow modification of the turbidity criteria to allow a temporary area of mixing during and immediately after necessary in-water construction activities.
[2] Total dissolved gas criteria does not apply when the stream flow exceeds the 7-day, 10-year frequency flood.
[3] pH variation is for human caused variations within the given range.
[4] Not more than 10% of all samples obtained for calculating the geometric mean value may exceed the fecal coliform organism levels shown in the table.
[5] Toxic, radioactive, or deleterious material concentrations, and aesthetic values are not shown in this table. Toxic, radioactive, or deleterious material concentrations shall be below the potential to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by Ecology; and aesthetic values must not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Table 4.5-2
303(d) Listed Stream Segments: Middle Snake River Implementation Area[1]

Segment Description [Stream ID; Listing ID(s)]	Parameter(s) Exceeding Standards	1998 List (#)	2002 List[2]		Comments
			4	5	
Snake River just upstream of Asotin Creek confluence [YB86JO; 16931]	pH			X	based on US Army Corp of Engineers unpublished data
Snake River just upstream of Clearwater River confluence [YB86JO; 16927, 16929]	Dissolved Oxygen			X	based on US Army Corp of Engineers unpublished data and Ecology data
	Temperature	X		X	based on Ecology data
Snake River just downstream of Clearwater River confluence [YB86JO; 8839, 34871]	Dioxin		X		EPA established a TMDL for the Columbia River Basin on February 25, 1991. U.S. District Court upheld the TMDL on August 10, 1993; based on data collected by consultants to Ecology
Snake River just upstream of Alpowa Creek confluence [YB86JO; 15174, 19121, 19018]	pH			X	based on NMFS and US Army Corp of Engineers unpublished data
	Total PCBs			X	based on data collected by consultants to Ecology
	4,4'-DDE			X	based on data collected by consultants to Ecology
Snake River at mouth of Alpowa Creek [YB86JO; 34888]	Dioxin		X		EPA established a TMDL for the Columbia River Basin on February 25, 1991. U.S. District Court upheld the TMDL on August 10, 1993; based on data collected by consultants to Ecology
Snake River just downstream of Alpowa Creek confluence [YB86JO; 16911]	Temperature			X	based on US Army Corp of Engineers unpublished data
Snake River near Steptoe Canyon Creek confluence [YB86JO; 19120, 19017, 15173, 16906]	Total PCBs			X	based on data collected by consultants to Ecology
	4,4'-DDE			X	based on data collected by consultants to Ecology
	pH			X	based on NMFS and US Army Corp of Engineers unpublished data
	Dissolved Oxygen			X	based on US Army Corp of Engineers unpublished data
Snake River near Wawawai Canyon confluence [YB86JO; 15175]	pH			X	based on NMFS and US Army Corp of Engineers unpublished data

[1] *Source: Ecology 2004b.*
[2] *The 2002/2004 Categories 4 and 5 are shown in the table.*

Table 4.5-2 continued
303(d) Listed Stream Segments: Middle Snake River Implementation Area[1]

Segment Description [Stream ID; Listing ID(s)]	Parameter(s) Exceeding Standards	1998 List (#)	2002 List[2]		Comments
			4	5	
Snake River upstream of Lower Granite Dam [YB86JO; 16903, 16905, 6306, 8286, 8161, 4871]	Dissolved Oxygen			X	based on US Army Corp of Engineers unpublished data
	Temperature			X	based on US Army Corp of Engineers unpublished data (2 listings)
	Total Dissolved Gas		X		Middle Snake River Total Dissolved Gas TMDL was approved September 30, 2003; based on US Army Corp of Engineers data (2 listings)
	Invasive Exotic Species		X		based on Ecology survey
Snake River just upstream of Little Goose dam [YB86JO; 4870]	Invasive Exotic Species		X		based on Ecology survey
Snake River near Little Goose dam [YB86JO; 6307, 8162]	Temperature	X		X	based on USACE data
	Total Dissolved Gas	X	X		Middle Snake River Total Dissolved Gas TMDL was approved September 30, 2003
Alpowa Creek at the mouth [EU09ED; 21998]	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: substrate embeddedness, large woody debris, pools
Alpowa Creek upstream of Pow Wah Kee Gulch confluence [EU09ED; 40556]	Fecal Coliform			X	based on WSU data
Alpowa Creek near Stember Creek confluence [EU09ED; 21197, 40557]	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: riparian, streambank condition, substrate embeddedness, large woody debris, pools, off-channel habitat
	Fecal Coliform			X	based on WSU data
Alpowa Creek between Robinson Gulch and Pinetree Canyon [EU09ED; 40558]	Fecal Coliform			X	based on WSU data
Steptoe Canyon near the mouth [PJ02YW; 21219, 18833]	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: riparian, streambank condition, floodplain connectivity, substrate embeddedness, large woody debris, pools
	Temperature			X	based on WDFW unpublished data
Steptoe Canyon near Stuart Canyon confluence [PJ02YW; 18834]	Temperature			X	based on WDFW unpublished data
Wawawai Canyon near the mouth [DW18MN; 18838]	Temperature			X	based on WDFW unpublished data

[1] *Source: Ecology 2004b.*
[2] *The 2002/2004 Categories 4 and 5 are shown in the table.*

Table 4.5-2 continued
303(d) Listed Stream Segments: Middle Snake River Implementation Area [1]

Segment Description [Stream ID; Listing ID(s)]	Parameter(s) Exceeding Standards	1998 List (#)	2002 List[2]		Comments
			4	5	
Almota Creek near the mouth [SA33EC; 21196, 20358]	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: streambank condition, substrate embeddedness, large woody debris, pools
	Temperature			X	based on WDFW unpublished data
Almota Creek near the headwaters [SA33EC; 20357]	Temperature			X	based on WDFW unpublished data
Little Almota Creek near confluence with Almota Creek [RL33QB; 16644, 21211, 20359]	Instream Flow		X		based on Kuttel 2002
	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: riparian, streambank condition, substrate embeddedness, large woody debris, pools
	Temperature			X	based on WDFW unpublished data
Little Almota Creek near headwaters [RL33QB; 20360]	Temperature			X	based on WDFW unpublished data
Penawawa Creek near the mouth [TG21GN; 18839]	Temperature			X	based on WDFW unpublished data
Penawawa Creek downstream of Little Penawawa Creek confluence [TG21GN; 18840]	Temperature			X	based on WDFW unpublished data
Deadman Creek near the mouth [GN97JI; 18827, 21205]	Temperature			X	based on WDFW unpublished data
	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: riparian, streambank condition, substrate embeddedness, large woody debris, pools
Deadman Creek near Willow Gulch confluence [GN97JI; 18829, 40553]	Temperature			X	based on WDFW unpublished data
	Fecal Coliform			X	based on WSU data
Deadman Creek upstream of Lynn Gulch confluence [GN97JI; 18828]	Temperature			X	based on WDFW unpublished data
Deadman Creek North Fork near confluence with South Fork [XW61JA; 21206, 40555]	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: riparian, streambank condition, floodplain connectivity, substrate embeddedness, large woody debris, pools, off-channel habitat
	Fecal Coliform			X	based on WSU data

[1] *Source: Ecology 2004b.*
[2] *The 2002/2004 Categories 4 and 5 are shown in the table.*

Table 4.5-2 continued
303(d) Listed Stream Segments: Middle Snake River Implementation Area [1]

Segment Description [Stream ID; Listing ID(s)]	Parameter(s) Exceeding Standards	1998 List (#)	2002 List[2]		Comments
			4	5	
Deadman Creek South Fork near confluence with North Fork [IU77IQ; 21218, 40554, 40534]	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: riparian, streambank condition, floodplain connectivity, substrate embeddedness, large woody debris, pools, off-channel habitat
	Fecal Coliform			X	based on WSU data
	Temperature			X	based on WSU data
Meadow Creek near mouth [FQ09UK; 11830, 21212, 16640]	Temperature			X	based on WDFW unpublished data
	Fish Habitat		X		based on Kuttel 2002, factors limiting salmon uses: riparian, streambank condition, floodplain connectivity, substrate embeddedness, large woody debris, pools, off-channel habitat
	Instream Flow		X		based on Kuttel 2002
Meadow Creek upstream from the mouth [FQ09UK; 18831]	Temperature			X	based on WDFW unpublished data
Alkali Flat Creek near Long Hollow confluence [OI59CE; 11841]	Temperature			X	based on WDFW unpublished data
Alkali Flat Creek upstream of Rock Stream Gulch confluence [OI59CE; 11842]	Temperature			X	based on WDFW unpublished data
Alkali Flat Creek downstream of Mud Flat Creek confluence [OI59CE; 11843]	Temperature			X	based on WDFW unpublished data

[1] *Source: Ecology 2004b.*
[2] *The 2002/2004 Categories 4 and 5 are shown in the table.*

4.5.2 Existing Surface Water Quality Monitoring

Water quality monitoring stations in the Middle Snake Implementation Area have been present since the late 1950's. Historical water quality data in the Implementation Area is available from federal and state agencies such as the EPA, USGS, U. S. Army Corp of Engineers (USACE), and Ecology. Station locations and years of record for Ecology, USGS and USACE and EPA monitoring stations in the Middle Snake Implementation Area are listed in Table 4.5-4.

In recent years, the WSU Department of Biological Systems has been monitoring temperature, total suspended solids, fecal coliform levels, pH, and dissolved oxygen levels at several locations in Alpowa, Deadman, and Meadow Creeks. The summary of monitoring in 2003 is documented in the "Quarterly Report Water Quality Monitoring Through 3rd Quarter February – October 2003" (WSU 2003a). Table 4.5-5 lists the WSU station locations and years of record.

WDFW has also collected temperature data at numerous locations in most of the tributaries to the Snake River including Steptoe Canyon, Wawawai Creek, Almota and Little Almota Creeks, Penawawa Creek, Alkali Flat Creek, Deadman Creek, and Meadow Creek. These locations are listed in Table 4.5-6 and have been documented in the draft "Brief Assessments of Salmonids and Stream Habitat Conditions in Snake River Tributaries of Asotin, Whitman and Garfield Counties in Washington, March 2001 – June 2003 – Final Report" (Mendel et al. 2004).

Stations where water quality data was monitored are illustrated in Exhibit 4.5-3. Ecology, USGS, USACE, Washington State University (WSU), and WDFW have collected the most recent water quality data.

Table 4.5-3
Historical Water Quality Monitoring Stations: Middle Snake Implementation Area[1]

Agency	Station Number	Description	Years of Record for Water Quality Data
Ecology	35A100	Snake River below Lower Granite Dam	1978
	35A150	Snake River at Interstate Bridge	1962-1966; 1968-1969; 1991-current
	35A200	Snake River at Anatone	1972-1979
USGS	**13334300** (USACE **ANQW**)	**Snake River near Anatone**	1989 (1 day); 2000-current
	13343500	Snake River near Clarkston, WA	1966-1972
	13343600	Snake River below Lower Granite Dam	1975-1978
	13343530	Alpowa Creek at mouth near Clarkston	1989
	13343560	Steptoe Canyon Creek at mouth near Clarkston	1989 (4 days)
	13343680	Deadman Creek near Central Ferry	1964-1967
	13343800	Meadow Creek near Central Ferry	1964-1967

[1] Sources: Ecology 2004a; EPA STORET 2004, USGS 2004.
Bold indicates stations with the most information.

Table 4.5-3 continued Historical Water Quality Monitoring Stations: Middle Snake Implementation Area[1]			
Agency	**Station Number**	**Description**	**Years of Record for Water Quality Data**
EPA (10EPAINT)	153645	Snake River at Asotin	1975 (3 days)
	153646	Snake River at HWY 12 Bridge	1975; 1977 (5 days)
	153648	Snake River 0.25mi below Clearwater	1975 (2 days)
	153649	Snake River 0.5mi below Clearwater	1975 (2 days)
	153650	Snake River 1.0 mi below Clearwater	1975 (3 days)
	153651	Snake River 3.0 mi below Clearwater	1975 (3 days)
	153652	Snake River 5.0 mi below Clearwater	1975; 1977 (4 days)
	153653	Snake River 10.0 mi below Clearwater	1975 (3 days)
	153654	Snake River 15.0 mi below Clearwater	1975; 1977 (5 days)
	153655	Snake River 20.0 mi below Clearwater	1975 (3 days)
	153656	Snake River 25.0 mi below Clearwater	1975; 1977 (5 days)
	153657	Snake River above Lower Granite Dam	1975; 1977 (5 days)
	153658	Snake River below Lower Granite Dam	1975; 1977 (3 days)
	153759	Snake River 30 mi. above Little Goose Dam	1975 (1 day)
	153760	Snake River 20 mi. above Little Goose Dam	1975 (1 day)
	153677	Little Goose Reservoir 13 mi. above Dam	1975 (1 day)
	08Z006	Alpowa Creek	1984 (1 day)
	153664	Alpowa Creek near mouth	1975 (2 days)
	08Z005	Almota Creek	1984 (1 day)
EPA (1119C050)	153846	Snake River at Anatone	1977 (2 days)
	543015	Snake River below Asotin	1969-1971
	543018	Snake River 7 mi below Clarkston	1969-1972
EPA (1119COE)	COE001	Snake River below Clarkston	1969-1971
	COE002	Snake River above Clarkston	1969-1971
	COE014	Little Goose Reservoir @ RM 94.2	1970-1971 (6 days)
	COE015	Little Goose Reservoir @ Central Ferry	1970-1971 (11 days)
EPA (10EPATOX)	08A002	Snake River below Lower Granite Dam @ Central Ferry	1978 (1 day)
EPA (1110NET)	**540049**	**WPSS Wawawai**	1958-1968, 1971
EPA (11EPALES)	531301	Lower Granite Reservoir	1975 (2 days)
	531302	Lower Granite Reservoir	1975 (2 days)
EPA (Idaho, 21IDSURV)	2020015	Snake River 10 mi below Clearwater River	1975 (2 days)
	2020016	Snake River 15 mi below Clearwater River	1975 (2 days)
	2020017	Snake River 20 mi below Clearwater River	1975 (2 days)
	2020072	Snake River above Lower Granite Dam	1976 (2 days)
USACE	**LGS**	**Little Goose Forebay**	1988-current
	LGSW	**Little Goose Tailwater**	1995-current
	LWG	**Lower Granite Forebay**	1988-current
	LGNW	**Lower Granite Tailwater**	1995-current

[1] Sources: Ecology 2004a; EPA STORET 2004, USGS 2004, USACE 2004.
***Bold** indicates stations with the most information.*

Table 4.5-4
WSU Water Quality Monitoring Stations: Middle Snake Implementation Area[1]

Station Number	Description	Years of Record for Water Quality Data
Alpowa 1	Alpowa Creek at Wilson's Banner Ranch	1998-2000; 2003-current
Alpowa 2	Alpowa Creek at Ledgerwood residence	1998-2000
Alpowa 2a	Alpowa Creek at bridge NW of Knotgrass Grade Intersection (replaces Alpowa 2)	1998-2000; 2003-current
Alpowa 3	Alpowa Creek at Lankammer residence	1998-2000; 2003-current
Alpowa 4	Alpowa Creek near Page Creek	1998-2000; 2003-current
Lower Deadman	Lower Deadman Creek at Willow Gulch bridge	1998-2000; 2003-current
North Deadman	North Deadman Creek bridge at Gould City	1998-2000; 2003-current
South Deadman	South Deadman Creek bridge at Gould City	1998-2000
Upper Deadman	Deadman Creek at Gould City, downstream of North Fork and South Fork confluence	2003-current
Lower Meadow	Meadow Creek at concrete bridge adjacent to SR 127 and Meadow Creek Rd. intersection	2003-current
Upper Meadow	Meadow Creek at Ben Day Gulch	2003-current

[1] *Sources: WSU 2003a and 2003b.*

Table 4.5-5
WDFW Water Quality Monitoring Stations: Middle Snake Implementation Area[1]

Site #	Location Description	Years of Record for Water Quality Data
ST 5	Steptoe Canyon below second culvert	2002
ST 7	Steptoe Canyon at first culvert	2001
WA 6	Wawawai Creek at first culvert on Wawawai Grade Rd.	2001-2002
A 1	Almota Creek just below upper culvert on LaFollette Rd.	2002
A 13	Almota Creek above culvert on Almota Rd.	2001-2002
LA 1	Little Almota Creek at culvert at Benedict Rd	2002
LA 3	Little Almota Creek above first culvert	2001-2002
P 5	Penawawa Creek below forks	2002
P 10	Penawawa Creek above mouth	2002
AF 1	Alkali Flat below bridge in Hay, WA.	2002
AF 7	Alkali Flat at Rock Spring Gulch confluence	2002
AF 17	Alkali Flat first bridge, below Long Hollow Road Bridge	2002
D 1	Deadman Creek below first bridge on Lower Deadman Rd.	2001-2002
D 5	Deadman Creek stream ford at farm, RM 1.4	2001
D 7	Deadman Creek at Willow Gulch Rd. Bridge	2002
MD 1	Meadow Creek at Gould City Rd.	2001-2002
MD 7	Meadow Creek stream ford, RM 5.6	2001
MD 10	Meadow Creek above farmhouse bridge, RM 0.4	2001-2002

[1] Source: Mendel et al. 2004.

Ecology 35A150, located at Interstate Bridge, is a long-term station that measures dissolved oxygen, pH, temperature, total suspended solids, turbidity, fecal coliform bacteria, soluble reactive phosphorus, total phosphorus, ammonia, nitrate plus nitrite, and total nitrogen. Numeric water quality standards associated with each of these parameters are presented in detail in WAC 173-201A.

USACE has been monitoring temperature and total dissolved gas at various locations along the Snake and Columbia Rivers as part of the Dissolved Gas Abatement Study (Exhibit 4.5-4). In WRIA 35, these stations include USACE LGS, LGSW, LWG, and LGNW, and USGS 13334300. Historical and real-time water temperature, total dissolved gas and flow data for these stations are available from their Northwestern Division Water Quality Program website (USACE 2004).

4.5.3 Areas of Impacted Water Quality

The following is a discussion of the specific water quality parameters that impact the mainstem Snake River and each of the major tributaries in this Implementation Area. Because the Snake River mainstem from the Clearwater River confluence accounts for less than 5 percent of its total drainage area and because the total stream flow in the Snake River is large, the focus of the water quality discussion is on the tributaries to the mainstem.

It should be noted that a majority of the identified water quality impairments are associated with elevated temperature. This is because temperature is the most commonly monitored parameter. Thus, the likelihood of detecting levels exceeding water quality standards is greater. Other parameters commonly monitored include suspended solids, turbidity, and pH, but they are not monitored to the extent that temperature is monitored. Similar exceedances of standards may be observed for the other parameters if and when they are monitored, as is the case in other streams where they are measured as described below. In reviewing the information provided below, it should be kept in mind that restoration actions should focus not solely on temperature issues, but in actions that can address temperature as well as the other parameters.

Snake River Mainstem

The primary concerns in the Snake River are elevated stream temperature along the entire length, excessive pH, dissolved oxygen, total dissolved gas levels and toxics levels, as can be seen from the water quality monitoring data and the 303(d) lists.

> **Temperature:** Based on the EPA (2001) *Preliminary Draft Problem Assessment for the Columbia/Snake River Temperature TMDL*, the water temperatures from July through October 2000 exceeded the Washington State water quality criteria approximately 40 out of 120 days sampled at the Lower Granite Dam Forebay; approximately 35 out of 80 days sampled at the Little Goose Dam Forebay; and approximately 20 out of 80 days sampled at the Little Goose Dam Tailwater (see Exhibit 4.5-5). According to the EPA (2002) *Preliminary Draft Columbia/Snake Mainstem Temperature TMDL*, the dams in the rivers appear to be a major cause of increasing the water temperature. The

occurrences of warm temperatures were much less frequent without the dams in place. The report also noted that cooling weather patterns had more of an effect of decreasing the average water temperature of a free flowing river than of the impounded river.

Fecal Coliform Bacteria: Ecology 35A150 has monitored fecal coliform concentrations since 1990. Exhibit 4.5-6 shows the mean monthly fecal coliform concentrations recorded by Ecology for the period of record and the fecal coliform concentrations recorded from 1999 to 2003. The mean fecal coliform concentrations recorded between 1999 and 2003 range from 1 colonies/100mL to 79 colonies/100mL, which is well below the designated use criteria for primary contact recreation of 100 colonies/100mL for fecal coliform concentrations.

pH: pH concentrations has been recorded by Ecology 35A150 at Interstate Bridge near Clarkston, WA. Exhibit 4.5-7 shows the mean pH concentrations recorded by Ecology for the period of record and the pH concentrations recorded from 1999 to 2003. The records indicate that the pH levels of 8 out of 56 samples taken between from 1999 to 2003 exceeded the acceptable upper limit of 8.5.

Dissolved Oxygen: Dissolved oxygen concentrations were also recorded by Ecology 35A150 at Interstate Bridge. Exhibit 4.5-8 shows the mean dissolved oxygen concentrations recorded by Ecology for the period of record and the dissolved oxygen concentrations recorded from 1999 to 2003. The records indicate that the dissolved oxygen concentrations were above the minimum 8.0 mg/L standard for salmon and trout spawning, non-core rearing, and migration for all of 57 samples taken between 1999 and 2003.

Total Dissolved Gas (TDG): USACE stations ANQW (same as USGS 13334300), LGS, LGSW, LWG, and LGNW monitored total dissolved gas concentrations along the Snake River. The mean total dissolved gas concentrations recorded from 2000 to 2003 in the Snake River at Anatone, the Little Goose Dam, and the Lower Granite Dam are shown in Exhibit 4.5-9. Based on monitoring data available at USACE Northwestern Division Water Quality Program, the total dissolved gas concentrations from July through September between 2000 and 2003 exceeded the Washington State water quality criteria 8 out of 642 days sampled at Anatone; 100 out of 697 days sampled at the Lower Granite Dam Forebay; 223 out of 700 days sampled at the Lower Granite Dam Tailwater; 26 out of 732 days sampled at Little Goose Dam Forebay; and 187 out of 726 days sampled at the Little Goose Dam Tailwater (see Exhibit 4.5-10).

The *Total Maximum Daily Load for the Middle Snake River Total Dissolved Gas* (Pickett and Harold, 2003) determined that the high TDG were mostly related to the dams. The water plunging from the spill events at the dams results in entrained air that is carried to a depth where the hydrostatic pressure forces gas into solution at high levels. The report sets the TDG loading capacity for the Middle Snake River and describes an implementation plan for short-term compliance and discusses long-term compliance.

Turbidity: Ecology 35A150 has monitored turbidity since 1990. Exhibit 4.5-11 shows that the mean monthly turbidity from 1990 to 2003 ranged from about 1.9 NTU to 12 NTU.

Suspended Solids: Total suspended solids (TSS) concentration was monitored by Ecology 35A150 since 1990. Exhibit 4.5-12 shows that the mean monthly total suspended solids concentrations recorded were well below the USFS recommended standard of 80mg/L.

Nutrients: Ecology 35A150 collected some data on ammonia and total phosphorous since 1990. Ammonia concentrations recorded between 1990 and 2003 ranged from 0.01 mg/L to 0.079 mg/L (as Nitrogen), with a mean concentration of 0.019 mg/L. The total phosphorous concentration recorded between 1990 and 2002 ranged from 0.01 mg/L to 0.28 mg/L, with a mean of 0.06 mg/L. All samples collected by Ecology were within the USFWS recommended range of 0.01 mg/L to 0.3 mg/L for trout.

Alpowa Creek

Alpowa Creek is listed on the 303(d) list for excessive fecal coliform concentrations near the mouth. In addition, high water temperature and low dissolved oxygen concentrations are also of concern as potential limiting factors to salmonid rearing in Alpowa Creek. WSU has recorded temperature, fecal coliform levels, pH, dissolved oxygen levels and total suspended solids at various locations along Alpowa Creek between 1998 and 2003. WSU recorded one to three readings per month at Alpowa 2 and 4 in 2002 and at Alpowa 1, 2a, and 3 in 2003. USGS 1334350 recorded water temperature and total suspended solids concentrations several times per month between February and June 1989 near the mouth of Alpowa Creek. There was no water quality data available on turbidity for this creek.

Temperature: Water temperature was recorded by WSU Alpowa 1, 2, 2a, 3 and 4, and USGS 13343530. The temperatures recorded by WSU between May and September ranged from 12ºC to 23ºC (53.6ºF to 73.4ºF) in 2002 and 2003. At USGS 1334350, the range of temperatures recorded in May and June of 1989 is between 13ºC and 20ºC (55.4ºF and 68ºF). Exhibit 4.5-13 shows the mean monthly water temperatures recorded by WSU in 2002 and 2003. Although Alpowa Creek is not listed on the 303(d) list, the temperatures recorded at the WSU and USGS locations were greater than the maximum designated use temperature standard of 17.5°C (63.5°F) for salmon and trout, non-core rearing and migration in the summer months.

Fecal Coliform Bacteria: Fecal coliform concentrations recorded by WSU Alpowa 1, 2, 2a, 3 and 4 indicate that out of a total of the 88 samples taken in 2002 and 2003, 59 of them exceeded state criteria, thus listing several reaches of Alpowa Creek on the 2002 303(d) list (see Table 4.5-3). Exhibit 4.5-14 shows the mean monthly fecal coliform concentrations recorded by WSU in 2002 and 2003. The mean fecal coliform concentration for 2002 and 2003 exceeds the state criteria from May through July at all WSU monitoring locations, and at four of the five locations in August and September.

pH: pH concentrations were recorded by WSU Alpowa 1, 2a, and 3 in 2003. Exhibit 4.5-15 shows that the mean monthly pH concentrations recorded by WSU in 2003 ranged from pH 7.3 to 8.4. The records indicate that the pH levels of all 63 samples taken in 2003 were within the pH standard of between 6.5 and 8.5.

Dissolved Oxygen: Dissolved oxygen concentrations were recorded by WSU Alpowa 1, 2a, and 3 in 2003. Exhibit 4.5-16 shows that the mean monthly dissolved oxygen concentrations recorded by WSU in 2003 were below the minimum 8.0 mg/L standard for salmon and trout spawning, non-core rearing, and migration for 19 of the 64 samples taken in 2003.

Suspended Solids: Total suspended solid concentrations were monitored by WSU Alpowa 1, 2, 2a, 3 and 4. Exhibit 4.5-17 shows that the mean monthly total suspended solids concentrations recorded in 2002 and 2003 were well below the USFS recommended standard of 80mg/L.

Nutrients: WSU Alpowa 2 and 4 recorded ammonia and total phosphorous concentrations one sample per month from May through August in 2002. The ammonia concentration recorded ranged from 0.01 to 0.049 mg/L. The total phosphorous concentration ranged from 0.064 mg/L to 0.096 mg/L, which is within the USFWS recommended range of 0.01 mg/L to 0.3 mg/L for trout.

Steptoe Canyon

Steptoe Canyon is listed on the 303(d) list for high water temperatures near the mouth and near Stuart Canyon. WDFW recorded temperature in the lower reach of Steptoe Canyon in 2001 and 2002, and USGS 133435360 recorded temperature and total suspended solids near the mouth on two days in early 1989. No other water quality data is available.

Temperature: WDFW recorded temperatures in Steptoe Canyon at the first culvert and below the second culvert in 2001 and 2002, respectively. The mean, minimum and maximum water temperatures recorded by WDFW in Steptoe Canyon are shown in Exhibits 4.5-18 and 4.5-19 for 2001 and 2002. The 7-day mean of maximum daily temperature was 24.8°C (76.6°F) in 2001 at the first culvert, and 20.3°C (68.5°F) in 2002 below the second culvert, as submitted to Ecology by WDFW (Ecology 2004b). These exceed the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration and resulted in the placement of this reach on the 2002 303(d) list for temperature (see Table 4.5-3).

Suspended Solids: USGS 133435360 recorded total suspended solid concentrations of 3,000 mg/L and 3,140 mg/L on February 22, 1989 and 72 mg/L on March 7, 1989.

Wawawai Canyon

Wawawai Canyon is listed on the 303(d) list for high water temperatures near the mouth. EPA 540049 recorded temperature, pH levels, dissolved oxygen concentration, turbidity, and nutrients for various periods from 1958 to 1971. More recent temperature data was recorded by WDFW near the mouth of Wawawai Canyon in 2001 and 2002. There is no data available for fecal coliform and total suspended solids concentrations.

Temperature: Water temperature was monitored near the mouth of Wawawai Canyon by EPA from 1958 to 1971 and by WDFW in 2001 and 2002. Exhibit 4.5-20 shows the mean temperature monitored by EPA for the period of record and Exhibits 4.5-21 and 4.5-22 show the mean, minimum and maximum water temperatures recorded by WDFW in 2001 and 2002. The records of both EPA and WDFW stations show that mean temperatures in July was frequently greater than the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration. The 7-day mean of maximum daily temperature at the first culvert was 19.9°C (67.8°F) in 2001 and 20.2°C (68.4°F) in 2002, as submitted to Ecology by WDFW (Ecology 2004b). These exceed the state criteria and resulted in the placement of this reach on the 2002 303(d) list for temperature (see Table 4.5-3).

pH: pH concentrations were recorded by EPA 540049 from 1958 to 1971. Exhibit 4.5-23 shows that the mean monthly pH concentrations recorded by EPA for the period of record ranged from pH 7.6 to 8.4. The records indicate that for the period of record, 15 out of 512 samples were outside of the pH standard of between 6.5 and 8.5.

Dissolved Oxygen: Dissolved oxygen concentrations were recorded by EPA 540049 from 1958 to 1968. Exhibit 4.5-24 shows that the mean monthly dissolved oxygen concentrations recorded by EPA for the period of record ranged from 8.5 mg/L to 13 mg/L. The records indicate that for the period of record, 25 out of 471 samples were below the minimum 8.0 mg/L standard for salmon and trout spawning, non-core rearing, and migration.

Turbidity: EPA 540049 monitored turbidity from 1958 to 1968; however the data was recorded in Jackson Candle Units (JTU).

Nutrients: EPA 540049 collected some data on nitrate in 1968 and 1971, 1 sample of total Kjeldahl nitrogen (TKN) in 1971, and some data on total phosphorous from 1964 to 1971. Nitrate concentrations ranged from 0.1 mg/L to 0.95 mg/L, with a mean concentration of 0.46 mg/L. The TKN concentration recorded on June 7, 1971 was 0.6 mg/L. The total phosphorous concentration recorded ranged from 0.01 mg/L to 0.72 mg/L, with a mean of 0.07 mg/L. Only 1 out of 51 samples was outside the USFWS recommended range of 0.01 mg/L to 0.3 mg/L for trout.

Almota Creek

Almota Creek is listed on the 303(d) list for high water temperatures near the mouth and at the headwaters. WDFW monitored temperature near the mouth of Almota Creek in 2001 and 2002 and in the upper reaches in 2002. EPA 08Z005 also recorded some water quality data in Almota Creek on July 27, 1984.

Temperature: WDFW recorded temperatures in Almota Creek just below the culvert on LaFollette Road in 2002 and above the culvert on Almota Road in 2001 and 2002. The mean, minimum and maximum water temperatures recorded by WDFW in Almota Creek are shown in Exhibits 4.5-25 through 4.5-27. The 7-day mean of maximum daily temperature just below the culvert on LaFollette Road was 19.2°C (66.6°F) in 2002, and 23.6°C (74.5°F) in 2001 and 23°C (73.4°F) in 2002 above the culvert on Almota Road, as submitted to Ecology by WDFW (Ecology 2004b). These exceed the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration and resulted in the placement of this reach on the 2002 303(d) list for temperature (see Table 4.5-23).

pH: A pH concentration of 8.3 was recorded by EPA 08Z005 on July 27, 1984.

Dissolved Oxygen: A dissolved oxygen concentration of 8.6 mg/L was recorded by EPA 08Z005 on July 27, 1984.

Turbidity: A turbidity of 7.9 NTU was recorded by EPA 08Z005 on July 27, 1984.

Nutrients: EPA 08Z005 collected a sample of ammonia, total Kjeldahl nitrogen (TKN), and total phosphorous on July 27, 1984. The ammonia concentration recorded was 0.005 mg/L, the TKN concentration recorded was 0.09 mg/L, and the total phosphorous concentration recorded was 0.13 mg/L.

Little Almota Creek

Little Almota Creek is listed on the 303(d) list for high water temperatures near the mouth and at the headwaters. WDFW monitored temperature in the lower reaches of Little Almota Creek in 2001 and 2002 and in the upper reaches in 2001. No other water quality data is available for this creek.

Temperature: WDFW recorded temperatures in Little Almota Creek at the culvert on Benedict Road in 2001 and above the first culvert near the mouth in 2001 and 2002. The mean, minimum and maximum water temperatures recorded by WDFW in Little Almota Creek are shown in Exhibits 4.5-28 through 4.5-30. The 7-day mean of maximum daily temperature at the culvert on Benedict Road was 21.4°C (70.5°F) in 2001, and 26.4°C (79.5°F) in 2001 and 25.7°C (78.3°F) in 2002 above the lowest culvert near the mouth, as submitted to Ecology by WDFW (Ecology 2004b). These exceed the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration and resulted in the placement of this reach on the 2002 303(d) list for temperature (see Table 4.5-3).

Penawawa Creek

Penawawa Creek is listed on the 303(d) list for high water temperatures near the mouth and in the upper reaches. WDFW monitored temperature in the upper and lower reaches of Penawawa Creek in 2002. No other water quality data is available for this creek.

Temperature: WDFW recorded temperatures in Penawawa Creek below forks at Getz-AE-Seaver Road Bridge and near the mouth in 2002. The mean, minimum and maximum water temperatures recorded by WDFW in Penawawa Creek are shown in Exhibits 4.5-31 through 4.5-32. In 2002, the 7-day mean of maximum daily temperature below the forks was 26.3°C (79.3°F) below the forks and 26.1°C (79°F) near the mouth, as submitted to Ecology by WDFW (Ecology 2004b). These exceed the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration and resulted in the placement of this reach on the 2002 303(d) list for temperature (see Table 4.5-3).

Deadman Creek

Deadman Creek is listed on the 303(d) list for excessive fecal coliform concentrations and high water temperatures along various segments of the creek. In addition, low pH and low dissolved oxygen concentrations may be of concern as potential limiting factors to salmonid rearing in Deadman Creek. WDFW recorded temperatures in Deadman Creek in 2001 and 2002. WSU has recorded temperature, fecal coliform levels, pH, dissolved oxygen levels and total suspended solids and data on nutrients at various locations along Deadman Creek between 1998 and 2003. In 2002, WSU recorded one to three readings per month at Lower Deadman, North Deadman and South Deadman, and at Lower Deadman and Upper Deadman in 2003. There was no water quality data available on turbidity for this creek.

Temperature: Water temperature was recorded by WDFW below first bridge on Lower Deadman Road in 2001 and 2002, at RM 1.4 in 2001, and at Willow Gulch Road Bridge in 2002. The mean, minimum and maximum water temperatures recorded in 2001 and 2002 by WDFW in Deadman Creek are shown in Exhibits 4.5-33 through 4.5-36. The 7-day mean of maximum daily temperature at the culvert below first bridge on Lower Deadman Road was 20.7°C (69.3°F) in 2001 and 20.1°C (68.2°F) in 2002, 24.3°C (75.7°F) at the stream ford at RM 1.4 in 2001, and 24.5°C (76.1°F) at Willow Gulch Road Bridge in 2002, as submitted to Ecology by WDFW (Ecology 2004b). These exceed the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration and resulted in the placement of this reach on the 2002 303(d) list for temperature (see Table 4.5-3). Mean WSU recorded temperatures in 2002 and 2003 are shown in Exhibit 4.5-37. Although WSU data recorded temperatures below the state criteria in the South Fork of Deadman Creek, it is listed on the 2002 303(d) list for temperature (see Table 4.5-3) from WSU data recorded in 1999, 2000 and 2001 (Ecology 2004b).

Fecal Coliform Bacteria: Fecal coliform concentrations recorded by WSU Lower Deadman, North Deadman, South Deadman and Upper Deadman indicate that out of a total of the 113 samples taken in 2002 and 2003, 61 of them exceeded state criteria, thus listing several reaches of Deadman Creek on the 2002 303(d) list (see Table 4.5-3). Exhibit 4.5-38 shows the mean monthly fecal coliform concentrations recorded by WSU in 2002 and 2003. The mean fecal coliform concentration for 2002 and 2003 exceeds the state criteria from May through August at all WSU monitoring locations, and at four of the five locations in September.

pH: pH concentrations were recorded by WSU Lower Deadman and Upper Deadman in 2003. Exhibit 4.5-39 shows that the mean monthly pH concentrations recorded by WSU in 2003 ranged from pH 6.2 to 8.4. Out of 19 samples taken at Lower Deadman, 2 were below the pH minimum standard of 6.5, while all 20 samples recorded at Upper Deadman were within the pH standard of between 6.5 and 8.5.

Dissolved Oxygen: Dissolved oxygen concentrations were recorded by WSU Lower Deadman and Upper Deadman in 2003. Exhibit 4.5-40 shows that the mean monthly dissolved oxygen concentrations recorded by WSU in 2003 ranged from 7.6 mg/L to 12.9 mg/L. The dissolved oxygen concentration was below the minimum 8.0 mg/L standard for salmon and trout spawning, non-core rearing, and migration 4 out of 19 samples recorded at Lower Deadman, and 2 out of 20 samples recorded at Upper Deadman.

Suspended Solids Total suspended solid concentrations were monitored by WSU Lower Deadman, North Deadman, South Deadman and Upper Deadman. Exhibit 4.5-41 shows that the mean monthly total suspended solids concentrations recorded in 2002 and 2003 were well below the USFS recommended standard of 80mg/L.

Nutrients: WSU Lower Deadman, North Deadman and South Deadman recorded ammonia and total phosphorous concentrations one or two samples per month from May through August in 2002. The ammonia concentration recorded ranged from 0.01 to 0.068 mg/L. The total phosphorous concentration ranged from 0.07 mg/L to 0.85 mg/L. All samples at South Deadman and Lower Deadman were within the USFWS recommended range of 0.01 mg/L to 0.3 mg/L for trout. One sample taken at North Deadman on July 23, 2002 was outside the USFWS recommended range; however, a second sample was taken at the same location on the same day that recorded a total phosphorous concentration of 0.072 mg/L, which is within the USFWS recommended range.

Meadow Creek

Meadow Creek is listed on the 303(d) list for high water temperatures near the mouth of Meadow Creek and also at approximate RM 0.4. Although not listed for excessive fecal coliform concentrations, WSU recorded high fecal coliform concentrations in 2003 at both the upper and lower reaches of the creek. In addition, low dissolved oxygen concentrations and high total suspended solid concentrations may be of concern as potential limiting factors to salmonid rearing in Meadow Creek. WDFW recorded temperatures in Meadow Creek in 2001 and 2002. WSU has recorded temperature, fecal coliform levels, pH, dissolved oxygen levels and total suspended solids at various locations along Meadow Creek in 2003. One to three readings were taken per month by at Lower Meadow and Upper Meadow. There was no water quality data available on turbidity or nutrients for this creek.

Temperature: Water temperature was recorded by WDFW below Gould City bridge in 2001 and 2002, at stream ford at RM 5.6 in 2001, and above farmhouse bridge at RM 0.4

in 2001 and 2002. The mean, minimum and maximum water temperatures recorded in 2001 and 2002 by WDFW in Meadow Creek are shown in Exhibits 4.5-42 through 4.5-36. The 7-day mean of maximum daily temperature at the culvert below Gould City bridge was less than the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration in both 2001 and 2002. At the stream ford at RM 5.6, the 7-day mean of maximum daily temperature was 21.2°C (70.2°F) in 2001, and above the farmhouse bridge at RM 0.4, the 7-day mean of maximum daily temperature was 21.6°C (70.9°F) in 2001 and 22.3°C (72.1°F) in 2002, as submitted to Ecology by WDFW (Ecology 2004b). These exceed the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration and resulted in the placement of these reaches on the 2002 303(d) list for temperature (see Table 4-6.3). Exhibit 4.5-47 shows that summer temperatures recorded by WSU in 2003 are fairly consistent with the data recorded by WDFW.

Fecal Coliform Bacteria: Fecal coliform concentrations recorded by WSU Lower Meadow and Upper Meadow indicate that out of a total of the 37 samples taken in 2003, 33 of them exceeded state criteria. Exhibit 4.5-48 shows that the mean monthly fecal coliform concentrations recorded by WSU in 2003 ranged from 16 colonies/100mL to 2,640 colonies/100mL, which is above the designated use criteria for primary contact recreation of 100 colonies/100mL for fecal coliform concentrations. 33 out of 37 samples taken in Meadow Creek exceeded the state criteria.

pH: pH concentrations were recorded by WSU Lower Meadow and Upper Meadow in 2003. Exhibit 4.5-49 shows the mean monthly pH concentrations recorded by WSU in 2003. The mean monthly pH levels recorded ranged from pH 7.2 to 8.4. Out of 19 samples recorded at Lower Meadow, 2 were below the pH minimum standard of 6.5, while all 20 samples recorded at Upper Meadow were within the pH standard of between 6.5 and 8.5.

Dissolved Oxygen: Dissolved oxygen concentrations were recorded by WSU Lower Meadow and Upper Meadow in 2003. Exhibit 4.5-50 shows that the mean monthly dissolved oxygen concentrations recorded by WSU in 2003 ranged from 7.8 mg/L to 12.4 mg/L. The dissolved oxygen concentration was below the minimum 8.0 mg/L standard for salmon and trout spawning, non-core rearing, and migration 3 out of 19 samples recorded at Lower Meadow, and 6 out of 20 samples recorded at Upper Meadow.

Suspended Solids Total suspended solid concentrations were monitored by WSU Lower Meadow and Upper Meadow in 2003. Exhibit 4.5-51 shows that the mean monthly total suspended solids concentrations recorded in 2003 ranged from 0 mg/L to 150 mg/L. The USFS recommended standard of 80mg/L was exceeded 1 out of 18 samples recorded at Lower Meadow, and 1 out of 19 samples recorded at Upper Meadow.

Alkali Flat Creek

Alkali Flat Creek is listed on the 303(d) list for high water temperatures at various locations along the creek. WDFW monitored temperature in Alkali Flat Creek in 2002. No other water quality data is available for this creek.

> **Temperature:** WDFW recorded temperatures in 2002 along Alkali Flat Creek below the bridge in Hay, WA, at the mouth of Rock Spring Gulch, and below Long Hollow Road bridge. The mean, minimum and maximum water temperatures recorded by WDFW in Alkali Flat Creek are shown in Exhibits 4.5-52 through 4.5-54. In 2002, the 7-day mean of maximum daily temperature was 23.5°C (74.3°F) below the bridge in Hay, WA, 23.4°C (74.1°F) at the mouth of Rock Spring Gulch, and 31.7°C (89.1°F) below Long Hollow Road bridge, as submitted to Ecology by WDFW (Ecology 2004b). These exceed the designated use temperature standard of 17.5°C (63.5°F) for salmon and trout spawning, non-core rearing and migration and resulted in the placement of this reach on the 2002 303(d) list for temperature (see Table 4.5-3).

Exhibit 4.5-1

1998 303(d) Listed Stream Segments near the Implementation Area

Source: Ecology, 2004. WRIA 35 - Middle Snake webpage

Exhibit 4.5-2
2002 303(d) Listed and Impaired Stream Segments: Middle Snake Implementation Area