Point of Diversion Inventory

In 2003, the PBWC Assessment Committee asked the Baker County Watermaster Office to complete a point of diversion inventory for the Assessment area. Due to a shortage of funds for the Assessment, the Watermaster Office was able to complete the inventory only for a portion of the Assessment area, the North Powder River, for a cost of $4,914. The information developed by the Watermaster Office is recorded in Appendix I. The Watermaster Office will develop similar summaries for other streams in the Assessment area in the future as resources become available for the work. This inventory is similar to the one the Watermaster Office is doing in the Pine Creek Watershed Assessment Area.

Information from the OWRD Water Rights Information System (WRIS) database for water rights of at least 0.1 cfs or storage of at least 9.2 acre-feet will be included on a CD in the final copy. The table does not include information for exempt surface water, groundwater, or storage. The table was edited by Tim Bliss (Assessment Committee Chair – Wallowa-Whitman NF) to provide a more accurate summary of water rights for the Assessment area.

Water Use Reporting

State law requires certain governmental entities to report water use annually; governmental entities include state and federal agencies and local governments. For more information on reporting requirements see Oregon Administrative Rules 690-85 on the OWRD website.

In the Assessment area, local governments required to report water use annually include the cities of Baker City, Haines, and North Powder, Powder Valley Water Control District, and Lower Powder Valley Irrigation District. State agencies required to report water use include the ODFW. Federal agencies required to report water use include the WWNF, Vale BLM District, and BOR. Lower Powder Valley Irrigation District and the BOR report the amount of stored water released from Thief Valley Reservoir to places of use outside of the Assessment area. Baker Valley Irrigation District reports water use for irrigation above the Assessment area. Direct questions about water use reporting to the OWRD Salem Office (503-378-8455).

Water Rights

<u>Irrigation</u>

Water is the lifeblood of the Powder Valley Watershed agricultural community as well as countless other species, local economies and communities in the assessment area and downstream. The east side of the valley receives an average 9 inches of precipitation each year. The west side receives about 18 inches, while the tops of the Elkhorn Mountains receive around 40 inches . . . mostly in the form of snow.

The mountains serve as a bank for moisture . . . accepting deposits of snow over a period of six months and releasing it as water over the warmer months. Much of the mountain snow runs off into streams as spring runoff; but much also seeps into the soil, percolates through the mountains' interior storage system, and either reemerges as springs which feed surface streams, or stays underground to replenish aquifers in the valley. The Elkhorn Mountains provide high quality water for all activities that occur within the watershed.

The earliest water rights in the area post-Euro-American settlement are 1862. Irrigation has altered the watershed hydrology over the last 140 years. Water rights are currently administered under state law by ODRW and county personnel (R. Lusk, Baker County Watermaster, pers. com. 5/12/04). While the earliest water rights were for mining agriculture is now the biggest water user. Water rights determine who can legally use water and where it can be legally used. Early settlers recorded claims to water from a stream and used the water on a specific parcel of ground. Those early filings were less than perfect and that gave rise to many misunderstandings and disputes about water use.

To solve the issues an adjudication process was undertaken through the courts to establish which water rights belonged to which parcel of ground. Claims were reviewed, testimonies were taken, and evidence was presented. The court then decreed the year in which the water was first used on each property. That year became the decreed water right. The oldest water rights on a stream had priority, and could use the water first and longest. Water rights junior to the older rights could have water only when there was extra flow in the stream not being used by the older rights. Under state law a water right can also be temporarily transferred from one place to another (R. Lusk, Baker County Watermaster, pers. com., 5/12/04).

Adjudication of the Powder River was undertaken in 1918. Adjudication of the North Powder River was done in 1913, 1914 and 1916. Under these decrees irrigators taking water from the North Powder River may have one inch per acre until July 1st, and one-half inch per acre after July 1st, with a total limitation of 2 1/2 acre feet per acre. An "inch of water" refers to one miner's inch, which is defined as the amount of water that will flow through a one-square inch hole with 6" of head, or pressure. One miner's inch is equal to 1/40 cubic feet of water per second.

Irrigators using water from other Powder River tributaries fall under the Powder River decree that allows one inch per acre during the irrigation season for as long as the water can be used beneficially with no waste. There is no limitation on the total amount used.

Water rights granted after 24 February 1909 have been done through a permit process. Applications were filed with the State Engineer and later with the State Engineer's successor, the Water Resources Department. They were reviewed, approved, and recorded as valid water rights carrying a priority based upon the date of filing.

The system of water rights described above is summed up by the saying, "first in time, first in right." In other words, those who have the oldest rights on a stream have first call on the water, regardless of others' needs, as long as the water is used without waste. Extra water left in the stream goes to the next senior water right. No preferential treatment is given to any entity (such as municipal users) over any other legal water user.

Floating Water Rights

Some parcels of land have a small water right that does not cover the entire parcel. For example, an 80-acre farm might have a water right for only 40 acres, but the 40-acre parcel carrying the water right was not designated when the water right was granted. Landowners who have this situation may report to the watermaster at the beginning of each irrigation season which 40-acre piece will be irrigated that year. This "floating water right" may be moved each year from one piece of land to another, as long as it is used within the original homesteaded boundaries of that farm.

Stock and Garden Water

Water for gardens or windbreaks does not receive special consideration for water rights. Water for livestock is provided in designated ditches beyond the normal irrigation season at the rate of 1/40 cubic feet per second per 1,000 head of cattle.

Multiple Priorities on Undefined Acres

Oregon's water rights system has gone far toward resolving confusion, but problems still exist. The biggest problem concerns multiple water rights being assigned to undefined acres. For example, a 40-acre farm might include 10 acres having an 1872 water right, 20 acres having an 1878 water right, and 10 acres having an 1890 right. The issue has been that all three water rights are designated as belonging to that 40 acres, without specifying which water right belonged to which acres.

The Oregon legislature attempted to address this issue with House Bill 3111. That legislation allowed a 4-year window of opportunity in which landowners could reconfigure their water rights and designate exactly where each water right was being used. The opportunity applied only for those individuals that were within an irrigation district, water control district or ditch company (R. Lusk, Baker County Watermaster, pers. com., 5/14/04).

These designations were to everyone's advantage. Some landowners, for instance, took advantage of this opportunity to put their best rights under their pivot irrigation systems, and their poorer rights in the less-productive corners. The legislation also allowed the transferring of water rights from land that had been overlaid with structures or roads to land where the water rights could be used. Watermaster's welcomed these changes because there would no longer be any confusion or argument about where water was being used. Landowners needed to initiate a petition for change by July 1, 1994. Less than half of the landowners who should have taken action did so (R. Lusk, pers. com., 2002; T. Rudolph, pers. com., 2002).

Instream Water Rights

The Oregon Water Resources Department (OWRD) was issued water rights for the "migration, spawning, egg incubation, fry emergence, and juvenile rearing" of fish. The in-stream water rights for this assessment area are shown in Table 32. The in-stream rights take their place in line by the "first in time, first in right" principal.

- The water rights are limited to not more than the amounts, in cubic feet per second, during the time periods shown.
- The water right holder shall measure and report the in-stream flow as may be required by the standards for in-stream water right reporting of the Water Resources Commission.

Table 31. In-Stream Water Rights Powder River – Powder Valley Assessment Area

Stream	Priority	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1	10/1	11/1	12/1
Anthony Fk	1/29/92	4.6	6.0	6.0	10.6	20	20	15	8.0	8.0	8.0	8.0	7.5
Anthony Fk	1/29.92	10	10	22.3	25	25	25	18	10	10	10	10	10
Antone Cr	1/29/92	4.0	4.0	5.0	9.1	10	10	5.5	3.0	3.0	4.0	4.0	3.6
Clear>Wolf	1/29/92	1.8	2.0	5.9	7.0	7.0	7.0	2.0	1.0	0.8	0.9	1.3	1.7
Dutch Flat	1/29/92	3.0	3.0	5.0	6.4	13	13	8.0	3.0	3.0	3.0	3.0	3.0
NFkAnthony	1/29/92	2.6	2.5	3.6	9.6	12	12	4.3	2.4	2.3	2.6	3.0	2.4
N Powder R	6/07/91	8.0	8.0	20	25	25	25	15	8.0	8.0	8.0	8.0	8.0
Rock Cr	1/29/92	6.0	6.0	8.2	14.3	20	20	12	6.0	6.0	6.0	6.0	6.0

Source: Oregon Water Resources Department, **www.wrd.state.or.us**

- For purposes of water distribution, these in-stream rights shall not have priority over human or livestock consumption.
- The in-stream flow allocated pursuant to these water rights are not in addition to other in-stream flows created by a prior water right or designated minimum perennial stream flow.
- The flows are to be measured at the lower end of the stream reach to protect necessary flows throughout the reach. The reaches are as follows:

Cert. 73325---Anthony Fork: from Anthony Lake to Indian Creek.
Cert. 73326---Anthony Fork: from Indian Creek to mouth.
Cert. 73327---Antone Creek: from headwaters to mouth.
Cert. 73328---Clear Creek: from east and west forks to mouth.
Cert. 73331---Dutch Flat Creek: from Dutch Flat Lake to mouth.
Cert. 73334---North Fork Anthony Fork: from headwaters to mouth.
Cert. 73321---North Powder River: from North Fork at river mile 22.2, to Antone Creek at river mile 12.9
Cert. 73322---Rock Creek: from Rock Creek Lake at river mile 15.8, to power Plant diversion headgate at river mile 9.5.

Wolf Creek Minimum Flows

No filings were made for instream water rights on Wolf Creek. However, the Watershed Work Plan for Wolf Creek calls for the maintenance of a live stream below the dam:

> "Stored irrigation waters will be released into Wolf Creek below the dam during the period June 1 through October 1, and diverted in various amounts in the first 6 miles of stream. A year-round minimum flow of 2 cfs will be provided for the maintenance of a live stream below the dam. Irrigation return flows are expected to supplement this minimum release."

The Powder Valley Water Control District releases 2 cfs of water at the dam. Some irrigation return flows occur downstream. The combined flows are frequently either insufficient to maintain a live stream to the mouth, or withdrawals are depleting the stream.

Recommended Minimum Flows

The Oregon State Game Commission completed a study in 1967 that resulted in the following recommendations for minimum flows in streams within the assessment area:

Surface Water Over-Appropriation

The State of Oregon defines "over-appropriation" of surface water as "a condition of water allocation in which the quantity of surface water available during a specified period is not sufficient to meet the expected demands from all water rights at least 80% (or 50%) of the time during that period." The 80 percent rule is used for live flow diversions, and the 50 percent rule is used for storage. See Appendix L for more information on this definition and for application of this definition in Water Availability Tables. The water availability tables indicate which streams are over-appropriated based on these current rules. Other over-appropriation concepts are also discussed in Appendix L.

Table 32. Recommended Minimum Flows by ODFW (Values in cfs).

Stream	Feb.	March May	June	July	Aug-Jan.	Point of Measure
Powder River	25-30	40	40-30	25	25	1.5 mi. below Sutton Cr
Powder River	25-30	40	40-30	25	25	5 mi below Muddy Cr
Powder River	25-30	40	40-30	25	25	Just above N. Powder R
Powder River	25-30	40	40-30	25	25	Entering Thief Valley Res
N Fk Powder River	8-15	25	25-15	10	8	Just above Antone Cr
N Fk Powder River	8-15	25	25-15	10	8	Just above Anthony Fork
N Fk Powder River	12-20	25	25-20	15	12	Mouth
Anthony Fk Cr	8-15	20	20-15	10	8	Just above Indian Cr
Anthony Fk Cr	10-18	25	25-18	7	4	Mouth
N Fk Anthony Fk Cr	4-7	12	12-9	7	4	Mouth
Antone Cr	4-6	10	10-8	6	4	Mouth
Dutch Flat Cr	3-8	13	13-10	8	3	Mouth
Rock Cr	6-12	20	20-15	12	9	Power Plant Diversion
Rock Cr	9-15	20	20-15	12	6	Mouth
Wolf Cr	4-8	12	12-8	4	4	Just above Clear Cr
Wolf Cr	4-8	12	12-8	4	4	Mouth
Clear Cr	2-4	7	7-4	2	2	Mouth

Source: Hutchison and Fortune, 1967

Historically streamflow was allocated to the capacity of the stream during the peak flow period in contrast to current rules. Usually there is sufficient water for all users during spring runoff when flows are high. After that initial flush, however, all of the remaining flow on every stream in the assessment area is fully allocated. The water is divided out to the oldest, most senior rights until the stream is totally allocated---either by diversions, or by in-stream rights that require a flow to be left in the stream.

Users holding younger water rights hold valid water rights to the stream, but there is insufficient water to exercise those rights later in the season. For example, in Rock Creek, junior users are tagged off each summer to provide water to irrigators with 1860's priority dates. In other words, water rights described a right to more water than is actually in the stream. This was the earliest form of "over-appropriation." It can be argued, however, that this should be defined as "full appropriation" since it's not possible to take more water from a stream than is actually there. Also, some residents of the assessment area believe over-appropriation is a non-issue since our water right system decrees whether or not water is available to exercise any particular right, as discussed above.

The Water Availability Tables indicate that most streams in this assessment area are "over-appropriated" during the summer. The exception is Cusick Creek. In contrast, most or all of those same streams are under-appropriated early in the season. This is represented by positive numbers in the right column of the Water Availability Tables.

Table 26 summarizes some of the information from the Water Availability Tables. The reason for potential over-appropriation (based on negative available water numbers in the tables) includes interactions between large consumptive uses (CU) and large instream water rights (IWR). There are more months of potential over-appropriation at 80% exceedence than at 50% exceedence.

Problems With Over-Appropriation Modeling Assumptions

Instream water rights appear to be excessive in several streams. Instream water rights for North Fork Anthony Creek, upper Anthony Creek, Antone Creek, Clear Creek, Dutch Flat Creek, Powder River above Rock Creek, Rock Creek at mouth, and Wolf Creek at mouth are greater than estimated natural streamflows for 50% exceedence. This creates false-negative numbers, that is, false over-appropriation numbers.

Table 33. Surface Water Over-Appropriation Summary.

Water Availability Basin (WAB)	Watershed ID (WID)	Net Available Water		Reason for Over-Approp.
		Over-Appropriation Months for 50% Exceedence	Over-Appropriation Months for 80% Exceedence	
Antelope Cr – at mouth	30920325	Jun-Sep	Jun-Sep	CU
Anthony Cr – at mouth	72165	Feb-Mar, July-Aug	Feb-Sep, Dec	CU, IWR
Anthony Cr, NF – at mouth	72184	Mar-Apr	Jan-Apr, Jun-Dec	IWR
Anthony Cr – above Indian Cr	72164	Dec	Feb-Mar, Jul-Dec	IWR
Antone Cr – at mouth	72166		Jan-Apr	IWR
Clear Cr – at mouth	72171	Jan-Mar, Jul-Dec	Jan-Mar, Jun-Dec	IWR
Cusick Cr – at mouth	30920324	none	none	
Dutch Flat Cr – at mouth	72176	Feb	Feb-Mar	IWR
Jimmy Cr – at mouth	30920326	Jun-Sep	May-Sep	CU
N Powder R – at mouth	72188	Jun-Aug	Apr-Sep	CU
N Powder R–above Anthony Cr	72187	Jul-Aug	Mar-Sep	CU, IWR
N Powder R–above Antone Cr	71685	Jul	Feb-Sep	CU, IWR
* Powder R – at mouth	30920301	Aug-Sep	Jul-Sep	CU, IWR
* Powder R – above Eagle Cr	72193	Jun-Oct, Dec	Jan-Feb, May-Dec	CU, IWR
** Powder R–above Goose Cr	72192	Jan, Jun-Oct, Dec	Jan-Mar, May-Dec	CU, IWR
Powder R – above unnamed stream	72191	Jun-Oct	Jan-Mar, May-Oct, Dec	CU, IWR
** Powder R – above Rock Cr	30920327	Jan, Jun-Dec	Jan-Dec	IWR
Rock Cr – at mouth	72194	Apr-Sep, Nov	Jan-Feb, Apr-Dec	CU, IWR
Rock Cr–above unnamed stream	72159	none	Jan-Feb, Dec	IWR
Salmon Cr – at mouth	30920329	Jan-Dec	Jan-Dec	CU
Willow Cr – at mouth	30920328	May-Sep	Apr-Sep	CU
Wolf Cr – at mouth	72163	Jan-Dec	Jan-Dec	CU, IWR
Wolf Cr – above Clear Cr	30920323	none	none	
* (below assessment area) ** (partly in assessment area)				

Source: T. Bliss, Soil Scientist/Hydrologist, Wallowa Whitman National Forest, 2003

Modeled streamflows may not mirror reality. There are some streamflow records for the assessment area, but none at the mouths of streams. There is no information about the quantity of surface and subsurface return flows.

Close scrutiny of the expected stream flow information in the water availability tables (Appendix L) suggests the modeled effects may not be very accurate. If one uses 50% exceedence to approximate mean monthly streamflow, one immediately questions the meaning of the negative numbers represented by the months in the table below. Several streams listed in Table 35 have very low flow in summer. For example, Rock Creek can dry up in Haines because most of the remaining flow in the lower part of the drainage is diverted into Sand Creek west of Haines, an old channel of Rock Creek. Willow Creek is usually dry during the summer.

Table 34. Over-Appropriation and Expected Stream Flows.

Water Availability Basin (WAB)	Watershed ID (WID)	Expected Stream Flow	
		Over-Appropriation Months for 50% Exceedence	**Over-Appropriation Months for 80% Exceedence**
Antelope Cr – at mouth	30920325	Jun-Sep	Jun-Sep
Anthony Cr – at mouth	72165	none	Jun-Jul
Anthony Cr, NF – at mouth	72184	none	none
Anthony Cr – abv Indian Cr	72164	none	none
Antone Cr – at mouth	72166	none	none
Clear Cr – at mouth	72171	none	none
Cusick Cr – at mouth	30920324	none	none
Dutch Flat Cr – at mouth	72176	none	none
Jimmy Cr – at mouth	30920326	Jun-Sep	Jun-Sep
N Powder R – at mouth	72188	Jul	May-Aug
N Powder R – abv Anthony Cr	72187	Jul	May-Aug
N Powder R – abv Antone Cr	71685	none	May-Jul
* Powder R – at mouth	30920301	Aug-Sep	Aug-Sep
* Powder R – abv Eagle Cr	72193	Jun-Sep	Jan, May-Sep, Dec
** Powder R – abv Goose Cr	72192	Jun-Sep	Jan, May-Sep, Dec
Powder R - abv unnamed str	72191	Jun-Sep	Jan, May-Sep
** Powder R – abv Rock Cr	30920327	Jun-Nov	Jan-Dec
Rock Cr – at mouth	72194	Jul	May-Jul, Sep
Rock Cr – abv unnamed str	72159	none	none
Salmon Cr – at mouth	30920329	Jan-Dec	Jan-Dec
Willow Cr – at mouth	30920328	May-Sep	Apr-Sep
Wolf Cr – at mouth	72163	Jan-Sep, Nov-Dec	Jan-Sep, Nov-Dec
Wolf Cr – abv Clear Cr	30920323	none	none
* (below assessment area) ** (partly in assessment area)			

Source: OWRD Water Availability Tables, summarized by Bliss, 2003.

<u>Groundwater Over-Appropriation</u>

Groundwater over-appropriation is defined as "a condition of water allocation in which the appropriation of groundwater resources by all water rights exceeds the average annual recharge to a groundwater source over the period of record or results in the further depletion of already over-appropriated surface waters." The OWRD Eastern Region indicates that no groundwater aquifers in the assessment area are over-appropriated at this time (See discussion of groundwater in "Wells" section).

Out-Of-Basin Appropriations

Oregon Administrative Rule 690-509-0010 prevents out-of-basin appropriations. It states: "To support present and proposed Powder Basin resource developments no out-of-basin or out-of-state appropriations of water shall be made or granted by any state agency or public corporation of the state for the waters of Pine Creek, Eagle Creek, Powder River and Burnt River or their tributaries." No water is being diverted from this assessment area for use in another basin.

Water Conservation Measures

Several things might be done to improve water use and to promote water conservation. Items of concern are:

- water lost through percolation into stream beds and ditch beds
- loss of water from the basin as spring runoff
- leaky delivery systems
- over-irrigation
- evaporation.

These items are not necessarily bad. Depending upon a person's viewpoint, some of these items are not water loss at all since the "lost" water goes into the ground to recharge aquifers or to reemerge farther downstream to restore stream flows or to cool surface water.

Water lost through percolation into streambeds and ditch beds, as well as water lost through leaky delivery systems, is not really lost from the watershed. It is just not being used where it was intended. Efficiency of water use, rather than water loss, is the key concern here.

Spring runoff that is not diverted for use is discharged into the Powder River and is lost from the basin. Historically these flushes of high water were used by anadromous fish fingerlings to carry them from their rearing streams to the ocean. Some of the spring runoff is now caught and stored in 11 reservoirs located in the assessment area (See "Reservoirs" section).

Wolf Creek Irrigation System

Residents of the Wolf Creek area have improved water use efficiency through construction of Wolf Creek Reservoir, Pilcher Creek Reservoir, and installing two extensive pipe systems (See maps, figures 10-12). Wolf Creek formerly dried up as early as May 10 due to diversion of water for irrigation (F. and C. Colton, pers. com., 2002). Irrigation water was always gone by July 1st. (See Appendix F for 1913 flow records which show that Wolf Creek did not dry up until sometime after that date). Construction of the reservoirs and pipelines has made water available throughout the irrigation season (L. Umpleby, pers. com., 2002).

Pilcher Creek Reservoir is an off-channel reservoir filled by Anthony Creek. Wolf Creek Reservoir is filled by both Wolf Creek and Anthony Creek. The two reservoirs are operated together as one system. Pilcher Creek Reservoir is filled first, being at a higher elevation, and then its' excess water is used to help fill Wolf Creek Reservoir.

Wolf Creek Reservoir was constructed in 1974. Irrigators pay $5.18 per acre-foot of water used plus a fee for operation and maintenance. Pilcher Creek Reservoir was constructed in 1983. Irrigators pay $15.50 per acre-foot plus operation and maintenance fees. The difference in the per-acre-foot costs between the two reservoirs is a function of inflation and timing of construction. The two reservoirs were constructed for the purposes of irrigation, recreation, and flood control through a federal loan that is being repaid by irrigators.

The reservoirs are used heavily for fishing, boating, camping, and water skiing. Recreation uses are compatible with irrigation, but jet skis and high-speed boats cause a problem by stirring up the water, eroding the reservoir shorelines, and plugging the screen to the P-2 pipeline. After holidays it is necessary to clean the screen every three hours (L. Umpleby, pers. com., 2002).

In the Wolf Creek Watershed Work Plan (Union SWCD and Powder Valley SWCD September 1966) a commitment was made to maintain a year round minimum flow of 2 cfs for the benefit of fish. "A year round minimum flow of 2 cfs will be provided for the maintenance of live stream flow below the dam. Irrigation return flows are expected to supplement that minimum release." Current management maintains the 2 cfs release at the dam (7 miles upstream from the mouth) but does not ensure that a minimum flow of 2 cfs is maintained year round from the dam to the mouth. A gauging station or measuring device may be necessary to monitor whether the flow is maintained. The maintenance of flow should be combined with the screening of ditches and providing passage to benefit fish.

The two pipeline systems on the project supply gravity-flow water. Pumping and electricity costs to farmers are eliminated. The W-1 pipeline feeds directly from Wolf Creek Reservoir and serves

6,700 acres. The P-2 pipeline starts 1 1/4 miles below Wolf Creek Reservoir and serves 2,850 acres (See maps, Figures 14 and 15).

Plans are under way to extend the P-2 pipeline clear to Wolf Creek Reservoir. This could put an additional 2,400 acres under the pipeline system. Most of those acres would change from flood to sprinkler irrigation. Only 80 of the 2,400 acres are now under sprinklers. Natural Resources Conservation Service (NRCS) began a feasibility study in the fall of 2001. If approved, NRCS would pay up to 75% of the construction costs because of water conservation.

Cooperative Pipelines

Another area that has taken cooperative action to improve efficiency of water use is the area north of Rock Creek. Two pipelines have been installed there: the North Powder-Rock Creek North pipeline (NPRC-N), and the North Powder-Rock Creek South pipeline (NPRC-S). (See map, Figure 16)

The pipelines have benefited their users by eliminating pumping and electricity costs, and by delivering 100% of diverted water to its place of use. The pipelines have benefited all other users of Rock Creek and Muddy Creek water as well, because more water stays in the creek. Any water saved goes to junior users or stays in the streams for fish. The pipelines draw less water than the cumulative ditch diversions that they replaced. The deputy watermaster who regulates Rock Creek estimates that the pipelines use 20-25% less water than what used to be diverted through ditches (T. Rudolph, pers. com., 2002). The pipelines have eliminated several diversions, and have caused others to be used less.

The NPRCS pipeline was installed in 1988 at a cost of $1.2 million. It was funded through a loan from Farmers' Home Administration on a 50% cost/share basis. Loan repayment is being accomplished through user assessments amounting to $13.75 or $15.75 per acre-foot per year, depending on how far down the pipeline the user takes out his water. The pipeline serves 2,231 acres. Most of the acres served are cropland.

The pipeline was designed to last 50 years. It lasted 12. Corrosion was eating through the steel pipes, necessitating their removal and replacement with PVC pipe. Sections of the steel pipe were sent away and analyzed to determine the cause of the corrosion. The PVWCD manager was told by (NRCS) that the reason for the failure of the steel pipes was that the water was "too clean" and "too oxygenated." Water normally carries minerals that tend to coat the insides of pipes and thus protect them from corrosion. Replacement of the NPRC-S pipeline cost $1.5 million and was cost shared with 50% of the funds coming from PL566 and 50% loans from the Farmers Home Administration. The Powder Valley Water Users Association is repaying the loans. Pipelines used on individual farms were funded partially by grants from the FSA and part from the individuals adding the improved irrigation systems.

The same problem occurred with the W-1 and P-2 pipelines on the Wolf Creek project. All of those pipes above 12" in diameter were opened up every 700 feet. A rotary tool was inserted that lined the insides of the pipe with 3/8"-1/2" of mortar. All pipes below 12" in diameter were replaced. The NPRC-N pipeline was PVC from the beginning, so no replacements or repairs were necessary there.

Many potential users to the pipelines chose not to enroll their land. Many acres nearest the north side of Rock Creek are underlain with rock, and are best used for pasture. Those landowners considered their current irrigation practices to be adequate, and did not believe that they could afford to put the ground under sprinkler irrigation.

Potential Pipeline Projects

Deputy watermaster Tom Rudolph is of the opinion that the most important and beneficial future water conservation project with respect to pipeline projects would be to install a pipeline system serving the lands south of Rock Creek. He envisions a pipeline being installed along the Wilcox Ditch right-of-way. The Wilcox Ditch is the highest ditch leading south from Rock Creek. It is a long, inefficient ditch subject to frequent washouts on steep hillsides.

A south Rock Creek pipeline could potentially serve several thousand acres. The water would all be gravity flow. The potential exists to eliminate unscreened diversions. Water savings could be enormous. Mr. Rudolph estimates, for instance, that of 17-second feet of water that he puts in the Wilcox Ditch, only five are delivered to the end of the ditch. Other ditches have similar, if not as severe, water losses. Pine Creek, which loses a great deal of its flow into its rocky bed, is another stream that may benefit from installation of a pipeline system, provided that the water savings are kept within the creek and not simply allocated to the next senior water right holder in line.

Value of Irrigation Investments

Dozens of pipeline systems serve individual farms. Individual landowners have expended much time, effort and money to install and upgrade their irrigation systems. Millions of dollars of public and private money have been spent on irrigation diversions, transmission systems, pivots, pipes, and wheel lines. These systems increase the value of the land and increase the tax base.

Wingville Rotational Irrigation Agreement

Users of Pine Creek water have had a written rotational agreement in place for over a decade. Under the terms of the agreement Pine Creek water is rotated between "Upper Users" and "Wingville Users." Each group is allowed the use of the entire flow of Pine Creek for a 14-day period on a rotational basis. The rotation continues until the flow of Pine Creek drops below 600 inches at the gage station. At that point there is no longer enough water to reach the Wingville users. The remaining water is used solely by the upper users.

Abandoned Water Rights

Water rights are considered to be abandoned and can be cancelled if they have not been used for a period of five years. Some water rights that fall in this category are still on the books. Water rights are not cancelled until there is a request to cancel.

Some abandoned rights were used for placer mining and are on ground managed by the federal government. In Oregon a landowner may cancel a water right on his own property. The federal government has taken the position that it cannot legally cancel water rights on ground that it manages. Old unused water rights remain on the books in public land in this watershed.

Irrigation Efficiency

Over-irrigation of some parts of a field is unavoidable where flood irrigation is used. With flood irrigation, water flows from the top of the field to the low end. The high parts of the field must, therefore, be over-watered in order to adequately irrigate the lower areas. Flood irrigation is still the irrigation system of choice on less-productive ground because delivery and distribution costs are low and fields can be quickly covered with water. Flood irrigation is used on as much as 50% of the ground in some areas of the watershed.

If land can be leveled and strip borders constructed, flood irrigation can be the most water-efficient irrigation system available,. Unfortunately, irrigable land in this watershed doesn't lend itself to leveling or strip borders because of the 1%-10% slopes and frequent draws and ridges. Flood irrigation might provide maximum soil profile saturation that provides late-season recharge of creeks (T. M. Kerns, pers. com., 2002). The ability of flood irrigation to contribute to late-season recharge of creeks, however, will depends on the distance between the irrigated fields and the streams and the field soil moisture conditions prior to the start of irrigation.
Elmer Hill observed that there is more bird life in flood-irrigated fields than in sprinkler-irrigated fields (E. Hill, pers. com., 2002).

Many hand-pack sprinkler systems were installed on the better agricultural ground 40 years ago. These were largely replaced by wheel lines as irrigation technology advanced. During the past decade the trend has been toward pivots. Some larger operators have installed pivot irrigation systems throughout the valley. Water lost through evaporation is greatest with sprinkler systems, but sprinklers of all types are generally believed to be a more efficient water delivery system than flood irrigation.

One of the larger landowners on Wolf Creek is carrying out an innovative project that will eliminate six of the seven ditch diversions that the farm presently has from the creek. Irrigation water for the entire farm will come from one diversion into a 2-mile pipeline system that will be used to flood irrigate700 acres. The pipeline will feature 43 six-inch outlets that will be progressively opened and closed as the farm is irrigated from top to bottom. The system will eliminate all ditches, and use considerably less water than was formerly required. One of the ditches to be eliminated is 1.25 miles long, and loses 50% of its water to percolation before it reaches the end of the ditch. Water loss from the pipeline should be minimal. More water will be left in the creek. The project is being carried out on a cost/share grant from OWEB (F. and C. Colton, pers. com., 2002).

Measuring Devices at Diversions

Some streams have measuring devices on most diversions. For example, Rock Creek and North Powder River have measuring devices at all but two diversions. Pine Creek has measuring devices in place above Pocahontas Road (T. Rudolph, pers. com., 2002). Measuring devices have not been required on the smaller streams as long as users were cooperating. Measuring devices will continue to be installed

Bottling Plant

A specialized local industry deals solely in water. Oregon Trail Mountain Spring Water, located one mile north of North Powder, began operation five years ago. The company bottles and markets "100% mountain spring water" from Parker Spring. The 150-gallon per minute spring arises just east of the freeway. It was just 30 yards from the Oregon Trail, and was used by the pioneers. The company bottles the water in 20-fluid ounce bottles, and has the capacity of bottling 65 per minute. A major analysis is made on the water every five years, but the water is sampled weekly for the presence of coliform bacteria. The water has never flunked a test, and is touted by its producer as being one of the few bottled water products in the country that is unadulterated and unprocessed (K. Holman, pers. com., 2003).

Hydropower

A hydropower plant is in place on Rock Creek. The Rock Creek Power Plant is situated a little over one mile above the edge of the forest, and straddles the creek. It consists of one long building, which houses the generator; and several homes, only one of which is occupied. The facility is owned by the Oregon Trail Electric Company (OTEC).

The plant has not been operated since 1996 when OTEC let its Federal Energy Regulatory Commission license expire. The license was allowed to expire because obtaining a new 50-year permit would have involved an Environmental Impact Statement, an expense that was not felt justified to continuing the operation.

OTEC owns a 1902 water right for diversion of 13 cfs for hydroelectric generation. The plant diverted water from Rock Creek into a nearly 2-mile long, 36-inch flume that carried water to a small reservoir on the ridge south of the plant. A penstock conveyed the water down a steep slope to the plant's generator where the water was returned to the creek.

Sections of the flume have since collapsed or been crushed by falling trees. With no water in the wooden flume to keep the boards swollen, the wood has shrunk and created gaps that render the flume unusable. Inquiries and efforts are occasionally made by individuals to purchase and reactivate the plant.

Reservoirs

Reservoirs serve a number of purposes. They can store spring runoff for use during the summer. They also provide recreation opportunities, such as boating and fishing, control flooding and associated erosion, and augment late-season stream flows.

For example, older residents on Wolf Creek report that, prior to construction of the dam, the creek below the dam went dry as early as May 10th due to irrigation withdrawals. In wet years it ran "red with mud," and big willows could be seen coming down the creek "rolling over and over" (F. and C. Colton, pers. com., 2002). Big trees now line the creek, and have narrowed the channel to the point that there is doubt that the creek could handle the floods that formerly came down the stream. In the 1977 drought, the Wolf Creek area was "the only green spot in the valley" (F. and C. Colton, pers. com., 2002) due to irrigation with stored water that was not available elsewhere. Fish are now year-round residents in the creek.

The Powder River – Powder Valley Watershed has many small ponds and 11 reservoirs. Information on the reservoirs can be found in Table 36 and Figure 40.

Thief Valley Reservoir is managed by the Lower Powder River Irrigation District and supplies irrigation water to farms downstream from this assessment area. It was constructed through a 40-year federal loan, which has been repaid. Up to 4,000 acre feet of the reservoir's capacity, by some estimates, may have been lost to siltation from dredging which took place in Sumpter Valley.

Although heavily used for fishing, the reservoir is not required to maintain a fishery. The reservoir can be, and is, drained almost annually. ODFW would like to maintain a year-round fishery, and recommends a minimum pool level of 2,000 acre-feet (Hutchison and Fortune, 1967).

Table 35. Reservoirs in Assessment Area.

Reservoir	Capacity Acre ft.	Surface Acres	Dam Type	Height ft.	Dam Length ft.	Crest Width ft.	Permit #	Year Built
Pine Creek	120	30	Rock Rubble	15		15	R-660	Before 1897
Killamacue	312	25	Grouted Rock	11	60		R-603	1902 rebuilt 1929
Van Patten	160	24	Earth	14	150	20	R-132 R-789	1911
Rock Creek	452	25	Earth	28	91	17	R-490	1918
Thief Valley	26,000	750	Buttressed Reinforced Concrete	73	390	7		1932
Shaw	504	55	Earth	47	800	18	R-1810	1954
Goodrich	603		Earth	23	65	8	R-2615	rebuilt 1962
Wolf Creek	10,800		Earth	130	1600	30	R-5776	1975
Jimmy Creek	675		Earth	42	265		R-8192	1981
Salmon Creek	255		Earth	41	16		R-8346	1983
Pilcher	5,912	222	Earth	105	2070	28	R-8353	1983

Source: Water Resources Department, Baker City, Oregon.
(Note: The water right allows for the filling of Rock Creek Reservoir up to 3 times per year, but in practice it is filled just once).

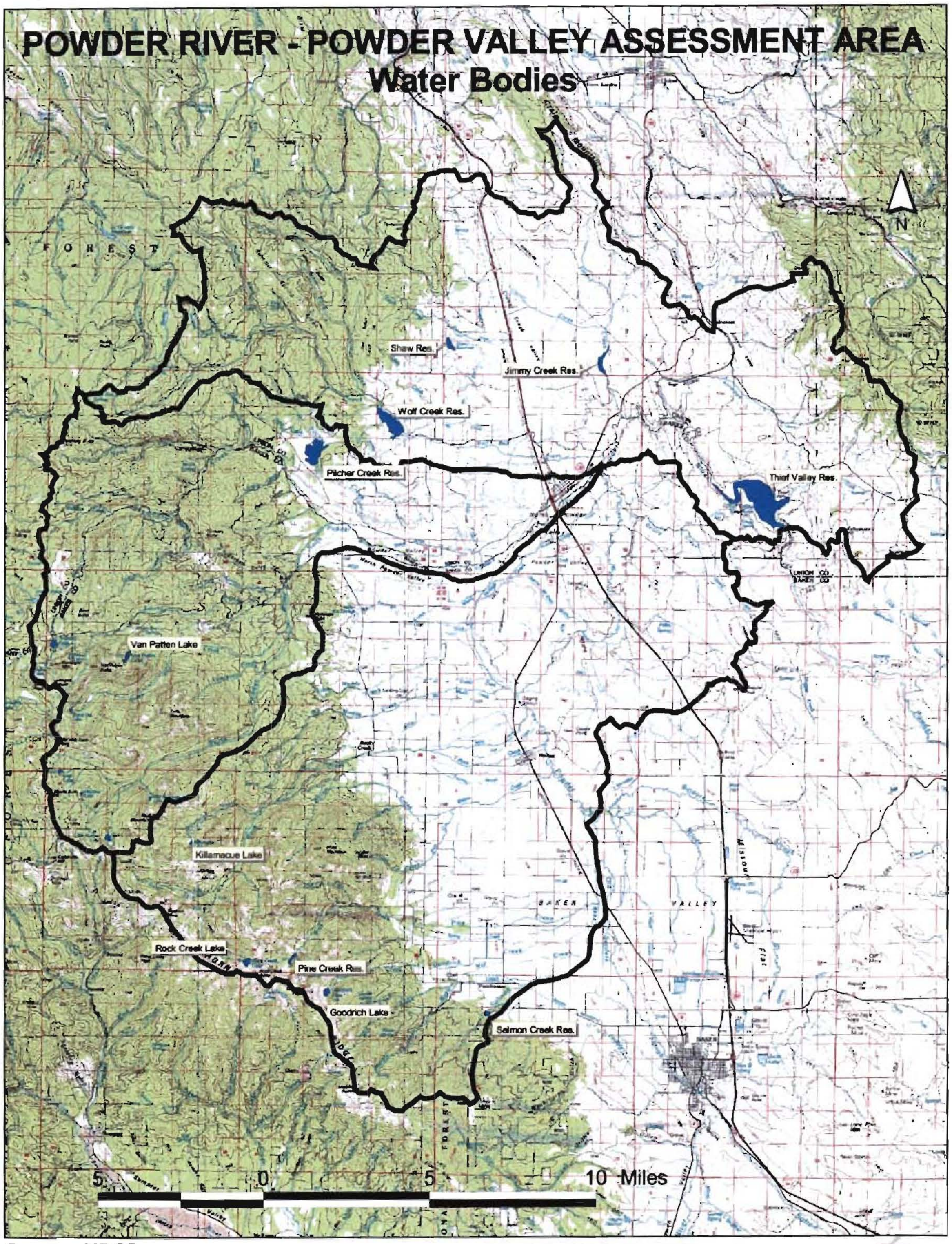
Previously-Considered Dam Sites

Three sites previously considered for reservoir construction are:

- Eilertson Meadow on Rock Creek
- the North Powder River just above the Anthony Lakes Highway
- lower Muddy Creek.

The proposed Rock Creek Reservoir site was rejected because test borings revealed the ground was too porous to provide a good anchor for a dam. The deputy watermaster, who regulates Rock Creek, estimates that if the dam were built, 5,000 to 6,000 acre-feet of spring runoff would be available to fill the reservoir (T. Rudolph, pers. com., 2002).

Figure 40. Reservoirs in the assessment area.



Source: NRCS

The proposed North Powder River Reservoir dam site is just above where the Anthony Lakes Highway enters the forest. The reservoir would have to be constructed to benefit irrigation, fisheries, recreation, and possibly provide power generation. Concerns include the presence of bull trout and the need to relocate the Anthony Lakes Highway and a few cabins south of the highway.

Plans to build the dam and a 19,500 acre-foot reservoir were drawn up in 1967, but the project was dropped because the per-acre-foot cost was too high for farmers to approve. A 75% signup was achieved at the $20 per acre-foot level as was originally offered, but updated estimates pushed the cost to $50 per acre-foot or higher. The estimated total installation cost of the North Powder Reservoir at that time was $3,858,630 (Baker Valley SWCD and Powder Valley WCD, June 1967). This reservoir site was reevaluated by the Oregon Department of Agriculture for a reservation of water for future economic development (see Water Reservation for Future Reservoirs, below).

The Muddy Creek Reservoir was to have been constructed two miles north of Haines, east of the railroad tracks, and just north of the Haines Cemetery. It was proposed as a storage and regulatory structure with a capacity of 810 acre-feet. Its capacity would have been limited by the presence of the Union Pacific Railroad tracks. Total construction costs of the reservoir would have been $218,050. The reservoir was to have been constructed in conjunction with the North Powder River Reservoir. When plans were dropped for the North Powder River Reservoir, plans were also dropped for the Muddy Creek Reservoir (ibid).

A water right application for a reservoir on Summit Lake, tributary to the North Powder River, was cancelled when proponents failed to follow through with their proposal. Other sites, which have been mentioned as possible dam sites, include two sites on Dutch Flat Creek, and another in Cougar Basin high in the Rock Creek drainage. Users of Pine Creek Reservoir have also considered increasing its storage capacity.

Reservoir Failures

Six dam failures have occurred on three streams over the years. These dam failures are also found in Appendix H that lists other stream channel alterations that have occurred since Euro-American settlement in the assessment area.

- Killamacue Reservoir. The dam at Killamacue Lake has failed twice. The first failure occurred as a tunnel was being drilled under the lake about 1900. Water broke through into the tunnel causing a roaring flood down Killamacue and Rock Creek canyons. The flood did a small amount of damage (G. Fisher, date unknown).

- Killamacue Reservoir. An earth-fill dam was built in 1902 at the outlet of Killamacue Lake. One morning in June 1917, with the reservoir full, a strong westerly wind whipped up waves and crowded water over the dam. Residents of the town of Rock Creek situated at the mouth of Rock Creek canyon heard the flood coming, ran for higher ground, and watched as their community was washed away (G. Fisher, date unknown). The dam was rebuilt with rock and mortar in 1929.

- Goodrich Reservoir. The dam at Goodrich Reservoir also failed twice. The first failure was of an earth dam that had been constructed in the early 1860's to supply water for mines served by the Auburn Ditch. The failure occurred just before 11 p.m. June 15, 1896. The flood claimed the lives of the seven members of the Clark French family living at the mouth of the canyon (G. Dielman, pers. com., 2003).

- Goodrich Reservoir. The second failure occurred in June 1956. (Dielman, 2003) This washout covered the creek's entire alluvial fan with rock, and ruined 100 acres. Those acres were purchased by the City of Baker, and are now being managed for tree production. The dam was rebuilt in 1962.

- Dutch Flat Reservoirs. Two dams have washed out on Dutch Flat Creek. The first was a dam at Dutch Flat Meadow that failed in 1922 (Baker County Historical Society, 1986).

- Dutch Flat Reservoirs. The second was a dam built lower on the creek in the 1930's. Improper provisions had been made for a spillway. The dam washed out as soon as the reservoir filled the first time (B. Vanderwall, pers. com., 2003). Neither dam on Dutch Flat Creek has been rebuilt.

All current dams are considered "safe," but hazard ratings have been assigned to each. Goodrich Dam has a "high" hazard rating because loss of life would be possible in the event of a failure. Killamacue and Salmon Creek Dams have a "significant" hazard rating because of the likelihood of loss of property. Shaw, Pine Creek, Rock Creek, and Van Patton Dams have "low" hazard ratings because "little or no downstream damage" would be expected. No ratings are known for the other reservoirs (Draft Baker County Study on Water Quality, 1995).

Water Reservation for Future Reservoirs

A study was recently completed in an attempt to forecast what the effects of global warming would be upon the Columbia, Sacramento, and Colorado River basins. More than two dozen scientists and engineers at Scripps Institution of Oceanography, the University of Washington, the U. S. Department of Energy, and the USGS conducted the study. The best-case scenario forecasts that water supplies will fall far short of projected future demands for water by cities, farms and wildlife (Bridges, 2002).

Overall precipitation levels are projected to remain constant, but some precipitation that now falls as snow would instead fall as rain. If more precipitation were to fall as winter rain, it would run off early when water demands are low. Snow packs would be greatly reduced, reservoir levels would drop earlier, and late-season water may be non-existent (ibid).

In anticipation of changing climate, droughts, increased demands, and future needs, the Oregon Department of Agriculture filed a reservation of water for the possible construction of future reservoirs in the Powder River and other subbasins. Oregon Administrative Rule (OAR) 690-509-0160 states that:

> "Unappropriated water is reserved for multi-purpose reservoirs to be constructed in the future. The priority date of the reservation is November 6, 1992. The quantity and source of reserved water is as follows: Twenty seven thousand (27,000) acre feet of the Powder River and tributaries upstream of Thief Valley Dam and below the confluence of Blue Canyon Creek (and) two thousand nine hundred (2,900) acre feet of water of the Powder River and tributaries below the confluence of Blue Canyon Creek, including Blue Canyon Creek."
>
> "This water reservation shall be effective until May 26, 2020, unless the effective date has been extended by further rulemaking of the Water Resources Commission."

Blue Canyon Creek is upstream from the Powder River-Powder Valley Watershed. Blue Canyon Creek has its mouth on Powder River at Auburn Road on Highway 7 at the head of Bowen Valley.

During the reservation process one reservoir site was considered within the watershed: the North Powder River Reservoir site above Anthony Lakes Highway. The OWRD modeled potential storage for ODA and found it to be only 5,500 acre-feet, 14,000 acre-feet less than the storage opportunity modeled in 1967.

Wells and Groundwater

Early residents in the rural areas of the watershed obtained their domestic water from hand-dug wells, piped-in springs, or from buckets carried from the creek. The first cable tool rigs capable of drilling wells appeared in Oregon in the 1930's. In the 70 years since the 1930's, over 800 wells have been drilled in the watershed. The exact number is difficult to determine since there was no requirement for filing start cards for wells until the 1970s. Most of the wells were drilled for domestic purposes. Nearly every rural home has a well. The number of wells in the watershed was estimated by counting homes and irrigation wells.

Table 36. Estimated Number of Wells in Watershed.

Number of Wells	Item	Source of Information
286	Dwellings receiving rural mail delivery from Haines/North Powder	Haines P.O.
5	Dwellings not receiving rural mail delivery	Haines P.O.
386	Dwellings between Pole Line Lane and Salmon Creek area	Counted
15	Dwellings in Telocaset area	Counted
20	Wells within cities of Haines and North Powder	Estimate
78	Irrigation wells drilled between late 1950's and 2000	Baker Co. Watermaster
20	Irrigation wells drilled before 1950's or after 2000	Estimate
810	**Total estimated wells within watershed**	

Source: James Kearns

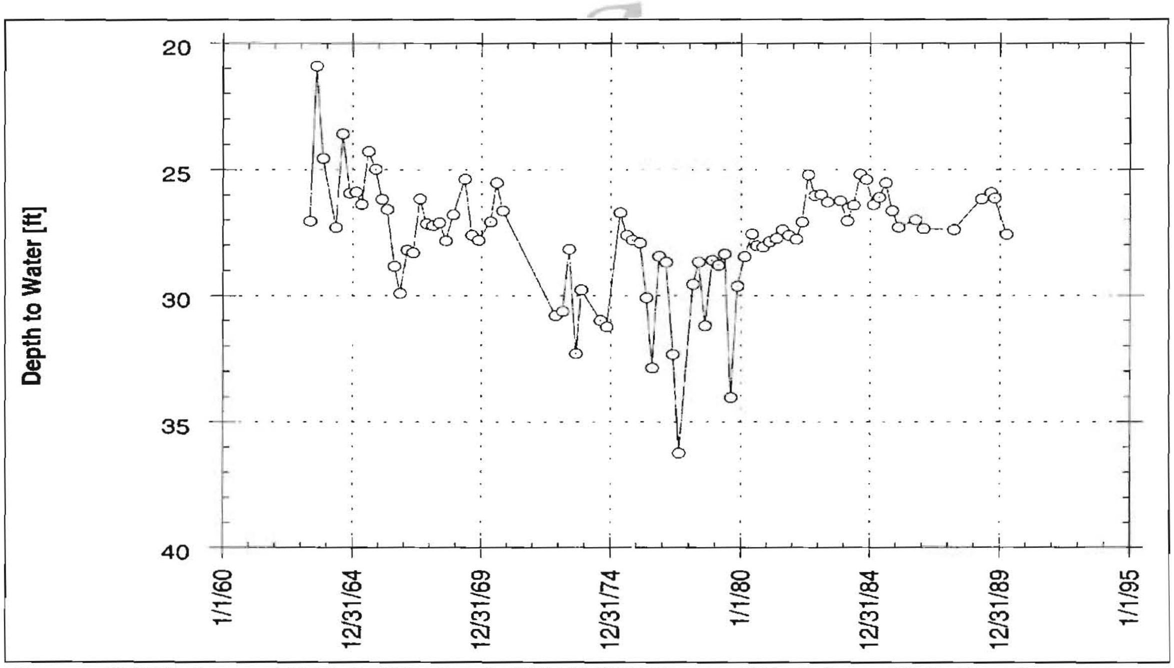
There are many more domestic wells than irrigation wells in the assessment area. An average water use per day of a domestic household of 4 with a lawn is at most 2000 gallons per day. Irrigation wells may pump anywhere from 150 to 1600 gallons per minute (Table 38).

Well Monitoring

The OWRD monitors selected wells throughout the state. Three wells were monitored in this watershed over periods of three or four decades. Hydrographs of those wells are shown in Figures 37-39. Monitoring of those wells was discontinued in the early 1990's due to budget constraints. No wells in the watershed are currently being monitored by the state.

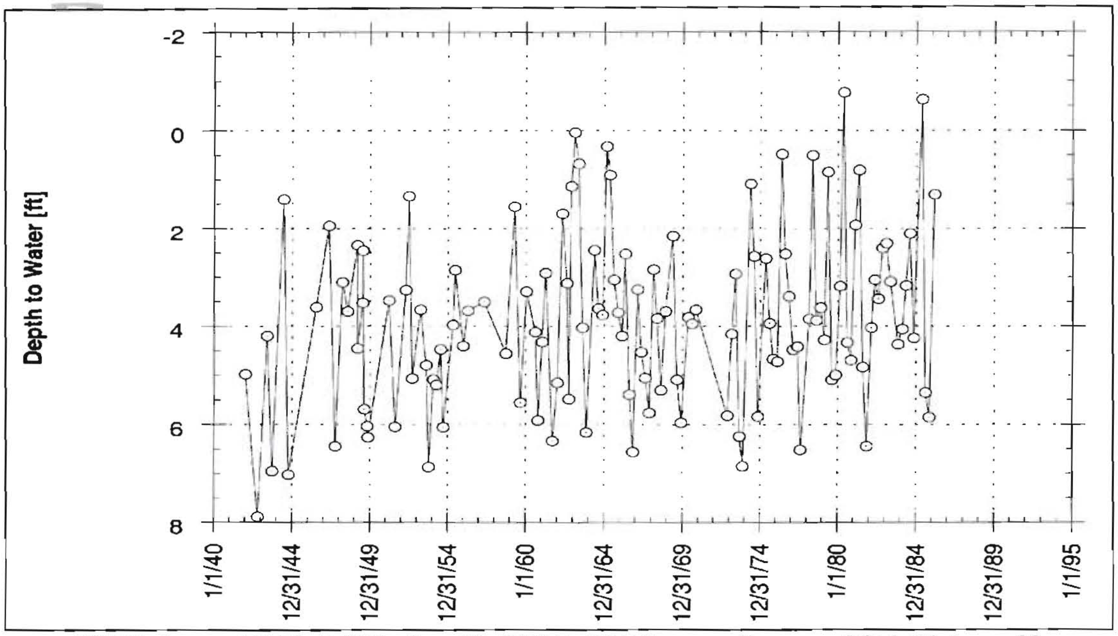
The wells were measured December 31 or January 1. The data varied widely between years, with the largest fluctuation being 15 feet on well #1. The overall trends are not conclusive. They show a trend varying by about ±1 foot since 1960 or earlier. The hydrographs show a year-by-year fluctuation that is much greater.

Figure 41. Hydrograph of State Observation Well #1.



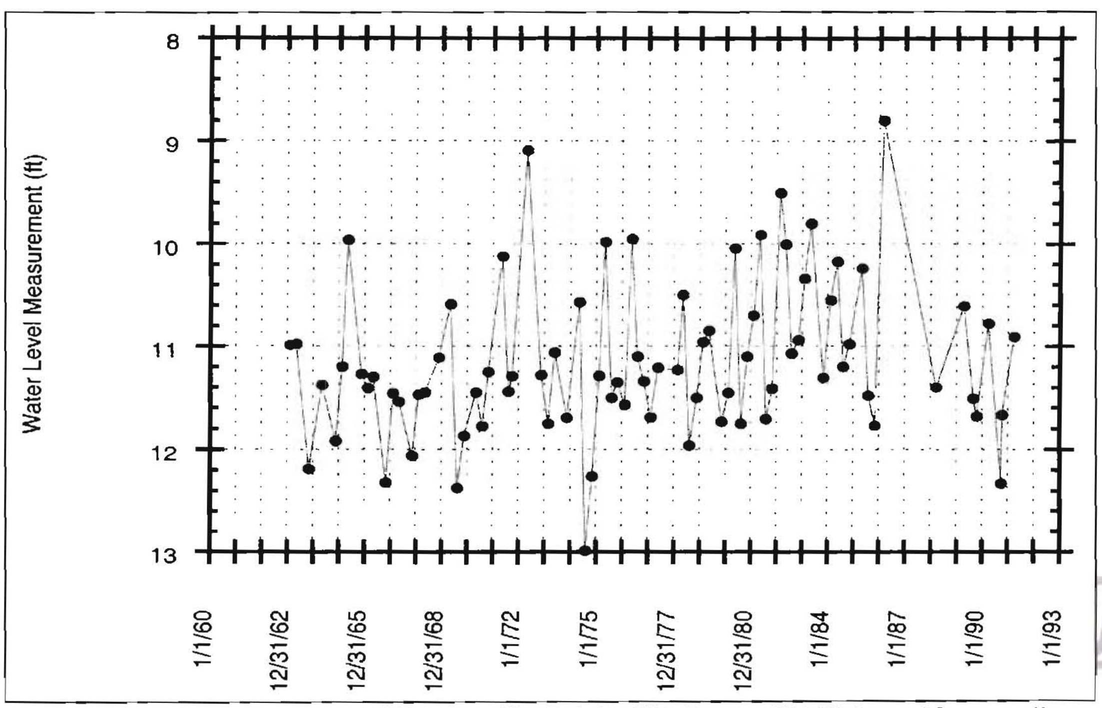
Source: OWRD. Located T.7S. R.39E., Sec. 3. NW1/4, NE1/4, near Old Highway 30, halfway between Haines and North Powder.

Figure 42. Hydrograph of State Observation Well #2.



Source: *OWRD.* Located T.7S. R.39E., Sec. 20, SW1/4, SW1/4, one mile west of Old Highway 30, on Haines Cemetery Lane.

Figure 43. Hydrograph of State Observation Well #3.



Source: OWRD. Located T.7S., R.39E., Sec. 28, NW1/4, SW1/4, near Old Highway 30, one mile north of Haines.

Well Problems

Dry Wells

The upper Pocahontas area is zoned "Rural Residential." Hundreds of homes are located in the area, with most having been constructed within the past 30 years. Many domestic wells in the upper Pocahontas area have experienced difficulties or have gone dry in recent years.

Complaints about wells to the watermaster's office in Baker City are investigated. The Watermaster has never found the problem well to have significant hydrologic connection to adjacent wells. If a connection was found, the older priority well would prevail.

Of the well problems investigated, approximately 80% were found to be problems with pumps. The other 20% were older, shallow wells between 50-70 feet deep. The watermaster's office theorizes that these shallower wells difficulty is because of agriculture's general switch from flood irrigation to sprinkler irrigation on the porous, rocky ground in that area. Less water is being recharged by irrigation than in years past.

Iron Bacteria

Some area farmers report a noticeable, and sometimes marked, decrease in their wells' production. Most often the problems are pump-related, or caused by "iron bacteria." Cameras have been lowered into problem wells in attempts to diagnose problems. The perforations in the well casings appear to be plugged with rust. The "rust" is iron bacteria. Iron bacteria are dealt with in two ways:

- One area farmer had a 1,700 gpm production decreased to 700 gpm over a 10-year period. A company from Pasco, Washington was hired that sets off blasting caps in the well. The blasting opened up the perforations in the well casing and his well went back to full production. This farmer considers blasting to be 100% successful in bringing his wells back to their original production.

- Another area farmer routinely dumps 5 gallons of bleach down his irrigation well at the end of each season. The bleach kills the iron bacteria. The OWRD issues guidelines for this treatment. In order to get bleach properly mixed with water in the well, they recommend pouring bleach into the well while the pump is running until bleach can be smelled in water coming from the pump. The pump is then shut off, and the well is allowed to sit idle for 24 hours.

Irrigation Wells

Domestic wells along the foothills of the Elkhorn Mountains are around 120-300 feet deep. An estimated average depth would be about 200 feet (B. Maynard, pers. com., 2003). Irrigation wells may go as deep as 800 feet, with 300 feet being about average. Water production from irrigation wells can generally be estimated to be around 2 gallons per foot of depth. Table 30 shows irrigation well production, and is a compilation of generalized data obtained from visits with various area farmers.

Figure 41 is a map of all irrigation wells of record located in the watershed. The map does not include wells drilled prior to the late 1950's or wells drilled after 2000. Records for those two time periods either do not exist or have not yet been processed in Salem. Two new wells that do not show up on the map were drilled between Willow Creek and the North Powder River in 2002. One older well exists in the lower area between Rock Creek and Muddy Creek.

Table 37. Depths and output of some individual irrigation wells.

Number of Wells	Depth in Feet	Gallons per Minute	Location
2	800	1600	Wingville
3	500	1000	Wingville
1	440	800	Wingville
1	300	600	Wingville
1	400	150	Wingville
1	160	100	Wingville
1	400	450	Wingville
2	100	400	Wingville
1	370	500	Wolf Creek
1	450	1000	Wolf Creek
2	300	1000	Willow Creek
1	300	550	Willow Creek
1	275	300	Willow Creek
1	175	600	Willow Creek
1	250	750	Willow Creek
1	800	800	Willow Creek
1	700	150	Willow Creek
1	450	750	North Powder

Source: Compilation from visits with area farmers.

Static Water Levels

Droughts and dry years are responsible for some, if not all, observable drops in static water levels in wells (see monitoring well charts, figures 38-40). Comparisons of annual precipitation to the hydrographs reveal that low static water levels occurred in dry years. When precipitation returns to normal, static water levels in these relatively shallow wells also returns to normal.

Static water levels in deeper wells may take longer to return to normal after dry years. A farmer in the Pine Creek area is of the opinion that static water levels in his deep wells don't return to normal until 9-12 months after precipitation returns to normal levels (Blatchford, 2003).

Groundwater Quality

Studies conducted about 40 years ago found groundwater quality to be good throughout the watershed. Some salinity/alkali hazard can be found in wells near the Powder River, but the hazard is generally low (Lystrom, et al. 1967; Ducret and Anderson, 1965). To avoid contamination from surface water and septic tanks, the OWRD requires that wells be sealed for their first 18 feet of depth, or 5 feet into an impermeable stratum, whichever is deeper.

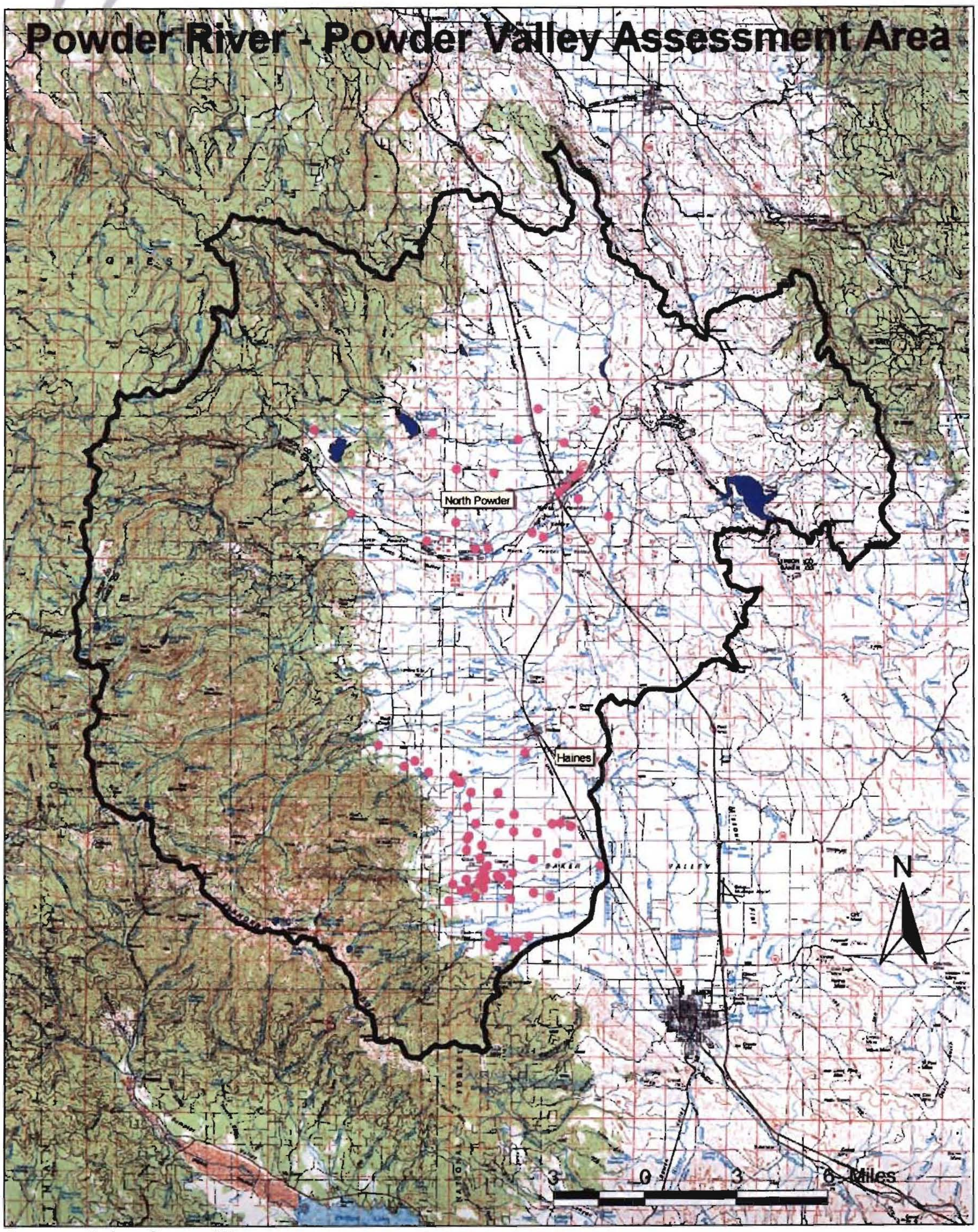
Pump Tests

In 1987 the Oregon Legislature passed ORS 537.772 requiring many well owners to conduct pump tests of their wells. Wells listed as a source of water on a water right permit must be tested, excepting, domestic wells not exceeding 15,000 gallons per day, wells used for stock watering, and wells used for watering lawns or noncommercial gardens not exceeding one-half acre in area. The exempted wells are not required to register or file for water right permits, and are exempt from the pump test requirements.

Pump tests on irrigation wells are conducted on or before the ten-year anniversary of the well's priority date. The well's static water level is measured before pumping, several times during pumping, and after the pump has run continuously for a period of four hours. The pump discharge rate is recorded at the beginning of the test and once every hour thereafter. The static water level is measured for four hours following pumping or until the well reaches 90 percent recovery from the maximum drawdown.

The information gathered from pump tests is submitted to the Oregon Water Resources Department. It is to be used to compile information on the aquifer. Due to budget constraints and reduced staff, the information collected on aquifers in the assessment area has not been compiled, and is only available in paper files at OWRD in Salem

Figure 44. Irrigation wells in the assessment area.



Source: Baker County Watermaster

Framework Geological Study

Little is known about the aquifers underlying the watershed. The Oregon Water Resources Department, in conjunction with the U. S. Geological Survey, conducts "Framework Geological Studies" that map the shape and composition of aquifers in the state. The studies produce 3-dimension geologic maps of the materials underlying a basin. They are currently working on the three areas of the state that have critical water supply problems---the Klamath, Willamette, and Umatilla Basins. The Umatilla study (where the aquifer level is dropping due to over-allocation) will be completed in 2004. When that study is completed, another basin will be surveyed.

The Powder River Basin would benefit from a Framework Geological Study. The best time to have the work done would be before problems manifest themselves. A federal government advisory committee prioritizes needs and selects basins to recommend for the next study.

Floodplains, Wetlands and Riparian Areas

Floodplain Maps

Floodplains are flatter areas along streams that are naturally subject to flooding. All streams have floodplains. Floodplain width varies along both sides of a stream and along the length of a stream. Floodplains generally increase in width as stream flow increases along the length of a stream and as stream gradient decreases. Floodplains are sometimes described as confined and unconfined. Bedrock or steep slopes often control the width of a confined floodplain.

Although floodplain width may be modeled for different flood frequencies, it is usually done for the flood flows that occur, on average, every 100 years. The President of the United States defined these floodplains as "the lowland and relatively flat areas adjoining inland…waters …including at a minimum, that area subject to a one percent or greater chance of flooding in any given year" (EO 11988). These are usually referred to as 100-year floodplains.

The width of the 100-year floodplain for a reach of any stream may be measured using the following guidelines. First, find a riffle, not a pool. Second, look for indicators along both sides of the stream for what is called "bankfull." Bankfull is the frequent low flood level of the stream that occurs on average every two years. It is near the base of well-established shrubs, such as alder, and is the transition between gravel and sand in the streambed and vegetation on the stream bank. It is easiest to see shortly after spring peak flows, and is evidenced by erosion lines on banks or deposits of sand/silt/organic materials. Bankfull may be difficult to determine where riparian grasses and herbs grow in the streambed below bankfull later in the summer. A comprehensive list of bankfull indicators is available from NRCS. Third, stretch a measuring tape or draw an imaginary line between the two bankfull indicators and estimate maximum water depth from that line to the nearest ½ foot. Fourth, double the height of the maximum water depth and stretch a tape or draw a second imaginary horizontal line. This is the approximate width of the 100-year floodplain.

A commonly used stream type classification system can be found in Applied River Morphology (Rosgen and Silvey, 1996). This system identifies 7 stream types (A through G) based on the parameters entrenchment, width/depth ration and sinuosity. This system is currently being used by the Wallowa-Whitman National Forest hydrologists, but stream classification is not yet finished.

The only known maps of 100-year floodplains within the assessment area are the maps published by the US Department of Housing and Urban Development (HUD) in 1978 for flood insurance evaluations in Baker and Union Counties. They used the same scale used on standard USGS topographic maps. These maps have not been put into a GIS database, so no small-scale maps of floodplains were developed for the assessment document. The HUD maps include 100-year floodplains that are at least 100 feet wide. This is the smallest width that could be shown on the 2.64-inch per mile HUD maps. The Baker and Union County Planning Departments have copies of these maps, as do some federal agencies in the area. Few areas on lands managed by the WWNF and BLM have floodplains at least 100 feet wide. Most of the wide floodplains are on private lands.

HUD maps for the Baker County portion of the assessment area, from NW to SE include Maps 4, 5 and 12. Copies of relevant sections of these maps are included in Appendix S as maps 4, 5a, 5b, 5c, 5d, 5e, 5f, 11, 12a, 12b, 12c and 12d. Floodplains shown on these maps are for the Powder River, North Powder River, Anthony Creek, Muddy Creek, an unnamed Muddy Creek tributary, Eilertson Meadow on Rock Creek, lower Rock Creek, Fish Creek, an area SW of Union Pacific Railroad south of Haines mostly in the Willow Creek drainage, Pine Creek, Goodrich Creek, Mill Creek, and Salmon Creek. The widest 100-year floodplain in the Baker County portion of the assessment area is shown on Map 5d about 3 miles upstream from the North

Powder River inflow to the Powder River, just east of the Interstate highway: it is about 4,900 feet wide.
Article .

Floodplains

Floods are less frequent and less intense along streams in the assessment area since installation of Phillips Reservoir on the Powder River above the assessment area. Wolf Creek and Pilcher Creek Reservoirs have virtually eliminated flooding in the Wolf Creek area. Spring flooding on the other streams is greatly reduced by opening all possible diversions to minimize flows in stream channels.

Altered Floodplain Function and Floodplain Restoration

Historic activities within and above the assessment area have altered floodplain function within all subwatersheds of the assessment area. See the HYDROLOGY section for a more broad discussion of historic land-use and their influence on Floodplain function. Some additional examples not included in the HYDROLOGY section are as follows: Most culverts installed on streams in the assessment area are only 50% to 80% of bankfull width. This increases water velocity through and below culverts. Increased water velocity erodes stream banks and straightens channels for some distance below each culvert until channels adjust to the new flow velocities. Federal agencies are now required to install culverts that will pass 100-year flood flows and that are bankfull width so as to not hinder fish passage or cause bank erosion and channel straightening. Most existing culverts on federal lands were designed for 25 or 50-year flood flows and are 50 to 80% of bankfull width (T. Bliss, Forest Service, field observations , 2002). The WWNF has completed an inventory of culverts on fish-bearing streams to prioritize future culvert replacement needs. Baker County, Union County and the BLM have also completed culvert evaluations.

As discussed in the HYDROLOGY section, flooding in the assessment area is less frequent and less intense in most areas due to upstream storage projects and diversion of water into ditches for irrigation beginning about April 1st of each year. Storage and diversion projects that reduce flooding in the assessment area include, but are not limited to, Phillips Reservoir on the Powder River above 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. Thief Valley Reservoir has the same effect downstream from the assessment area.

On the other hand, storage projects cause flooding of stream channels within the reservoir area. As reservoirs are drawn down and filled up, the old channels become flooded. Tail water (excess water not used by plants) from irrigation ditches may increase peak flows of small receiving streams, such as Big Muddy Creek and Willow Creek, or may change the timing of high flows to later in the summer. During intense rainfall from thunderstorms, ditches can intercept peak flows at stream diversions and/or as overland runoff, and that may cause ditch blowouts and/or increase peak flows of streams receiving tail waters.

Dikes and stream channelization have also affected flooding. Dikes and stream channelization constrain floodplains, thereby increasing local water depth and peakflow velocity. Some dikes were recently removed along the Powder River upstream from Haines. The Union Pacific Railroad fill functions as dikes in some locations. Examples are in the Willow Creek drainage where floodplains are shown on Map 12b and in the Warms Springs Creek drainage. Little information is available on effects of channelized reaches in the assessment area. Channelized reaches of Spring Creek, Goodrich Creek, Mill Creek, and Salmon Creek can be seen on Map 12d. Rock Creek is channelized through Haines; the old channel is north of the current channel.

Wetland Maps

Wetlands are "those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds" (E.O. 11990). All perennial and most intermittent streams have wetlands. Wetland width varies along both sides of a stream along the length of a stream. Wetlands are sometimes referred to as lotic riparian-wetlands (i.e. those along running water) and lentic riparian-wetlands (those along standing water) (USDI BLM 1994).

The USFWS mapped wetlands on 7.5-minute USGS quadrangles (2.64 inch/mile) in the 1970's as part of the National Wetlands Inventory. The USFWS maps do not show all wetlands. For instance, wetlands under forest cover are poorly mapped. See USFWS 1979 for an explanation of the classification system. Standing waters less then 2 meters deep (6.6 feet) are classified as wetlands. The USFWS is converting paper maps to GIS coverage state by state as funds permit. Progress of the conversion for Northeast Oregon is shown on the USFWS website at **www.wetlands.fws.gov/webstat.gif**. As of winter 2003, because only a few maps on the NE side of the assessment area had been converted to GIS coverage, no attempt was made to develop a GIS wetlands map for this assessment area. It is sufficient to note that wetlands occur along all perennial streams and portions of intermittent streams in the assessment area shown on USGS topographic maps. Wetlands have also been mapped along many ditches in the assessment area. Paper copies of wetland maps may be obtained from the Oregon Department of State Lands (ODSL), or may be viewed at county planning offices or NRCS offices.

Anyone who desires to map jurisdictional wetlands may do so by using the protocol in the 1987 US Army Corps of Engineers Wetlands Delineation Manual (USACE 1987). One must understand how to identify wetland hydrology, hydrophytic vegetation and hydric soils, as defined in the manual. Jurisdictional wetlands are those wetlands where dredge, fill and draining are regulated under the federal Clean Water Act by the Oregon Department of State Lands and the US Army Corps of Engineers.

Altered Wetland Acreage and Function

Some information is available about changes in wetland acreage within the assessment area. Wetlands have been created along irrigation ditches, in irrigation tail water areas, and as seeps where ground water resources are enhanced. Reservoirs both destroy old and create new wetlands. Federal funds have been used in the past to drain wetlands on private lands to enhance crop production. It is unknown to what extent these activities may have occurred on private lands in the assessment area because NRCS and FSA are not authorized to release this information for private lands. Wetlands have been filled to allow development of infrastructure (roads, culverts, railroads, dams, ditches) important for land management. Historic activities within and above the assessment area that altered floodplain function (discussed above) have also altered wetland function. It is possible that development of ground water resources (more than 800 plus wells) in the assessment area has reduced ground water flow in some shallow aquifers that do or did support wetlands in spring areas in the valleys.

Riparian Areas

The areas adjacent to streams are termed "riparian areas." They include floodplains and wetlands, but may include non-floodplain and non-wetland areas. A riparian area interacts with and is dependent upon the stream for its biologic integrity. It has higher levels of soil moisture than adjacent areas. An undisturbed riparian area supports native vegetation that serves important functions (Watershed Professionals Network, 1999).

Riparian vegetation reduces sediment entering the stream by reducing raindrop splash, helping control erosion, and filtering water. Riparian vegetation also provides habitat for insects that may fall into the stream and provide a food source for fish. Vegetative litter becomes an important nutrient source for aquatic insects that feed on it, and in turn, become food for fish. Large woody debris falling into streams creates pools, traps sediment, creates rearing areas for fish, provides cover from predators, and develops refuge areas for fish during high stream flows. Riparian vegetation can provide shade that reduces solar radiation warming of the stream. The roots of riparian vegetation hold stream banks in place and stabilize channels (ibid).

For these reasons riparian areas play a key role in the health of streams. Their function was not understood in earlier times and efforts were often made to reduce or eliminate the trees and shrubs that grew along stream banks. The result was often eroded stream banks and streambeds, widened stream channels, increased sediment, decreased stream flows, warmer water, fewer fish, and less wildlife.

Riparian areas in the mountains are mostly very narrow bands due-to the steep terrain (Baker Ranger District, 1999). In flatter areas, such as the Anthony Lakes basin, riparian areas are wide. Riparian areas increase in width in the valleys as stream gradient decreases and floodplain width increases.

Riparian Area Alteration and Restoration Projects

Riparian areas in the valleys have been altered more on average than those in the mountains. Stating this another way, all streams have had their riparian areas altered more in their lower reaches than in their headwaters. For example, there are areas in the valleys where riparian shrubs have been cleared from floodplains and streambanks. There has not been as much similar activity in the headwaters. This situation is changing as more landowners become aware of the advantages of healthy riparian areas, and of the agencies and organizations that are available to help with technical and financial assistance.

Several farms in the watershed have undertaken projects designed to improve the riparian areas of the streams that pass through their properties. The following discussion is taken from personal interviews with Wilson and Colton in 2002. Some of the projects were begun as long as 15 years ago without help from cost/share programs. Wolf Creek and North Powder River are the two streams that have had the most riparian restoration work done on them.

Feedlots that used to straddle these two streams have been moved back away from the water. Cattle are watered from tanks that are fed by springs. Miles of fencing have been installed along both streams to exclude livestock. The fenced riparian areas on each side of the streams may be as narrow as 15 feet or as wide as several hundred feet. Trees and shrubs have been planted. Native trees, shrubs, and grasses have been allowed to put out shoots, spread and grow. Ponds are being installed in wet, less-productive areas. Fish are being screened away from diversions.

The motivation behind these projects was a desire on the part of the landowners to increase the value of their assets. When financial help became available through governmental agencies, the landowners did cost/benefit analyses. They found that grazing the areas near streams might have paid them a little more than did the financial assistance that was offered, but the long-term benefits of excluding livestock and improving riparian areas were deemed more worthwhile (J. Wilson, pers. com., 2002).

More wildlife is observed in riparian areas now. Where no ducks or geese nested 15 years ago along the North Powder River, 30 nests were counted in a one-mile stretch (Wilson, 2002). Water quality and the fishery have both improved, according to the landowner and FSA personnel who have assisted him. The deputy watermaster stated that whereas the lower reaches of North Powder River used to "smell like a cesspool" late in the season, "it is now a live stream" (T. Rudolph, pers. com., 2002) indicating that improvements in stream water quality and stream flows are possible.

Technical and financial help to improve riparian areas, wetlands and forests are available through NRCS, FSA, OWEB, Nature Conservancy, ODFW, and other agencies and organizations. NRCS administers the Environmental Quality Incentive Program (EQIP), the Wildlife Habitat Incentive Program (WHIP), and the Wetlands Reserve Program (WRP). The FSA administers the Conservation Reserve Program (CRP). Most programs are cost/share programs with the public agency providing 60% or 75% of the funds, and the landowner providing 40% or 25%. The landowner's share can usually be provided through labor with little, or no, out-of-pocket expenses.

The landowners who have done riparian work on Wolf Creek and North Powder River feel that the government funding is doing a positive thing by paying farmers to improve their land rather than requiring them to do it and absorb a financial hit. They are surprised that more people don't take advantage of the programs that are offered.

The programs are generally designed to pay landowners to take land out of production. In some cases limited use might be allowed if wildlife habitat is improved through that use. An example would be cutting hay from the reserved land if green, lush growth for wildlife would result later in the season.

Sedimentation

Two former mining sites have produced large amounts of sediment:

- One site was a mine on the upper reaches of Marble Creek where large amounts of lime rock were stockpiled. Material from the stockpile washed down the creek to the valley. Baker County cleaned up the stockpile, and reclaimed the channel. The mine is no longer in operation, and no longer causes sedimentation problems (Helgerson, 2002).
- Gold dredging in another watershed caused a large amount of sedimentation in this watershed in the past. Up to three dredges operated on the Powder River in Sumpter Valley from 1913 to 1954. Tons of soil carried downstream from the dredging activities kept the Powder River in a constant state of turbidity for many years. It is felt that Thief Valley Reservoir has lost a significant amount of its storage capacity to sedimentation.

Sediment was also produced by placer mining activities on Salmon Creek and Wolf Creek. Sedimentation may also be occurring in Pine Creek in the area of the 1997 slide (See discussion on landslides in geology section).

Perhaps the most critical sedimentation in the watershed are four gullies caused by irrigation ditches south of the North Powder River.

- The Blume-Zilkey Ditch obtains its water from the Lower Bulger Ditch. The ditch flows straight east down a very steep hill, and has cut a channel 30 feet deep and 30 feet across. The gully can be seen where Foothill Road crosses it one mile north of Bulger Flat Lane. Four projects have been completed to abate the force of flow and catch sediment. One-quarter mile above the road landowners have installed a barrier composed of concrete rubble and rubber tires that were wired together and staked down with metal rods. The project was a cost/share program between government agencies and landowners. Most of the water is now in a pipeline, and most of the erosion is under control. Sediment has refilled half of the former gully. The gully is approximately 3/4-mile long.

- The Lower Bulger Ditch obtains its water from the Upper Bulger Ditch. It flows in a general easterly direction down a very steep hill, and has cut a 1/2-mile long gully through soft granite rock. The upper section of the gully is 60 feet deep and 30 feet wide with straight, perpendicular walls. Eight concrete structures have been installed with government assistance. They create a series of waterfalls to abate the force of flow and catch sediment behind the dams. The uppermost structure has caught enough sediment to refill half of the original gully.

- The Upper Bulger Ditch obtains its water from the North Powder River, and feeds the two previously mentioned ditches. The Upper Bulger Ditch has created its own impressive gully in a forested area. During the irrigation season a large volume of water is carried in the ditch that continues to erode the channel and banks. The chasm is 70 feet deep and 70 feet wide in places. The gully is cutting through glacial moraine and soft granite rock. Banks are crumbling away and taking large trees with them. The gully is about 1/2-mile long.

Figure 45. Blume-Zilkey Ditch Gully

Photo by Kevin Bradford. A dam of broken concrete rubble, and tires wired together and staked down, has filled the gully half full and abated the force of the stream.

Figure 46. Lower Bulger Ditch Gully

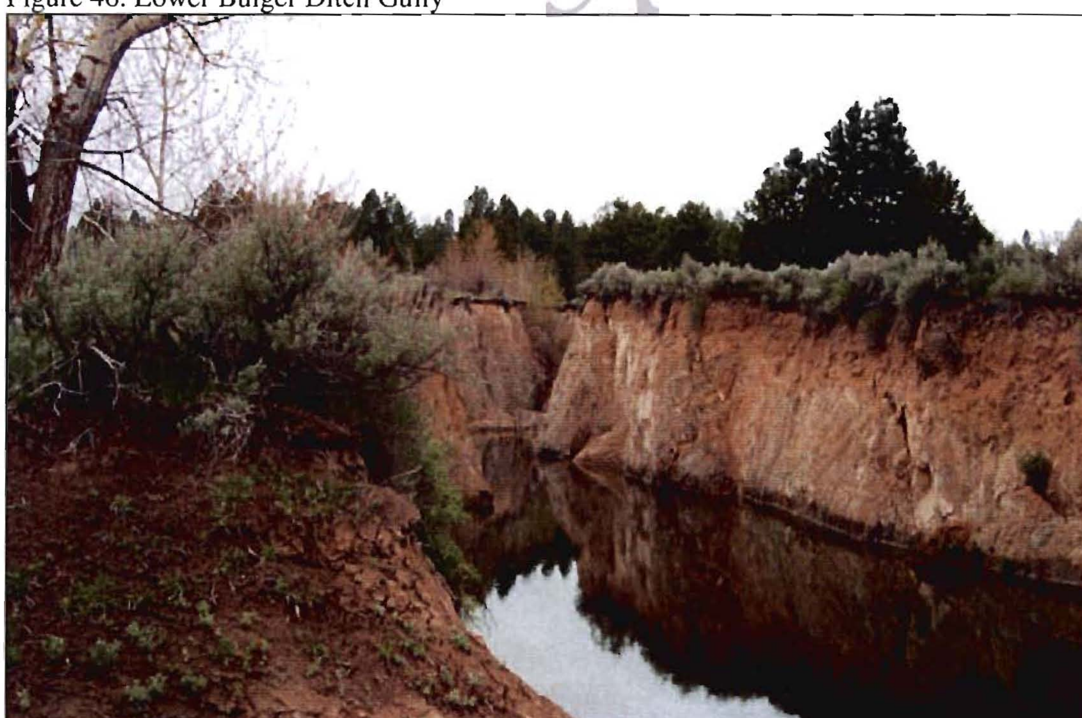


Photo by Kevin Bradford. A dam, located just out of the picture, lower right, has backed water up and created a settling pond for sediment. Before installation of the dam, the gully at this site was twice as at present.