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SECTION 2.0 CONSUMPTIVE AND ENVIRONMENTAL & RECREATIONAL NEEDS

This chapter provides an overview of the YWG Basin's M&I, energy, agricultural, and environmental and recreational needs. The majority of information presented in this chapter was developed through a series of State and basin-wide studies. A summary on each of these studies is provided in Appendix A along with a comprehensive overview of the 2014 Projects and Methods Study (P&M Study), which is the most up-to-date study conducted on the YWG Basin. The P&M Study incorporates current and future water demand projections to evaluate water supply needs, shortages, in-stream flows, and impacts that IPPs may have on the YWG Basin. A large portion of information presented in this chapter and in this BIP originates from this study. This chapter summarizes the most up-to-date information on the YWG Basin's water needs while also disclosing water demands incorporated into the BIP modeling effort. Future YWG Basin planning studies will continue to assess and update water demands accordingly.

2.1 M&I NEEDS

To portray the water needs of growing populations, the M&I demand forecast reflects typical municipal system water needs. Large industrial or SSI water usage depicts economic growth within the state. M&I and SSI demand terminology used throughout this report is defined in Table 2-1 below.

Table 2-1 Definitions of M&I and SSI Demand Terms

Demand Terminology	Definition
M&I Demand	Water use of typical municipal systems: residential, commercial, light industrial, landscape irrigation and firefighting
SSI Demand	Large industrial water users that have their own water supplies or lease raw water from others: mining, manufacturing, snowmaking, thermoelectric power generation (coal and natural gas facilities) and energy development
M&I and SSI Demand	The sum of M&I and SSI demand

Source: Yampa-White Basin Needs Assessment Report, 2011

A variety of studies have been completed that analyze M&I and SSI water needs in the YWG Basin. These studies evaluate current and forecasted water use and assess water supply gaps. These studies include (citations can be found in Section 1 Table 1-1):

- SWSI 2004 and 2010
- 2011 Yampa-White Basin Needs Assessment
- 2012 CRWAS
- 2014 P&M Study
- 2011 Energy Development Water Needs Assessment Phase II and 2014 Update

Most of these studies have evaluated M&I and SSI water needs on a county or regional basis. The most recent study, the P&M Study, provides a summary of the YWG Basin's M&I and SSI consumptive needs using the previous reports, but it also evaluated M&I and SSI demands on a more detailed scale, i.e., on a model node basis rather than county level. The discussion that follows regarding M&I and SSI needs, both current and future, will focus on results of the P&M Study.

2.1.1 Current M&I Needs

The YWG Basin is characterized by large areas that are rural and agricultural in nature, with low population density. Therefore, M&I demands are smaller compared to agricultural demands in the YWG Basin. Municipal demands are focused near the population centers of Craig (Moffat County), Meeker (Rio Blanco County), and Steamboat Springs (Routt County). The SWSI 2010 county-level values that formed a basis for the P&M Study's more detailed analysis are shown in Table 2-2. These values reflect M&I demands (as of 2008).

Table 2-2 Current M&I Demands, County-level

County	Water Demand (AFY)
Moffat	3,200
Rio Blanco	2,000
Routt	6,500
Total	**12,000**

Source: P&M Study, 2014.

As described in more detail in Appendix A, the P&M Study used the SWSI 2010 and Basin Needs Assessment Report county-level demands and applied them to specific model nodes in the 2009 release of the Yampa and White Basins StateMod models. Table 2-3 presents current M&I demands at each model node, grouped by county[1]. The demands at the model nodes for Moffat and Rio Blanco counties were used in both the P&M Study and BIP updated modeling effort. The demands in Routt County were updated for purposes of the BIP modeling per recommendations from Mt. Werner Water and Sanitation District.

Table 2-3 Current M&I Demands, Model node

Diversion Name	Current Average Annual Water Demand[1] (Diversions) (AFY)
Moffat	
Craig Water Supply Plant (440581)	2,200
District 44 Existing M&I (44_AMY001)	740
District 55 Existing M&I (55_AMY003)	10
Moffat County Total	**2,950**
Rio Blanco	
Rangely Water (430889)	1,710
Meeker Demand (950810)	370
District 43 Existing M&I (43_AMW001)	1,100
Rio Blanco County Total	**3,180**
Routt	
District 57 Existing M&I (above Craig) (57_AMY001)	480
District 58 Existing M&I (Steamboat Springs) (58_AMY001)	1,340

[1] Amounts presented are diversion amounts.

Diversion Name	Current Average Annual Water Demand[1] (Diversions) (AFY)
Fish Creek Municipal Intake (580642)[2]	2,310
Steamboat Well A (585055)[3]	300
Mt Werner Well G (586140)[3]	90
Mt Werner Well H (585059)[3]	210
Routt County Total	**4,730**
Total	**10,860**

Source: P&M Study, 2014. Mt. Werner Water and Sanitation District provided updated demands, since the P&M Study, at the Fish Creek Municipal Intake, Steamboat Well A, Mt Werner Well G and Mt Werner Well H nodes.
[1]Amounts presented are diversion amounts.
[2]The Fish Creek Municipal Intake (580642) includes Fish Creek direct flow rights (1892) that are pre-1922 with Fish Creek Reservoir storage rights (1946, 1964, 1996).
[3]The Steamboaot Well A, Mt Werner Well G and Mt Werner Well H include Yampa wellfield rights (1977, 1992) that are post-1922 and that seasonally pump about 600 AFY.

Figure 2-2 below shows a spatial representation of the current M&I demands and thermoelectric water demands on a model node basis as presented in the P&M Study and BIP modeling efforts.

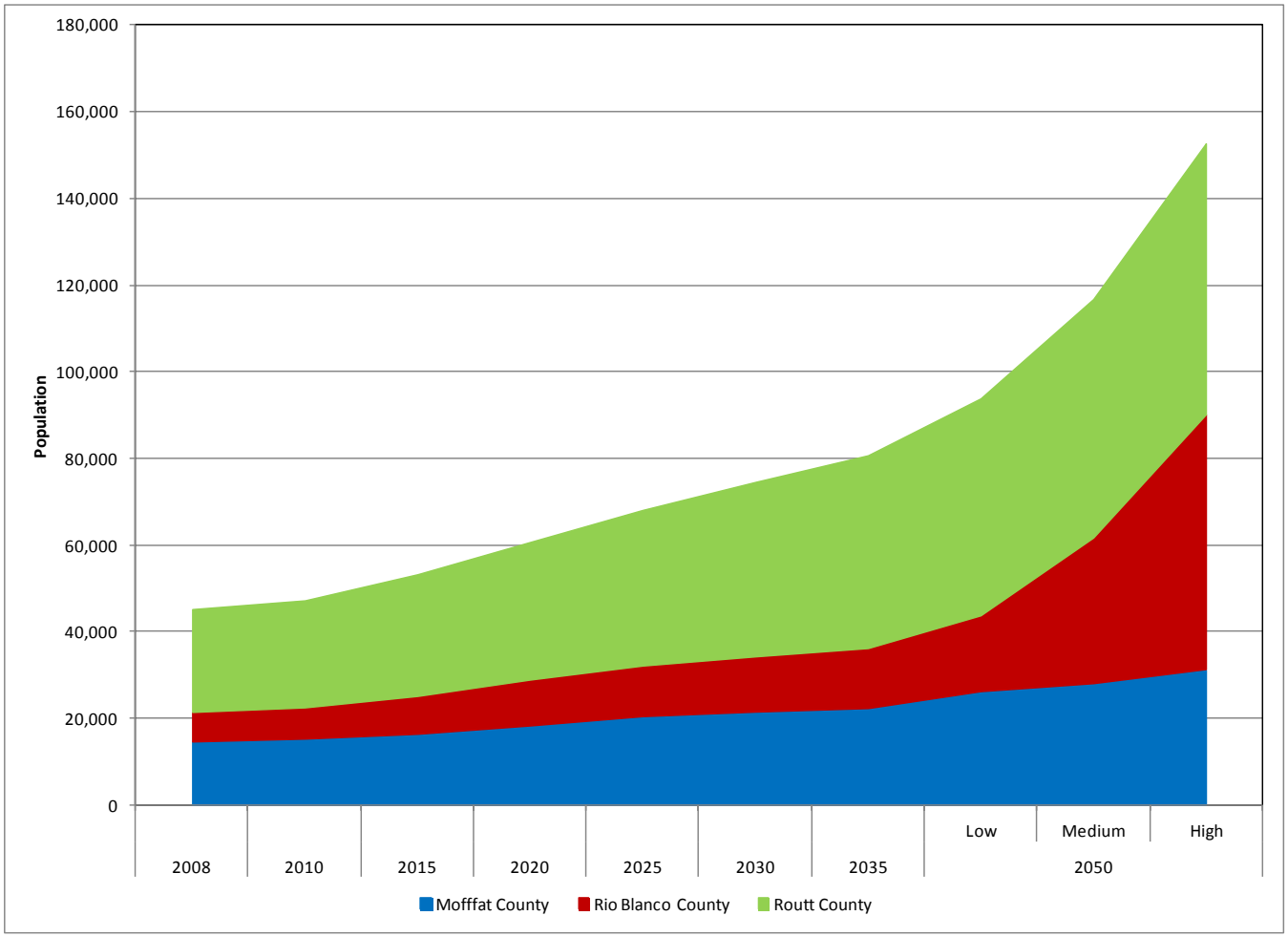
2.1.2 Future M&I Needs

To estimate future M&I needs, SWSI 2010 used a water planning horizon extending to 2050. The SWSI 2010 and Basin Needs Assessment Report estimates also include passive conservation, and were developed for low, medium and high demand categories. Passive conservation mainly reflects water demand reductions due to policy measures such as those requiring manufacture of more efficient toilets, washing machines and dishwashers and the subsequent installation, or retrofit, of these appliances into existing housing and commercial buildings.

The YWG Basin BIP Subcommittee chose the high demand, low supply scenario from the P&M Study to be analyzed; therefore, only the future high demand analyzed; therefore, only the future high demand results are discussed below. As shown in Source: State of Colorado 2050 Municipal & Industrial Water Use Projections (CWCB 2010c)

Figure 2-1, for the high economic growth scenario, the population in the YWG Basin is expected to more than triple by the year 2050. The high population growth scenario includes a 550,000 barrel per day oil shale industry[2] . Population growth attributed to the oil shale industry is especially evident in Rio Blanco County after 2035. The oil shale industry is discussed further in Section 2.2 SSI Needs.

[2] State of Colorado 2050 M&I Water Use Projections (CWCB 2010c)



Source: State of Colorado 2050 Municipal & Industrial Water Use Projections (CWCB 2010c)

Figure 2-1 Population Projections through 2050

As shown in Table 2-4 below, even with passive conservation, the M&I demands are predicted to more than triple as well.

Table 2-4 Future M&I Demands, County-level

County	Current Population	Current Water Demand (AFY) 2008	Future Population 2050 High	Water Demand with Passive Conservation (AFY) 2050 High[1]
Moffat	14,600	3,200	31,000	6,400
Rio Blanco	6,700	2,000	59,000	17,000
Routt	23,800	6,500	63,000	16,000
Total	**45,100**	**12,000**	**153,000**	**39,400**

Source: P&M Study, 2014; Yampa-White Basin Needs Assessment Report, 2011; SWSI 2010

Table 2-5 presents future M&I demands at each model node, grouped by county. The demands at the model nodes for Moffat and Rio Blanco counties were used in both the P&M Study and BIP updated modeling effort. The

demands in Routt County were updated for purposes of the BIP modeling per recommendations from Mt. Werner Water and Sanitation District.

Table 2-5 Future M&I Demands, Model node

Diversion Name	Future Water Demand (AFY) 2050 High
Moffat	
Craig Water Supply Plant (440581)	5,350
District 44 Existing M&I (44_AMY001)	740
District 55 Existing M&I (55_AMY003)	10
Moffat County Total	**6,100**
Rio Blanco	
Rangely Water (430889)	10,610
Meeker Demand (950810)	2,290
District 43 Existing M&I (43_AMW001)	4,120
Rio Blanco County Total	**17,020**
Routt	
District 57 Existing M&I (above Craig) (57_AMY001)	4,250
District 58 Existing M&I (Steamboat Springs) (58_AMY001)	6,270
Fish Creek Municipal Intake (580642)[1]	3,850
Steamboat Well A (585055)[1]	825
Mt Werner Well G (586140)[1]	250
Mt Werner Well H (585059)[1]	575
Routt County Total	**16,020**
Total	**39,140**

Source: P&M Study, 2014.
[1] Updated demands since the P&M Study were provided by Mt. Werner Water and Sanitation District at the District 58, Existing M&I, Fish Creek Municipal Intake, Steamboat Well A, Mt Werner Well G and Mt Werner Well H nodes.

Figure 2-3 below shows a spatial representation of the future M&I demands, and thermoelectric demands, on a model node basis, as used the modeling update for the BIP.

2.2 SSI NEEDS

Water is a necessary component for self-supplied industries in Colorado such as mining, manufacturing, food processing, power generation and energy development and is therefore an integral part of these important drivers of the state economy. In fact, the YWG Basin is the only basin in the state where SSI water needs exceed M&I water needs. The SSI subsectors are diverse and are categorized in the following groups for the BIP:

- large industrial
- thermoelectric power generation
- energy development

SSI needs have been analyzed in the same reports mentioned above for M&I and results indicate that currently, the largest SSI water demand in the YWG Basin is for thermoelectric power. However, due to the potential for energy resource development in northwest Colorado, and the concern that traditional water uses in the YWG Basin such as agriculture and recreation could be impacted if large energy industries develop, specific studies have been completed that analyze associated energy water needs in the area. Previous studies, found in Table 1-1, developed for the Colorado and YWG Basin include:

- Energy Development Water Needs Assessment Phase I
- Energy Development Water Needs Assessment Phase II
- Energy Development Water Needs Assessment Phase III

The P&M Study and Energy Development Water Needs Assessments represent the most recently completed analyses of current and future SSI water needs. Results from these studies are presented below

2.2.1 Current SSI Needs

Large Industrial

Large industrial demands in the YWG Basin, such as snowmaking demands for the Steamboat Springs Ski Resort, Twenty-mile Mine in Routt County, Trapper Mine in Moffat County, and golf courses in Routt County compose a sizable portion of the demands outside of the typical municipal demands and are therefore categorized separately. For example, Rollingstone Ranch Golf Course (a.k.a. Sheraton Starwood) diverts an average of 115 AFY (max 144 AFY) under a limited lease on a fraction of the Mt. Werner Water District's 5.8 cubic feet per second (cfs) Hoyle & Knight water right (1892). Large industrial demands presented in SWSI 2010, the Basin Needs Assessment Report and the P&M Study are shown in Table 2-6 below. With exception to snowmaking at Steamboat Springs Ski Resort, the P&M Study and the BIP do not include current large industrial demands in the modeling effort.

Table 2-6 Current Large Industrial Demands, County-level

County	Water Demand (AFY)
Moffat	2,600
Rio Blanco	0
Routt	3,800
Total	**6,400**

Source: P&M Study, 2014.

Thermoelectric Power Generation

Despite a mandate requiring 20 percent of the state's electricity to be provided by renewable energy resources by 2020, demand for coal-fired and natural gas energy production will continue into the foreseeable future. In the YWG Basin, two thermoelectric power generation facilities exist – the Craig Station in Moffat County operated by Tri-State and the Hayden Plant in Routt County operated by Xcel Energy. The current county-level water demands for thermoelectric power generation from SWSI 2010 and the Basin Needs Assessment Report are presented in Table 2-7.

Table 2-7 Current Thermoelectric Power Generation Demands, County-level

County	Water Demand (AFY)
Moffat	17,500
Rio Blanco	0
Routt	2,700
Total	**20,200**

Source: P&M Study, 2014.

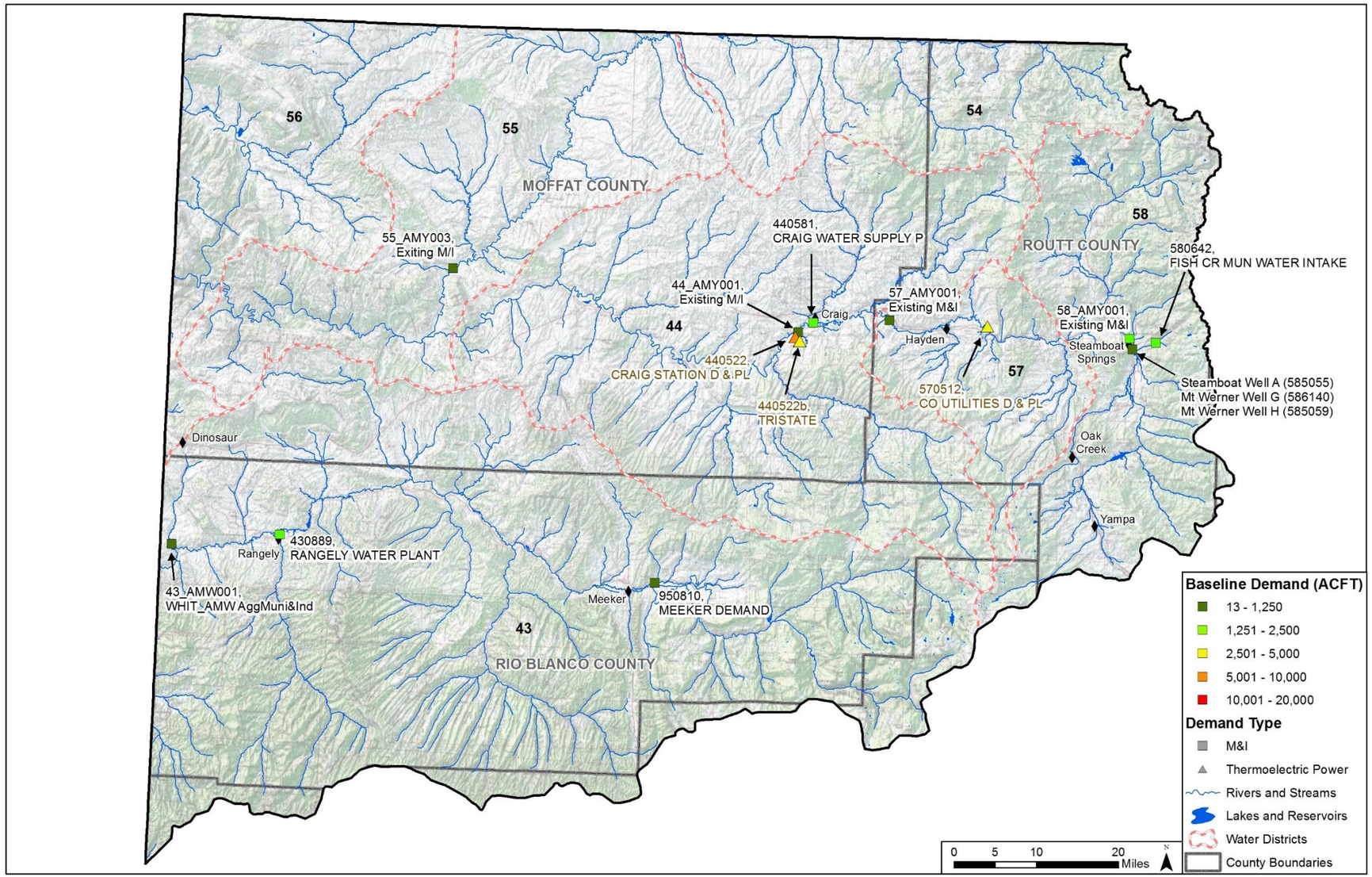
In the P&M Study, the county-level demands were distributed to the two existing thermoelectric power generation facilities in the basin, using a methodology similar to that used for M&I demands (described in more detail in Appendix A). These results are shown in Table 2-8 and were used in the updated BIP modeling.

Table 2-8 Current Thermoelectric Power Generation Demands, Model Node

Diversion Name	Average Annual Simulated Diversion (AFY)
Moffat	
CRAIG STATION D & PL (Units 1&2) (440522)[1]	9,340
Tri-State (Unit 3) (440522b)[1]	4,670
Moffat County Total	**14,010**
Routt	
COLO UTILITIES D & PL (Hayden Station) (570512)	4,890
Routt County Total	**4,890**
Total	**18,900**

Source: P&M Study, 2014.
[1] The water demand for the Moffat County nodes has been updated since the P&M Study per input from Tri-State.

Figure 2-2 shows a spatial representation of the current M&I and thermoelectric water demands on a model node basis.



Source: P&M Study, 2014. Note: This figure has been updated to reflect the updated SSI and M&I demands provided in Tables 2-3 and 2-8.

Figure 2-2 Baseline M&I and Thermoelectric Power Generation Demands

Energy Development

Studies have been completed that evaluate the current and future water requirements of various energy development sectors in northwest Colorado, in particular for the natural gas, uranium, coal and oil shale industries. Some components of the water needs are included in the M&I and thermoelectric power generation demands discussed above, but direct demands for oil shale development, which includes the water required for construction, operation, production and reclamation, are included in a separate category.

2.2.2 Future SSI Needs

Large Industrial

The modeling effort for the P&M Study and BIP do not evaluate future large industrial need with exception to snowmaking at Steamboat Ski Resort.

Thermoelectric Power Generation

Since thermoelectric power demands are related to needs of the population served, it will trend in a similar manner to changes in population and the associated M&I demands. County-level thermoelectric future (high demand) needs from SWSI 2010 and the Basin Needs Assessment Report are shown in Table 2-9.

Table 2-9 Future Thermoelectric Power Generation Demands, County-level

County	Current Water Demand (AFY) 2008	Water Demand with Passive Conservation (AFY) 2050 High
Moffat	17,500	26,900
Rio Blanco	0	0
Routt	2,700	17,100
Total	**20,200**	**44,000**

Source: P&M Study, 2014.

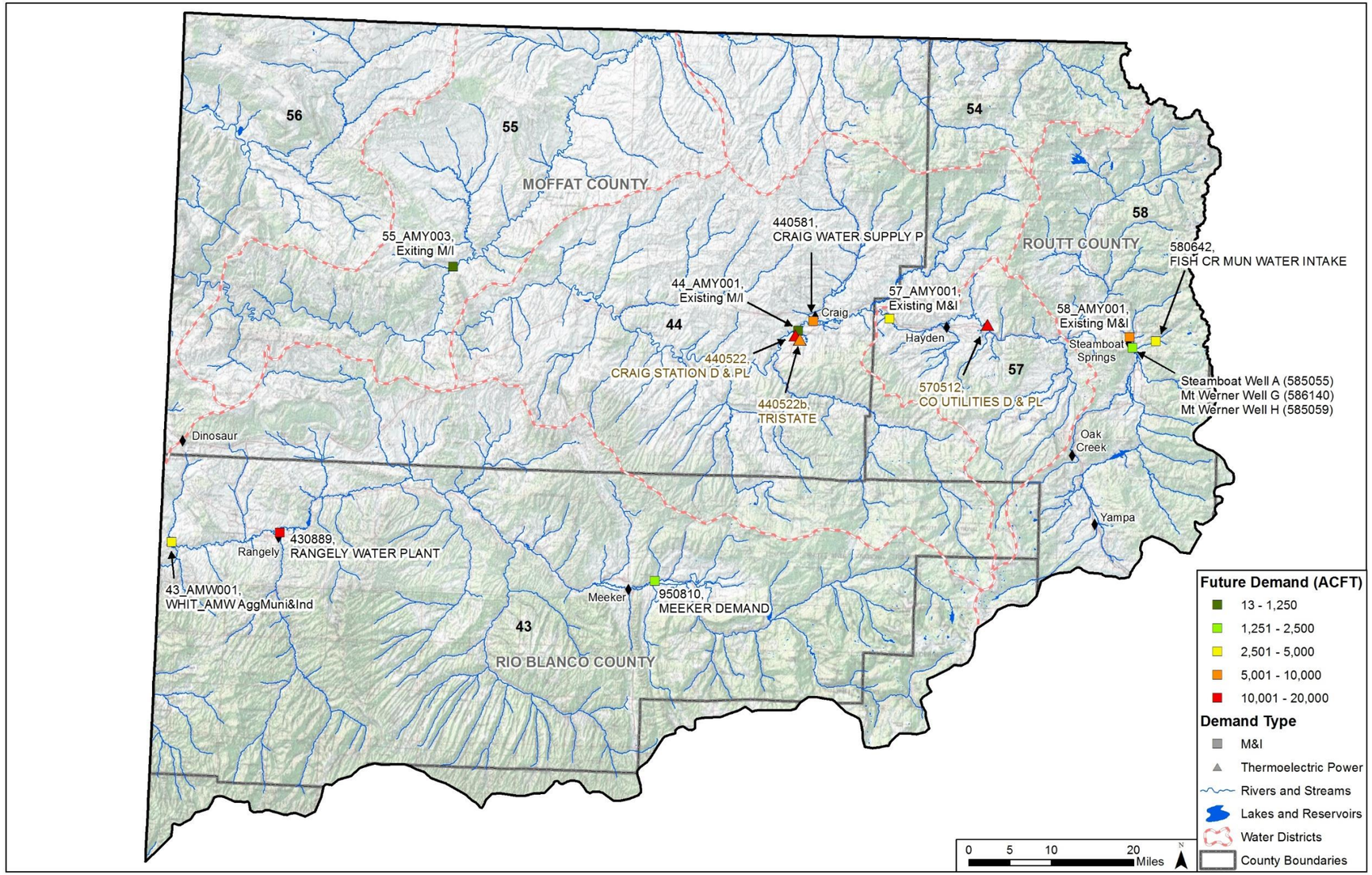
Results for future thermoelectric demands from the P&M Study based on model nodes are shown in Table 2-10. These demands were used in both the P&M Study and updated modeling for the BIP.

Table 2-10 Future Thermoelectric Power Generation Demands, Model node

Diversion Name	Future Water Demand (AFY) 2050 High
Moffat	
CRAIG STATION D & PL (Units 1&2) (440522)	17,930
Tri-State (Unit 3) (440522b)	8,970
Moffat County Total	**26,900**
Routt	
COLO UTILITIES D & PL (Hayden Station) (570512)	17,100
Routt County Total	**17,100**
Total	**44,000**

Source: P&M Study, 2014.

Figure 2-3 below shows a spatial representation of the future M&I demands and thermoelectric demands used for the BIP modeling update on a model node basis.



Source: P&M Study, 2014. Note: This figure has been updated to reflect the updated M&I demands provided in Table 2-5.

Figure 2-3 Future M&I and Thermoelectric Power Generation Demands

Energy Development

The Energy Development Water Needs Assessment Studies estimated water uses associated with the development of the four energy sectors of natural gas, oil shale, coal, and uranium. The water uses include direct demands, water supplies serving the operations, construction, processing, and reclamation purposes; indirect demands, attributed to the municipal and domestic water supplies required by the growth in population associated with the development of the resources; and water uses for thermoelectric power generation, power supplies for the new population growth and a portion of the industrial power requirements. The Energy Development SSI water uses includes only the direct uses associated with each energy sector. The indirect uses are included in the M&I estimates and the thermoelectric demands are included in SSI thermoelectric demands as discussed above.[3]

The recently completed Energy Development Water Needs Assessment Study Phase III reviewed and updated the direct water uses for energy development. The Phase III study carries forward the Phase I water use estimates for the coal and uranium sectors (because there is no new information or development prospects in those sectors) and updates water use estimates for the oil shale and oil and gas sectors. Since the Phase II report was published, both Chevron and Shell have ended their oil shale research projects in Colorado. The National Oil Shale Association markedly reduced water use estimates mainly because the large in situ projects proposed by Chevron and Shell were discontinued. Therefore, the Phase III reports new water use estimates for oil shale. Additionally, the Phase III report updates the direct water uses associated with oil and gas well drilling and completions since new information on drilling activity and resource development planning is available since 2008.

Table 2-11 Future Energy Sector Development Direct Demand Forecast

Energy Sector	Water Demand Levels (AFY) 2050 High Production
Natural Gas and Oil	6,000
Uranium	130
Coal*	6,000
Oil Shale	76,000
Total	**88,000**

Source: Energy Development Water Needs Assessment Study Phase III, 2014.
*Updated with information from Peabody Coal feasibility planning for Peabody-Trout Creek water supply project.

The P&M Study and updated BIP modeling did not include evaluation of the small and nearly insignificant water demands associated with uranium development. For the water supplies associated with oil and gas, the P&M Study indicates that "demands will not be met through direct diversion rights" and did not model those uses. Nonetheless, water supplies for drilling and well completion will, in part, come from tributary sources[4].

The P&M Study and updated BIP modeling included a water supply project for the coal energy sector based on updated information developed in the Peabody-Trout Creek water supply feasibility studies[5]. The work focused on a water storage project on Trout Creek upstream of the confluence with the Yampa River. This project will be developed to help Peabody Energy meet 6,000 AFY of energy development demands as part of the Peabody-Trout Creek Project.

[3] Oil shale development direct demands include water supplies for electrical generation as required for the electrical heating in situ commercial technologies.
[4] Energy Development Water Needs Assessment Update Phase III, 2014
[5] (Peabody 2014)

The P&M Study and updated BIP modeling did not re-evaluate direct water demands associated with a commercial oil shale industry yet carried forward the evaluations of oil shale water supplies developed in the Energy Development Water Needs Assessment Phase II report.

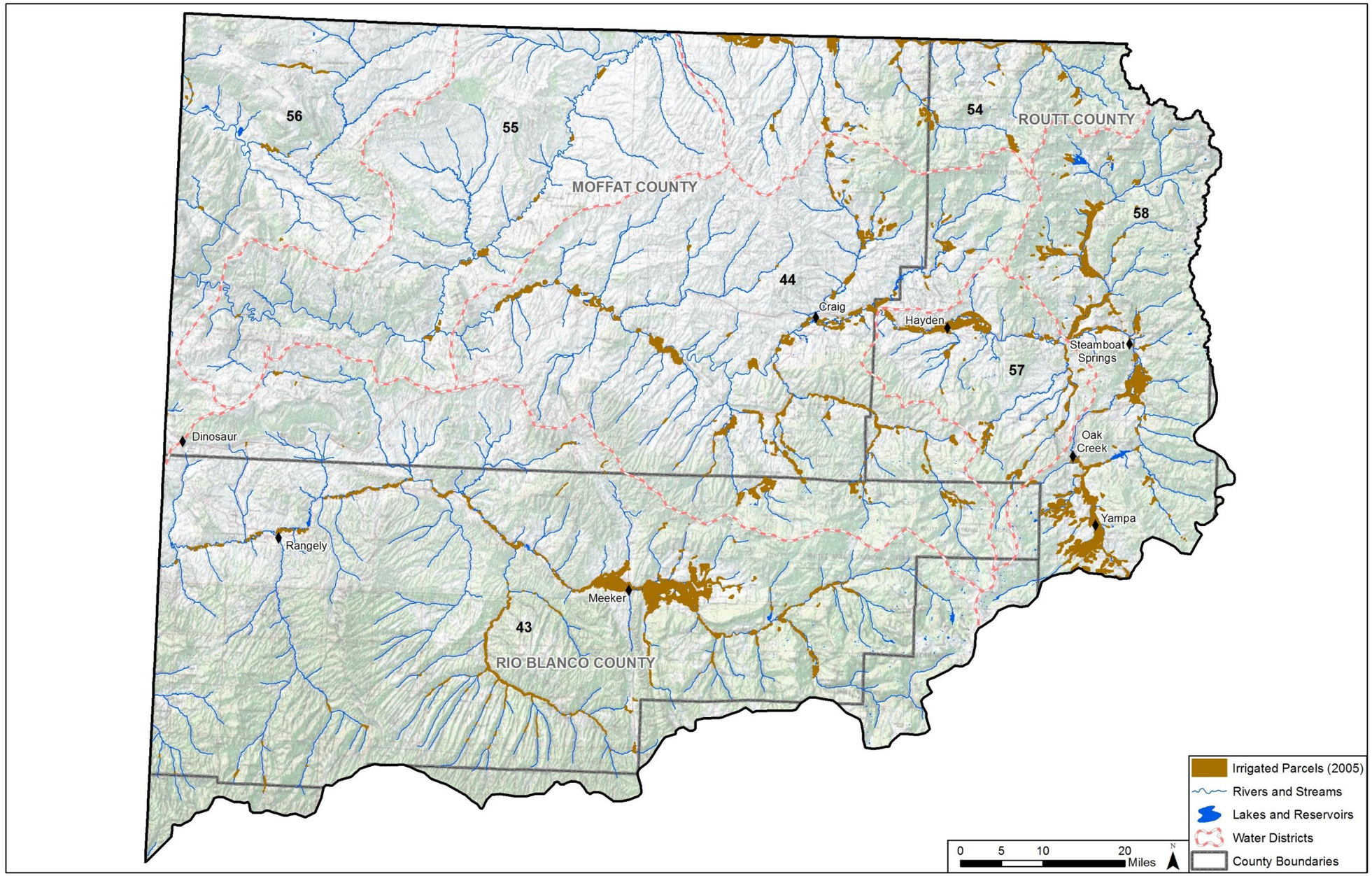
2.3 AGRICULTURAL NEEDS

2.3.1 Current Agricultural Needs

Irrigated Acreage

Irrigated acreage in the YWG Basin has varied over the past several decades, fluctuating between approximately 86,000 and 119,600[6] acres in the Yampa and Green Basins while irrigation in the White Basin has remained relatively stable. Figure 2-4, shows the total irrigated acres in the YWG Basin. The most recent estimates of irrigated acreage indicates that there is a total of 100,900 irrigated acres in the YWG Basin, of which 27,500 acres are in the White Basin, and 73,400 acres are in the Yampa and Green Basins.[7] Almost all of the acreage is irrigated with surface water; groundwater pumping in the YWG Basin is minor relative to surface water diversions. The irrigation demands in the Agricultural Water Needs Study, the P&M Study and updated BIP modeling were based on the irrigated acreage from 1993 totaling 119,607 acres, however.

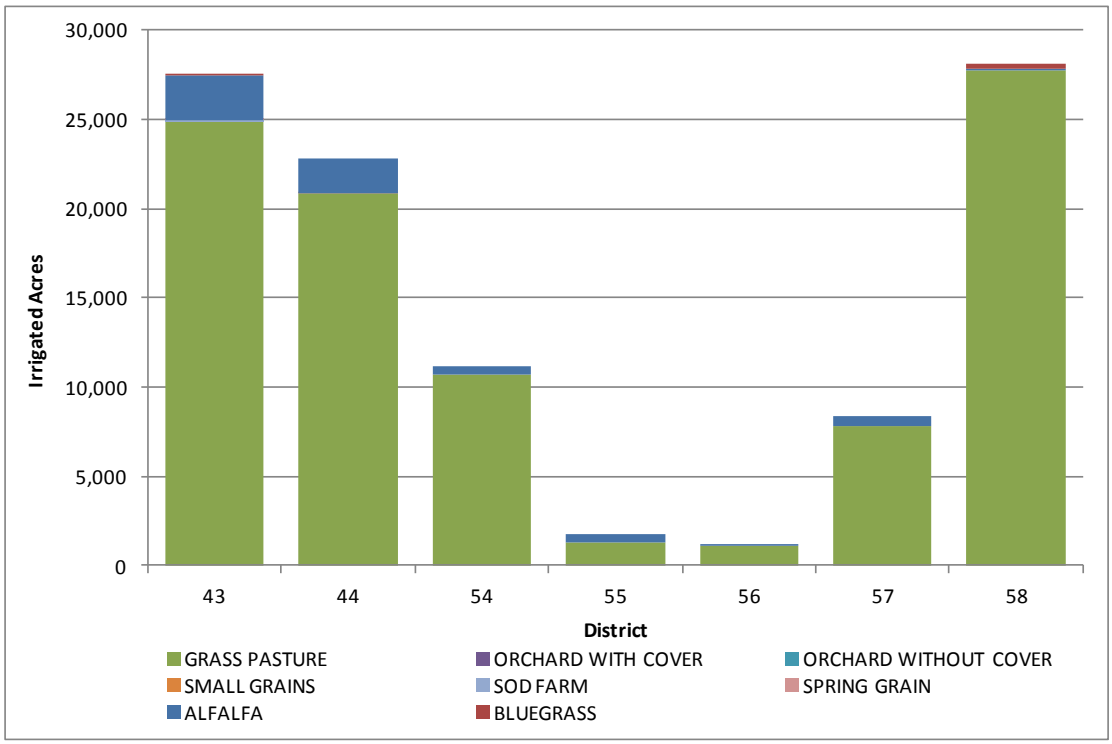
[6] Agricultural Water Needs Study, 2010.
[7] This is based on the CDSS 2005 spatial Geographic Information Systems (GIS) coverage of the irrigated areas in the Basin. (CDSS 2005)



Source: (CDSS 2005) GIS irrigated acres.

Figure 2-4 Current Irrigated Acres

Figure 2-5 shows the irrigated acres by crop type for each water district. District 58 has the greatest amount of irrigated acres followed by District 43 and District 44. The majority of crops grown in the YWG Basin are grass/pasture and hay. A small amount of alfalfa is grown in District 43, 44, 54, 55 and 57 while District 58 grows a small amount of bluegrass.



Source: (CDSS 2005). GIS irrigated acres.
Note: The bluegrass component represents the acreage of golf courses and recreational parks.

Figure 2-5 Current Irrigated Acres by Water District

Current Irrigation Demands

The current irrigation headgate demands are shown in Figure 2-6. These irrigation demands account for estimates of irrigation system efficiency, representing the amount of water diverted from the stream to meet the irrigation water requirement (IWR) by hydrologic unit code (HUC).[8] The largest amount of irrigation water diverted from the stream at the ditch headgate (this includes water used to meet the consumptive IWR in addition to diversions and irrigation losses) occurs in District 58 upstream of Steamboat Springs in the Yampa Basin and in District 43 upstream of Meeker in the White Basin. These areas are shown as red in Figure 2-6.

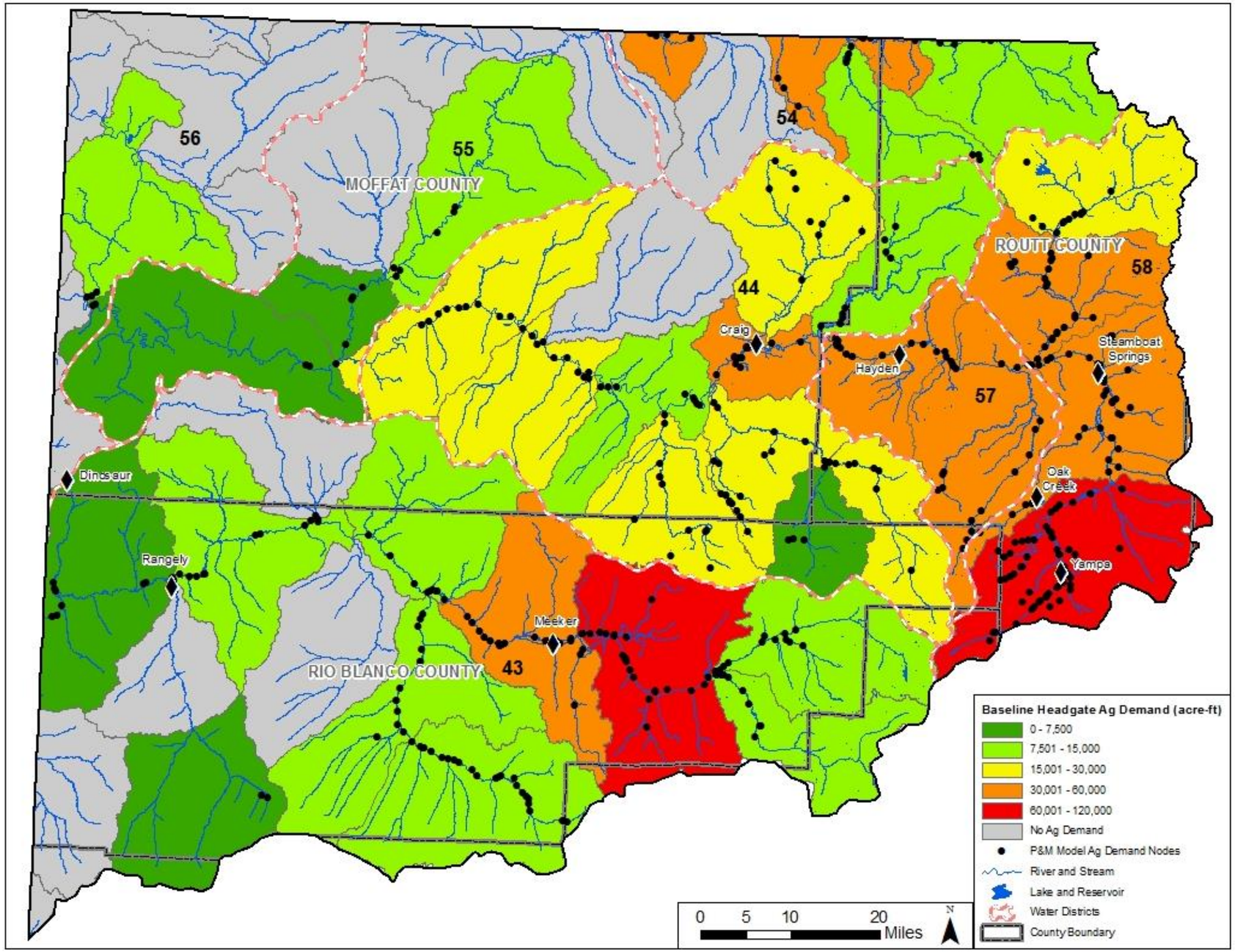
The current average annual consumptive IWR for the YWG Basin used for this BIP is taken from the Agricultural Water Needs Study and is 229,018 AF. This total consumptive demand in irrigation is broken down by sub-basin and compared with other recent estimates in Table 2-12.

[8] The IWR is defined as the potential crop evapotranspiration minus effective precipitation (amount of precipitation that is used by the crop). The IWR does not include losses incurred through ditch seepage and through application onto the field.

Table 2-12 Average Annual IWR in Different Model Versions (AF)

Basin/Stream (Water District)	SWSI	CDSS 2008	Agriculture Needs and P&M Study*
White (43)	32,634	39,465	45,740
Green (56)	2,878	2,759	3,516
Yampa *(Sub-basins in italics below)*	104,248	170,207	179,762
Study Area	**139,760**	**212,431**	**229,018**
Lower Yampa (44)	*37,924*	*49,828*	*55,003*
Slater/Timberlake (54)	*19,673*	*32,160*	*33,401*
Little Snake (55)	*2,529*	*2,407*	*2,869*
Middle Yampa (57))	*10,136*	*14,449*	*16,556*
Upper Yampa (58)	*33,986*	*71,364*	*71,933*

Source: Yampa/White Basin Needs Assessment Report, 2010.
Note: The demands presented in this table are IWR demands which do not include system losses from the headgate diversion to the field. Figure 2-6 provides the headgate diversions for the 2014 P&M Study.



Source: P&M Study, 2014. Modeling Results.

Figure 2-6 Baseline Headgate Agricultural Water Demands

Other Current Agricultural Water Demands

In addition to irrigation water demands, statewide planning efforts (SWSI 2010) have estimated non-irrigation agricultural demands. These include livestock consumptive use and stockpond evaporation[9] and are provided in Table 2-13. These non-irrigation agricultural demands are relatively minor when compared to the irrigation demands discussed above and were not incorporated into the P&M Study or updated BIP modeling effort.

Table 2-13 Non-Irrigation Agricultural Demands

Water District	Livestock Consumptive Use (AF)	Stockpond Evaporation (AF)*	Total (AF)
Lower Yampa (44)	306	2,493	6,728
Slater/Timberlake Crks (54)	102	not provided	2,921
Little Snake River (55)	186	619	1,072
Green River (56)	121	not provided	418
Middle Yampa (57)	65	not provided	1,422
Upper Yampa (58)	149	not provided	5,485
Total	**929**	**3,112**	**18,046**

Source: SWSI, 2010*Estimates of stockpond evaporation were not provided for Water Districts 54, 56, 57, and 58 in SWSI 2010.

2.3.2 Future Agricultural Needs

Future Irrigated Acreage

SWSI 2010 lists a variety of factors that could impact the future development and/or reduction of irrigated acres in the YWG Basin. These include the following:

- Urbanization and transfers from agricultural to M&I
- Water management decisions
- Demographic factors
- Biofuels production
- Climate change
- Farm programs
- Subdivision of agricultural lands and lifestyle farms
- Yield and productivity
- Open space and conservation easements
- Economics of agriculture

SWSI 2010 developed estimates of the decrease in irrigated acres as a result of urbanization and municipal to agricultural transfers, assuming 119,000 acres of current irrigation.[10] These estimates indicate that in the YWG Basin 1,000 to 2,000 acres (approximately 2%) may be removed from irrigation as a result of land acquisition and development in urban centers throughout the regions. This is relatively low when compared to other basins in the State. SWSI 2010 also indicated that an additional 3,000 to 64,000 acres may be taken out of agricultural production in the YWG Basin due to in-basin agricultural to municipal water transfers needed to meet growing M&I water

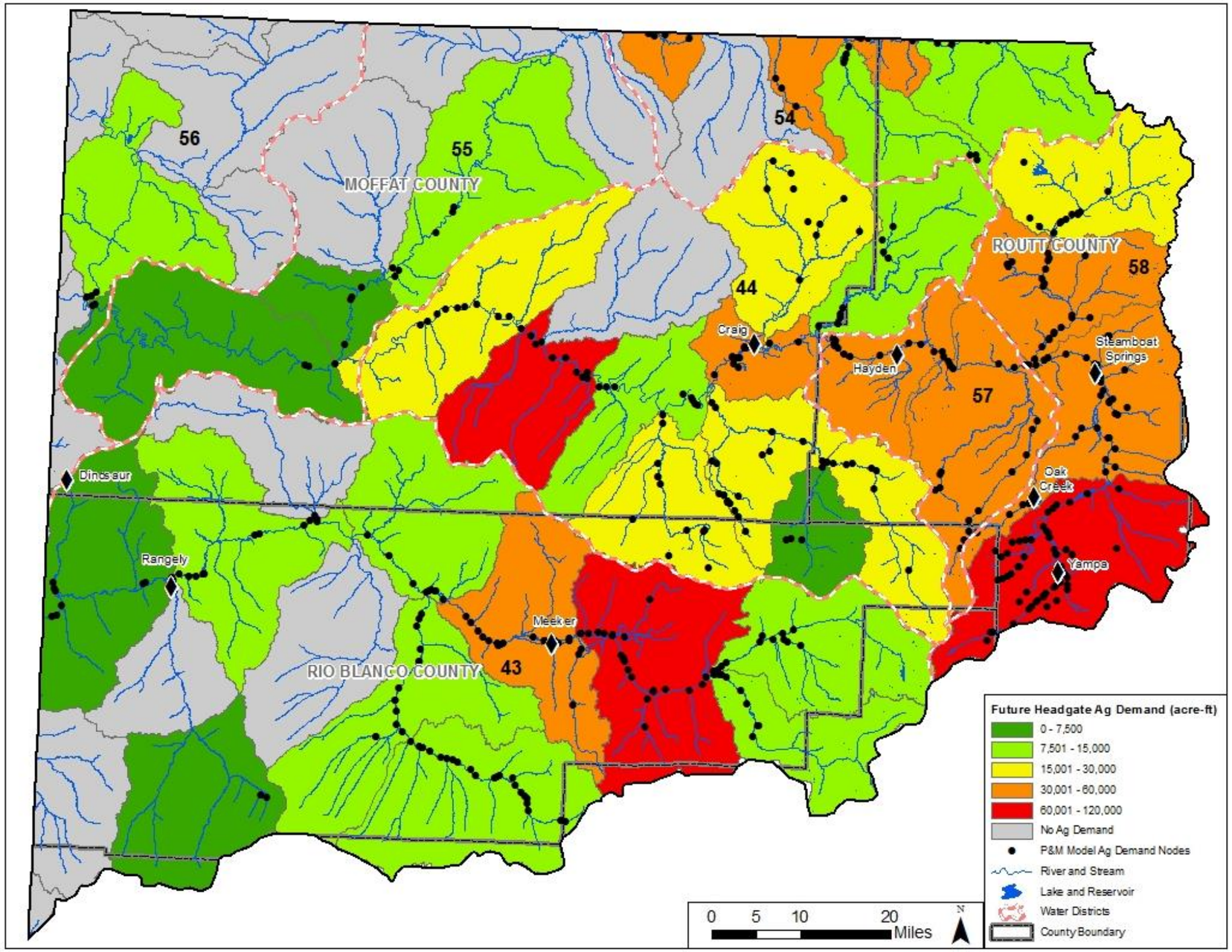
[9] SWSI 2010 also provided estimates of incidental losses which occur along canals and tailwater areas. These losses are incorporated in the irrigation water demands at the model models in the P&M Study and therefore are not included in Table 2-13.
[10] This based on CDSS's 1993 irrigated acres GIS coverage. (CDSS 1993)

demands, but some of the growing demands may be supplied by new appropriations. These results suggest that the total irrigated acres in the YWG Basin could range from 53,000 to 115,000 acres by 2050. Irrigated acres are also anticipated to increase in certain areas of the YWG Basin. The P&M Study and Agricultural Water Needs Study estimate that 7,400 to 14,805 acres may be developed along the oxbows of the Yampa River, yet does not assume any reduction in irrigated acres. This is further described in the next section.

Future Irrigation Demands

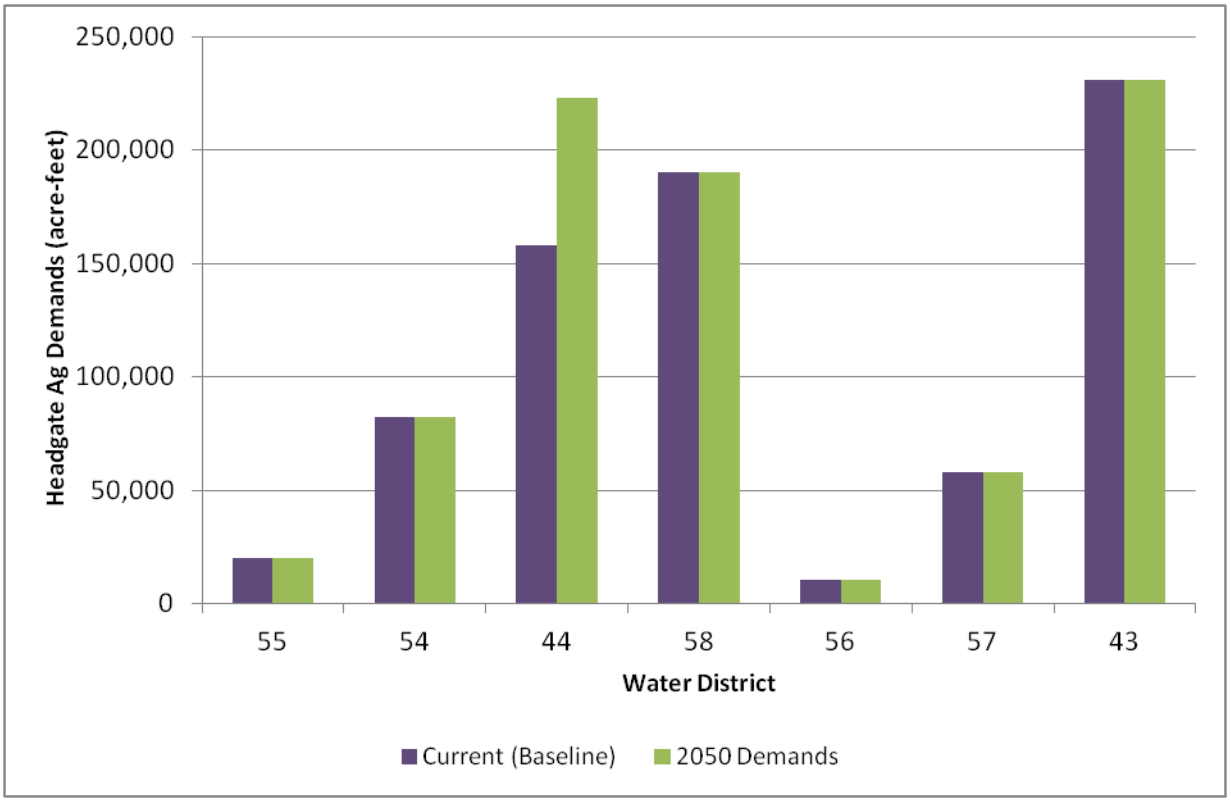
The YWG Basin's future irrigation demands at the ditch headgate are shown in Figure 2-7 by HUC. These demands were developed using the StateCU model for the Agricultural Water Needs Study, P&M Study and updated BIP modeling effort. Figure 2-8 shows the future irrigation demands relative to current demands. The demand projections assume that 14,805 acres[11] of irrigation is developed on the Yampa oxbows and the remainder of the YWG Basin continues to irrigate at current levels based on the acreage reported by CDSS in 1993. The reduction of 1,000 to 2,000 irrigated acres due to urbanization or the reduction of 3,000 to 64,000 acres due the transfers to meet a municipal gap estimated for SWSI 2010 was not included in this estimate, given the uncertainty on the amount of reductions and where they would occur in the YWG Basin. This is reflected in Figure 2-7 and Figure 2-8, where the irrigation demand increases in the downstream portion of District 44, yet no additional changes occur elsewhere in the YWG Basin.

[11] As part of the Agricultural Needs Assessment, SWSI identified a total of 14,805 acres of potentially irrigable acreage that can be developed in the future along the oxbows of the Yampa River.



Source: P&M Study, 2014. Modeling Results.

Figure 2-7 Future Headgate Agricultural Water Demands



Source: P&M Study, 2014. Modeling Results.

Figure 2-8 Current and Future Headgate Agricultural Demands (AF)

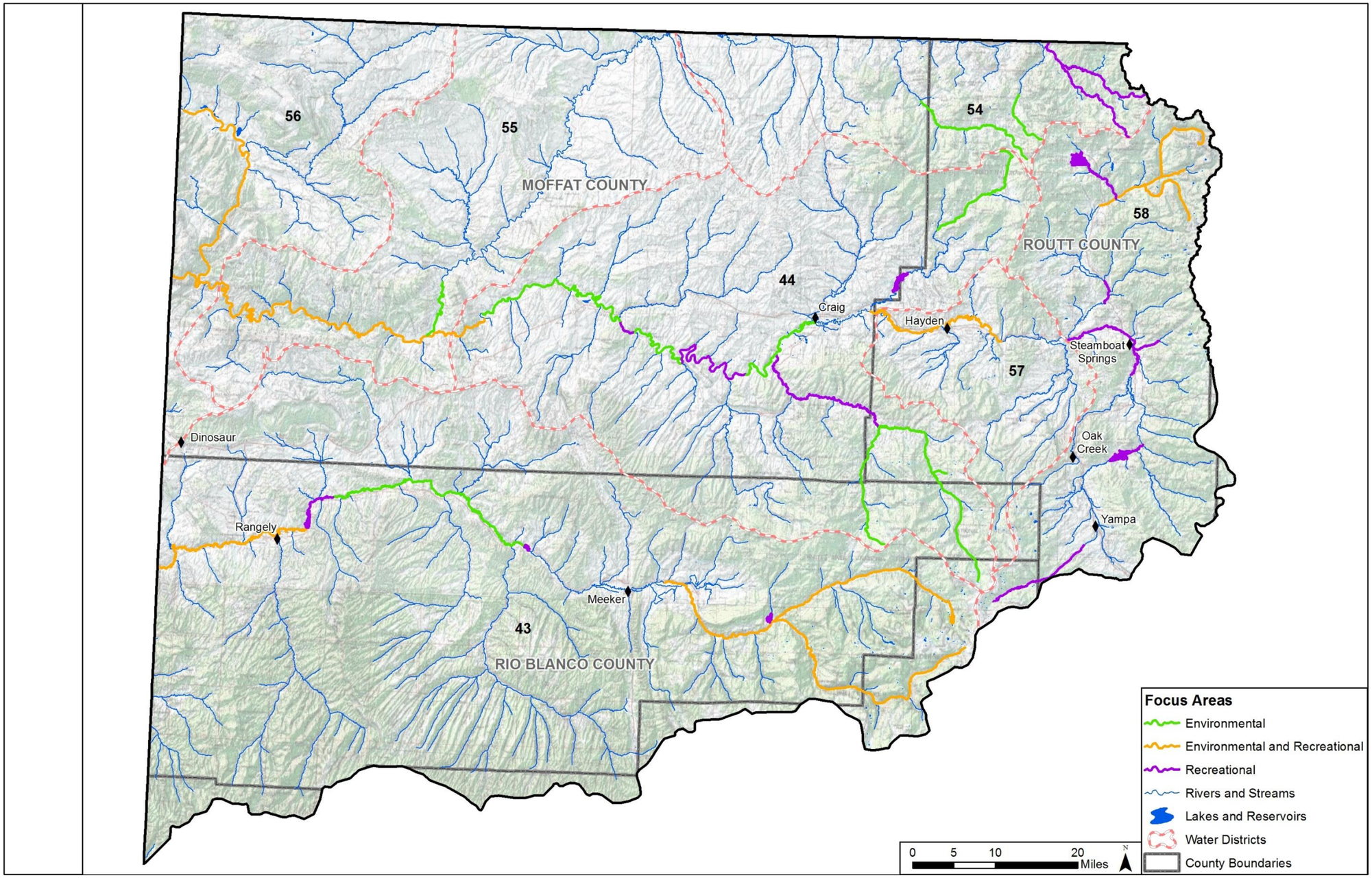
2.4 ENVIRONMENTAL AND RECREATIONAL NEEDS

One of the many attractive attributes of the YWG Basin is the outdoor environment and recreational opportunities. Many popular recreational activities including skiing, hunting, bicycling, camping, hiking, reservoir-based recreation, fishing, wildlife viewing and boating depend on the health of the environment and/or are water based activities. The recreational and environmental needs identified in this BIP are intended to maintain or improve the natural flows supporting environmental attributes and recreational activities.

2.4.1 Focus Areas and Environmental and Recreational Attributes

Through a variety of State and Basin-wide planning efforts, the YWG Basin developed a map of environmental and recreational focus areas.[12] These focus areas are depicted in Figure 2-9 and can be used as a planning tool when identifying needs and potential future projects. However, while these focus areas are located in areas with key environmental and recreational attributes; environmental attributes exist on virtually all streams and lakes. New IPPs can be advantageous in the designated focus areas as well as in other stream reaches within the YWG Basin. For instance attributes associated with major stream reaches are commonly dependent on conditions in upstream tributary reaches. The achievement or maintenance of attributes depends upon achieving or maintaining necessary values in upstream reaches in addition to the subject main reach. Table 2-14 provides the environmental and recreational attributes associated with each focus area. This table was developed through the non-consumptive needs focus mapping and are presented in the WFET study.

[12] Non-consumptive Needs Focus Mapping Report, 2010



Source: SWSI 2010 and 2016. GIS shapefiles produced in support of BIP.

Figure 2-9 Focus Areas

Table 2-14 Attributes of Major Stream and Lake Segments

No.	Stream or Lake Segment (Based Upon Segment Maps)	ATTRIBUTE CATEGORY	1. Federal Threatened & Endangered Fish	2. State Threatened and Endangered Species	3. Important Riparian Habitat	4. Instream Flows and Natural Lake Levels	5. Fishing	6. Boating	7. Waterfowl Hunting	Rationale for Consideration as a Major Segment
Major Environmental & Recreational Segments										
1	Yampa River - from entrance of Cross Mountain Canyon (East Cross Mountain) to confluence with Green River		a,b,c,d,e	a,b,c,f,e	a,b		c	a	a	Multiple environmental values including critical habitats for endangered fish plus Yampa's most sought after white water and overnight rafting destination including Dinosaur National Monument
2	Yampa River - from Pump Station to confluence of Elkhead Creek			a,c,e,f	a,c		c	a	a	Multiple environmental values plus high use boating and fishing includes TNC's the Carpenter Ranch
3	Green River - from Utah State line (Browns Park Wildlife Refuge) to the Utah State line		a,b,d	a,c,e,f	a,b,c		c	a	a	Multiple environmental and recreational values includes Browns park National Wildlife Refuge and rafting in Dinosaur National Monument
4	Elk River - from headwaters to the County Road 129 bridge at Clark; including the North, Middle and South Fork as well as the mainstem of the Elk			d,f,g	b	a	c	a		Multiple environmental and recreational values including high levels of recreation and significant fisheries use, multiple/critical environmental values
5	White River - from headwaters to Meeker; including the North and South Fork and mainstem of the White			c,d,f	a,b	a	c	a	a	Multiple environmental and recreational values including most extensive, valuable connectivity of Colorado Cutthroat Trout populations in the Yampa/White/Green basin; G1-G3 plant/wetland communities; valuable private and public water fisheries providing significant economic benefits for the upper White basin
6	White River - below Kenney Reservoir dam to Utah State line		b,d,e	a,b,c,f			c	a	a	Multiple environmental and recreational values including critical habitat for endangered fish
Major Environmental Segments										
7	White River - from Rio Blanco Lake Dam to Kenney Reservoir		b,e	a,b,c				a		Multiple environmental and recreational values including critical habitat for Federal endangered species, multiple state aquatic species of concern
8	**Slater Creek - from headwaters to the Beaver Creek confluence**			**d**	**b**		c	a		**Valuable connectivity of Colorado Cutthroat Trout populations, with G1-G3 plant communities and multiple recreational opportunities**

No.	Stream or Lake Segment (Based Upon Segment Maps)	ATTRIBUTE CATEGORY	1. Federal Threatened & Endangered Fish	2. State Threatened and Endangered Species	3. Important Riparian Habitat	4. Instream Flows and Natural Lake Levels	5. Fishing	6. Boating	7. Waterfowl Hunting	Rationale for Consideration as a Major Segment
9	Elkhead Creek - from headwaters to confluence of North Fork of Elkhead Creek			a,d	b	a		a		Valuable connectivity of Colorado Cutthroat Trout populations, Boreal toad as well as G1-G3 plant communities and recreational opportunities
10	South Fork of the Little Snake - from headwaters to confluence of Johnson Creek			a,d		a				Valuable connectivity of Colorado Cutthroat Trout populations
11	South and East Fork of the Williams Fork - from headwaters to the confluence of the Forks			d,f	b	a	c			Valuable connectivity of Colorado Cutthroat Trout populations
12	Little Snake River - from Moffat County Road 10 to confluence of the Yampa River		c,d	b	a,b					Significant environmental values including occurrences of Colorado Pikeminnow and rare collections of Humpback Chub, populations of Roundtail Chub and valuable riparian plant communities
13	Yampa River - from Craig (Hwy 394 Bridge) to mouth of Cross Mountain Canyon		d,e	b,e,f	b		c	a	a	Critical habitat for Federal endangered species, multiple state aquatic species of concern
	Major Recreational Segments									
14	Yampa River - from Stagecoach Reservoir "Tailwaters" to northern boundary of Sarvis Creek State Wildlife area			a,c	a	a	c		a	High recreation and fisheries use
15	Fish Creek - from Fish Creek Falls to confluence of the Yampa River				a	a		a		Most significant, highest use kayaking "creek run" in basin
16	Yampa River - from Chuck Lewis Wildlife Area to Pump Station			a,c,e,f	b		c	a,b	a	Highest recreation use along entire Yampa River allowing for multiple recreational opportunities; only RICD in entire Yampa/White/Green Basin
17	Elk River - at Christina State Wildlife Area			c		a	c			Highest public fishery use on Lower Elk River
18	Willow Creek - below Steamboat Lake to confluence with the Elk				a		c	a		Valuable kayaking creek and fisheries use
19	Bear River - from headwaters to USFS boundary			d			c			Cutthroat Trout habitat and significant recreational fishing
20	Stagecoach Reservoir			a			c	a	a	High recreation and fisheries use

No.	Stream or Lake Segment (Based Upon Segment Maps)	ATTRIBUTE CATEGORY	1. Federal Threatened & Endangered Fish	2. State Threatened and Endangered Species	3. Important Riparian Habitat	4. Instream Flows and Natural Lake Levels	5. Fishing	6. Boating	7. Waterfowl Hunting	Rationale for Consideration as a Major Segment
21	Elkhead Reservoir						c	a	a	High recreation and fisheries use
22	Steamboat Lake			d	a		a,b	a	a	High recreation and fisheries use including only Gold Medal Water in basin
23	**Little Snake River - from headwaters of Middle Fork of the Little Snake River and King Solomon Creek to Wyoming border**			**a,c,d**	**b**	**a**	**c**	**a**		**Important fishery including public access and private waters; significant environmental values**
24	**Williams Fork - from South Fork to confluence of the Yampa River**				**a,b**	**a**	**c**			**Important Fishery**
25	**Avery Lake**						**c**		**a**	**Important recreational destination**
26	**Rio Blanco Reservoir**				**b**		**c**		**a**	**Important recreational destination**
27	**Kenny Reservoir**						**c**	**a**	**a**	**Important recreational destination**
28	**Yampa River - Duffy Canyon**		d,e	b,e,f	b		**c**	**a**	**a**	**Important recreational canyon**
29	**Yampa River - Little Yampa Canyon**		d,e	b,e,f	b		**c**	**a**	**a**	**Important recreational canyon**
30	**Yampa River - Juniper Canyon**		d,e	b,e,f	b		**c**	**a**	**a**	**Important recreational canyon**

[1] The CWCB's Statewide Water Supply Initiative Report (http://cwcb.state.co.us/WATER-MANAGEMENT/WATER-SUPPLY-PLANNING/ Pages/SWSI2010.aspx) provides further detail on the data sources used to generate this map.

KEY TO ATTRIBUTE CODES

Attribute 1 - Federal Threatened & Endangered Fish
- a. Bonytail Chub
- b. Razorback Sucker
- c. Humpback Chub
- d. Colorado Pikeminnow
- e. Federally Listed Critical Habitat

Attribute 2 - State Threatened and Endangered Species
- a. Bluehead Sucker
- b. Roundtail Chub
- c. Flannelmouth Sucker
- d. Colorado River Cutthroat Trout
- e. River Otter
- f. Northern Leopard Frog
- g. Boreal Toad

Attribute 3 - Important Riparian Habitat
- a. Riparian/Wetland - Dependent Rare Plants
- b. Significant Riparian/Wetland Plant Communities
- c. Audubon Important Bird Areas

Attribute 4 - Instream Flows and Natural Lake Levels
- a. CWCB Instream Flow Water Rights
- b. CWCB Natural Lake Level Water Rights

Attribute 5 - Fishing
- a. Gold Metal Trout Streams
- b. Gold Medal Trout Lakes
- c. Significant Fishing Waters (based on local knowledge)

Attribute 6 - Boating
- a. Rafting/kayaking/flatwater Reaches
- b. Recreational In-Channel Diversion Structures

Attribute 7 - Waterfowl Hunting
- a. Waterfowl Hunting

Notes (disclaimer verbiage):
1. Nonconsumptive environmental and/or recreational attributes exist on virtually all stream and lake segments, whether such attributes are identified herein or not. Exclusion of a segment from this chart does not indicate absence of non-consumptive attributes.
2. Attributes associated with the major segments are commonly dependent on conditions in upstream tributary segments. Therefore, the achievement or maintenance of non-consumptive attributes depends upon achieving or maintaining necessary values in upstream segments as well as within the major segment itself.

Important Riparian Habitats were considered based on the following CNHP rankings:

G/S1 Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction.

G/S2 Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.

G/S3 Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).

Source: WFET, 2012

2.4.2 Evaluation of Environmental Needs

The YWG Basin evaluated the recreational and environmental needs in the YWG Basin through the P&M Study and WFET. The WFET provides series of criteria to quantitatively measure and compare environmental and recreational risks based on existing and modeled flow conditions in the Yampa and White Basins. This methodology is incorporated into the P&M Study to assess risk to environmental and recreational uses indicated by the P&M Study model runs.

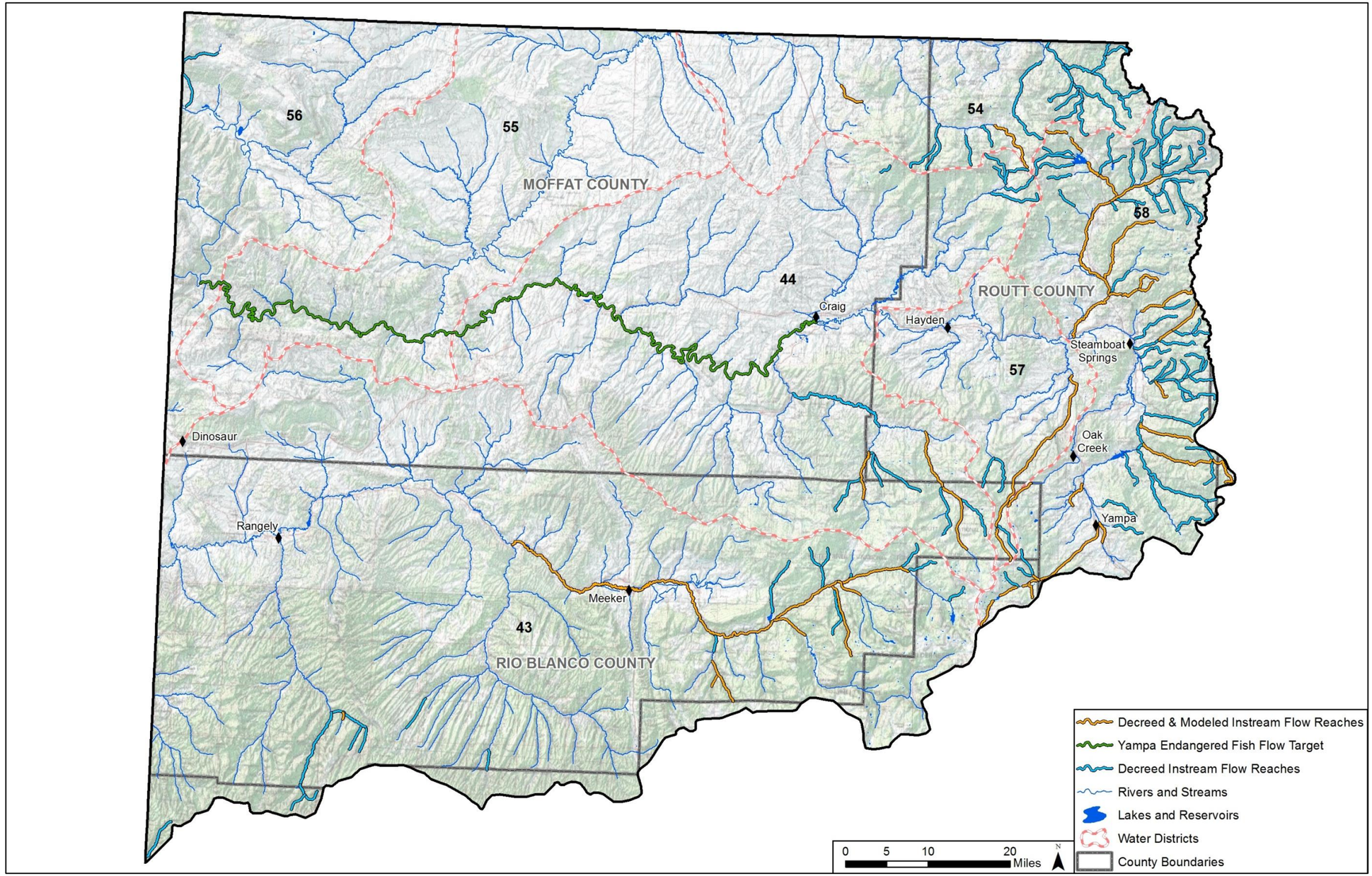
The P&M Study specifically addresses the target at the Maybell gage for augmenting existing base flows to assist in endangered fish recovery[13] and instream flow shortages and incorporates a series of risk-based ecology and flow relationship metrics to assess how current and potential future flows could impact the ecology and boating at specific locations within the YWG Basin. This section focuses on the results of the modeled current condition in the P&M Study and also provides an overview of the Green River PBO. Future environmental and recreation needs will depend on a multitude of factors including future water development and climate conditions. These future needs are addressed in Chapter 3.

Instream Flows

CWCB instream flow reaches are decreed water rights used to protect flow levels in delineated stream reaches throughout the State. The instream flows protect diverse environments including cold water and warm water fisheries, as well as critical habitat for threatened or endangered native fish in the Yampa and White Basins. These instream flows have decreed water rights and therefore provide flow protection in the designated reaches. Upstream and intervening junior water users are not able to divert water from the stream which could result in flows less than the decreed flow rates. It is noted that the targeted decreed flow rates for instream flows are often developed based on the minimum flows necessary to sustain natural conditions. The aquatic health of many streams can often be improved through flows that exceed the minimum decreed limits.

Figure 2-10 shows the decreed instream flows within the YWG Basin and the instream flows modeled for the P&M Study. Some instream flows were not included in the model because they are in headwaters areas or do not have direct relation, or impact, to demand nodes. Table 2-15 shows the average annual flow target and how much of that average annual target flow is met at a minimum along the modeled reach (i.e. the average annual flow target minus the instream flow shortage). Table 2-17 provides the monthly flow targets and percentage of modeled years that attained the target. A number of decreed instream flows in Figure 2-10 could not be modeled and are not included in Table 2-15 and Table 2-16.

[13] The P&M Study did not address the rest of the flow regime that may be necessary for endangered fish recovery on this reach of the Yampa River, on the lower Little Snake River, on the Yampa River in Dinosaur National Monument, and on the Green River. These flow needs were addressed for the WFET report by replicating the full flow assessment of the existing and future depletions covered by the Yampa PBO.



Source: P&M Study, 2014.

Figure 2-10 Decreed and Modeled Instream Flows

Table 2-15 Annual Instream Flow Target and Baseline Modeled Flows

Diversion Name	WDID*	Average Annual Target Flow (cfs)	Modeled Average Annual Flow Along Reach (cfs)
Bear River (Middle)	582404	7.9	4.1
Bear River (Lower)	582202	12	5.8
Big Creek	582206	15	10.7
Coal Creek	582214	5	3.4
Dome Creek	582216	2	0.3
East Fork Williams Fork	441452	14.2	12.2
Elk River (Lower)	581355	65	26.9
Elk River (Upper)	582219	65	27.3
Green Creek	582245	5	2.1
Hunt Creek	582519	5	2.4
Marvine Creek	432334	40	39
Miller Creek	432337	10	8.4
North Fork Fish Creek	582287	5	4.3
North Fork White River	432339	70	69.7
North Fork White River	432338	120	117.5
Oak Creek	582290	2	1.9
Phillips Creek	582409	6	2.4
Service Creek	582306	6	3.9
Slater Creek	542076	3	2.9
Soda Creek	582311	5	4.1
South Fork White River	432344	80	74.8
South Fork Williams Fork	441456	5.9	5.4
Trout Creek (Lower)	571009	5	3.8
Ute Creek	432372	6	6
White River	431845	200	190.8
Williams Fork River	441448	20.7	20.3
Willow Creek	582332	7	4
Willow Creek	581461	5	3
Willow Spring & Pond	582162	13	6.7
Yampa River	582164	56.9	52.5

* Water District Structure Identification (WDID)

Table 2-16 Monthly Instream Flow Targets and Percentage of Modeled Years that Reached the Target

Node	Name	ISF StateMod Demand & % of Yrs Met Target	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
582404	Bear River (Middle)	ISF Demand	5.0	5.0	5.0	5.0	12.0	12.0	12.0	12.0	12.0	5.0	5.0	5.0
		% of years above	71%	59%	66%	86%	0%	0%	0%	0%	0%	89%	38%	55%
582202	Bear River (Lower)	ISF Demand	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
		% of years above	66%	52%	61%	75%	52%	59%	18%	4%	4%	9%	34%	50%
582206	Big Creek	ISF Demand	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
		% of years above	0%	2%	13%	86%	100%	100%	95%	41%	14%	13%	5%	0%
582214	Coal Creek	ISF Demand	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		% of years above	0%	2%	7%	80%	100%	100%	95%	39%	13%	7%	2%	0%
582216	Dome Creek	ISF Demand	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
		% of years above	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%
441452	East Fork Williams Fork	ISF Demand	10.0	10.0	10.0	10.0	20.0	20.0	20.0	20.0	20.0	10.0	10.0	10.0
		% of years above	23%	9%	57%	98%	100%	98%	70%	5%	5%	64%	71%	46%
581355	Elk River (Lower)	ISF Demand	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
		% of years above	0%	0%	2%	21%	100%	98%	48%	0%	13%	2%	0%	0%
582219	Elk River (Upper)	ISF Demand	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
		% of years above	0%	0%	2%	21%	100%	100%	48%	0%	0%	0%	0%	0%
582245	Green Creek	ISF Demand	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		% of years above	0%	0%	5%	100%	100%	84%	11%	0%	0%	2%	0%	0%
582519	Hunt Creek	ISF Demand	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		% of years above	0%	2%	13%	82%	98%	93%	34%	2%	2%	5%	7%	0%
432334	Marvine Creek	ISF Demand	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
		% of years above	48%	34%	38%	100%	100%	100%	95%	84%	75%	71%	73%	57%
432337	Miller Creek	ISF Demand	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		% of years above	50%	73%	82%	93%	95%	77%	89%	80%	86%	86%	64%	45%



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Node	Name	ISF StateMod Demand & % of Yrs Met Target	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
582287	North Fork Fish Creek	ISF Demand	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		% of years above	0%	9%	7%	96%	100%	100%	100%	100%	100%	16%	18%	0%
432339	North Fork White River	ISF Demand	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
		% of years above	84%	86%	86%	100%	100%	100%	96%	98%	96%	95%	96%	88%
432338	North Fork White River	ISF Demand	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0
		% of years above	50%	39%	43%	100%	100%	100%	96%	91%	88%	80%	75%	59%
582290	Oak Creek	ISF Demand	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
		% of years above	84%	79%	100%	100%	100%	100%	98%	75%	63%	89%	86%	91%
582409	Phillips Creek	ISF Demand	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
		% of years above	0%	0%	5%	57%	23%	7%	14%	13%	2%	2%	2%	0%
582306	Service Creek	ISF Demand	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
		% of years above	5%	7%	48%	100%	100%	91%	70%	14%	7%	14%	9%	5%
542076	Slater Creek	ISF Demand	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
		% of years above	100%	100%	100%	100%	100%	100%	89%	68%	73%	96%	100%	100%
582311	Soda Creek	ISF Demand	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		% of years above	57%	70%	77%	100%	100%	100%	93%	41%	38%	43%	64%	57%
432344	South Fork White River	ISF Demand	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
		% of years above	16%	14%	18%	79%	100%	100%	96%	88%	66%	61%	34%	16%
441456	South Fork Williams Fork	ISF Demand	5.0	5.0	6.5	8.0	8.0	8.0	8.0	3.5	3.5	5.0	5.0	5.0
		% of years above	66%	70%	71%	98%	100%	98%	50%	52%	38%	46%	46%	48%
571009	Trout Creek (Lower)	ISF Demand	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		% of years above	61%	66%	82%	100%	100%	100%	45%	13%	13%	36%	79%	70%
432372	Ute Creek	ISF Demand	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
		% of years above	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
431845	White River	ISF Demand	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
		% of years above	96%	100%	100%	100%	100%	96%	80%	59%	54%	91%	100%	82%






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Node	Name	ISF StateMod Demand & % of Yrs Met Target	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
441448	Williams Fork River	ISF Demand	14.0	14.0	14.0	14.0	30.0	30.0	30.0	30.0	30.0	14.0	14.0	14.0
		% of years above	100%	100%	100%	100%	100%	100%	89%	93%	63%	100%	100%	100%
582332	Willow Creek	ISF Demand	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
		% of years above	4%	13%	30%	88%	100%	100%	100%	98%	82%	5%	0%	2%
581461	Willow Creek	ISF Demand	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		% of years above	5%	18%	36%	88%	100%	100%	100%	100%	100%	14%	2%	5%
582162	Willow Spring & Pond	ISF Demand	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
		% of years above	4%	5%	46%	100%	100%	93%	82%	14%	7%	14%	7%	5%
582164	Yampa River	ISF Demand	47.5	47.5	47.5	72.5	72.5	72.5	72.5	60.0	47.5	47.5	47.5	47.5
		% of years above	57%	46%	86%	100%	98%	91%	84%	84%	70%	73%	57%	55%





Yampa PBO - Endangered Species Fish Flow Target

In the late 1990's, a Management Plan for Endangered Fishes in the Yampa River Basin (Management Plan) was developed by the USFWS to assist with the recovery of four endangered fish species on the Yampa River[14]. These species include the humpback chub, bonytail chub, Colorado pike minnow and razorback sucker. The Management Plan proposes to implement the following measures to minimize negative impacts to the listed fish and critical habitats:

- Provide and protect instream flows
- Reduce negative impacts of nonnative fishes
- Restore habitat (habitat development and maintenance)
- Manage genetic diversity/augment or restore populations
- Monitor populations and habitat
- Provides for future consumptive depletions

The Management Plan included an assessment of the flow impacts of existing storage and of increasing depletions by 30,104 AFY on the Yampa River above the Little Snake in Colorado and by 23,428 AFY on the Little Snake River in Wyoming. An important component of the Management Plan was to augment the remaining base flows in the critical habitat reach of the Yampa River above the Little Snake River by making storage releases from an enlarged Elkhead Reservoir that were decreed for instream use down to the confluence with the Green River. This reach is shown as the Endangered Fish Flow Reach in Figure 2-10. These augmentation releases were targeted to the flows at the Maybell gage that remained after existing irrigation in this reach and all upstream depletions and existing storage. Water can be released up to a rate of 50 cfs and added to the remaining base flows to meet the monthly targeted flows at Maybell. While these flow targets are not decreed, the PBO relied on the availability of the remaining base flows in setting these targets with access to only 7,000 AF of storage at Elkhead Reservoir. The PBO also relied on the adjudication of the releases for instream use that is protected from even the most senior diversions. A permanent water storage account of 5,000 AF was funded up-front and is reserved in Elkhead Reservoir for maintaining flows throughout the Endangered Fish Flow Reach. In addition, another 2,000 AF may be released from Elkhead Reservoir for flow augmentation under a long-term (20 years), renewable lease with an annual fixed rate of $50 per acre-foot for the first 20 years. The water released from storage for instream augmentation can vary by year. In wet years, the program may not need its full storage allotment given that the natural flows at the Maybell gage may often be high enough to meet the targeted monthly flows without necessitating releases.

Table 2-17 Selected Endangered Fish Flow Targets Baseline Condition[15]

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Flow Target (cfs)	120	169	169	169	169	0	0	0	0	138	120	120
Average Minimum Simulated Flows Along the Reach (cfs)	117	168	153	164	158	0	0	0	0	120	57	88
Years Met of Exceeded Target	91%	89%	77%	75%	89%	N/A	N/A	N/A	100%	95%	70%	68%

Source: P&M Study, 2014.

[14] (Roehm 2004)
[15] Originally the PBO targeted 138 cfs at the Maybell gage from July-October and 169 cfs from November-March for the combined underlying flows and storage releases. The USFWS has since requested operations at a lower target of 120 cfs for August-October. The P&M Study mixed that lower target with those in the PBO as shown in this table. The FWS has also since requested operations at a higher target of 134 cfs for July-October.

Table 2-17 also shows the average minimum simulated flow along the reach and the percentage of modeled years in which the targeted flows were met for the baseline condition. Shortages occurred if the native flows and 50 cfs release from Elkhead Reservoir could not achieve the targeted flows. Additionally, releases from Elkhead Reservoir only occurred if the native flows at the Maybell gage were below the target.[16]

Green River Biological Opinion

The Green River PBO provides a list of operational criteria for the Flaming Gorge Dam to assist in the recovery of the four endangered fish. These releases impact instream flows in the Green River reach that runs through Colorado and provides habitat for the fish. The action alternative in the Flaming Gorge Dam Final Environmental Impact Statement[17] calls for a peak release magnitude of sufficient duration in April through July to achieve flow targets in the Green River upstream and immediately downstream of the confluence with the Yampa River. With exception for cases when the Flaming Gorge minimum release rate requirement is 800 cfs, the flow objectives for Green River from the Flaming Gorge Reservoir to the confluence with the Yampa River (specified as Reach 1 in the BO) and immediately downstream of the confluence (specified as Reach 2 in the BO) are the same. These flow objectives include the following:

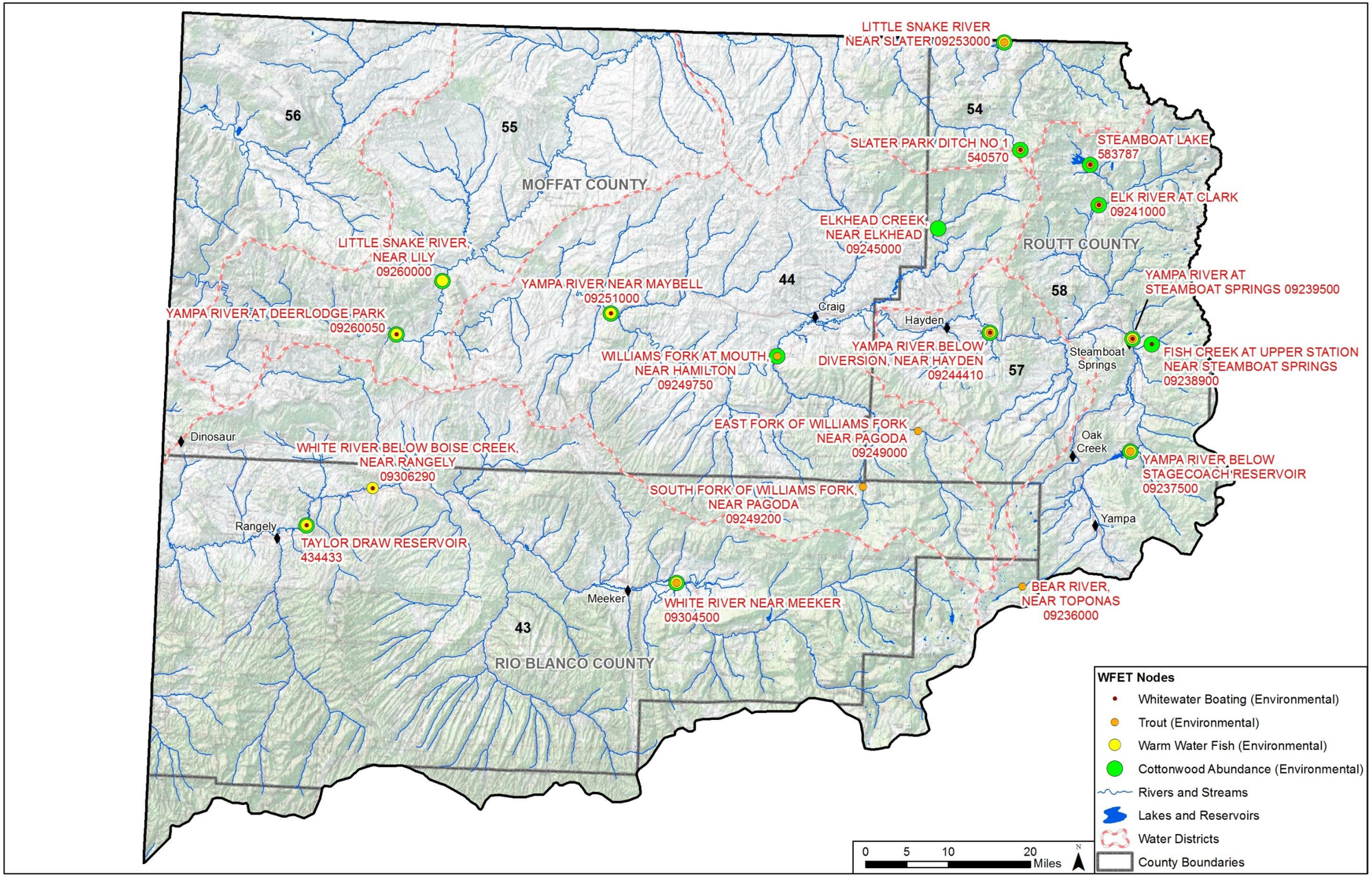
- Achieve peak of 26,400 cfs for at least 1 day in 10% of all years
- Sustain peak of 22,700 cfs for at least 2 weeks in 10% of all years
- Sustain peak of 18,600 cfs for at least 4 weeks in 10% of all years
- Sustain peak of 20,300 cfs for at least 1 day in 30% of all years
- Sustain peak of 18,600 cfs for at least 2 weeks in 40% of all years
- Sustain peak of 18,600 cfs for at least 1 day in 50% of all years
- Sustain peak of 8,300 cfs for at least 1 week in 90% of all years
- Sustain peak of 8,300 cfs for at least 2 days in 98% of all years
- Sustain peak of 8,300 cfs for at least 1 day in 100% of all years

The Green River PBO followed closely on the heels of the Yampa PBO and therefore relied on the flow regime for the Yampa River resulting from that programmatic opinion to help meet these targets for Reach 2 of the Green River.

Fisheries and Cottonwood Flow-Ecology Relationship Risks

The WFET (Sanderson 2012) developed a series of flow-ecology metrics to measure the ecological risk associated with decreased flows in the Yampa and White Basins. These metrics were originally applied as a pilot study in the Roaring Fork and Fountain Creek watersheds and have been updated for the Yampa and White Basins. The metrics are applied to the 19 P&M Study nodes shown in Figure 2-11. These metrics were developed using the Ecological Limits of Hydrologic Alternation framework (Framework) which was publicized in 2006 by an international group of river scientists[18]. The Framework is used for evaluating and managing environmental flows in large regions where time and resources (i.e. intensive field studies) are not available. The Framework applies information from rivers that have been studied intensively to rivers that have not yet been studied without needing site-specific detailed information.

[16] This accounting will mask shortages to the endangered fish flows in this reach under future conditions if the native flows at Maybell on which the PBO relied, are not maintained. That is, if these native base flows are reduced under future conditions, then the starting point for reporting such shortages is also reduced. On the other hand, if the native flows below Maybell were reduced by existing depletions and were not relied upon by the PBO, that should not constitute a shortage to the endangered fish flows.
[17] (USFWS 2005b)
[18] (Arthington et al. 2006)



Source: P&M Study, 2014.

Figure 2-11 Modeled Nodes for the Flow-Ecology Risks

The metrics provide a means to assess the stream's ability to support trout, warm water fish and cottonwood populations by relating modeled streamflows to the natural flows of the stream prior to human development. A summary of each metric is provided below. Additional details on each metric, including the equations used for each metric is provided in Appendix A.

- Trout flow-ecology relationship –Compares modeled monthly flows in August and September (spawning season) relative to the annual natural flows.
- Warm water fish flow-ecology relationship – Represents the reduction in potential biomass of warm water fish based on 30-day minimum flows in a stream under modeled flow conditions for July through November.
- Cottonwood flow-ecology relationship[19] – Relationship between high peak flows under natural conditions relative to modeled flow conditions in April through June.

Each of the metrics above was used to assess the current ecological risk to trout, warm water fish and cottonwood riparian habitat relative to natural conditions. The results for the P&M modeled baseline conditions are presented in Table 2-18. Additional information on how each of the risk levels were developed for each flow-ecology metric is provided in Appendix A.

These results indicate that the modeled cottonwood areas are least impacted by current human river depletions whereas trout followed by warm water fish are more impacted. Areas of high risk for trout include the South Fork of the Little Snake from the headwaters to the confluence of Johnson Creek (9245000) and from the South Fork of the Williams Form from the headwaters to the confluence of the Forks (9249200). Warm water fish are assessed to be at high risk in the Little Snake River from Moffat County Road 10 to the confluence of the Yampa River (9260000) and cottonwoods are assessed to be at high risk on the Yampa River from Stagecoach Reservoir tailwaters to the northern boundary of Sarvis Creek State Wildlife Area (9237500).

Table 2-18 Risks Levels Based on the Ecology-Flow Metrics for Baseline Conditions

	Reach Name	Evaluation Node	Trout Flow-Ecology Relationship	Warm Water Fish Flow-Ecology Relationship	Cottonwood Abundance
1	Yampa River from entrance of Cross Mountain Canyon East Cross Mountain to confluence with Green River	9260050	n/a	Moderate Risk	Low Risk
2	Yampa River from Pump Station to confluence of Elkhead Creek	9244410	Moderate Risk	Low Risk	Low Risk
4	Elk River from headwaters to the County Road 129 bridge at Clark including the North Middle and South Fork as well as the mainstem of the Elk	9241000	Minimal Risk	n/a	Low Risk
5	White River from headwaters to Meeker including the North and South Fork and mainstem of the White	9304500	Minimal Risk	Low Risk	Low Risk
6	White River below Kenney Reservoir dam to Utah State line	434433	n/a	Low Risk	Moderate Risk
7	White River from Rio Blanco Lake Dam to Kenney Reservoir	9306290	n/a	Low Risk	n/a
8	Slater Creek from headwaters to the Beaver Creek confluence	540570	Moderate Risk	n/a	Low Risk

[19] The WFET and P&M Study refer to the "cottonwood flow-ecology" metric as the "riparian flow-ecology" metric. This metric has been renamed to reflect that the metric exclusively assesses cottonwood as opposed to other riparian species.

	Reach Name	Evaluation Node	Trout Flow-Ecology Relationship	Warm Water Fish Flow-Ecology Relationship	Cottonwood Abundance
9	Elkhead Creek from headwaters to confluence of North Fork of Elkhead Creek	9245000	n/a	n/a	Low Risk
10	South Fork of the Little Snake from headwaters to confluence of Johnson Creek	9253000	High Risk	Low Risk	Low Risk
11a	East Fork of the Williams Fork from headwaters to the confluence of the Forks	9249000	Minimal Risk	n/a	n/a
11b	South Fork of the Williams Fork from headwaters to the confluence of the Forks	9249200	High Risk	n/a	n/a
11c	Williams Fork from the South Fork to the confluence with the Yampa River	9249750	Moderate Risk	n/a	Low Risk
12	Little Snake River from Moffat County Road 10 to confluence of the Yampa River	9260000	n/a	High Risk	Low Risk
13	Yampa River from Craig Hwy 394 Bridge to mouth of Cross Mountain Canyon	9251000	n/a	Moderate Risk	Low Risk
14	Yampa River from Stagecoach Reservoir Tailwaters to northern boundary of Sarvis Creek State Wildlife area	9237500	Minimal Risk	Low Risk	High Risk
15	Fish Creek from Fish Creek Falls to confluence of the Yampa River	9238900	n/a	n/a	Low Risk
16	Yampa River from Chuck Lewis Wildlife Area to Pump Station	9239500	Moderate Risk	Low Risk	Low Risk
18	Willow Creek below Steamboat Lake to confluence with the Elk	583787	Low Risk	n/a	Low Risk
19	Bear River from headwaters to U.S. Forest Service (USFS) boundary	9236000	Low Risk	n/a	n/a

Source: P&M Study, 2014. Note: Errors have been identified with the node locations and metrics.

2.4.3 Evaluation of Recreational Needs

Steamboat Recreational In-Channel Diversion (RICD)

The City of Steamboat Springs has an absolute recreational instream channel diversion water right for the Steamboat Springs boating park. When in priority, this junior water right may be used to protect flows through the Steamboat Springs boating park at the specified rates shown in Table 2-19. These claimed flows are limited to the hours of 8:00 am to 8:00 pm with exception of 10 days between April 15 and July 15 for nighttime competitive events. The RICD was modeled in the P&M Study. In order to conduct the modeling, the decrees flow rates were modified to fit within a monthly timestep. The surrogate modeled flows are shown in Table 2-19.

Table 2-19 Decreed Flow Rates for the Steamboat RICD

Time Period	April 15-20	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug 1-15
Decreed Flow Rates (cfs)	400	650	1000	1400	650	250	100	95
StateMod Surrogate Flow Rates (cfs)	200	825		1025		175		47.5

Source: P&M Study, 2014.

The modeled baseline results, shown in Table 2-20, indicate that the RICD is currently met in April yet experiences shortages 21% and 37% of the modeling period for June and July, respectively. The majority of these shortages occur in drier years.

Table 2-20 Percentage of Modeled Year in Which the Target RICD Monthly Target is Met

Time Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
StateMod Surrogate Flow Rates (cfs)	0	0	0	200	825	1,025	175	47	0	0	0	0
Years Met or Exceeded Target	100%	100%	100%	100%	98%	79%	63%	95%	100%	100%	100%	100%

Source: P&M Study, 2014.

Boating Flow-Usability Relationship

The WFET also developed a means to characterize the usability of flows along key recreational reaches for whitewater recreation. A survey was conducted by American Whitewater to determine recommended flow ranges for the eleven locations shown in Table 2-21. The P&M Study integrated the survey information in Table 2-20 with modeled flows to determine the percentage of months with usable flows. Figure 2-12 presents the percentage of months under which the flows are characterized as minimal, optimal and highest for boating purposes for 10 segments within the modeled timeframe[20]. These data are based on the P&M Study which incorporated the information from Table 2-20 into monthly flows for the purposes of modeling. Flow conditions are considered usable for boating under the optimal and highest flow conditions. These results indicate that the Yampa River from the entrance of Cross Mountain Canyon to the confluence with the Green River and the Little Yampa Canyon have the greatest percentage of usable months during the baseline modeling period. Four of the reaches in Figure 2-12 do not have usable boating flows.

[20] Figure 2-12 presents baseline results only for modeled boating segments and not for all the segments listed in Table 2-21.

Table 2-21 WFET Whitewater Boating Flows

	Segment	Measurement Gage	Minimum (cfs)	Optimal (cfs)	Highest (cfs)	Season
15	Fish Creek	9238900	400	800-1,000	1,400	April through July
16	Steamboat Town	9239500	700	1,500-2,700	5,000+	April through July
4a	Elk River Box	9242500[1]	700	1,000-2,100	5,000+	April through July
4b	Elk River – Clark	9241000	700	1,300-4,000	5,000+	April through July
18	Willow Creek	583787	300	700-800	1,250	April through July
	Mad Creek	Visual	400	400-1,000	2,000+	April through July
	MF Little Snake	Visual	500	800-1,100	2,000+	April through July
8	Slater Creek	540570[2]	600	1,100-2,100	3,000+	April through July
2	Yampa - Lower Town	9244410	900	1,500-1,500	4,000	April through July
13/29	Little Yampa Canyon	9247600	1,100	1,700-2,500	10,000+	April through July
1	Cross Mountain Gorge	9251000	700	1,500-3,500	5,000	April through July
1	Yampa Canyon	9260050	1,300	2,700-20,000	20,000+	April through July
3	Gates of Lodore	9234500[3]	1,100	1,900-15,000	20,000+	April through July
5	SF White River	No Defined Gage[4]	700	2,500-3,500	10,000	April through July
6	White River below Kenney Reservoir	434433	700	1,500-2,500	10,000+	March through October
7	White River Rangely to Bonanza	9306290	700	1,500-5,000	10,000+	April through July

[1] Gage not in the StateMod Model
[2] Not evaluated in the WFET, due to insufficient data
[3] Gage not in the StateMod Model
[4] No defined location in the WFET study to evaluate whitewater boating flows

Source: P&M Study, 2014.

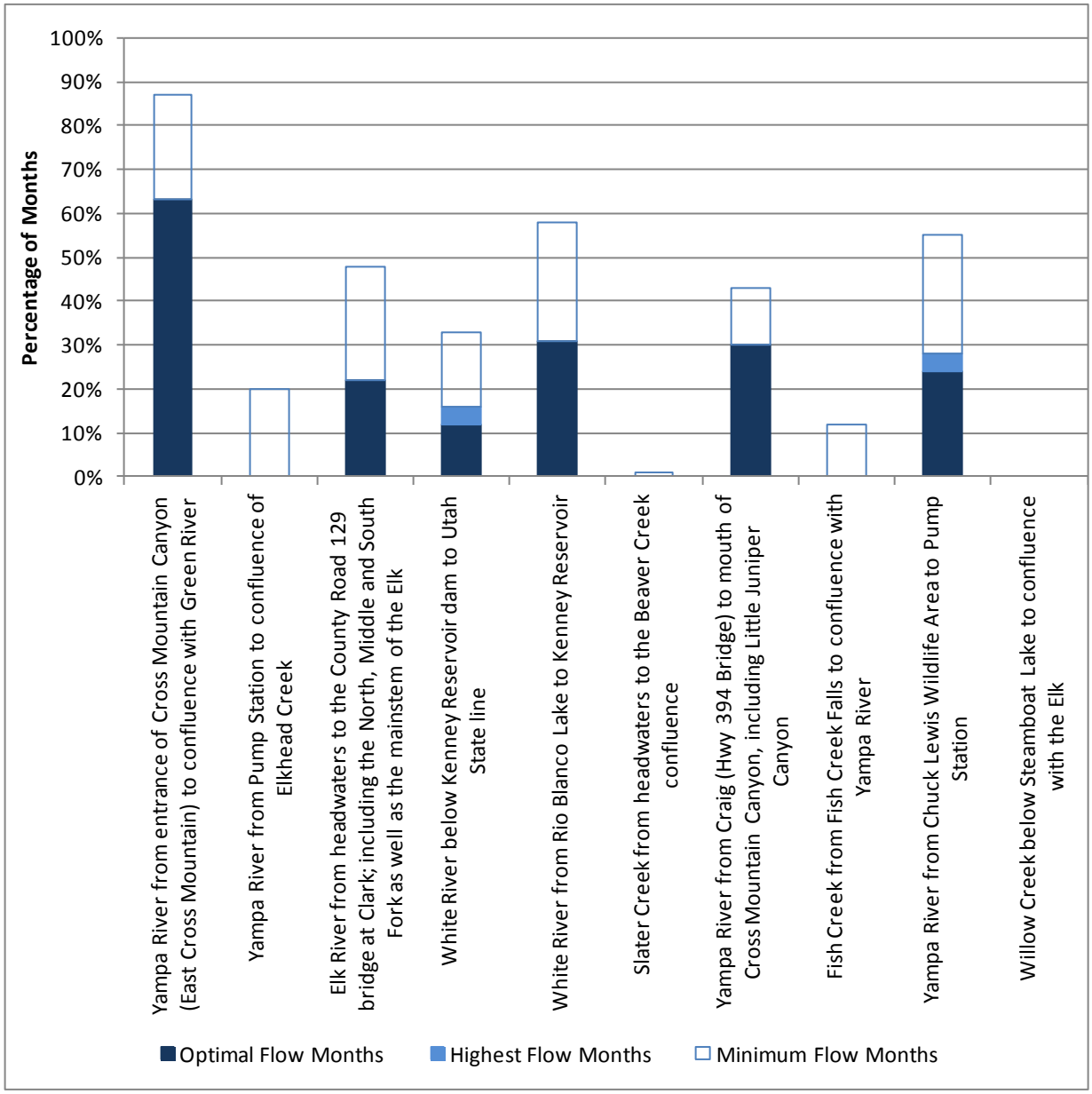


Figure 2-12 Baseline Recreational Whitewater Boating Results

Source: P&M Study, 2014.
Note: The frequency of months with high and low flows days are averaged in the P&M Study because the model is based on a monthly timestep. This reduces variability.