Lower Wise River Assessment
Survey and Prioritization

April 23, 2010

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1. INTRODUCTION

In early November 2009, OASIS Environmental, Inc. (OASIS) conducted a stream corridor assessment of the lower Wise River over approximately 11.5 river miles beginning at the confluence with Pattengail Creek downstream to the mouth at the Big Hole River Appendix A: Maps 1-8). The purpose of this project was to inventory, assess and prioritize projects based on conservation, preservation and enhancement of the natural resources, which will benefit the public at large (BHWC-SOW, 2009). The following report provides a detailed and prioritized list of projects addressing natural resource concerns. Stakeholder concerns of primary interest include: water management improvements and irrigation efficiency leading to improved instream flow and support of irrigator needs; fish habitat enhancement; streambank stability opportunities; and stream channel morphology protection or enhancement. The Wise River from its headwaters to the mouth is listed as an impaired water body, which does not fully support its beneficial uses. The TMDL summarizes impairments as physical substrate habitat alterations, alteration in streamside or littoral vegetative covers, and low flow alterations.

This report is intended to serve as a working document and management tool to promote and support water conservation, restoration, and sustainable natural resource stewardship of the lower Wise River corridor. This document is also expected to be a part of a larger Big Hole Watershed Committee's (BHWC) protection and future flow monitoring and drought management planning effort. The BHWC and the community of Wise River intend to use this assessment and proposed project prioritization effort to collaboratively pursue additional grants from the Montana Department of Natural Resources (DNRC) as well as additional funding sources as appropriate.

2. METHODS

OASIS worked with the Big Hole Watershed Committee's Technical Advisory Committee, (BHWC TAC) to develop a strategy and methodology to inventory and prioritize irrigation infrastructure, fish habitat, stream bank and stream channel morphological needs throughout the project reach. To summarize, OASIS walked the entire 11.5 mile project reach starting at the confluence of Pattengail Creek and the Wise River downstream to the mouth at the Big Hole River. Prior to field reconnaissance, field base maps- consisting of color aerial photograph imagery (2005) plotted at scale of 1 inch equal to 600 feet were generated to use in the field inventory and assessment. All relevant infrastructures, physical features, areas of degradation, and/or potential natural resource improvements projects were mapped, photographed and quantified where applicable along the main stem Wise River corridor including the Smart Creek spring corridor and the unnamed springs-ponds on the Kampershroer Ranch (PKR). While outside the immediate 11.5 mile project reach, OASIS also examined the historic Pattengail reservoir, breached dam site, and the creek outlet to gain a firsthand appreciation of magnitude and extent of the dam failure, and subsequent 1927 episodic flood.

Personal communication and phone interviews with various stakeholders, including all major water users, irrigators, landowners, natural resource agency personnel, and local fishing outfitters and anglers were conducted to gain local knowledge, geography, water use practices, and history of the Wise River project area. The following stakeholders were either interviewed in person during the Wise River field site visit and/or contacted by phone and/or email.

- Liz and Don Jones, Rafter Ranch (landowners/irrigators)
- Dean and Matt Stanchfield, Stanchfield Land & Cattle Co. (landowners/irrigator/son)
- Peter Kampershroer (landowner)
- Lee Kirkpatrick (Kampershroer ranch manager/irrigator/stock owner)
- Fred Lovell (landowner)
- Cory Lamey (Zucker ranch manager/irrigator)
- Steve Buckner Split Diamond Ranch (landowner/irrigator)
- Ron Russell (Connolly caretaker)
- Andrew Hanson, manager Complete Flyfisher (outfitter)
- Craig Fellin, Owner Big Hole Lodge (outfitter)
- Darrin Kron, MT DEQ Water Quality Specialist
- Jim Olsen – MFWP (Regional Biologist)
- Dan Downing – USFS Fisheries Biologist
- Dave Amman, MT DNRC Hydrologist

3. RESULTS

The following section provides a summary of field reconnaissance, inventory, structural assessment, and personal meetings in the first week of November 2009 with landowners, water users, as well as phone interviews with additional stakeholders, outfitters, and government agency personnel. Aerial photo inventory base maps (Appendix A) show the entire project reach by river mile (RM) beginning at 0.00 at the mouth of the Wise River upstream to the confluence with Pattengail Creek (RM 11.43), and identifies major infrastructure and natural features as noted. The only available flow data are historic USGS flow records from a discontinued gage site that was located near RM 9.1. Discharge data includes a period of record from 9/28/1972 to 9/30/1985. Summary information for USGS Gage No. 06024590 Wise River near Wise River MT may be reviewed at:

http://waterdata.usgs.gov/nwis/nwisman/?site_no=06024590&agency_cd=USGS.

Summary mean monthly and peak flow data may be found in Appendix B.

3.1 IRRIGATION INFRASTRUCTURE

A summary of major water users on the lower Wise River project reach is presented in Table 1 below. The data was compiled from the MT DNRCs water right database found at:

http://nris.mt.gov/dnrc/waterrights/default.aspx.

An abridged summary (unofficial abstract) for each water right number listed in Table 1 is found in Appendix C. Note that each water right listed denotes a unique water right number, but multiple water rights may be used to irrigate the same place of use or acreage, and the water may be diverted from more than one source or point of diversion. Not a single ditch or head gate structure within the project reach was observed to have any kind of flow measuring device.

Table 1. Summary of the lower Wise River watershed water rights, location by river mile, and infrastructure. Note that most ditches serve multiple unique water rights; therefore, source name/ditches are repeated as appropriate below.

No.	Wise River Mile (RM)	MT DNRC Water Right No.	Source Name/Ditch	Owner(s)	Priority Date (yr/m/d)	Head Gate (HG) Type	Functional /Non-Funct.	Approx. Distance (ft) POD to HG	Max Flow Rate (cfs)	Max Acres
1	0.25	41 D 93829	Wise River RB	Kampershroer (PKR)	18900830	push up berm; none	NF	1600	1.25	252
2	na	41 D 93437	Smart Creek LB	Jones- Rafter Ranch	19120516	siphon under Hwy 43	F	0	3.13	50
3	na	41 D 93826	unnamed PKR spring creek	Kampershroer (PKR)	18870501	pond-culvert riser	F	0	3.75	252
4	1.55	41 D 93824	Wise River RB- Town Ditch	PKR- Allen- Lovell	19070501	timber/slot board	NF	100	2.50	61
5	1.55	41 D 1080	Wise River RB- Town Ditch	Hursh-MacD.-Nichols	19070505	timber/slot board	NF	100	1.25	5.2
6	2.08	41 D 93445	Wise River LB- Jolly Ditch	Jones- Rafter Ranch	19070501	remant timber- none	NF	50	6.25	163
7	2.29	41 D 93820	Wise River RB	Kampershroer (PKR)	18890501	none	NF	0	5.00	470
8	na	40 D 93822	Swamp Creek	Allen- Lovell	18900501	timber/slot board	F	0	1.00	90
9	na	41 D 93823	Swamp Creek	Allen- Lovell	19080501	timber/slot board	F	0	1.50	320
10	na	41 D 93099	Swamp Creek	Allen- Lovell	19120531	?	?	?	1.52	40
11	2.63	41 D 93828	Wise River RB	Kampershroer (PKR)	18900830	timber/slot board	NF	0	9.88	470
12	2.69	41 D 182379	Wise River RB	PKR- Allen- Lovell	18900501	timber/slot board	NF	0	6.25	635
13	2.71	41 D 93825	Wise River RB	PKR- Allen- Lovell	19040501	timber/slot board	F	200	2.00	579
14	5.10	41 D93442	Wise River LB- Truman/Co. Ditch	Jones- Rafter Ranch	19050417	timber/steel gate	F	150	2.30	205
15	5.10	41 D93443	Wise River LB- Truman/Co. Ditch	Jones- Rafter Ranch	19150501	timber/steel gate	F	150	3.45	205
16	5.10	* 41 D 4208	Wise River LB-Truman Ditch	Stanchfield	18900501	timber/steel gate	F	150	20.00	710
17	5.88	41 D 93438	Wise River LB- Company Ditch	Jones- Rafter Ranch	19050417	timber/steel gate	F	600	8.00	855
18	5.88	41 D 93439	Wise River LB- Company Ditch	Jones- Rafter Ranch	19050113	timber/steel gate	F	600	12.50	855
19	5.88	41 D 93440	Wise River LB- Company Ditch	Jones- Rafter Ranch	19120501	timber/steel gate	F	600	4.00	185
20	5.88	41 D 93441	Wise River LB- Company Ditch	Jones- Rafter Ranch	19130501	timber/steel gate	F	600	6.25	855
21	5.88	41 D 49589	Wise River LB- Company Ditch	Zuckers	19160501	timber/steel gate	F	600	10.00	197
22	6.73	41 D 49586	Wiser River LB Vineyard Ditch	Jones- Rafter Ranch	18990501	timber/steel gate	F	300	12.50	353
23	6.73	41 D 49588	Wiser River LB Vineyard Ditch	Vineyard Acres Sub.	19050417	timber/steel gate	F	300	8.75	140
24	6.73	41 D 93833	Wiser River LB Vineyard Ditch	Connolly	19050928	timber/steel gate	F	300	2.63	63
25	7.53	41 D 93835	Wise River RB Connolly Ditch	Connolly	18950501	timber/steel gate	F	50	3.75	369
26	7.53	40 D93832	Wise River RB Connolly Ditch	Connolly	19040501	timber/steel gate	F	50	1.35	369
27	7.53	41 D93836	Wise River RB Connolly Ditch	Connolly	19050417	timber/steel gate	F	50	2.70	369
28	7.53	41 D 93834	Wise River RB Connolly Ditch	Connolly	19150501	timber/steel gate	F	50	4.05	369
29	10.1	41 D 41592	Wise River LB Split Diamond	Buckner	19190101	timber/slot board	F	245	3.50	200
30	10.1	42 D 41592	Wise River LB Split Diamond	Buckner	19200401	timber/slot board	F	245	7.50	200

Notes: River Mile (RM) refers to base maps (Appendix A) where RM 0.00 begins at confluenec with Big Hole River.
LB = left bank; RB = right bank (looking downstream); POD = point of diversion
*Stanchfield (POD) listed at Truman Ditch, but actual source is Company Ditch at RM 5.88

3.1.1 Lower PKR Ditch

The first observed point of diversion on the Wise River is located on the right bank at River Mile (RM) 0.25, Map 1. The lowermost diversion within the project reach belongs to the Kampershroer Ranch, hereafter referred to as (PKR). No structural control is present; an alluvial gravel berm on the right bank is used to divert flows down the ditch. The ditch runs to the north through a series of holding ponds, head gates, timber frame diversion boxes, and beaver dams. Lateral ditches branch from the main ditch to irrigate hay fields farther north adjacent to the south terraces of the Big Hole River valley.

Photo 1. Lower Kampershroer, Wise River, RM 0.25, right bank (RB) no structural control.

3.1.2 Town Ditch

The next major point of diversion upstream is located on the right bank at RM 1.55, Map 2. Town Ditch is in poor condition and includes annual back hoe and heavy equipment work in the active channel to maintain an alluvial 'push-up' berm on the right bank to divert flows to the head gate. The head gate is composed of old timbers and a slot board frame which is nearly defunct and relies on temporary measures (tarps) to divert and control flows into the ditch as shown. The head gate is located approximately 100 feet downstream from the point of diversion, a narrow alluvial berm with sparse willows near the old timbers (Photos 2 and 3).

Photo 2. Town Ditch head gate structure, looking upstream, right bank, at RM 1.55 (Map 2).

Photo 3. Town Ditch, looking downstream.

On the opposite (left bank) of the Wise River adjacent Town Ditch, approximately 300 feet of an historic levee is present and parallels the left bank and floodplain margin (Photo 4). The levee consists of native alluvial cobbles piled on the edge of the left bank to an approximate height of four feet above the floodplain. The rock levee does not appear to serve any direct function or purpose at this time, but perhaps the structure was constructed for downstream flood control alleviation and/or means to confine flows towards the historic Town Ditch head gate. Further analysis is necessary to determine if removal of the levee is warranted to provide greater floodplain connectivity to the lower reach above town.

Photo 4. Opposite Town Ditch point of diversion, approximately 300 feet of historic cobble levee piles parallel the left bank in willows, photo background.

The Town Ditch bisects the right floodplain of the Wise River (Map 2) and then parallels the School House Road south of town (Map 1). Water users of the Town Ditch noted this segment of the canal is vulnerable to a failure where the ditch is perched well above the adjacent floodplain-terrace on the left margin. Loss of the ditch embankment at this site (Map 2) could potentially cause further channel avulsion and prohibitive costs associated with repair. Likewise, the Town Ditch runs through two 2- ft. diameter corrugated metal arch pipes as it crosses under the School House Road, which appears to be undersized as it causes backwater and flooding on the road.

3.1.3 Jolly Ditch

The Jolly Ditch point of diversion (POD) and remnant head gate structure is located on the left floodplain margin of the Wise River at RM 2.08 (Photo 5). As shown, the ditch no longer has a functional head gate and the ditch conveys flows only during high water. In fact, the existing ditch slope is adverse for some distance from the POD, conveying return wastewater flows derived from the upper bench (Mosley Ditch) back to the Wise River. While the Jolly Ditch remains in disrepair, its surface-groundwater contribution to Smart Creek, if any, is not fully known.

Photo 5. Remnant Jolly Ditch head gate looking upstream, Map 2, RM 2.08.

3.1.4 PKR Ditch 2

The next major point of diversion is located at RM 2.29, labeled as Kampershroer Ditch 2, Map 2. This POD has no structural control and appears to carry only high water flow to the Town Ditch.

Photo 6. Point of diversion with no structural control or head gate looking upstream, Wise River, RM 2.29, Map 2

3.1.5 Swamp Creek

Swamp Creek flows directly into the PKR- Lovell-Allen active ditch, intermixes with ditch water and then a portion of water flows thorough a concrete pipe to a series of additional timber- slot board diversions, and finally a small quantity of water discharges into the Wise River. The infrastructure and inability to measure or differentiate sources (Wise River vs. Swamp Creek) is problematic. In addition, Westslope cutthroat, a Montana Fish of Special Concern, is present in Swamp Creek. Isolation of this cutthroat population from Wise River is desirable to alleviate hybridization. The Swamp Creek historic creek channel is not readily apparent as the water is split and spreads out across a series of man-made impoundments, berms, and diversion check dams.

Photo 7. Swamp Creek flows directly into the PKR Ditch.

Photo 8. Swamp Creek outflow from PKR Ditch shows channelized creek corridor.

3.1.6 PKR-Lovell-Allen Ditches

Between RM 2.63 and 2.71, three head gates (PODs) are located on the right bank of the Wise River (Table 1, Map 2). The lowermost head gate has been completely abandoned and remains perched well above the active channel (Photo 9). Water right owners in the area include PKR, Lovell, and Allen, who cooperatively share the uppermost and most active ditch at RM 2.71. The middle ditch belongs to Lovell-Allen and remains functional only at high water (Photo 10). These two upper marginal head gate structures are constructed from old timbers and rely on slot boards to divert irrigation flows. The uppermost ditch POD consists of a 200 foot +/- alluvial cobble berm that requires annual maintenance and cleaning. The constricted nature of the corridor and dense riparian zone makes maintenance access a high impact, cumbersome, and dangerous (Photos 11-13).

Photo 9. Remnant diversion structure; PKR, RM 2.63, Map 2.

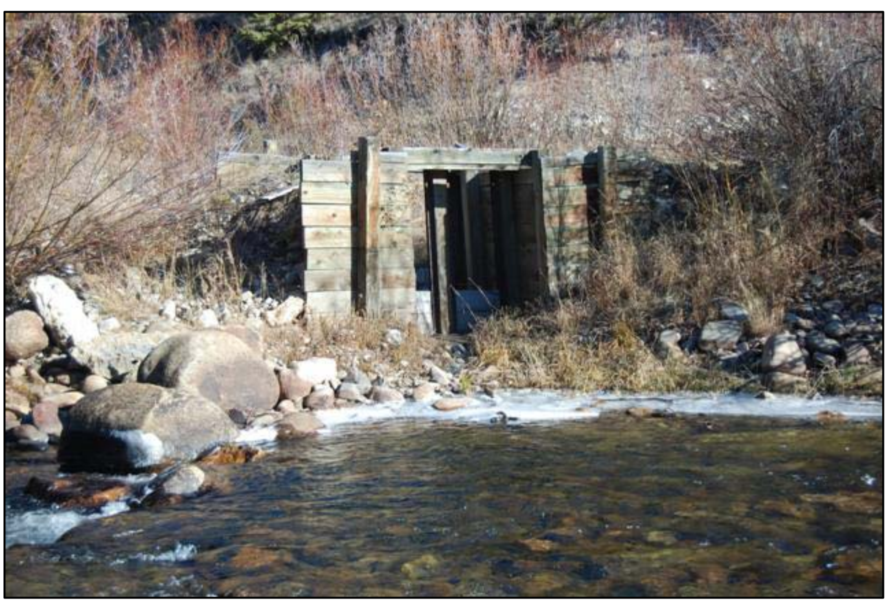


Photo 10. Lovell-Allen head gate diversion structure at RM 2.69, timber-slot board only functions during high water.

Photo 11. Looking down valley at PKR head gate structure on right bank, RM 2.7, Map 2.

Photo 12. Looking up valley at PKR head gate structure on right bank, RM 2.7, Map 2. Note poor access, temporary boardwalk and debris to access POD approximately 200 feet upstream.

Photo 13. Point of diversion on right bank to PKR Ditch at RM 2.71 requires annual maintenance and work in the active channel to control quantity of water inflow.

3.1.7 Truman Ditch

The next head gate and POD is located at RM 5.10, the Truman Ditch, which services the Rafter Ranch. The head gate configuration includes a timber frame and steel gate assembly. Several years ago, a grade control structure comprised of native boulders was constructed on the main Wise River channel to help maintain channel grade and divert flows to the Truman head gate. The grade control has started to lose some of its “footer” boulders on the far right bank, but overall, the head gate and diversion appear to function adequately. Additional efforts to improve and re-stabilize the grade structure across the main channel are warranted.

Photo 14. Truman Ditch head gate comprised of treated timber and steel gate assembly.

Photo 15. Looking upstream at Truman Ditch boulder grade control structure.

3.1.8 Company Ditch

The next major POD and head gate is called the Company Ditch, located at RM 5.88, Map 4 and is responsible for conveying irrigation water rights to the Jones, Stanchfield, and Zuckers ranches. Similar to the Truman Ditch, a grade control structure was constructed several years ago immediately upstream from the head gate. While the steel head gate and wheel stem assembly was also replaced at this time (circa 2004), the timber framing remains off kilter and needs repair or replacement. The point of diversion from the main Wise River is located over 600 feet farther upstream from the head gate.

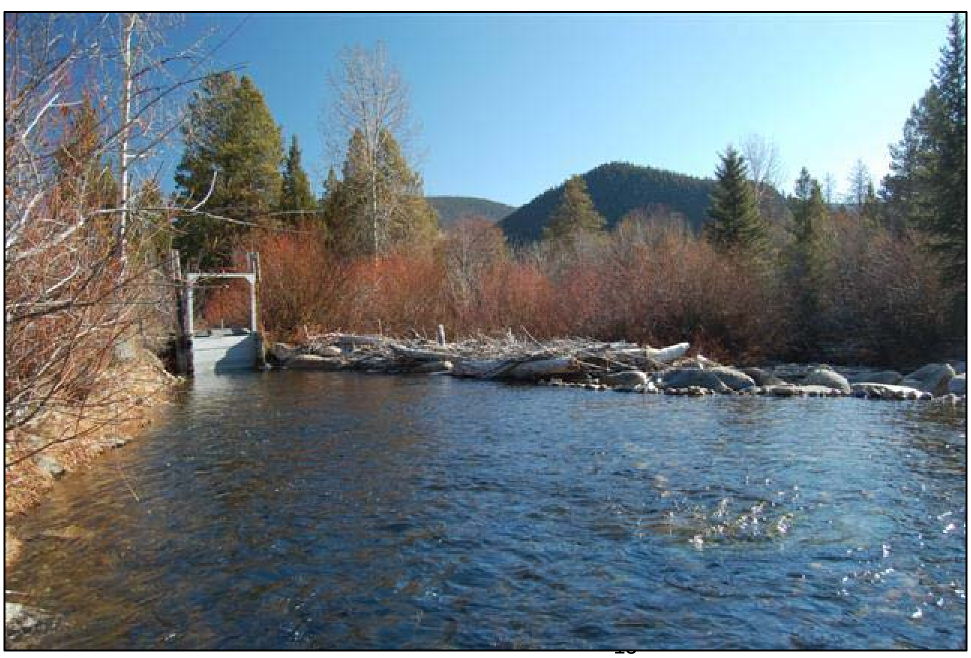


Photo 16. Looking downstream at the Company Ditch head gate, RM 5.88, left bank.

Photo 17. Looking upstream at steep grade control structure at Company Ditch.

The boulder grade control structure appears to function well for water delivery, but the steepness of the structure is not ideal from a structural or fish passage standpoint. Instead of taking up the entire grade in one major drop, the structure could be improved with several less severe step-plunge pools with at least two major sills to accommodate the steep gradient at this site.

3.1.9 Vineyard Ditch

The Vineyard Ditch is located on the left bank, RM 6.73, Map 4 and serves the Rafter Ranch water rights as well as the Vineyard Acres subdivision (Table 1). The Vineyard head gate is comprised of a steel gate and timber frame, same as Company and Truman head gates. The POD is located approximately 300 feet upstream from the head gate; a well vegetated willow-boulder berm and grade control structure across the main channel appear stable and functional. No other issues were identified with this infrastructure except, like all diversions in the project reach, Vineyard lacks a water measuring device, staff gage, and/or flume to quantify a flow rate.

Photo 18. Looking upstream at the POD grade control above the Vineyard head gate, RM 6.73.

3.1.10 Connolly Ditch

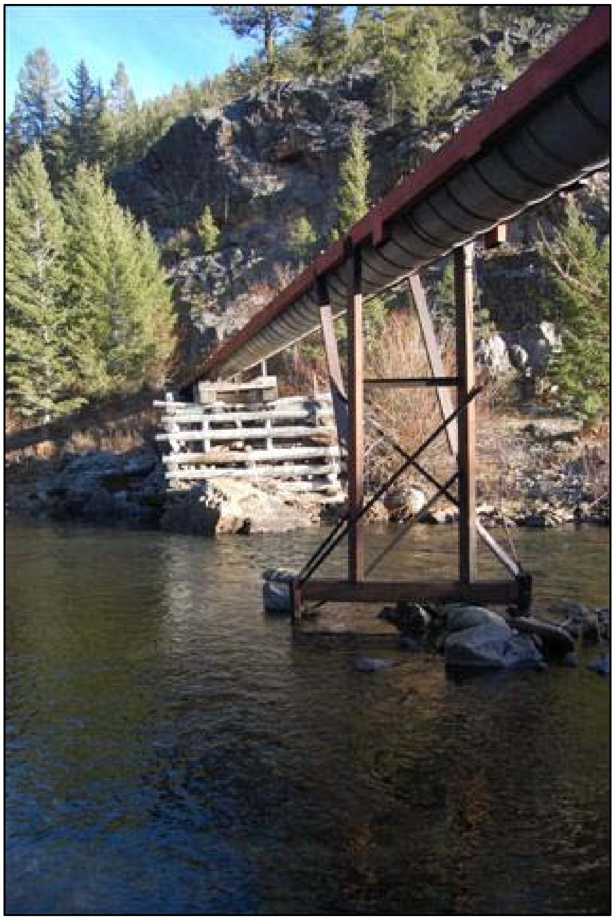
The Connolly Ditch (Photo 19) is located on the right bank of the Wise River, RM 7.53, Map 5. The head gate and rock vane grade control structure, which extends approximately 50 feet upstream was installed the mid to late 1990s by R.E. Miller and Sons. The head gate and diversion structure function well and does not require annual maintenance in the main channel. The structure consists of a slide gate and timber frame connected to a 3- ft diameter arch pipe outlet. No other issues were identified at this site, with the exception of no flume or measuring device present.

Photo 19. Looking downstream at the Connolly head gate and rock vane structure, RM 7.53.

3.1.11 Split Diamond Ranch Ditch

The most upstream point of diversion within the Lower Wise River project reach services Buckner's Split Diamond Ranch, located at RM 10.10 on the left bank and floodplain. Unfortunately, the POD and the place of use are on opposite sides of the river. The ditch takes off approximately 245 feet upstream from the head gate and return channel, a timber slot board structure as shown in Photo 20 below. The head gate structure appears functional. Remnant irrigation tarps in multiple channel threads were observed upstream, including the main channel, to help deliver adequate water to the head gate during summer base flow conditions. Downstream at RM 9.65, an open metal bottom flume elevated about 15 feet above the channel, supported by log crib piers and abutments is used to convey irrigation water across the Wise River to the Split Diamond hay fields or pasture (Photos 21-22). While not seen in operation, the flume is aged and leaks with dime sized holes visible in its bottom. Upstream from the flume crossing, the right bank margin of the Wise River is stabilized with riprap sourced from angular local bed rock that appears to protect the flume crossing as well as a road or historic railroad embankment.

Photo 20. Split Diamond head gate and return channel at RM, 10.10, Map 6. Timber and slot board assembly.



Photos 21 and 22. Split Diamond flume crossing on the Wise River, RM 9.65, Map 6.

3.2 FISH HABITAT

3.2.1 Wise River

Montana FWP has little if any quantitative fish population data on the Wise River for the last decade (MT FWP, Olson, personal comm.). Fish habitat along the Wise River is often limited by long steep riffles and few deep water pools or runs. Large boulders forming pool-pocket water is prevalent throughout the upper project reach. The higher quality, uncommon pool-run features are most often formed from a backwater effect where the river has eroded laterally into till or glacial outwash, forming a boulder barrier the modern hydrologic regime cannot mobilize and/or down cut through (Photo 23). Spawning habitat appears limited, mainly by the relative coarseness of the substrate and predominance of shallow, high velocity riffles. Homogeneous, relatively straight, high energy, steep river segments with low sinuosity and few in-channel obstructions does not appear to provide for gravel sorting and in-channel storage of readily available spawning-sized gravel sources. In general, lower energy holding water, and/or juvenile refuge sites were associated with side channels or secondary flood channel convergence zones within the main channel corridor. Lack of large woody debris within the base flow channel is likely attributed to a low rate of LWD recruitment from stable banks, and debris that does enter the channel, is typically flushed through and/or deposited outside the base flow channel, or in vicinity of irrigation diversion structures.

Photo 23. Pleistocene terrace on the left bank; a source of large boulders provides both vertical grade control and lateral bank stabilization, and influences hydraulics at baseflow, a slow water habitat upstream (Map 5, RM 6.90).

Photo 24. A secondary flood- side channel on the Wise River (Map 3, RM 3.10) provides some limited low velocity refuge and juvenile rearing habitat. Brookies and 20- inch plus brown trout were observed spawning in vicinity of the side-main channel confluence (11/2/09).

MT FWP personnel indicate seasonal use and distribution of resident and non-resident trout and grayling populations throughout the Wise River are not well understood (J. Olsen, personal comm.). Nonetheless, future head gate diversion structure improvements and replacement should consider the ability to retrofit or provide some kind of fish screen or fish passage mechanisms for the future.

3.2.2 Smart Creek and PKR Spring Creek Tributaries

Smart Creek and an unnamed spring creek on the Kampershroer Ranch as well as the Wise River itself has been identified by MT DEQ and others as a major cold water source, critical to the thermal regime and cold water fisheries of the Big Hole River (DEQ TMDL 2009; ,Kron, personal communications). Wise River and its contributing springs are one of few sources in the Middle and Lower Big Hole River TPA that substantially reduces the water temperature downstream on the main Big Hole River. The effects of flood irrigation on adjacent benches throughout the lower watershed and its contribution to groundwater supply and recharge are not well understood. While the efficiency of water use through flood irrigation can be questionable in general, its role as a means to recharge the river or springs during base flow and hot summer months needs to be further evaluated through the lower Wise River and Big Hole River valley. Replacing flood irrigation practices with sprinkler systems is not recommended until the irrigation return flow- spring creek hydrology through Wise River is better understood. Beaver and muskrat activity, sedimentation, and development of ephemeral and willow shrub wetlands are typical of the Smart Creek and unnamed springs in the lower valley. Spreading the water out laterally across a wide floodplain through this lower 1.5 miles or Wise River corridor is likely contributing to a large recharge zone for the local aquifer, and subsequent cold water source downstream.

Photo 25. Looking upstream at series of beaver dams near origin of Smart Creek below bench southwest of town, Wise River corridor (Map 2).

Photo 26. Looking down valley at PKR spring creek tributary and broad willow riparian corridor, approximately 0.5 miles upstream from Big Hole River confluence.

3.2.3 Meadow Creek

Meadow Creek, a tributary of the Big Hole River, flows through portions of the Zucker and Stanchfield ranch properties before entering the Big Hole River approximately 1.5 miles upstream of the Town of Wise River. Meadow Creek's flow regime is augmented by irrigation return flows and/or a recharge of the aquifer that occurs annually due to summer and fall irrigation practices. Landowners and resource agency personnel have observed Meadow Creek is an important fishery for wild salmonids including Westslope cutthroat and native fluvial Arctic grayling, *Thymallus arcticus* (D. Stanchfield, personal communications). Similar to flow augmentation and recharge of Smart Creek from Rafter Ranch irrigation practices, the Meadow Creek drainage maintains higher base flows derived from Zucker and Stanchfield flood irrigation, an important recharge and supply of cold water for the native and non-native fisheries. If local ranch properties do not flood irrigate, then Meadow Creek is either severely depleted of flow or dries up altogether in the fall (D. Stanchfield, personal communications). Prior to any ditch lining on the lower Company Ditch and/or recommendations for change in irrigation practices, the irrigation-groundwater-surface water dynamics that influence Meadow Creek need to be further evaluated. Further fish surveys to identify species of concern are

3.3 STOCK WATER WELLS

Two sites on the Kampershroer Ranch immediately north and south of Hwy 43 were identified as proposed candidate sites for the installation of stock water wells (Map 1a). The purpose of the wells is to provide an alternative and permanent source of stock water rather than the main PKR Ditch. By installing wells, water diversion at PKR Ditch head gate, near RM 2.71, could be reduced or turned off at an earlier date immediately following the irrigation season, and thus, provide more instream flow to the main Wise River through the late summer and fall season.

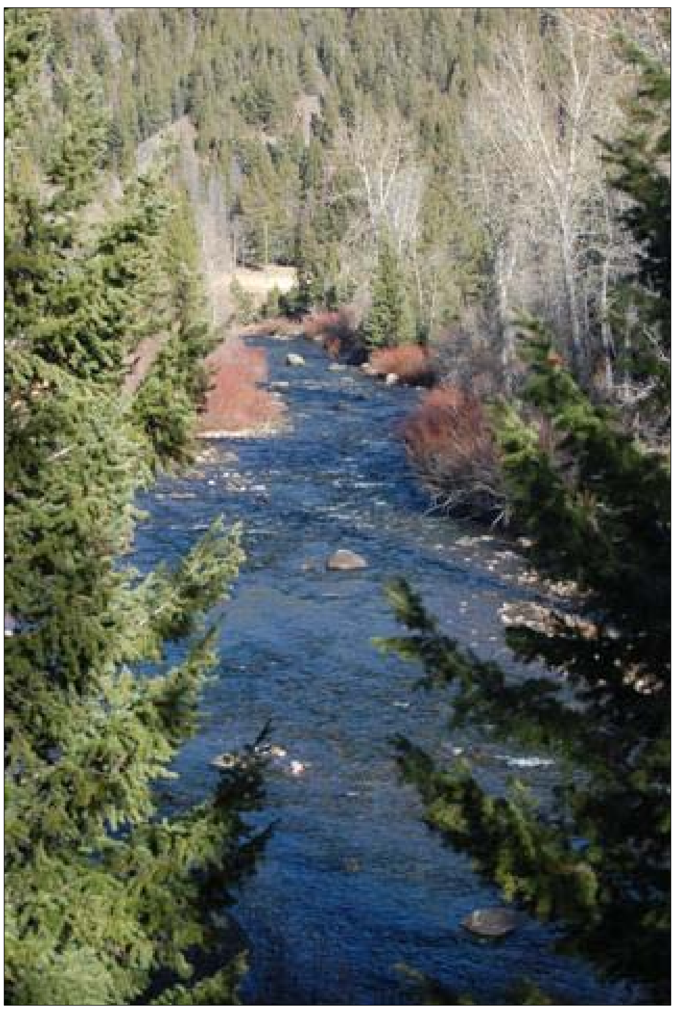
3.4 STREAMBANK AND STREAM CHANNEL MORPHOLOGY

The lower Wise River project reach may be characterized as a relatively steep, entrenched Type B3 or C3 (Rosgen, 1994) channel type whose bed and bank materials are composed of sand to large boulders. The channel bed and banks are well armored; the dominant substrate consists of cobble sized alluvium whose median particle size (D_{50}) often exceeds 4 inches or 100 mm. The historic and existing meander belt width is relatively narrow due to high valley bottom confinement. The 1927 breach of the Pattengail Dam and subsequent flood clearly was a catastrophic event that continues to affect the geomorphic character and condition of the project reach. Flood signatures or relict flood deposits remain visible today after 83 years. The 1927 flood appears to have caused a base lowering event, especially in the upper reaches of the project area. The base lowering event and ecological response on Pattengail Creek immediately below the dam has been documented by Schmitz et. al, (2009). The apparent downcutting or entrenchment that occurred also likely caused a shift in major plant community types where more upland (coniferous) forests recolonized adjacent terrace features now located well above the water table and active channel. Although discreet in places, field observations indicate the Wise River also likely experienced a base lowering as indicated by paleo flood deposits located well above the active channel and floodplain; coarse alluvium deposited on top of alluvial terrace features no longer accessible to the existing hydrologic regime. Thus, the 1927 catastrophic flood caused severe bank and bed erosion, down cutting, and major morphological change immediately during and decades after the event, and deposited boulders and cobbles, and railroad debris that remain well perched above today's active channel. As a result, the existing Wise River shows various levels of entrenchment and a simplified, often over widened channel geometry that lacks complexity in many reaches. Nonetheless, the majority of the project corridor remains laterally constrained and stable in its exiting configuration.

The modern (Holocene) channel of the Wise River has a relatively narrow meander belt width, meaning the active floodplain and the channel tends to be constrained laterally within a narrow valley bottom corridor. The active channel is often bounded within a narrow corridor by Pleistocene till and/or glacial outwash, and alluvial fan deposits, which consists of an unsorted mixture of boulders, cobbles, and sand deposited by glaciers, including at least two episodes of glaciations (Ruppel et. al, 1993). As a result of the local geology, valley topography, and coarseness of native substrate, the existing Wise River project reach remains laterally stable. Natural self-armoring of the bank margins is prevalent throughout the project reach. Accelerated stream bank erosion is not a substantial issue throughout the project reach. Isolated segments of eroding banks are few and do not pose a long-term issue. The moderate frequency of mid channel bars or vegetated islands suggests the existing Wise River channel may be sediment transport limited; the substrate deposited during the 1927 flood, and perhaps as recent as the 1997 flood on record, is no longer readily mobile under the existing hydrologic regime. Some of these island bar configurations tend to cause an over widening; a high width-depth ratio and an simplified shallow channel morphology where base flows are split into more than one channel thread.

The lack of large woody debris (LWD) directly in contact with the main channel is an interesting phenomenon throughout the lower Wise River. Mid- to small sized woody debris were notably built up and causing maintenance issues at major head gate structures. However, the majority of the project reach did not exhibit LWD in the active channel. Field observations again suggest that rates of lateral bank erosion; and therefore, recruitment of LWD, is not common due to natural bank armoring (sorting), and high lateral channel stability. Well vegetated, cobbly banks were prevalent along both steep mountain escarpment- conifer forest bank margins as well as broader floodplain-cottonwood forest, lower gradient reaches. Due to the high energy of the system and extreme variance in flood stage versus base flow stage, it is assumed the majority of LWD recruited into the channel is either flushed through the system or deposited on the distal edges of the floodplain and side channels.

Areas of accelerated stream bank erosion were not frequent; however, more notable, isolated segments of erosion are shown on Maps 1-8, including all major infrastructure, bridges, and observed riprap bank margins or levees.



Photos 27 and 28. Typical stable channel configuration, moderately entrenched with coarse bank materials and bed armor, a fringe of willow, and lodge pole pine and Douglas fir along the floodplain-terrace bottom.

4. MANAGEMENT AND MONITORING RECOMMENDATIONS

This section provides a list of potential monitoring activities, irrigation/infrastructure, and water/fisheries resource related projects within the lower Wise River project reach. As an adaptive management strategy, this report recognizes ongoing input from local stakeholders is critical to help further identify and prioritize potential projects for future MT DNRC Renewable Resource Grant program(s) and/or other funding sources, and eliminate unworthy or unfeasible projects herein.

The following Section 4.0 is a summary of potential conceptual projects and pre- project monitoring activity that would fulfill the goals and objectives of this inventory, assessment, and further identify projects whose main goal is to improve low instream flow through improved water management, increased efficiency and/or ease of operation to landowner/ irrigators (Wise River SOW, 2009).

4.1 FLOW MONITORING

Pre-project flow monitoring should include synoptic flow measurement (flow above irrigation takeouts, at mouth of Wise River and in all ditches). Synoptic data collection should all occur in a single day, and data should be collected two or three times in July, August, and September (D. Amman, DNRC, email FW: correspondence).

Development of a ***voluntary*** Drought Management Plan (DMP) amongst all major water users in the lower Wise River project reach will be a critical step to improve instream flow during sustained drought conditions. A Drought Management Plan- specific to the lower Wise River could be modeled after or incorporated into the existing BHWC DMP.

Prior to the DMP process, ***measuring devices*** are lacking and necessary infrastructural requirements on all major head gate ditches and structures, and sites where existing irrigation ditches branch or diverge to other water users down valley. All major irrigation diversions and head gates discussed in this report are in need of a mechanism to quantify and monitor the flow rate at any given time. Custom Cutthroat or Parshall flumes are recommended to be installed in concert with future head gate improvements, maintenance and/or total replacement of head gates to accommodate the given water right volume for each ditch system (Table 1). Further refinement of candidate sites for flumes is summarized in Table 2, Section 5.

4.2 FISH MONITORING: ENTRAINMENT AND ENTRAPMENT

Ditch monitoring for fish entrainment and entrapment would include fish surveys in ditches pre- and post-project implementation. Pre-project ditch surveys would help identify which ditches, if any, are candidates for fish ladders and/or fish screens. Fish ladders providing passage from the ditch back to the main channel on the lower Big Hole River have proven to reduce brown trout entrapment by nearly half after two years of monitoring (J. Olsen, personal comm.) Fish passage mechanisms such as a ladder or bypass channel may be preferred over fish screens because screens require high level of maintenance and if truly self-maintained, are extremely expensive. Other alternative options to mitigate entrapment include slow, incremental draw down of ditches and reducing in-channel habitat in ditches ie. (smooth bottom, minimize rocks, cover, deep water). Updated fish surveys of Meadow Creek and Swamp Creek are recommended to better understand population distribution and potential fish passage and fish barrier requirements to conserve native species.

4.3 IRRIGATION INFRASTRUCTURE

4.3.1 Lower PKR Ditch

Install a permanent head gate and grade control structure similar to the boulder weirs that have been effective at other head gates and a flume to measure flows in the ditch. Pre-fabricated cast iron gate frames and assemblies are available from regional manufacturers.

4.3.2 Town Ditch

Discontinue use of the Town Ditch. See Section 4.3.5.

4.3.3 Jolly Ditch

Install a permanent head gate and grade control structure similar to the boulder weirs that have been effective at other head gates and a flume to measure flows in the ditch. Pre-fabricated cast iron gate frames and assemblies are available from regional manufacturers.

4.3.4 Swamp Creek

The lower reach of Swamp Creek is captured by and/or flows directly into the PKR Ditch. Westslope cutthroat trout, *Oncorhynchus clarki lewisi,* a Montana Species of Special Concern (M FWP) are known to be present in upper Swamp Creek (J. Olsen, personal comm.). At present, non-native fish could physically access upper Swamp Creek through the main PKR Ditch. Therefore, a siphon or pipe system that provides a physical fish barrier and separates native Swamp Creek flow from Wise River ditch flow is recommended on Swamp Creek proper. The purpose of improved infrastructure and source control is to 1) restore Swamp Creek flow to the Wise River and 2) prevent hybridization and loss of a fragmented pure Westslope cutthroat population. The lowermost segment of Swamp Creek is ditched and denuded with a century of stock use and manipulation of the drainage and ditch system. Restoration efforts of the last 500 +/- feet of Swamp Creek and better irrigation control structures would provide resource improvements for multiple stakeholders including the general public.

4.3.5 PKR-Lovell-Allen Ditches

Consolidate five (5) separate points of diversions into one shared head gate and major source ditch. Discontinued use of the Town Ditch at RM 1.55, PKR Ditch 2 (RM 2.29), remnant PKR Ditch (RM 2.63), and Allen-Lovell Ditch at RM 2.69; and partner all remaining water rights through a single point of diversion and head gate assemblage and flume near the PKR-Allen-Lovell POD (RM 2.69). Two, 2- ft diameter round metal culverts (CMPs) on a ditch / road crossing approximately 3,600 feet north of the POD are undersized and would require resizing and replacement.

4.3.6 Truman Ditch

Improve and maintain boulder grade control structure. Install a flume to measure flows on ditch near POD.

4.3.7 Company Ditch

Improve and maintain grade control structure, replace old timber frame head gate with either treated timber or a custom formed concrete headwall assembly.

4.3.8 Split Diamond Ranch Ditch

As a conceptual idea to eliminate use of the existing flume crossing on the Wise River, further stakeholder inquiry and detailed topographic survey data are necessary to determine if Split Diamond Ranch could feasibly change its POD to the right (east) bank. In addition, it is unknown at this time whether or not the Flying Cloud Ranch and USFS would consider a ditch or pipe easement across respective properties.

At existing POD (RM 10.1), recommendations include 1) design and installation of a fish passable grade control native boulder structure, 2) design and installation of a measuring flume on ditch, and 3) repair existing flume at crossing (RM 9.65).

4.4 DITCH LINING

Ditch lining and/or piping over long spans of upland terraces that are miles from perennial streams sources, and where the native substrates appear especially porous may be a prudent best management practice (BMP). However, before various techniques and/or materials to eliminate ditch loss due to high seepage rates are recommended, an understanding of ditch segments that are clearly 'losing' reaches should be further analyzed**.** Prior to this effort, appropriate flow measuring devices must be in place on the subject ditch(es) to establish quantifiable baseline discharge data near the points of diversion and to identify specific open ditches that may be prone to high seepage loss.

4.5 FISH HABITAT

Smart Creek, Meadow Creek, the PKR Spring Creek, and the Wise River provide the Big Hole River and its fishery with a vital source of cold water input. The area near these sources is one of a few key places where the Big Hole River thermal regime is reset, providing the coldest sources of incoming surface flow measured in the middle Big Hole River reach (Kron, personal comm..). For this reason, it is not recommended the Wise River valley bottom or adjacent high terraces be converted from flood to sprinkler irrigation practice without further understanding of surface-groundwater interactions. While greater efficiency may be achieved, the long-term, overall consumption and impact to the groundwater table and surface water hydrology needs to be further evaluated.

A conceptual project to create and promote greater geomorphic habitat complexity on the main Wise River includes the engineering and installation of boulder and large woody debris structures (Figure 1). The lower Wise River project reach, especially the lowermost three miles is characterized by simplified channel geometry, long segments of shallow riffles with little habitat value. Opportunity exists to design a series of engineered boulder and log jams to promote greater physical habitat complexity, cover, and refuge for fish. Log jam structures are often used for mitigation and restoration purposes targeting threatened or endangered anadromous fish populations throughout the Pacific Northwest. As a steep, well timbered glacial mountain valley, the Wise River is an appropriate drainage to incorporate native wood and boulder materials to enhance aquatic habitat and provide alternative, bioengineered bank stabilization and revegetation techniques.

Due to the 1927 catastrophic flood caused by the breach of Pattengail Dam, the Wise River experienced episodic geomorphic and aquatic habitat alteration including channel straightening and entrenchment as well as coarsening of the channel bed. Limited in-channel habitat complexity remains today, which is most prevalent towards the lower three miles of the Wise River. Future projects that increase channel length and belt width (sinuosity), and encourage self-maintained pool and deep water habitat for thermal refuge are recommended.

Insert Figure 1

4.6 STREAMBANK AND STREAM CHANNEL MORPHOLOGY

4.6.1 Site 1- upper reach

A short, 50- ft segment of the Wise River's left bank immediately below the confluence with Pattengail Creek is eroding in vicinity of the NF 73 Scenic byway pull off, RM 11.38, Map 7. While the upper terrace is not in imminent danger of collapse, the asphalt covered shoulder of the road could potentially fail if undermining of the bank continues.

Photo 29. Bank erosion on the left bank margin, Wise River, RM 11.38. Note close proximity of parked vehicle on road pull-off, upper left corner.

4.6.2 Site 2- lower reach

Bank stabilization and revegetation and fencing on two, 200- foot long eroding right (east) bank segments located below Town Ditch, between RM 1.20 and 1.35, Map 2 (photos 32-33). These 5-7 ft high floodplain-terrace banks appear susceptible to further bank retreat with no riparian buffer as the channel continues to laterally migrate into a coarse gravelly unconsolidated alluvium overlain with a thin veneer of soil and sparse sagebrush and upland grasses. Water users expressed concern that if the channel avulses and changes coarse here, the main channel will capture the Town Ditch and bypass the Hwy 43 Bridge downstream. This segment of the lower Wise River offers potential to initiate pro-active, bioengineered bank stabilization and revegetation measures while also recognizing natural geomorphic processes, channel adjustment, and an increase in the meander belt width (sinuosity) and decrease in channel slope occurring over time.

Photos 30-31 provide uncommon examples of active bank erosion in the lower Wise River, RM 1.20- 1.35. Both banks lack a woody riparian buffer zone and provide candidate sites for bank stabilzation, revegetation, and fish habitat enhancement.

5. PROJECT PRIORITIZATION

After further Wise River Watershed Group meetings and input from various stakeholders, the following projects were rated as the primary priority for potential government grant program(s) and to support baseline flow monitoring activity.

5.1 IRRIGATION INFRASTRUCTURE

5.1.1 Flumes

The following irrigation ditches, a subset of Table 1, are proposed for final design plan and specifications to size and install Parshall or Cutthroat flumes.

Table 2. Proposed irrigation ditches for design and installation of flume measuring devices.

No.	Wise River Mile (RM)	Source Name/left or right bank (LB/RB)/Ditch Name	Owner(s)	Existing Head Gate (HG) Type
1	0.25	Wise River RB (PKR 1)	Kampershroer (PKR)	push up berm; none
2	na	Smart Creek LB	Jones- Rafter Ranch	siphon under Hwy 43
3	1.55	Wise River RB- Town Ditch	PKR- Allen- Lovell-Hursh-MacD.-Nichols	timber/slot board
4	2.08	Wise River LB- Jolly Ditch	Jones- Rafter Ranch	remant timber- none
5	2.29	Wise River RB (PKR 2)	Kampershroer (PKR)	none
6	2.69	Wise River RB	PKR- Allen- Lovell	timber/slot board
7	2.71	Wise River RB	PKR- Allen- Lovell	timber/slot board
8	5.10	Wise River LB- Truman Ditch	Jones- Rafter Ranch	timber/steel gate
9	5.88	Wise River LB- Company Ditch	Jones-Stanchfield-Zucker	timber/steel gate
10	6.73	Wiser River LB- Vineyard Ditch	Jones-Connolly- Vineyard Subdivision	timber/steel gate
11	7.53	Wise River RB- Connolly Ditch	Connolly	timber/steel gate
12	10.1	Wise River LB- Split Diamond	Buckner	timber/slot board
Notes:	River Mile (RM) refers to base maps (Appendix A) where RM 0.00 begins at confluence with Big Hole River. LB = left bank; RB = right bank (looking downstream); POD = point of diversion *Stanchfield (POD) listed at Truman Ditch, but actual source is Company Ditch at RM 5.88			

5.1.2 Head Gate and Point of Diversion Channel Improvements

This section and Table 3 below assumes the proposed five PODs associated with the PKR-Allen-Lovell water rights are combined as a single, shared POD (see Sec. 4.3.5). As such, the following ditches will require installation and/or replacement of a head gate assemblage, including flumes in the ditches, and potential fish ladder or passage apparatus if fish entrapment in ditches proves to be a concern.

Table 3. Summary of proposed sites for infrastructural improvements including flumes, head gates and/or grade control structures.

No.	Wise River Mile (RM)	Source Name/left or right bank (LB/RB)/Ditch Name	Major Water UsersOwner(s)	Proposed Infrastructure Improvements
1	0.25	Wise River RB (PKR 1)	Kampershroer (PKR)	Head gate/ Flume/ GC
2	2.08	Wise River LB- Jolly Ditch	Jones- Rafter Ranch	Head gate/ Flume/ GC
3	2.69	Wise River RB - Main Ditch	PKR- Allen- Lovell	Head gate/ Flume/ GC
4	5.10	Wise River LB- Truman Ditch	Jones- Rafter Ranch	Flume/GC
5	5.88	Wise River LB- Company Ditch	Jones-Stanchfield-Zucker	Head gate/ Flume/ GC
6	9.65	Wise River Split D. Flume	Buckner- Split Diamond Ranch	Flume Xing repair/lining
7	10.1	Wise River LB- Split Diamon	Buckner- Split Diamond Ranch	Grade Control/Flume
Notes:	River Mile (RM) refers to base maps (Appendix A) where RM 0.00 begins at confluence with Big Hole River. LB = left bank; RB = right bank (looking downstream) GC = proposed grade control improvements with native boulders			

5.2 STOCK WATER WELLS

Two proposed sites for drilling and installation of stock water wells were identified on the Kampershroer Ranch near Hwy 43 (see Map 1a; Section 3.3) The wells would alleviate use of the main PKR Ditch as the only source of stock water; and therefore, allow water users to reduce irrigation ditch withdrawals and/or turn off the ditch altogether immediately following the irrigation season. As a result, additional instream flows would be available in the main Wise River channel downstream from RM 2.70 in the late summer and fall season. Accordingly, ditch operations and schedule of flow reductions should be incorporated into a voluntary DMP.

6. REFERENCES

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APPENDIX A: LOWER WISE RIVER ASSESSMENT MAPS 1-8.

APPENDIX B: USGS HISTORIC FLOW DATA

APPENDIX C: ABRIDGED SUMMARY OF WATER RIGHTS