Chapter 3
Watershed Profiles

Developing a basin management plan requires understanding the nature and characteristics of the basin with which you are working. This chapter of the plan presents profiles of the Clark Fork River basin and each of its six watersheds. The profiles provide information describing the physical availability of water and address issues related to the legal availability of water.

Information presented in this chapter is based on currently available information and data that vary in age, accuracy, and depth. Gaps in information and knowledge discovered during development of the profiles are discussed at the end of this chapter.

Overview of Clark Fork River Basin

The Clark Fork River basin covers most of Montana's portion of the Columbia River basin, which drains the mountains and valleys of Montana west of the Continental Divide. It is a headwaters basin, meaning that almost all of the water leaving the basin originates within the basin.

For the purposes of this plan, the Clark Fork River basin has been divided into six smaller watersheds: Flathead River, Bitterroot River, Blackfoot River, Upper Clark Fork River, Middle Clark Fork River, and Lower Clark Fork River. Each of the watersheds is defined by the USGS gaging station that measures flows at its outlet point. Table 3.1 presents a brief description of each watershed, its sub-basins, and the gaging station used to define its outlet.

Figure 3-1

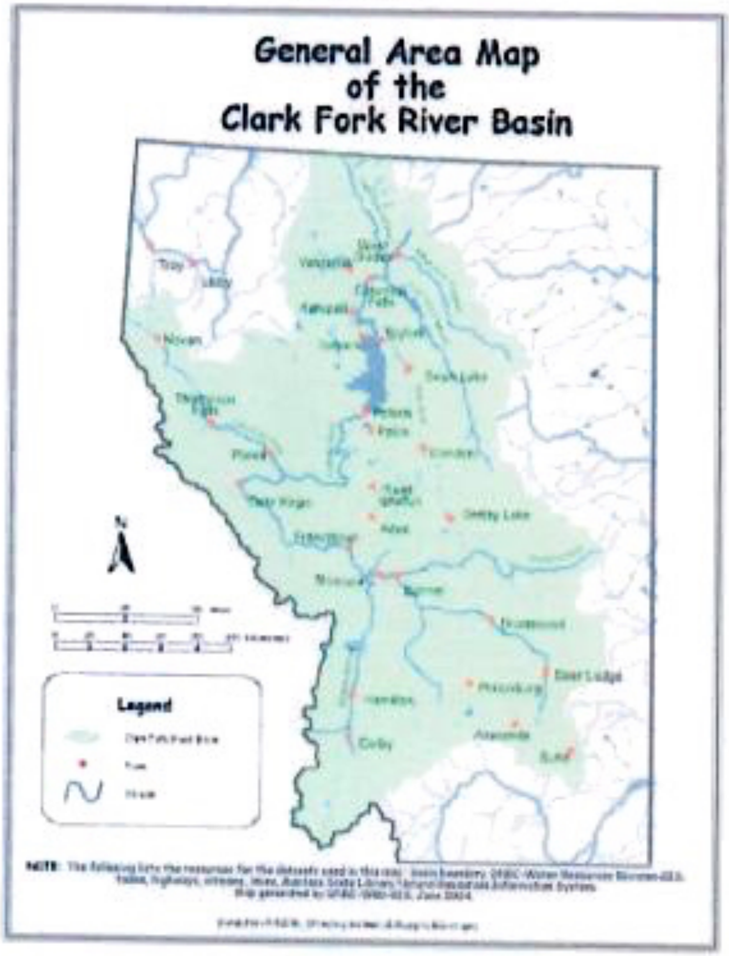

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Table 3-1 Watersheds of the Clark Fork River Basin

Watershed	Description	Sub-Basins	Representative USGS Gaging Station
Flathead River	Flathead River above confluence with Clark Fork River	• North-Fork Flathead, Stillwater, Flathead Lake (76LJ) • Middle Fork Flathead (76I) • South Fork Flathead (76J) • Swan (76IL) • Lower Flathead (76L)	12388700 Flathead River at Perma
Bitterroot River	Bitterroot River above confluence with Clark Fork River	• Bitterroot (76H)	12352500 Bitterroot River near Missoula
Blackfoot River	Blackfoot River above confluence with Clark Fork River	• Blackfoot (76F)	12340000 Blackfoot River near Bonner
Upper Clark Fork River	Clark Fork River above confluence with Blackfoot River	• Flint-Rock (76E, 76 GJ) • Upper Clark Fork (76G)	1234550 Clark Fork at Turah, Mt
Middle Clark Fork River	Clark fork River from its confluence with Blackfoot River to confluence with Flathead River	• Middle Clark Fork (76M)	12354500 Clark Fork at St. Regis
Lower Clark Fork River	Clark Fork River below confluence with Flathead River.	• Lower Clark Fork (76N)	12391400 Clark Fork below Noxon Rapids Dam near Noxon

Physical Availability of Water in the Clark Fork River Basin

Precipitation and Surface Water

The Clark Fork River near the Idaho border is the largest stream in Montana.[1] The physical availability of water in the basin is a function of a combination of natural and human factors. Climate and precipitation, geology, local and regional hydrology, and, of course, water use practices all affect the physical availability of water at any given point in the basin and in the basin as a whole.

Naturally, precipitation, geology, and drainage basin size are the major factors that determine the physical availability of water in the basin. The climate in the Clark Fork River basin is strongly influenced by moist air masses from the Pacific Ocean. This condition produces relatively abundant precipitation and mild winters compared to the rest of Montana, with occasional extended cold periods in winter and hot, dry periods in summer.[2] Precipitation in the Upper Clark Fork watershed averages around 28 inches a year, ranging from a low of less than 14 inches per year in the valleys to a high of over 100 inches per year in the mountains.*

The range in annual precipitation is reflected in the range of annual streamflows. Water leaving the basin is measured by the USGS gage in the Clark Fork River near Noxon. Here, annual streamflows have ranged from a low of 11,380 cfs in 1971 to a high of 31,979 cfs in 1997.# Over a 40-year period, the annual flows at this point averaged 20,504 cfs or 14,818,240 acre-feet.

Table 3-2 presents the average annual precipitation, drainage and watershed areas, and average annual streamflow for each watershed within the basin. Streamflows presented for the Lower Clark Fork River watershed represent the flows leaving the Clark Fork River basin.

Table 3-2 Watershed Precipitation, Area, and Streamflows

Watershed USGS Gage	Average Annual Precipitation[26] (inches)	Drainage Area[27] (sq miles)	Watershed Area (sq miles)	Average Annual Streamflow[27]		
				(cfs)	(af)	(years of record)
Flathead River 12388700	37.35	8,795	8,795	11,505	8,314,664	1984-2003
Bitterroot River 12352500	33.23	2,814	2,814	2,193	1,384,881	1990-2003
Blackfoot River 12340000	29.53	2,290	2,290	1,573	1,136,807	1940-2003
Upper Clark Fork River 12354500	28.11	3641	3641	1,206	873,300	1985-2003
Middle Clark Fork River 12354500	28.11	10,709	1,108	7,352	5,313,290	1911-2003
Lower Clark Fork River 12391400	36.79	21,833	2,329	20,504	14,818,240	1961-2000

The mountainous terrain and northern latitude of the basin combine to form snow-dominated precipitation and runoff regimes. This means that the majority of precipitation in the basin falls as snow in winter and early spring, with streamflows peaking in early summer after snowmelt has occurred. Low flows occur in early fall after the dry summer and in late winter before snowmelt has begun.

Natural streamflow patterns are affected by the cumulative impacts of all water uses occurring upstream. In many tributaries and in the upper reaches of the Clark Fork main stem, irrigation can dramatically reduce streamflows in the summer months, sometimes combining with natural factors to nearly deplete smaller streams in dry years. Depending on water use practices and local physical features, return flow from used water, especially flood irrigation, can augment late season natural flows. The construction of reservoirs, which capture part of the spring runoff and then release those waters later in the season, has further modified the basin's hydrology. Hungry Horse Reservoir and Kerr Dam (Flathead Lake) are the most significant. (The cumulative affect of such reservoirs in the greater Columbia River basin has significantly altered the natural hydrograph. Waters from Montana reservoirs are now currently released early in the season to mitigate these affects.)[3]

The Clark Fork River basin is also home to numerous ponds, lakes, and reservoirs. The basin contains 21 reservoirs with capacities greater than 5,000 acre-feet.[4] These reservoirs were constructed to provide water for irrigation, hydropower, and municipal water supply, and for flood control, but they also provide a means of regulating downstream flows. The largest of these are Hungry Horse reservoir on the South Fork Flathead River at almost 3.5 million acre-feet capacity, Flathead Lake on the Flathead River at 1.8 million acre-feet capacity, and Noxon Rapids on the Clark Fork at almost 500,000 acre-feet capacity.

Groundwater

Groundwater use within the Clark Fork River basin generally occurs within valleys filled with unconsolidated or poorly consolidated deposits between mountain ranges composed of relatively impermeable bedrock. The deposits in these valleys range from several hundred to several thousand feet thick. The valleys have perennial streams with recent floodplains adjacent to glacial deposits that extend up the mountain fronts. Often these mountain fronts are associated with faults or fault systems.[5]

Groundwater supplies in the Clark Fork River basin come from two basic types of aquifers: basin fill aquifers and fractured bedrock aquifers. Basin fill aquifers are typically found in valleys and can be either shallow and unconfined or deep and confined. These aquifers range from being very limited in extent and productivity, to highly productive and dependable. Fractured bedrock aquifers generally occur around valley margins and have relatively small water storage capacities with variable and typically low yields.[4]

Aquifer water supplies are recharged through the infiltration of water from precipitation, snowmelt, excess irrigation water, canal leakage, surface water streams, and other aquifers. An aquifer's water supply can be diminished by discharge to streams, evaporation, and withdrawals from pumping.

The largest uses of groundwater in the basin are for irrigation and public water supply, but most water for irrigation comes primarily from surface water sources. Most households in the basin rely on groundwater from wells or springs.[1]

Groundwater is growing in importance as a source of water supply in the basin. There are currently records of more than 58,000 wells in the Clark Fork River basin, 40% of which have been installed since 1990.[4] DNRC's water rights database identifies nearly 67,000 uses of groundwater in the basin. Of these, nearly 56,262 (97%) were developed after 1970. This reflects the changing land use trends, growth, and, to a decree, changes in water right record keeping process. Domestic, urban, and municipal uses—which are year-round rather than seasonal—account for 57% of these groundwater uses.

Surface water – Groundwater Interconnections

When surface water and groundwater are hydraulically connected, water can travel between a stream or other surface water body and the surrounding groundwater. For example, in a "losing reach" of a stream, the stream tends to leak water into the groundwater. In a "gaining reach," groundwater tends to seep into the stream. Aquifers act as natural storage sources that are recharged annually in varying degrees. Except for spring runoff, the majority of water in the streams of western Montana comes from groundwater discharge. Discharge to the streams is controlled by the water pressure or "head" in the aquifer. Reduced head results from withdrawal by wells and reduced recharge. Reduced head in the aquifer results in lower stream flows.

Pumping

Water uses can affect natural surface water-groundwater flow patterns in several ways. One way is by pumping water out of an aquifer that is hydraulically connected to a stream. About 40% of the wells in the Clark Fork basin tap into shallow alluvial (basin fill) aquifers and are located within one mile of a stream. For example, most of the wells in the Missoula Valley are developed in a highly productive aquifer that is recharged by the Clark Fork and Bitterroot rivers. Pumping these wells will intercept some of the groundwater that would otherwise discharge from the shallow aquifer to the stream. Depending on the location of a well, if pumping occurs hard or long enough, the water can actually be drawn from the stream and through the shallow aquifer to the well.[7]

Return Flows

Another way water use can affect surface water-groundwater interconnections is through irrigation return flows. Some portion of the water that is pumped from groundwater or diverted from surface water for irrigation will seep down through the soil profile and into the underlying groundwater. Seepage can occur through the sides and bottoms of irrigation ditches and canals or through the soil profile of irrigated fields. Seepage losses are greater through unlined conveyance systems and with flood-type irrigation systems where application of water in excess of plant consumption is common. Seepage water that makes it way back to a stream through the groundwater is called return flow. Though irrigation diversions reduce streamflows at the point and time of diversion, return flows augment streamflows further downstream and later in the year.

Flathead River Watershed

The Flathead River watershed covers 8,795 square miles of area drained by the Flathead River and its tributaries above its confluence with the Clark Fork River.[27] The lowest point of the watershed is defined by USGS gage 12388700 Flathead River at Perma.[27] This watershed is made up of seven smaller sub-basins: North Fork Flathead, Stillwater, and Flathead Lake (76LJ); Middle Fork Flathead (76I); South Fork Flathead (76J); Swan (76IL); and Lower Flathead (76L)[28].

The Flathead River watershed is defined by the Flathead River, with Flathead Lake being the most notable surface water body. Major tributaries in the basin include the North, South, and Middle forks of the Flathead River; Swan River; Jocko River; Stillwater River; Whitefish River; and Little Bitterroot River. The watershed is dominated by mountains and forests, but includes approximately 183,800 acres of irrigated lands in the valleys (USBR Remote Sensing Analysis). A map of the watershed is provided in Figure 3-4.

Figure 3-4 Flathead Watershed

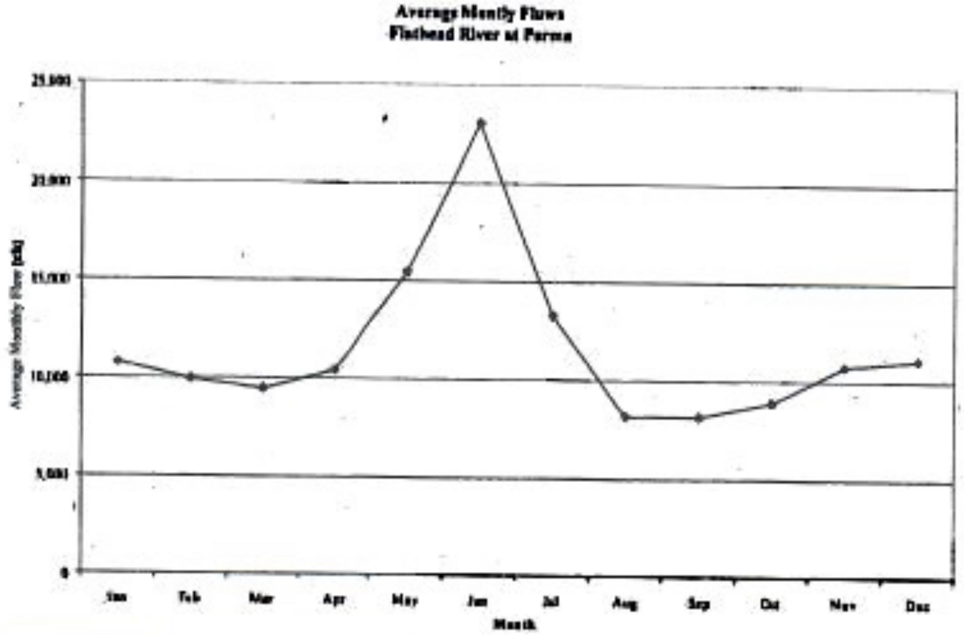
Physical Availability of Water in the Flathead River Watershed

Precipitation and Surface Water

Precipitation in the Flathead is the highest among watersheds in the Clark Fork River basin, averaging over 37 inches per year. Precipitation amounts vary over the watershed, with significantly more precipitation falling in the mountains in the form of snow.

The Flathead River is also the largest tributary of the Clark Fork River, contributing approximately 56% of the flow in the Clark Fork River where it leaves the state. An average of 11,505 cfs (8,314,664 acre-feet) flows out of the Flathead River watershed annually. Average monthly flows at the mouth of the watershed range from a high of 23,060 cfs in June to a low of 8,157 cfs in August. Flows in the Flathead River are regulated by Hungry Horse Dam on the South Fork Flathead River and to a lesser extent by Kerr Dam just south of Flathead Lake. These reservoirs serve to reduce high flows during spring runoff and substantially increase flows during typically low flow periods.[3] The average monthly flows of the Flathead River at Perma are illustrated in Figure 3-5. Several other small dams and reservoirs on the Swan River and Little Bitterroot River, and 17 reservoirs in the Flathead Irrigation Project affect flows locally.

Figure 3-5 Average Monthly Flows in the Flathead River at Perma



Groundwater

The aquifer systems in the Flathead River watershed are characterized by alluvial aquifers in the valleys with fractured bedrock aquifers at the valley fringes; however, the nature and combination of aquifer systems in each valley varies. The Kalispell Valley, north of Flathead Lake, has productive deep and shallow basin fill aquifers with more limited bedrock aquifers along the valley margins. The Mission Valley, south of Flathead Lake, contains thin, discontinuous basin fill aquifers that are not as productive or extensive as those in the Kalispell Valley.

The Montana Bureau of Mines and Geology Ground Water Assessment Program is completing a baseline assessment of the groundwater resources of the Flathead Lake area. This assessment will include information describing the hydrogeologic framework of the area, hydraulic characteristics of the aquifers, and aquifer recharge and discharge characteristics. This program uses wells of opportunity – existing wells – and therefore the assessment has limitations.

Existing Appropriations of Water in the Flathead River Watershed

Water rights records as of June 2004 show nearly 32,000 water use appropriations within the Flathead River watershed. The breakdown of appropriations among different water uses is presented in Table 3-7 below.

The vast majority of existing appropriators in the watershed are supplied by groundwater (24,000 uses). Surface water supplies more than 7,600 uses. Of these, 2,800 are for traditional irrigation.. As population in the valleys increase, new uses of groundwater also increase. For example, in the populated Flathead Lake sub-basin (76LJ), the number of residential uses of water far exceed that for irrigation.

Table 3-7 Water Use Appropriations Flathead Watershed

Purposes	Totals	Post 1970	Ground water	Surface Water
Agricultural Spraying	6	1	1	5
Commercial	794	551	686	108
Domestic	15762	12113	12984	2,778
Erosion Control	1	1	1	
Flood Control	1	0		1
Flow Through Fish Pond	1	1	1	
Fire Protection	26	9	15	13
Fish Raceways	54	11	32	22
Fisheries	93	92	50	43
Fish and Wildlife	325	208	129	196
Geothermal17		15	16	1
Geothermal Heating	16	10	10	
Industrial	122	61	81	41
Irrigation	4,301	1,700	1,494	2,807
Institutional15		13	15	
Irrigation - lawn and garden	3,781	1,571	3,452	329
Municipal	139	71	116	23
Multiple Domestic	701	600	663	38
Mining	8	2	5	3
Navigation	2	0		2
Other Purposes	26	26	12	14
Observation and Testing	1	1	1	
Pollution Abatement	3	2	2	1
Power Generation	50	13	9	41
Power Generation Nonconsumptive	1	0		1
Recreation	166	62	58	108
Storage	4	0		4
Stockwater	5,289	3,915	4,256	1,033
Wildlife	2	2	1	1
Wildlife & Waterfowl	20	20	4	16
Other	6	5	5	1
Total	31,727	21,533	24,077,	630

Diversionary Uses

Irrigation

The Flathead River watershed contains approximately 182,800 irrigated acres, which represents almost 40% of the irrigated land in the Clark Fork River basin. Over 115,000 acres lie in Lake County and below Kerr Dam. Based on the assumptions presented above, if all of these acres were fully irrigated, then irrigation in the watershed would divert close to 700,000 acre-feet and consume 350,000 acre-feet of water per year. Spread over the irrigation season, this volume of water would translate to a flow of roughly 2,470 cfs in diversions and consume 1,235 cfs.

Municipal and Residential

The Flathead River watershed includes all of Flathead and Lake counties, the northern portions of Missoula and Powell counties, and the eastern portion of Sanders County. Cities in the watershed include Whitefish, Columbia Falls, Kalispell, Polson, Evergreen, and Ronan. About 111,000 people live in the greater Flathead Lake area. All of the major communities (except Whitefish) and most rural residences in the region use groundwater for municipal and domestic water supplies.[28] The deep alluvial aquifers are the most utilized and generally the most productive aquifers in the watershed. However, use of the fractured bedrock aquifers is increasing, corresponding to the increase in residential development at valley fringes.[29] The Montana water rights database indicates 18,234 water rights for municipal and domestic uses. Groundwater sources service 80% (14,545) of these municipal and domestic uses.

Non-Diversionary Uses

Hydropower

Both Hungry Horse and Kerr dams are located within the Flathead River watershed. Hungry Horse is a USBR facility located on the South Fork Flathead River that is used primarily for flood control and power generation. Kerr Dam, owned by PPL Montana (formerly owned by Montana Power Company), is located on the Flathead River just downstream from Flathead Lake, which serves as its

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reservoir. This facility is used for power generation, flood control, and recreation. Both of these facilities provide significant amounts of storage and serve to regulate the flows of the Flathead and Clark Fork rivers, decreasing streamflows during naturally high flow periods and increasing flows during low flow periods. Additional hydropower facilities are located at Bigfork and Big Creek.

Instream Flows

DFWP has claimed Murphy Rights on several stream reaches within the Flathead River watershed. The reaches, priority dates, periods, flows, and volumes of these claims are presented in the Tables 3-8 through 3-11. In addition to these Murphy Rights, DFWP may have additional water right claims on selected streams, creeks, ponds, lakes, reservoirs, or swamps in the watershed.

Table 3-8 Murphy Right Claims on the Flathead River (filed under SB 76)

Reach	Priority	Period	Flow (cfs)
Flathead Lake to South Fork	12/22/70	8/1 – 4/15	3,500
		4/16 – 4/30	6,650
		5/1 – 7/15	8,125
		7/16 – 7/31	5,402
South Fork to Middle Fork	12/22/70	10/1 – 3/31	1,950
		4/1 – 4/15	2,100
		4/16 – 4/30	3,597
		5/1 – 7/15	5,000
		7/16 – 7/31	3,945
		8/1 – 9/30	2,100

Table 3-9 Murphy Right Claims on the Middle Fork Flathead River (filed under SB 76)

Reach	Priority	Period	Flow (cfs)
Mouth to Bear Creek	12/22/70	8/1 – 4/15	850
		4/16 – 4/30	1,831
		5/1 – 7/15	2,125
		7/16 – 7/31	1,904
Bear Creek to Cox Creek	12/22/70	10/1 – 3/31	75
		4/1 – 9/30	180

Table 3-10 Murphy Right Claims on the North Fork Flathead River (filed under SB 76)

Reach	Priority	Period	Flow (cfs)
Middle Fork to Bowman Creek	12/22/70	10/1 – 3/31	987.5
		4/1 – 4/15	1,400
		4/16 – 4/30	1,766
		5/1 – 7/15	2,625
		7/16 – 7/31	2,041
		8/1 – 9/30	1,400
Bowman Creek to Border	12/22/70	10/1 – 3/31	625
		4/1 – 4/15	750
		4/16 – 4/30	1,100
		5/1 – 7/15	1,500
		7/16 – 7/31	1,279
		8/1 – 9/30	750

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Table 3-11 Murphy Right Claims on the South Fork Flathead River (filed under SB 76)

Reach	Priority	Period	Flow (cfs)
Hungry Horse Reservoir to Powell/Flathead County Line	12/22/70	10/1 – 3/31	600
		4/1 – 4/15	700
		4/16 – 4/30	1,180
		5/1 – 7/15	1,750
		7/16 – 7/31	943
		8/1 – 9/30	700
Powell/Flathead County Line to Headwaters	12/22/70	4/1 – 9/30	270
		10/1 – 3/31	100

The assessment of existing appropriations in the Flathead River watershed, and indeed the entire Clark Fork River basin, is complicated by the unquantified prior water rights of the Confederated Salish and Kootenai Tribes (CSKT) on and potentially off of the Flathead Reservation. The CSKT claim rights not only on the reservation, but for fishing and hunting off the reservation (instream flows) everywhere in Montana west of the continental divide. Their water rights are senior to those of everyone else in the basin, and that seniority applies to their future as well as past and present uses. In other words, CSKT may want to develop and consume some additional water that could come at the expense of existing water users, or they may desire to commit a greater share of their rights to instream flow protection. Recent Montana Supreme Court decisions extended the Tribes' right not just to surface water, but also to groundwater. However the water rights of CSKT are eventually quantified, they will have an enormous impact on the legal availability of water to present and future water users.[31]

Water Available for Future Use in the Flathead River Watershed

Surface Water

As with the larger basin, water available for future use in the Flathead River watershed could be dictated by hydropower water rights. The 14,540 cfs turbine capacity at Kerr and the 8,900 cfs turbine capacity at Hungry Horse are of sufficient size to utilize all of the average annual flows of the rivers upon which they are located. The study evaluating the effects of irrigation on hydropower by Cunningham et al.[32] indicated that power generation at facilities with significant storage, such as Kerr and Hungry Horse, is reduced with increasing levels of upstream irrigation. This information suggests that water availability for new surface water development would be limited by existing hydropower water rights in the watershed. This is compounded by limitations presented by Avista's water rights at Noxon Rapids dam as discussed above. Local water shortages have led to small administrative rule closures in Walker Creek, tributary to the Whitefish River, and Truman Creek, tributary to Ashley Creek.

Groundwater

A preliminary water use study of the Upper Flathead Basin by RLK Hydro[33] indicated that unappropriated water exists in all four sub-basins within the watershed. The study also found that 98% of existing appropriations, by volume, are for surface water including hydropower, instream flows, and consumptive uses. Future appropriations are likely to emphasize development of groundwater resources. Information collected by MBMG suggests that sufficient water is available to allow for continued development of shallow aquifer systems in the watershed, but that these resources are susceptible to contamination. The deeper aquifers also appear to contain sufficient water for continued development, but they are becoming more vulnerable to drought.[34]

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Projected Demand for Future Water Use in the Flathead River Watershed

Municipal and Residential

Population growth in the Flathead area has been significant, averaging 2.4% a year over the past 10 years. The population of the area is currently over 111,000 people and is expected to continue growing into the foreseeable future. If the population continues to grow at its current rate, then the Flathead River watershed will have a population of over 137,000 people by the year 2020. At the relatively high water use rates exhibited in Missoula County (400 gpd), the added population would require an additional 11,677 acre-feet of water per year, which would translate into a flow rate of about 16 cfs. The preliminary water use study by RLK Hydro[11] indicated that future appropriations for residential uses are likely to emphasize development of groundwater resources.

Irrigation

The RLK study indicated that all of the potential agricultural soil is located in the Central Flathead River Valley, an area of 270,000 acres. Currently the basin contains approximately 179,000 irrigated acres. The percentage of the remaining un-irrigated agricultural lands that could be logistically or economically irrigated is unknown. The RLK study found that the rate of new appropriations for agriculture have been declining for approximately 20 years. DNRC records indicate that agricultural development, in terms of number of rights being developed, has been in the range of 1,000-2,200 new uses per decade during the period of 1970 to 2004, although size of these appropriation and size of irrigated parcels may be smaller than pre-1970 agriculture developments.

Bitterroot River Watershed

The Bitterroot watershed covers the 2,814 square miles drained by the Bitterroot River above its confluence with the Clark Fork River.[27] The watershed is formed by the Bitterroot Mountains to the west and the Sapphire Range to the east. The lowest point in the watershed is defined by USGS gage 12352500 on the Bitterroot River near Missoula.[27] This watershed is also identified as Montana Hydrologic Sub-Basin 76H. The Bitterroot River is fed by the West Fork and East Fork above Darby. Painted Rocks Lake and Lake Como are the largest reservoirs in the watershed.

The 60-mile long Bitterroot Valley averages around 7 miles wide and covers an area of about 430 square miles. Running down the middle of the valley is the 1- to 2-mile wide floodplain of the Bitterroot River. Extensive high benches ranging from 3 to 6 miles in width run along the east and west slopes of the valley.[3] A map of the watershed is provided in Figure 3-6.

Figure 3-6

Physical Availability of Water in the Bitterroot River Watershed

Precipitation and Surface Water

Precipitation in this watershed averages 33 inches per year,[31] most of it in the form of snowfall, with greater totals in the higher elevation south.[3] Streamflows leaving the Bitterroot River watershed average 2,193 cfs (1,584,881 acre-feet)[27] annually. Average monthly flows range from a high of 8,525 cfs in June to a low of 889 cfs in September. Figure 3-6 shows the average monthly flows in the Bitterroot watershed. Streamflows in the Bitterroot are regulated, in part, by Painted Rocks Lake

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