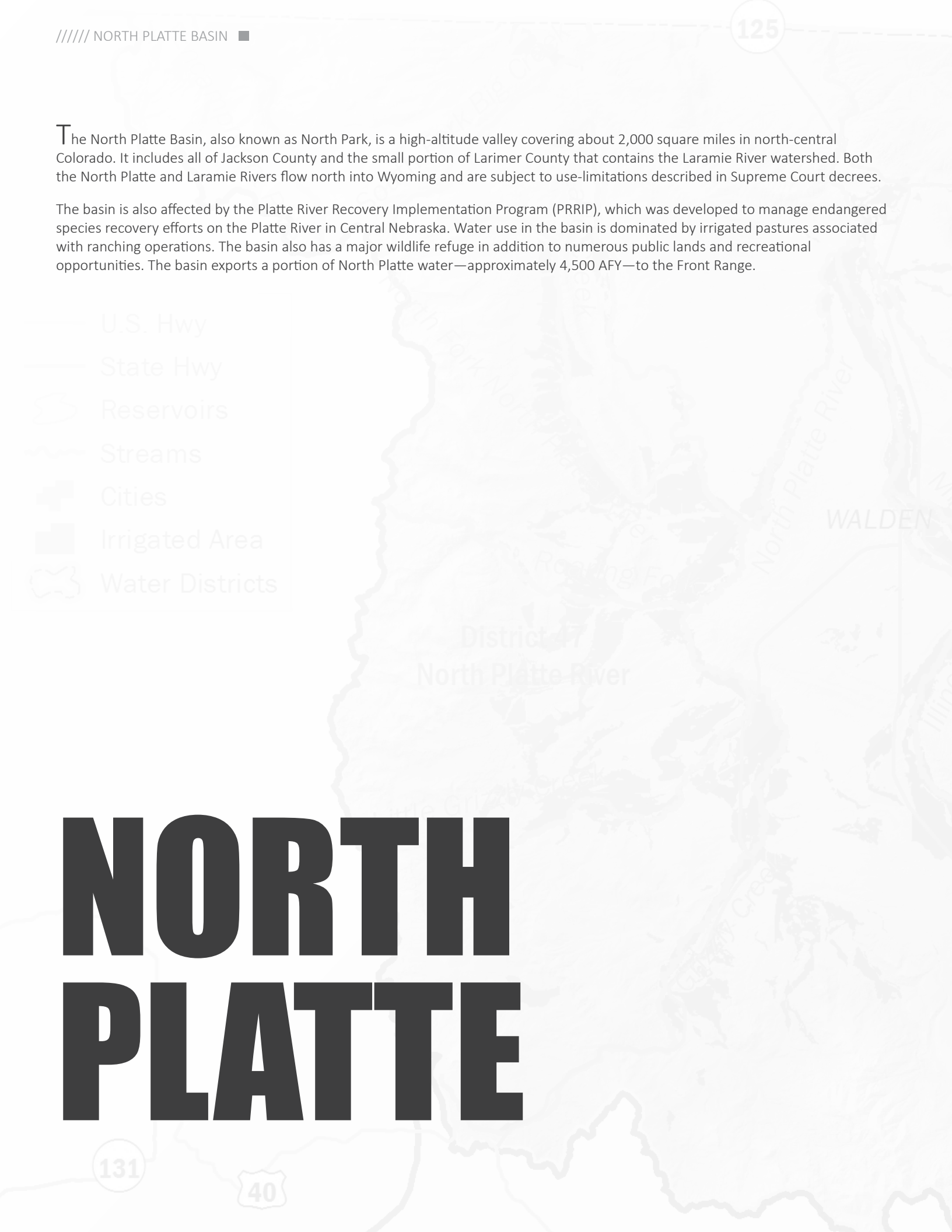
The North Platte Basin, also known as North Park, is a high-altitude valley covering about 2,000 square miles in north-central Colorado. It includes all of Jackson County and the small portion of Larimer County that contains the Laramie River watershed. Both the North Platte and Laramie Rivers flow north into Wyoming and are subject to use-limitations described in Supreme Court decrees.

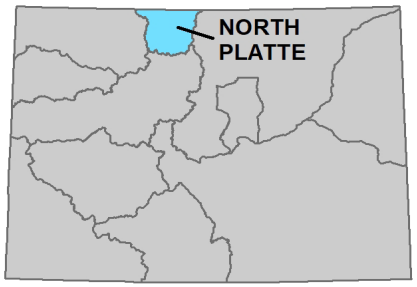
The basin is also affected by the Platte River Recovery Implementation Program (PRRIP), which was developed to manage endangered species recovery efforts on the Platte River in Central Nebraska. Water use in the basin is dominated by irrigated pastures associated with ranching operations. The basin also has a major wildlife refuge in addition to numerous public lands and recreational opportunities. The basin exports a portion of North Platte water—approximately 4,500 AFY—to the Front Range.



NORTH PLATTE


District 76
Sand Creek
127
Sand Creek
Laramie River
District 48
Laramie River
Lost Lake
Barnes Meadow Reservoir
Chambers Lake
14
34
36

4.6 NORTH PLATTE BASIN RESULTS



4.6.1 BASIN CHALLENGES

The North Platte Basin will face several key issues and challenges pertaining to water management, endangered species, and resource development in the future. These are described in The Colorado Water Plan and summarized below.

Table 4.6.1 Key Future Water Management Issues in the North Platte Basin

Agriculture	Environment and Recreation	Municipal and Industrial	Compacts and Administration
• Gaining knowledge of the basin's consumptive uses and high-altitude crop coefficients.	• Maintaining healthy rivers through the strategic implementation of projects that meet prioritized nonconsumptive needs. • Enhancing forest health and management efforts for wildfire protection and beetle-kill effects.	• Increasing economic development and diversification through strategic water use and development.	• Maintaining compliance with the equitable apportionment decrees on the North Platte* and Laramie** rivers that quantify the amount of available water and lands that can be irrigated. • Successfully resolving endangered species issues on the Platte River in Central Nebraska through the PRRIP in a manner that does not put pressure on water users to reduce existing uses. • Promoting water-rights protection and management through improved streamflow-gaging data.
• Continuing to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies. • Quantifying and strategically developing available unappropriated waters within the basin.			

**The North Platte decree limits total irrigation in Jackson County to 145,000 acres and allows 17,000 AF reservoir storage annually during the irrigation season. In addition, the decree limits exports from the basin within Colorado to 60,000 AF over 10 years.*
***The Laramie River decree limits Colorado's total diversions and exports from the Laramie River to 39,750 AFY, divided among specific water facilities.*

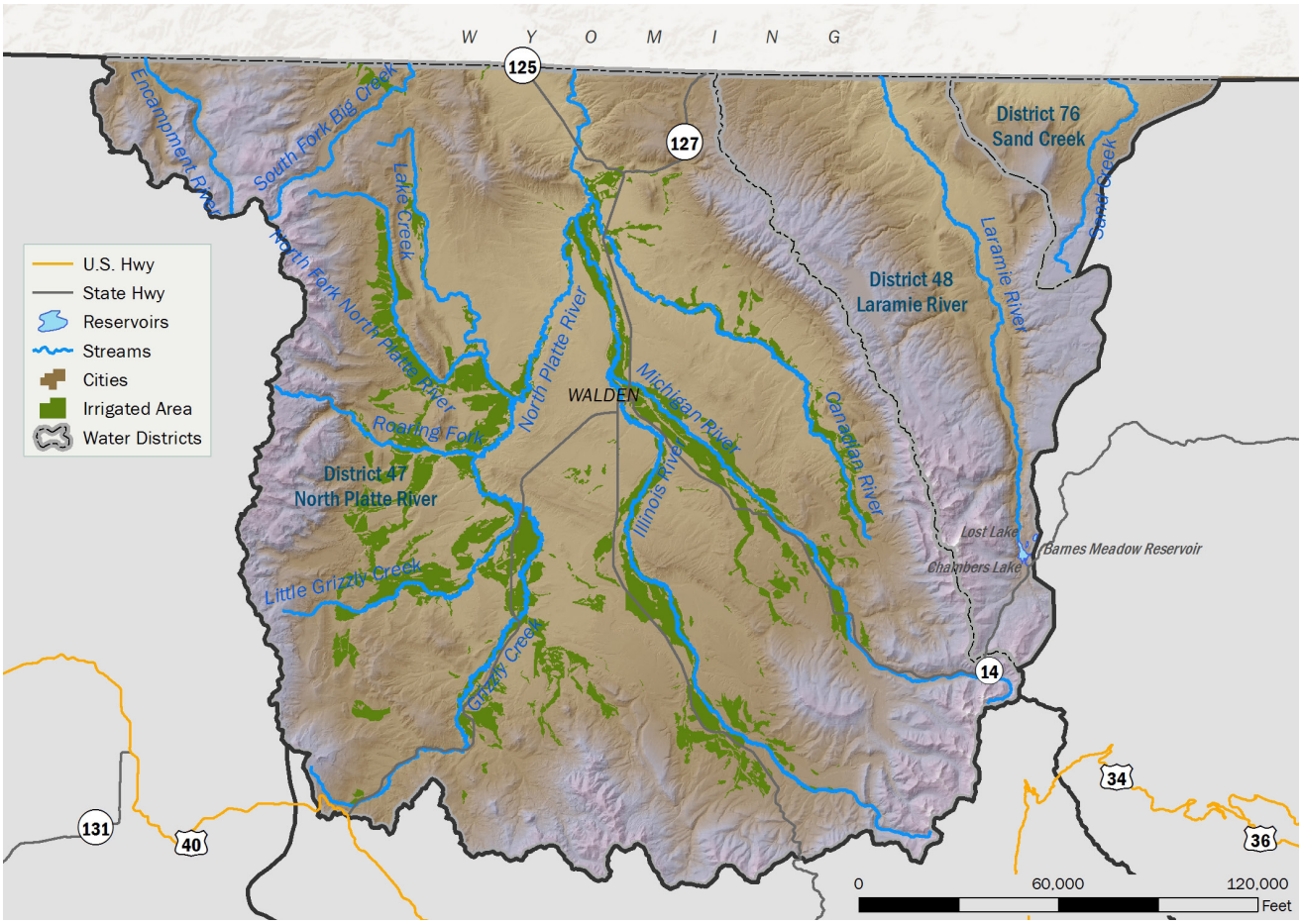


Figure 4.6.1 Map of the North Platte Basin

4.6.2 SUMMARY OF TECHNICAL UPDATE RESULTS

Key results and findings of the Technical Update pertaining to agricultural and M&I demands and gaps, as well as findings related to environmental and recreational attributes and future conditions, are summarized in Table 4.6.2 below.

Table 4.6.2 Summary of Key Results in the North Platte Basin

Agriculture	Environment and Recreation	Municipal and Industrial
• An additional 10,600 acres will increase agricultural demand in the future. • Although some technology improvements may occur, climate impacts may increase the agricultural demands and gap by 8 to 14 percent.	• In climate-impacted scenarios, peak flow generally moves earlier in the year. • Risks for trout increase in climate-impacted scenarios.	• Relatively small M&I demands are a reflection of the rural nature of this basin. There is little anticipated municipal growth, and no SSI water demand now or projected for the future.

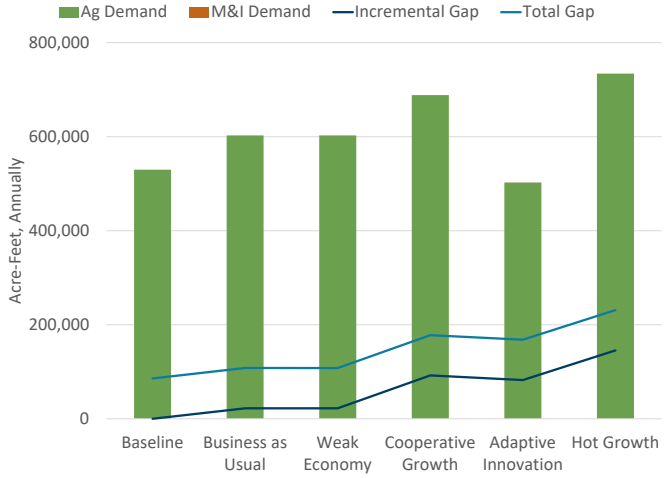
Results describing current and potential future M&I and agricultural demands and gaps are summarized in Table 4.6.3 and in Figure 4.6.2.

Table 4.6.3 Summary of Diversion Demand and Gap Results in the North Platte Basin

	Current (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Average Annual Demand						
Agricultural (AFY)	529,200	602,400	602,400	688,300	502,300	733,500
M&I (AFY)	400	400	300	300	400	500
Gaps						
Ag (avg %)	16%	18%	18%	26%	33%	32%
Ag (incremental-AFY)	-	22,200	22,200	92,100	82,400	145,400
Ag (incremental gap as % of current demand)	-	4%	4%	17%	16%	27%
M&I (max %)	0%	4%	4%	4%	5%	10%
M&I (max-AF)	0*	20	10	10	20	50

**CDSS water allocation model in this basin calculates small baseline M&I gaps, but they are either due to calibration issues or they are reflective of infrequent, dry-year shortages that are typically managed with temporary demand reductions, such as watering restrictions.*

Figure 4.6.2 Summary of Diversion Demand and Gap Results in the North Platte Basin



Environmental and Recreational Findings

- Peak flows are projected to shift earlier in the year (April and May flows increase, offsetting June flow decreases) while magnitude may remain similar, keeping riparian/wetland and risk to fish habitat low to moderate. Possible mis-matches between peak flow timing and species needs may occur.
- Mid- and late-summer flows in North Park are moderate risk for trout under natural conditions, moderate to high risk under baseline conditions, and are projected to become high and very high risk for trout under *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth.*

4.6.3 NOTABLE BASIN CONSIDERATIONS

- Irrigation demands reflect full season demand, but basin irrigators generally end irrigation earlier in the season. In general, North Platte Basin irrigators tend to get a first cutting of grass/hay around mid-July; falling stream flow conditions in late summer and, in some years, early frosts can make it difficult to get a second cutting. In addition, many farmers do not have access to supplemental storage that would provide late-season supplies. If this trend continues, agricultural gaps may not be as large as projected.
- The Technical Update used water allocation models that reflect a strict application of water administration. In the North Platte Basin, some water users refrain from placing a call to share the benefit of available supplies, but these practices are not reflected in the models
- SSI water demands for fracking are not included in the overall M&I diversion demands. Water demand data for fracking was researched, but reliable sources of data were not found. The M&I diversion demands technical memorandum includes a recommendation to improve this dataset.

4.6.4 AGRICULTURAL DIVERSION DEMANDS

Agricultural Setting

Ranchers in the North Platte River and Laramie River basins irrigate more than 113,000 acres of grass and hay to support numerous cow-calf operations throughout the basin. These high mountain meadows are generally flood irrigated, and with limited storage in the basin irrigators rely on diversions of spring and summer runoff for supplies. With low population projections for the basin, future agricultural diversion demands in the basin will be most impacted by the ability to maintain and even increase irrigated acreage and potential impacts from climate change.

Planning Scenario Adjustments

Section 2 described ways in which inputs to agricultural diversion demand estimates were adjusted to reflect the future conditions described in the planning scenarios. The North Platte BIP identifies parcels of historically irrigated or potentially irrigable land that may be irrigated in the future if infrastructure improvements are made and water rights secured. Altogether, the North Platte BIP identified seven planned agricultural development projects throughout the basin that totalled a potential increase of 10,576 irrigable acres. Due to a short growing season and the prevalence of irrigated pasture grass related to ranching operations in the basin, it is reasonable to assume that these planned agricultural projects will also be operated for hay and cattle ranching. The North Platte basin roundtable consistently emphasizes the importance of maintaining and increasing irrigated acreage in the basin allowable under the Nebraska v. Wyoming Equitable Apportionment Decree and foresees implementing the planned agricultural projects in all planning scenarios.

Table 4.6.4 summarizes the planning scenario adjustments described above and other adjustments that impact agricultural diversion demands in the various scenarios, including increased irrigated acres.

Table 4.6.4 Planning Scenario Adjustments for Agricultural Demands in the North Platte Basin

Adjustment Factor*	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Change in Irrigated Land due to Urbanization	-	-	-	40 Acre Reduction	40 Acre Reduction
Planned Agricultural Development Projects	10,576 Acre Increase	10,576 Acre Increase	10,576 Acre Increase	10,576 Acre Increase	10,576 Acre Increase
IWR Climate Factor	-	-	25%	39%	39%
Emerging Technologies	-	-	-	10% IWR Reduction 10% System Efficiency Increase	-

** See Section 2.2.3 for descriptions of adjustment methodologies and assumptions*

Agricultural Diversion Demand Results

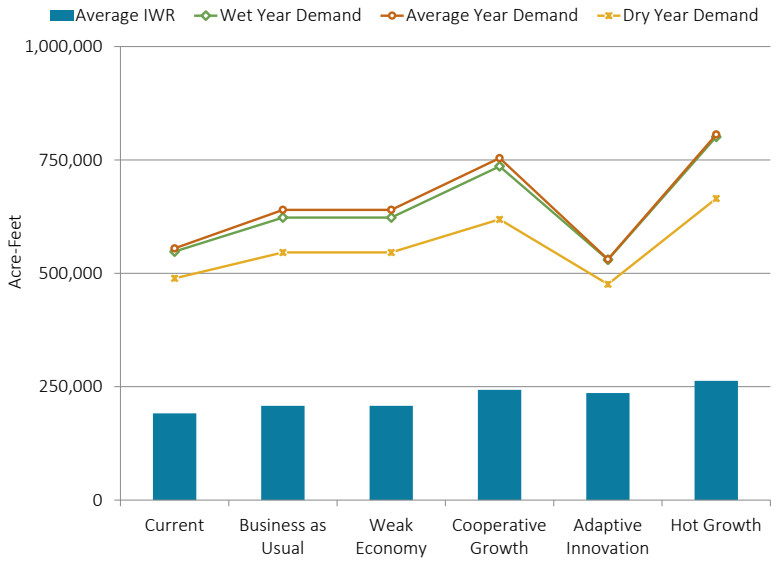
Table 4.6.5 and Figure 4.6.3 summarize the acreage, IWR, and the agricultural diversion demand for surface water supplies in the North Platte Basin for current conditions and the five planning scenarios. Agricultural diversion demands are projected to increase by 2050 due to additional irrigated acres; however, despite increased irrigated acres, *Adaptive Innovation* projects decreased demands as compared to baseline due to 10 percent reduction in IWR and 10 percent increase to system efficiency. *Hot Growth* projected the largest increase in demand due to higher IWR resulting from a warmer and drier future climate.

Table 4.6.5 Summary of Agricultural Diversion Demand Results in the North Platte Basin

	Current (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Irrigated Acreage (acres)	113,600	124,200	124,200	124,200	124,200	124,200
Average IWR (AFY)	191,100	208,000	208,000	243,000	236,000	263,000
Diversion Demand						
Average Year (AFY)	555,000	640,000	640,000	754,000	531,000	806,000
Wet Yr. Change	-1%	-3%	-3%	-2%	0%	-1%
Dry Yr Change	12%	15%	15%	18%	10%	17%

Average agricultural demand is calculated from the average of the "average" hydrologic years from 1950-2013

Figure 4.6.3 Summary of Agricultural Diversion Demand Results in the North Platte Basin



4.6.5 Municipal and Self-Supplied Industrial Diversion Demands

Population Projections

The North Platte Basin includes about 0.02 percent of the statewide population. Between the years 2015 and 2050, it is projected to change from approximately 1,400 to between 1,100 and 1,500 people in the low and high growth projections, respectively. This ranges from a 22 percent decrease in population to an increase of 8 percent. On a basin scale, the North Platte Basin represents the lowest baseline population and the lowest basinwide growth in the state. Table 4.6.6 shows how population growth is projected to vary for the North Platte Basin under each planning scenario.

Table 4.6.6 North Platte Basin 2015 and Projected Populations

Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
1,353	1,279	1,055	1,210	1,364	1,457

Current Municipal Demands

The North Platte Basin baseline demands relied entirely on estimated data from neighboring counties. No municipal data were available for utilities within Jackson County, which is the only county in the North Platte Basin.

Figure 4.6.4 summarizes the categories of municipal, baseline water usage in the North Platte Basin. Because there was no water provider-reported data available for Jackson County, the statewide weighted average demand category distribution was used for the North Platte Basin.

Projected Municipal Demands

Figure 4.6.5 provides a summary of per capita baseline and projected water demands for the North Platte Basin. Systemwide, the projected per capita demands are projected to decrease relative to the baseline except for *Hot Growth*. The residential indoor demand is the greatest demand category in the baseline, but the residential outdoor demand exceeds the residential indoor demand in *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth*. Outdoor demands increased significantly for *Hot Growth* due to an increase in outdoor demands driven by the "Hot and Dry" climate factor (described in Section 2).

The North Platte Basin municipal baseline and projected demands provided in Table 4.6.7 show the combined effect of population and per capita demands. Municipal demands are projected to grow from approximately 400 AFY in 2015 to between 300 and 440 AFY in 2050.

The baseline and projected municipal demands are shown in Figure 4.6.6, which also shows how the population varies between the scenarios. *Hot Growth* is the only planning scenario in which the projected demands increase from the baseline; all other planning scenarios show an overall decrease in demands by 2050.

DECREASING GPCD

The North Platte Basin average baseline per capita systemwide demand has decreased from 310 gpcd in SWSI 2010 to approximately 264 gpcd.

Figure 4.6.4 Categories of Water Usage in the North Platte Basin

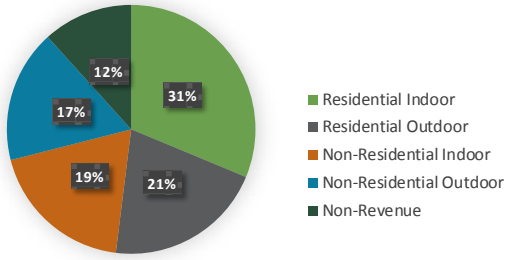


Figure 4.6.5 North Platte Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category

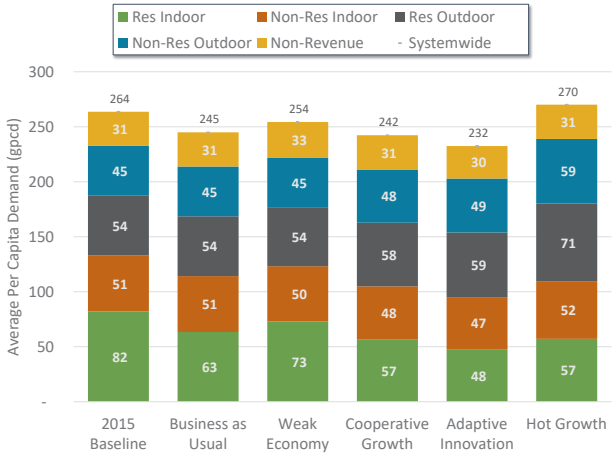


Figure 4.6.6 North Platte Basin Baseline and Projected Population and Municipal Demands

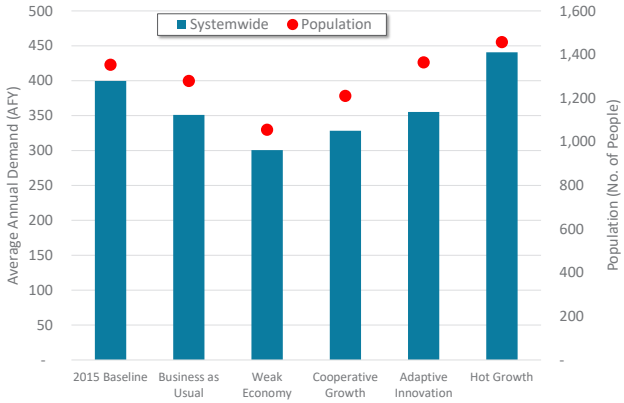


Table 4.6.7 North Platte Basin Municipal Baseline and Projected Demands (AFY)

Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
400	350	300	330	360	440

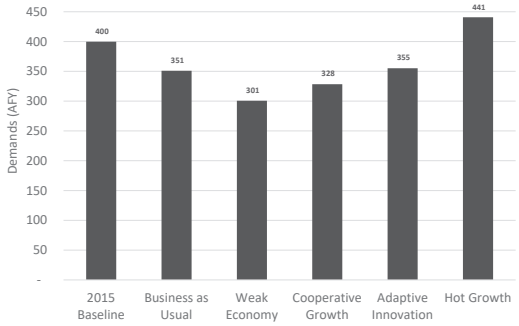
Self-Supplied Industrial Demands

The analysis does not include baseline and projected industrial demands in the North Platte Basin. Water demands for fracking occur in the basin, but no reliable sources of data were identified that could be used to quantify the water demands.

Total M&I Diversion Demands

North Platte Basin combined M&I demand projections for 2050 range from approximately 300 AFY under *Weak Economy* to 440 AFY in *Hot Growth*, as shown in Figure 4.6.7. On a basin scale, the demand projections follow the statewide sequence of the scenario rankings described in the CWP.

Figure 4.6.7 North Platte Basin Municipal and Self-Supplied Industrial Demands



4.6.6 Water Supply Gaps

The agricultural and M&I diversion demands were compared against available water supply modeled for current conditions and the five planning scenarios. Gaps were calculated when water supply was insufficient to meet demands.

Agricultural

The North Platte Basin agricultural diversion demands, demand gaps, and consumptive use gaps for the baseline and planning scenarios are presented in Table 4.6.8 and illustrated on Figure 4.6.8. An annual time series of gaps in terms of percent of demand that was unmet is shown on Figure 4.6.9.

INCREMENTAL GAP

The incremental agricultural gap quantifies the degree to which the gap could increase beyond what agriculture has historically experienced under water shortage conditions.

Table 4.6.8 North Platte Basin Agricultural Gap Results (AFY)

		Scenario					
		Scenario	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Average	Average Annual Demand	529,200	602,400	602,400	688,300	502,300	733,500
	Average Annual Gap	85,700	108,000	107,900	177,900	168,100	231,100
	Average Annual Gap Increase from Baseline	-	22,200	22,200	92,100	82,400	145,400
	Average Annual Percent Gap	16%	18%	18%	26%	33%	32%
	Average Annual CU Gap	40,300	50,800	50,800	83,600	92,000	108,500
Maximum	Demand in Maximum Gap Year	521,600	582,400	582,400	659,400	494,900	694,000
	Gap in Maximum Gap Year	296,900	336,700	336,700	394,800	320,800	441,000
	Increase from Baseline Gap	-	39,800	39,700	97,900	23,800	144,100
	Percent Gap in Maximum Gap Year	57%	58%	58%	60%	65%	64%

Study period for Water Supply Analysis is 1975-2013, reflecting different baseline demand than described in Agricultural Diversion Demands section

Figure 4.6.8 Projected Average Annual Agricultural Diversion Demand, Demand Met, and Gaps in the North Platte Basin

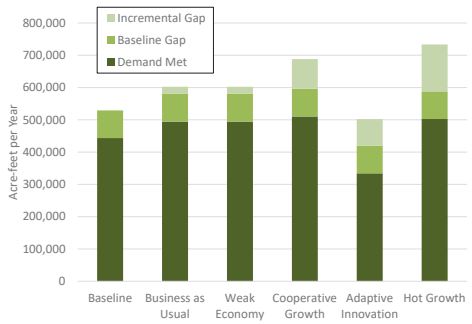
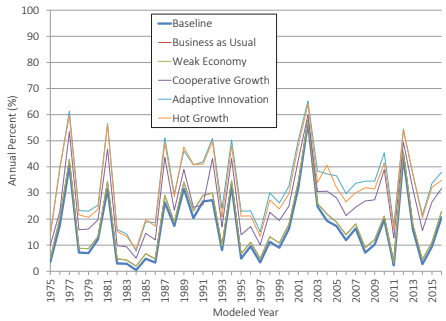


Figure 4.6.9 Annual Agricultural Gaps (expressed as a percentage of demand) for Each Planning Scenario



Observations on agricultural demands and gaps include:

- An additional 10,600 acres will increase agricultural diversion demand in the future.
- Although some technology improvements may occur, climate impacts will serve to increase the agricultural gap by 8 to 16 percent.
- Annual agricultural gaps can vary significantly and are more pronounced in dry years.

M&I

The diversion demand and gap results for M&I in the North Platte Basin are summarized in Table 4.6.9 and illustrated on Figure 4.6.10. An annual time series of gaps in terms of percent of demand that was unmet is shown on Figure 4.6.11.

Table 4.6.9 North Platte Basin M&I Gap Results (AFY)

		Scenario					
		Scenario	**Business as Usual**	**Weak Economy**	**Cooperative Growth**	**Adaptive Innovation**	**Hot Growth**
Average	Average Annual Demand	400	370	310	350	380	460
	Average Annual Gap	0	0	0	1	2	21
	Average Annual Percent Gap	0%	0%	0%	0%	1%	5%
Maximum	Demand in Maximum Gap Year	400	370	310	350	380	460
	Gap in Maximum Gap Year	0*	15	13	13	18	45
	Percent Gap in Maximum Gap Year	0%	4%	4%	4%	5%	10%

** CDSS water allocation model in this basin calculates small baseline M&I gaps, but they are either due to calibration issues or they are reflective of infrequent, dry-year shortages that are typically managed with temporary demand reductions, such as watering restrictions.*
Study period for Water Supply Analysis is 1975-2013, reflecting different baseline demand than described in M&I Demand section.

Figure 4.6.10 Projected Maximum Annual M&I Demand Met and Gaps in the North Platte Basin

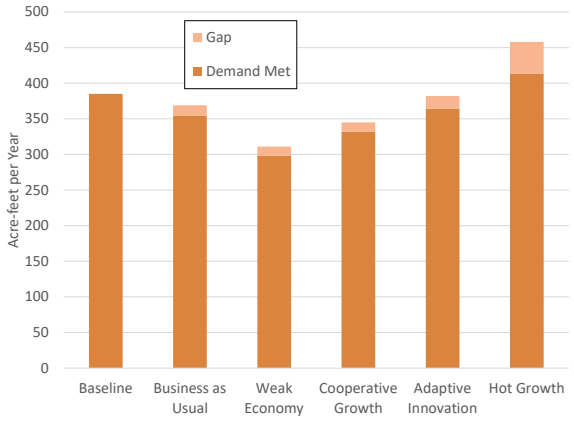
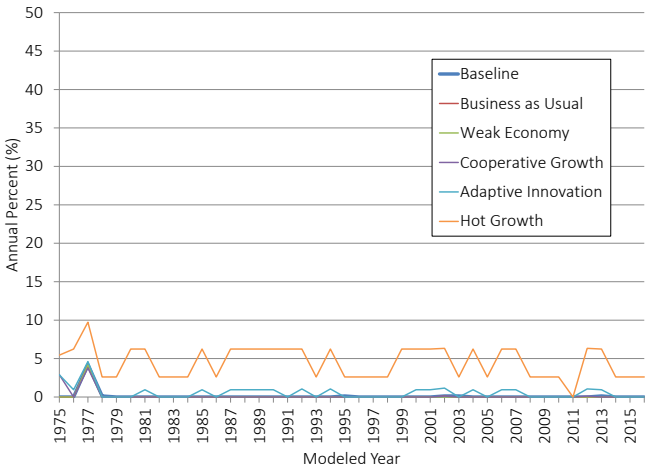


Figure 4.6.11 Annual M&I Gaps (expressed as a percent of demand) for Each Planning Scenario



The following are observations on M&I diversion demands and gaps:

- Relatively small M&I demands are a reflection of the rural nature of this basin. There is little anticipated municipal growth.
- Consistent M&I gaps are only present in *Hot Growth*.

Total Gap

Figure 4.6.12 illustrates the total combined agricultural and M&I diversion demand gap in the North Platte Basin. The figure combines the average annual baseline and incremental agricultural gaps and the maximum M&I gap. In all future scenarios, gaps are driven by agricultural demands, which increase due to more irrigated acres and climate impacts.

Supplies from Urbanized Lands

By 2050, irrigated acreage in the North Platte Basin is projected to decrease by only 40 acres due to urbanization, reflecting the rural nature of the basin. These decreases are only projected to occur in *Adaptive Innovation* and *Hot Growth*. Irrigation supplies for these lands could potentially be used for M&I needs in the future (subject to a variety of unknowns such as seniority and type of water supply, willingness to change the use of water through water court, etc.). The average annual historical consumptive use associated with potentially urbanized acreage for each scenario is reflected in Table 4.6.10. The data in the table represent planning-level estimates of this potential supply and has not been applied to the M&I gaps.

Figure 4.6.12 Projected Average Annual Agricultural Gaps and Maximum M&I Diversion Demand Gaps in the North Platte Basin (AFY)

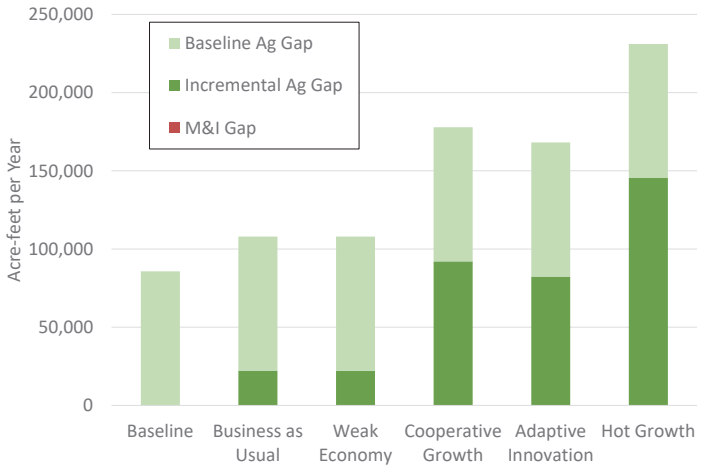


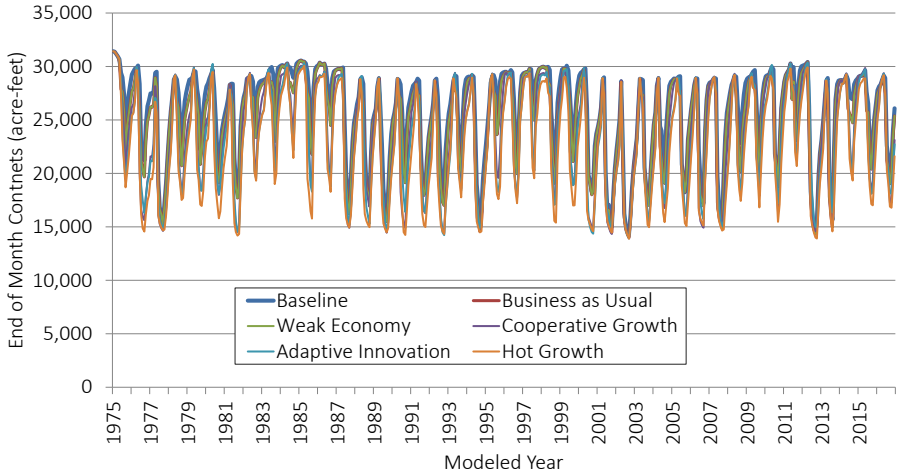
Table 4.6.10 Estimated Consumptive Use from Lands Projected to Be Urbanized by 2050 in the North Platte Basin

	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Urbanized Acreage (acres)	-	-	-	40	40
Estimated Consumptive Use (AFY)	-	-	-	50	50

Storage

Total simulated reservoir storage from the North Platte River water allocation model is shown in Figure 4.6.13. Baseline and *Weak Economy* scenarios show the highest levels of water in storage (in general) and the lowest is in *Hot Growth*; however, storage levels for all future scenarios track closely with baseline throughout the study period.

Figure 4.6.13 North Platte Basin Total Simulated Storage



4.6.7 Available Supply

Figures 4.6.14 and 4.6.15 show simulated available flow at a location on the Lower Michigan River upstream of the confluence with the North Platte River. The location represents water availability near the senior calling rights, which include the Hiho Ditch, Kiwa Ditch, and diversions to storage in Carlstrom Reservoir. Water availability is only moderately impacted by the calling rights, and flows are projected to be available in most years (but vary greatly on an annual basis). Peak flows are projected to increase at this location but could diminish in the late summer in climate-impacted scenarios.

Figure 4.6.14 Simulated Hydrograph of Available Flow at Michigan River at Cumberland Ditch

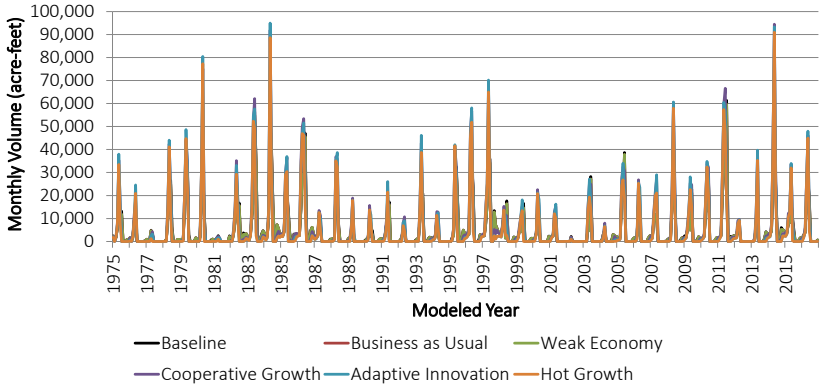
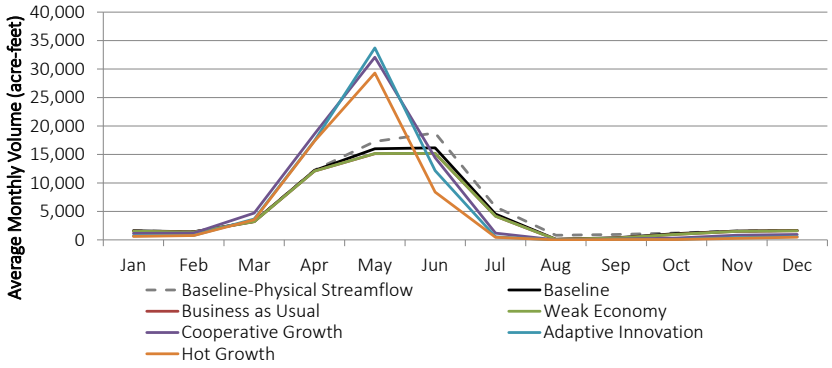


Figure 4.6.15 Average Monthly Simulated Hydrographs of Available Flow at Michigan River at Cumberland Ditch



4.6.8 Environment and Recreation

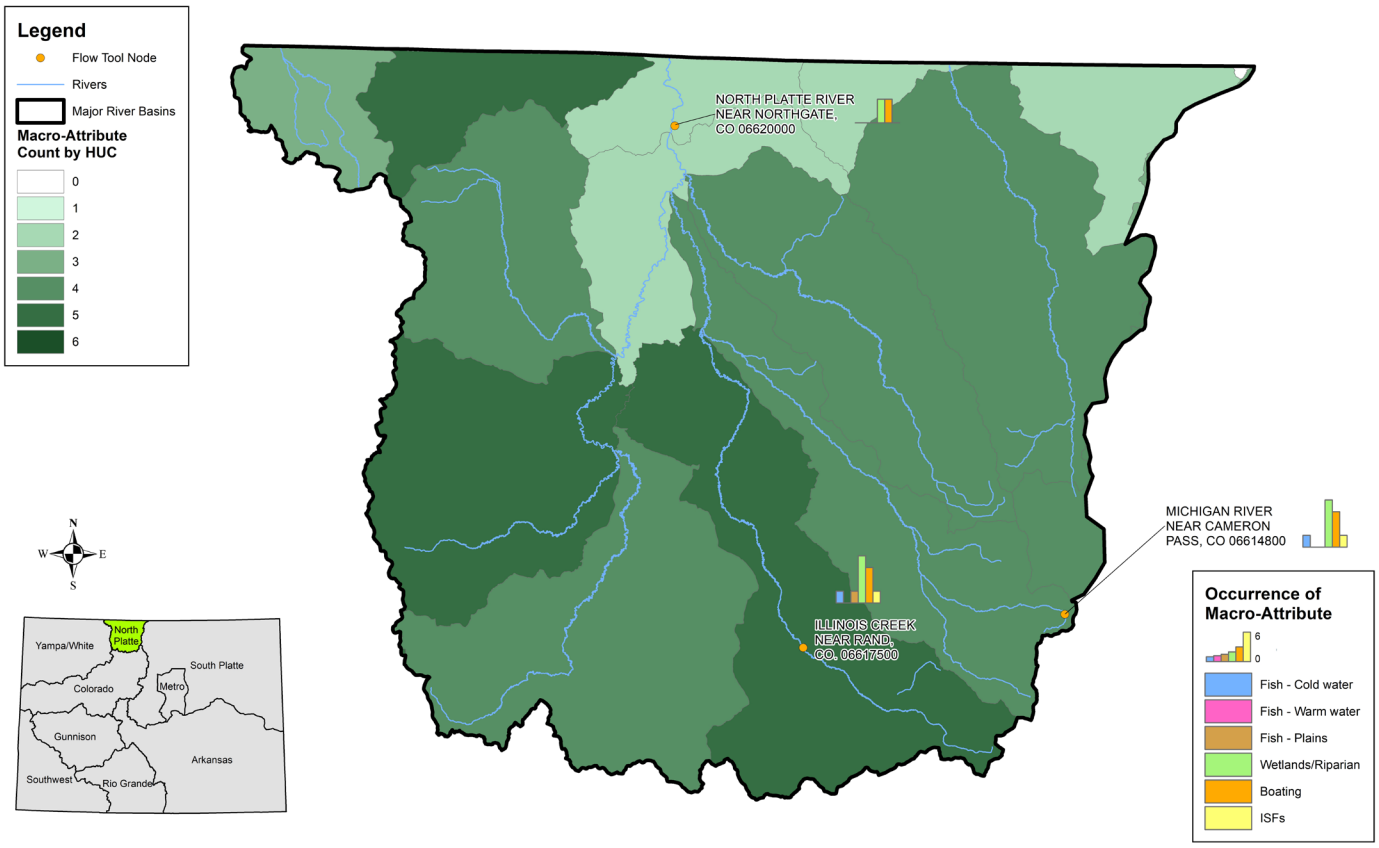
A total of three water allocation model nodes were selected for the Flow Tool within the North Platte Basin (see list below and Figure 4.6.16). Figure 4.6.16 also shows subwatersheds (at the 12-digit HUC level) and the relative number of E&R attributes located in each subwatershed.

- Michigan River near Cameron Pass, Colorado (06614800)
- Illinois Creek near Rand, Colorado (06617500)
- North Platte River near Northgate, Colorado (06620000)

NATURALIZED FLOW

Naturalized flows reflect conditions that would occur in the absence of human activities. Baseline flows reflect current conditions as influenced by existing infrastructure and river operations. While observations regarding naturalized flows may be informative, baseline flows reflect actual conditions and the diverse operations of a river's many users.

Figure 4.6.16 Flow Tool Nodes Selected in the North Platte Basin



Results and observations describing Flow Tool analyses using flow data developed in the water supply and gap analyses for baseline conditions and the planning scenarios are described in Table 4.6.11.

Table 4.6.11 Summary of Flow Tool Results in the North Platte Basin

Category	Observation
Projected Flows	Mean annual flows in North Platte Basin under baseline conditions are 20 to 35 percent below naturalized conditions.
	Unlike all other basins analyzed, mean annual flow changes little under all scenarios, including climate change scenarios.
	Although there is little projected change in mean annual flow in future scenarios compared to baseline, peak flows do change. Peak flow magnitude under baseline conditions are approximately 15 percent below naturalized conditions at higher elevations and decrease further below naturalized conditions where the North Platte leaves Colorado near North Gate.
	Under *Business as Usual* and *Weak Growth*, projected peak flows change little. Under scenarios with climate change, peak flow magnitude may increase slightly. The timing of peak flows is also projected to change, shifting earlier in the year (April and May flows increase, offsetting June flow decreases).
	Under baseline conditions, mid- and late-summer flows in North Park are 30 to 60 percent below naturalized conditions, depending on location. This condition may not be as ideal for trout as many other locations in Colorado at similar elevation. Under climate change scenarios, mid- and late-summer flows are likely to decline further.
Ecological Risk	Baseline peak flow magnitudes create some risk for maintaining riparian/wetland plants and fish habitat, but this risk may lessen under climate change scenarios as peak flow magnitude increases. However, earlier and larger peak flows may lead to lower mid- and late-summer flows, and these lower flows could increase risk for trout under *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth*. Also, the change in peak flow timing under climate change scenarios may lead to mis-matches between peak flows and species' needs.