WATERSHED CHARACTERIZATION
Water and Fish

HYDROLOGIC UNITS

The words "river," "creek," "slough," "gulch," "stream," and "drainage" are used to refer to waterways. Examples in the assessment area are Powder River, Salmon Creek, Christensen Slough, and Shingle Gulch. The terms stream and drainage are not used as names; they are general terms.

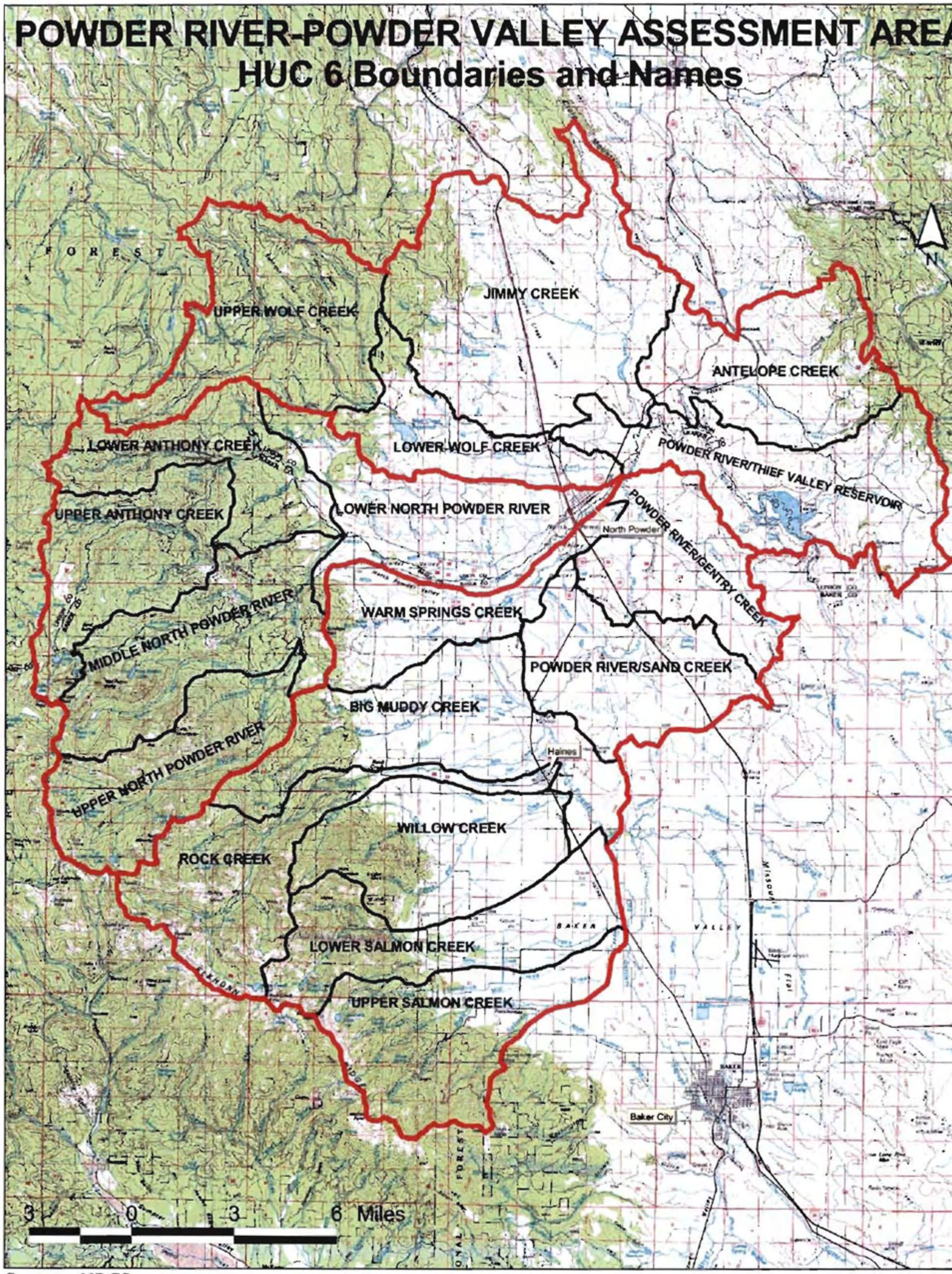
The words "basin," "sub-basin," "watershed," "sub-watershed," and "drainage" are used to refer to the hydrologic boundaries of waterways. The words "basin" and "sub-basin" refer to areas larger than the assessment area. The assessment area is within the OWRD Powder Basin, and within the USGS Lower Middle Snake River Basin (170502) and Powder River Sub-basin (17050203).

The numeric codes shown above are called Hydrologic Unit Codes (HUC). They are part of a national watershed coding system. Each level of the hydrologic code is a pair of numbers. Hence, 17-05-02 is a HUC3 watershed, and 17-05-02-03 is a HUC4 watershed. The term "field" is also used, such as 3rd field HUC for a HUC3 watershed.

During the past few years, a federal interagency taskforce has been mapping USGS HUC5 and HUC6 watersheds. The draft interagency HUC6 watersheds in the assessment area are shown on the HUC6 Boundaries and Names map (Figure 28). The red lines represent the draft interagency HUC5 boundaries.

The names and codes of HUC5 and HUC6 watersheds in the assessment area are listed for easy reference in the Hydrologic Unit Names and Codes Table (Table 16). They are often required on state and federal grant applications and other communications with state and federal agencies.

Figure 25. HUC 6 boundaries and names.



Source: NRCS

Table 17. Hydrologic Unit Names and Codes.

Watershed Name/Subwatershed Name	HUC5 (10 digits) HUC6 (12 digits)
Powder River/Rock Creek	**1705020304**
Upper Salmon Creek	170502030401
Lower Salmon Creek	170502030402
Willow Creek	170502030403
Rock Creek	170502030404
Muddy Creek	170502030405
Powder River/Sand Creek	170502030406
(a) Warm Springs Creek	170502030407
Powder River/Gentry Creek	170502030408
North Powder River	**1705020305**
Upper North Powder River	170502030501
Middle North Powder River	170502030502
Upper Anthony Creek	170502030503
Lower Anthony Creek	170502030504
Lower North Powder River	170502030505
Powder River/Wolf Creek	**1705020306**
Upper Wolf Creek	170502030601
Lower Wolf Creek	170502030602
Jimmy Creek	170502030603
Antelope Creek	170502030604
Powder River/Thief Valley Reservoir	170502030605

Source: USGS

Maps of each subwatershed can be found in Appendix D.

MAJOR SURFACE WATER RESOURCES

The major water resources of the assessment area include streams, lakes, reservoirs, springs, and groundwater aquifers.

Streams, Lakes, Reservoirs and Springs

The Powder River and major tributaries within the assessment area are listed below for reference in the left column of Table 17, followed by large named lakes, large reservoirs, and municipal streams and springs that occur in those watersheds. Tributaries of the Powder River are listed sequentially from Salmon Creek down the river to Cusick Creek. Several small unnamed alpine lakes and dozens of small reservoirs and ponds are not included. See the Reservoirs section for more information. Of the hundreds of springs and seeps in the assessment area, only those used as municipal and quasi-municipal sources are listed. See Baker City Water System for more information. A large reservoir is one that requires normal filing with the OWRD and that will hold 9.2 acre feet of water plus have an embankment (dam) 10' tall or taller

Table 18. Streams, Lakes, Reservoirs and Springs.

Stream Name	Named Lakes	Large Reservoirs	Municipal Springs and Streams
Powder River		Thief Valley Res	
Salmon Creek	Goodrich Lake Pine Creek Lake	Salmon Creek Res Goodrich Lake Res Pine Creek Lake Res	Marble Spring, Goodrich Cr Campers Spring, Little Mill Cr Herman Spring, Mill Cr Henry Spring, Little Marble Cr Findley Spring, Marble Cr Little Salmon Spring, Salmon Cr, Little Salmon Cr
Willow Creek	Willow Creek Lake		
Rock Creek	Rock Creek Lake Bucket Lake Cougar Pond Killamacue Lake	Rock Creek Lake Res Killamacue Lake Res	
Christensen Slough			
Fish Creek			
Spring Creek		(small reservoirs)	
Big Muddy Creek			
Warm Springs Cr			
Gentry Creek			
North Powder R	Lost Lake Meadow Lake Little Summit Lake Summit Lake Red Mountain Lake Dutch Flat Lake Van Patton Lake Black Lake Lilipad Lake Anthony Lake Mud Lake	Van Patton Lake Reservoir Pilcher Creek Reservoir	Tumbleoff Spring
Wolf Creek		Wolf Creek Res	
Jimmy Creek		Jimmy Creek Res Shaw Res	
Antelope Creek			
Spring Creek			
Cusick Creek			

Source: Summary generated by Tim Bliss, Wallowa Whitman National Forest, Interdisciplinary Soils/Hydrologist

Aquifers

Little is known about the aquifers of the watershed. Well logs provide limited information on aquifers in the valleys and foothills because wells are not deep.

Springs and seeps indicate locations where aquifers are near the ground surface. There are hundreds of springs in the assessment area. Only a small number have been mapped. The presence of hot springs in Warm Springs Creek indicates deep artesian-like aquifers in that area, which may be associated with faults.

It is unknown if groundwater flows into or out of the assessment area. For example, the Grande Ronde Valley is lower elevation than Jimmy Creek and Antelope Creek. It is not known if there is water transfer between the Grande Ronde Valley and the Powder Valley along or within the basalt bedrock. Snowbanks along I-84 and Highway 30 indicate that prevailing winds blow from those subwatersheds toward the Grande Ronde Valley. This indicates that some precipitation that falls in those subwatersheds in the form of snow is blown into adjacent subwatersheds of the Grande Ronde Valley (Ladd Creek and Pyles Creek), which diminishes water delivery to aquifers in Jimmy Creek and Antelope Creek. Many factors influence aquifer characteristics: precipitation amount and form, evapo-transpiration, porosity of geologic materials, faults and fractures, stratigraphy, landform, elevation, slope gradient, and surface and ground water withdrawals.

A simple classification of shallow aquifers associated with streams is to note whether stream flow is influent (decreasing) or effluent (increasing). Perennial streams have effluent to weakly influent aquifers. Intermittent and ephemeral streams are dominated by influent aquifers.

The primary groundwater aquifers providing water for irrigation, municipal, domestic and stock use are the recent alluvium (Qal) and terrace and pediment (Qt) geologic map units discussed in the Geology section.

Trans-basin and Trans-drainage Transfers of Water

There are no known trans-basin diversions of water into or out of the assessment area. However, within the assessment area, dozens of ditches and pipelines convey water across drainage divides of watersheds and subwatersheds. Baker City and irrigated agriculture depend on this practice. Water is piped from the Baker City watershed (parts of which are in the assessment area) to Baker City, which lies outside of the assessment area. Water from Rock Creek is conveyed to Willow Creek, Christensen Slough, Spring Creek and Muddy Creek. Water from the North

Powder River is conveyed to Muddy Creek, Warm Springs Creek and Wolf Creek. Water from Wolf Creek is conveyed to the North Powder River and Clover Creek.

HYDROLOGY

The current hydrology of the Powder River/Powder Valley assessment area is the result of historic and current land and water uses inside and upstream of the assessment area interacting over time and space with stream processes and climate to alter watershed vegetation, groundwater flow patterns, stream channel widths and depths, and stream flow magnitudes and patterns. The net result is a change in the distribution and availability of surface and subsurface water for local human communities and our wild communities of fish, migratory birds and wildlife. A quick review of Appendix H shows that the streams in the Powder River/Powder Valley area have changed and reflect altered conditions, not pre-trapping, pre-settlement conditions. These historic channel and vegetation changes, and ongoing land uses continue to influence the hydrology and streams in the assessment area.

Synopsis of the Land Use History and Resulting Channel Changes

Major watershed changes in the Powder River/Powder Valley began with the arrival of the North West Company 1819-1820 or 1820-1821 beaver trapping expeditions into the Snake River country. Documentation of the trappers' route is slim but it is known that company trappers trapped the Owhyee River to the south during that time (Williams et al. 1971). By the late 1820s, the area was being trapped by both British and American trappers. Peter Skene Ogden, working for Britain's Hudson Bay Company, led three expeditions into the Snake River country and trapped in the assessment area each time. In addition to Ogden's group, Americans also trapped the area in the 1820s. By 1828 beaver were scarce as a result of the constant trapping (Williams et al. 1971).

With the removal of beavers, beaver dams failed and were not repaired setting in motion the first watershed-scale change in this area and throughout North America (Dobyns 1981; Naiman et al. 1986; Fouty 2003a). As the dams failed, the ponds drained and water began to erode the fine sediments stored behind the dams forming channels that over time increased in number and connectivity. Consequently, water was routed more rapidly from the upper to lower watershed and water storage throughout the watershed decreased. Channelization also steepened the slope between the stream's water surface and the water table. The steeper slope enhanced the flow of groundwater towards the channel causing some marshy areas to begin draining. By 1844 when the first pioneers crossed into the Powder River Valley (about 15 years after the trappers) and by 1862 when gold was discovered (about 32 years after the trappers), the watershed had already changed and was likely still adjusting to the loss of beaver and their stabilizing influence on the watershed's hydrology.

Current research suggests that channels in the assessment area likely developed rapidly once the dams began failing because the sediment behind the dams was fine and easily eroded (Naiman et al. 1986; Fouty 2003a). Numerous examples exist inside and outside of the Powder River valley of how quickly channels can form, widen and deepen when conditions are right (Appendix E). Unfortunately, there are no recorded images or written records of the channel changes until about 1844 when immigrants began passing through the valley (Evans 1991). Their diaries provide the first limited observations of the area. The discovery of gold in 1861 in Griffin Gulch, and subsequent settlement of the area, resulted in many more recorded observations of the area and began the second large-scale change in the watershed's hydrology. Ditches were dug and water routed to the mines and later to agricultural fields. Large numbers of sheep and cattle began to graze the area (Oliphant 1968; Hudson 1983; Evans 1991). By 1900, 70 years had passed since the trappers mined the area for beavers, and 30 to 40 years had passed since huge numbers of cattle and sheep had first arrived in the valley and began to graze the valley and uplands. With settlement, upland, valley, and riparian vegetation changed as did the pattern and distribution of stream flows.

The historic channel changes decreased the frequency of valley floor flooding and therefore decreased groundwater recharge. Channels are now wider, deeper and straighter and can carry water faster and in more volume before they begin to flood the valley floor. There are now upstream storage projects and diversion of water into ditches for irrigation beginning about April 1st of each year, and dikes were built to constrain the channel and prevent flooding of the valley. These changes affect the hydrology of the watershed.

Storage and diversion projects in the area include, but are not limited to, Phillips Reservoir on the Powder River above the assessment area and Thief Valley Reservoir at the bottom of the assessment area, Wolf Creek Reservoir, Pilcher Creek Reservoir, the Carnes Ditch which diverts water from Anthony Creek to these two reservoirs, Shaw and Jimmy Creek Reservoirs in the Jimmy Creek drainage, diversions in the Baker City Watershed, and dozens of irrigation diversions. Storage projects can also cause flooding of stream channels upstream of the reservoir dam as water backs up behind the dam and fills upstream valleys. Tail water (water flowing through the irrigation system and not used) from irrigation ditches may increase peak flows of small receiving streams such as Big Muddy Creek and Willow Creek. During intense rainfall from thunderstorms, ditches also intercept peak flows at stream diversions and as overland runoff.

Table 19 shows the abundance and complexity of water withdrawals in this area. Figure 30 shows some of the ditches and ways that surface water is routed through the basin. Figure 30 is a first draft only and will continue to undergo updates and improvements as more information becomes available. Figure 30 shows the following:

1. Known locations of irrigation wells. The total number of irrigation wells is estimated to be about 98 (Baker County Watermaster's office),
2. Location of the Baker City municipal watershed and its pipelines (USFS GIS data base)
3. Known current and historic ditches (USFS GIS data base as of February 2004 and Baker County Watermaster data base as of February 2004)
4. Location of USGS stream gauges
5. Location of USFS stream temperature gauge sites (See the DEQ 303d list section for more information on these sites.)

The map represents only a small part of what is out there. It does not include:

1. The location of domestic wells outside the city limits of Baker City, North Powder and Haines.
2. The location of the numerous diversions that take water out of the various streams that supply irrigation water.
3. The location of city wells.

Table 19. Number of Points of Diversion for Selected Streams.

Creek	Points of Diversion
Anthony Creek	7
Marble Creek	10
Mill Creek	15
North Powder River	23
Pine Creek	20
Rock Creek	44 to 47
Salmon Creek	10 to 15

Source: Baker County Watermaster

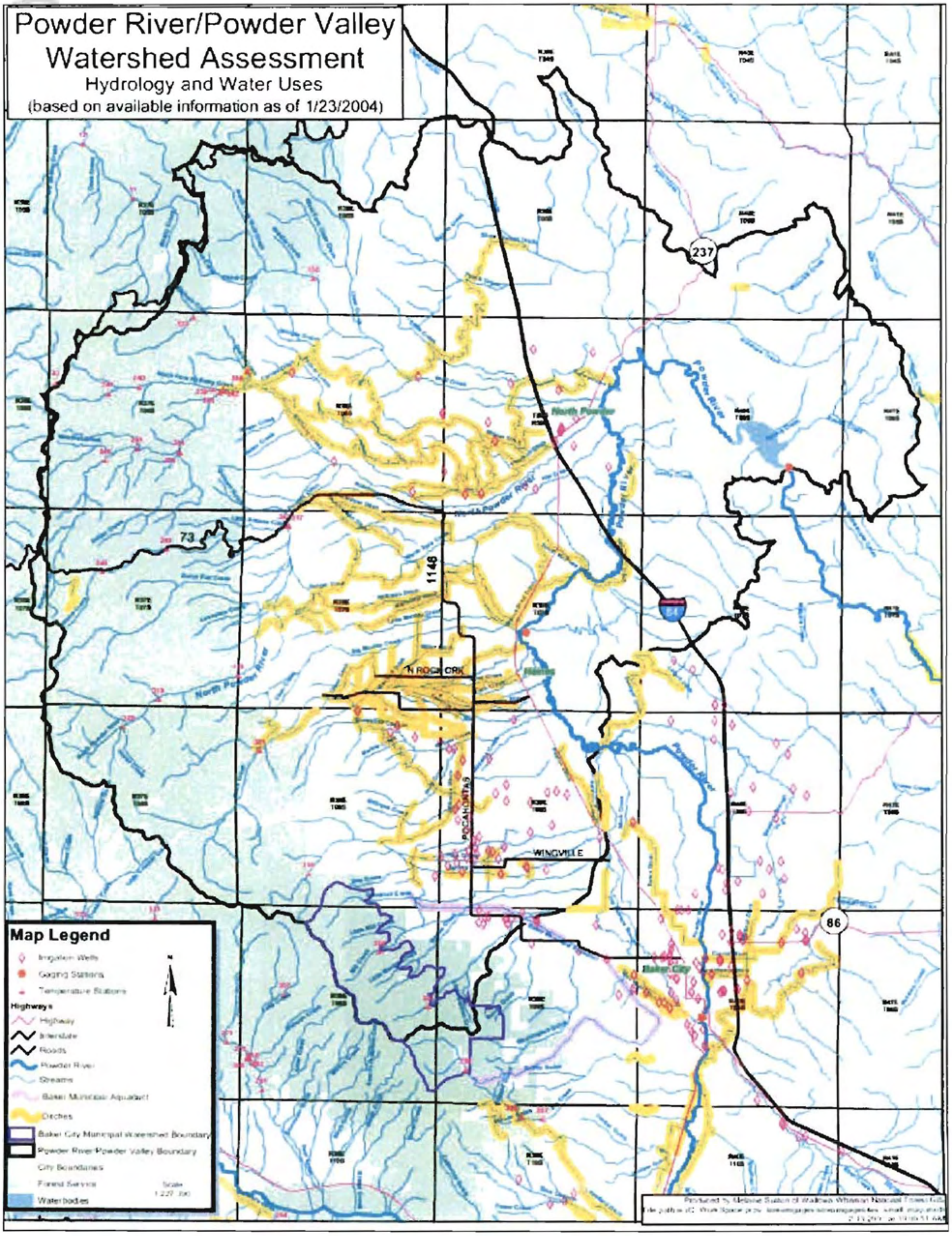
While the towns of Baker, North Powder and Haines keep records of how much water they pump out of the ground, there is no similar information available for domestic wells. Owners of domestic wells are not required to file water rights information. The domestic wells along the mountain front may be of concern in the future because mountain fronts are a key groundwater recharge area as are the areas adjacent to streams (Dunne and Leopold 1978, p. 216).

Streamflow Reduction and Stream Dewatering

The most common concern voiced by parties interested in stream flows is that there isn't enough of it for all uses and needs. Spring snowmelt runoff provides water for instream habitat and riparian vegetation, for groundwater recharge, and for fish. Although flows are diminished by irrigation diversions beginning about April 1st, most tributary streams of the Powder River have sufficient flow to reach the Powder River. Later in the season, however, all of the streams emanating from the Elkhorn Mountains are nearly dewatered at their junction with the Powder River. The dewatering occurs for a number of reasons, many which are acting together. The most obvious causes are upstream diversions, decreased late-season flows, and percolation into the streambed (See comments of Tom Rudolph, deputy watermaster, in Appendix G, page 514). Groundwater pumping by city, irrigation and domestic wells contribute to dewatering of streams by reversing the flow of cold groundwater away from the streams and towards the wells (Dunne and Leopold 1978; Driscoll 1986). Local areas may have site-specific alluvial conditions that are highly permeable and result in higher rates of infiltration into the channel bed. Finally, channel capacity is greater now than it was historically as a result of current and historic land uses that increased channel dimensions. Increased channel size and straighter channels has resulted in water passing through the system more quickly because it takes larger and larger flows before the stream over tops its streambanks and floods the valley floor (Campbell et al. 1972; Shankman and Pugh 1992). The decrease in the frequency of valley floor flooding has lead to a decrease in the frequency of groundwater recharge and contributed to a reduction in late-season groundwater return flow during the summer months. Because many of these uses and changes have been going on for years, recovery of stream flow will occur on time periods greater than a year. Examples of streams that are currently dewatered include:

- Salmon Creek. The Public Works Director for Baker City states "Baker City does not normally withdraw water from Salmon Creek in the winter. Even with the City not taking water, the stream soaks into the ground entirely below Salmon Creek Road (Baker County Bull Trout Response, 2003)."

Figure 26. Draft map of the location of known irrigation wells, ditches, stream temperature gages and stream gaging stations (WWNF).



- Pine Creek. Once its flow is less than 600 inches (about 15 cfs) at the gauge station located in the NW¼NW¼ Section 26 Township 8 South Range 38 East, Willamette Meridian, the stream does not have enough water to reach the lower users even when the upper users' ditches are shut off. Pine Creek is a tributary to Salmon Creek. Its confluence with Salmon Creek is in the Powder River valley, northwest of Baker City just west of the railroad tracks.

- Spring Creek. Spring Creek begins where Pine Creek exits the mountains. Spring Creek's water is supplied by Pine Creek. The construction of the Bowles Ditch captured all of the Spring Creek water and the creek below the Bowles Ditch dried up. The creek channel is now dry late in the season as far as Brown Road. According to T. M. Kerns (May 10, 2004 written communication), the Bowles ditch does not operate past mid-June. Further investigation is needed to determine what factors are contributing to the creek going dry later in the summer.

- Wolf Creek. Early residents of the area claim that the stream sometimes dried up as early as mid-May (F. and C. Colton, personal communication, 2002).

- Powder River. The Baker Valley Irrigation District Manager states, "the lower river did not flow enough water to provide stock water. There were shallow wells drilled to provide the stock water. There are a few remaining wind mill pumps in the lower valley [above Haines] to show where these old wells were" (Jim Colton in Baker County Bull Trout Response, 2003). Warner (Baker County Bull Trout Response) stated "There were times when the Powder River would run completely dry in the Valley floor during the late summer. Diversions, separately, or in combination with the presence of local areas in the channel bed with high permeability, typically dewater the river below Hughes Lane at Baker City upstream from the assessment area. Seepage restores the flow about two miles downstream.

Some people theorize that most or all of these streams were dewatered at their lower reaches late in the season even before European settlement of the valley. It is important to keep in mind when reading the above examples that this entire assessment area and all the streams in it have undergone large-scale and long-term watershed and stream channel changes (Appendix A, Appendix E). For example, Salmon Creek was placer mined. There are historic mine tailings at the base of the mountains (Slum Dam). The mining and the mine tailings have altered the channel shape and its infiltration capacity. In addition, the Salmon Creek Reservoir was constructed in 1983 where Salmon Creek exited the mountains (T. Hanley, personal communication, March 2004) and the owner has a water right to capture 255 acre-feet (State of Oregon certificate of water right # 67810).

Water was observed flowing below Salmon Creek Road for several years from at least 1976 (C. Howard, personal communication, March 2004). The city is probably not the only influence on Salmon Creek flows. The current dewatering of Salmon Creek is a combination of multiple land uses and withdrawals, historic and current. Regular dewatering during the low-flow season for years results in a lowering of the water table in the channel bed and the development of a dewatered subsurface zone. Depending on the length of stream that has repeatedly been dewatered and the thickness of the subsurface dewatered zone, it may take considerable time before the subsurface zone is filled again with water. Only when the subsurface zone is filled will the stream flow become surface again.

Present streamflow and channel conditions are a combination of current and historic land-uses interacting over time and space with stream processes and climate leading to increased channel widths and depths and straightened channels, decreased the frequency of valley floor flooding and decreased the frequency of groundwater recharge. Intensive beaver trapping in the 1820s led to the development of channels as beaver dams failed and were not repaired. That resulted in local changes in groundwater flow. The arrival of cattle and sheep into the Powder River watershed, beginning in the late 1850s, led to increased stream widths, depths and decreased sinuosity as stream banks were trampled, valley floor and upland vegetation consumed by livestock, and vegetation and stream locations altered for agricultural purposes. Stream channel widths and depths also changed in response to the early building of diversions and ditches as well as reservoir failures on some streams (See Appendix H). The reasons for the streams being nearly dewatered by the time they reach the Powder River are many. Discovering the cause(s) will be complicated.

Understanding the hydrology of the assessment area is further complicated by the fact that irrigation at the higher elevations of the valley sometimes increases stream flows in the lower reaches of the streams. It percolates into the ground and reemerges lower down as seeps and springs. Many examples of this can be observed throughout the valley. Three are cited below:

- Spring Creek is a small stream within the watershed in the Pocahontas area. When the Bowles Ditch was dug, Spring Creek flowed into the ditch, and the creek's natural channel below the Bowles Ditch dried up. The creek channel is now dry late in the season as far as Brown Road. According to T. M. Kerns (May 10, 2004 written communication), the Bowles ditch does not operate past mid-June. Within a half mile below Brown Road the creek channel develops a significant flow---enough to do late-season irrigating.

- A second example is Powder River itself. Diversions typically dewater the river below Hughes Lane at Baker City. Seepage restores the flow about two miles downstream.

- A third example of upland irrigation helping lowland irrigation and stream flow can be seen in the croplands just south of Rock Creek. That area sits on a rocky, subterranean ridge. Upper landowners must irrigate heavily in order to soak the rocky ground. Landowners lower down might need to irrigate only once and yet get a third crop of hay because of sub-irrigation from the upper areas. However, other portions of the stream go dry as water is removed for irrigation.

As shown above and documented in Taylor et al. (2003), irrigation of fields can contribute groundwater return flows to streams and help cool streams. This works the same as natural groundwater return flows. Depending on the pre-irrigation soil moisture conditions, there can be a time lag by as much as a month between the start of irrigation and when return flows begin reaching the creek (Taylor et al. 2003). Irrigation diversions reduce or dry up down stream flows. The contribution of irrigation to subsurface return flows decreases as irrigation efficiencies increase and with increasing distance to a stream. While both irrigation and snowmelt floodwaters contribute to groundwater recharge and cool subsurface return flows, the two mechanisms have some important differences leading to different stream flow volumes and stream continuity. These differences are summarized in Table 21 and discussed in greater depth in the subsection titled <u>Factors influencing Stream Temperatures.</u>

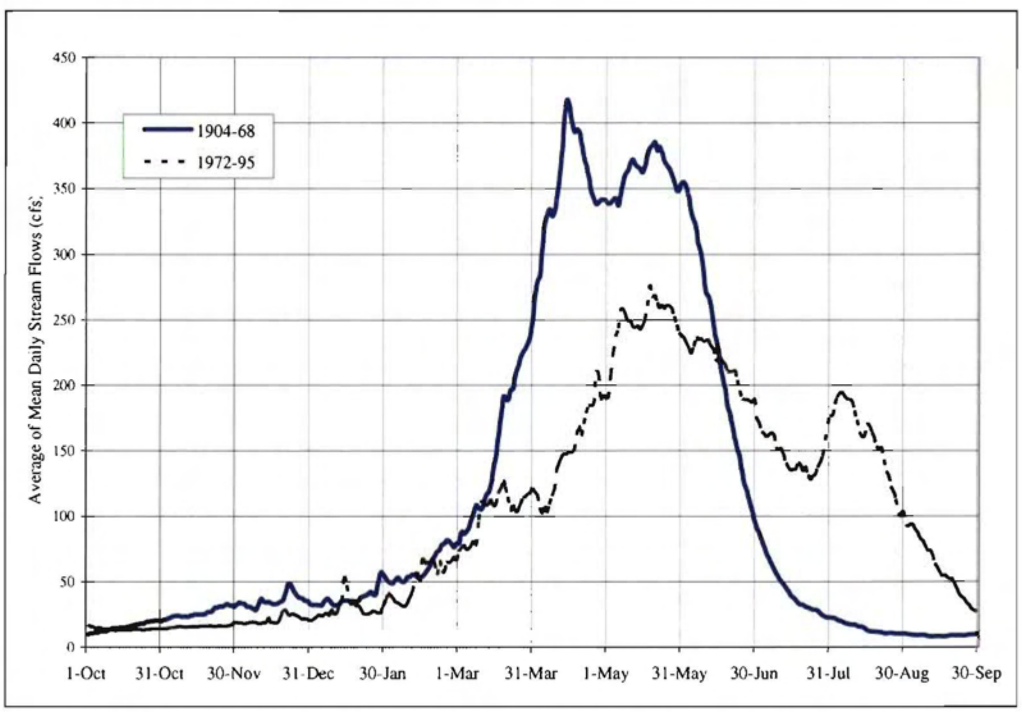
Table 20. Comparison of Irrigation versus Spring Snowmelt Flooding as it pertains to the effect on summer discharge volumes.

	Irrigation Season	Pre-settlement Spring high flow Season
Timing of event	April through October	March through mid-June
Surface area influenced	Fields below irrigation ditches and below irrigated fields. Area may be adjacent to or distance from streams and areas down slope of the irrigation fields.	Valley bottoms adjacent to streams. (NOTE: Prior to major channel changes the valley floor was the active floodplain)
Frequency of water table recharge	Low and localized. Groundwater recharge occurs only where flood irrigation occurs or during very large flood events. Subsurface return flows are low and spotty. The efficiency of sprinkler irrigation means that its contribution to groundwater recharge is limited.	High. Frequent flooding of valley bottoms results in regular recharging of groundwater table and maintenance of high water tables and steady subsurface return flows in the summer.
Water demands in watershed versus water availability	Water demands are high at the same time that water availability is decreasing.	Water demands are low at the same time that water availability is very high.
Contribution of subsurface return flows into streams	Irrigation subsurface return flows may be delayed by as much as a month depending on soil moisture conditions. Water may not enter streams during the summer months if irrigated areas are distant from streams and flows are intercepted by irrigation wells. Location of return flow is spotty.	Subsurface return flows begin as soon as water levels in the streams begin to drop (water flows from high to low elevations) and is common.
Relationship between water on fields and stream flow	Water removed from the streams and used for irrigation on fields during the summer and fall when flows in the streams are the lowest.	Water overtops the stream banks and floods the valley bottoms when flows in the streams are the highest.
NET RESULT		
Dewatered Reaches	Numerous reaches become dewatered because 1) water is diverted from the creeks into ditches and 2) water table has lowered and there is minimal groundwater return flow.	None. All reaches flowing at capacity

Source: Summary by Suzanne Fouty, Whitman Unit District Hydrologist, Wallowa-Whitman National Forest

There are two very important caveats that must be kept in mind when reviewing Table 21. First, the characteristics of the spring snowmelt flooding and its impact on stream flow conditions prior to Euro-American trapping and settlement are different than present patterns and volumes because of the presence of reservoirs, diversions and channel modifications. As discussed earlier in the section and presented in Appendix E, the majority of streams in this area have widened, deepened and/or straightened since the 1820s. A wider and/or deeper channel means that the channel can carry more water before the stream overtops its banks. In addition, the presence of Phillips, Wolf, and Pilcher reservoirs, as well as numerous smaller reservoirs in the headwaters of the Elkhorns, has also contributed to the decrease in the frequency of valley floor flooding and the size of yearly high water event. The influence of reservoirs on flood peaks, stream discharge and the pattern of stream flows are visible in Figure 31. Figure 31 shows the average daily stream flows of the Powder River near Baker City before and after the construction of the Mason Dam below Phillips Reservoir. Prior to building Mason Dam, the average spring melt stream flows were much higher than they are after the dam construction (about 400 versus 250 cfs). In addition, stream flows in the Powder River from mid-June through September 30 are greater post-dam construction as a result of the release of reservoir water during the irrigation season. The combination of increases in channel widths and/or depths and dam building has decreased the flood frequency since Euro-American settlement. One of the consequences of decreased flood frequency is a reduction in the frequency of groundwater recharge.

Figure 27. Comparison of the average of daily streamflows for the Powder River near Baker City, Oregon for periods 1904-68 and 1972-95.



Source: USGS stream gage #13275500. Graph generated by Bob Gecy, Wallowa Whitman Forest Plan Revision Team Physical Scientist.

Second, the Table 21 summary does not take into account the impact of groundwater withdrawals via irrigation wells, domestic wells and city wells on the depth to groundwater, its volumes and gradients. Groundwater pumping reverses the direction of groundwater flow and causes water to flow towards the well and away from the stream (Dunne and Leopold 1978; Driscoll 1986). It can also lower the water table surface below the streambed elevation. A number of the irrigation wells are in close proximity to the stream channel and groundwater pumping during the irrigation would reverse the direction of flow away from the stream and towards the well. At present, there is no monitoring of surface water and groundwater interactions. This represents an important information need since both irrigation and domestic use of groundwater is highest during the summer.

Depending on the depth to groundwater and the degree to which groundwater and stream are hydrologically connected, groundwater pumping can effectively reduce or eliminate subsurface return flows into a stream during the summer months, causing it to dry up. As groundwater pumping in the assessment area is highest during the summer months, there is some impact to the streams. The amount of impact is unknown at present and needs to be identified.

Dewatered Reaches of North Powder River and Anthony Creek

Flows of many streams in the watershed are reduced below diversions during the irrigation season and below reservoirs during the non-irrigation season (Table 21). Streamflow reduction in these reaches (or portions of these reaches) ranges from a few percent to 100%. Two examples are discussed below.

The North Powder River is usually dry from August to October starting at the Powers Ditch diversion to North Powder's confluence with Anthony Creek. The exception is when the stored water in Van Patten Lake is released. Van Patten Lake has the only stored water on the North Powder River. It provides water for three farms. One of the three farms diverts its water through the Hillside Ditch. Another diverts its water through the Powers Ditch, which lies below the Hillside Ditch. The third farm owns half of the Van Patten Lake storage. This farm is lower in the valley and must run its water down the North Powder River channel. In the process of getting the water to its diversion point, the dewatered reach of the river is recharged for about one week. Fish have the opportunity to move back into that reach during this time and become stranded when the water is abruptly shut off.

Anthony Creek also had a portion of its stream go dry during the summer. It was typically dry from the Lone Pine Ditch diversion to Anthony Creek's confluence with the North Powder River . . . a two-mile stretch of creek. In this case a solution to the dewatering was found. In cooperation with the Baker County Watermaster, the Powder Valley Water Control District implemented a water exchange. Now this reach of the creek has continual water. The water exchange has been tested for several years. Instead of diverting Anthony Creek Water into the Couganhour Ditch, which lies above the Lone Pine Ditch, water is left in Anthony Creek. The Couganhour Ditch remains dry until just below Pilcher Reservoir dam. Pilcher Reservoir water is put into the Couganhour Ditch. Anthony Creek water is thus exchanged for an equal amount of Pilcher Reservoir water. Anthony Creek now retains its flow and fisheries concerns in this stretch of river are addressed.

Table 21. Known Streams with Seasonal or Yearlong Flow Reductions.

Stream Name	Affected Stream Reach	Seasonal or Yearlong
Powder River	Entire reach through the assessment area	Yearlong
Salmon Creek	Baker City Watershed to mouth	Yearlong
Marble Creek	Baker City Watershed to mouth	Yearlong
Mill Creek	Baker City Watershed to mouth	Yearlong
Little Mill Creek	Baker City Watershed to mouth	Yearlong
Goodrich Creek	Baker City Watershed to mouth	Yearlong
Spring Cr	Bowles Ditch to mouth	Seasonal
Gee Creek	Gee Creek Ditch to mouth	Seasonal
Pine Creek	Williams Ditch to mouth	Seasonal
Willow Creek	Willow Creek Lake to mouth	Seasonal
Rock Creek	Olsen-Nicholson Ditch to mouth	Seasonal
Rock Cr Lake Cr	Rock Creek Lake Reservoir to mouth	Seasonal
Killamacue Creek	Killamacue Lake Reservoir to mouth	Seasonal
Muddy Creek	More local information needed	???
Warm Springs Cr	Fisher Hot Springs to mouth	Seasonal
Gentry Creek	No diversions	
North Powder R	Mansfield Ditch to mouth	Seasonal
Dutch Flat Cr	Van Patten Lake Reservoir to mouth	Seasonal
Anthony Creek	Carnes Ditch to mouth	Seasonal
NF Anthony Cr	Carnes Ditch to mouth	Seasonal
Dutch Creek	Carnes Ditch to mouth	Seasonal
Wolf Creek	Wolf Creek Reservoir to mouth	Seasonal
Jimmy Creek	Jimmy Creek Reservoir to mouth	Seasonal
Clover Creek	Shaw Reservoir to mouth	Seasonal
Antelope Creek	Antelope Ditch to mouth	Seasonal
Cusick Creek	Cusick Ditch to mouth	Seasonal

Source: Tim Bliss, Soil Scientist/Hydrologist, Wallowa-Whitman National Forest based on Water Rights information as provided by Oregon Department of Water Resources.

Streamflow Augmentation

Flows of several streams in the watershed are augmented during the summer, as shown in Table 23. Streamflows in these reaches are believed to be higher than natural late summer flows.

Gaging Stations

Gaging stations have been in place on Rock Creek, Pine Creek, Wolf Creek, and in Powder River above Thief Valley Reservoir for some time. New stations were recently installed on North Powder River and Anthony Creek. The Wolf Creek gage station has been discontinued because the information collected there was not being used. In addition, there are four U.S. Geological Survey stream gaging stations in the study area. Gaging stations record valuable information about stream flows. The deputy watermaster uses the information from the Rock Creek, North Powder River and Anthony Creek stations regularly. Table 24 lists the stream gauges and years of record available for each site.

Table 22. Streams with Late Summer Flow Augmentation.

Stream Name	**Stream Reach With Late Summer Flow Augmentation**
Pine Creek	Pine Creek Lake Reservoir to Williams Ditch
Willow Creek	**Needs additional information**
Rock Creek and Rock Cr Lake Creek Killamacue Creek Sand Creek Fish Creek	Rock Creek Lake Reservoir to Olsen-Nicholson Ditch Killamacue Lake Reservoir to Olsen-Nicholson Ditch Maxwell Ditch to mouth (water diverted off Rock Creek) Maxwell Ditch to mouth (water diverted off Rock Creek)
Muddy Creek	Olsen Ditch inflow to mouth
Dutch Flat Creek and Van Patten Lake Creek	Van Patten Lake Reservoir to North Powder River
Wolf Creek below Wolf Creek Reservoir	More information is needed
Jimmy Creek	Jimmy Creek Reservoir to Bryant Ditch

Source: Tim Bliss, Soil Scientist/Hydrologist, Wallowa-Whitman National Forest

The Oregon Water Resources Department tries to make up for the lack of gaging stations by modeling stream flow using local data. The modeling involves measuring the daily flows on one stream and then using that data to estimate what is happening on neighboring streams. Modeling is a helpful tool but it has some important limitations. Storms in the Elkhorn Mountains are often localized rather than general. This can have the effect of two neighboring streams having greatly different flows. The Elkhorn Mountains are also highly dissected. As a result, some stream drainages have predominantly northern exposures, with slower and later spring runoff, while other drainages have predominantly southern exposures and may emanate from lower elevations.

Table 23. List of stream gages in the area and their period of record.

Creek	Organization responsible for Stream Gage	Period of record	Gage number
Powder River near Baker	USGS	1904 - 1968	13275500
Powder River at Baker City	USGS	1971 – 1995	13277000
Powder River near Haines	USGS	1946 – 1953	13281500
Powder River below Thief Valley dam reservoir near North Powder	USGS	1978 - 1995	13285500
Rock Creek	ODWR	1976 – 1999	13281200
Pine Creek	ODWR	1928 – 1930	13277500
Wolf Creek	ODWR	1973 – 2000	13283600
Anthony Creek	ODWR	1962 - 1978	13282400

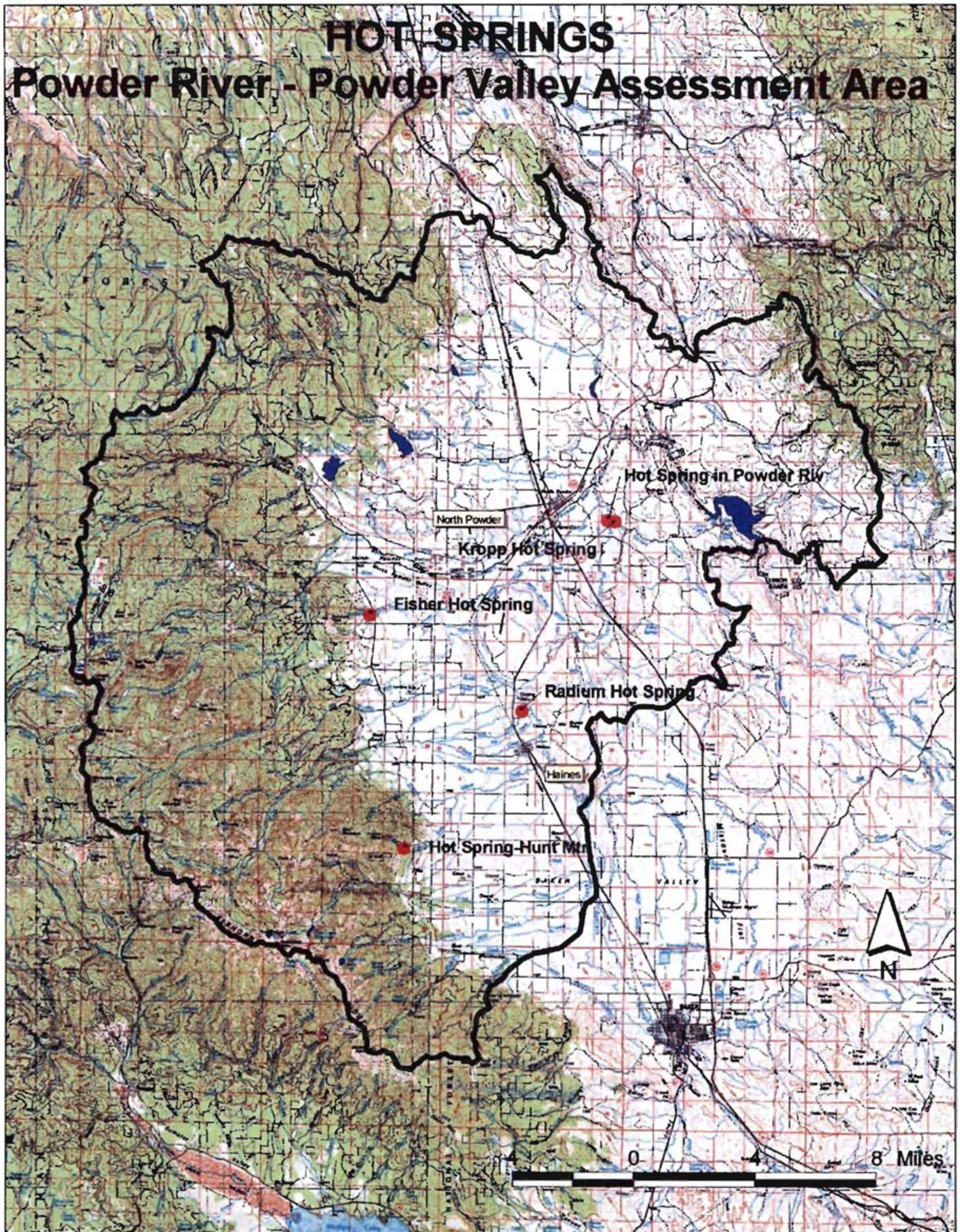
Source: USGS stream gages (www.nwis.water.data.usgs.gov). Oregon Department of Water Resources stream gages (www.wrd.state.or.us)

Hot Springs

There are four commonly known hot springs located in this watershed (Figure 32). A hot spring that was used by pioneer families in the area emanated from the foothills on the eastern side of Hunt Mountain five miles southwest of Haines. It is a small stream. No pool was constructed there. Its location still shows on some maps, but the spring is no longer hot. When Mt. St. Helens erupted on May 25, 1980 the spring lost its heat (M. Olsen, pers. com., 2002) (Figure 32).

- The most notable hot spring is Radium Hot Springs located a mile north of Haines and several hundred feet west of the Powder River. It has a flow of approximately 300 gallons per minute (0.67 cfs) with a water temperature of 140°F. Two successive sanitariums occupied the site from about 1905 to 1916 using the spring as a mineral spring for health purposes. A large swimming pool was constructed about 1925 making the spring a swimming resort for many years. For the past decade or more the pool has not been operated as a for-profit enterprise (J. Stevens, personal communication, 2002). T. M. Kerns (5/10/04, written communication) indicated that there are additional springs in the area. Additional information is needed to determine their discharge and temperatures before being able to determine how the additional springs influence stream temperatures in the Powder River.
- Fisher Hot Spring flows from the side of a hill and is located a thousand feet above Foothill Road northwest of Haines. It produces approximately 600 gallons per minute of 101°F water (1.34 cfs). A small concrete pool was constructed in 1915 that served for a

Figure 28. Hot springs in the assessment area.



Source: NRCS

time as a commercial enterprise. For most of its existence its owners used the pool privately. It was bulldozed in 2001 to prevent possible lawsuits arising from liability if unauthorized users were to have had an accident there. No use other than irrigation is presently being made of the stream that is identified as "Hot Creek" or as "Warm Springs Creek" on area maps. A century ago, the stream was used to power a woodworking shop that was located just above Foothill Road.

÷ A hot spring is located in the Powder River just east of North Powder. Being in the river, its flow is difficult to measure. Its temperature is between 90-110°F (M. Miles, personal communication, 2002).
÷ Kropp Hot Springs are located on the east side of Powder River near the above-mentioned hot spring. Others may exist on private ground between North Powder and the area just south of Haines (E. Schoenfeld, personal communication, 2002).

The Powder River is 303 (d) listed as water-quality limited for temperature. The presence of hot springs, some in or within close proximity to the Powder River, has raised questions about their influence on the stream temperatures of the Powder River during the summer. While some of the hot springs are contributing hot water into the Powder River, their potential influence on stream temperatures varies at any point in time as a function of stream discharge. In turn summer stream flows are strongly influence by reservoir releases and irrigation use making it difficult to identify a clear relationship between the hot springs and stream temperatures.

First, historic and current channel changes have widened, deepened and straightened the Powder River and many of its tributaries. Wider channels result in a decrease in water depth for the same discharge. As Meays et al. (2003) showed in a study done in the Burnt River, wide, shallow, slow moving streams are highly sensitive to air temperatures and changes in elevation. Inputs of cool subsurface water and higher stream velocities, which decreased thermal exposure time, were found to slow the rate of stream temperature increases with decreasing elevation and increasing air temperature. Therefore, any land use that results in increased channel widths, decreased stream velocities, and increased thermal exposure will result in higher stream temperatures.

Second, the increase in channel widths on the Powder River has been accompanied by channel straightening on the Powder River and many of its tributary streams (Appendix H) that has increased stream gradient and accelerated that speed at which surface water leaves the assessment area. The result of channel widening and straightening has been a decrease in the frequency of valley flooding, more rapid routing of water out of the watershed, and therefore a decrease in the amount and frequency of groundwater recharge. The net result is a decrease in cool subsurface return flows to the river except locally in areas that are being flood irrigated. In addition to a reduction in flooding and therefore groundwater recharge, the steeper channel gradients and wider channels have caused snowmelt waters and storm waters to leave the valley faster. The end result is a reduction in the amount of water stored in the watershed.

Third, the removal of riparian vegetation from along the river and its tributaries resulted in decreased shade and decreased the stream banks' resistance to erosion. The loss of shade results in greater solar input into the streams (Larson and Larson). The loss of riparian vegetation makes the bank more easily eroded during high flow events. The dense riparian vegetation is the glue that holds fine-grained banks together (Smith 1976).

Finally, flows in the Powder River are seasonally altered by the larger amount of water withdrawals from streams in Powder River watershed and groundwater via irrigation wells, domestic wells, and city wells during the summer months. The net result is that high air temperatures, shallow water depths, and low groundwater return flows all coincide in time. Therefore, the hot springs represent only one of many factors influencing stream temperatures in the Powder River.

FISH AND FISH HABITAT

Fish native to the Powder River – Powder Valley Watershed included Chinook salmon, steelhead, bull trout, redband trout, and several non-game species. Of the four species named, two have been extirpated, one is threatened, and the other is a species of concern.

Species introduced to the watershed include brook trout and lake (mackinaw) trout. This section will discuss the named species, fish stocking, fish passage, and fish screens.

Chinook Salmon and Steelhead

The Powder River Basin historically provided habitat for runs of both spring Chinook salmon (*Onchorhynchus tshawtytscha*) and summer steelhead (*Onchorhynchus mykiss).* Adult spring Chinook arrived in May-June and spawned in August and September. Like steelhead a primary harvest took place in the Columbia River with some harvest in the Powder basin. Adult steelhead arrived in the basin in the fall/winter and early spring before they spawned April-June.

The Thief Valley Dam was constructed in 1931-32 on the Powder River to provide water for irrigation of hay and alfalfa crops. It was built without fish passage and eliminated spring Chinook salmon and summer steelhead runs upstream of river mile 69. Brownlee Dam on the Snake River was completed in 1958 and was built for flood control and power production. The dam was designed to accommodate passage for both adults and juveniles, with the belief that tributary runs of salmon and steelhead would be maintained (Big Creek, Daley Creek, Eagle Creek and Goose Creek). Facilities were installed and operated but failed to successfully collect juveniles for by-pass. The idea of passage was abandoned and replaced by hatchery mitigation in the Snake River. These two dams eliminated the runs of salmon and steelhead from the Powder basin.

Bull Trout and Brook Trout

Bull trout (*Salvelinus confluentus*) was listed as a threatened species under the Endangered Species Act on November 1, 1999. The U.S. Fish and Wildlife Service was sued in 2002, and forced to designate critical habitat for the species. The completion date for the process of designating critical habitat is September 2004.

<u>Description and Habitat Needs</u>

There may be two distinct life history forms in the watersheds, fluvial and resident (Pratt 1992; Buchanan et al. 1997). Fluvial forms rear in natal tributaries for one to four years before moving to larger rivers to mature. Fluvial bull trout may use a wide range of habitats ranging from second to sixth order streams and varying by season and life stage. They live for another two to four years in these larger systems, growing to much larger sizes than resident forms, before returning to natal tributaries to spawn (Bjornn 1957, and Shepard, et al. 1984). Seasonal movements may range up to 300 km as migratory fish move from spawning and rearing areas into overwintering habitat in downstream reaches of larger basins (Elle et al. 1994). The resident form may be restricted to headwater streams throughout life. Both forms are believed to exist together in some areas, but migratory fish may dominate populations where corridors and sub adult rearing areas are in good condition (Rieman and McIntyre 1993).

Bull trout in these watersheds typically migrate from May through the end of December and spawn from September 1 through the end of October (Smith, personal comm., 2000). Hatching may occur in winter or early spring, but alevins may stay in the gravel for an extended period after yolk absorption (McPhail and Murray 1979). Emergence from gravels occurs at the end of April. Growth, maturation, and longevity vary with environment. First spawning is often noted after age four, with individuals living 10 or more years (Rieman and McIntyre 1993). Rearing occurs year-round in the watersheds.

Bull trout require colder water than most other salmonids for incubation, juvenile rearing, and spawning. Loose, clean gravel relatively free of fine sediments is required for spawning and early rearing. Bull trout use migratory corridors to move from spawning and rearing habitats to foraging and overwintering habitats.

Bull Trout can be identified by light-colored spots covering their olive green-brown back and flanks. They lack the worm-like markings on their backs, and the red on the paired fins that characterize brook trout.

Figure 29. Bull Trout

Source: Oregon Department of Fish & Wildlife.

Brook Trout can be identified by worm-like markings on dorsal fin and back, and red on paired fins.

Figure 30. Brook Trout.

Source: Oregon Department of Fish & Wildlife.

<u>Distribution</u>

Bull trout are found from the Pacific Northwest and Montana, to Alaska and The Yukon. Historical distribution of bull trout within the watershed is difficult to determine. Current populations exist in Salmon Creek, Pine Creek, Big Muddy Creek, North Powder River, Anthony Creek, North Fork Anthony Creek, Indian Creek, and Wolf Creek (U.S. Fish and Wildlife Service, 2002) (See Bull Trout Distribution Map Figure 33).

Stream habitat surveys were made by ODFW of Anthony Creek, North Fork Anthony Creek, North Powder River, Antone Creek, and of a tributary of Antone Creek in the 1970's. These surveys were not specifically looking for bull trout, and did not identify any. (See surveys in appendix H). Surveys conducted in the 1990's found individual bull trout and fragmented populations in all of the streams mentioned in the previous paragraph. The 1990's fish surveys are summarized in Appendices F and G, and in Tables 25 and 26. The surveys show that redband (rainbow) and brook trout are the most common species in the named streams. Anthony Creek is the only stream that had hybrids, and only Indian Creek, Pine Creek and the North Powder River had sizeable populations of bull trout. The highest number of bull trout found was 29 in the North Powder River. The surveys are not population counts, but only samples of the streams.

Table 24. Bull Trout Distribution (Summary of 1996 WWNF Fish Sampling Report).

Stream	# of Bull Trout Found	# of Bull/Brook Hybrids Found	Predominate Fish Species Found
Anthony Creek	3	23	Rainbow and Brook
Antone Creek	0	0	Nearly all Brook
Goodrich Creek	0	0	All Brook Trout
Indian Creek	11	0	Rainbow (no Brook)
Little Mill Creek	0	0	All Rainbow Trout
Marble Creek	0	0	All Rainbow Trout
Mill Creek	0	0	No fish at all
Muddy Creek	3	0	5 Brook Trout
North Powder River	29	0	Rainbow and Brook
Rock Creek	0	0	Rainbow and Brook
Pine Creek	18	0	In 1994 found only Rainbows. In 1995 found mostly Brook.
Salmon	2	0	14 Rainbow
Wolf Creek	3	0	Many Rainbow

Source: Wallowa – Whitman National Forest, 1996 Fish Sampling Report. (See full survey in appendix F)

The 1994 fish surveys shown in Appendix G showed an entry on 09/21/94 that was penciled onto the typewritten report. This added entry has not been included in the table above nor in the summary in the appendix. The entry states that one hybrid bull trout/brook trout, 7-9" long, was found at the confluence of Rock Creek and Killamacue Creek. This entry is the only known indication of the presence of bull trout in Rock Creek.

Table 25. Bull Trout Distribution (Summary of 1994 ODFW Fish Surveys).

Stream	# of Bull Trout Found	# of Bull/Brook Hybrids Found	Predominate Fish Species Found
North Powder R	29	2	Mostly Brook
Rock Creek	0	0	Rainbow & Brook
N. Fork Rock Cr	0	0	Mostly Brook

Source: ODFW Aquatic Inventory Project, Fish Surveys 1990 to 1995. See full survey in appendix G.

The 1994 survey was limited in scope compared to the 1996 survey. Note that there were not bull trout detected in Rock Creek. The North Powder River had both bull trout and hybrids present.

<u>Limiting Factors to Bull Trout Distribution</u>

The major factors suppressing bull trout in the Powder River Basin are felt to be brook trout and habitat degradation (Ratliff and Philip, 1992). The ODFW listed the suppressing factors as "habitat degradation as a result of streamflow diversions, upstream passage barriers at dams and downstream losses at unscreened diversions" (ODFW, 1997).

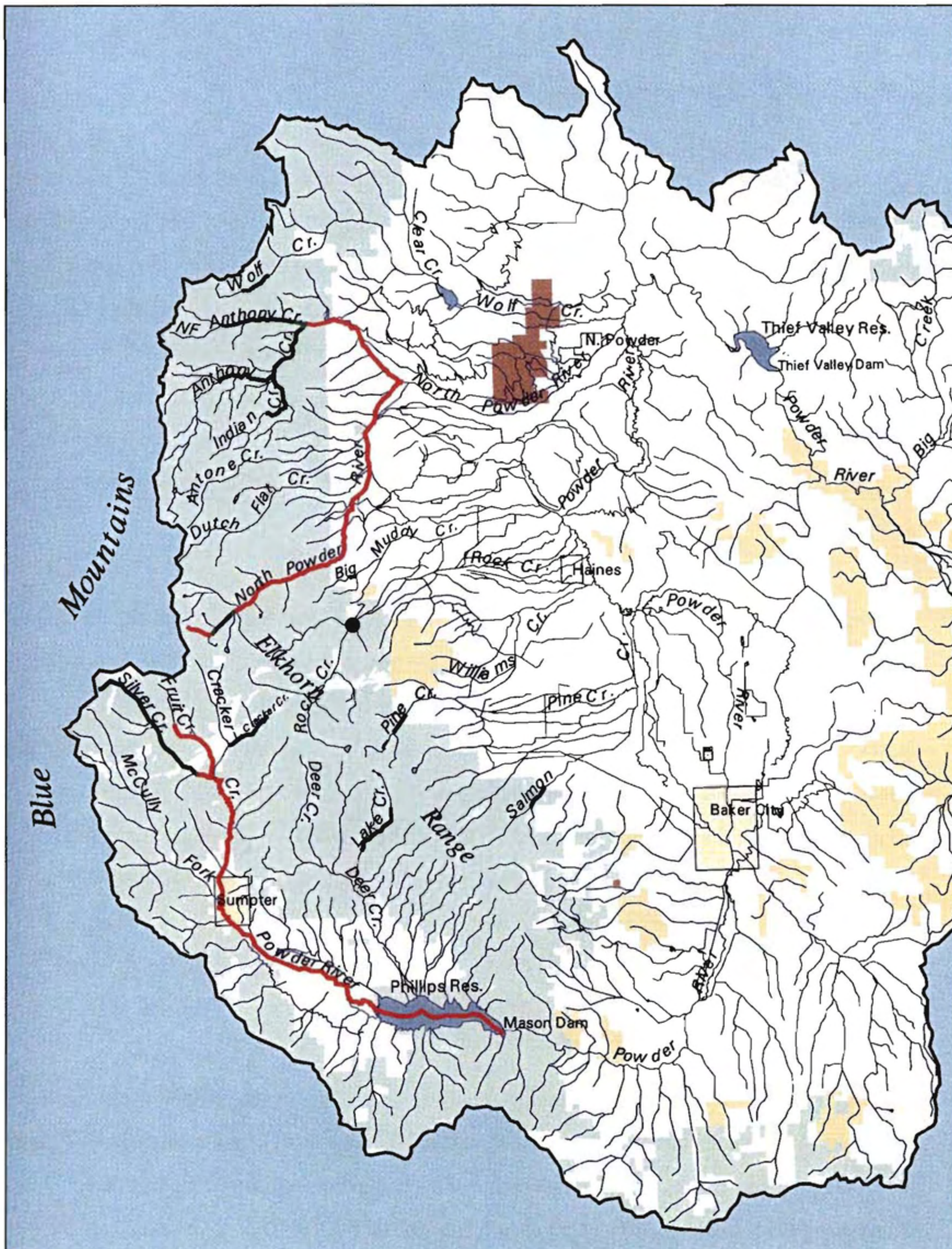
Factors affecting bull trout survival and recovery include:

÷ Hybridization and competition with brook trout. Bull trout and brook trout are both char, unlike rainbow trout, a true trout. Bull trout and brook trout are capable of mating. The hybrid offspring are generally sterile. Brook trout is a non-native species that was introduced to most of the streams on the watershed. Brook trout are considered to be a threat to the stability and recovery of bull trout populations because of the ability of the two species to interbreed. In all areas where the two species co-exist, bull trout populations are declining (Willamette National Forest, 1989). The stocking of lakes and streams with brook trout has been discontinued in areas of known or potential bull trout habitat.

÷ Passage barriers. Fish passage barriers are threats to bull trout survival and recovery. Barriers fragment populations, limit genetic exchange, and have curtailed some historic food sources. The construction of Thief Valley Dam in 1932 blocked connectivity between bull trout populations above and below the dam. The dam also became a barrier for passage of Chinook salmon and steelhead whose eggs, fry and adult carcasses were likely a major food source for bull trout. The impact to bull trout from the loss of salmon and steelhead as a food source is unknown, but is felt to be significant (ODFW, 1997). Other fish passage barriers exist within the Powder River – Powder Valley Watershed. They include falls, culverts and diversions. These are summarized in Table 29 in the "Fish Passage" section.

÷ Habitat degradation. Habitat degradation includes elevated stream temperatures. Bull trout need cold water in which to spawn and rear. Temperatures below 50 degrees F. are necessary for spawning, and 54 degrees F. seems to be the optimum temperature for supporting the highest density of adult bull trout (ODFW, 1997).

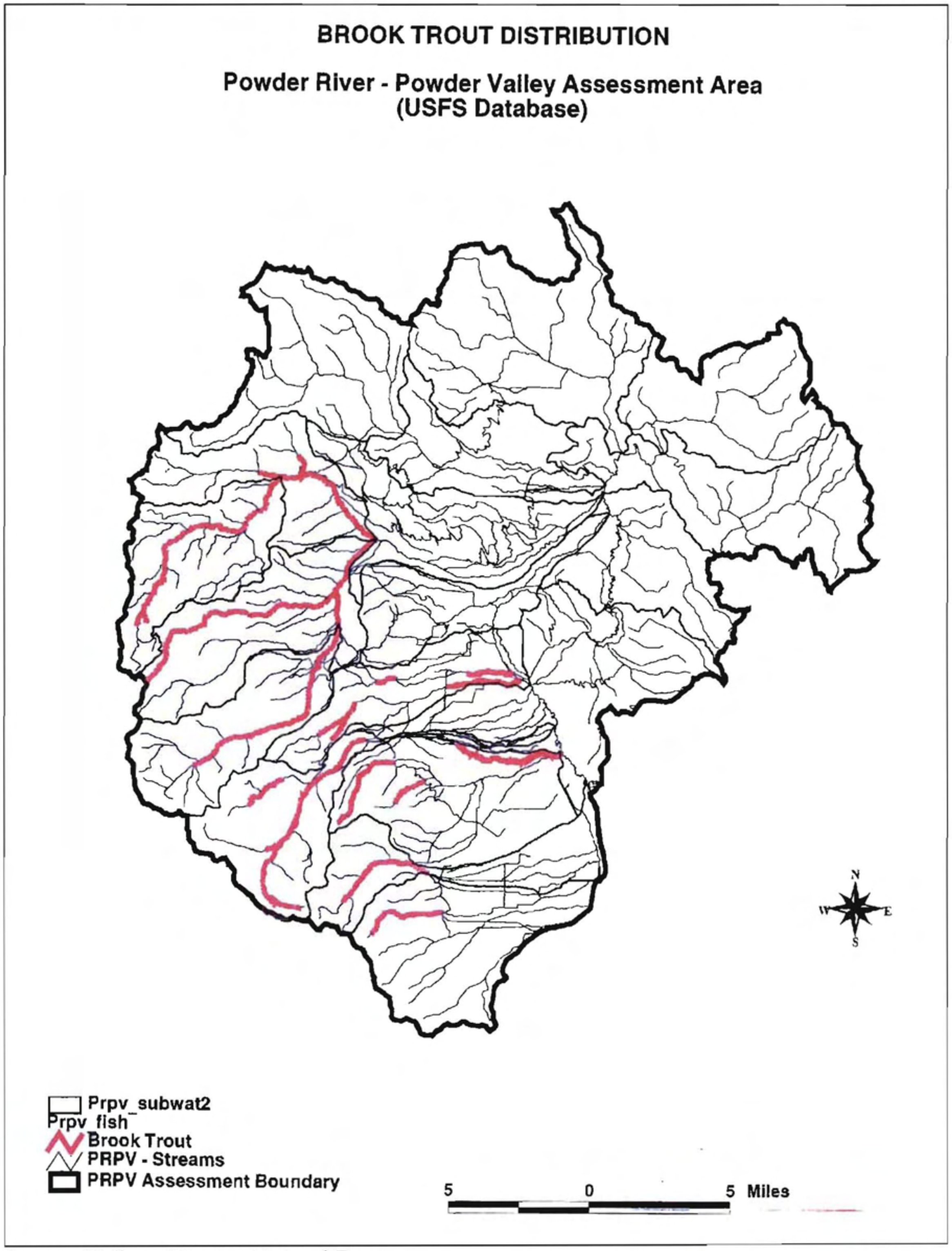
Figure 31. Bull Trout Distribution in Upper Powder River Sub-basin.



Key: Green line -Spawning, rearing or resident adult bull trout, Red line -Historic (pre-1990), Green dot -Isolated sighting after 1990.

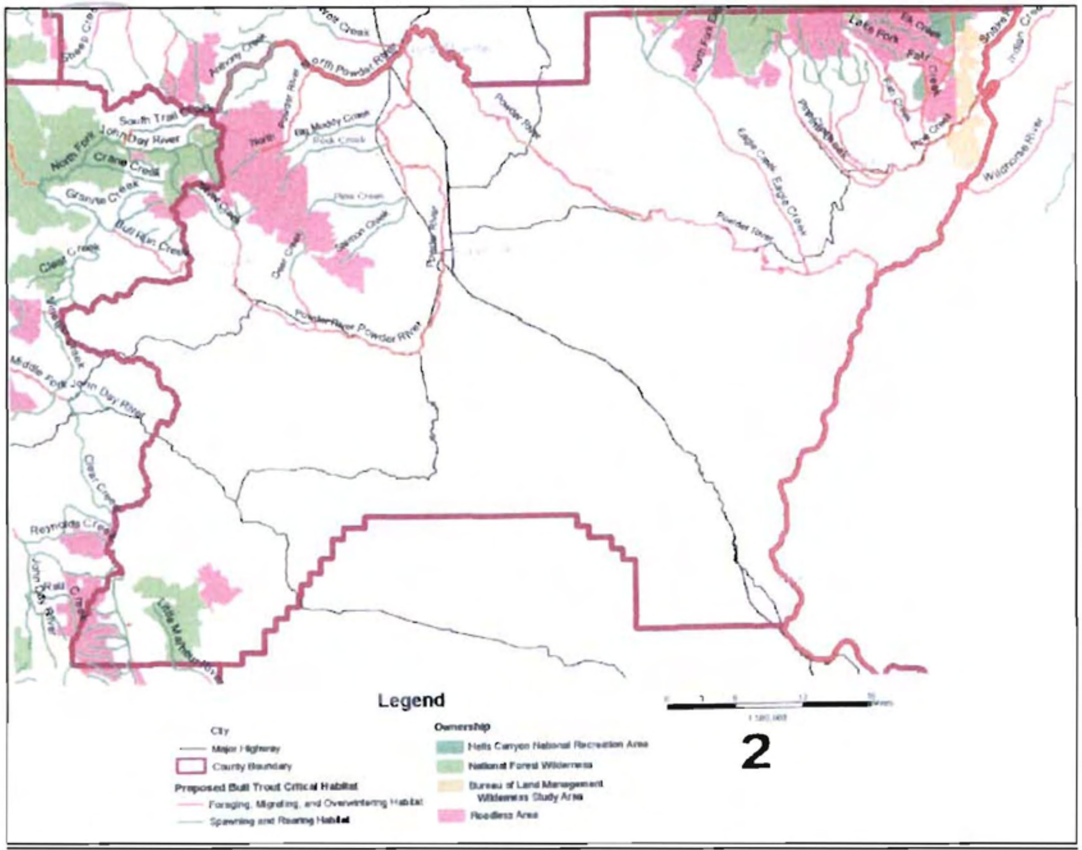
Source: Oregon Fish and Wildlife, 1997. Status of Oregon's Bull Trout.

Figure 32. Brook Trout distribution.



Source: Wallowa-Whitman National Forest

Figure 33. Proposed critical habitat for Bull Trout.



Source: *<u>Bull Trout Draft Critical Habitat Plan</u>, U.S. Fish and Wildlife Service.*

- Channel modifications have lead to a loss of complexity and cover and a reduction in stream depths leading to higher temperatures. Channels have been modified for irrigation and roads in the past creating a loss of vegetation within the riparian area. The loss of native riparian vegetation has reduced the stability of the streambanks. Unstable streambanks erode during flooding events widening the stream. The widening of the channel eliminates many pools and usually increases stream temperature due to a loss of cover and depth and an increase in solar radiation.
- Over-harvest. Concerns about over-harvest have been addressed by making the taking of bull trout illegal. Angling for bull trout in the Powder River Basin was closed in 1992. Bull trout caught while angling for other species must be released. The USFWS is concerned about incidental mortality due to angling in some watersheds, particularly those that support low numbers of bull trout.

- Downstream losses. Downstream losses occur at ditch diversions. Ditch diversions in the watershed number in the hundreds and could be listed as migration barriers during irrigation season. Diversions contribute to downstream losses. Very few of the diversions are screened. A listing of known screens is found in Table 22 in the "Fish Screens" section.
- Chemical treatment projects. Chemical treatment projects to eliminate non-game fish may have affected bull trout in some areas of the Powder River Basin, but not within the area of this watershed study. Available reports for this watershed indicate that squawfish (Pike minnow) were a common target species. The reports provide lists of species impacted by treatments (J. Zakel, pers. com., 2003).

<u>Recovery</u>

The goal of the bull trout recovery plan (***http://www.pacific.fws.gov/bulltrout***) is to "ensure the long-term persistence of self-sustaining complex interacting groups of bull trout distributed throughout the species' native range so that it can be delisted. To achieve this goal the following objectives have been identified for bull trout in the Hells Canyon Complex Recovery Unit:

- Maintain the current distribution of bull trout and restore distribution in previously occupied areas within the Hells Canyon Complex Recovery Unit.
- Maintain stable or increasing trends in bull trout abundance.
- Restore and maintain suitable habitat conditions for all life history stages and forms.
- Conserve genetic diversity and provide opportunity for genetic exchange.

An estimated 50 to 100 adult spawners per year are needed to minimize potential inbreeding effects within local populations. Between 500 and 1,000 adult spawners are needed in a core area to provide sufficient genetic variation to avoid genetic drift.

The Powder River Core Area is thought to contain less than 500 adult fish. The goal is to achieve 5,000 adult individuals in the Hells Canyon Complex Recovery Unit (a tenfold increase). The Hells Canyon Complex Recovery Unit includes 2 core areas: The Powder River Core Area drains into Brownlee Reservoir. The Pine-Indian-Wildhorse core area drains into the Hells Canyon and Oxbow Reservoirs. Pine Creek (Halfway)-and Indian Creek (Idaho) drains into Hells Canyon Reservoir and Wildhorse Creek (Idaho) drains into Oxbow Reservoir.

The Bull Trout Draft Recovery Plan states that specific barriers inhibiting bull trout movement and connectivity between populations need to be addressed. Those barriers include Oxbow Dam, Thief Valley Dam, and Wolf Creek Dam. Methods need to be implemented at these dams to provide two-way fish passage.

Actions are identified in the recovery plan that the US Fish and Wildlife Service believes will promote the recovery of bull trout in the recovery unit. Although USFWS believes these actions are necessary, they are not mandatory. The identified actions in the recovery plan are:

1. Inventory and identify water diversion structures and ditches affecting bull trout. The recovery plan recommends that all diversions and ditches be inventoried and evaluated for adverse effects on bull trout. The plan also recommends implementing actions to reduce negative effects on bull trout when necessary.
2. Identify areas where insufficient stream flow creates passage barriers and develop and implement actions to provide fish passage. The recovery plan recommends assessing reduced stream flows that result only from man mad or man caused actions or structures and investigating/implementing opportunities to reduce fish passage barriers.
3. Restore shade and canopy cover provided by riparian vegetation along select stream reaches where riparian habitats have been degraded. Shade and canopy provides cover that slows the rate of warming of the stream. Canopy vegetation also provides litter fall for nutrients for insects that are food for fish. Examples of areas in which shade and canopy cover could be improved include the main-stem Powder River above Haines, and the North Powder below Anthony Creek.
4. Identify and implement actions to "restore stream and riparian habitats that have been degraded. The effects of stream channelization, agricultural and urban development, and mining have degraded habitats by confining and straightening streams, reducing recruitment of large wood debris, and reducing riparian vegetation. Riparian vegetation helps stabilize the streambanks, reduces erosion of the stream and captures/reduces sediment delivery to the stream. Examples of areas affected by channelization for agricultural and urban development include the Powder River Valley and lower reaches of streams along the Elkhorn Mountain front (e.g. Big Muddy Creek, Rock Creek, Pine Creek, and Salmon Creek.

At completion of the final recovery plan specific tasks and priorities will be proposed for the Hells Canyon Complex. The recovery plan process included numerous public meetings and opportunities for input. A group from Baker County prepared extensive comments and submitted them to USFWS. The USFWS staff is considering these and other comments.

Redband Trout

Redband trout, rainbow trout and steelhead are all the same species, *Onchorhynchus mykiss.* The species probably consists of multiple subspecies, none of which have been formally recognized (ODFW, Dec. 1995). Steelhead migrate to the ocean and spend part of their life cycle in salt water. Rainbow trout spend their entire life in fresh water (J. Dougan, pers. com., 2002).

Redband trout is listed as a "species of concern" by the USFWS. It was listed in 1990 as "sensitive" in Oregon. Redband/rainbow trout are native to Eastern Oregon and are present in most of the streams of this watershed (See Redband/Rainbow Trout Distribution Map, Figure 34)(Also see Appendices F-H, Fish Survey Records, for relative abundance in area streams). "Wild trout distribution surveys conducted in the…Powder drainage in 1991 indicate that redband trout are widespread and abundant in all streams surveyed." (ODFW, Dec. 1995).

Fish Stocking

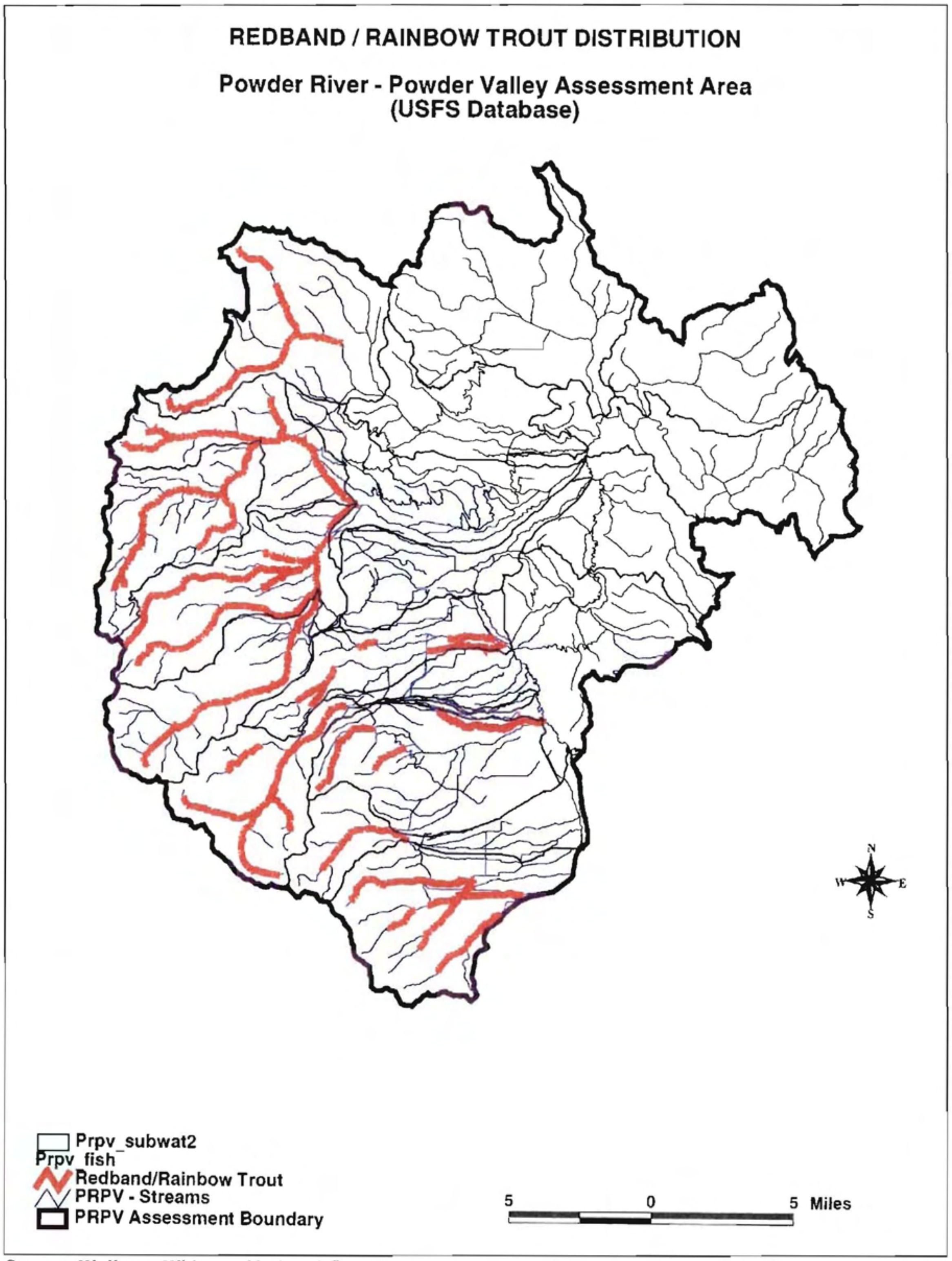
The high mountain lakes of the Elkhorn Range did not have resident populations of fish. Fish were planted in the lakes in the early 1900's. Early records of fish stocking are shown in Table 27.

Table 26. Early Fish Stocking of Lakes in Elkhorn Range.

Lake	First Recorded Stocking	Species
Twin Lakes	1926	Brook Trout
	1928	Rainbow Trout
Rock Creek Lake	1925	Rainbow Trout
	1926	Brook Trout
Lost Lake	1929	Rainbow Trout
	1929	Brook Trout
Van Patten Lake	1929	Rainbow Trout

Source: J. Zakel, ODFW.

Figure 34. Redband Trout distribution.



Source: Wallowa-Whitman National Forest

All but three of the lakes in the Elkhorn Range now support self-sustaining populations of brook trout, as do most of the streams (See Brook Trout Distribution Map, Figure 36). The three exceptions are Willow Creek, Meadow, and Little Summit Lakes. Meadow Lake and Little Summit Lake are too shallow to support fish. According to early residents of the watershed, Willow Creek Lake raised large trout early in the last century. No fish have been present there for many years, and attempts to stock the lake have been unsuccessful.

Rock Creek Lake has a self-sustaining population of lake (mackinaw) trout (*Salvelinus namaycush*). When they were planted and by whom are not known. A specimen was caught there as recently as 2001.

Gildemeister (1992) reported on an interview with Louise Dodson, born 1904, daughter of Thomas H. Parker:

> "Forest Ranger Thomas H. Parker was the first to stock the high lakes of the Elkhorns, transporting 'Dolly Varden' [bull trout], whitefish and 'wild' trout by packhorse, probably in the 'teens or early 1920's…"

Another statement on early fish stocking comes from Marjorie S. Loennig (See full letter in Appendix N):

> "Frank's Grandfather, who was born in 1864 here in Rock Creek, used to talk about the Indians and later the sheep herders stocking the lakes---Rock Creek, Elk, Green and Lost---with Dolly Varden by hand-carrying buckets of fingerlings to the creeks that fed the lakes. I recall Frank saying that except for these fish the lakes were essentially devoid of fish when the first pioneers settled here or so he had heard from his grandfather."

Current fish stocking efforts by ODFW of lakes and ponds are summarized in Table 28. Stocking of brook trout has been discontinued throughout the watershed.

Table 27. Current Fish Stocking Efforts by ODFW.

Lake or Pond	Stocking Frequency	Species	Size	umber
Highway 203	Annually	Rainbow Trout	Legal-size	8,600
Haines Pond	Annually	Rainbow Trout	Legal-size	3,500
N. Powder #1	Annually	Rainbow Trout	Legal-size	4,000
N. Powder #2	Annually	Rainbow Trout	Legal-size	1,000
Anthony Lake	Annually	Rainbow Trout	Legal-size	7,500
Thief Valley	Annually	Rainbow Trout	Fingerling	98,000
Pilcher Cr. Res.	Annually	Rainbow Trout	Fingerling	14,000
Wolf Cr. Res.	Annually	Rainbow Trout	Fingerling	16,000
Twin Lakes	Every 3rd year	Rainbow Trout	Fingerling	1,000
Lost Lake	Every 3rd year	Rainbow Trout	Fingerling	1,500
Rock Cr. Lake	Every 3rd year	Rainbow Trout	Fingerling	2,500
Van Patten L.	Every 3rd year	Rainbow Trout	Fingerling	3,000

Source: J. Zakel, ODFW.

(Note: Fish stocking records for 1960-1964 can be found in Hutchison and Fortune, 1967).

Fish Passage

Fish passage barriers in the watershed also include natural barriers, such as waterfalls and intermittent reaches of perennial streams. Waterfalls may hinder or block upstream passage for certain life stages of fish. Intermittent streams would block fish passage during the low-flow or non-flow period. Examples are:

÷ A waterfall on Indian Creek at its confluence with Anthony Creek. This waterfall prevents brook trout from entering Indian Creek and mingling with resident bull trout.

÷ A waterfall on Wolf Creek 4-5 miles above the reservoir.

÷ Rock Creek Falls between Eilertson Meadow and Rock Creek Lake

- Also see Tom Rudolph's (Deputy Watermaster) commentary in Appendix N for discussion regarding his thoughts on possible connectivity to Powder River of each Elkhorn Mountain stream if no irrigation diversions occurred.

Figure 35. Photo of Upper [Bulger Ditch Diversion on North Powder River.

Example of fish passage barriers that are found on most streams in the watershed.
Photo by Kevin Bradford.

Table 28. Fish Passage Barriers at Ditch Diversions.

Stream	Ditch Diversion	Comments
Salmon Creek	Farmers	Irrigation Season Only
	Steiger	Irrigation Season Only
	Beasley	Irrigation Season Only
	Payton	Irrigation Season Only
Mill Creek	West	Irrigation Season Only
	Pocahontas Mining & Irrigation Company Diversions #1, #2, #3, #4	Irrigation Season Only
Pine Creek	Bowles	Irrigation Season Only
	Cartmill	Irrigation Season Only
	Payton #1	Irrigation Season Only
	Payton #2	Irrigation Season Only
Willow Creek		None
Rock Creek	Power Company Flume	Possibly Now Removed
	Burke Owens Cartmill	Log---Possible Barrier
	Moore	Irrigation Season Only
	Owens	Irrigation Season Only
	Ashwood Green	Log---Possible Barrier
	Locken Toney	Irrigation Season Only
North Powder River	Mansfield	Year-round Barrier
	Bulger	Year-round Barrier
	Hutchinson Hillside Gardner Millrace	Irrigation Season Only
	Powers Company	Irrigation Season Only
	Daly	Year-round Barrier
	Kelsey-Wilson and Kelsey	Year-round Barrier
	Smith McPhee Tanner	Year-round Barrier
	Jacobson	Year-round Barrier
	Lun	Year-round Barrier
Wolf Creek	Approx. 10 diversions	Irrigation Season Only
	Wolf Creek Reservoir Dam	Year-round Barrier
	Lower Wolf Creek	Subterranean Flow 300 ft.
Powder River	Thief Valley Res. Dam	Year-round Barrier

Source:

Table 29. Baker County Culvert Status.

Stream	Priority	Road	Length	Diam	Drop	Comments
Big Muddy	Med	636	30	36	10	Possible step & velocity barrier
Big Muddy	Med	636	40	36	15	Step barrier, poss. Velocity barrier
Big Muddy	Low	636	45	36	6	Vel barrier, poss. juvenile step barrier
Mansfield D.	Low	1144	50	60	24	Step barrier & 3' falls 30' above
Little Antone	Low	1146	50	36	6	Possible juvenile step/velocity barrier
Prescott Gulch	Low	107	30	24	2	Possible velocity barrier
Mill Creek	Low	696	45	120	0	High velocity
Pine Creek	Low	696	45	180	0	High velocity
Marble Cr	Low	701	40	48	4	Possible velocity barrier
Mill Creek	Low	701	30	120	0	Velocity barrier
Spring Creek	Low	1124	45	36	0	Velocity barrier
Mansfield D	Low	1146	80	72	12	Vel. barrier, & a 2' step out of culvert
Sand Creek	Low	1146	50	120	0	Velocity barrier/sheet flow
E. Clover Cr	Low	848	30	108	8	Step at lower end
Sand Creek	Low	635	30	144	0	High velocity, lower 5' tilted down
Clover Creek	Low	848	40	72	8	Possible step barrier
Clover Creek	Low	850	50	84	0	10" step out of culvert
Willow Cr	Low	635	45	36	0	Small step out of culvert

Source: Baker County Road Department

A copy of the Union County fish culvert inventory can be obtained at ODFW in La Grande.

Fish Screens

Six fish screens are known to exist within the area of this watershed assessment:

Assistance is available through ODFW and OWEB to landowners who desire to install fish screens. These are cost/share programs that are currently offered on a 60%-40% basis. The landowner is asked to supply 40% of the cost involved. That percentage can usually be met through the landowner's own labor and use of equipment. Information on some cost share programs can be obtained at ODFW's website **www.dfw.state.or.us.** Under "Fish," click on

"Main fish page," and then "Fish Screening and Grant Program." A rule of thumb for total installation costs for fish screens runs between $1,000-$2,000 per cfs (D. Dyke, pers. com., date unknown).

Table 30. Fish Screens in Watershed.

Article . Stream	Article . Article . Diversion	Type of Fish Screen
Rock Creek	South Rock Creek Pipeline	Flat-plate debris screen
Rock Creek	Locken-Toney Ditch	Rotary Drum
Willow Creek	ODFW ditch	Rotary Drum
Anthony Creek	ODFW ditch #1 ODFW ditch #2	Rotary Drum Rotary Drum
Wolf Creek	Wilson Ranch Ditch	Rotary Drum

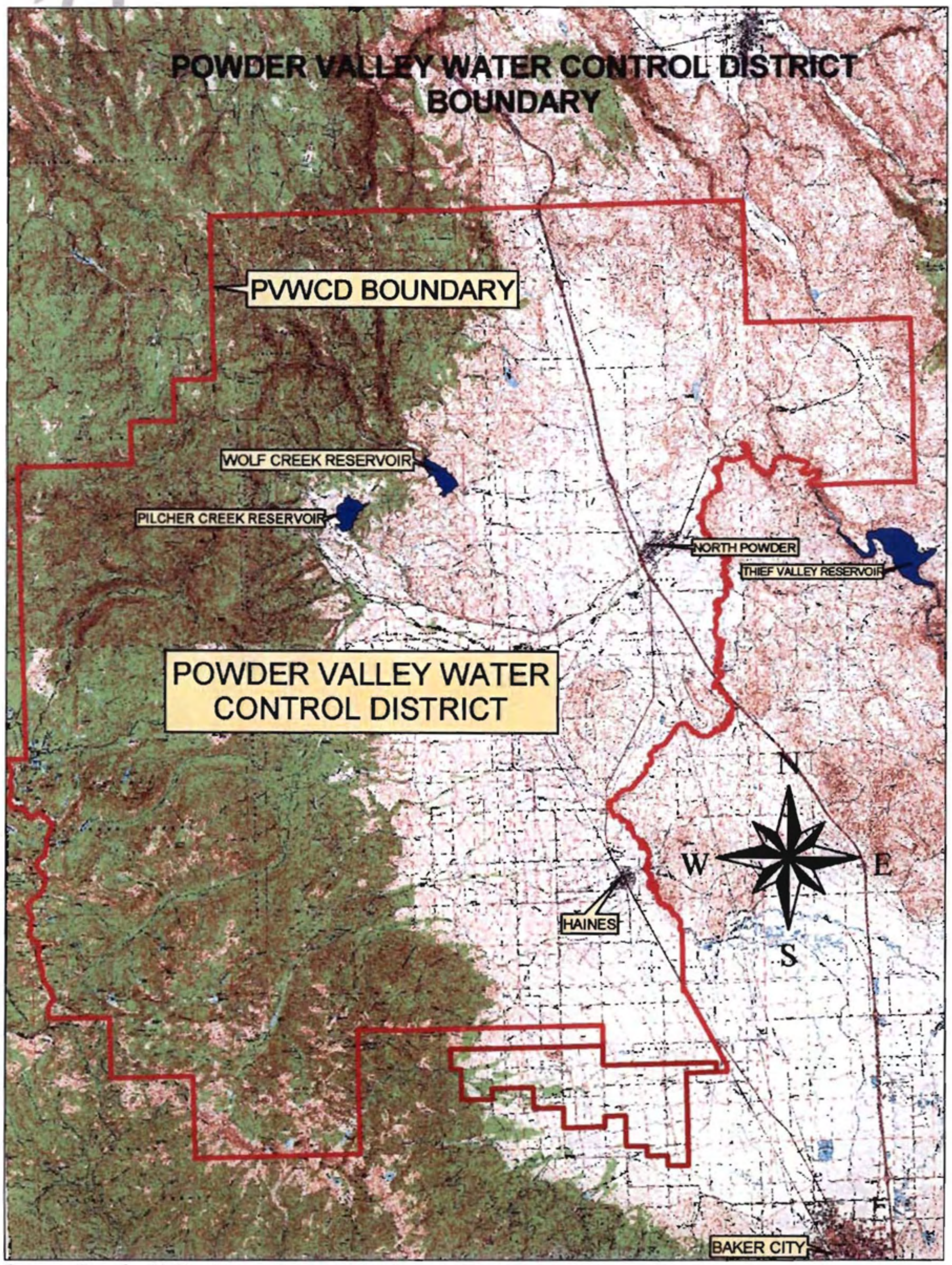
Sources: Owners.

WATER USE AND MANAGEMENT

Water Control District

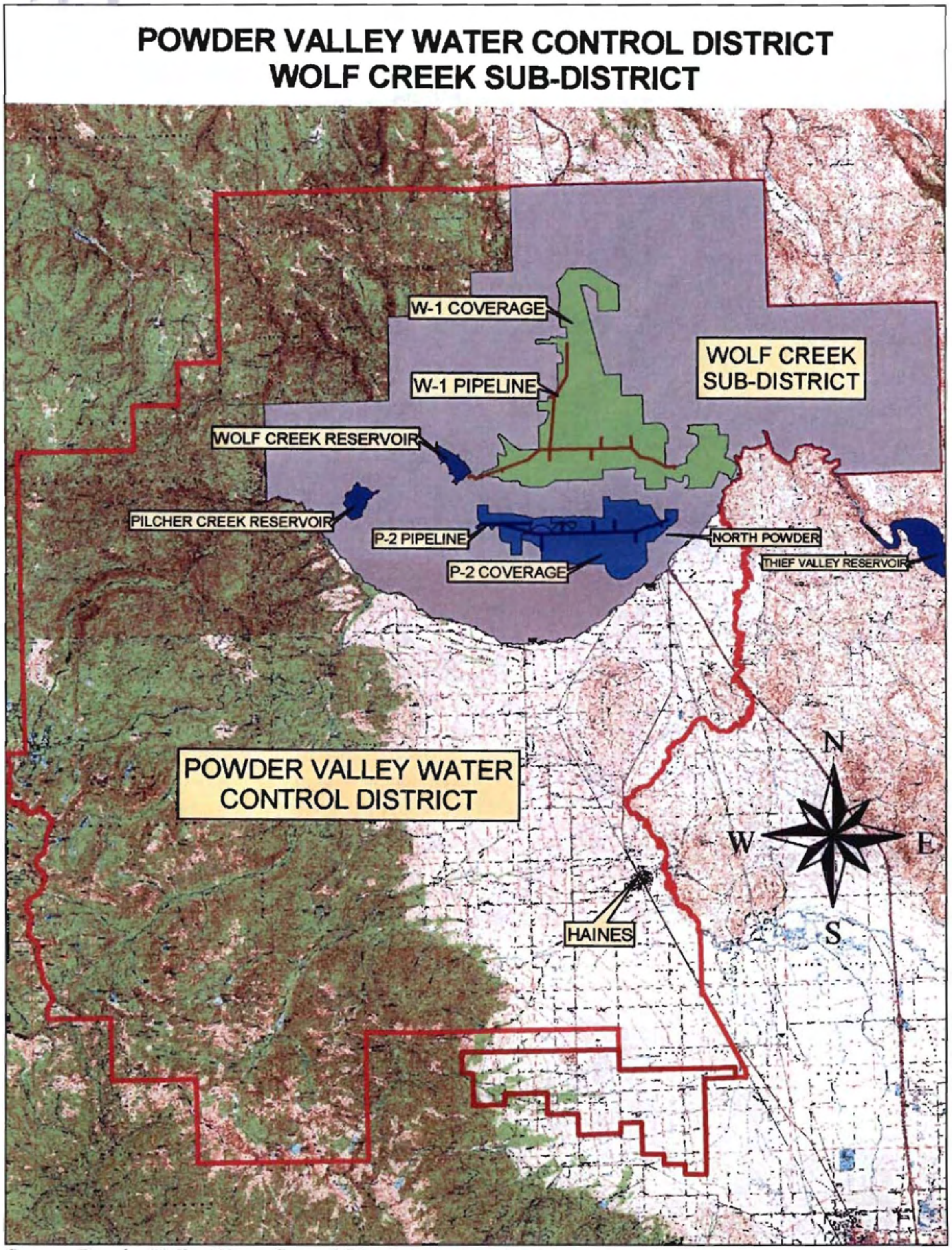
The Powder Valley Water Control District covers most of the watershed. The District was formed in December 1962 in accordance with Oregon State Statute 553. The following four maps show the district and its three sub-districts. The district was created large enough to include any irrigation project that might be undertaken in the future. The area outlined separately in the Wingville vicinity in the south end is an area that was annexed to the Powder Valley Water Control District in the 1980s to cover a proposed project.

Figure 36. Boundary of Powder Valley Water Control District.



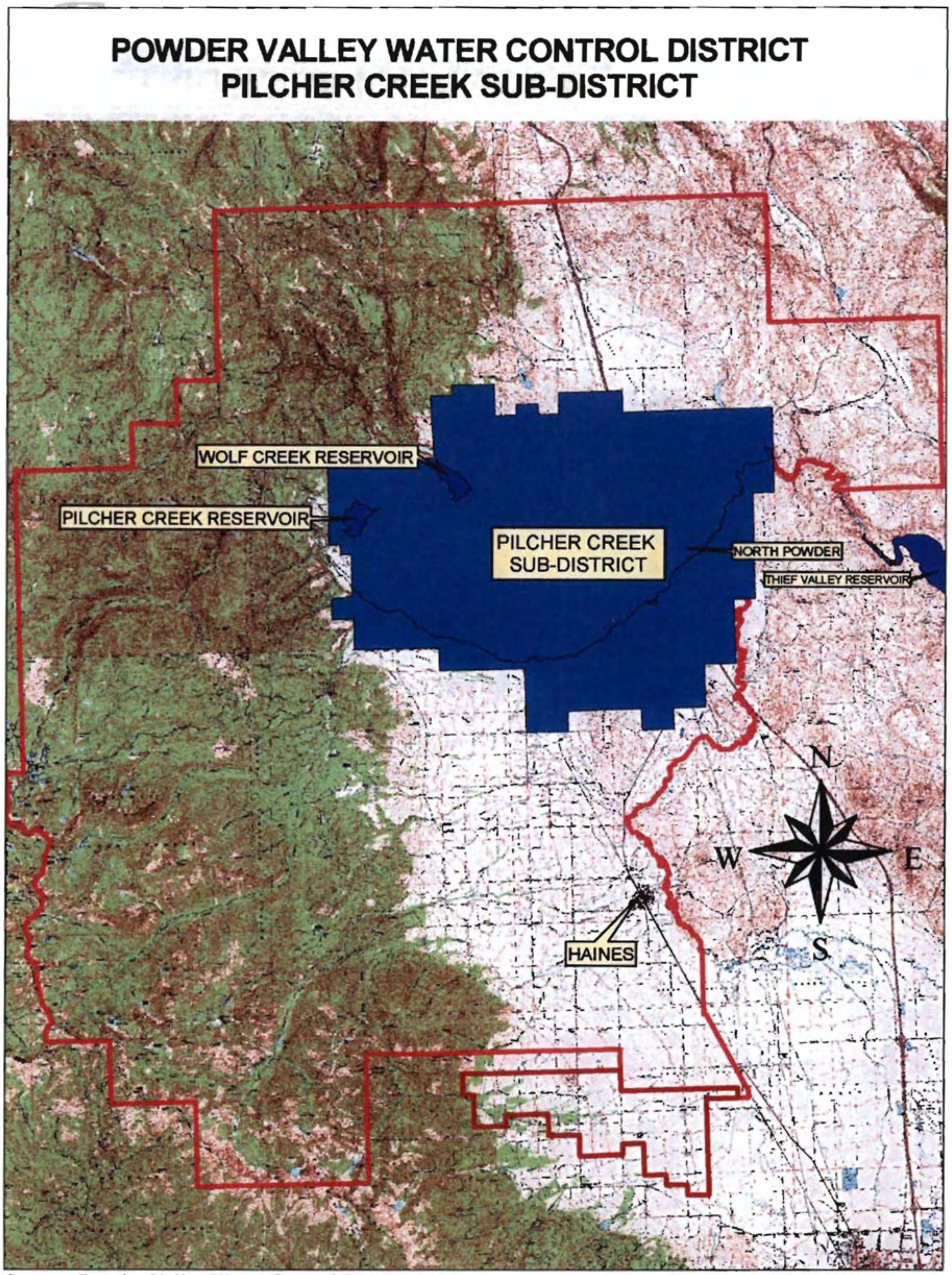
Source: Powder Valley Water Control District

Figure 37. Boundary of PVWCD Wolf Creek Sub-district.



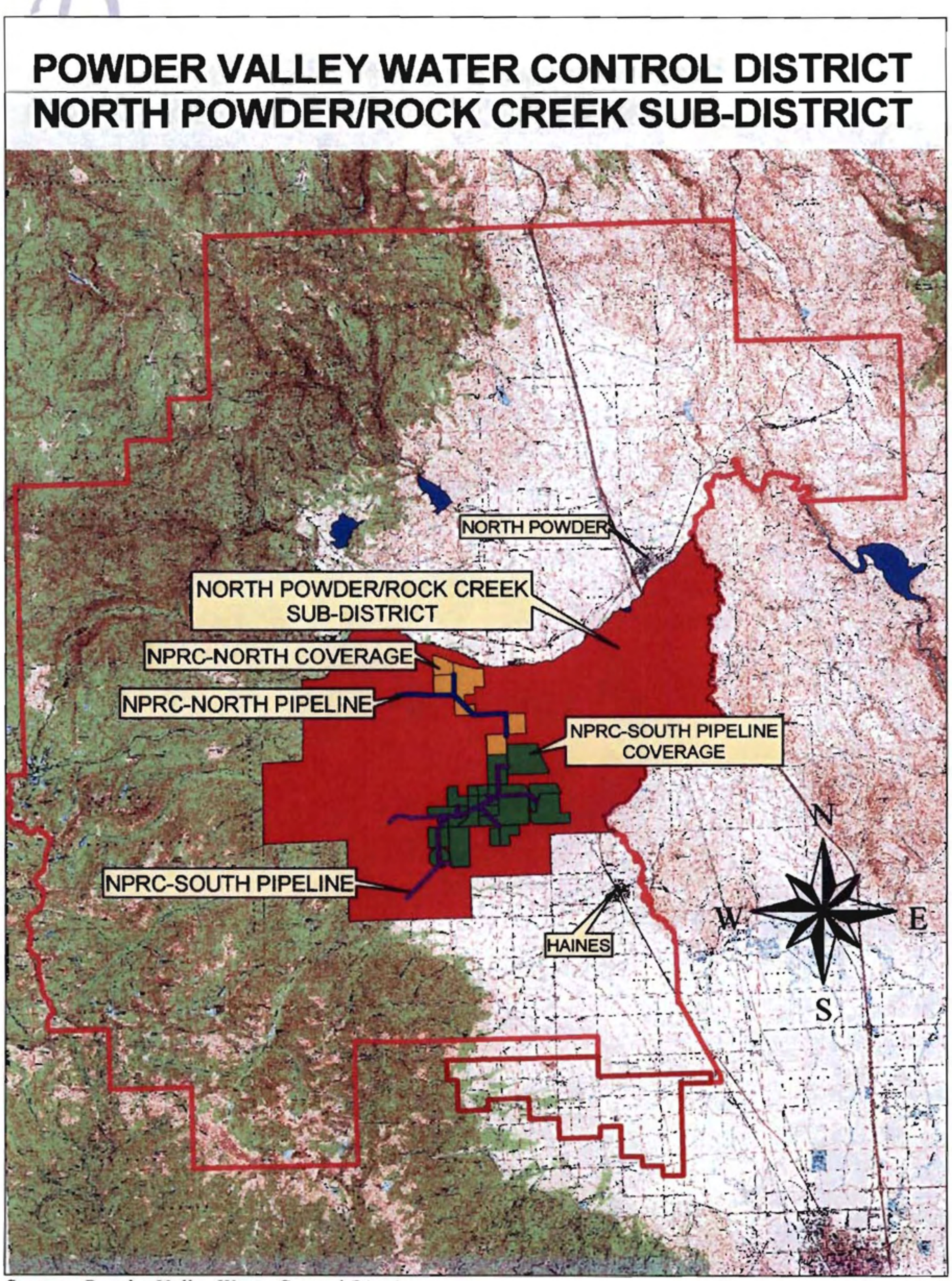
Source: Powder Valley Water Control District

Figure 38. Boundary of PVWCD Pilcher Creek Sub-district.



Source: Powder Valley Water Control District

Figure 39. Boundary of PVWCD North Powder/Rock Creek Sub-district.



Source: Powder Valley Water Control District