Feasibility Study of Program and Implementation Alternatives for a Hood River Water Bank

FINAL DRAFT

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Acknowledgements

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1. Introduction

In fall of 2017, the Hood River Watershed Group (HRWG) received grants from the Oregon Water Resources Department (OWRD) and Oregon Watershed Enhancement Board (OWEB) to study the feasibility of implementing a water bank in the Hood River Basin. This report, a key part of that effort, discusses different program and implementation alternatives for a water bank in the Watershed.

The goals of the Feasibility Study are: 1) to assess the viability of a Hood River water bank to increase summer stream flows for fish and provide greater irrigation water reliability for perennial crop growers during dry or drought years, and 2) to determine the feasibility of implementing a bank in the Hood River Basin. The role of this report in meeting these goals is to analyze and recommend specific programmatic alternatives for building and operating a water bank in the basin.

At a high level, the programmatic elements of a water bank considered in this report include:

- program form and format (level of formality, roles and responsibilities, etc.);
- water bank supply (including water value and pricing);
- water bank demand;
- operational costs and capacity needs;
- water bank funding approaches; and
- institutional and governance concerns.

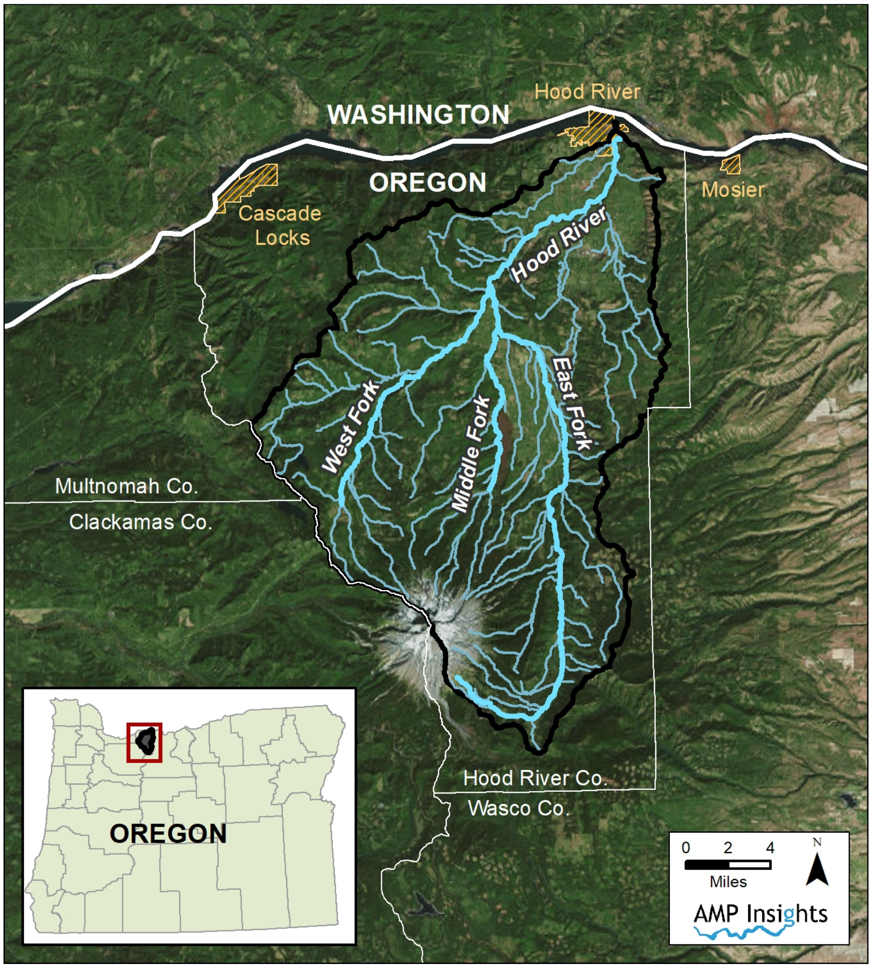
This report discusses each of these elements in detail and analyzes a range of implementation options and their feasibility and applicability to the basin context. Within each of these elements, alternatives are discussed and analyzed for best fit with the hydrologic, economic, environmental and social/cultural context of the basin. Analysis of the alternatives was done in consultation with the HRWG, Watershed Professionals Network (WPN) and local stakeholders, including representatives of local irrigation districts. The results of this analysis and consultation with the HRWG are a set of recommendations on the most feasible approach to water banking in the Hood River Watershed.

The report begins with a brief overview of the Hood River Basin with a focus on hydrologic, economic, environmental and social/cultural factors that are important in water bank feasibility. Next, the report provides a discussion of what water banks are, some hallmarks of water bank form and function and what roles water banks can play. This is important background information before discussing alternatives for designing and implementing a bank. This discussion includes an outline of the necessary functional elements of a water bank and a more thorough explanation of the programmatic elements listed above. Next, this report discusses each programmatic element above and provides alternative ways to address them in the Hood River Basin's unique context, assessing the feasibility of each alternative. Within each discussion of these elements, the report makes a recommendation about the most feasible, best fitting alternatives for the basin.

2. Hood River Basin Context

This section briefly discusses important physical, hydrologic, economic, environmental and other traits of the Hood River Basin, with a focus on aspects of the basin that are most relevant to the feasibility of a water bank.

Figure 1: Map of the Hood River Watershed

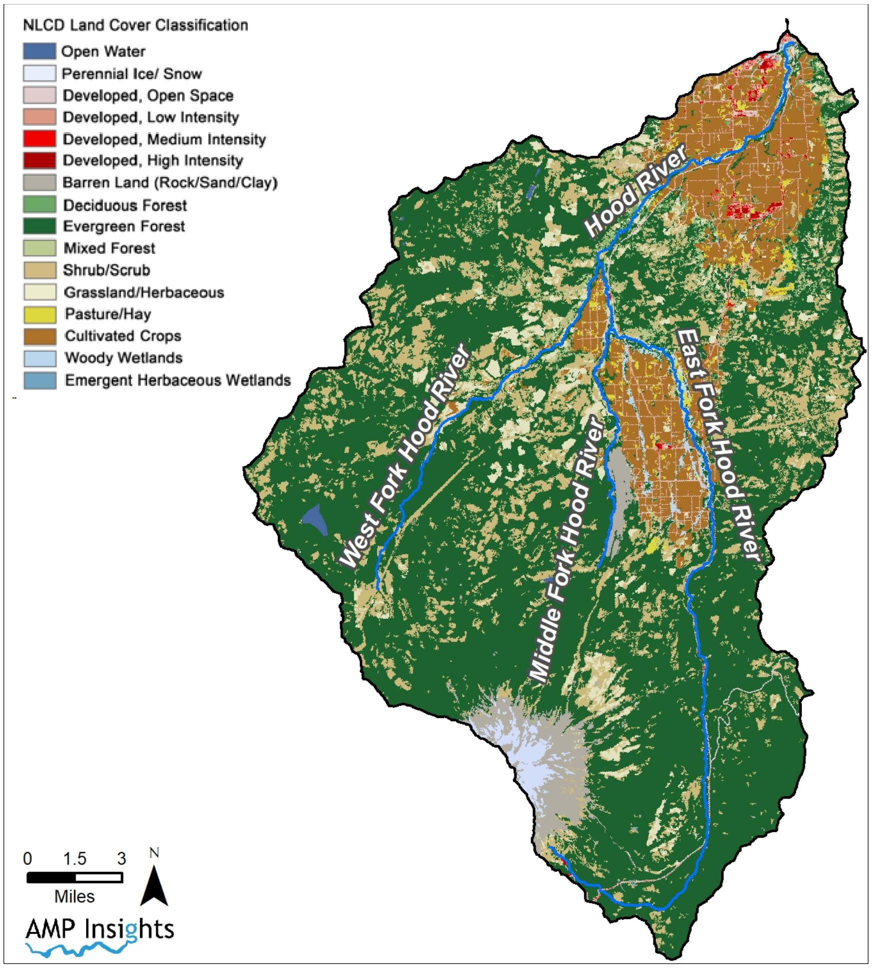


2.1 Hood River Basin Physical and Hydrologic Characteristics

The Hood River Basin covers 339 square miles in the northernmost part of the Cascade Range in Oregon. The Basin's rivers flow north from the peak of Mt. Hood at more than 11,000 feet of elevation and terminate at their confluence with the Columbia River at an elevation of only 74 feet (Hood River Watershed Group 2014). These rivers' glacial and snowpack origins and the steep plunge of their waters over a relatively short distance are two hallmarks of this unique basin. The Hood River mainstem is formed by the confluence of the West and East Forks of the Hood River. The Middle Fork Hood River flows into the East Fork just above its confluence with the West Fork.

Of the 533 square miles that comprise Hood River County, 326 square miles, or 60%, are owned by the United States Forest Service (USDA 2012). There are two large pockets of cultivated cropland – the first is nestled between the East Fork Hood River and Middle Fork Hood River near the confluence, and the second is further downstream along the Hood River mainstem near the outlet at the Columbia River. High-density developed areas are interspersed within the major cropland areas. The land cover in the remainder of the basin is primarily deciduous forest and shrub/scrub, with the exception of Mount Hood with its barren rock and perennial glaciers (Figure 2) (Homer et al. 2015).

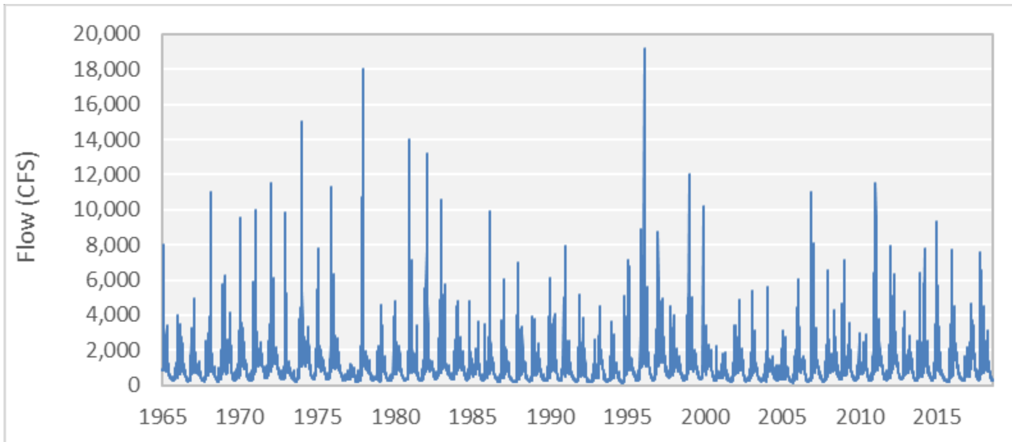
Figure 2. Hood River Basin Land Use and Land Cover



There is significant variability in the geographic distribution of precipitation, with the summit of Mount Hood receiving roughly 150 inches of precipitation per year, while the western and eastern portions of the basin typically receive 45 and 24 inches per year, respectively (Bureau of Reclamation 2015). Glacial and snow melt from Mount Hood contribute significantly to stream baseflows through the summer. As the meltwater tapers off, this leads to naturally lower flows through late summer and into fall.

There are several gages throughout the basin operated by the US Geological Service (USGS) as well as the Oregon Water Resources Department (OWRD). From upstream to downstream, on the West Fork there is Dee Irrigation Camp Creek (OWRD 14116495), Dee Irrigation near Dee (OWRD 14116200), and West Fork near Dee (OWRD 14118500). There is one gage on the East Fork Irrigation District's Main Canal off of East Fork Hood River, East Fork Irrigation District (USGS 14114000), and one gage on the mainstem, the Tucker Bridge gage (USGS 14120000). Hydrographs of the Tucker Bridge and West Fork gages demonstrate the extreme flow variability of the system, with high flows at the beginning of the water year in October to around April, and then a steady decline for the remainder of the year (Figure 3 and Figure 4). At Tucker Bridge, high flows typically occur in winter months and can be upwards of 10,000 CFS. As runoff volumes decrease, flows between 200 and 400 CFS are common during summer and fall months (Figure 3).

Figure 3. Water Year Streamflow at Tucker Bridge Gage, 1965-2018 (top) and 2014-2017 (bottom)



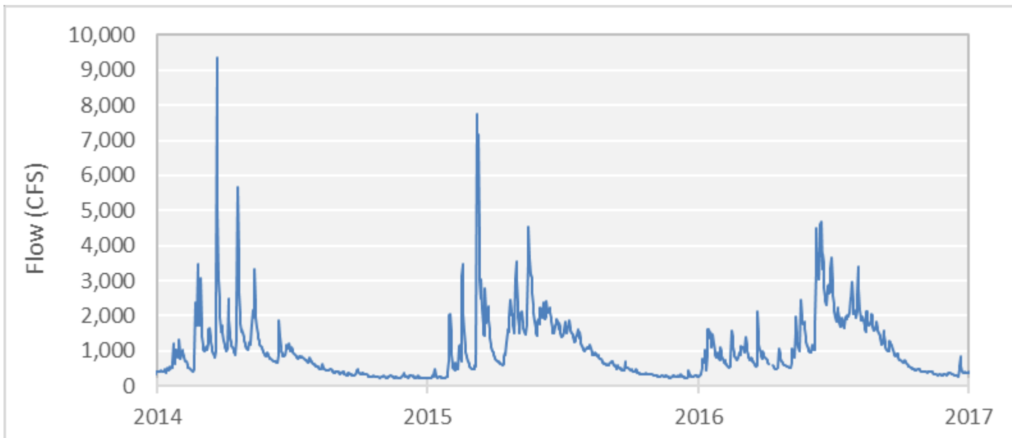
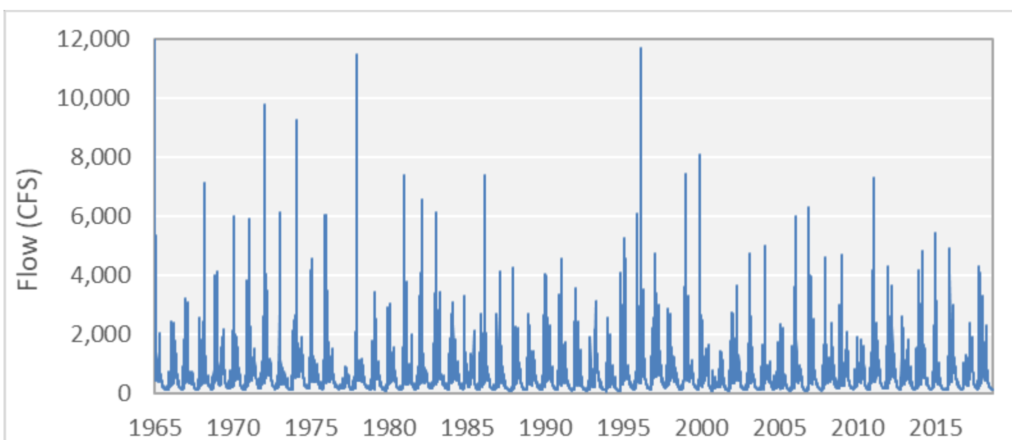
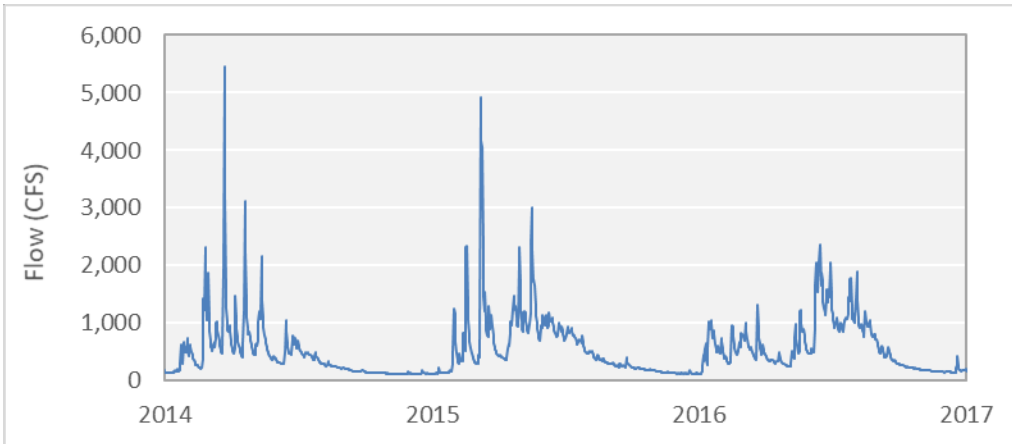


Figure 4. Water Year Streamflow at West Fork near Dee Gage, 1965-2018 (top) and 2014-2017 (bottom)





Due to the unique climate and geography of the basin, climate change is expected to have significant impacts on the hydrology and surface water availability in the basin. The amount of snowpack in the basin has been decreasing since the 1920s and this pattern is predicted to continue. In 2015, the Bureau of Reclamation published the Hood River Basin Study that looked at the effects of climate change scenarios on the hydrology of the basin (Bureau of Reclamation 2015). The three scenarios used in the model are More Warming/Drier (MW/D), Median (MED), and Less Warming/Wetter (LW/W). When compared to a projected baseline, model results show a 3% to 12% increase in average precipitation in the fall and a 15% to 33% decrease in average precipitation in the summer. Average temperature is expected to increase in every season under each scenario, ranging from 0.7 °C to 2.4 °C (Table 1).

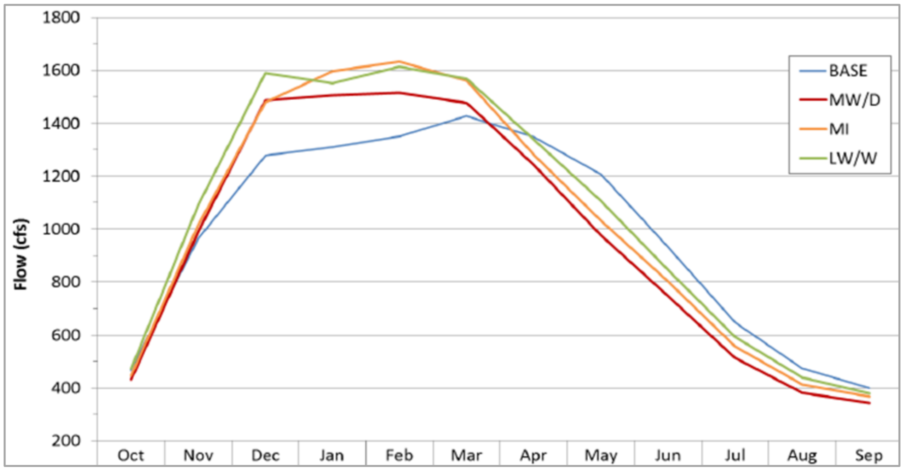
Table 1. Changes in Average Precipitation and Temperature Under Climate Change Scenarios

Climate Change Scenario	Average Precipitation Change (%)				Average Temperature Change (°C)			
	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
More Warming/ Drier (MW/D)	-3	-7	-33	+4	+1.2	+1.5	+2.4	+1.5
Median (MED)	+7	0	-14	+3	+1.2	+1.1	+1.5	+1.2
Less Warming/ Wetter (LW/W)	+5	0	-15	+12	+0.8	+0.7	+1.3	+0.9

Source: (Bureau of Reclamation 2015)

The Bureau's climate model predicts that increasing temperatures will have cascading impacts on hydrology and water supply - the extent and volume of glaciers on Mount Hood will diminish, snowpack will arrive later and depart earlier, the volume of melt water from glaciers and snowpack will be greater and will arrive earlier over time, the timing of peak stream flows will shift, and spring and summer runoff volumes will decrease. A decreased snowpack typically results in higher streamflow during winter months and lower runoff volumes during spring and summer months (Figure 5). A flexible, adaptable, and multi-faceted approach to water management would help mitigate the impacts of climate change.

Figure 5. Monthly Averages of Modeled Natural Stream Flows in Hood River at Tucker Bridge



Source: (Bureau of Reclamation 2015)

2.2 Hood River Basin Demographic and Economic Characteristics

The entirety of the Hood River Watershed lies within Hood River County, covering two-thirds of the county's land area. The current population of Hood River County is roughly 23,300 and includes the cities of Hood River and Cascade Locks, with populations of 7,700 and 1,100, respectively. There are three census designated places, the largest being Mount Hood Village with a population of 4,900, followed by Odell with 2,500 residents, and then Parkdale with 500 residents (US Census Bureau 2016). Approximately one-fourth of the county population lives outside of these towns.

Hood River County has seen steady population growth over the past 45 years, particularly beginning around 1993 (Figure 6). Over the last five years, the county population has increased by 165 people per year (BEA 2018). Additionally, per capita personal income of Hood River County residents has also been trending upward over the period of record (Figure 7).

Figure 6. Population of Hood River County, 1969-2016

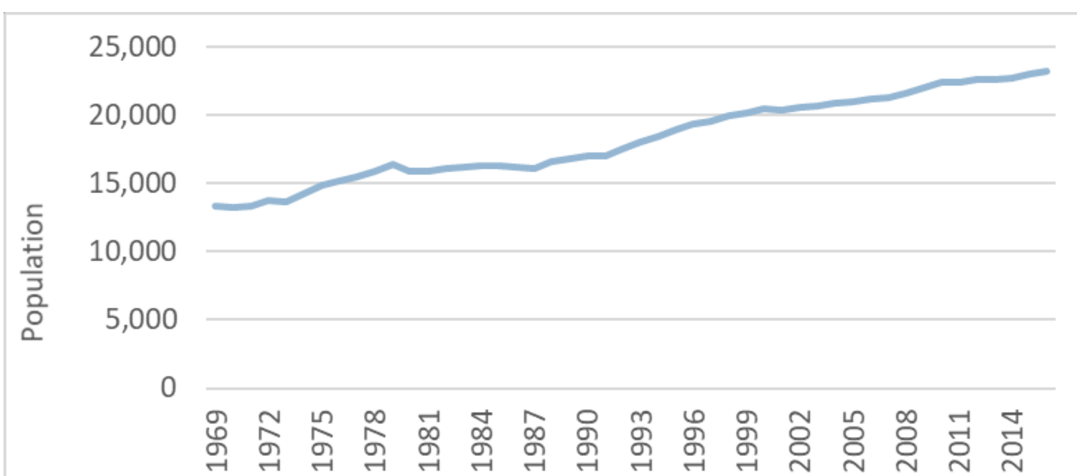
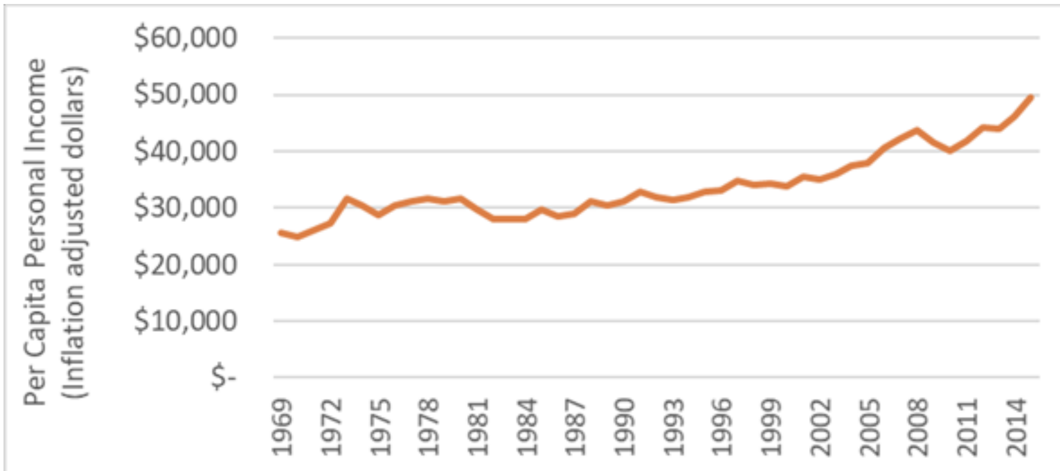


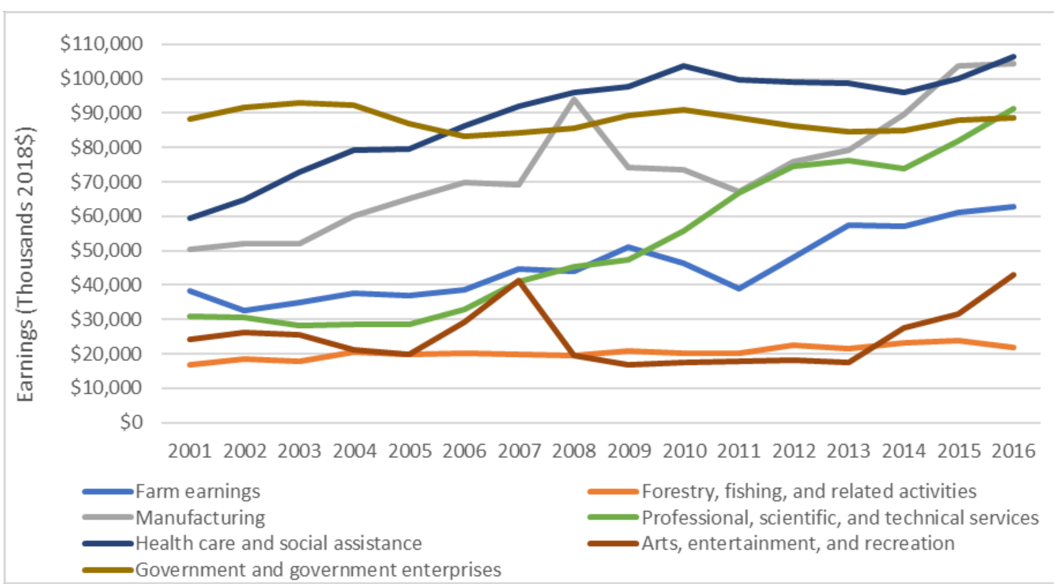
Figure 7. Per Capita Personal Income of Hood River County, 1969-2016



The predominant economic industries in Hood River County based on annual earnings include healthcare and social assistance, government services, manufacturing, professional services, and agriculture (Figure 8). The professional and technical services sector has seen the largest growth in earnings since 2001, closely followed by manufacturing. Earnings in the art, entertainment, and recreation industry have also seen an uptick in recent years, while government and forestry and fishing have remained stagnant.

Though long-term growth in farm earnings has been slow compared to other industries, recent growth since 2011 has yielded a nearly 50% increase (BEA 2017). Additionally, a significant portion of the county population is employed in the agricultural industry. A total of 7,663 farm workers were reported in Hood River County in 2012, accounting for one-third of the county population. A majority of these workers, 6,480, work less than 150 days out of the year. Additionally, 2,693 of these workers are migrant workers. However, the 1,183 workers that work over 150 days plus the 554 principal operators account for 7.5% of the county population (USDA 2014). Agriculture continues to be a vital part of the Hood River County economy in terms of market value and employment.

Figure 8. Earnings of Select Industries in Hood River County, 2001-2016



In 2012, the market value of agricultural products sold in Hood River County was over $77 million dollars. This was generated by 550 farms comprising over 25,000 acres of land area in the county. Of those farms, 448 reported harvesting crops on 15,000 acres with the remaining acreage either used for grazing, cover crops, or fallowing (USDA 2014). Of the 15,000 acres of crops harvested, the overwhelming majority were irrigated. Orchards are the most commonly irrigated crop, with 10,800 acres in the County, followed by forage at 1,600 acres. According to USDA, there are also 1,800 acres of irrigated pastureland. (USDA 2014). The total market value of crops in the state of Oregon is roughly $3.25 billion, averaging $152,000 per farm. In Hood River County, this average is $172,000 (USDA 2014) and is likely higher than the state average due to the high value crops such as tree fruits and grapes grown in the region. As such, irrigated agriculture is an important facet of the economy of Hood River County.

With this hydrologic and economic context in mind, the next section discusses water banks in general, including the various forms they can take and the functions and roles of water banks in helping to manage water.

3. Water Bank Form, Function and Roles

This section briefly defines and describes water banks and the various roles they can play. This is an important introduction to water banks and informs much of the discussion throughout the remainder of this report.

The term *Water Bank* encompasses a broad variety of institutional forms that play different roles at varying levels of formality. However, there are several unifying features that help to differentiate water banks from less organized water market and water transaction efforts. First, water banks are intermediaries. Rather than simply being an open market like a grocery store that anyone can walk into and transact in, water banks function akin to stock brokers that give buyers and sellers needed access to a market. Second, many water banks are organized to guide water market activity in one or more ways. Another way of stating this is that water banks often direct market activity toward one or more specific goals.

In an open market, buyers and sellers are free to trade for any reason. Water banks however, are most often set up to provide a subset of buyers, sellers or both with access or to or support for a specific type of trade, or for trades that achieve a specific goal. Common examples of water bank goals include facilitating agricultural to municipal water trades, promoting trades that help mitigate for groundwater pumping impacts to surface water sources, or providing water to increase stream flows to meet ecological needs. It is important to note that water banks can exist even without significant existing water market activity. In some places, water banks may be the majority or the only source of water market activity while in other places, they may simply be part of the overall market.

The final defining trait of water banks is that they are institutions. The term *institution* is used broadly in this case. It does not mean that water banks are always formal, brick-and-mortar establishments (in fact, they rarely, if ever, are), but it does mean that water banks are intentional, organized efforts. Some water banks are in fact highly organized institutions with dedicated staff, boards (or advisory councils), and physical locations. However, many water banks are informal institutions that are programs of another entity or based on an agreement or joint venture between two or several different entities.

For the purposes of this report then, a water bank is an institution that functions as an intermediary in a water market to direct at least a subset of market activity toward one or more specific goals. The remainder of this section discusses more specific details of water banks, the roles they play and a general discussion of a water bank in the Hood River Watershed.

3.1 Water Bank Functions and Roles: General

Water banks can perform numerous different specific functions. For example, existing water banks have taken on the roles of broker, clearinghouse and market-makers (Clifford, Landry, and Larsen-Hayden 2004). In the broker role, a bank encourages market activity by finding and connecting buyers and sellers. Banks that are simply clearinghouses serve primarily as a common platform for finding information about water market activity (for example bid and offer information). Banks that are market-makers work to ensure there are equal or at least a suitable number of buyers and sellers in a market. In addition to these roles, banks may also pool water supplies from willing sellers and remarket these supplies to buyers. In this role, the bank may actually own water itself or may simply pool water by identifying willing sellers.

In addition to these broad roles, water banks can provide specific functions including (Clifford, Landry, and Larsen-Hayden 2004):

- Determining what specific water rights or what types of water rights can participate in the bank;
- Establishing the quantity of banked water;
- Establishing policies and rules for who can purchase or rent from the bank;
- Setting contract terms and/or prices (and developing corresponding templates);
- Facilitating regulatory and administrative requirements.

3.2 Goals for a Hood River Water Bank

As noted above, water banks often operate to promote one or more specific goals. A water bank in the Hood River Watershed would have a primary and a secondary goal:

- **Primary Goal:** lease water from growers cultivating an irrigated crop that can be periodically fallowed and temporarily dedicate this water to instream flow to increase streamflows in support of habitat and water quality needs of ESA-listed anadromous and resident fish.
- **Secondary Goal:** lease water from growers cultivating an irrigated crop that can be periodically fallowed and temporarily provide this water to other irrigators to meet those water user's out-of-stream needs.

Examples of irrigated crops that can be periodically fallowed include pasture, hay, alfalfa, small grains and others.

> *This report uses the term "annual" to describe crops that can withstand periodic fallowing. It is important to note that not all of these crops are annual crops in the strict sense. Depending on farm practices, pasture and alfalfa for example, may or may not need to be replanted each year. The term annual is used as a shorthand way to refer to a subset of crops that can be fallowed seasonally, annually, or for several seasons in succession.*

Annual crops contrast with other irrigated crops grown in the basin that cannot withstand fallowing. Crops like tree fruits (apples, pears, cherries, etc.), blueberries, strawberries, wine grapes and others require significant time and investment before they become commercially viable and productive. These perennial plants therefore require consistent water supply every year to avoid jeopardizing significant investments of time, labor and capital.

The next section begins the discussion of specific elements of water bank feasibility. The first analysis to determine whether a bank is feasible in the Watershed is supply – the amount of water that might be available for lease and dedication to instream flow or other irrigation uses. Another aspect of supply discussed below is the various ways that a bank might solicit supplies from annual crop growers and how this water could be dedicated to either instream flow or alternative irrigation uses.

4. Water Bank Supply

The term "supply" is used in this report to refer to water that is made available by the Bank for instream flow restoration or for use by a different irrigator. This section discusses and quantifies the most likely sources of supply: irrigation water rights currently used for hay, alfalfa, pasture, grains and other crops that do not require significant up-front investment or time to be commercially viable. Quantifying supply involves both a discussion of how much total potential supply there might be in the Watershed and a discussion of how willing annual crop irrigators might be to participate with the Bank. The discussion of landowner willingness to participate is informed by results of a survey conducted among annual crop growers in the basin combined with AMP's experience in other Watersheds across the western U.S.

After the discussion and quantification of supply, this section then discusses the various tools that can be used to dedicate irrigation water rights to instream flow or to move irrigation water rights between different out-of-stream water users. These tools include a combination of formal water right changes involving the Oregon Water Resources Department (OWRD) and informal, contractual pathways.

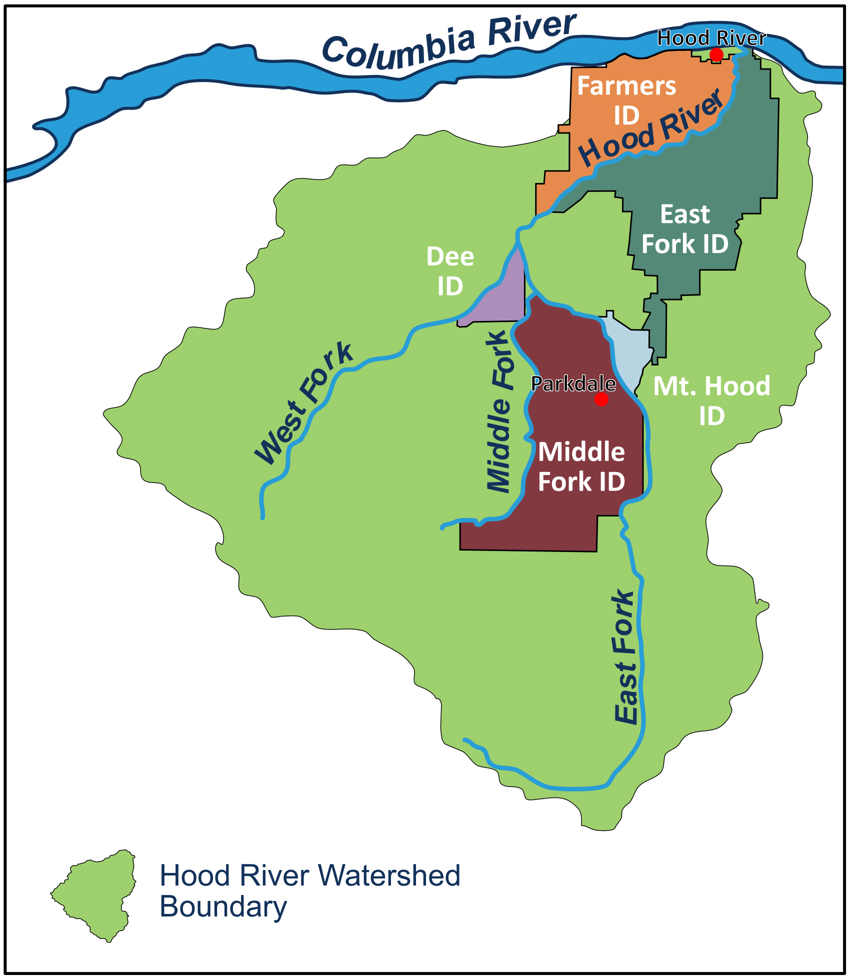
4.1 Overview of Water Rights and Infrastructure

Potential water bank supply is a subset of the total amount of valid water rights in the Hood River Watershed. Though bank supply can theoretically come from water rights permitted for any use, the most likely source of supply are irrigation water rights. Irrigation water use in the Watershed is dominated by the five irrigation districts that collectively irrigate more than 23,000 acres of land (Table 2) (Bureau of Reclamation 2015). These five districts (Figure 9) divert water from the three main forks of the Hood River as well as many smaller tributaries.

Table 2: Irrigation District Total Water Right Acres

Irrigation District	Abbreviation	Acres of primary irrigation (From OWRD Water Rights Information System)
Dee Irrigation District	DID	870
East Fork Irrigation District	EFID	9,608
Farmers Irrigation District	FID	5,868
Middle Fork Irrigation District	MFID	6,317
Mount Hood Irrigation District	MHID	1,017
	Total	**23,682**

Figure 9: Hood River Watershed Irrigation Districts



4.2 Quantifying Potential Supply

AMP worked with WPN to conduct a GIS analysis to help quantify the total potential amount of bank supply. WPN's GIS methods are described in detail in more detail in Appendix A. A summary of this work is provided here. WPN combined aerial photos (that were collected as part of the LiDar data collected in 2008/2009) and National Agricultural Statistics Service (NASS) data from 2017 with OWRD and irrigation district water right data to identify lands with valid water rights that are currently irrigating annual crops. WPN created two estimates, one using the NASS data and one using the LiDar data.

The analysis of the LiDar data shows a larger possible amount of irrigated annual crop acreage compared to the NASS data for several reasons. The LiDar data includes grass lawns grown in and around houses and within the urban portions of FID. LiDar analysis also captures annual crops grown in between and around orchards which the NASS data may not capture. Finally, the total footprint of annual crops being grown in the Watershed is likely declining because perennial crops are a more valuable (in economic terms) use of irrigated land in the Watershed and growth in cultivation of these crops will happen at the expense of annual crops.

A summary of the results of WPN's analysis are show in Table 3 below. In addition to WPN's two analyses, Table 3 also shows the number of parcels in each district with equal to or greater than five, seven and ten acres. Larger parcels represent the best targets for water bank supply for practical reasons. It is more efficient to source water from one ten-acre parcel than ten one acre or five two-acre parcels due to the amount of transaction costs for individual deals. Therefore, it is useful to develop an understanding of the number of larger sized parcels within each district. This information was also used to help target the landowner survey (described below in Section 4.2.1).

Table 3: Irrigated Annual Crop Acreage Within Irrigation Districts

	Range of acres		Number of parcels by max size (acres) (based on LiDar analysis)		
Irrigation district	**NASS**	**LiDar**	**>= 5 Ac.**	**>=7 Ac.**	**>=10 Ac.**
DID	88	233	16	8	6
EFID	1,405	2,955	181	124	83
FID	1,485	2,445	100	64	32
MFID	1,045	2,494	124	92	59
MHID	287	629	29	20	18
Total	**4,317**	**8,771**	**451**	**309**	**198**

The true total irrigated annual crop acreage likely lies somewhere between the NASS and LiDar totals in Table 3 above. For comparison, in a 2016 study, WPN received an estimate from local irrigation districts that annual crops represented approximately 3,000 acres of their irrigated total (Salminen et al. 2016).

So far, this discussion has focused on identifying irrigated annual crop *acreage*. The next step is to translate this into the amount of *water* used to irrigate annual crops in the Watershed. There are two complimentary approaches to doing this. The first approach is to use estimates of net irrigation water requirements (NIWR) for representative crops to estimate the total NIWR for the annual crop acreage in the Watershed (Table 4 and Table 5). The source of NIWR information is an Oregon State University manual from 1992, still widely in use today, that catalogued irrigation requirements for a wide variety of crops in different watersheds throughout Oregon. This approach has the benefit of providing an estimate of the total consumptive use. The second approach is to reference the relevant water rights and state court water right decrees to determine the maximum allowed volume (in acre-feet) and rate (in cubic feet per second, CFS) for water rights in the Watershed (Table 6).

Table 4: Net Irrigation Water Requirement (NIWR) for Pasture and Alfalfa in the Hood River Valley (7 out of 10 Years)

	Pasture (Hood Basin)		Alfalfa (Columbia Plateau)	
	Crop Evapotranspiration (ET)	**Net Irrigation Requirement (Inches/acre)**	**Crop ET**	**Net Irrigation Requirement**
March	0.79	0.04		
April	3.84	2.4	2.91	2.76
May	5.39	5.33	6.14	5.87
June	6.1	5.59	6.89	6.57
July	7.24	7.24	8.03	7.95
August	6.1	5.91	6.85	6.85
September	4.33	3.74	4.72	4.49
October	2.44	0.71		
Total	**36.23**	**30.96**	**35.54**	**34.49**

Source: (Cuenca et al. 1992)

Table 5: Calculating Consumptive Use for Pasture and Alfalfa Using Estimated Annual Crop Irrigated Acres

		Estimated Irrigated Acres			Estimated Irrigated Acres	
		Low (NASS)	High (LiDAR)		Low	High
		4317	8771		4317	8771
	Pasture NIWR (Inches)	Total Consumptive Use (Acre Feet)		Alfalfa NIWR (Inches)	Total Consumptive Use (Acre Feet)	
March	0.04	14	29			
April	2.4	863	1754	2.76	993	2017
May	5.33	1917	3896	5.87	2112	4290
June	5.59	2011	4086	6.57	2364	4802
July	7.24	2605	5292	7.95	2860	5811
August	5.91	2126	4320	6.85	2464	5007
Septem ber	3.74	1345	2734	4.49	1615	3282
October	0.71	255	519			
Total	**30.96**	**11,138**	**22,629**	**34.49**	**12,408**	**25,209**

Another method for estimating the total amount of water use is to apply the maximum rate and duty allowed by the relevant state court decree and water rights to the estimate of the total irrigated annual crop acres (Table 6). The Circuit Court decree for Hood River County limits irrigation water rights to 1/80 CFS per acre and no more than three acre-feet per acre measured at the point of diversion (Hood River Decree 1921).

Table 6: Decreed Water Right Limitations Applied to Estimated Annual Crop Irrigated Acres

	Estimated Irrigated Acres		Total Consumptive Use (Acre-Feet at POD)		Average Rate (CFS at POD)	
	Low (NASS)	High (LiDar)	Low	High	Low	High
DID	88	233	264	699	1.1	2.9
EFID	1405	2955	4215	8865	17.6	36.9
FID	1485	2445	4455	7335	18.6	30.6
MFID	1045	2494	3135	7482	13.1	31.2
MHID	287	629	861	1887	3.6	7.9
Total	**4,317**	**8,771**	**12,951**	**26,313**	**54.0**	**109.6**

For the maximum water right decree amounts in Table 6, it is important to note that these numbers are applicable at the point of diversion and therefore do not necessarily represent the amount of water available at the place of use. Depending on the efficiency of the irrigation water conveyance and application infrastructure, there could be only as much as 40-50% of the total amount diverted from the POD available at the place of use in an unlined or un-piped earthen ditch and up to 90+% in a piped system.

In summary, using the estimated irrigated annual crop acreages modeled by WPN combined with both NIWRs for pasture and alfalfa as well as water right decree maximums, the maximum range of water use for these crops in the Watershed ranges from approximately 11,138 acre-feet per year up to a maximum of 26,313 acre-feet per year (Table 7). It is important to keep in mind that not all of this water use is eligible as water bank supply. Estimates of potential total water bank supply are developed below in Section 4.3.

Table 7: Summary of Water Use Estimates

Estimate Approach	Pasture NIWR (NASS Acres)	Pasture NIWR (LiDar Acres)	Alfalfa NIWR (NASS Acres)	Alfalfa NIWR (LiDar Acres)	Water Right Decree Limits (NASS Acres)	Water Right Decree Limits (LiDar Acres)
Estimated Total Water Use Volume (AF)	11,138	22,629	12,408	25,209	12,951	26,313

4.2.1 Survey of Landowner Willingness

In addition to WPN's analysis, AMP worked with the HRWG and Summit Conservation Strategies to conduct a survey of annual crop growers within area irrigation districts to gauge the level of willingness to participate in temporary fallowing to support water banking goals. The full survey and survey results are included in Appendix B, but an overview of the survey and highlights of survey results are presented here.

The survey consisted of eight substantive questions covering water right holder's current land use, future land use plans, and willingness to consider participation in a voluntary fallowing program. Several questions explored important factors influencing landowner willingness, including attitudes towards instream and farm-to-farm leasing. The survey was distributed by mail during spring and early summer of 2018 to approximately 200 water right holders identified in WPN's GIS analysis as irrigating 10 acres or more of annual crops. Surveys were distributed to water right holders in each of the Watershed's irrigation districts. 36 responses were received by July 15, 2018 for a response rate of approximately 18%. Though it seems low, this is a healthy response rate for mail surveys of this nature.

Due to time and budget limitations, there is not precise information on the extent to which respondents are representative of the larger population within the Watershed who received the survey. However, data does show that the population of survey respondents came from four of the five irrigation districts in the Watershed (Table 8). While it is of limited statistical importance, the observed response rates are roughly in proportion with what would be expected based on the relative sizes of irrigation districts in the Watershed (note that a large amount of FID's acreage is in small, urban parcels which could partly account for the difference between its representation overall in the Watershed compared to within survey respondents).

Table 8: Survey Respondents by Irrigation District Compared to Watershed

District	Number of Responses	Percentage of Responses Received	Number of Total Water Right Acres in Watershed	Percentage of Water Right Acres in Watershed
MFID	11	31%	6,317	27%
EFID	11	31%	9,608	41%
MHID	6	17%	1,017	4%
FID	2	6%	5,868	25%
DID	0	0	870	4%
No Data	6	17%	N/A	N/A
Total	36	100%	23,682	

Two questions from the survey resulted in statistically significant responses. Question 4 asked, "Based on the description above, would you consider participating in a voluntary, paid fallowing program?" In a result reflecting strong interest in water leasing, 71% of respondents answered "yes" or "maybe" when asked whether they would consider participating in a voluntary, paid fallowing program. The 90% confidence interval around this value is +- 13%, implying that there is 90% probability that the proportion of the population receptive to leasing (i.e. who responded "yes" or "maybe" to question 4) lies between 58 and 83%. The finding that most of the target irrigators are potentially receptive to a leasing program is statistically significant and is also a significant positive indicator of program feasibility in the Watershed.

Question 6 asked "What is your overall impression of the idea of voluntary, paid fallowing to benefit stream flows?" Overall, 89% of respondents had a positive or neutral impression of water right leasing to benefit streamflows. The finding that a majority of respondents have a positive or neutral impression of leasing is statistically significant with the 90% confidence interval around the result extending from 80% to 97%. Overall, there is strong statistical evidence that most of the target irrigators have positive or neutral impressions of instream leasing.

One additional survey question deserves discussion here. Question 4a asked those who indicated some willingness to participate in temporary fallowing “what factors would influence your choice [to participate]?” Perhaps unsurprisingly, the amount of compensation offered for fallowing was the factor most frequently cited as influencing interest in leasing. That factor was followed by administrative concerns around protection of water rights and whether participants would need to formally, temporarily change their water rights (Table 9).

Table 9: Factors Influencing Interest in Participating in Fallowing

Factor	Count	Percent
How much I would be paid	18	72%
Whether my water rights would be protected	14	56%
Whether I would need to temporarily change my water right	12	48%
Whether other people are participating	5	20%
Crop/livestock prices	6	24%
Other	3	12%

Along with the survey results, AMP has broad experience with water markets and environmental water transactions in Oregon and the western US. Applying this experience to the Hood River Watershed provides some additional insights into the survey data. As a general rule of thumb, interest in voluntary, compensated land fallowing for environmental purposes is initially low in watersheds with no previous experience with the practice. The Hood River Watershed, however, does have past experience with instream leases and other pathways, like allocations of conserved water, that involve dedicating irrigation water to environmental uses. Even in watersheds with experience in voluntary, compensated land fallowing for environmental purposes, the initial prevailing attitude toward the practice will likely be skepticism. Other factors not captured by the survey that are important in landowner willingness to participate include the reputation and existing relationships of those doing outreach to solicit landowner participation and the support of third parties like irrigation districts, local tribes and state and federal administrative agencies.

4.3 Flow Restoration Scenarios

The final step in the quantification analysis is to synthesize the forgoing discussions into estimates of feasible water bank supply for the primary goal of the bank (flow restoration). Based on the range of water use estimates (Table 7), if every acre of irrigated land growing an annual crop in the Watershed were to fallow their land at the same time, this would free up between 11,138 and 26,313 acre-feet (between 46 and 105 CFS) of water spread out among various tributaries and the mainstem Hood River.

Fallowing all acres at once is not realistic, so scenarios were developed to highlight a more likely range of flow restoration outcomes. These scenarios capture different levels of restoration outcomes from 5% success (i.e. enrolling 5% of annual acres on five-plus acre parcels in a given geography) to 10% and 20%

success rates. These success rates are applied at the whole-watershed scale (i.e. to all of the annual acres in the Watershed) and also at different scales based on the locations of the Watershed's major irrigation district points of diversion. District PODs were grouped when necessary based on what reach would benefit from fallowing of acres served by one or more POD. Figure 10 below shows the seven different reaches that resulted from this grouping along with the number of acres modeled for each reach. Figure 11 shows the results of the flow restoration scenario modeling. The reaches below were also calibrated to correspond to reaches where IFIM studies have been conducted in the past. Only a subset of the seven reaches modeled have IFIM studies completed.

The number of acres corresponding to each POD was roughly estimated using data from WPN's GIS analysis (described above in Section 4.2). Parcels of five or more annual acres (based on LiDar analysis) within each district were summed to arrive at total acres for scenario modeling. Where possible, these acres were attributed to specific PODs for the purpose of the flow restoration scenario modeling (Table 10). It is important to note that this analysis was done at a coarse level and there was not an attempt made to assign specific acreages to some of the PODs on smaller tributaries. Where data allowed for easy differentiation between acres serviced from different PODs, these were grouped together and are noted in Figure 11 below. For example, no attempt was made to differentiate between a number of MFID's PODs on small Middle Fork tributaries. Similarly, without additional water rights and GIS analysis, it is difficult to determine how many annual acres might be specifically attributable to FID's Green Point POD due to complicated interconnections in FID's system.

Finally, it is important to note that the scenario modeling assumes that when water is left instream at a POD as a result of fallowing, that water is not diverted by a downstream POD. Stated differently, the modeling assumes an agreement by the Watershed's irrigation districts that they will not increase their diversions, even if they are legally allowed to do so based on their water right priority dates, to capture water left instream by upstream districts. Given the relatively small amounts of water in question, it is not likely that districts would be able to specifically capture water left instream by upstream water users. However, this highlights the importance of working toward a cooperative approach between districts to managing water left instream.

Table 10: POD Combinations and Acreages for Scenario Modelling

Reach	Upstream PODs	Min. Annual Acres	Max Annual Acres.	Scenario Acres (5+ Acre Parcels)
1. Hood River at the Mouth	All	4,317	8,771	**5,748**
2. West Fork Hood River at the Mouth	DID and FID (Green Point Creek)	602	1,143	**850**
3. East Fork Hood River Below Middle Fork	EFID, MHID and MFID	2,473	5,464	**4,577**
4. East Fork Hood River Above Middle Fork	EFID and MHID	1,692	3,584	**2,577**
5. Middle Fork Hood River at the Mouth	MFID	1,045	2,496	**2,000**
6. West Fork Hood River Above Green Point Creek	DID	88	233	**150**
7. Green Point Creek at the Mouth	FID (Green Point Creek)	514	910	**700**

Figure 10: Reach Delineation for Flow Restoration Scenarios

Reach	Upstream PODs	Min. Annual Acres	Max Annual Acres.	Scenario Acres (5+ Acre Parcels)
1. Hood River at the Mouth	All	4,317	8,771	**5,748**
2. West Fork Hood River at the Mouth	DID and FID (Green Point Creek)	602	1,143	**850**
3. East Fork Hood River Below Middle Fork	EFID, MHID and MFID	2,473	5,464	**4,577**
4. East Fork Hood River Above Middle Fork	EFID and MHID	1,692	3,584	**2,577**
5. Middle Fork Hood River at the Mouth	MFID	1,045	2,496	**2,000**
6. West Fork Hood River Above Green Point Creek	DID	88	233	**150**
7. Green Point Creek at the Mouth	FID (Green Point Creek)	514	910	**700**

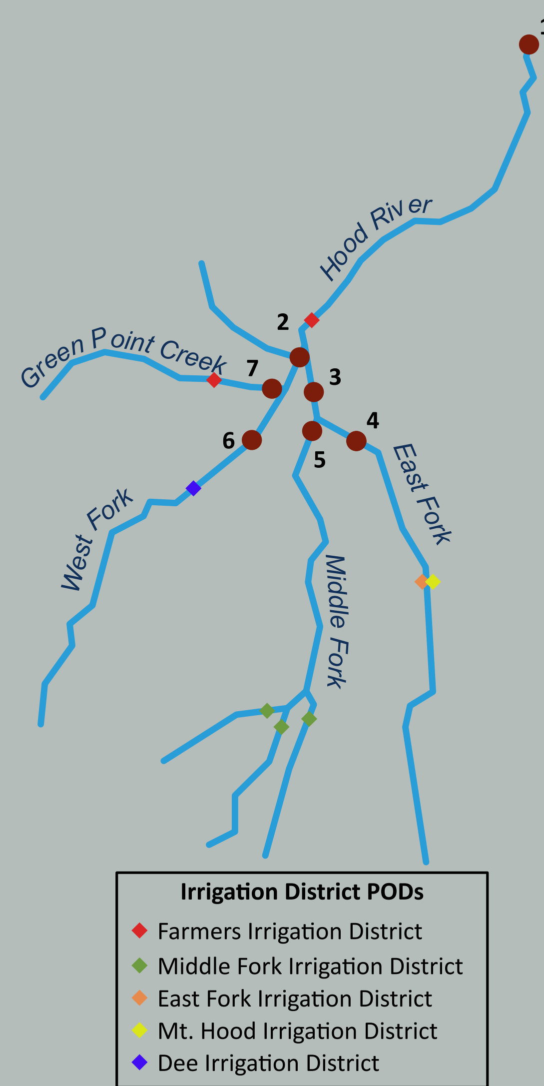


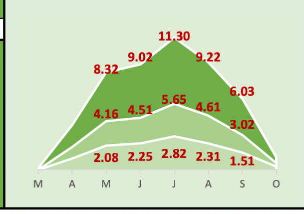
Figure 11: Flow Restoration Scenario Modeling Results

Flow Restoration Scenarios*

Reach 1: Hood River at the Mouth

Estimated Annual Acres			5748
Success Rate	5%	10%	20%
	Rate (CFS)		
March	0.02	0.03	0.06
April	0.97	1.94	3.87
May	2.08	4.16	8.32
June	2.25	4.51	9.02
July	2.82	5.65	11.30
August	2.31	4.61	9.22
September	1.51	3.02	6.03
October	0.28	0.55	1.11

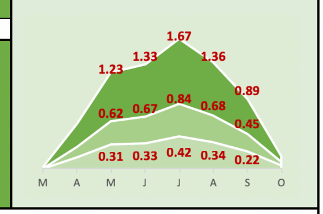
May-September Modeled Flow Restored (CFS)



Reach 2: W. Fork Hood River At the Mouth

Estimated Annual Acres			850
Success Rate	5%	10%	20%
	Rate (CFS)		
March	0.00	0.00	0.01
April	0.14	0.29	0.57
May	0.31	0.62	1.23
June	0.33	0.67	1.33
July	0.42	0.84	1.67
August	0.34	0.68	1.36
September	0.22	0.45	0.89
October	0.04	0.08	0.16

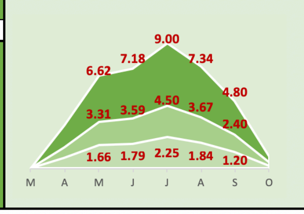
May-September Modeled Flow Restored (CFS)



Reach 3: E. Fork Hood River below Middle Fork

Estimated Annual Acres			4577
Success Rate	5%	10%	20%
	Rate (CFS)		
March	0.01	0.02	0.05
April	0.77	1.54	3.08
May	1.66	3.31	6.62
June	1.79	3.59	7.18
July	2.25	4.50	9.00
August	1.84	3.67	7.34
September	1.20	2.40	4.80
October	0.22	0.44	0.88

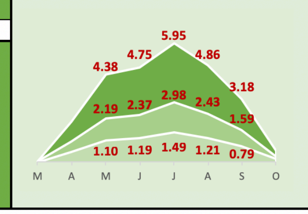
May-September Modeled Flow Restored (CFS)



Reach 4: East Fork Hood River above Middle Fork

Estimated Annual Acres			2577
Success Rate	5%	10%	20%
	Rate (CFS)		
March	0.01	0.02	0.03
April	0.51	1.02	2.04
May	1.10	2.19	4.38
June	1.19	2.37	4.75
July	1.49	2.98	5.95
August	1.21	2.43	4.86
September	0.79	1.59	3.18
October	0.15	0.29	0.58

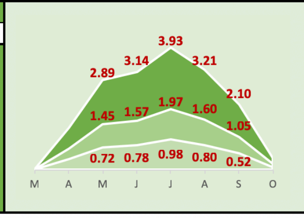
May-September Modeled Flow Restored (CFS)



Reach 5: Middle Fork Hood River at the Mouth

Estimated Annual Acres			2000
Success Rate	5%	10%	20%
	Rate (CFS)		
March	0.01	0.01	0.02
April	0.34	0.67	1.35
May	0.72	1.45	2.89
June	0.78	1.57	3.14
July	0.98	1.97	3.93
August	0.80	1.60	3.21
September	0.52	1.05	2.10
October	0.10	0.19	0.39

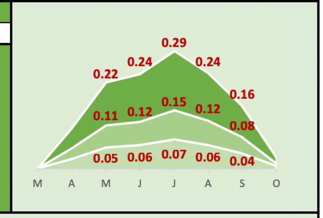
May-September Modeled Flow Restored (CFS)



Reach 6: W. Fork Hood River Above Green Point Creek

Estimated Annual Acres			150
Success Rate	5%	10%	20%
	Rate (CFS)		
March	0.00	0.00	0.00
April	0.03	0.05	0.10
May	0.05	0.11	0.22
June	0.06	0.12	0.24
July	0.07	0.15	0.29
August	0.06	0.12	0.24
September	0.04	0.08	0.16
October	0.01	0.01	0.03

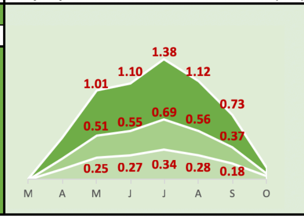
May-September Modeled Flow Restored (CFS)



Reach 7: Green Point Creek at the Mouth

Estimated Annual Acres			700
Success Rate	5%	10%	20%
	Rate (CFS)		
March	0.00	0.00	0.01
April	0.12	0.24	0.47
May	0.25	0.51	1.01
June	0.27	0.55	1.10
July	0.34	0.69	1.38
August	0.28	0.56	1.12
September	0.18	0.37	0.73
October	0.03	0.07	0.13

May-September Modeled Flow Restored (CFS)



*To err on the conservative side, scenarios model pasture NIWR which is slightly lower than alfafa

4.3.1 Flow Restoration Scenario Modeling Results Discussion

Figure 11 shows a range of feasible water supply estimates for instream flow leasing in the Hood River Watershed. It is important to note that these estimates are calibrated to apply to supply for instream restoration more so than supply for additional irrigation water. Annual crop growers could be more hesitant to lease water for instream restoration than to lease water for fellow irrigators but there is no way to quantify this difference. In fact, the survey data discussed above show a generally willing, or at least neutral attitude toward instream flow restoration so a difference may not exist at all.

The 5, 10, and 20% success rates are based on AMP Insights' experience with instream flow restoration in the western U.S. where such activities are generally slow to develop and gain acceptance. A 5-10% success rate measured by acres in a district or Watershed would be a significant achievement in the early years of water bank operation and 20% represents a realistic long-term goal. Table 11 below summarizes some of the results of the flow restoration scenario model, showing the modeled peak flow restored during the month of July at 5%, 10% and 20% success rates. "Modeled Peak (July) Flow Restored" is the amount of flow restored at the different success rates, which would *add* to existing monthly flows. "Modeled New July Flows with Flow Restoration" are based on the "Modeled Peak (July) Flow Restored" added to 80% exceedance flows. 80% exceedance flows are generally used as a proxy for drought flows and represent a flow level that is exceeded in four out of five years. Exceedance flow figures comes from existing streamflow gauge records where available and from OWRD modeled flows where gauges are not available. The time period of record varies for gauge data, but the entire record is used wherever gauge data is included.

Table 11: Modeled Peak Flow Restoration Summary

Reach	Modeled Peak (July) Flow Restored (CFS)			Modeled New July Flow with Flow Restoration*		
	5% Success	10% Success	20% Success	5% Success	10% Success	20% Success
(1) Hood River at the Mouth	2.7	5.41	10.81	309.8	312.6	318.3
(2) West Fork Hood River at the Mouth	1.23	2.46	4.91	139.7	140.28	141.7
(3) East Fork Hood River at the Mouth	2.28	4.55	9.1	133.3	136.5	143
(4) East Fork Hood River Above Middle Fork	1.51	3.03	6.05	46.8	49	53.6
(5) Middle Fork Hood River at the Mouth	0.98	1.97	3.93	86.5	87.5	89.5
(6) West Fork Hood River Above Green Point Creek	0.07	0.15	0.29	124.2	125.5	127.9
(7) Green Point Creek at the Mouth	0.25	0.49	0.98	16.3	16.5	17.3

*Calculated as observed (where possible) or modeled July 80% exceedance flow plus modeled flow restoration in CFS

4.4 Water Bank Supply Strategies: Instream Flow Restoration

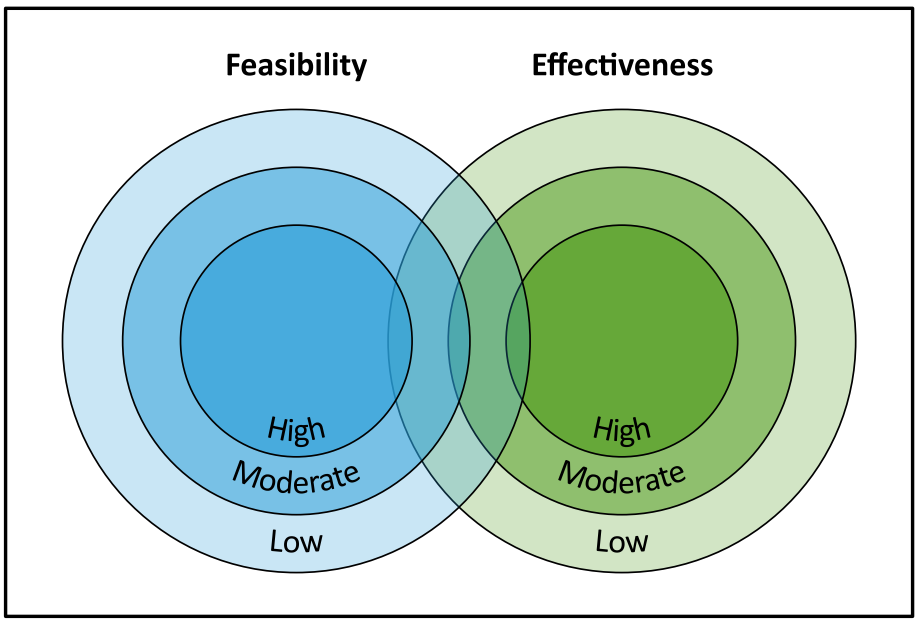
This section turns from quantifying possible bank supply for flow restoration to discussing the specific mechanisms at the bank's disposal to *move* water within the Watershed. Moving water here means dedicating it to instream use to meet the bank's primary goal and, in the following section, changing the place of use for irrigation from an annual crop irrigator to a perennial grower. Two basic types of mechanisms are discussed: formal water right changes and contractual agreements. Formal water right changes involve application, administrative review and enforcement by OWRD and can range from seasonal water right changes to permanent changes. Contractual agreements do not involve OWRD or any other state administration or enforcement. Rather, contractual agreements are contracts between the bank (or the entity running the bank or acting on behalf of the bank) and an irrigator or irrigation district. Both mechanisms can be effective and have benefits and draw backs which are discussed below. The full range of instream mechanisms is outlined in Table 12.

Table 12: Instream Flow Mechanisms

<table>
<thead>
<tr><th></th><th>Duration</th><th>Require OWRD Approval?</th><th>Approval Process</th><th>Time to Approve</th><th>Instream Flow Benefit</th><th>Enforcement/ Protection</th><th>Notes</th></tr>
</thead>
<tbody>
<tr><td>Instream Lease</td><td>Full season, 1 to 5-year terms, renewable</td><td rowspan="5">Yes</td><td rowspan="2">Simple injury review</td><td rowspan="2">30-75 days</td><td rowspan="2">Consumptive use, minus channel loss</td><td rowspan="2">OWRD regulation of junior water rights; water rights not at risk of forfeiture</td><td>Could include stored water</td></tr>
<tr><td>Split-Season Lease</td><td>Partial season, 1 to 5-year terms, renewable</td><td>Requires measurement device, monitoring and reporting</td></tr>
<tr><td>Time-Limited Instream Transfer</td><td>Full season, up to 99-year term</td><td rowspan="2">Full injury review</td><td rowspan="2">75 days-1 year +</td><td rowspan="2">Consumptive use; various possible reductions to limit injury</td><td rowspan="3">OWRD regulation of junior water rights</td><td>Can be expedited by paying for processing</td></tr>
<tr><td>Permanent Instream Transfer</td><td>Full season, permanent term</td><td>Can be expedited by paying for processing</td></tr>
<tr><td>Instream Allocation of Conserved Water</td><td>Can be permanent, time-limited, lease or split-season</td><td colspan="3">Depends on duration</td><td>Can be applied for conservation projects finished within the last five years</td></tr>
<tr><td>Water User Agreements (WUA): Diversion Reduction</td><td>Full or partial season, no limit on term</td><td rowspan="3">No</td><td rowspan="3">N/A</td><td rowspan="3">N/A</td><td rowspan="3">Increased flow at POD</td><td rowspan="3">Contractual enforcement</td><td rowspan="3">Need to be cognizant/careful not to expose water rights to risk of forfeiture (practically, this limits terms to 1-4 years in many cases); could include stored water</td></tr>
<tr><td>WUA: Fallowing/Forbearance</td><td>Full or partial season, no limit on term</td></tr>
<tr><td>WUA: Minimum Flow Agreement</td><td>Partial or full season, no limit on term</td></tr>
</tbody>
</table>

Along with identifying these mechanisms, it is useful to begin to think about their feasibility and applicability for water bank use in the Hood River Watershed. The basic tension between the mechanisms is between the potential instream flow benefit they provide, and their potential social, cultural, and practical feasibility. Specifically, the mechanisms with the highest likely instream flow benefit are those that are approved and enforced by OWRD for the longest terms. A permanent instream transfer of a senior water right provides the highest level of instream benefit and it provides this benefit forever. But the longer the transfer, the less socially and culturally acceptable it is and the more difficult and costly it is to plan, negotiate, and implement. Additionally, many irrigation districts in Oregon ban permanent instream transfers of district water rights. At the other end of the spectrum, short term transactions that don't require OWRD approval will likely meet the fewest social/cultural feasibility issues. While these mechanisms can be designed to provide significant instream flow benefit, they have an inherent disadvantage compared to longer, more formal pathways. They can be more difficult to monitor and enforce, especially if they only involve small amounts of water. The feasibility/effectiveness dichotomy is common (Figure 12).

Figure 12: Feasibility and Effectiveness of Instream Flow Strategies



Adapted from (Lotic Hydrological 2016)

Another issue of feasibility in prioritizing between instream flow restoration tools is funding. All things being equal, funders prefer certainty and longer-term protection over shorter-term, more informal transactions. That said, experienced water transaction funders (discussed in more detail below in Section 8.2) also understand the tension between long-term, formal water right protections and practical, social and cultural feasibility of shorter-term, informal transactions. These funders are generally willing to fund less formal, short-term transactions, especially at the beginning of a basin-wide flow restoration effort, because they recognize that these transactions can lead to longer term, more formal transactions in the long-run.

In the Hood River Basin in particular, it is important to note that, due to the relatively limited number of PODs in the Watershed and the overall support and level of cooperation from the districts who manage these PODs, there is a high likelihood of being able to design successful WUAs that provide similar and possibly equal instream benefit compared with more formal water right changes. With that said, it is important not to lose sight of the potential effectiveness of short-term and long-term formal water right changes. Formal short-term changes offer water right protection from forfeiture that WUAs do not, while long-term formal changes offer the most significant instream flow benefits and provide funders with the most certainty. A final consideration for moving irrigation district water rights instream involves policies set by the districts themselves. How district policies might affect water bank actions is addressed briefly below in Section 4.5.3

4.5 Water Bank Supply Strategies: Transfer to Perennial Irrigator

This section discusses how water might be moved from annual acres to another irrigator in the basin. This analysis involves three different questions. The first question is spatial: what land (or district) might be able to receive water from what other land based on the relative locations of PODs? The second question is legal: what mechanisms exist under Oregon law and policy to move water between out-of-stream users? The final question is how irrigation district policies affect the movement of water between districts. Each of these questions are discussed in order below.

4.5.1 Spatial Considerations for Moving Water Between Out-of-Stream Uses

Figure 13 below shows the spatial feasibility of moving water between out-of-stream uses. Blue cells represent trading of water within irrigation districts which is the simplest form of trading possible. Green cells show areas where trading between districts might be possible if a legal/policy tool and district policies allow it. Finally, red cells indicate inter-district trades are not likely feasible. Red cells represent trades that would involve moving water to a POD upstream from its current POD. Generally, water rights cannot be transferred (temporarily or permanently) upstream because doing so is likely to cause injury to other water rights, including instream water rights. There may be narrow, specific circumstances where upstream water right changes are allowed but those would have to be analyzed on a case-by-case basis.

Figure 13: Moving Water Between Irrigation Districts

	MFID	EFID	DID	MHID	FID
MFID	Intra-district	Not likely feasible	Not likely feasible	Not likely feasible	Inter-district
EFID	Not likely feasible	Intra-district	Not likely feasible	Inter-district	Inter-district
DID	Not likely feasible	Not likely feasible	Intra-district	Not likely feasible	Inter-district
MHID	Not likely feasible	Inter-district	Not likely feasible	Intra-district	Inter-district
FID	Not likely feasible	Not likely feasible	Not likely feasible	Not likely feasible	Intra-district

Legend: **Intra-district** (blue) | **Inter-district** (green) | **Not likely feasible** (red)

4.5.2 Legal and Policy Mechanisms for Moving Water Between Out-of-Stream Uses

There are several different legal and policy pathways by which a water use can be moved from one irrigation place of use to another. Table 13 below outlines the most feasible pathways. Some of these can only be done during an official drought declaration, while others are only allowed within an irrigation district and could not be used between different districts. Among these tools, temporary intra-district transfers are the simplest changes that can be made.

Table 13: Mechanisms to Transfer Between Irrigation Uses

Mechanism	Duration	Require OWRD Approval?	Approval Process	Time to Approve
Temporary Transfer	Full season, 1-5-year terms, renewable	Yes	Simple injury review	30-75 days
Time-Limited Transfer to User	Full season, up to 99-year term	Yes	Full injury review	75 days-1 year +
Drought Transfer	Full season, only available during official drought declaration	Yes	Simple injury review	30-75 days
Temporary Transfer W/in District	Full season, 1 year	Yes	Simple injury review	30-75 days
Permanent Transfer W/in District	Permanent	Yes	Full injury review	75 days - 1+ year(s)
Storage Releases: Formal, Temporary Water Right Change	Full season, 1-5-year terms, renewable	Yes	Simple injury review	30-75 days

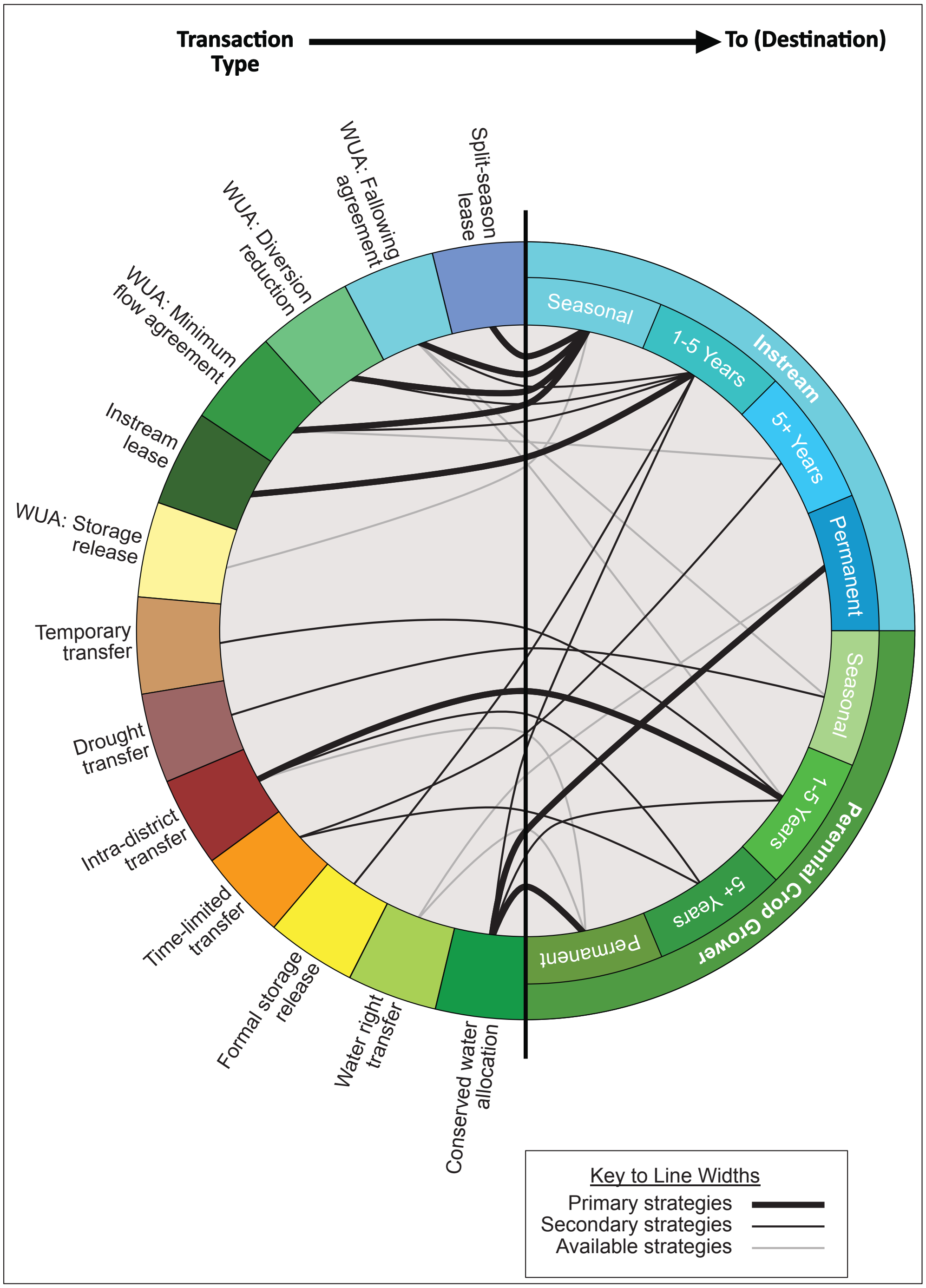
4.5.3 Irrigation District Policies

The final consideration for moving water between different irrigators/irrigation uses is whether some or all of the local irrigation districts have specific policies on the subject. District policies could be related both to transfers within district and between district. Many irrigation districts have policies that prevent permanent transfer of water out of the district. Most districts will also have policies that dictate how changes can be made within the district including whether such changes must be approved by the board of directors. Additional research is needed to determine the specific policies of all five of the Hood River Watershed irrigation districts, however this information is critical to making a final determination about the feasibility of moving water between irrigation uses and districts.

4.5.4 Summary of Mechanisms to Move Water Instream and to Out-of-Stream Uses

A visual representation called a "chord diagram" is also used to depict all of the possible ways to move water in the Watershed both to instream use and between irrigation uses (Figure 14). This diagram divides the mechanisms into three levels of feasibility: primary, secondary and available strategies. Primary strategies are those that are most feasible based on both technical considerations like transaction costs and the time and effort required for implementation as well as perceived social and cultural acceptance. Secondary strategies are effective strategies that are either more difficult or complex to implement than primary strategies or could be more difficult from a social or cultural acceptance viewpoint; these are generally longer-term strategies that require formal approval by OWRD. Finally, available strategies are the most complex to implement – they require the most effort and time and are likely to be the least socially and culturally acceptable strategies (i.e. they are long-term or permanent, formal water right changes). However, it is important not to dismiss the most difficult strategies to implement as they are also some of the most effective. For this report, they are prioritized lower because they are less feasible in the short-term, though over time they may become more feasible as trust in the water bank grows in the Watershed.

Figure 14: Supply Options Chord Diagram



4.6 Water Valuation

This section describes methods used to arrive at the price the bank or a perennial grower might pay for water from an annual crop grower. Water valuation is a key water bank design question but also bears on water bank feasibility. This section discusses different methods for valuation and provides some general guidance on feasibility of water valuation for a water bank in the Hood River Watershed.

Generally, the acquisition (by lease, agreement or sale) of water rights is based on one of three appraisal methods:

- **Market value:** using comparable sales data from local water markets to estimate the market price for water;
- **Production value:** using financial calculations of the net returns to water from its use in agricultural production for the lands and crops being appraised; and
- **Hedonic value:** using land sales data to determine values of land with and without water rights, with the value of water being the difference between the two.

Among these approaches, the market value approach is preferred because of its simplicity and reliability. However, for this approach to be viable, there needs to be an existing market and very few Watersheds have enough market activity to make for robust market value analysis. In the absence of comparable market data some water transaction programs rely on market data from nearby, similar Watersheds. Though this is not a perfect approach, it can at least provide a starting place for valuation.

In Watersheds that lack significant market activity, the production approach is an alternative water valuation method. This approach uses a farm income model to estimate the contribution of water to a farm's net income. Models are often built for one or more commonly-grown crop in a Watershed and include data about crop sales, farm productivity, labor and capital costs and other costs of production. The production approach is most useful to estimate short-term (seasonal or annual) value. Short term values derived from either the market approach or the production approach can be used to estimate long-term or permanent values by applying a realistic rate of capitalization.

Finally, the hedonic value approach models the value that land has with and without water rights and compares the two to arrive at an estimate of water value. This approach provides a robust way to estimate permanent water value. However, a full hedonic valuation is data and time intensive, involves sophisticated statistical modelling and therefore usually requires dedicated funding or academic research time. The hedonic method can also suffer from a lack of data as the market for irrigated land may not be very active in many agricultural Watersheds.

In addition to the valuation approaches outlined above, there is also another, less-used method based on the costs of alternatives. If alternative methods of meeting water needs exist, i.e., the cost to replace one source of water with another source such as trucked water, then the costs of meeting water need in this fashion is another method that can be used. It does not reveal what should be paid, but rather the cost of the next best alternative, which suggests a ceiling on what price a buyer might pay for water rights. This approach could be particularly useful in the case of perennial crop growers. The amount they would be willing to pay for water in an emergency, could be a useful proxy for the upper limit of their willingness to pay to lease water from annual crop growers.

In the Hood River Watershed, there is little comparable sales data to determine market value besides that developed by MFID in their 2015 water leasing program and a handful of other transactions conducted by the Oregon Water Trust/Freshwater Trust. Additionally, there has been some water leasing and water use agreements completed in the nearby Fifteenmile Watershed that could provide useful references. Most of the existing data is for annual leases with some limited data on permanent acquisitions. Westwater Resources has prepared water valuations for the Oregon Water Trust that include information on transactions in both the Fifteenmile and Hood River Watersheds as well as surrounding areas like the Deschutes basin. However, these are proprietary documents. The HRWG should reach out to The Freshwater Trust (successor organization to the Oregon Water Trust) and ask if they would be willing to share this information.

One final aspect of water value to discuss is the issue of deciding whether and when a valuation or appraisal is needed or advisable. A water bank should develop a policy that dictates one or more thresholds that, when crossed, will require some level of formal valuation. In other words, certain size or length leases or purchases by the bank should trigger greater valuation scrutiny. There is no widely-accepted size or length of transaction that should trigger scrutiny. Rather, such a policy is best thought of in terms of the relative cost of the valuation compared to the likely value of the transaction. For example, the Bank's policy could be that the cost of the valuation should not to exceed 10% of the prospective cost of a proposed transaction. If a valuation costs $10,000 then carrying out an appraisal on a $50,000 acquisition would violate the policy, but for a transaction worth $100,000 the valuation would be required. Some funders, like OWEB and CBWTP have their own specific water valuation thresholds and requirements that would need to be followed to qualify for water transaction funding.

4.6.1 Recommended Valuation Approach for Early Water Bank Activity in the Hood River Watershed

This section briefly recommends a feasible valuation approach for early transactions that might occur as pilot transactions while a Hood River water bank is being developed and for transactions that occur shortly after (if and when) a water bank is implemented. Because early transactions are likely to be small and of short duration, there is no need for an overly formal approach to valuation. However, for transactions to have credibility with funders, some level of economic valuation should be undertaken. A first step is to try to solicit existing valuations completed for the Oregon Water Trust/Freshwater Trust and to compare these to the leasing program run in the Middle Fork Irrigation District in 2015. If funding is available, the bank might then hire a firm to do a Watershed level farm income model to determine a range of potential water value for full and partial season leases of annual crops in the Watershed. Such studies can cost between $10,000 and $20,000, depending on the number of crops involved and other details. Only if/once the bank begins to consider larger transactions (in either size or duration), would the need to conduct specific water right appraisals arise. The thresholds for size and duration are context and funder specific, but as a starting place, transactions of longer than five years and for total dollar amounts above $50,000 are common.

5. Water Bank Demand

The previous section discussed a variety of different elements related to water bank supply. This section discusses the counterpart to supply, water bank *demand*. Demand in the water banking context refers broadly to the various motivations for the water bank to operate and more specifically, to the details about who buys water from the bank and how they access the market the bank creates. With its primary and secondary goals, demand for the bank will come from two places:

- **Primary:** Instream demand is motivated by environmental flow needs in the basin. In turn, instream demand is expressed in terms willingness to fund and funding availability.

- **Secondary:** Demand for additional water for irrigation is less well defined because there is not currently a specific, known quantity of unmet irrigation need. Demand for additional irrigation supplies will be primarily driven by climate considerations including interannual changes in water availability, drought and climate change.

This section begins by describing in more detail what demand means for the both the primary and secondary water bank goals. For the primary, instream goal, this includes discussion of existing instream flow targets in the Watershed as well as the results of an analysis conducted to estimate the benefit to specific fish species of several flow restoration scenarios. For the secondary goal, the analysis includes the results of qualitative discussions with irrigators about what would motivate them to seek water from the bank as well as some discussion of the likely future hydrologic conditions in the Watershed and how these might contribute to demand for water banks supplies from irrigators.

5.1 Instream Demand

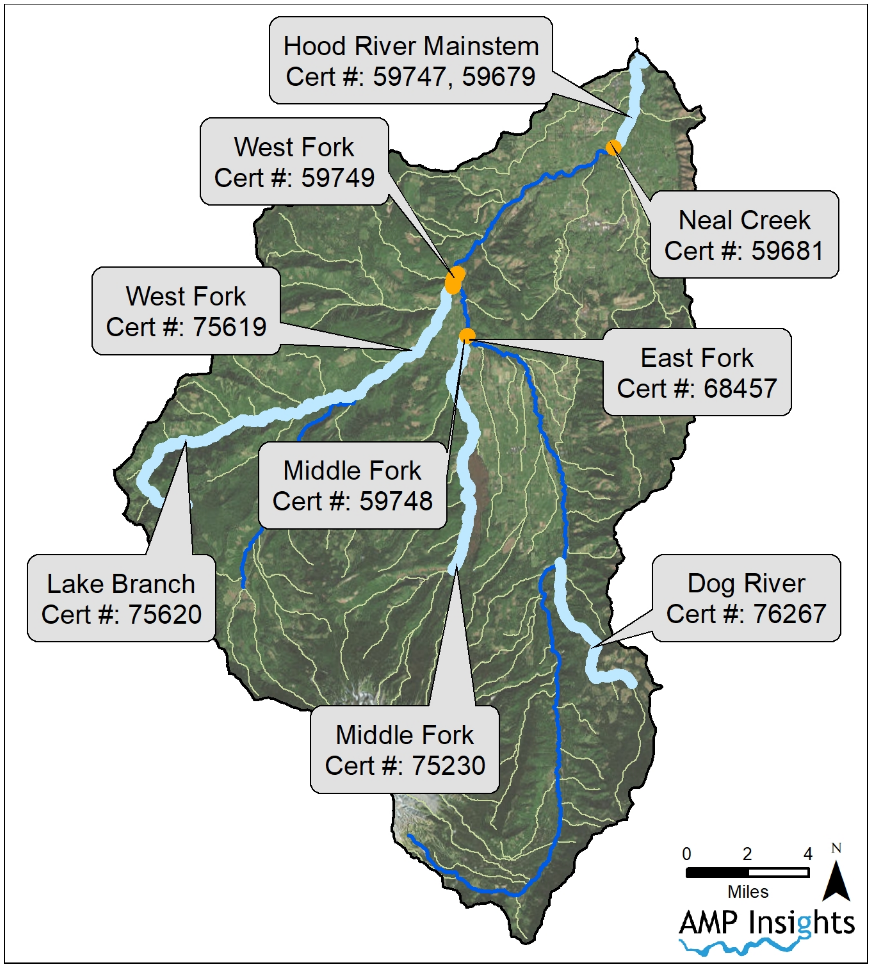
The hydrologic characteristics of the Hood River Basin results in lower flows during summer and through fall. These naturally lower flows, coupled with agricultural diversions, can substantially reduce instream flows available for aquatic species from July through September (Coccoli 2004).

There are several anadromous and resident fish species in the basin, several of which are listed by the National Oceanic and Atmospheric Administration (NOAA) or US Fish and Wildlife Service (USFWS) as Threatened or listed by the Oregon Department of Fish & Wildlife (ODFW) as a State Sensitive species. Threatened species include winter and summer steelhead, bull trout, spring and fall Chinook salmon, and Coho salmon. The Pacific lamprey and sea-run cutthroat trout are considered State Sensitive species. Other species in the basin include cutthroat trout and rainbow trout. Several reports have identified limiting factors to the recovery and production of anadromous salmonids within the Hood River Basin. These factors include low streamflow, impaired habitat diversity, altered hydrology, channel instability, increased sediment load, elevated water temperatures, fish passage barriers, and instream pesticide levels (Coccoli 2004), (ODFW 2010).

As part of the Hood River Basin Study, Reclamation simulated streamflow at 42 locations throughout the basin. This data was fed into the Hood River MODSIM model and an IFIM habitat model was also used to better understand how various climate change scenarios may impact future water supply. Results of this study, as well as other IFIM studies and more detailed discussion of the connections between instream flow and habitat benefit are discussed in Section 6.

Aside from scientific study of flow needs of important fish species, instream flow water rights can also be used to help understand the potential need, or demand, for increased instream flow. Under the prior appropriation system, water has been withdrawn from Oregon's lakes and streams since the late 1800's for agriculture, domestic and industrial uses. Instream uses were not given consideration until 1955 when the Oregon Legislature passed the Minimum Perennial Streamflow Act, authorizing the state to determine baseline stream flows necessary to support aquatic species and minimize pollution (Pilz 2006). In 1987, this act was supplemented with the Instream Water Rights Act, which allowed for 1) instream allocations through converting the minimum perennial stream flows to instream rights, 2) the Department of Environmental Quality, the Parks and Recreation Department, and the Department of Fish and Wildlife to apply for and instream right, and 3) water rights that were established for other uses could be leased or transferred to an instream use (ODFW 1997). There are several minimum perennial stream flows as well as state instream water rights in the Hood River Basin (Figure 15). There have also been senior water rights that were transferred instream, however those are not captured here.

Figure 15. Location of Instream Flow Certificates



Minimum perennial stream flows have a priority date of 1966, while instream water rights have a priority date of 1983 or later. The volumes for these rights are based on a monthly need to maintain, restore, and enhance fish populations. Less volume is needed in the smaller tributaries, such as Neal Creek, Lake Branch, and Dog River. On the East Fork, Middle Fork, West Fork and mainstem Hood River, instream water rights range from 100 CFS to 280 CFS (Table 14) (OWRD 2018). However, due to the junior status of these rights, instream rates are not always met.

Table 14. State Instream Flow Water Rights in the Hood River Basin

Certificate Number	Priority Date	Instream Flow Rate (CFS)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hood River Mainstem													
59747	3/30/1966	45	45	45	45	45	45	45	45	45	45	45	45
59679*	11/3/1983	170	270	270	270	170	280	130	100	100	100	100	170
Neal Creek (Tributary to Hood River)													
59681	11/3/1983	13	13	13	20	20	20	13	13	5	20	20	13
Middle Fork Hood River													
59748	3/3/1966	10	10	10	10	10	10	10	10	10	10	10	10
75230^	8/12/1991	150	150	150	221	246	233	150	140	100	116	145	150
West Fork Hood River													
59749	3/30/1966	100	100	100	100	100	100	100	100	100	100	100	100
75619^	12/6/1991	150	150	150	255	255	255	150	180	176	195	255	180
East Fork Hood River													
68457	11/3/1983	100	100	100	150	150	150	100	100	100	150	150	150
Lake Branch (Tributary to West Fork)													
75620	12/6/1991	67	67	67	168	113	66.9	44.8	38.6	37.1	35.7	67	67
Dog River (Tributary to East Fork)													
76267	12/6/1991	12	12	12	20	20	20	12	7.01	6.05	7.79	14.7	12

**flows listed include flows established by earlier dated water right*

^water right is not in addition to other instream flows created by a prior water right

At Tucker Bridge, the daily median flow over the period of record exceeds instream flow right volumes all months of the year. However, on the West Fork near Dee, flows are likely to be less than the instream flow right from August to November (Figure 16). For the West Fork near Dee gage period of record, nearly all years had some percentage of flows below the instream flow rights, as indicated by the pinks and reds in Figure 18. These shortages have typically occurred in August, September, and October, followed by June and November. There is ample water to meet these rights in winter and early spring.

Figure 16. Frequency State Instream Rights are Met; Tucker Bridge (L) and West Fork near Dee (R)

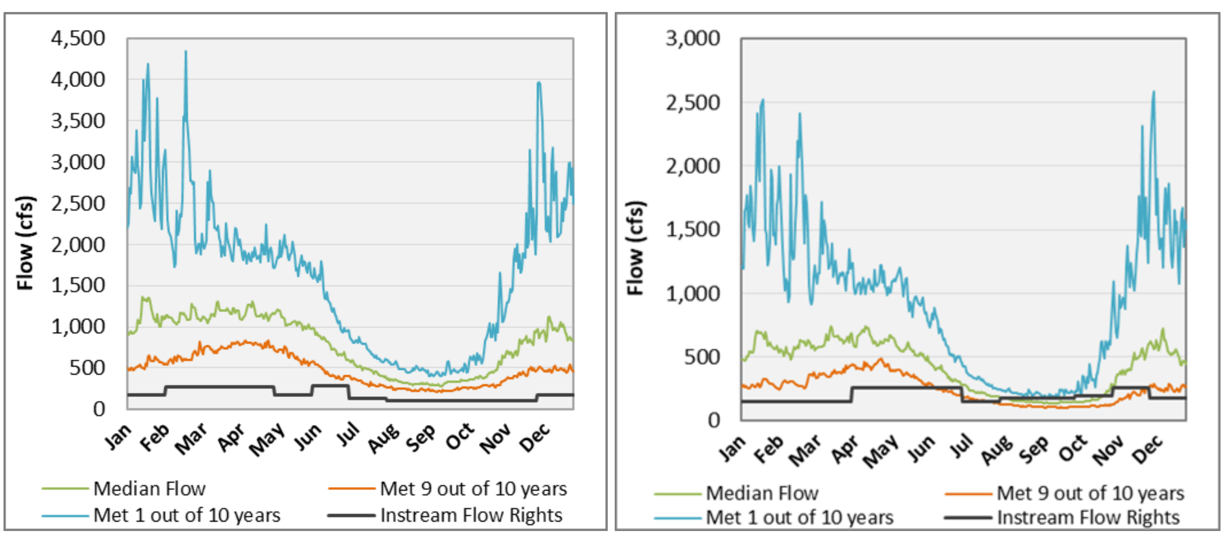
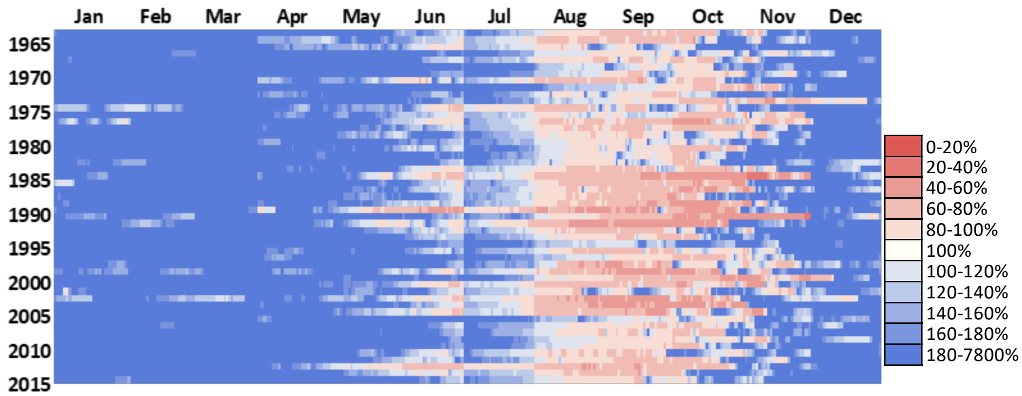
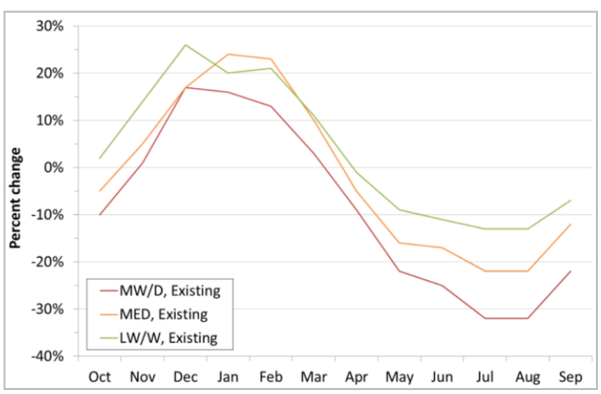


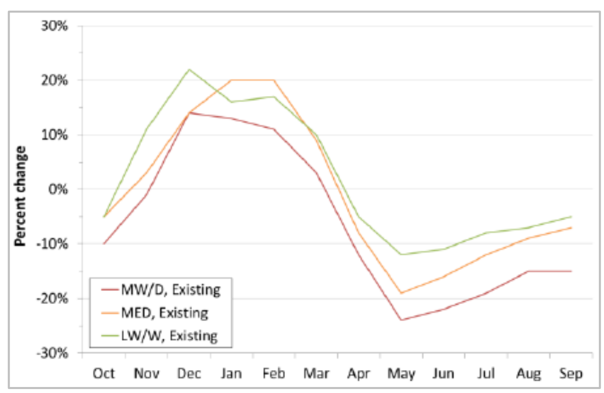
Figure 17. Percent of State Instream Water Rights Attained at West Fork Near Dee



As climate change progresses, the quantity and timing of instream demands of aquatic species and habitat may shift. Models predict that due to climate change, snowpack melt will occur earlier in the water year, with peak stream flows and runoff volumes shifting earlier as well. As a result, summertime flows are predicted to decrease (Bureau of Reclamation 2015). For example, under three climate scenarios More Warming / Drier (MW/D), Median (Med), and Less Warming / Wetter (LW/W), summertime flows at Tucker Bridge gage are predicted to be 10% to 30% lower than simulated historical streamflow and at West Fork near Dee summer flows are predicted to be between 5% and 20% less than historic flows (Figure 18). These lower flows will occur during the same time at which instream flow rights are either close to not being met (Figure 16 - Tucker Bridge) or already not being met (Figure 16 - West Fork near Dee), resulting in a decreased likelihood of reaching streamflow targets.

Figure 18. Relative Departure from Simulated Historical Flows, Hood River at Tucker Bridge (Left) and West Fork near Dee (Right)

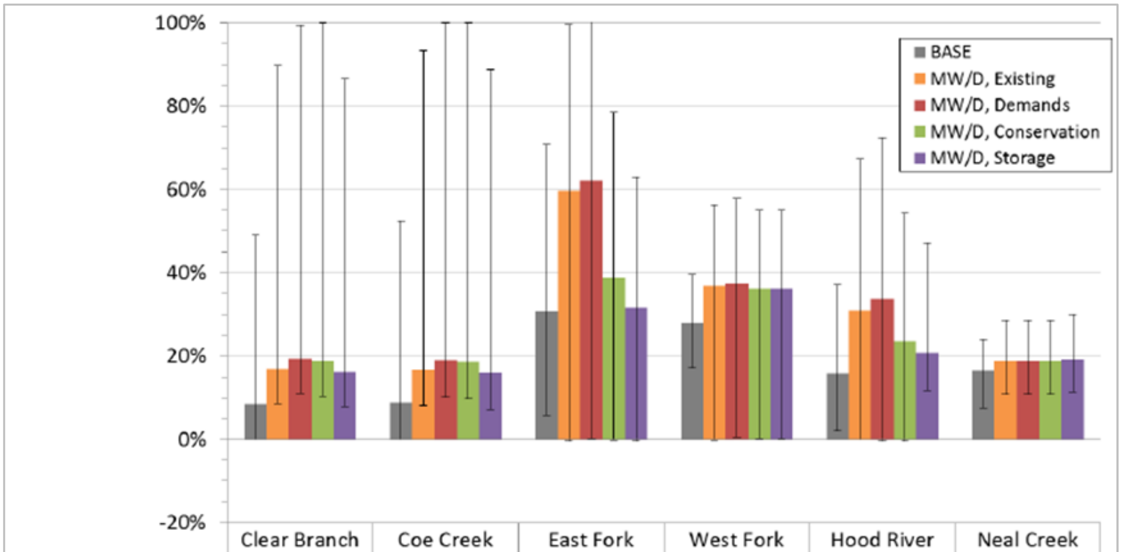




Source: (Bureau of Reclamation 2015)

Though there are several state instream flow rights throughout Hood River Basin, the junior status of these rights means they will see greater negative impact from climate change than senior consumptive use or hydropower rights. An analysis of the effects of climate change on instream flows was conducted at Clear Branch and Coe Creek on the Middle Fork Hood River, the East Fork above the Middle Fork, the West Fork below Lake Branch, Neal Creek at the mouth, and Hood River at Tucker Bridge. Climate change scenarios were coupled with potential changes in water use and management to evaluate impacts to minimum instream flows. The simulation included increased water demand, increased conservation, and the implementation of storage alternatives, (Figure 19).

Figure 19. Modeled Instream Flow Shortages as a Percent of Average Demands in an Average Water Year from July to September for the More Warming / Drier Climate Scenario



	Clear Branch	Coe Creek	East Fork	West Fork	Hood River	Neal Creek
BASE	8%	9%	31%	28%	16%	17%
MW/D, Existing	17%	17%	60%	37%	31%	19%
MW/D, Demands	19%	19%	62%	37%	34%	19%
MW/D, Conservation	19%	19%	39%	36%	24%	19%
MW/D, Storage	16%	16%	32%	36%	21%	19%

Source: (Bureau of Reclamation 2015)

In the More Warming/Drier (MW/D) scenario, instream flow shortages are expected at all sites despite the water use or management strategy. Tributaries to the Middle Fork, Clear Branch and Coe Creek, will experience instream flow shortages of approximately 20% regardless of strategy. On the East Fork, instream flows shortages could be up to approximately 60% under the MW/D climate scenario. However, based on Basin Study analyses, constructing a reservoir or completing planned conservation actions could reduce the chance of shortage to less than 40% of the time. The Hood River mainstem could experience instream flow shortages 30% of the time in warming climate conditions (Bureau of Reclamation 2015). Though not presented as an option in the above figure, a water bank could help to mitigate instream flow losses due to climate change by providing a platform for environmental water transactions.

In addition to state instream water rights and climate change modeling, several different instream flow analyses have been conducted using the Instream Flow Incremental Methodology (IFIM) in various areas of the Watershed (Normandeau Associates 2014).

5.2 Instream Flow Targets and Demand Triggers

This section briefly discusses how and when the water bank would be mobilized to restore stream flows. One assumption underlying the water banking concept for the Hood River Watershed is that water bank transactions may not be needed every year. In wet and possibly even normal years, water bank transactions for instream flow might not be needed or might not be needed in some locations in the Watershed. The question then becomes what conditions would trigger water bank action? Designing and fully quantifying a set of triggering factors is beyond the scope of this feasibility study, however, it is nonetheless important to outline the kinds of information that could be used to develop triggers and determine the feasibility of deploying such a framework in the Watershed.

A baseline for developing a framework for triggering the water bank's instream flow restoration functions is setting flow restoration targets. As discussed above, state instream water rights as well as existing IFIM studies in the Watershed are both good starting places for setting flow restoration goals. However, additional work is required. Flow restoration goals need to take into account a range of factors including aquatic species' life stage, presence and timing needs for flow (i.e. classic indicators of how much water fish need and when they need it) but also other factors like water demand timing, location of points of diversion relative to critical habitat and river reaches, and finally, practical considerations of how much flow restoration can be reasonably accomplished while maintaining a viable agricultural economy and community. Successfully meeting instream flow targets requires buy-in not just from flow restoration proponents and fish and wildlife advocates, but also from the agricultural community from which water supplies need to be voluntarily sourced. This does not mean that fish and habitat need to always be prioritized lower than agricultural water use, but it does mean that an incremental and adaptable approach is more likely to lead to success over time than an approach that asks for all of the water immediately.

As a leader in collaborative conservation in the Watershed, the HRWG is in position to convene a group of diverse basin stakeholders to meet and begin the process of setting realistic flow restoration targets that can meet aquatic species' needs over time. This process could be part of follow on work to this feasibility study and would be an important undertaking for an advisory group convened to help lead the work of a Hood River water bank or leasing program.

5.3 The "Market" for Meeting Instream Demand

This section briefly discusses the underlying drivers of instream demand. This is in contrast to the previous section that discussed quantifying instream demand and is also distinct from Section 8.2 related to funding instream flow restoration by the bank. This section asks and answers the questions: why are instream flow demands important and what is the "market" for them? The term "market" here refers to motivations by funding entities to pay for instream flow restoration. Section 5.5 below provides a similar analysis in the out-of-stream water use context, analyzing how water could be marketed to irrigators to meet the bank's secondary goal of providing irrigation water.

The market for instream flow is driven by several related factors. The most important of these factors is the presence of fish species listed under the Endangered Species Act. As part of the Bonneville Power Administration's (BPA) Federal Columbia River Power System Biological Opinion (FCRPS BiOp or simply BiOp), BPA is required to mitigate for negative impacts to anadromous fish species that use the Columbia River and its tributaries. BPA provides millions of dollars of funding each year to organizations across the Columbia River Basin in the U.S. for restoration actions and hatchery operations in an attempt to protect ESA-listed species' habitat and recover populations of listed fish. A small portion of this funding is dedicated to increasing instream flows in Columbia River tributaries like those in the Hood River Watershed. ESA-listed fish species recovery is therefore the primary driver of the market for instream flow restoration.

In addition to this federal market driver, there are also state drivers as well. The Oregon Watershed Enhancement Board is a state agency tasked with restoring and protecting healthy Watershed and natural habitats throughout Oregon. Though they do not have a specific legal requirement to fund restoration like BPA, OWEB was created by the legislature and funded, primarily with receipts from the Oregon Lottery, to undertake Watershed restoration projects. Instream flow projects are one of the many types of actions that OWEB funds. In addition to OWEB, the Oregon Department of Fish and Wildlife (ODFW) works with state, federal and tribal partners on recovery of aquatic species of concern under both federal and state law. In addition to BPA's BiOp obligations, OWEB and ODFW and their related missions and activities are additional drivers of the market for instream flow restoration.

Native tribes are sovereigns who, alongside the federal government and state, focus on restoring Watersheds and fish habitat, and also operate hatcheries to increase fish populations. Tribes in the Northwest have treaty rights to fish for salmon and steelhead, but these rights have been severely impacted by fish population declines resulting from Columbia River dam operations and other anthropomorphic and climate-change impacts. Tribal restoration priorities are yet another driver of the market for instream flows.

Federal, state and tribal drivers of demand for instream flows are often related and interconnected. For example, much of the funding for tribal restoration and hatchery programs is funded by BPA. Likewise, OWEB and ODFW's restoration priorities are influenced by and often overlap with tribal and federal priorities. Taken together, federal state and tribal restoration priorities are the primary basis for instream flow demand and in turn, funding for instream flow restoration. In addition to these specific market drivers, other drivers are also important. For example, local economies depend on dollars spent by tourists and recreationists and much of this spending is driven by the presence and ongoing health of flowing rivers and healthy fish populations.

5.4 Market Pricing for Instream Flow

Instream flow supports both economic and non-economic benefits. Examples of economic benefits of instream flow include money spent to recreate in and around rivers (rafting, fishing etc.) as well as harvest and sale of fish by native tribes. Examples of non-economic benefits of instream flow include species recovery more generally and aesthetic values of flowing rivers. Benefits of instream flow can be difficult to price because they are not like traditionally traded goods and services. There are ways to value species recovery, aesthetics and recreational benefits of instream flow, but they are not simple and often involve subjective analyses such as willingness-to-pay surveys and other contingent valuation methods.

Because of the difficulty valuing instream flow benefits, the price of instream flow is, for practical reasons, often simply the cost of leasing or buying the water and restoring it to rivers. There are several reasons for this. Buyers of instream flow are almost always public entities (they are more often referred to as funders rather than buyers) and they do not compete with each other on price. A water bank, in other words, does not conduct instream flow restoration and then sell the benefits to the highest bidder. Water banks and other environmental water restoration programs simply seek funding to conduct flow restoration actions. To compare this to a more common market good, it would be like a consumer paying a farmer to plant trees and grow apples rather than simply walking into a market and buying apples that have already been grown.

The pricing of instream flow is therefore inextricable from water valuation itself. The price of water for instream flow will almost certainly be its cost to the bank. Ideally, the price includes not just the cost of the water itself, but also the costs incurred by the bank to achieve flow restoration (discussed further below in Section 8, "Water Bank Capacity Needs, Transaction Costs and Funding").

5.5 Irrigation Demand

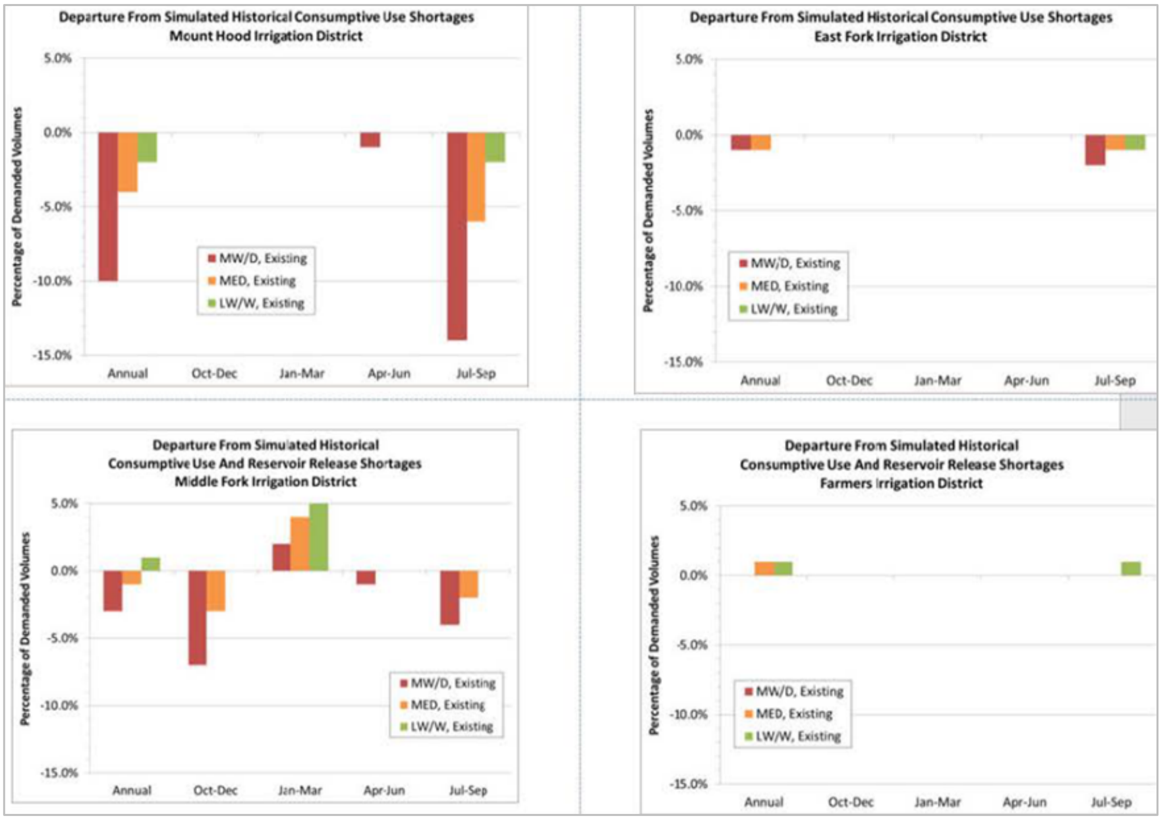
Future demand for irrigation water supplies could take different forms. Farmers could seek to expand the amount of irrigated acreage in the Watershed. Alternatively, farmers could seek additional water to make up for reductions in their current supplies as melting glaciers and climate change impacts take effect. Both of these types of demand could theoretically be met at least partially through a water bank, though there are also other ways to supplement existing supplies. While this report is not focused on strategies other than the water bank, it is worth noting that expanding existing storage, water conservation, and increased groundwater use are all additional tools that might help the basin meet irrigation needs in the future. A water bank would likely not be able to meet all future irrigation water needs.

Unlike with instream demand discussed above, out-of-stream demand, and specifically potential future shortages in out-of-stream demand, have not been the subject of extensive study in the Watershed to this point. The 2015 Bureau of Reclamation Basin Study modeled potential impacts of climate change scenarios on out-of-stream water uses including potable water use for cities and irrigation water use. For potable water use, the Basin Study predicted potential future shortages under all of the different climate change scenarios, but these shortages were primarily predicted to impact the city of The Dalles (outside of the Hood River Watershed) and Crystal Springs, a tributary to the upper East Fork Hood River (Bureau of Reclamation 2015). These potable water shortages were not specifically quantified, and some of them were based on a model that used less than ten years of historical data. However, even though these shortage predictions are not specific and are based on less-than-ideal data sets, all of the different climate scenarios showed potential future shortages.

The Basin Study also predicts potential future shortage for most of the Watershed's irrigation districts. These shortages range from less than 1% to almost 10% for MFID during July through September under a warm/dry scenario (Bureau of Reclamation 2015)(Figure 20). Consumptive use shortages relative to historical conditions are predicted to occur in four of the five irrigation districts – MFID, EFID, MHID, and FID (Figure 20). Mount Hood, East Fork, and Middle Fork Irrigation Districts all show that projected demand volumes will exceed the historical consumptive use during the irrigation season. The results include reservoir releases to support hydropower operations, which are shown during the non-irrigation season. Results were calculated using average demands over a ten-year period or less, and therefore the quantitative values may not be accurate, however the general trend suggests that irrigation water use could be at risk. It is important to note that these predictions do not incorporate ongoing and planned water conservation projects by the irrigation districts. If all of the planned conservation projects are completed, the water supply risks for irrigation districts would be significantly reduced.

Conversations with irrigation district managers also point to some possible sources of demand for out-of-stream water supply from the water bank. In MFID for example, as many as 200 acres have been cleared and prepared for new plantings and the owners of these acres have let the district know that they are interested in water should any become available. Also, in MFID, some growers might be motivated to add water supply to avoid being subject to water rotations when supplies are stretched thin. During dry years, MFID puts its users on rotation to spread out reduced supplies. This means that growers are only allotted certain days of the week when they have access to water. Additional water supplies from annual crop fallowing might be made available so that some users could avoid this practice.

Figure 20. Projected Consumptive Use Shortages of Irrigation Districts



Source: (Bureau of Reclamation 2015)

5.6 The Market for Irrigation Demand

The market for irrigation water will primarily be driven by declines in existing water supplies caused by climate change, population growth and generally increasing competition for scarce water supplies. To a lesser extent, the market for irrigation water may also be driven by a desire to increase the number of irrigated acres to capitalize on the Hood River Watershed's ability to produce high value crops like fruits and, increasingly, wine grapes.

Unlike the market for instream flow, the market for irrigation water is more straightforward and conforms more easily to common perceptions about what markets are and how they work. Demand for fresh fruit and other crops provides an opportunity for farmers in the Hood River Watershed to make a living and generate economic activity. The Watershed has developed into one of the foremost regions in the western U.S. for several different high value fruit crops including pears, apples and cherries. Water is a critical input in producing these crops and can also be a critical limiting factor when it is or becomes scarce. The primary driver of the market for irrigation water will therefore be preserving the Watershed's ability to grow crops to meet demand in the region and beyond.

5.7 Market Pricing to Irrigators

Pricing water to out-of-stream users can differ from instream uses. In theory, water pricing to growers could be set in a more traditional market setting where a landowner with water leases or sells their water to the farmer who is willing to pay the most for it. There are several issues with this approach, however.

First, offering water for sale to the highest bidder could lead to a scenario where it is more valuable for the water bank to provide water for irrigation than to provide water for instream flows. Because instream flows are the primary goal of the water bank, this is not desirable. Second, there can be significant restrictions on trade that can impact pricing of water between growers. Trade within irrigation districts may be relatively simple but trade between districts may be banned altogether or, if allowed, may be administratively complex, time consuming and expensive.

Therefore, while it is feasible for a Hood River water bank to transact irrigation water alongside instream flows, careful design and pricing choices will need to be made. There may be some instances where instream flows are not needed, and the bank can approach pricing to irrigators using traditional market strategies like an auction where the highest bidder wins. Broadly speaking though, the bank needs to take care that out-of-stream transactions do not result in setting a market price that instream buyers are not willing or cannot afford to meet. Generally, then, as with pricing for instream flow, the price of irrigation water from the bank should in most cases be set at the bank's water cost plus an administrative charge to cover transaction costs incurred by the bank in making the water available.

5.8 Competing Demands and Dual Benefits

In addition to considering instream and out-of-stream demands separately, it is also important to address scenarios where the Watershed faces both types of demands simultaneously. The same conditions that exacerbate low stream flows and drive instream demand are also likely to drive out-of-stream demand. The simplest answer to how to prioritize between in and out-of-stream demand is that instream restoration is the primary goal of the bank and so instream demand should be prioritized in many cases. However, there will likely be situations where both instream and out-of-stream demands could be met in the same transaction. For example, if the primary low-flow problem occurs near the mouth of the East Fork, then a downstream lease of water from EFID to FID could achieve the desired instream flow benefits and also meet an out-of-stream need in FID. These cases are likely the exception rather than the rule, but the bank should be aware of their potential and, when considering competing demands, first look to see if in and out-of-stream benefits might be met simultaneously.

There are other situations where the bank could consider facilitating both types of transactions at the same time. For example, if there are not ongoing instream flow concerns on a tributary such as Green Point Creek or the Middle Fork, the bank could facilitate out-of-stream trading on those systems while only allowing instream transactions in other locations. Also, if there is not funding for instream flow restoration on a specific river or river reach but there are irrigators willing to pay for additional water, the bank could help facilitate those transactions as well. Added together, the bank has several different options to balance competing demands and could use a decision process such as:

- Start with the assumption that instream demand is met first when funding is available, unless an exception applies;
- Exceptions could include:
    - Downstream trades between irrigation districts (if allowed by districts) where instream benefit is provided through the reach where it is needed (note that if such a transaction would only provide flow through part of a reach in need of flow, this would be a more difficult proposition and the bank would likely then need to prioritize the transaction that provided instream benefit to the entire reach);
    - A situation where one or more tributaries is not experiencing instream flow depletions and out-of-stream trades can be facilitated on those tributaries;
    - Funding is not available for instream flow restoration on a specific river or river reach;
    - Intra-district trading that could be approved when an instream transaction could not be approved.

One final note about potential competing demands, is that, to effectuate the prioritization of instream flow, the bank would need to take this prioritization into consideration when thinking about water pricing paid to landowners for fallowing. If the bank does not have policies setting prices, then an out-of-stream user might be able to afford paying more than an instream funder. There is nothing wrong with this in principal, however, if bank operations are being funded by public entities, then the priority for instream benefit would take precedence over a higher willingness to pay from an irrigator. If, however, the bank was funded by the irrigation districts or was self-sustaining through fees charged on transactions, the bank might be freer to prioritize transactions in a manner of its choosing.

6. Instream Flow Benefits of Streamflow Restoration

This section discusses results of a study that evaluated the effects of instream flow increases on habitat and water temperature. WPN evaluated the incremental instream benefits associated with water leasing at key locations within the Hood River Watershed over the course of the irrigation season (April-October). Existing studies were used that relate instream flow to fisheries habitat, and existing and new water temperature modeling was also used to examine the incremental benefits of saved water on water temperatures. WPN evaluated impacts over a broad range of instream flow savings from zero (no water bank leasing) up to 30 CFS. It is important to note that this range is much broader than the instream flow benefits modeled above in Section 4.3. That section was focused on likely early-phase outcomes of water bank activity in the Watershed and used very conservative assumptions. The broader flow range in this section was selected to demonstrate the extremes of what could be possible with instream flow restoration in the Basin. WPN used the 0-30 CFS range at all locations studied for the sake of consistency in reporting, however it is important to note that some locations, for example Green Point Creek, do not currently withdraw water at the upper end of this range and would therefore never likely see the high end of the flow restoration modeled. WPN's modeling is separated into a fish habitat model and a water temperature model, each of which is discussed below.

6.1 Fish Habitat Results

There are two Instream Flow Incremental Methodology (IFIM) studies available for streams in the Hood River Basin. The Middle Fork Hood River IFIM (Watershed Professionals Network LLC, Meridian Environmental Inc., and Caldwell and Associates 2013) looks at five representative locations within the Middle Fork Hood River sub-basin, and Normandeau (2014) covers an additional five key locations in other parts of the system (Figure 21). In addition, PacifiCorp (1998) used a similar methodology to evaluate flow-habitat relationships at sites in the lower mainstem below the Powerdale Dam site (Figure 21). These studies served as the basis for WPN's habitat evaluation.

The IFIM studies developed a relationship between streamflow and the quantity of habitat at a given flow, the weighted usable area (WUA), expressed as square feet of habitat per 1,000 feet of stream reach. The PacifiCorp (1998) study for the lower mainstem used a similar approach but expressed results in terms of percent of optimum habitat. These relationships are specific to different species and life stage (Figure 22). A different set of relationship curves applies to each individual location.

Four fish species and two life stages per species were considered in this analysis (Table 15). Not all species/life stages are present at each location. In order to normalize results across locations WPN developed average WUA at each location by month, assigning the same weight to each species and life stage. Results were then expressed as the change in WUA associated with the change in monthly streamflow over baseline conditions.

Figure 21. Hood River Basin showing principal diversion, water source by irrigated acreage, and IFIM study site locations.

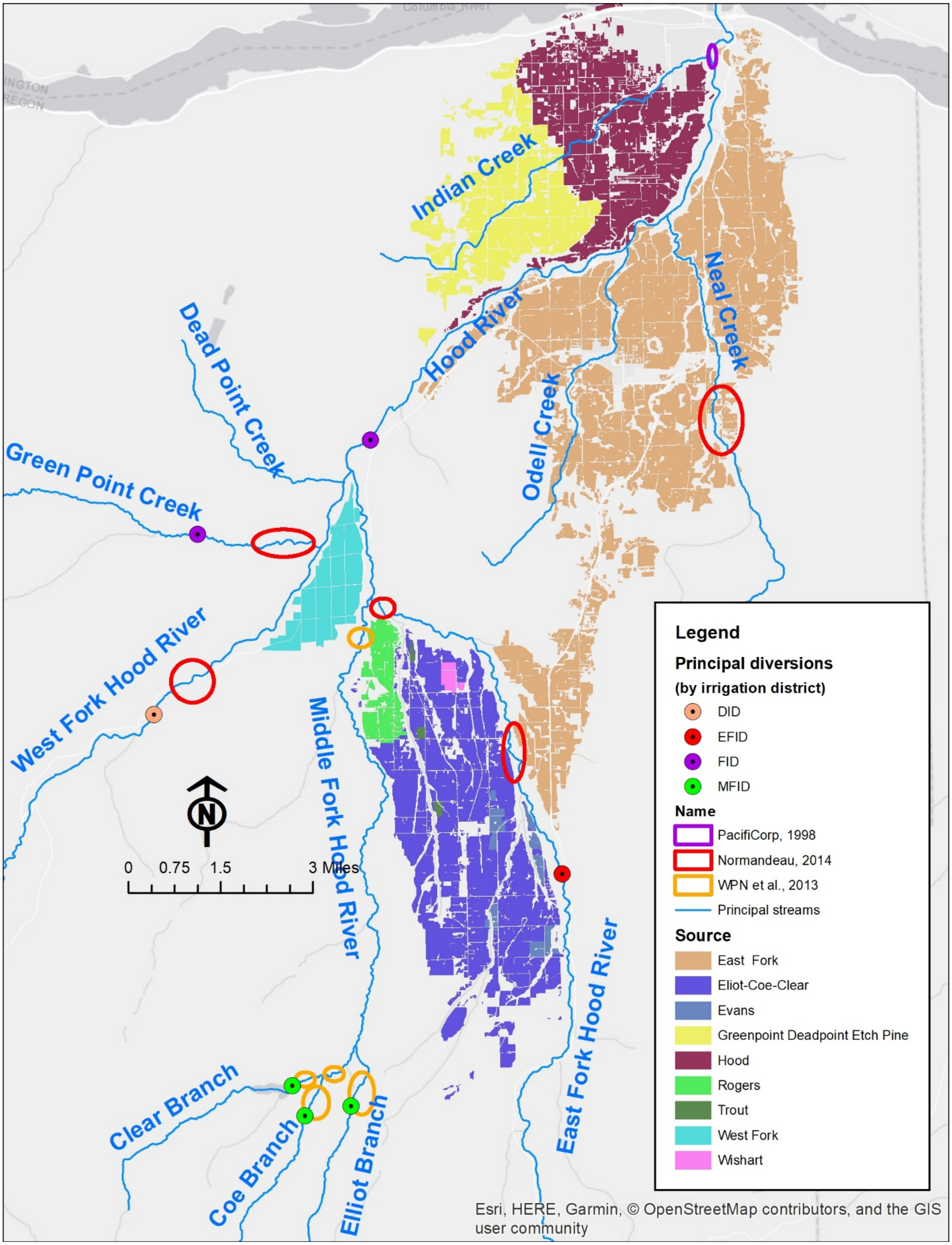


Figure 22. Weighted usable area (WUA) for the Clear Branch.

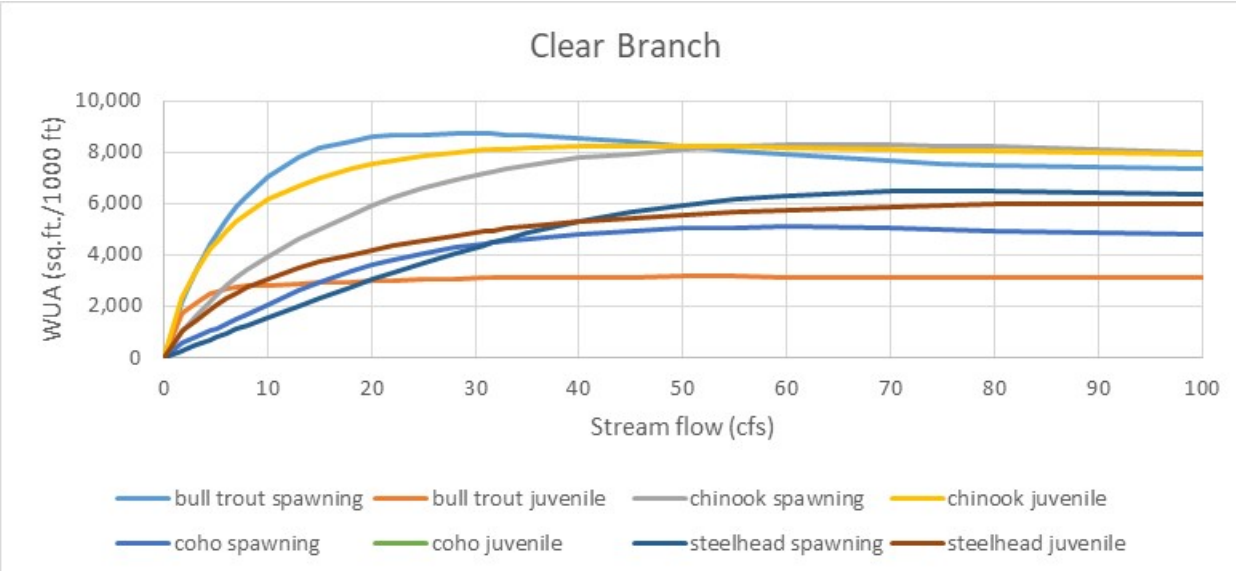


Table 15. Species and life stage use within the Hood River Basin.

Species	Life Stage	APR	MAY	JUN	JUL	AUG	SEP	Applicability
Spring Chinook	juvenile rearing							All sites
	spawning							All sites
Coho	juvenile rearing							All sites except Clear Branch
	spawning							All sites
Steelhead	juvenile rearing							All sites
	spawning							All sites
Bull trout	adult rearing							Clear Br, Middle Fk, and West Fk. only
	spawning							Clear Br, Middle Fk, and West Fk. only

In order to evaluate the change in WUA WPN established a baseline streamflow condition to compare changes against. The Oregon Water Resources Department (OWRD) estimates net streamflow (natural flow minus consumptive uses) for reaches downstream of the principal diversions. The net streamflow estimates available from the OWRD are the monthly 50% and 80% exceedance flows. The 50%

exceedance streamflow is the streamflow that occurs at least 50% of the time in a given month. Conversely, the streamflow is also less than the 50% exceedance flow half the time. The 50% exceedance flow can be thought of as representing a “normal” streamflow for that month. The 80% exceedance streamflow is exceeded 80% of the time. The 80% flow is smaller than the 50% flow and can be thought of as the streamflow that occurs in a dry month. **The 80% exceedance flow was used as the baseline for this analysis** (Figure 23 and Figure 24, preceding pages).

Figure 23. Median (50% exceedance) and dry (80% exceedance) mean monthly streamflow at the mouths of Clear, Coe, and Eliot Branches, and at the mouth of the Middle Fork Hood River Watersheds.

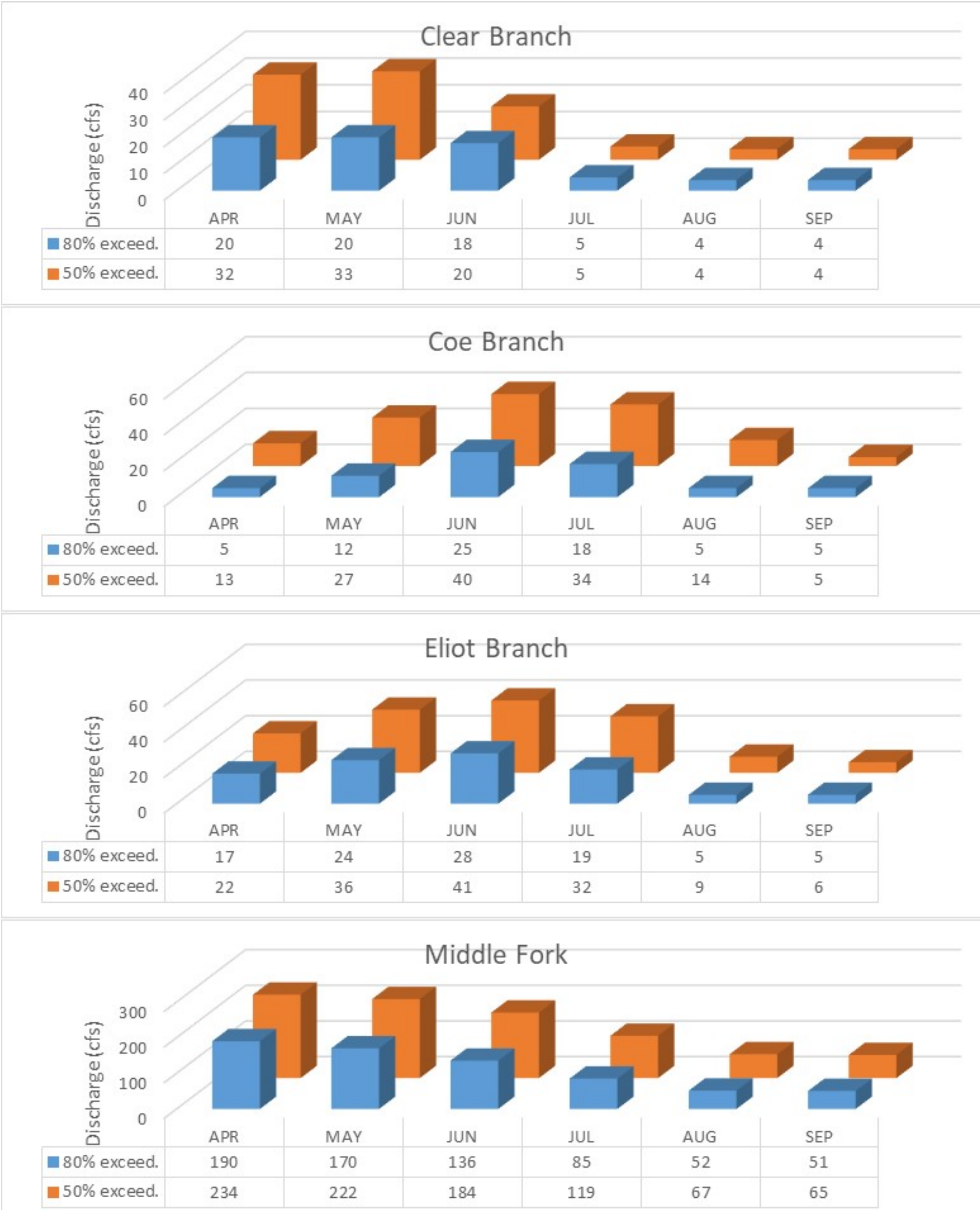
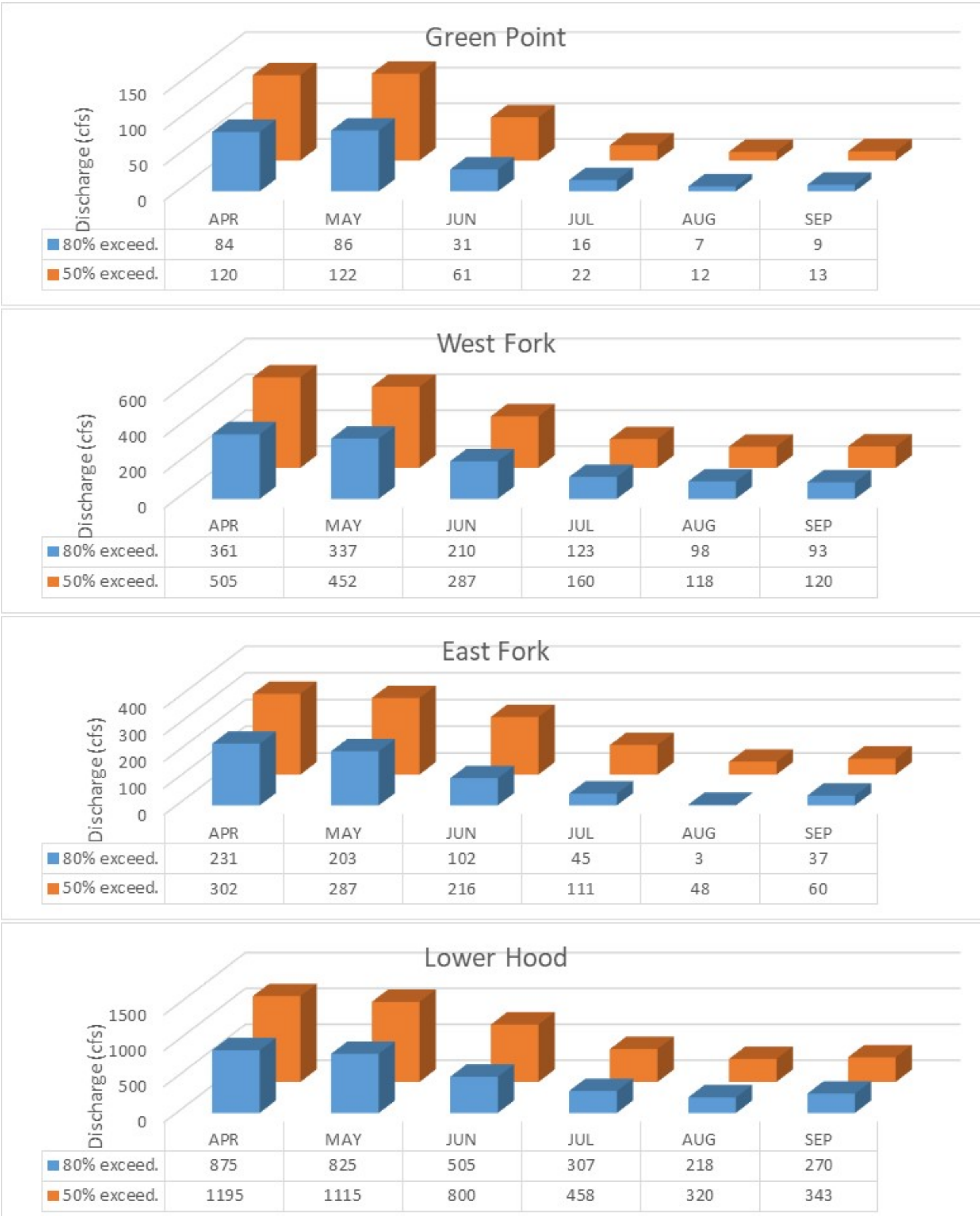


Figure 24. Median (50% exceedance) and dry (80% exceedance) mean monthly streamflow at the mouths of Greet Point, West Fork, East Fork, and mainstem Hood River Watersheds.



Results are presented by month in Figure 25 and Figure 26 below. All IFIM locations use the same Y-axis scale to visually display the relative differences in flow-related benefits:

- **Green Point Creek** (Figure 25, top) responds positively to increased stream flow, with the greatest change occurring from the initial additions. August and September are the months of greatest change in habitat area. Given the relatively low diversion rate from Green Point we would not expect increases in flow of greater than approximately 5 cfs associated with water savings.
- The **West Fork Hood River** (Figure 25, middle) has a flatter response curve, indicating less change in habitat area with increasing flows. August and September are the months of greatest change in habitat area. June and July show almost no change in habitat area with higher flow, and the month of May shows a negative response. These results are probably due to the relatively high baseline flows (Figure 24), and the general tendency for WUA to remain relatively constant at higher flow levels (e.g., Figure 22 from Clear Branch).
- The **East Fork Hood River** (Figure 25, bottom), shows a linear and large positive response to flow additions during the month of August, due to the very low baseline flow (Figure 24), September shows a positive though flattening response. The response for all other months is flat, indicating little change in habitat area with increasing flow. This response is likely due to the importance of low velocity habitat along the channel margins, which may change location at different flow levels, but remain essentially the same over the range of flows.
- **Clear Branch** (Figure 26, top) shows a positive though flattening response for all months, with the largest increase in habitat in August and September. Clear Branch has more complex instream structure (large wood, boulders, etc.) that provide for increased habitat area with increasing flows.
- In contrast to Clear Branch, the **Middle Fork** site (Figure 26, middle) shows almost no change in habitat area with increasing flows. This is due to the relatively high baseline flows (Figure 23), lack of instream structural complexity, and habitat being provided primarily by low velocity areas along the channel margins.
- Results for the **mainstem Hood River** (Figure 26, bottom) are based on percent of preferred habitat. The April, May, and June response is flat; no change in habitat conditions with increased flow. July shows a very slight (1% over the range) decrease in habitat with increasing flows. August shows an initial benefit up to a 7 cfs increase, and then a decline in habitat. September is almost the reverse of August, with an initial decline followed by an increase. It is important to note that all of these changes are relatively small, and the overall result is that habitat in the lower mainstem is relatively unaffected by flow changes.

Figure 25. Change in composite weighted usable area in dry conditions (80% exceedance) mean monthly streamflow at the mouths of Green Point, West Fork, and East Fork Hood River.

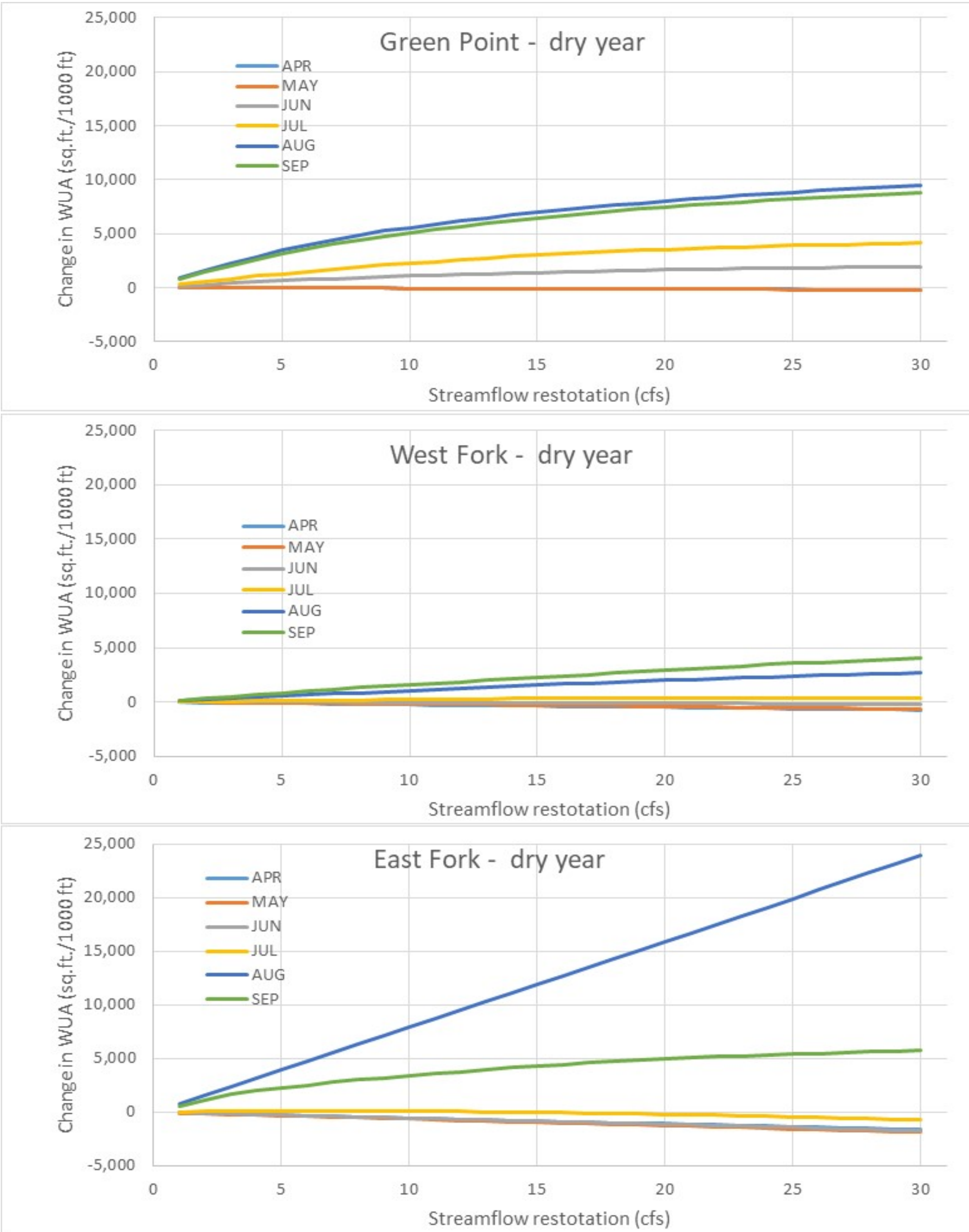
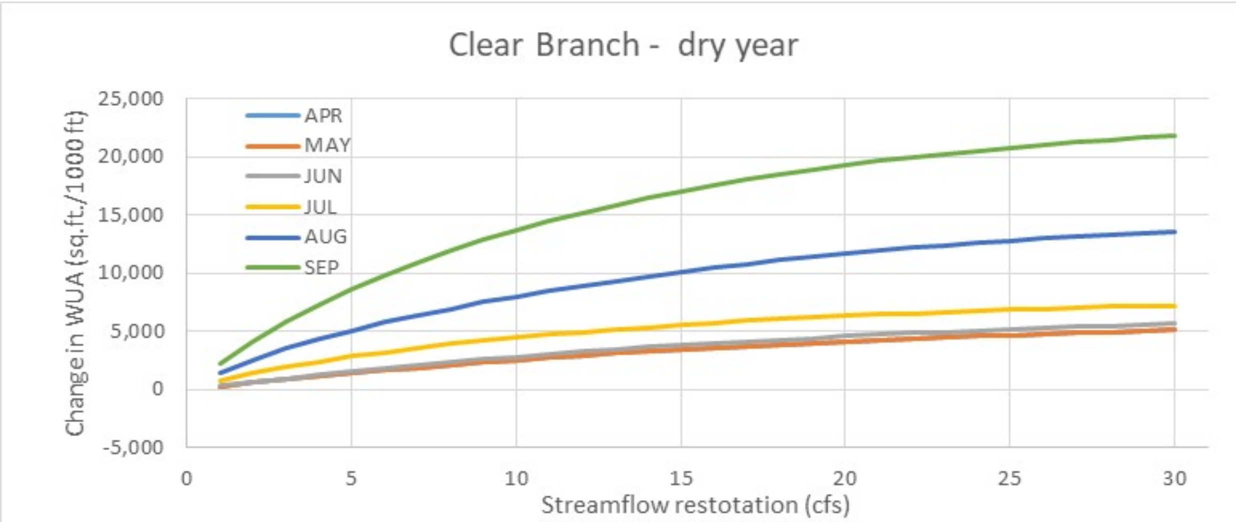
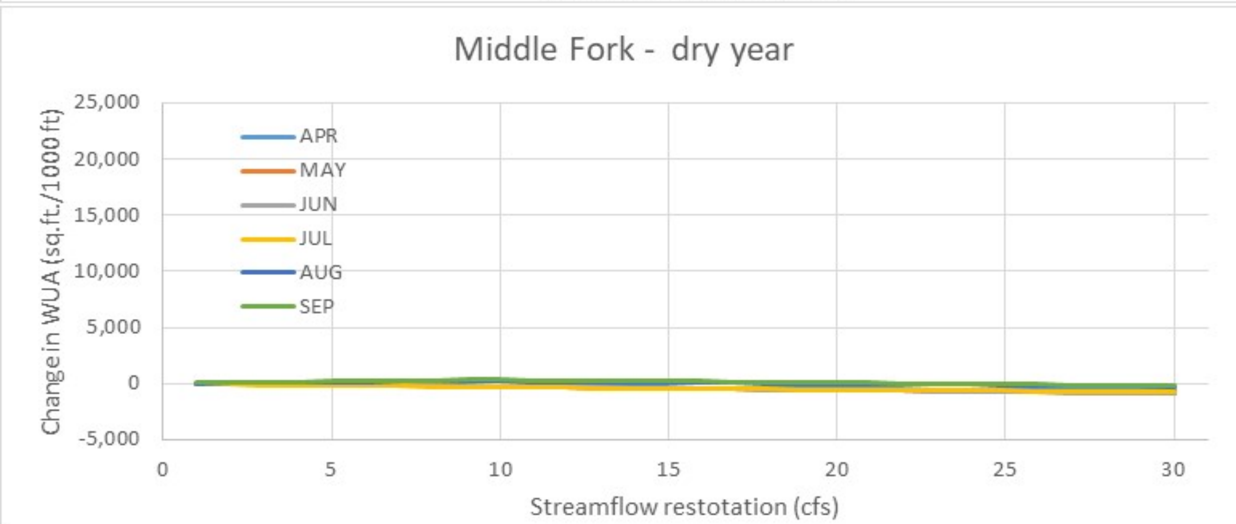
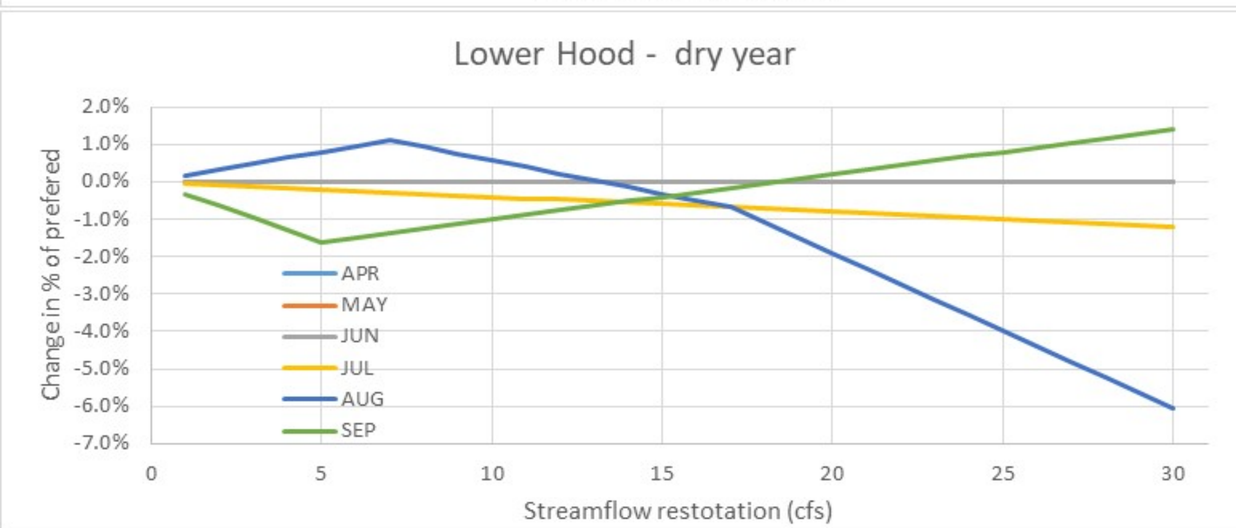


Figure 26. Change in composite weighted usable area in dry conditions (80% exceedance) mean monthly streamflow in Clear Branch and Middle Fork and change in % of preferred at the mouth of the Hood River (bottom).







6.2 Water Temperature Results

In 2018 MFID completed a HeatSource (Boyd and Kasper 2003; Boyd et al. 2018) temperature model for Coe Branch / Middle Fork Hood River from the base of Clear Branch Dam to the confluence with the East Fork (Watershed Professionals Network LLC 2018; Figure 27). This model was developed as part of the environmental analysis of proposed infrastructural and operational changes that MFID is proposing. This model was calibrated to 2014 conditions, and validated to 2015, 2016, and 2017 observations. The MFID model has been evaluated and approved by an independent third-party and is currently being evaluated by ODEQ. The MFID model was used to evaluate temperature changes associated with flow increases in the Middle Fork.

No calibrated temperature models are available for the remainder of the streams in the Hood River Basin. As part of this analysis WPN developed four additional HeatSource models; one each for the East Fork, West Fork, Green Point, and Mainstem Hood locations (Figure 27). The longitudinal extent of these model locations was driven by the availability of water temperature data to use as upstream boundary conditions, and for validating results at downstream locations. No calibrations were performed for these models. Parameter values were mostly taken from the MFID models (WPN, 2018). Despite this simplistic approach the models appear to replicate observed conditions well at most sites (Figure 28).

Temperature data for this analysis were provided by the Confederated Tribes of the Warm Springs, ODFW, The Hood River Watershed Group (HRWG), MFID, and by Zbigniew Grabowski, a PhD candidate doing research in the Hood River Basin. Only 2016 had data needed at all locations and consequently, results are limited in their temporal scale. Further work on model calibration and for additional years would increase our confidence in the results presented below.

Streamflow data are also needed to run the HeatSource models; both upstream (boundary condition) inflow and any outflows along the reaches. Gage data on the mainstem Hood River, West Fork, and Middle Fork were used, along with measured outflows for the DID, EFID, and MFID diversions. The daily FID diversions were not available; however, monthly reported amounts were used to estimate daily values. The HeatSource models are also driven by hourly meteorology data. One single station, the PARO Agrimet station, maintained by the USBR and located in Parkdale, was used for all models.

Channel location was digitized from high-resolution 2016 aerial photography provided by Hood River County, and channel widths were measured from the resultant data set. Bare earth and highest hit (i.e., top of vegetated canopy) LiDAR data (modified for digitized channel locations) were used to measure channel gradients, aspect, view to sky (from both vegetation and topography) and other model parameter data using the ODEQ TTOOLs python scripts (Mitchie, n.d.).

Figure 27. Stream temperature model locations.

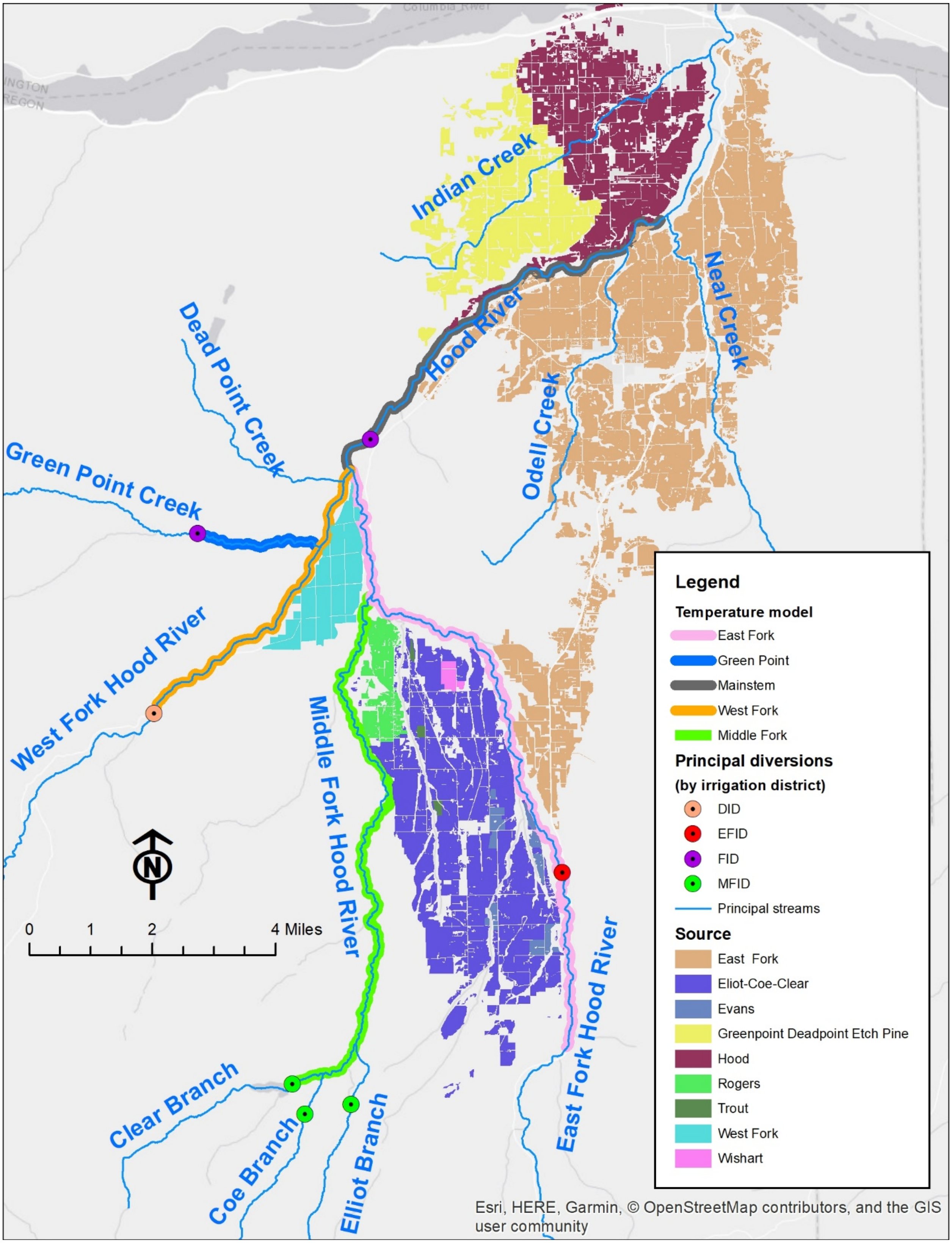
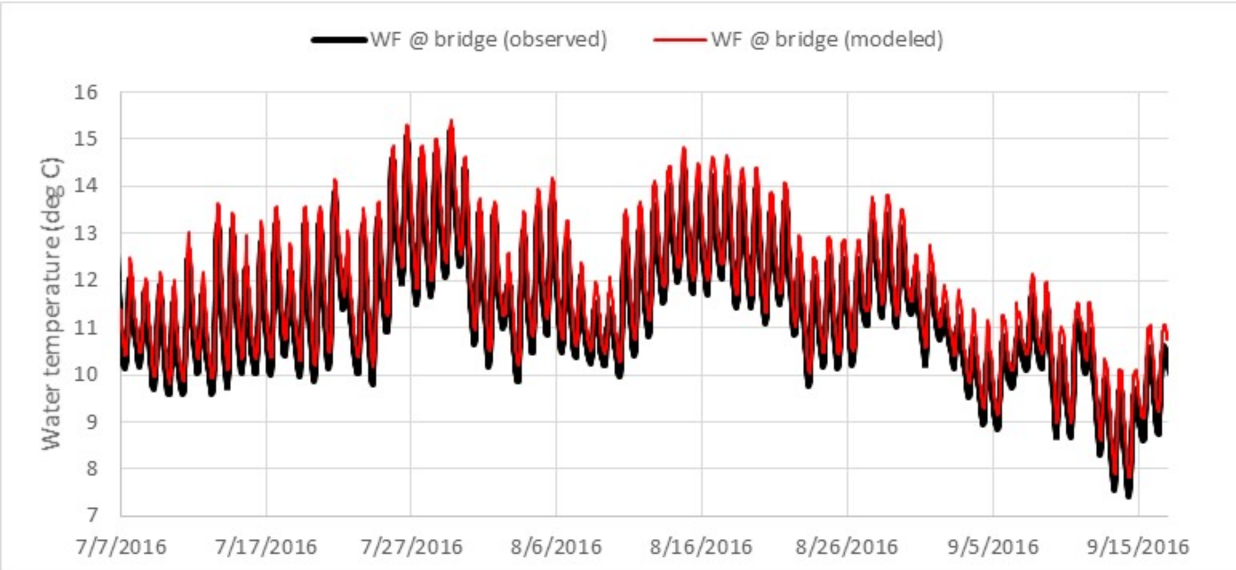


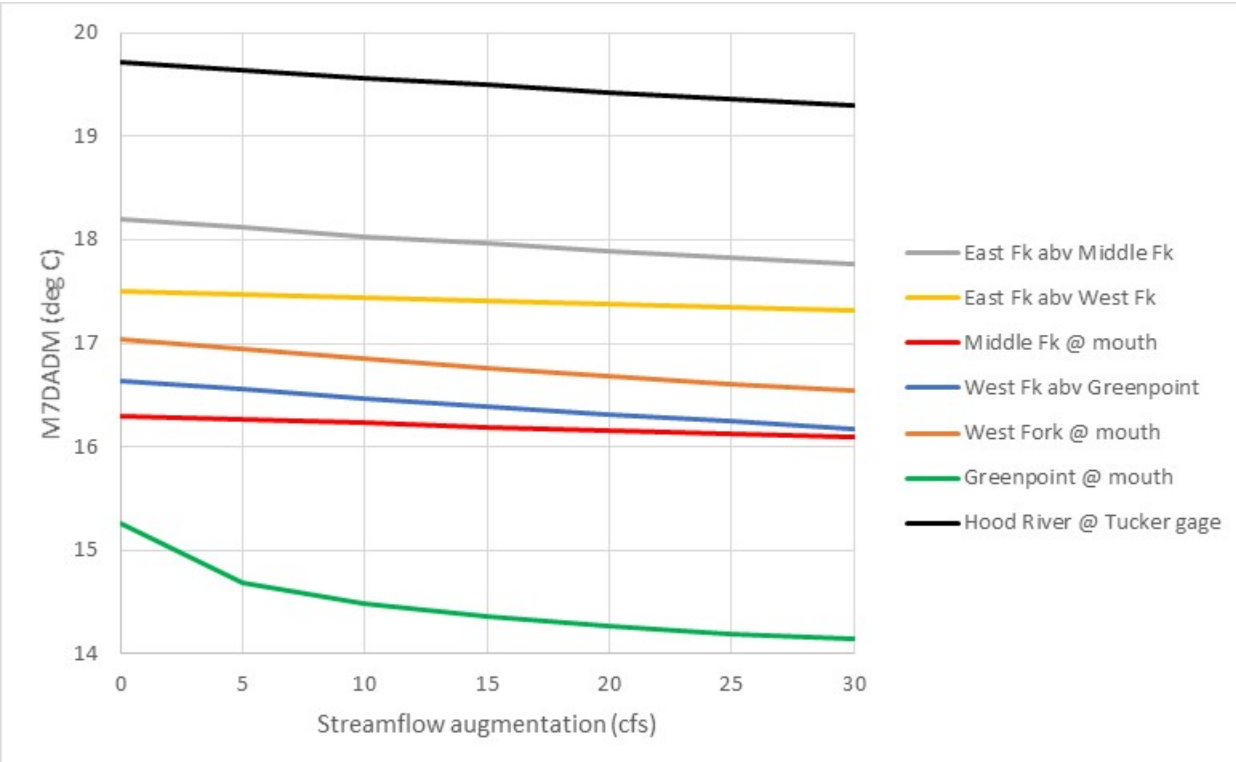
Figure 28. Temperature model validation, West Fork Hood River at the Lost Lake Road bridge.



The ODEQ uses the seven-day-average of daily maximum water temperatures (7DADM) for evaluating water impacts. Figure 29 shows the period of record maximum 7DADM, herein referred to as the M7DADM water temperature, at selected locations with increasing streamflow augmentation for summer 2016. WPN modeled temperatures using 5 CFS incremental increases in streamflow. In each case WPN assumed the total increase occurred at the diversion affecting the given reach.

- **Greenpoint Creek** showed the largest relative change in M7DADM temperature, although given the low rate of diversion these results are probably not valid beyond five CFS.
- M7DADM stream temperatures in the **Middle Fork Hood River** were the least sensitive to streamflow augmentation, probably due to the relatively large volume of water during the summer months.
- The **East Fork above the West Fork** had a relatively flat response to increased flows, however, this is likely due to the inflow of water from the Middle Fork; the response above the Middle Fork confluence was more robust.
- The **East Fork above the Middle Fork**, **West Fork** at both sites, and **Hood River at Tucker gage** all respond relatively similar to augmentation of flow.

Figure 29. Modeled M7DADM water temperatures at selected locations with increasing streamflow augmentation for summer 2016.



6.3 Applicability to Water Bank Feasibility

WPN's analysis demonstrates that both habitat and temperature benefits can result from increased streamflow in Hood River tributaries. These benefits are likely higher in some areas of the Watershed than in others. While WPN's analysis tested a top end restoration benefit that exceeds even the most successful restoration scenario modeled above in Section 4.3, it is nonetheless important information to consider in analysis of a water bank's feasibility in the Watershed. WPN's analysis demonstrates that instream flow restoration has fish habitat and water temperature benefits, key drivers of funders' demand for, or willingness to fund, water transactions. WPN's work also helps to demonstrate one tool that could be critical in targeting instream flow restoration where and when it is most needed. Analyses like the one above can be used to plan partial season flow restoration transactions that are focused on solving specific habitat and temperature issues in both time and space. Finally, WPN's analysis could be considered as part of a process to set realistic flow targets, and by association, fully quantify flow restoration need, for area rivers.

7. Water Bank Operational Considerations

This section discusses a wide range of issues related to how a water bank might operate in the Hood River Watershed. These considerations involve the nuts and bolts of operating a water bank. However, because this report is a feasibility study, it does not make specific water bank design recommendations. Rather, this report explores different options and offers suggestions and analysis about the feasibility of various operational choices.

This section begins by examining alternative institutional forms for a Hood River Water Bank. Next, different ways to solicit water bank supplies are discussed from practical and transactional standpoints. Finally, water bank governance and oversight issues are presented, including governance structure and examples of policies to guide water bank transactions.

7.1 Alternative Water Bank Institutional Forms for the Hood River Watershed

As noted in the introduction, water banks can take a variety of institutional forms. These different forms are primarily differentiated by their level of formality or, stated differently, the degree to which the bank operates autonomously from other entities in the Watershed or water market. On one end of the spectrum, a water bank can be a fully self-contained entity with its own staff, office, board and business plan. At the other end, a water bank can simply be a program of an existing entity, sharing staff, office space and oversight with that entity. Finally, at the informal end of the spectrum, there is a question of when a water transaction project becomes formal enough to be classified as a water bank. For example, if the HRWG simply decided it wanted to occasionally engage in water transactions to help boost instream flow during dry years, would that be best classified as an informal water bank or just a water transaction project?

In the end, a precise answer to this question is not critical. If that is indeed the path the HRWG ends up on, what is important is to have a plan in place to make the water transaction effort as efficient and effective as possible.

The key determinants of what level of formality is most appropriate for a new water bank in a given context include the scope of the water transaction effort needed to meet the bank's goals, the complexity of the water rights and regulatory environment, and the available funding. Specific goals at a large geographic or other scale and a complex water right and regulatory environment both mitigate in favor of greater formality. Funding is less straightforward. Availability of funding for water bank startup costs, either from public or philanthropic sources in the case of a bank with a public purpose (like streamflow restoration), or from potential water bank participants in the case of a bank that has either a primarily private or at least dual private/public goal, will necessarily influence the form the water bank takes. Funding and financing are discussed in greater detail below in Sections 8 and 8.2.

The options for water bank institutional form can be broken into four different options: a standalone organization, a program or venture of an existing organization, a partnership effort with an existing organization outside of the Watershed, and an informal ad-hoc transaction approach. Each of these are discussed briefly below.

7.1.1 Organizing a Water Bank as a Standalone Entity

The standalone option represents the most formal option. Under this option, a new entity would be formed as either a non-profit or for-profit business. The entity would have its own board of directors or other governance structure. The entity would also require its own funding, its own office space and its own staff. A non-profit standalone water bank has several advantages. First, it is the most independent format for a water bank. It can operate independently of the various interests, buyers and sellers who participate in the water market. This helps to facilitate (though it does not guarantee) an open and transparent market. Because water banks often operate as brokers and market makers, being independent from any one strong influence provides the bank with an unbiased position in the marketplace. Some of these advantages are also applicable to a for-profit water bank though profit seeking, by its very nature, can limit the independence and the reputation of a bank as unbiased.

The disadvantages of a water bank operating as a standalone organization, both in the non-profit and for-profit scenarios are mostly practical and involve the difficulty of funding, setting up and sustaining such an entity. The most significant hurdle is finding startup funding. For a non-profit bank, startup funding can come from foundations or other sources of philanthropic or public funding. For a for-profit bank, startup funding needs to come from private capital, though some public or philanthropic funding might be available if the bank helps to meet some public needs.

7.1.2 Organizing a Water Bank as a Program of an Existing Entity

Most water banks in the western U.S. are not standalone entities and are instead run as a program of an existing entity. Many, but not all of these entities are non-profits. As such, the bank shares office space and at least some staff time with the existing entity. The water bank may or may not require its own dedicated staff and this need can change over time if the program is successful. Though often the water banking work may be eligible for additional sources of funding, the bank may also share operational funding with the existing entity. In the case of a non-profit entity housing the bank, the water bank may be overseen by an existing board of directors or by a newly formed advisory council or committee of the board. When a water bank is a program of an existing entity, the water bank takes on the reputation and values of that entity, meaning it may not be seen as independent. However, the water bank will benefit from any positive reputation and trust built by the existing entity.

The primary advantages of organizing a water bank as a program of an existing entity are simplicity and reduced startup expenses. Sharing staff and office space and not needing to go through the steps of forming a new company greatly simplify the process of founding a water bank. This also reduces the amount of startup funding required. An additional advantage is that the bank benefits from the reputation and trust built by the entity where it is housed. Especially for water transactions, trust is an important and valuable currency and having this trust "built in" to the water bank by making it part of an existing entity is beneficial. Finally, housing a water bank within an existing entity allows the bank to grow at an appropriate pace. If it takes years for transaction activity to pick up, a program of an existing entity can grow slowly to meet demand whereas a new entity will have a lot of sunk costs in initial setup and may not be well-positioned to handle slow growth over time.

Organizing a bank as a program of an existing entity leads to the question of what kind of entity is best to house a water bank. This depends on the goals of the water bank, the entities that exist in the Watershed and which, if any, might be interested in and have the capacity to take on the water bank program. In the Hood River context, the most obvious candidate to house a water bank program is the HRWG or Hood River Soil and Water Conservation District (SWCD) because these organizations have strong reputations in the Watershed and could be a trusted partner for water transaction work. The other option would be for water banking to be housed by one or more of the local irrigation districts. The districts could join forces to co-host water bank activity or each interested district could have its own water bank program. A centralized program, or at least a program highly coordinated between different districts would be most likely to succeed because consistency of message and implementation are both benefits to water transaction activity.

7.1.3 Conducting Streamflow Restoration in Partnership with Another Organization

Another option is to forgo formation of a specific water bank program in the Watershed and instead partner with an outside organization that specializes in streamflow restoration and water transactions. In Oregon, The Freshwater Trust (TFT), the Deschutes River Conservancy (DRC) and Trout Unlimited (TU) all operate instream flow restoration programs using the same tools that would be used by a water bank in the Hood River Watershed. The Freshwater Trust, formerly the Oregon Water Trust, has completed transactions in the Hood River Watershed in the past and the Deschutes River Conservancy worked with a local irrigation district to help with some water conservation planning. Both of these organizations' limited past work in the basin would provide at least some name recognition and a platform from which they could begin to engage in future work.

One advantage of working with TFT, DRC or TU is that they have deep experience and expertise using Oregon's instream flow laws as well as conducting more informal water transactions that do not involve formal regulatory pathways. These organizations also have staff who have experience conducting outreach to landowners and working with landowners to consummate instream flow transactions. These organizations would be able to facilitate the instream flow goals of the Hood River Watershed. Finally, these organizations also may be able to bring unique funding sources to the Watershed that are not currently available to the HRWG. For example, all three entities receive funding for instream flow restoration from the Columbia Basin Water Transactions Program (CBWTP), a Bonneville Power Administration (BPA) program that is only open to entities that have gone through a qualification process to become Qualified Local Entities (QLEs).

The disadvantage of working with one of these organizations is primarily that they are not locally-based entities with the same level of trust as the HRWG and the irrigation districts. While this hurdle is not fatal, it is an important consideration. Also, none of these organizations currently has the Hood River Watershed as a priority Watershed where they are looking to work. This does not mean they might not be enticed to work in the Watershed, but it is a challenge nonetheless and also means that they may not have funding available for staff time or transactions in the Watershed. A final disadvantage of this option is that none of these organizations are positioned to help the Watershed with farmer to farmer transactions, the secondary goal of a Hood River water bank.

7.1.4 **No Formal Water Bank**

A final option is to forgo creation of a formal bank or even a water bank program of an existing entity and to instead conduct transactions in a more ad-hoc way as needed. Transactions could be completed by the HRWG, irrigation districts or both, during years where they would be beneficial. One disadvantage of this approach is that it would be challenging to find funding. The timing of funding needs could be unpredictable, making fundraising difficult. Without a formal, consistent plan in place, funders might also be hesitant to support such an effort. Finally, water transaction activity conducted by the HRWG or an irrigation district, with the exception of intra-district transfers between farmers, would require expertise and capacity that is not currently found in the HRWG or the districts. Training would likely be required but the expense of such training could be difficult to justify without at least a basic water bank or bank-like program in place.

7.1.5 **Recommended Institutional Form for a Hood River Water Bank**

The most feasible and recommended institutional form for a Hood River Water Bank is to manage the bank as a program of the HRWG and/or SWCD, working in close partnership with the irrigation districts in the Watershed. The HRWG and SWCD are established and respected entities with good working relationships with the area's irrigation districts. The scope of a Hood River water bank's goals and likely amount of market activity are relatively limited as is the geographic scale of the Watershed. Additionally, funding may be a limiting factor for water bank activity and to the degree possible, funding should be used for implementing deals rather than for setting up a new institution in the Watershed.

Close coordination between a HRWG/SWCD water bank program and the Watershed's irrigation districts would be critical. This coordination could take one or more forms. Irrigation district staff are already represented on the HRWG Operations Committee. However, if the HRWG were to create a committee or a discrete advisory board tasked specifically with overseeing the water bank program, the irrigation districts could participate more directly on this committee/board (see Section 7.4 below for more discussion on oversight and governance). In addition to participating in an oversight role, district staff could be trained alongside HRWG or SWCD staff to develop expertise in the types of water transactions the bank will complete – primarily informal and formal temporary fallowing/instream leasing. If farm to farm trades grow to become an important part of the water bank's activities, the need for close coordination with the area districts would be greater. At that point, it might be worth exploring a more formal partnership where the districts provide some staffing support to the water bank program.

7.2 Soliciting Water Bank Supplies

The strategies discussed in this section refer to various outreach and other mechanisms to find water users willing to work with the bank. Four basic strategies might be used individually or in concert for this purpose:

- One-on-one transactions
- Posted offer approaches
- Reverse auctions
- Smart markets.

One-On-One Transactions: This approach involves individually soliciting and negotiating deals with water users. Soliciting supplies this way happens through a process of identifying likely water user partners and conducting individual outreach. The identification of partners could begin with some of the information collected in the landowner survey conducted for this project and could also involve talking and working with irrigation district managers to highlight water users who may be interested. Once partners are identified, the bank would conduct outreach to users through individual or small group meetings and proceed with negotiations with any who are willing. At this point, it is useful for the bank to have conducted some basic water right due diligence to ensure that only individuals with valid water rights are contacted about potential deals. One-on-one transactions are then negotiated in confidence with each individual. This means that the specific terms of individual deals, the price paid by the bank, for example, might be different between transactions.

One-on-one deals are best suited to small-scale water bank efforts with discrete goals and geographic scopes. Depending on the amount of staff capacity and irrigation district or other help, it is only likely realistic to negotiate ten to twenty individual deals each year and even that represents a high level of efficiency. This method of procuring supplies is time and labor intensive. The individual nature of deals can also lead to some variations in price which is not necessarily a problem. However, if sophisticated or hard bargaining landowners end up being paid more and other landowners find out, there can be unease or anger. This issue works itself out over time as landowners informally compare prices and begin to converge around their asking price.

Another factor mitigating in favor of one-on-one negotiations is if the water bank works in a context where water rights are heterogeneous. In these settings, individual negotiations may even be necessary to tailor deals to water rights with different seniorities, volume or rate limitations or other variations. Because the vast majority of water rights a Hood River water bank will deal with are irrigation district rights and seniority is not a major differentiation between these rights, this factor is not widely applicable in the Watershed. To the extent that water rights outside of districts will participate in the bank now or in the future, one-off deals with those water right holders might be advisable.

Posted-Offers: Posted offers are a less labor- and time-intensive approach than individual negotiations. Much of the time and resource commitment associated with this approach occurs up-front in planning, rather than in negotiating with landowners. While this planning and set up may take time and resources, once it is invested, the same basic template can be reused, meaning that efficiencies mount with each irrigation season. This approach involves broadcasting key deal terms to all water right holders and allowing interested parties to approach the bank if the terms are acceptable to them. In most instances, the advertised parameters include the price paid per acre or per acre-foot and, if minimum or maximum acreage limitations and/or durations apply, the minimum or maximum parcel sizes and/or durations sought by the bank. Advertising deal terms can be achieved through a variety of pathways. It can be as simple as posting offers in irrigation district offices or through periodic irrigation district communications such as newsletters. Phone, email and direct mail can also be effective depending on the audience.

Posted offer approaches offer the obvious efficiency of avoiding numerous negotiations and tracking a number of deals with different key terms. This approach is well suited to areas with homogenous water rights. For example, if all water rights are of equal priority, then only one price per unit needs to be offered. There may be some cases where different water right priorities or other factors, such as location in the Watershed, might mitigate in favor of posting different level offers for different classes of water rights. As long as the number of different classes is not high, the posted offer approach can still be used.

One disadvantage of the posted offer approach is that it relies on landowners to approach the bank and can result in some potential supply not being offered to the bank if the right landowners do not see the advertisements or are not inclined to approach the bank on their own motivation. One way to combat this disadvantage is to combine some of the outreach that would be done for individual negotiations with the posted offer approach. In other words, the offer can be posted as noted above and a representative of the bank can spend additional time doing direct outreach to landowners they think might be interested or who they suspect might be reached by the posted offer advertisements.

Reverse Auctions: The final mechanism for soliciting water bank supply is through a reverse auction. Among all of the mechanisms discussed, reverse auctions require the greatest amount of planning and careful implementation to ensure success. In a traditional auction, buyers, or bidders, compete with each other to buy an item or unit of a commodity – the auction house solicits offers to *buy*, in other words. In a reverse auction, the entity running the auction, in this case the water bank, solicits offers to *sell* or lease water rights. These offers take the form of a price per unit that the seller is willing to accept to sell or lease their water.

Reverse auctions can be run in many different ways. The first option is whether or not to establish a reserve price. A reserve price is a threshold price above which the bank will not accept any offers. The reserve price can either be advertised or kept secret depending on the goals of the auction. An advertised reserve price helps provide lessors/sellers with a price signal and may be appropriate in a market context where people might not know how much their water is worth. Advertised reserves may also have the effect of concentrating bids around the highest price the bank is willing to accept. On the other hand, keeping the reserve price secret keeps the market open to greater price variation and competition. Some bids may be above the reserve price and some below, but bids will be less likely to concentrate around the reserve price.

How and when the auction takes place can also vary. A reverse auction could theoretically be run like a traditional auction – taking place in public over the course of some number of hours. Given the nature of water markets however, reverse auctions for water rights are not run this way. Instead, reverse water right auction promoters choose a period of weeks during which they will accept bids, along with a specific, advertised date on which bid selection will be announced. Regardless of the specific way a reverse auction is implemented, education and communication/outreach are critical to success. Especially in communities unaccustomed to water marketing and auctions more specifically, considerable amounts of time are required to educate participants about how the auction will work and how/when/where they can participate.

As with posted offer approaches, reverse auctions are most suitable in areas where water rights are homogenous. If many different water right classes exist, differentiated for example by seniority, then the auction might need to set different reserve prices for each different class and/or hold separate auction events for different classes. Reverse auctions are also most suitable for locations where potential participants are comfortable or experienced with water market activity. In locations with little history of water markets, reverse auctions can be intimidating and difficult to understand and navigate, not least because participants may not understand how to price their offers to lease or sell.

Smart Markets: Unlike the previous three mechanisms, smart markets are not, in themselves a separate supply solicitation strategy. Rather, they are a specific way to implement a posted offer or reverse auction-like mechanism. The basic concept behind smart markets is to develop software that can automatically match buyers and sellers based on criteria the software's designers program into the tool. Smart markets can make very complex market contexts manageable and user-friendly. For example, if a Watershed has numerous different classes of water rights or complicated regulatory restrictions on water transfers or trades, smart markets can be designed with these in mind and designed in a way that the market will only match buyers and sellers whose trades will "work" under the specific circumstances.

Smart markets are most applicable to water markets with complicated regulatory contexts and/or markets with many different types of buyers and sellers. For the water bank's primary goal of instream flow restoration, a smart market is not likely needed. However, if trading between out-of-stream users becomes active in the Watershed, a smart market could be used to help automate such trades or simplify the analysis required for such trades.

7.3 Recommended Supply Solicitation Strategies for the Hood River Watershed

The Hood River Watershed's small scale and water right homogeneity mean that a posted offer approach is feasible. However, a posted offer alone might not reach all the targeted landowners. Therefore, a posted offer approach with significant outreach to ensure that the offer is seen by as many land owners as possible is the best approach, especially for the first few years of the bank or program's operations. The bank should establish and set the terms for leasing water rights from landowners including the price paid per acre, per acre-foot or both, as well as the desired duration of the leases. The bank should also standardize the format for leases – either formal instream leases approved by OWRD or informal leases managed by the irrigation districts. Over time, the amount of outreach required could lessen as landowners in the Watershed become more familiar with the bank's activities.

7.4 Governance and Oversight of Bank Activities

Options for water bank governance and oversight vary and generally track the level of formality of the bank itself. Governance and oversight describe how a bank will be guided at a high level, akin to how a board of directors oversees a business, NGO or irrigation district, for example. Due to the sensitive nature of water bank work (i.e. working with water rights), it is important for a water bank's credibility to have governance and oversight that builds trust within the community where the bank operates.

At minimum, an informal water bank effort housed within an existing organization (such as the HRWG) should consider forming an advisory board or committee of its existing board tasked with water bank governance. This group should be made up of members with some expertise with water rights/water law and also knowledge of local water management issues. For example, a representative from one or more of the irrigations districts, a tribal representative, an ODFW representative, an OWRD representative and perhaps one or more landowner or "at large" representatives would provide broad perspectives and help to ensure credibility.

Another possibility is a leasing program that is less formal than a water bank. There is no bright line when a leasing program becomes a water bank. It boils down to a choice in the level of commitment to consistently undertaking water leasing whenever it is needed and having a developed set of policies in place versus only undertaking leasing periodically and doing so under existing organizational policies. In other words, a leasing program could be undertaken without a formal governance body. For example, the HRWG could simply pursue instream leases, as needed, in anticipation of drought years and could simply use existing board members and project approval processes to guide leasing activity. From a funding perspective, a formal water bank with its own governance structure, even if that structure is relatively informal itself, could be appealing and provide greater credibility.

7.5 Recommended Governance Structure

As noted above in Section 7.1.5, the most feasible and recommended institutional form for a water bank in the Hood River Watershed is a program housed within the HRWG and/or SWCD that coordinates closely with the area irrigation districts. With this and the preceding discussion of governance options in mind, the water bank program of the HRWG or SWCD should be overseen at a high level by the HRWG's existing Operations Committee or the SWCD's Board of Directors, respectively. In addition, a new Water Bank Advisory Council should be created. The advisory council could have one or more current HRWG/SWCD board members but should also include a representative of each of the five area irrigation districts and representatives of other water and resource managers in the Watershed. An example makeup for the advisory council could be:

- One member of the HRWG Operations Committee
- One member of the SWCD board not affiliated with an irrigation district;
- One official representative from each of the five area irrigation districts (could be a district employee or board member);
- One landowner from within one of the irrigation districts;
- One representative of the Confederated Tribes of the Warm Springs;
- One OWRD employee (likely the local watermaster); and
- One ODFW employee.

7.6 Bank Policies to Guide Transactions

This section will briefly outline and discuss some of the most important types of policies that a water bank could enact. Formal policies serve several purposes. First, they help build trust and credibility when they are made public because they allow the public to better understand how a bank operates and what limitations there are on the bank. Second, they help the bank itself operate efficiently by providing guidance and rules about everything from day to day bank operations to bigger picture strategic issues.

To begin with, there are a number of general principles that should guide bank transactions and policies including:

- ensuring no net loss in hydrologic function;
- leasing/acquiring water rights only from willing participants;
- respecting private property rights;
- avoiding impairment of other water users with senior water rights;
- leasing and transferring only water that was previously diverted or withdrawn and used ("wet" water);
- respecting irrigation district rules and regulations;
- avoiding, addressing, and where necessary, mitigating for any third-party impacts;

- operating consistent with land use and other local jurisdictional requirements.

Beyond this list of general principals, recommending specific policies for a Hood River water bank is outside the scope of this report, however a comprehensive list with brief descriptions of some of the specific types of policies a water bank might consider is presented below in Table 16.

Table 16: Water Bank Policy Options

Policy Type	Example Policies	Purpose/Notes
Supply eligibility requirements (instream)	Minimum seniority requirement	Required if senior water rights are necessary to have instream flow protected
	Location/POD requirements	May be used if there is a preference for flows at certain locations
	Minimum acreage requirement	Promote administrative efficiency
	Irrigation district review or approval	Maintains trust with districts and gives them an ongoing role with the bank
Due diligence requirements	Detailed outline of how to conduct due diligence on proposed water rights/projects	Promotes consistency in analyzing water rights for bank use; provides operating procedures for staff
Irrigation buyer eligibility	Location/POD/ infrastructure requirements	Ensure that water can be transferred from person A to B and used by B
	Water volume/rate and timing match	Align the amount of water needed with available supplies
Water valuation	Set threshold (cost or duration) for when to seek formal valuation	Provides funders with assurances of value and best practices/consistency
Pricing and selling water to irrigation buyers	Process for setting price of water for irrigation buyers	Prioritize and ensure transparency and equity
	How to allocate water to irrigation buyers when demand exceeds supply	
	Timing of when water is offered to irrigators	
Instream vs. out-of-stream supply	When does the bank offer water to irrigators and when does it limit water to instream demand only?	Balance the Bank's primary and secondary goals with water availability
Monitoring: supplier	What types of monitoring is required of users/irrigation districts who supply water to the bank?	Ensure that land from which water is leased is in fact fallowed
Monitoring: instream	What types of flow monitoring are required?	Can/how can instream flow benefit be verified?
Monitoring: out-of-stream	What types of monitoring of use are required for irrigation buyers?	Ensure that water leased from the bank for irrigation is put to beneficial use as anticipated and required in agreements; how might water moving between districts or PODs be verified?

8. Water Bank Capacity Needs, Transaction Costs and Funding

For the purpose of this feasibility study, it is important to outline basic capacity, transaction cost and funding needs so that Watershed stakeholders have a basic idea of what is required to start and maintain a water bank. Generally, the resource needs of a water bank depend on the intended scope of the bank, the complexity of transactions anticipated, and the level of formality of the proposed bank. This section discusses resource needs at two ends of this spectrum: a simple water bank/transaction program operated from an existing entity (like the HRWG) and a more formal, standalone water bank entity.

8.1 Capacity Needs

Water transactions are time-intensive and therefore staff-intensive projects. Even the most simple, small transaction can require significant staff time to find willing participants, develop a deal, draft contracts and any necessary water right change applications and then implement and monitor the project. Adding several transactions together as a bank would be trying to do, means doing all of these things simultaneously for each transaction. While there are ways to streamline transactions, especially where individual transactions are similar, there is no way to avoid the time and expense involved in developing and implementing water transactions.

This section begins by briefly discussing the capacity in place for several existing water trusts/ transaction programs doing instream flow transactions in Oregon. This provides some real-world examples comparable to what a standalone, formal water bank entity might need. Following this, capacity needs for a simpler approach – running water bank transactions though an existing entity like the HRWG – is discussed.

8.1.1 Oregon Water Transaction Program Examples

Oregon currently has three entities with dedicated water transactions programs:

- The Freshwater Trust (TFT, formerly the Oregon Water Trust)
- The Deschutes River Conservancy (DRC); and
- Trout Unlimited Western Water Project in Oregon (TU).

The DRC is the only one of these three that is a standalone entity entirely dedicated to instream flow transactions while both TFT and TU undertake water transactions as part of a larger program of river restoration. However, both TFT and TU have distinct flow restoration programs with dedicated staff. Staffing at DRC and TFT has fluctuated considerably over time. TFT's dedicated flow restoration staff has varied from approximately three Full-Time-Equivalent (FTE) staff to more than seven. Before merging with Oregon Trout and becoming TFT, the Oregon Water Trust had an executive director, a program administrator/development coordinator, two project managers and a monitoring coordinator. After the merger, TFT maintained between one and four FTE dedicated to project management, one half up to two FTE dedicated to monitoring and one quarter to two FTE for development, administration and program oversight/leadership. The development, administration and oversight roles were often split with staff who also worked on other areas of programmatic work for the organization (for example the ED's time was only partially dedicated to water transaction work, as was development and administrative functions). The DRC staff has varied from ten or more FTE to its current size of approximately seven FTE (ED, three project staff, one monitoring staff, two shared administrative staff and one communications manager). TU's effort in Oregon has all or parts of five staff dedicated to instream flow restoration. It is not clear exactly how many FTE TU dedicates to this effort, but it is somewhere between one and five.

8.1.2 **Hood River Water Bank Capacity Needs**

With these observations in mind, the next question is what is a feasible level of capacity for a Hood River water bank? As noted above, the most feasible initial structure for a Hood River bank is to conduct transactions through the HRWG or SWCD. With some initial training and support, a small number of pilot water bank transactions (approximately 1-5 per year) could conceivably be developed and implemented with the organizations' existing capacity. As long as these transactions remain relatively simple (which most temporary transactions are), this could require as little as 0.10-0.5 FTE total. For example, AMP Insights recently helped set up an agricultural water bank in the Snoqualmie Valley outside of Seattle, WA, run by the director of the Snoqualmie Valley Watershed Improvement District (a flood control and irrigation district under Washington law). The director recently reported that she spends less than 200 hours per-year (approximately 0.1 FTE) related to undertaking approximately five small, short-term water bank transactions. In addition to her time, she does have limited outside legal support for contracting, but nonetheless, she has been able to integrate water bank work in with her existing responsibilities.

The required HRWG or SWCD capacity could be lessened by help from irrigation district staff on water rights issues and from OWRD staff on processing any necessary water right changes. It is important to note again that formal transactions through OWRD (such as split or full season instream leases) require more time and expense than informal WUAs (see Section 4.4) but also offer additional security for the stream and protection against forfeiture concerns for landowners. At the same time, WUAs may require less up-front time due to their lack of a water right change process, but they may require more time because developing landowner contracts and coordination with irrigation districts to manage reduced diversions can be complex. In addition to the time required to develop and implement transactions, it is also important to recognize the time required for monitoring and enforcement of transactions. This too can be streamlined and supported by help outside of the HRWG and SWCD but should be considered carefully as part of the necessary capacity to conduct bank transactions.

If pilot bank transactions prove successful and the number and scale of transactions increases, capacity needs will likewise increase. Unfortunately, there is not a formula nor other way of discerning exactly how capacity needs increase with transaction activity. Too many variables, including transaction complexity, transaction type, and enforcement and monitoring issues exist to make such a prediction possible. Some entities do many simple transactions with few FTE while others do only a few large complex transactions that require significant FTE. For this reason, it will be important for the HRWG or SWCD to carefully track the time required to develop, implement, enforce and monitor any pilot transactions to begin to develop an idea of the FTE requirements if and as the bank grows. In addition to HRWG or SWCD staff time, assistance from local districts and others should also be noted and tracked as closely as possible to develop a full picture of capacity requirements.

In summary, a low level of activity, perhaps up to ten simple and similar short-term transactions, is likely feasible with the existing capacity of the HRWG or SWCD. Achieving this level of transaction activity would require some initial training and assistance from partners with working knowledge of water transactions, especially in the first one or two years and would also benefit from support and assistance of irrigation district staff and others like local OWRD staff.

8.1.3 **Transaction Costs**

This section briefly addresses transaction costs necessary for implementing water bank transactions. Transaction costs can be defined as all costs related to developing and implementing bank transactions outside of the cost of paying for water itself. Rather than provide a pro-forma budget or discussing specific operational cost metrics, this section discusses costs in terms of the relative costs of different elements of conducting water transactions. Table 17 shows the basic elements of transaction development and briefly describes their relative costs. This table is applicable to simple transactions that would likely form the basis of pilot water bank activities. As transaction numbers, scale and complexity increases, individual transaction element costs can go up generally as well as relative to one another. For example, planning for longer-term transactions, transactions involving complex and large water rights, or transactions requiring complex coordination with an irrigation district can make transaction planning, contract negotiation, administration, enforcement and monitoring all significantly more time and resource intensive.

Table 17: Relative Costs of Transaction Development and Implementation

Transaction Element	Description	Relative Cost
Outreach	Find willing landowners	Low, if combined with existing HRWG outreach activities and supported by irrigation districts
Transaction Planning	Conduct water right due diligence and determine specific transaction parameters	Medium; can also be supported by districts and/or local partners (incl. OWRD)
Contract Negotiation	Formalize transaction and payment terms	Low, if using the same contract for each landowner; Medium to high if individual contracts are negotiated or projects are complex
Administration	Make necessary applications for water right changes or, for WUAs, coordinate with irrigation districts for diversion reduction or other necessary actions	**Medium to high**, depending on whether transactions require OWRD applications or if WUAs require complex coordination with irrigation districts
Enforcement	Conduct periodic site visits to ensure compliance with contract terms	Low; for temporary transactions, one to two visits are acceptable, can include a simple drive past a field to verify fallowing
Monitoring	Monitor instream flows or diversion reductions where possible	Low for small transactions; can simply include verifying fallowing if gauging infrastructure is not available
Renewal	Discuss/plan future transactions with existing participants	Low

While it is helpful to look at relative costs as in the table above, some specific examples of transaction costs are also useful to provide a broader perspective and also offer some insight into what a fully operational, larger-scale water transaction effort requires. One useful way to examine transaction costs is to look at past performance of existing water transaction organizations. Specifically, analyzing the ratio of transaction costs to water costs is illustrative. Many non-profit organizations report on their efficiency at delivering on their mission in this way. For example, if The Nature Conservancy were to advertise that eighty cents of every dollar given to the organization goes to protecting lands, what they are saying is that they have a ratio of 80/20 between land protection and program costs like administration, fundraising, etc.

Though the study is now outdated, Garrick and Aylward (2012) conducted the most in-depth study comparing water transaction costs with performance in terms of water restored to streams. They found that results among different water trusts and water transaction programs in the Columbia River Basin varied greatly but were generally high in terms of transaction costs. Results of the study were collated by sub basin. In the Upper Columbia, the study found the ratio to be 30/70, meaning that 70 percent of funds were expended on transaction costs while only 30 percent went to funding water transactions themselves. In other areas with more mature programs and conducive enabling conditions for water transactions like the Deschutes Basin in Oregon, the ratio was 62/38 (Garrick and Aylward 2012). Outside of formal study, through analysis of various organization's Internal Revenue Service 990 forms, AMP insights has observed even wider variance, finding some organizations in some years with a 50/50 balance and even one organization that only spent 2 percent of funds on water while spending 98 percent on transaction costs.

The simplest and most important lesson to be drawn from these observations is that water transaction work often requires high transaction costs. It is important not to underestimate the amount of work that can be required to conduct an ongoing water transaction program. In the Hood River Watershed there are a number of factors that have been discussed throughout this report that indicate that transaction costs should be reasonable for early-phase pilot transactions. However, in looking toward a future where the water bank grows, transaction costs will be an important ongoing consideration.

8.2 Water Bank Funding

Several potential funding sources exist for a water bank in the Hood River Watershed. Funding discussed in this section is focused on bank operations rather than funding for further Bank feasibility study or design activities. In Oregon, three primary entities have funding available for instream flow restoration: the Columbia Basin Water Transactions Program (CBWTP), Oregon Watershed Enhancement Board (OWEB), and the Oregon Water Resources Department (OWRD). Details and feasibility of successful funding from each of these entities is discussed below and summarized in Table 18. Other funding sources, including private foundations and federal agencies are also briefly discussed.

8.2.1 Columbia Basin Water Transactions Program

The Columbia Basin Water Transactions Program (CBWTP) was founded in 2003. The Program was created and funded by the Bonneville Power Administration (BPA) in response to mitigation requirements stemming from litigation over BPA's operation of the Columbia and Snake River dams and power system. The National Fish and Wildlife Foundation (NFWF) has managed the program since its inception. CBWTP is a grant-making program that focuses on funding both transaction and project costs for instream flow restoration in the Columbia River basin in Oregon, Washington, Idaho and Montana. CBWTP's budget ranges from $3-$4 million per year, approximately half of which is allocated to projects and the remaining to program administration and transaction costs.

CBWTP's funding model is unique. Rather than an open competitive grant-making process, CBWTP funds only entities it has pre-qualified as Qualified Local Entities (QLEs). QLE status means that an entity is eligible both for project funding (i.e. costs of water for streamflow restoration) and for project development (transaction cost) funding. QLEs vary in organizational type but are made up of three broad categories: place-based water trusts, statewide organizations and state agencies. The Deschutes River Conservancy in Bend, Oregon is the place-based QLE archetype. The Freshwater Trust (formerly Oregon Water Trust) and Washington Water Trust are examples of statewide organizations that are QLEs. State agency QLEs include all of the water-resources focused agencies of the four Columbia Basin states and do not implement flow restoration transactions but instead are funded to help facilitate these transactions.

The QLE qualifying process is restrictive. BPA and NFWF have only added new QLEs several times in the life of the program. It is not likely feasible for the HRWG to become a QLE in the near future because there are no plans to add QLEs. However, becoming a QLE is not the only way to receive funding for water bank transactions. The HRWG could work with an existing QLE like The Freshwater Trust, the Deschutes River Conservancy or Trout Unlimited. An existing QLE could work with HRWG to develop projects and propose them for funding through the CBWTP. One major downside of not being a QLE however, is that only costs for water could be funded and CBWTP would not fund transaction costs. The CBWTP does not restrict the types of transactions (i.e. water use agreement, lease, permanent transfer, split-season lease, etc.) they fund but instead review each transaction plan individually.

CBWTP funds are awarded to QLEs through a competitive process. A key factor in determining a proposed transaction's competitiveness is whether it is in a Watershed that is a priority for BPA in meeting its BiOp obligations. The Hood River Watershed is not one of BPA's highest priority areas, but transactions proposed in the Watershed could nonetheless be competitive for CBWTP funding if they score highly in other areas. Other considerations include whether the transaction is part of an innovative and/or comprehensive restoration program, whether transactions are well-integrated into existing Watershed plans, whether low stream flows are a key limiting factor in the target reach, and others.

8.2.2 **Oregon Watershed Enhancement Board**

OWEB funds streamflow restoration through their Water Acquisition Grants program. OWEB's funding is open to anyone unlike CBWTP's more restrictive QLE-based approach. OWEB funding can be used both for leasing and buying water and to pay for transaction costs. OWEB funding does, however, require a minimum of 25% match but that match can include pending funds and in-kind match. The OWEB board reviews proposed water transaction projects according to criteria adopted in administrative rules. OAR 695-046-0200 lays out the relevant criteria. Examples of these criteria include: consistency with the OWEB board's established priorities, significance of projected ecological outcomes, capacity of the applicant to achieve sustained ecological outcomes over time, and the soundness of the legal and financial terms of the agreements that are part of the transaction.

8.2.3 **Oregon Water Resources Department**

Another Oregon state program that funds streamflow restoration is OWRD's Water Project Grant and Loan program. This program supports water resources projects that have economic, environmental and social/cultural benefits. Flow restoration and protection projects are included among the project types listed as eligible for OWRD funding under this program. While the program consists of both loans and grants, for initial water bank operations, a grant would be preferable. In the future if the water bank is high functioning and especially if the bank is full or almost fully self-sustaining through fees charged to water users accessing the bank, a loan could be an option.

The program requires at least 25% match and that match can be in-kind. After a completion review by department staff, applications are posted for public comment and then forwarded to a multi-agency Technical Review Team (TRT). The TRT considers public comments and also evaluates the economic, environmental and social benefits of the proposed project according to a specific set of criteria. Examples of economic criteria include benefits to employment, increased agricultural productivity or economic productivity in general. Examples of environmental criteria include whether proposed projects increase protected stream flows, improve water quality, or result in water conservation. Finally, examples of social/cultural benefit criteria include promotion of public health, safety and local food systems, improving conditions for minority or low-income communities, or promoting recreation and scenic values. Water bank activities, both instream and out-of-stream would likely score well under OWRDs scoring process.

Table 18: Funding Opportunities for Water Bank Activities

Name	State/Federal	Match Requirements	Special Requirements/ Qualifications	Fund Transactions, Transaction Costs or Both
Columbia Basin Water Transactions Program (CBWTP)	Primarily federal (Bonneville Power Association)	None; match is considered when reviewing projects	Must be a "Qualified Local Entity" (QLE) to receive funding for transaction costs	Both (if applicant is a QLE); HRWG would only be eligible for project funding if working with an existing QLE
Oregon Watershed Enhancement Board (OWEB)	State	Minimum of 25%; in-kind qualifies	None	Both
Oregon Water Resources Department (OWRD)	State	Minimum of 25%; in-kind and pending qualify	None	Both

In addition to the funding sources outlined above, several other funders are worth mentioning. First, the Bureau of Reclamation (BOR) occasionally has funding opportunities related to water markets. Some of these opportunities are purely for planning related activities but some of them might also fund actual water bank implementation. BOR funding usually must go through an irrigation district or other entity with a connection to BOR facilities. Private foundations are another potential source of funding for water bank activities. The Freshwater Trust and the Deschutes River Conservancy both receive some funding every year from private Oregon, regional, and national foundations that fund environmental restoration. It is beyond the scope of this report to research and report on current funding priorities of private foundations, but such an effort could be useful in further water bank design or implementation work.

8.2.4 Timing of Funding and Transactions

One challenge with funding water transactions worth discussing in more detail is the challenge of matching the timing of funding with transaction implementation. This could be especially challenging for a Hood River water bank that only operates during low water years. Matching funding timing with implementation can present a classic chicken and egg problem. It is important to have funding available *before* soliciting water transactions from willing landowners, but it can be difficult to secure funding without committed landowners in the first place. Funders like CBWTP and OWEB that have experience with water transaction funding are generally flexible and knowledgeable enough of the funding and transaction cycle that they will work with project proponents to find a solution to this potential issue.

One way to work around the timing issue is to develop a project proposal that encompasses multiple years and a set instream leasing volume. For example, the HRWG could propose a five-year project and estimate the number of likely low water years in that time span. For argument's sake, say that number is two out of five years. Then HRWG would estimate the total volume of water anticipated to be leased during those two years and propose funding based on that volume. The funding proposal would be a five-year project, with a commitment to lease X acre-feet of water instream during the five years. Five different scenarios could happen under such a proposal:

1. Both the number of years and volume of water end up as anticipated;
2. More low water years occur than anticipated;
3. Fewer low water years occur than anticipated;
4. Higher volume of water available from landowners than anticipated;
5. Lower volume of water available from landowners than anticipated.

Each of these scenarios, as well as combinations of them would be dealt with differently, however only a few of the scenarios/combinations presents a problem. Any scenario where the full amount of funding would not be needed (i.e. fewer years and/or less volume) could result in the HRWG not fulfilling the commitment under the project proposal. The guiding principal to avoid this is to approach such a project adaptively. The project could be adapted in different ways as it proceeds:

- If the first two years of the project are both low flow years and there are willing lessors, all of the funding could be expended. This is a good problem to have and the HRWG could declare the project a success after two years and apply for additional funding early.
- If the volume of water available from willing lessors in the first low water year is greater than expected, and additional flows would be beneficial, the HRWG should take the opportunity and lease as much water as possible. This could result in all of the funding being expending in one year (year one, two, three, or four). In this scenario again, the HRWG could declare success and end the project early and reapply for additional funding.
- If years one, two and three are not low flow years, the project could be in jeopardy of failure. At this point, the HRWG could adjust the trigger for what qualifies as a low water year and then make an effort to lease the promised instream flow volume in the most beneficial way possible in the last two years. Depending on the availability of willing lessors, this could involve leasing the full volume in year four, ending early and reapply for funding, or distributing the leasing volume over the final two years in some way.

Regardless of what actually happens, a guiding principal should be to lease as much as possible that is also beneficial when it is available. Leasing too much too early is a good problem to have, in other words, whereas leasing too little would likely put both the HRWG and the funders in more of a bind. As noted above, both CBWTP and OWEB are knowledgeable and flexible water transaction funders. As long as they know what all of the contingencies are at the outset of the project term, there should not be a significant problem.

It is also worth noting that both CBWTP and OWEB also can approve projects relatively quickly. For partial season leases that would not start until July for example, it should be possible to wait to request funding until the spring preceding that July and have funding secured in time for project implementation. While this strategy presents a bit less certainty than a multi-year funding strategy, it is nonetheless an option.

9. Economic Impacts and Benefits

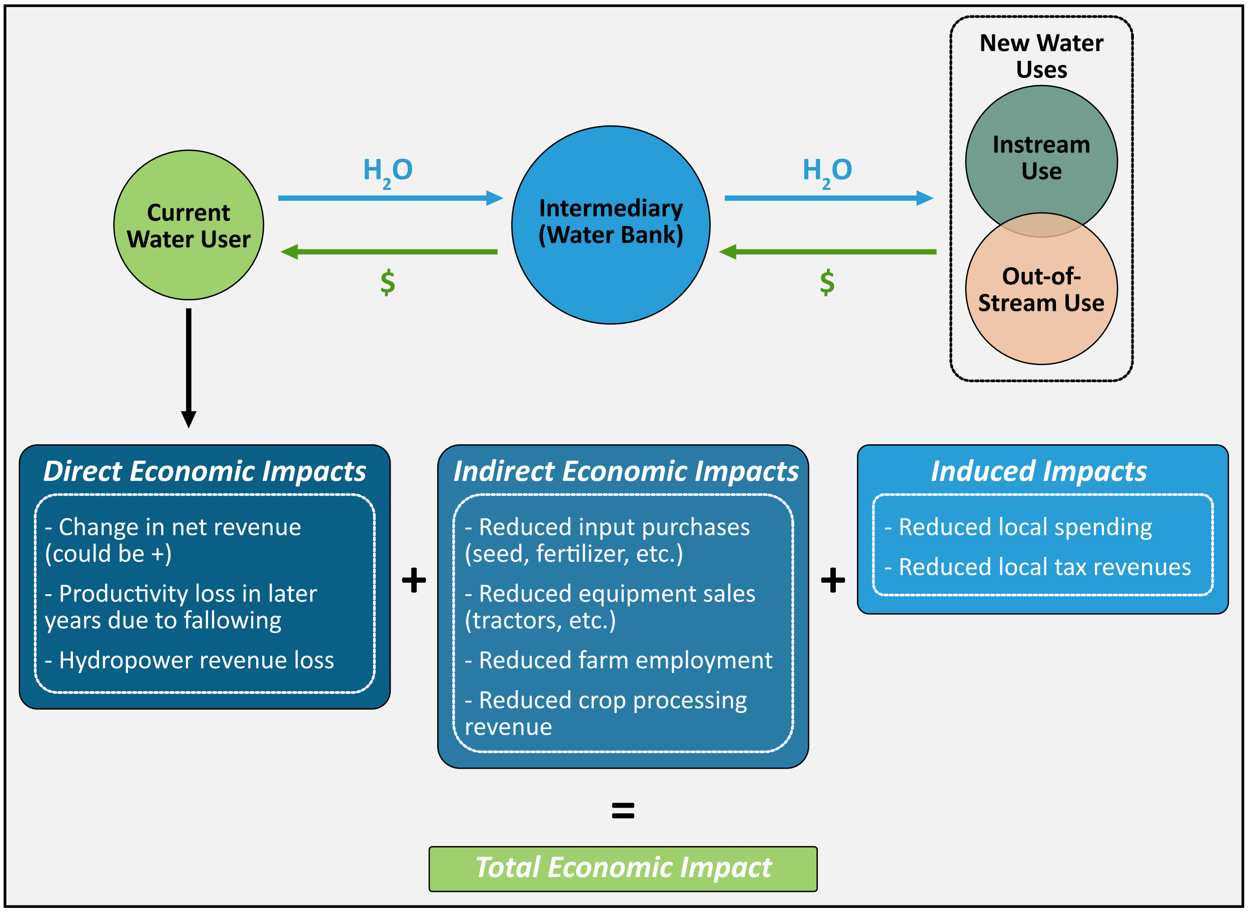
This section describes a qualitative analysis of potential economic impacts of operating a water bank. A full-scale quantitative economic study is not possible or necessary at this phase of feasibility study. Instead, we discuss and characterize the most likely direct impacts of the bank, as well as indirect and induced economic impacts. Results of quantitative analyses in other Watersheds in the western U.S. are discussed and summarized to provide an indication of the scale of impacts felt in other locations.

Before discussing potential economic impacts in the Hood River Watershed, it is important to first define some key terms. Figure 30 provides an overview of impacts that might be expected from operating a water bank. The *total economic impact* of bank operation is the sum of *direct* impacts, *indirect* impacts and *induced* effects or impacts. Direct impacts are those felt by the grower or owner (often the same person, though not always in the case of land that is leased to a tenant) who enrolls their water in the bank. These impacts are caused by a reduction in water availability and may be partially, fully, or more than fully offset by a payment from the bank or from another irrigator in the case of grower-to-grower trades.

Indirect impacts are economic impacts felt by businesses and others that rely on the participant(s). Those impacted include, but are not limited to, dealers of seed, fertilizer and other annual inputs that alfalfa, pasture and grain growers would purchase but for their participation in the Bank. Machinery sales and employment can also be indirectly impacted by a reduction in the number of acres in production in the Watershed. Finally, businesses that process or transport outputs from growers who are participating in the bank may also feel these indirect economic impacts. Induced economic impacts are the final variable for calculating total economic impact. These impacts include reduced spending in the community at large and reduced tax receipts.

Finally, it is important to consider that all of these economic impacts can be offset to some extent, possibly to their full extent, by payments from the bank to water users participating in the Bank combined with various forms of mitigation. Impacts can also be offset or mitigated in other ways in addition to direct payments to water users. Examples include offering technical assistance with choosing and managing crops that are amenable to periodic fallowing. These strategies are discussed in more detail below.

Figure 30: Direct, Indirect and Induced Impacts from Water Bank Activity



9.1 Approaches to Quantifying Economic Impacts

Measuring the regional economic impact of changes in water use like fallowing can be done in several different ways. The most common approach is to use an Input-Output (I-O) model. I-O models are built to help quantify specific economic relationships within a larger regional economy. I-O model predictions are based on the concept of economic multipliers. Multipliers are used to measure indirect and induced effects specifically by quantifying how changes in one industry's outputs impact the sales of goods and services in related industries in the same region and then how these changes effect overall regional household spending (Thorvaldson and Pritchett 2006). As indirect and induced effects grow, so too does the multiplier used for modeling purposes. Multipliers for irrigated agriculture are generally high, meaning that for each additional dollar of output from this sector, more than a dollar's worth of regional economic benefit might be expected (Thorvaldson and Pritchett 2006).

The most common I-O modeling approach is to use IMPLAN (IMact analysis for PLANning), a tool developed jointly by the Forest Service, the Federal Emergency Management Agency and Bureau of Land Management to help the Forest Service with land planning decisions. IMPLAN has built-in multipliers for different industries and the simplest way to use the model is to use these pre-determined multipliers. However, existing IMPLAN multipliers are based on national economic data and this data does not produce very good results when used at the regional scale. Many regional I-O modelling efforts therefore create custom multipliers based on regional economic data to better fit the IMPLAN model to specific locations. Another drawback of I-O models is that, because they are simplified versions of regional economies, they are not tailored to account for the varied types of adaptations that may occur as a result of changes in agricultural activity. For example, while fallowing may reduce agricultural outputs, farmers may change their behavior and adopt a different economically valuable agricultural or other type of activity that cannot be captured by an I-O model.

The first step to quantifying total economic impact using an I-O model is to measure the direct effects of changes in water use. For a fallowing program, this change would be the difference in agricultural output, or the decrease in gross agricultural revenues resulting from fallowing. Farm budgets can be developed for one or more types of crops to model these direct impacts. Next, specific multipliers are developed, ideally based on regional rather than national, level economic data. For example, if the agriculture sector as a whole had a multiplier of 1.67 that would mean that each dollar of activity or, conversely each dollar of decline in activity, resulted in 1.67 dollars' worth of economic impact. I-O models are best thought of as generalized snapshots of a regional economy, and they are therefore not well-suited to examining long-term impacts of changes in economic behavior.

I-O models are also not well suited to modeling how payments made to offset direct impacts (for example, payments to landowners in exchange for fallowing) affect the regional economy. It can be difficult to determine what landowners will do with their payments and therefore it is difficult to come up with an economic multiplier to apply to these payments. For example, there is a significant difference in impact if this money is spent in the region on, for example new machinery for future years where the landowner will not be fallowing, than if the money is spent on taking a vacation outside of the region during the time the landowner would normally have been irrigating and cultivating a crop.

Another approach to modeling economic impacts is to use a computable general equilibrium model. These models are more complex and more dynamic than I-O models. Instead of using multipliers, equilibrium models use supply and demand functions specifically developed for all goods and sectors within a regional economy (Seung et al. 2000). Unlike I-O models, this approach can help demonstrate impacts that do not change proportionally. Multiplier models assume a constant relationship between actions while equilibrium models can have more complex relationships. Full economic equilibrium models however, are vastly more expensive and data intensive than I-O models and are most commonly used in academic settings.

9.2 Examples of Economic Impact Analyses in Other Geographies

This section briefly summarizes some recent economic impact studies involving various types of water management changes in the western U.S. While these studies are not directly applicable to the Hood River Watershed, they do help illustrate how economic impact analyses work and also the scale of impacts estimated in other locations.

9.2.1 Case Study: Permanent Irrigated Land Reductions in Colorado

In a 2006 study conducted in four agricultural basins in Colorado, Thorvaldson and Pritchett (2006) used an I-O model to estimate economic impact from reductions in irrigated agriculture resulting from taking irrigated land permanently out of production. These reductions were based on predictions of growing water needs for municipal use that would be met by transferring water permanently from irrigated agriculture to cities. Estimated reductions in acreage ranged from 20,000 acres in the Republican Basin, to 159,000 acres in the East South Platte Basin. Some highlights of the study's results include:

- A range of economic activity per acre for the four basins from $428/acre in the Arkansas East Basin to $1,235/acre in the Rio Grande where the primary output (potatoes) is a high value crop that is largely exported out of the region.

- Total regional economic impacts of between -$20,333,467 to -$110,065,962 due to permanent reductions in irrigated acreage.
- As a percentage of total economic output, the study found impacts of between 0.12% and 3.95% and as a percentage of agricultural output, the study found impacts of between 0.82% and 8.16%;
- For the largest total economic impact estimate (for the East South Platte Basin, the basin predicted to lose 159,000 acres) the total economic impact was made up of a direct loss of approximately $62 million, indirect impacts of approximately $37 million and induced impacts of approximately $11 million. This Basin also had the highest output multiplier (1.78), meaning that for every dollar of reduced agricultural production, there could be a loss of $1.78 in total economic activity.
- Other output multipliers in the study ranged from 1.22 to 1.42 (Thorvaldson and Pritchett 2006);
- Employment impacts were estimated in the study:
  - For the East South Platte (the basin predicted to lose the most acreage), a total of 907 jobs were modeled to be lost, 508 of which came from agriculture, representing a decline of 9.1% of total farm jobs in the region, but only 0.13% of the total regional workforce.
  - Other basins ranged from 437 to 1,086 total jobs lost (162-884 agricultural jobs lost) representing between 2.8% and 39.3% (in the Rio Grande basin) of total farm jobs and 0.64% and 5.03% of total employment.
  - The significant job losses predicted in the Rio Grande Basin are likely due to the fact that the main crop in terms of acres planted is hay which requires significantly more labor than crops grown in other regions analyzed in the report (such as grain corn).

9.2.2 Case Study: Rotational Fallowing in the Imperial Irrigation District, California

Kleinman (2001) used an I-O model to study rotational fallowing of irrigated lands in the Imperial Irrigation District (IID) in California. At the time, IID was analyzing implementation of a program to periodically fallow acreage within the district and provide water resulting from the fallowing to municipal use in the San Diego area. Kleinman looked at gross (direct) economic impacts as well as indirect and induced impacts in the regional economy for five different fallowing scenarios. The scenarios ranged from reducing water use from one to five percent. Reduced water use was assumed to come from reductions in irrigation of alfalfa. A one percent reduction in water use required fallowing approximately 3,000 acres of alfalfa, producing 19,895 acre-feet of saved water. A five percent reduction required fallowing just over 15,000 acres of land and provided 99,475 acre-feet of estimated water savings. The per-acre productivity reductions due to fallowing alfalfa in IID were estimated at approximately $94.20 per acre of fallow land.

Modeled total reductions in gross annual profit lost due to fallowing one to five percent of alfalfa grown in IID (i.e. the sum of the direct economic impacts on those participating in the fallowing program) ranged from $288,324 (1% water use reduction), to $1,441,622 (5% water use reduction)) (Kleinman 2001). The study found a multiplier effect for fallowing alfalfa of 1.23, meaning that every dollar lost due to fallowing alfalfa costs the regional economy 1.23 dollars. In total, this translates to a total economic loss in the region of between $707,797 (1% water use reduction) and $3,538,984 (5% water use reduction). The employment impacts modeled in this study were modest, ranging from 10 jobs lost due to a 1% reduction up to 50 total jobs lost from a 5% reduction; from a total private sector employment perspective, these represent between 0.02% and 0.1% of total jobs in the county.

9.2.3 Case Study: Reallocation of Water to Stillwater National Wildlife Refuge, Nevada

In another study, Sueng et al. analyzed the impact of reallocating Newlands Project surface water near Fallon, Nevada from irrigated agriculture to recreational use at the Stillwater National Wildlife Refuge (Seung et al. 1999). Unlike the previous study, this study used a Computable General Equilibrium Model

(CGE). The purpose of this study was to determine whether compensation for reduced agricultural production to free up water for use in the refuge offset the economic impacts from the reduction in agricultural output. To model the answer to this question, the researchers tested three alternative assumptions about how farmers would spend the money they received as an incentive to reduce water use. The three alternatives were:

1. All proceeds from water right sales leave the study region either through retiring debt or purchasing outside consumer goods.
2. 50% of proceeds leave the study through retiring debt and consumer purchases and the remainder is saved, generating interest for the landowners.
3. Similar to Scenario 2 except all proceeds remain in the region (Seung et al. 1999).

The modeled water use and irrigation changes in the study included 30,000 acre-feet of water rights permanently acquired and reallocated to the refuge which amounted to roughly 1/3 of the water rights delivered to farms in the area. Payment for the water rights was made at a rate of $471 per acre foot or approximately $14.13 million in total payments. The water rights acquisition and reallocation increased wetland acreage by approximately 3,000 acres which in turn was assumed to increase visitation and wetland-related recreation such as water fowl hunting.

The study concluded that impacts on income to land (money made by landowners from land ownership) varied between the three scenarios, reducing by 10.84%, 7.04% and 3.34% respectively. Scenarios 2 and 3 showed lower reductions in income to land because some or all of the water right sales proceeds stayed in the region and generated interest income for landowners (Seung et al. 1999). Seung et. al. also found that the price paid to landowners ($417 per acre-foot of water) was not enough to compensate for modeled lost income and that a price of $670 per acre-foot would exactly compensate for a loss of 30,000 acre-feet of water rights from land.

The researchers did note however, that the model assumes that land that is taken out of production is not put to any alternative use and that if a productive alternative use could be found (for example some kind of dry-land agriculture), the $471 per acre-foot price could be sufficient. In a corollary to this finding, the study concluded that total regional economic output was not affected differently in the different scenarios and that under each scenario, it decreased by approximately 1%. This means that, despite compensation, overall economic output was modeled to decrease, albeit only slightly.

9.3 Discussion of the Case Studies

These three case studies are useful illustrations of the problems in using these regional economic analyses for policy or normative decision-making. The key issues with these studies are the completeness of the studies, the difficulty in valuing environmental goods and services, and their “regional” nature.

The first two studies consume themselves with assessing the economic impact of removing water from irrigation and, in the second case, what happens to the direct payments. Neither study assess the economic impact of the transfer of water to a new use. The two studies did not try to estimate the economic benefits that were engendered by moving water to municipal and industrial use. As these types of impact studies only assess one side of the transfer they are partial in nature and should not be used to make policy or normative decisions.

The third study is more well-rounded in that it purports to not just examine the economic impact (and loss) on the agriculture sector but to assess the economic impacts (and gain) on the recreation sector. In this case, the finding was that the loss narrowly outweighed the gain. This study then begins to be relevant to making policy decisions and choosing between economic alternatives. The difficulty of course is that assessing the economic impact of moving water to fish and wildlife uses is notoriously difficult, and far more difficult than in the case of moving water to municipal or industrial uses. Given that many such values were likely not incorporated into the analysis – due to the lack of the necessary microeconomic valuation studies – it is hard to assess the net impact in this case. And, finally, as stated above, the Stillwater analysis was only of the local economy. A full assessment would require adding in the impacts on the broader national economy. For example, national (or even global) existence values for migratory waterfowl will accrue outside the local economy.

This discussion highlights that regional economic studies are often partial in nature and thus, literally, really are about the economic impacts on a region and sector. In this sense, they are of more value for considering policy responses to the change wrought by water transactions programs then they are useful in decision-making about the viability of the programs themselves.

9.4 Applicability of Case Studies to Hood River Watershed

Directly extrapolating the results of the case studies above to the Hood River Watershed is not possible due to the many regional and other specific variations between the areas above and the Hood River Watershed. However, the case studies provide value by helping illuminate how economic impacts on agriculture and the Hood River Watershed might take shape. This section highlights some of the differences between the regions/studies described above and the Hood River Watershed, as well as discussing how the information from these studies is useful in thinking about economic impacts of a water bank in the Watershed.

The first difference is that the scales of water use reduction in the three case studies described above are significantly different from what is comprehended in the Hood River Watershed. The smallest scale investigated above is the low end of the fallowing program in IID consisting of approximately 3,000 acres. Especially in the near term, the scale of potential annual fallowing in the Hood River Watershed is not expected to be close to that number. Two of the studies discussed above also only involve permanently removing water from land. Very little, if any, permanent fallowing is anticipated in the Hood River Watershed as a result of operating a water bank. Another difference is that per-acre economic productivity estimates from the studies above also do not directly translate to the Hood River Watershed as crop prices are often region-specific. However, the per-acre values from the studies above are likely not orders of magnitude different than what could be expected locally.

Despite these differences, some insight from the studies above provides a useful comparison for the Hood River Watershed. In particular, the ranges of multipliers found in the Colorado and California case studies are illustrative of the scale of economic impacts from fallowing agricultural lands. The multiplier values for agriculture from the I-O studies discussed above range from approximately 1.2 up to 1.78. As mentioned above, the multiplier for the agriculture industry is often one of the higher multipliers in a regional IMPLAN model. This is likely true broadly for the Hood River Watershed with its wide-spread, high value irrigated fruit and other crops. There is some question about whether this would be true for annual crops that are the focus of this report given that they are not the dominant crops in the basin. However, it would not be surprising if an I-O study of these crops in the Watershed found a multiplier in the range observed in the studies above.

The economic impact of fallowing on the regional economies, measured by comparing the reductions modeled as a result of fallowing to total economic output range from very small (0.12%) to almost 4%. One of the driving factors here is the size and diversity of the regional economy. Small, rural non-diverse economies where agricultural output is one of the main economic drivers will experience a greater impact than larger, more diverse economies. Hood River County has a diverse economy and, as noted above in Section 2.2, measured by earnings, agriculture is only the fifth highest earning sector. This does not mean that reductions in irrigated acreage could not have a significant impact on the region, but at the scale anticipated for a Hood River water bank, the impacts as a percentage of the region's overall economy would likely be moderate.

It is also instructive to look at the employment impacts predicted by the Colorado and California case studies. These impacts ranged from moderate to severe, with the most severe impacts occurring in a basin where the dominant crop by acreage was hay and where the economy was highly dependent on agriculture. In the closest analog to the Hood River context, the IID case study estimated a loss of ten jobs due to periodic fallowing of approximately 3,000 acres of irrigated alfalfa. While this report does not have information on employment directly attributable to irrigation of annual crops, these crops are not the dominant crops in the region and are likely not a major driver of employment by themselves. While some employment impacts could be expected as a result of water bank activities, these would not likely be high compared to overall regional employment and would likely look more like the IID case than the Rio Grande case.

9.5 Mitigating for Economic Impacts of Water Bank Activities

There are several ways to try to mitigate potential economic impacts of removing water from irrigated land. These can be divided into landowner payments and other mitigation strategies. Landowner payments are payments made to landowners who participate in fallowing while other strategies can involve payments or provision of services to either or both participating landowners and others in the community. This section discusses both types of mitigation approaches and provides examples of each.

9.5.1 Landowner Payments

Landowner payments are payments to landowners who participate in fallowing. These types of payments are generally the foundation of market-based fallowing programs for instream flow or other goals. Payments are usually based on one of the water valuation methods discussed above in Section 4.6. However, from the perspective of mitigating for economic impacts, there are two important questions. First, does the payment to landowners for fallowing partially, fully, or more-than-fully compensate the landowners for their own direct economic impacts (i.e. for direct costs of fallowing)? And second, what do landowners who receive payments do with those payments and how does this impact the regional/community economy?

The first question, the degree to which payments offset the economic impacts of fallowing is relatively straightforward. The assumption is that most landowners would not voluntarily fallow their land if they did not feel that the payment they negotiated or were offered would at least make them whole. The same is true from the water bank or water transaction practitioner's perspective: the goal of water valuation is almost always to at least make the landowner whole in the transaction. In fact, most water valuation analyses end up paying a premium on top of the base value of foregone production both because landowners will not commit to a transaction without some premium and also as a way of building in assurance that the payment will cover or more than cover the cost of foregone production.

Despite this, there may still be some situations where payments do not fully cover the costs of foregone production. For example, as mentioned above, (Seung et al. 1998) estimated that the price paid to landowners in the Newlands Project ($417 per acre-foot of water) might not be enough to compensate for modeled lost income. These same researchers also admitted that their model did not account for any continued productive use of fallowed land (for example unirrigated pasture or dryland farming) which is an important point. Most farm income models used for water valuation purposes assume that some productive use can be made of land even while fallow. If this is not the case, then landowner payments may not fully offset lost productivity in some cases. However, in the case of the Newlands project this is probably a reasonable assumption given that these are desert lands. This example also points to the variation in values that can emerge from different approaches to valuing irrigation production. Most likely the issue in this Newlands Project study is that economic analyses of agricultural production overvalued agricultural uses of water when compared to comparable values emerging from water market data.

The question of whether landowner payments partially, fully or more-than-fully offset impacts to participating landowners is primarily concerned with whether the direct economic impacts of a program are mitigated. But the second question identified above, what landowners who are compensated for fallowing do with the payments they receive, is concerned with whether landowner payments also help offset indirect economic impacts. If landowners use payments to improve their own land or otherwise spend it in their community, then landowner payments can at least partially offset indirect economic impacts. However, if landowners use payments to pay down debt or otherwise spend the money outside of the community, then landowner payments will help less to mitigate indirect economic impacts.

A survey conducted after a two-year pilot fallowing program in the Palo Verde Irrigation District in California found that approximately 60% of landowners expected to spend their payments in the local region (Cubed 2002). The study did not measure the degree to which this helped offset indirect economic impacts. It is also worth repeating that Seung et al. (1999) modeled indirect economic impacts based partially on the percentage of landowner payments that were spent in the local economy and found that the more money was spent locally, the greater the regional economic benefit.

9.5.2 **Other Mitigation Strategies**

In addition to payments to landowners who participate in fallowing, other mitigation strategies can be employed to help offset potential economic impacts. These strategies can be targeted at either or both participating landowners or their surrounding community. Other mitigation strategies can also take a variety of different forms, some including payments and others including support like technical assistance or service provision. This section will briefly discuss some types of mitigation strategies employed in Watersheds outside of the Hood River and also provide some concepts that could be used in the Hood River Watershed itself.

Both the Imperial and Palo Verde Irrigation Districts (discussed above) implemented mitigation strategies in addition to paying landowners for participation in fallowing programs. IID implemented a competitive grant program to compensate farm service providers, support local job creation and community business development, and invest in specific capital projects. Similarly, PVID created a Community Improvement Fund (CIF) with an initial investment of $6 million, managed by a board, to provide loans and grants for workforce training, small business investment and community development (Mitchel and Cubed 2014). CIF small business loans went to a wide variety of different economic sectors ranging from food services to nursing and residential care facilities. These loans were not limited to agriculturally-related businesses and were intended to help increase and retain employment across a broad spectrum of economic sectors. CIF grants primarily went to local community organizations to support job training, education, child care, recreation and other community functions (Mitchel and Cubed 2014).

In another large federally-funded water transactions program in the Walker Basin of Nevada, proponents of permanent transfer of water lake from agriculture to Walker Lake have implemented two different mitigation strategies in addition to direct payments to landowners. First, the Walker River Basin Restoration Program has granted money for local water management projects including irrigation system modernization, land stewardship, sediment removal and a weir redesign (NFWF 2016). Additionally, the Program acquired irrigated lands and worked with a local farmer to pilot a crop conversion project that substituted organic vegetable crop production for high water use alfalfa cultivation (Kendy et al. 2018).

9.5.3 Mitigation Concepts for the Hood River Watershed

This section briefly discusses other mitigation strategies that could be used in tandem with a Hood River water bank. Unlike the California and Nevada programs mentioned above, which are all multi-million-dollar programs, a Hood River bank will be small and will not have nearly the same level of resources or capacity. A large-scale grant or loan program therefore is not feasible for the foreseeable future in the Hood River Watershed. However, there are several types of mitigation that could be considered, even within a smaller water bank context. Mitigation in the Hood River Watershed could focus on technical support and also possibly provision of services to participating landowners.

Discussions with local annual crop growers as well as comments received as part of the landowner survey identified several areas where technical support or service could provide a useful complement to direct landowner payments. First, the long-term health of land supporting annual crops that will be periodically fallowed requires maintenance and stewardship during fallowing periods. A water bank could work with local Oregon State University (OSU) extension agents to develop best practices for land stewardship during fallow periods and distribute these to participating landowners. Such practices could include weed and pest control as well as information about cover-cropping or other ways to use unirrigated land while maintaining soil productivity and generally maintaining the health of fallowed lands.

Additionally, one landowner interviewed after the survey indicated concern with the costs of replanting alfalfa after a period of fallowing. These costs could include ground preparation (tilling etc.) as well as seed costs and costs of planting a new crop. One specific concern was that the machinery necessary for tilling is expensive and not easily available in the Watershed and therefore might need to be hired/rented from outside the Watershed and then operated by someone with experience doing the work. With this in mind, another feasible mitigation strategy for a Hood River water bank would be to develop contacts with contractors who perform the services necessary to help prepare for replanting alfalfa or other annual and help coordinate the provision of these services in the Watershed. If funding was available, the bank could help offset some of these costs, but even if funding was not available, a coordinating role alone would still be helpful. One of the issues is that transporting the machinery into the Watershed to prepare one small field could be cost-prohibitive, but if the bank could coordinate several different landowners who need the service at the same time, the transport costs for the machinery could be shared, lowering the costs for each individual.

A final consideration for the Watershed involves the tax status of lands enrolled in a fallowing program. Farm land in Oregon is granted tax relief compared to other types of land uses. This Exclusive Farm Use (EFU) status might be put in jeopardy when lands are fallowed, even temporarily. Other Watersheds in Oregon have encountered this problem, though it has yet to become a major issue. Whether or not EFU status is jeopardized by fallowing is often a matter of discretion by local county taxing authorities. There has yet to be widespread cancellation of EFU status in Watersheds where significant fallowing has occurred in Oregon, but there have been isolated incidents and much discussion about the topic. Most of the confusion stems from the belief that without irrigation, farm land cannot be productively used for farming. This is not the case, as dryland farming and pasture are both feasible land uses without irrigation. Enrolling a water right in an instream lease with OWRD also prevents forfeiture of the water right which is arguably a farm use in itself as it maintains the land's ability to be irrigated for farming purposes in the future.

With all of this in mind, a Hood River water bank could play a role in guarding against the loss of EFU status for landowners who participate in fallowing. The bank could do this in several ways. First, the bank could work with Irrigation Districts to conduct outreach to county tax authorities about possible fallowing activities. Such outreach could educate local authorities about continued farm use of irrigated lands. Second, some of the advice and support for best practices for participating landowners could be focused on how to maintain farm use of land without irrigation by educating landowners on the issue and by encouraging dryland farming including use of non-irrigated lands as pasture for livestock. For example, if the landowner participating in fallowing does not raise livestock, the bank could play a role in helping find someone who needs to rent pasture land periodically.

9.6 Summary: Economic Impacts

At this phase of water bank planning, it is not feasible or necessary to conduct a full economic analysis of potential impacts from water bank operation in the Watershed. Instead, this report provided an overview of the types of economic impacts that are caused by fallowing agricultural land and reviewed studies and experiences of other Watersheds in the western U.S. Additionally, this report briefly reviewed and discussed mitigation strategies to help offset impacts from fallowing, including direct payments to landowners and other mitigation strategies.

In reviewing economic impacts generally and from other Watersheds specifically, it is important to note that fallowing productive irrigated land can and often does have economic impacts. These impacts include direct impacts to landowners who participate in fallowing. However, these impacts are typically assumed to be fully offset by payments to landowners for the market transaction in water. But the impact of the water transaction may also occasion impacts that ripple through the regional economy. These ripples, indirect and induced economic impacts, can include impacts on local employment and businesses that provide goods and services to or transport outputs from local farms; they can also include impacts on the local tax base and on regional spending on consumer and other goods. As noted, and demonstrated in numerous studies, the agricultural sector of a regional economy often has a substantial economic multiplier meaning that for every dollar of reduced agricultural production, the economy loses more than a dollar in overall productivity.

With that said, the scale of the reduction in agricultural productivity matters. It matters both in the broadest sense (i.e. how many acres are affected?) and in the temporal sense (i.e. are productivity reductions permanent? Or temporary and periodic?). The more affected and the more the balance tips toward permanent reductions in productivity, the higher the likely economic impacts. Because a Hood River water bank, especially in early phases of piloting and operation is likely to be small and only involve temporary, periodic fallowing, the economic impacts are likely to be low relative to the overall and to the total agricultural economy of the region. One possible future avenue of inquiry is to conduct a tipping-point analysis to try to estimate at what point water bank activities would start to cause serious economic impacts. Such an analysis could develop an I-O model of economic impacts from fallowing annual crops in the region and test a range of scenarios that differ by number of acres involved and also differ in the ratio of temporary and longer-term or permanent fallowing.

In summary, small to moderate scale temporary fallowing in the Hood River Watershed is not likely to cause harmful economic impacts in the regional economy. This conclusion is not based on modelling or specific data analysis, but rather on a review of much larger scale fallowing programs that, while they had observable and modelled negative economic impacts, nonetheless had impacts that were low to moderate when compared to their overall regional economic settings. Water banking will surely have some economic impacts, but further study is necessary to determine at what point these might become a serious concern for the region. For the early phases of water bank implementation in the Watershed, the focus should be on ensuring that participating landowners are fully, or more-than-fully compensated for direct reductions in productivity.

10. Conclusions, Recommendations and Next Steps

The goals of this Feasibility Study were: 1) to assess the viability of a Hood River water bank to increase summer stream flows for fish and provide greater irrigation water reliability for perennial crop growers during dry or drought years, and 2) to determine the feasibility of implementing a bank in the Hood River Basin. At a high level, the conclusion of this study is that a water bank or water leasing program, properly designed and implemented, is a viable tool for increasing summer stream flows and providing irrigation water for perennial crop growers. Designing and implementing a viable program is also feasible in the Watershed. The feasibility of the program is driven primarily by three things. First, the HRWG is a high-functioning and effective Watershed council with a proven track record of success. This success is attributable to many things, but foremost to a skilled and knowledgeable staff and to the organization's reputation and history of building trust with the Watershed's irrigation districts and fisheries and natural resources managers. The ability to gain and keep the trust of irrigation districts and farmers in general is a key factor mitigating in favor of the HRWG's ability to successfully carry water leasing in the form of a water bank or other, less formal program. Second, the landowner survey conducted as part of this effort revealed that farmers irrigating hay, alfalfa, grains and other crops capable of being fallowed showed a general level of support or at least neutrality on the concept of voluntary, compensated water leasing. This point cannot be highlighted enough as significant resistance to the concept would be a strong sign that a program would be difficult if not infeasible. Finally, the water rights, hydrology, and general water management context of the Watershed is conducive to water leasing. The vast majority of water rights are in irrigation districts with managers who are generally supportive of the concept of water leasing or a water bank. Maintaining this support by carefully designing a program in cooperation with these managers and their patrons is critical.

To support this feasibility study, AMP Insights, with help from HRWG, WPN, Summit Conservation Strategies and local stakeholders completed a number of tasks that are incorporated and summarized into this report. To review, these tasks included:

1. A geospatial analysis to identify and quantify annual crop acreage in the Watershed. This analysis was critical to quantifying potential leasing/banking supply and demand.
2. A landowner survey to gauge the general attitude toward voluntary, compensated water leasing in the Watershed, the results of which were positive and gave no indication that such work should not at least be piloted in the Watershed.
3. An analysis of potential benefits to key fish species in the Watershed from operation of a water leasing/water bank program.
4. A high-level survey of potential economic impacts from water leasing and other water transaction types like what might be implemented by a water bank.
5. Ongoing and final reporting summarizing the outcomes of tasks listed above and synthesizing these outputs into this final report.

The programmatic elements of a water bank considered in this report included:

- program form and format (level of formality, roles and responsibilities, etc.)
- water bank supply (including water value and pricing);
- water bank demand;
- operational costs and capacity needs;
- water bank funding approaches; and
- institutional and governance issues.

This list of elements also provides a useful basis to consider some of the specific conclusions, recommendations and next steps (Table 19).

Table 19: Recommendations and Conclusions

Programmatic Element	Recommendation/Conclusion
Program form and format	Operate a water leasing program or water bank from within the HRWG or SWCD with close coordination of irrigation districts; program can be informal at first and grow into additional formality over time as success dictates.
Water bank supply	Under current conditions, there is enough potential supply from annual crops in the Watershed for instream flow restoration to help increase reliability of some out-of-stream uses; additional work is required to determine how these competing goals/uses would be balanced; also, supply is likely to be reduced over time as land currently dedicated to annual crops is developed for higher value perennial agriculture.
Water bank demand	There is significant unmet instream flow demand in the Watershed; this need may be currently concentrated in some tributaries and reaches and be less acute in others but over time, instream flow demand will likely increase; out-of-stream demand is less clear at this time, especially with ongoing efforts to make more efficient uses of existing supplies through water conservation efforts; additional work is needed to estimate the magnitude of out-of-stream demand and whether/how fast this demand might increase.
Operational costs	Costs could be minimized by operating within an existing entity and with support of irrigation districts.
Capacity	Current capacity of HRWG, with cooperation of irrigation districts and some irrigation district staff time is likely sufficient for pilot water leasing/water bank implementation; pilot implementation will help illuminate if/when additional capacity might be needed.
Funding	OWEB is the most likely initial funding source for water leasing/water bank pilot implementation; OWRD funding should also be sought and is another likely source; at this time, CBWTP is not expanding its QLE network so CBWTP funding would need to come through a partner such as The Freshwater Trust, Trout Unlimited or another QLE.
Institutional and governance issues	HRWG should begin the process of outreach and planning to convene a diverse advisory group to help guide pilot water leasing/water bank implementation.

10.1 Next Steps

A water leasing program or water bank is a viable tool and is feasible for the Hood River Watershed and the logical next step therefore is to pilot water leasing and begin to develop a detailed water bank design. These two efforts can and should be undertaken simultaneously as water bank design can be directly informed by progress in pilot leasing projects. Developing pilot projects and beginning specific program design work require additional funding so a threshold next step is to seek funding for these activities. If funding can be secured, a multi-year project could be undertaken that would involve implementing a small number of instream flow restoration transactions each year with a design effort taking place at the same time.

Programmatic design would include specific planning for how to carry out pilot transactions: what tools (i.e. leases, WUAs, etc.) to use, how to conduct outreach and solicit participation from landowners, how to monitor and enforce pilot transactions, water valuation, and other related tasks. The design effort would also guide the selection and of an advisory group and commencement of advisory work including setting program policies and working with irrigation districts to formalize coordination between transactions and district management. Other outstanding questions from this report could also be explored as part of the design effort including additional work to understand and quantify possible out-of-stream demand, further discussing funding options with CBWTP and existing QLEs, and exploring other possible funding sources including private foundations and federal programs.

The Hood River Watershed is unique in its ability and past success at bringing diverse stakeholders together to make progress on critical water management issues. Water banking could add another tool to the Basin's tool box to help meet streamflow and water supply challenges. This report demonstrates that this tool is a feasible option for the Basin and recommends pursuing additional work to pilot the tool.

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12. Appendix A: GIS Analysis Procedures

February 20, 2018

MEMORANDUM

To: David Pilz, Director, AMP Insights
From: Ed Salminen, WPN
Subject: Task One: Draft geospatial database and maps of land available for water banking

David:

This memo serves as documentation for the draft task one deliverables; Geospatial database and maps of land available for water banking. The memo below describes the methodology and the draft products produced. The products themselves can be downloaded from the project share site[1].

Overview of approach and products

The draft products assembled here are intended to provide the information needed by the Watershed Partners Group (WPG) to make timely decisions on where to go for short-term water leases. The analysis was limited to acres having primary irrigation water rights[2] within the five irrigation districts located within Hood River County (Table 1; Figure 1).

Table 1. Acres of primary irrigation water rights by irrigation district. Source: OWRD

Irrigation District	Abbreviation	Acres or primary irrigation from OWRD
Dee Irrigation District	DID	870.00
East Fork Irrigation District	EFID	9,608.65
Farmers Irrigation District	FID	5,868.64
Middle Fork Irrigation District	MFID	6,317.10
Mount Hood Irrigation District	MHID	1,017.90
		Total: 23,682.29

The following sections describe 1) the approach taken to map water rights and to tie them to the Hood River County (HRC) tax parcels, and 2) mapping of potential areas for water banking and linking these to tax parcels.

Water right mapping

The 23,682.29 acres of primary water rights are distributed among 39 separate OWRD records (see the "OWRD" worksheet in the attached spreadsheet). Priority dates range from 1874 to 4/27/1989. Contact was made with all five irrigation districts to identify available spatial data. No spatial data is currently available on crop types. MFID and EFID have all irrigated areas within parcels mapped in GIS and linked to the applicable water right(s). FID and MHID[3] have all larger irrigated areas within parcels mapped and linked to water rights. DID has not mapped any of the actual area within parcels that are irrigated. All irrigation districts have tabular information on irrigated acreage by parcels.

[1] https://cloud.wpn2.com/index.php/s/4o5HwAjwx7r3Pk4
[2] http://www.oregon.gov/owrd/pages/wr/wris.aspx
[3] http://www.oregon.gov/owrd/Pages/maps/index.aspx#Water_Right_Data/GIS_Themes

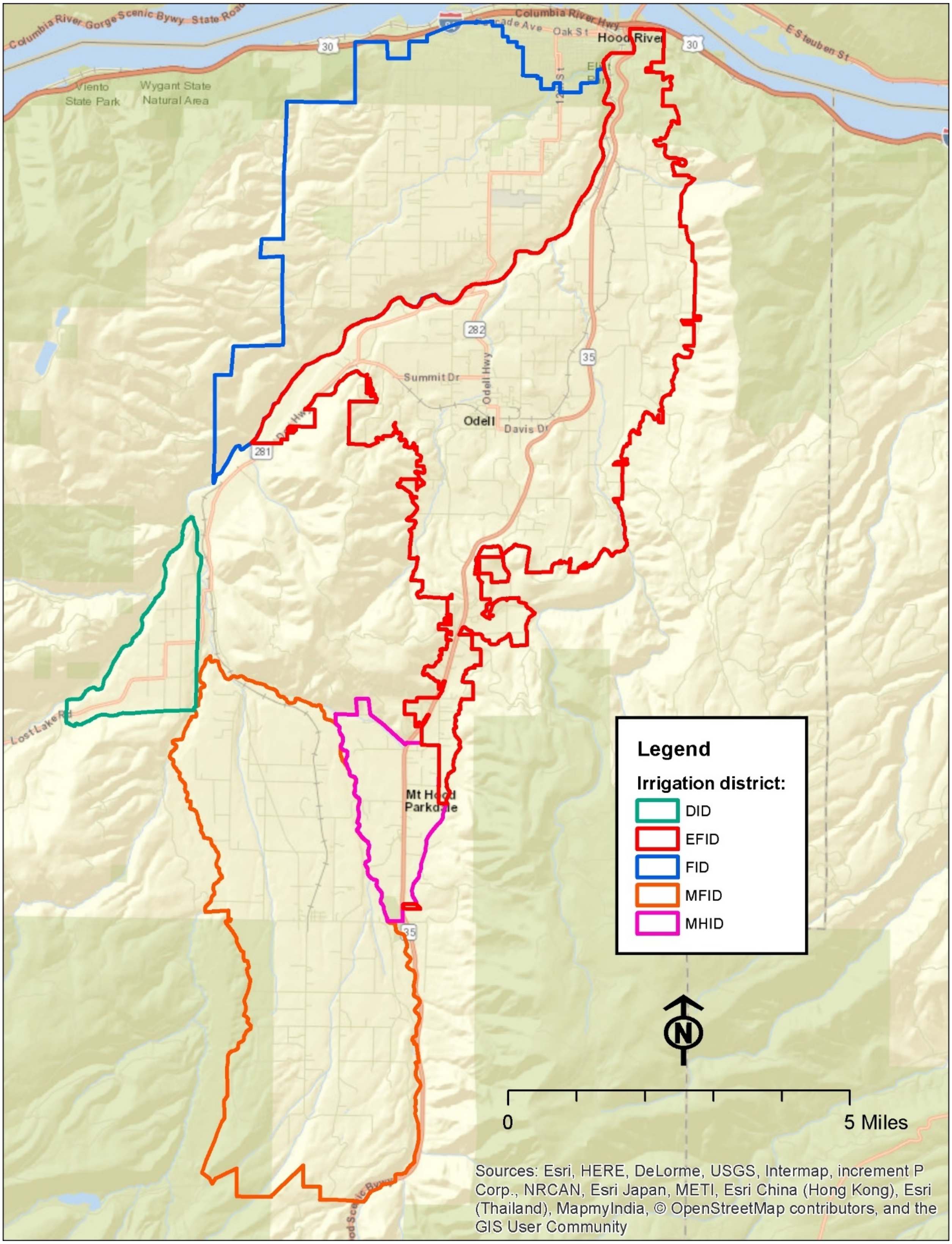

Figure 1. Hood River County Irrigation Districts.

Given the mixture of mapped and unmapped water rights a two-tier approach was taken. All mapped water rights (Figure 2) were combined into a single layer. The resulting water rights layer was then intersected with tax parcel data from HRC[4] and crop types (discussed in following section). For those tax parcels that are served by irrigation districts but do not have mapped water rights (Figure 2) the acres of irrigation by water right were given, along with the total acres by crop type for the parcel. When interpreting these data keep in mind that it is not known which portions of the parcel are irrigated or not.

Cover type mapping

Annual crop types were mapped using two methods; 1) Derivation of cover types using 2008/2009 LiDAR[5] datasets for HRC, and 2) use of 2017 USDA National Agricultural Statistics Service (NASS) cropland spatial data sets. Each method is described below. Acres by cover type were summed by the parcels described in the previous section.

LiDAR mapping approach:

LiDAR data for Hood River County was collected in May-October 2008, and April 2009. Bare earth and highest hit (i.e., top of vegetative canopy) data were available at a 3-foot resolution, and intensity images (a measure of surface reflectance) were available at a 1.5-foot resolution. A vegetative canopy height was calculated by subtracting the bare earth elevations from the highest hit elevations. Data sets were merged and clipped to an analysis area that included all of the irrigation districts (Figure 3). Areas of potential annual crops were identified using the following approach:

Eliminate areas of high canopy – Only annual crops (alfalfa, hay, row crops), pasture, and lawn areas were considered potential areas for water banking. The first step was therefore to eliminate areas with high vegetative canopy. These were assumed to be areas with an average canopy height of greater than one foot. The resolution of the canopy height data set was 3x3 feet, however, orchard crops and other high-canopy vegetation often have areas of low canopy (e.g., grass rows between orchard rows) interspersed among higher canopy areas. The ArcGIS "Block Statistics" tool was used to eliminate these features without losing the resolution of the original dataset. Mean canopy height was calculated for each raster cell within a fixed rectangular area 15x15 feet in size. The average height is assigned to all cells within this area

Eliminate areas of roads, driveways, and water bodies – The interim data set produced from the previous step includes these areas of "low canopy" but which are not potential water banking areas. The "Iso Cluster Unsupervised Classification tool" was used within ArcGIS to identify all of the areas of roads, driveways, and water bodies. The prefix "iso" is an abbreviation for the "iterative self-organizing" approach to organizing similar raster cells into clusters for classification. The merged and clipped LiDAR intensity grid was used as the input source for this process. A total of four classes were selected for the operation, with a minimum class size of 400 cells (~1/10 acre). Inspection of the output classification indicated that areas of roads, driveways,

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[4] Data are current as of 1/3/2018.
[5] Light Detection and Ranging

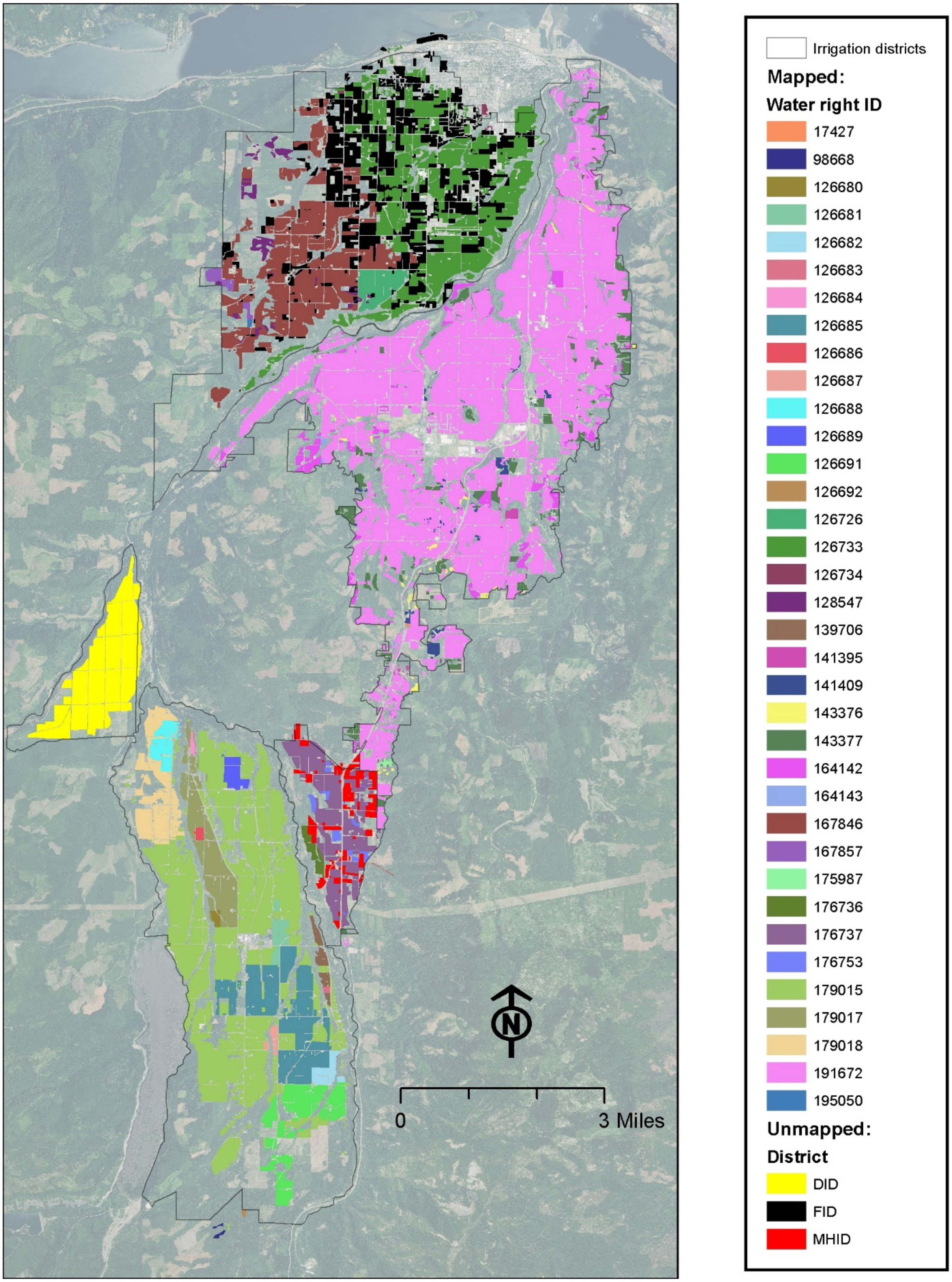

Figure 2. Mapped and unmapped water rights. Water right ID is from OWRD.

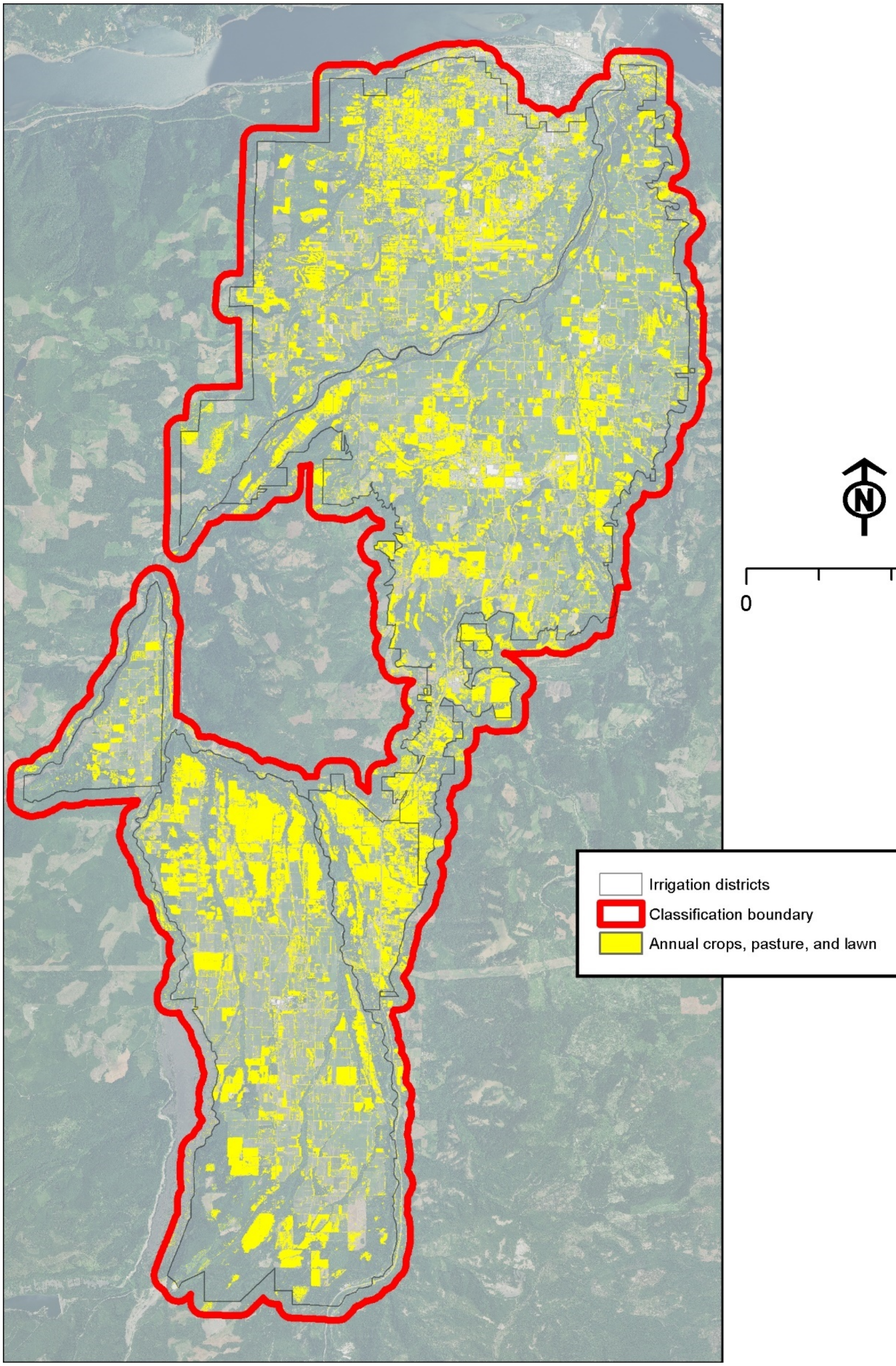

Figure 3. Classification of potential water banking areas using 2008/2009 LiDAR data.

and water bodies all fell within one class. These areas were eliminated from the resulting raster grid shown in Figure 3, which was resampled at a 3x3-foot resolution.

The final acreage of potential water banking area was summarized by parcel.

NASS cropland mapping approach

The data set from the previous section is a very good representation of areas available for water banking at the time that the LiDAR data was collected (2008/2009). However, crop types have changed in some locations over the intervening years. Furthermore, some relatively easy approach of updating the annual crop type categories would be desirable to keep the products current in future years. For these reasons the USDA National Agricultural Statistics Service (NASS) data set from 2017[6] was used as a second approach to characterize acreage by crop type within the project area. The NASS project has produced geo-referenced, crop-specific land cover raster data layers from 2007 to the present. The 2017 data set has a ground resolution of 30 meters and was produced using satellite imagery from the Landsat 8 OLI/TIRS sensor and the Disaster Monitoring Constellation (DMC) DEIMOS-1 and UK2 sensors collected during the 2017 growing season. Percent of area within classification boundary by NASS 2017 cover type are summarized in Table 2.

Table 2. Percent of area within classification boundary by NASS 2017 cover type.

NASS Class	% area	Grouping
Evergreen Forest	26.26%	Forest/natural
Pears	23.40%	Orchard
Shrubland	20.16%	Forest/natural
Developed/Open Space	6.77%	Annual crops, pasture, lawn
Cherries	5.64%	Orchard
Grass/Pasture	5.45%	Annual crops, pasture, lawn
Developed/Low Intensity	3.47%	Developed
Other Hay/Non Alfalfa	1.56%	Annual crops, pasture, lawn
Deciduous Forest	1.37%	Forest/natural
Developed/Med Intensity	1.17%	Developed
Mixed Forest	0.89%	Forest/natural
Apples	0.74%	Orchard
Barren	0.68%	Forest/natural
Alfalfa	0.59%	Annual crops, pasture, lawn
Developed/High Intensity	0.44%	Developed
Open Water	0.39%	Forest/natural

NASS Class	% area	Grouping
Fallow/Idle Cropland	0.38%	Annual crops, pasture, lawn
Woody Wetlands	0.36%	Forest/natural
Squash	0.11%	Annual crops, pasture, lawn
Corn	0.07%	Annual crops, pasture, lawn
Barley	0.03%	Annual crops, pasture, lawn
Grapes	0.03%	Orchard
Herbaceous Wetlands	0.01%	Forest/natural
Winter Wheat	0.01%	Annual crops, pasture, lawn
Blueberries	0.01%	Orchard
Triticale	0.01%	Annual crops, pasture, lawn
Sod/Grass Seed	0.00%	Annual crops, pasture, lawn
Christmas Trees	0.00%	Forest/natural
Radishes	0.00%	Annual crops, pasture, lawn
Rye	0.00%	Annual crops, pasture, lawn
Peas	0.00%	Annual crops, pasture, lawn

NASS cover types in Table 2 were grouped into four categories which are summarized in Table 3. Areas classed as "Developed" and "Forest/natural" are assumed to not be irrigated. Areas classified as "Orchard" are assumed to be unsuitable for water banking, leaving the "Annual crops, pasture, lawn" category as potential for water banking. NASS groupings are shown in Figure 4.
The final acreage of cover type groupings was summarized by parcel.

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6 https://nassgeodata.gmu.edu/CropScape/index.jsp?state=OR

Table 3. Percent of area within classification boundary by cover type groupings.

Grouping	Sum of % area
Annual crops, pasture, lawn	15%
Developed	5%
Forest/natural	50%
Orchard	30%

Interim Products, Limitations, and Next Steps

GIS layers for all figures in this memo are included on the project share site.

The "summary_2018-02-21.xlsx" spreadsheet has the following information by worksheet:

- OWRD: Table of all primary irrigation rights from OWRD. The "snp_id" is the unique water right record identifier. The hyperlink in the spreadsheet will open up the associated record in the OWRD WRIS database.

- OWRD sum: Summary table of irrigated acreage from above by irrigation district.

- LiDAR-mapped: This gives the acres of annual crops, pasture, lawn from the LiDAR classification by water right ID (columns C- AO) for all mapped water rights. The sum (column B) is used in the summary sheets discussed below, however, this sheet is included in case the user would like to link the acreage to the water right and priority date.

- NASS-mapped: This is the same as the previous sheet, but for the NASS classification.

- sum-mapped-parcel: This has the acres of annual crops, pasture, lawn from both the LiDAR and NASS classifications by tax parcel. The OBJECTID is the unique identifier linking to tax parcel. The list is currently sorted from largest acreage (based on LiDAR classification) to smallest.

- sum-mapped-owner: This sheet summarizes the previous sheet by landowner. It is also sorted from largest acreage (based on LiDAR classification) to smallest.

- sum-unmapped-parcel: This is the summary sheet for the unmapped water rights. The OBJECTID is the unique identifier linking to tax parcel. The total acreage of the parcel is given, along with the total acres of water right for that parcel (summed from columns K-T). The acres of annual crops, pasture, lawn from LiDAR classification are given, along with the acreages of all four NASS classifications. The acres by water right ID and priority year are also given. The list is currently sorted from largest acreage (based on LiDAR classification) to smallest.

- sum-unmapped-owner: This sheet summarizes the previous sheet by landowner. It is also sorted from largest acreage (based on LiDAR classification) to smallest.

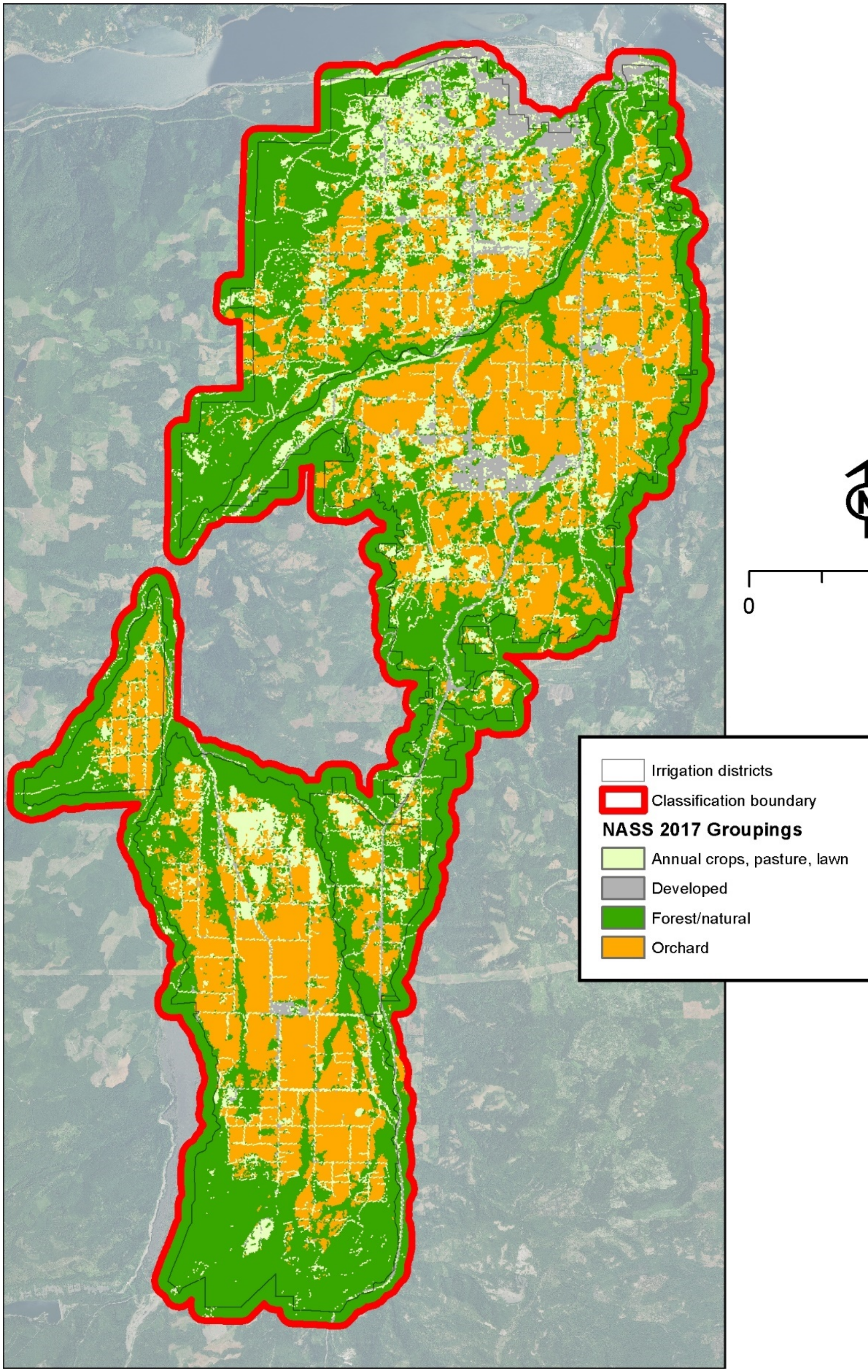


Figure 4. Cover type groupings derived from 2017 NASS data.

- HRCo_Taxlots_010318: This is the complete attribute table from the tax lot shapefile. The OBJECTID column links to the previous worksheets.

There are likely some errors in the mapping of water rights, the selection of tax parcels for unmapped water rights, and in the cover type classifications. Ideally these errors are small and will not limit the usefulness of the data sets. Interim products should be share back with the irrigation districts to verify their accuracy

The final products should include the points of diversion (PODs) associated with each water right. This will allow us to link any water savings to the POD and to the downstream aquatic habitat. This approach may allow us to identify higher priority PODs (and by association tax parcels) for water banking.

13. Appendix B: Landowner Survey Results

Summit
Conservation
Strategies

August 7, 2018

To: David Pilz, Aylward, McCoy, and Pilz Consulting
From: Ray Hartwell, Summit Conservation Strategies
Re: Hood River Growers Survey Results

This memorandum presents a statistical summary of the results of a survey gauging Hood River area irrigators' agricultural operations and receptivity towards programs to temporarily lease water rights for instream or agricultural use. The objective of the survey was to inform analysis of the feasibility of water leasing as a streamflow restoration tool in the Hood River basin.

Survey Overview

The survey consisted of eight substantive questions covering water right holder's current land use, future land use plans, and willingness to consider participation in a voluntary leasing program. Several questions explored important factors influencing landowner willingness to consider leasing, including attitudes towards instream and farm-to-farm leasing.

The survey was distributed by mail on DATE to ?200? water right holders owning at least 10 acres of rights. Outreach through irrigation districts, grower's organizations, and events was used to encourage completion of surveys. 36 responses were received by July 15, 2018 for a response rate of 18%. This is a healthy response rate for mail surveys of this nature.

The specific characteristics of respondents are described below by question. Importantly, we do not have information on the extent to which respondents are representative of the larger population who received the survey. In some research, it is possible to compare the characteristics of respondents (e.g. parcel size, choice of crops) with known characteristics of the population in order to assess, at a high level, whether the respondents are representative of the survey's target population. In the case of this survey, we have limited ability to assess this representativeness in this way. This was a deliberate survey design choice in favor of a concise survey that would maximize the number of responses informed by an acknowledgment that a lack of population data would make it difficult to assess the representativeness of the sample regardless of the information collected. In practical terms this means that any conclusions drawn about all water right holders receiving the survey is based on the 36 responses, which may or may not be representative.

Results

Results are presented below by survey question as both counts and percentages, as well as in chart format where applicable. For each question, the number of valid responses is also presented. A prose description highlights key conclusions, any irregularities in the data, as well as the results of hypotheses testing as applicable.

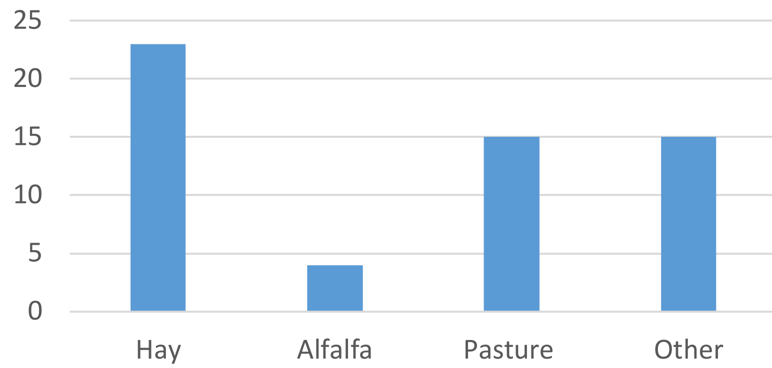
Question 1:

On land where you grow annual crops, what crops are you currently irrigating (select all that apply)?

	Count	Percent
Hay	23	64%
Alfalfa	4	11%
Pasture	15	42%
Other	15	42%
Valid N	36	

Responses are not mutually exclusive, with 17 respondents (47%) reporting that they grow two or more crops. Of respondents answering "other", a wide variety of crops were reported, some of which are not annual crops (e.g. fruit trees, wine grapes, etc…).

Unsurprisingly, 28 respondents (78%) reported growing forage on their land. 5 respondents reported growing only orchard or vineyard crops; these answers reflect a misunderstanding of the intent of the question.



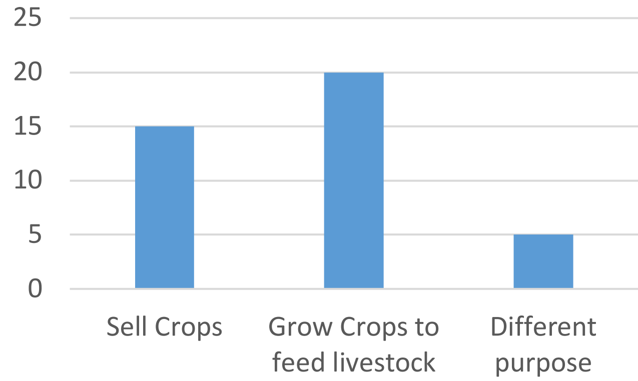
Question 2:

Do you grow and sell annual crops, do you grow crops to feed livestock, or do you grow annual crops for a different purpose (for example for fire control or to maintain water rights)?

	Count	Percent
Sell Crops	15	47%
Grow Crops to feed livestock	20	63%
Different purpose	5	16%
Valid N	32	

Responses are not mutually exclusive, with 8 respondents (22%) reporting multiple purposes. Responses can be further divided as follows:

- 7 respondents (15%) answered that they only sell crops.
- 15 respondents (47%) responded that they sell crops along with some other activity.
- 12 respondents (38%) reported growing crops exclusively to feed livestock.
- 20 respondents (63%) grow crops to feed livestock along with another activity.

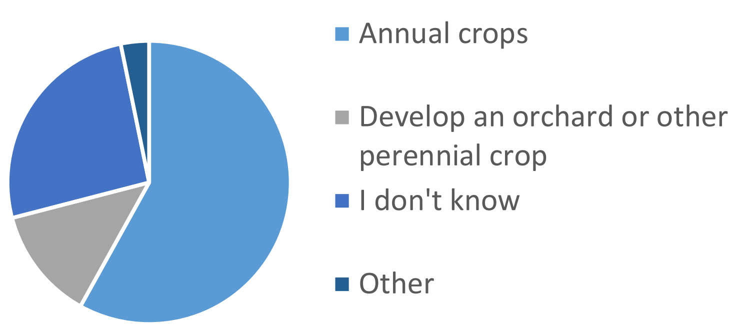


Question 3:

For the land you have in annual crops, do you plan to keep it in annual crop production, or do you have plans to develop a perennial crop or make another change?

	Count	Percent
Annual crops	18	58%
Develop an orchard or other perennial crop	4	13%
I don't know	8	26%
Other	1	3%
Valid N	31	

Some 58% of respondents plan to keep growing annual crops on land currently used in annual crop production. Only 13% of respondents have plans to develop perennial crops, while twice that number do not have concrete plans. The "other" response was from a farmer specifying plans to continue production of perennial hay (drawing a distinction that some forage production is in fact perennial).

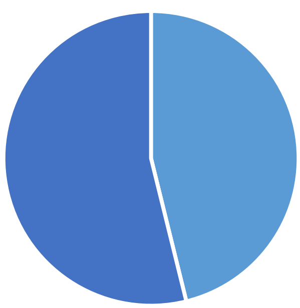


Question 3a:

If you plan to change crops, are you planning to

	Count	Percent
Make the change in the next five years	6	46%
Make the change in the next ten years	0	0%
I don't know	7	54%
Valid N	13	

Importantly, all of the 4 respondents citing plans to develop and orchard or perennial crop in their answer to question 3 plan to make the change in the next 5 years.



Question 4:

Based on the description above, would you consider participating in a voluntary, paid fallowing program?

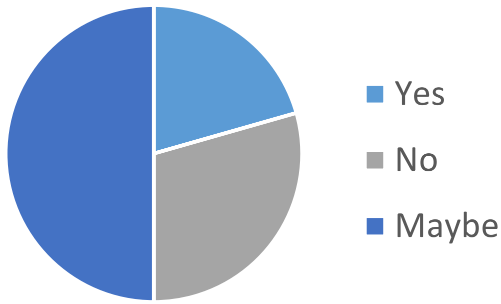
	Count	Percent
Yes	7	21%
No	10	29%
Maybe	17	50%
Valid N	34	

In a result reflecting strong interest in water leasing, 71% of respondents answered "yes" or "maybe" when asked whether they would consider participating in a voluntary, paid fallowing program. The 90% confidence interval around this value is +- 13%, implying that there is 90% probability that the proportion of the population receptive to leasing (i.e. who responded "yes" or "maybe" to question 4) lies between 58 and 83%. The finding that most of the target irrigators are potentially receptive to a leasing program is statistically significant.

To increase understanding of the interest in leasing, we also evaluated responses for different subgroups of respondents based on answers to questions 1 through 3.

	Yes	No	Maybe	Blank	N	Yes or Maybe
All Respondents	7	10	17	0	34	71%
Question 1 Responses						
Grows Forage	5	8	13	2	28	64%
Orchard or Vineyard Only	2	1	2	0	5	80%
Question 2 Responses						
Sells Crops Only	0	1	5	1	7	71%
Sells Crops along with another activity	3	3	8	1	15	73%
Grows Crops to Feed Livestock Only	2	4	5	1	12	58%
Grows Crops to Feed Livestock along with another activity	5	6	8	1	20	65%
Question 3 Responses						
Plans to Develop Orchard	0	0	4	0	4	100%
Plans to Remain in Annual Crops	4	8	5	1	18	50%

Analysis of responses by subgroup failed to reveal material differences in receptivity for the leasing program. Compared to the 71% of all respondents who answered "Yes" or "Maybe" to question 4, receptivity across the different subgroups ranged from 100% (for the four respondents with plans to develop orchards) to 50% (for the 18 respondents with plans to remain in annual crops). Statistical evaluation of subgroup results shows that in many cases, there is not statistical evidence of receptivity to the leasing program at the subgroup level. For example, while 71% of respondents to question 2 who answered that their only activity is selling crops, the 90% confidence interval around this value ranges between 43% and 100%. The wide confidence interval is driven primarily by sample size and implies that we cannot be 90% certain that more than half of the population is receptive to leasing.



Question 4a:

If Yes or Maybe, what factors would influence your choice (select as many as you want)?

	Count	Percent
How much I would be paid	18	72%
Whether other people are participating	5	20%
Crop/livestock prices	6	24%
Whether my water rights would be protected	14	56%
Whether I would need to temporarily change my water right	12	48%
Other	3	12%

Perhaps unsurprisingly, the amount of compensation offered for a lease was the factor most frequently cited as influencing interest in leasing, followed by administrative concerns around protection of water rights.

Question 5:

How much would you want to be paid to voluntarily fallow your land on a temporary basis?

	Count	Percent
I would be willing to donate my water in some years	2	7%
As much as I make on my land now	6	21%
More than I make on my land now	3	10%
I would not participate no matter the price	3	10%
I don't know	15	52%
Valid N	29	

A majority of water right holders responded that they did not know how much they would want to be paid to lease their water rights. This is unsurprising given the lack of familiarity with leasing generally, and may indicate the need for additional research or price discovery. Of respondents who selected one of the responses offered, more than half (8 of 14) expressed willingness to lease in exchange for payments at or below their current earnings.

Question 6:

What is your overall impression of the idea of voluntary, paid fallowing to benefit stream flows?

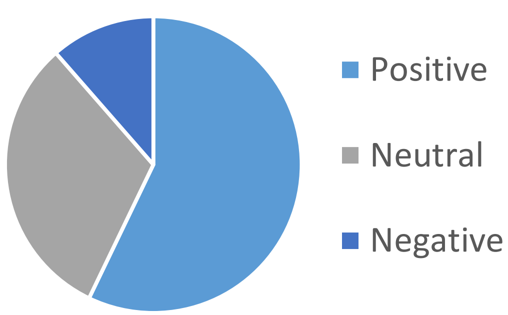
	Count	Percent
Positive	20	57%
Neutral	11	31%
Negative	4	11%
Valid N	35	

Overall, a majority of survey respondents had a positive impression of water right leasing to benefit streamflows, with 57% expressing support. Analysis reveals that this is not a statistically significant result – the 90% confidence interval around this value extends from 43% to 71%, implying that we cannot be confident that a majority in the population have a positive impression of instream leasing.

At the same time, some 89% of respondents had a positive or neutral impression of water right leasing to benefit streamflows. The finding that a majority of respondents have a positive or neutral impression of leasing is statistically significant with the 90% confidence interval around the result extending from 80% to 97%. Overall, there is strong statistical evidence that most of the target irrigators have positive or neutral impressions of instream leasing.

Analysis of responses across different subgroups based on responses to questions 1, 2, and 3 did not add much context to results, with results for most subgroups generally mirroring those of the full sample. Two exceptions bear mention:

- Respondents engaged only in orchard or vineyard production (based on question 1 responses) uniformly had a positive impression of instream leasing, though the sample was small (N=5).
- Respondents reporting plans to continue annual crop irrigation were less receptive to leasing, with only 28% reporting a positive impression of the activity.



Question 7:

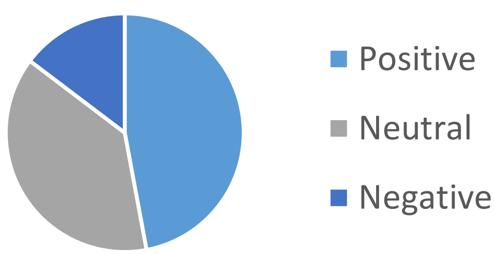
What is your overall impression of voluntary, paid fallowing to benefit other farmers?

	Count	Percent
Positive	16	47%
Neutral	13	38%
Negative	5	15%
Valid N	34	

Respondents' viewpoint regarding water leasing that would benefit other farmers was slightly more tepid than that regarding instream leasing with just under half (47%) reporting a positive overall impression. At the same time, only 15% of respondent reported a negative impression of leasing to benefit farmers.

Statistically, these results do not differ materially from responses to question 6 – in both cases there is not statistically significant evidence that a majority of respondents have a positive impression, but there is evidence that a strong majority hold positive or neutral feelings. At the same time, it is clear that some respondents changed their responses to reflect less positive feelings about farm to farm leasing. This bears further exploration as part of program design.

As in question 6, responses categorized by subgroups based on responses to questions 1, 2, and 3 did not yield much additional insight. As in question 6, water right holders growing orchard crops or wine grapes had strong positive views, and impressions were less favorable among those planning to continue irrigation of annual crops.



Question 8:

Do you have any specific concerns about the program?

	Count	Percent
No, I am willing to think about participating when I know more specifics	20	63%
Yes, I worry about negative economic impacts (to me or others)	6	19%
Yes, I worry about the impact of fallowing on the health of my land	6	19%
Yes, I'm opposed to putting water instream	0	0%
Other	4	13%
Valid N	32	

The majority of respondents expressed no specific concerns about the program and expressed willingness to consider participation. Positively, no one expressed concern with putting water instream. Small numbers of respondents cited economic impacts and land stewardship as areas of potential concern.