Appendix C – Environmental and Recreational Impact from Agricultural and Urbanization Trends

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin Roundtable

April 17, 2015

Contents

Tables

Figures

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Environmental and Recreational Impact from Agricultural and Urbanization Trends

The agricultural and urbanization historical and future trends in the South Platte River were analyzed to assess the potential impact to environmental and recreational attributes currently and in the future. The review and analysis of these trends is described in detail in this technical memorandum.

1 Agricultural Dry-Up Trends

Section 2.2.2.2 describes the SWSI analysis used to estimate the projected amount of irrigated acres dried up in the South Platte and Metro Basins by 2050. The BIP planning effort developed an additional approach for projecting future dry-up trends based on the historical rate of dry-up. Historical rates of dry-up were estimated on a county-by-county basis and applied to project the future dry-up of irrigated acres by 2050. This appendix provides the details of this approach.

Reference Documents

The following discussion is based upon:

SWSI 2010 South Platte Basin Report Basinwide Consumptive and Nonconsumptive Water Supply Needs Assessments- and the Colorado Decision Support System Irrigated Agriculture spatial data.

The SWSI 2010 estimated irrigated dry-up acreage is greater than that identified by the historical trends. Therefore this methodology was used to determine an estimate of where dry-up may occur in the future.

1.1 Historical Trends

The historical dry-up of irrigated acres was evaluated from 1950 to 2010 using the Colorado Decision Support System (CDSS) GIS coverages of irrigated acres. The CDSS GIS coverages provide snapshots of irrigated acres in 1956, 1976, 1987, 2001, 2005 and 2010. Table 2-1 shows the total amount of acres irrigated with surface water and groundwater within each county of the South Platte and Metro Basins.

Table 1-1 - Historical Irrigated Acres by County

Counties	1956	1976	1987	2001	2005	2010
Adams	44,304	46,556	42,098	32,028	27,717	28,273
Arapahoe	3,950	3,251	2,676	3,081	2,977	2,576
Boulder	71,103	62,947	60,920	46,244	42,521	44,665
Broomfield	2,992	2,462	3,034	1,677	955	1,121
Clear Creek	156	156	144	23	23	23
Denver	1,282	1,188	1,543	591	365	365

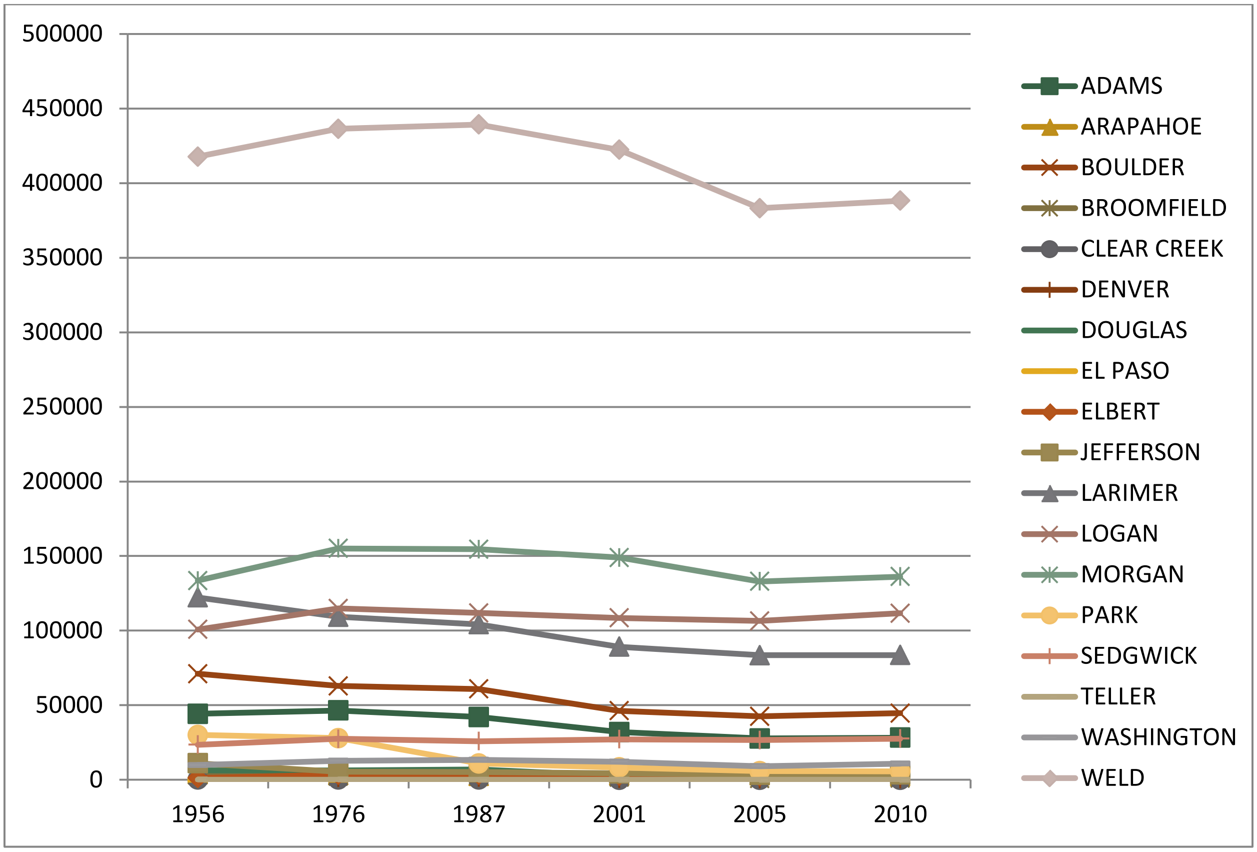
Counties	1956	1976	1987	2001	2005	2010
Douglas	6,434	6,295	6,994	2,666	2,180	2,492
El Paso	-	8	253	135	133	142
Elbert	1,279	3,532	3,406	2,732	2,323	3,163
Jefferson	11,111	5,468	5,227	4,374	3,431	3,623
Larimer	122,236	109,302	104,195	89,186	83,480	83,684
Logan	100,769	114,854	111,869	108,548	106,486	111,642
Morgan	133,485	155,069	154,510	148,994	132,946	136,196
Park	30,050	27,901	11,009	8,363	5,897	5,779
Sedgwick	23,496	27,568	25,858	27,220	26,683	27,590
Teller	157	135	103	64	60	68
Washington	9,945	12,820	13,445	12,176	9,156	10,896
Weld	417,647	436,323	439,219	422,288	383,084	388,123
Totals	980,394	1,015,834	986,502	910,391	830,416	850,422

Source: CDSS Irrigated Acres GIS Data. Accessed at: http://cdss.state.co.us/GIS/Pages/Division1SouthPlatte.aspx

Irrigation tended to increase from 1950 to 1976 as irrigators started to rely on groundwater pumping. In the 1970s, the increase in pumping leveled off, yet the urban Front Range continued to grow. This resulted in a decrease in irrigated acres. Urban areas were developed on lands formerly used for irrigated agriculture and municipalities began to purchase senior agricultural water rights to meet growing demands. These senior agricultural water rights were transferred from irrigation to municipal use, resulting in the permanent dry-up of the irrigated lands.

Beginning in 2002 due to the drought and stricter water rights administration, the requirement to replace depletions from junior groundwater pumping in the South Platte Basin was strictly enforced, resulting in the curtailment of junior groundwater users who did not have a temporary substitute water supply plan or an augmentation plan to replace out-of-priority pumping depletions. Initially, many groundwater users were required to cease pumping. This is reflected in Table 2-1 and Figure 2-1, where the irrigated acres for some counties are relatively low in 2005. However, the irrigated acreage increases in 2010 once some groundwater users were able to obtain augmentation plans and again pump wells for irrigation.

Figure 1-1 Irrigated Acreages by County and Year (based on CDSS GIS coverages)



For purposes of the BIP agricultural dry-up projection trends, the historical period of 1976 to 2010 was selected as the timeframe most conducive for projecting future agricultural dry-up. This period excludes the development of groundwater pumping in the 1950s and 1960s. Also, using 2010, rather than the year with the least irrigated acreage (2005), excludes the lowering in groundwater use that was seen in 2005, due to the drought and stricter administration.

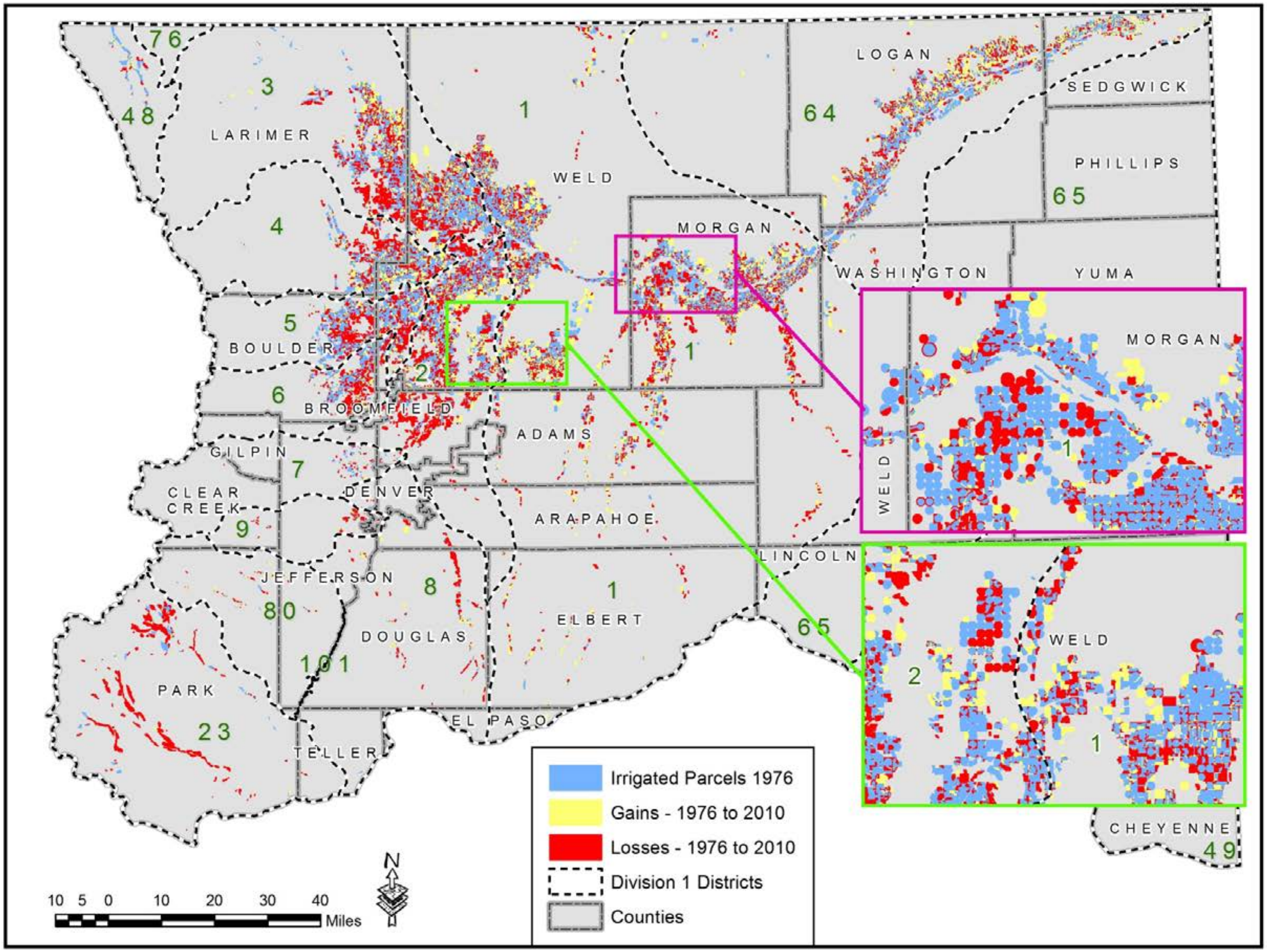
Figure 2-2 shows the changes in irrigated acres in the South Platte and Metro Basins from 1976 to 2010. The areas highlighted in yellow and red, show the areas where new irrigation was developed and where formerly irrigated areas were dried up, respectively. Table 2-2 shows the average annual rate of acres dried up and the percentage of irrigated acres dried up per county from 1976 to 2010. The counties with the largest percentage of dry up tend to be the counties that experienced the largest amount of urban growth or where municipalities purchased senior agricultural water rights to meet their needs. These include Adams, Broomfield, Clear Creek, Denver, Douglas, Park and Teller counties.

Table 1-2 Rates of Irrigated Acre Dry-Up from 1976 to 2010

Counties	Acre-Feet per Year	% Per Year
Adams	538	1.2%
Arapahoe	20	0.6%
Boulder	538	0.9%
Broomfield	39	1.6%
Clear Creek	4	2.5%
Denver	24	2.0%
Douglas	112	1.8%
El Paso	0	0.0%
Elbert	11	0.3%
Jefferson	54	1.0%
Larimer	753	0.7%
Logan	94	0.1%
Morgan	555	0.4%
Park	651	2.3%
Sedgwick	0	0.0%
Teller	2	1.4%
Washington	57	0.4%
Weld	1,418	0.3%
Totals	4,870	n/a

Source of irrigated acres: CDSS Irrigated Acres GIS Data.
Accessed at: http://cdss.state.co.us/GIS/Pages/Division1SouthPlatte.aspx

Figure 1-2 Dry-Up of Irrigated Acres from 1976 to 2010



1.2 Projection of Future Agricultural Dry-Up

Future agricultural dry-up in 2050 was projected using the historical 1976-2010 rates of irrigation dry-up provided in Table 2-2. For each county, projections were developed based on the following historical rates:

- Acres per year methodology - The average amount of historical dry-up (acres per year shown in Table 2-2) was multiplied by the number of years between 2050 and 2010 (40 years) and subtracted from the amount of irrigated acres in 2010.
- % per year methodology– The average amount of historical dry-up (% per year shown in Table 2-2) was multiplied by the number of 2010 acres and by the number of years between 2050 and 2010 (40 years) and then subtracted from the amount of irrigated acres in 2010.

The results, presented in Figure 2-3, shows the total amount of irrigated acre dried up (in acres) and the % of irrigation acres in the county dried up for the two methods described above. These results indicate that the methodology using the % per year rate resulted in a lower projected dry-up than the methodology using the acres per year rate.

The results also indicate that there is a distinct difference between the number of acres dried up and the percentage of irrigated acres dried up per county. As shown in Figure 2-3, the greatest amount of dry-up on an acre basis is projected to occur in Weld County although the dry-up may only account for 13% to 15% of the county's total irrigated acres. In contrast, the projected number of acres dried-up in Clear Creek County is minimal, yet, if the amount of dry-up continues at the same rate as historically observed, all of the irrigated acres in Clear Creek County will be dried up.

Figures 2-4 and 2-5 spatially show the magnitude of dry-up for each county, for both the acres per year and % per year methodologies. The counties highlighted in red are anticipated to experience the largest percentage of dry-up whereas the green counties are projected to experience no dry-up. Counties highlighted in gray were not included in the analysis. These counties rely on very little to no surface water irrigation and are not included in the CDSS irrigated acres database.

It is important to emphasize that this approach to projecting future irrigation dry-up based on historical trends simply assumes that future dry-up will continue at the average rate observed between 1976 and 2010. Factors that contributed to the historical agricultural dry-up such as water market conditions, urbanization and the transfer of agricultural to municipal water transfer are assumed to be similar to historical conditions. Future efforts to slow or abate the rates of dry-up such as conservation easements and alternative agricultural transfers were not considered in the analysis.

Figure 1-3 Projected Dry-up of Irrigated Acres Based on Historical Trends

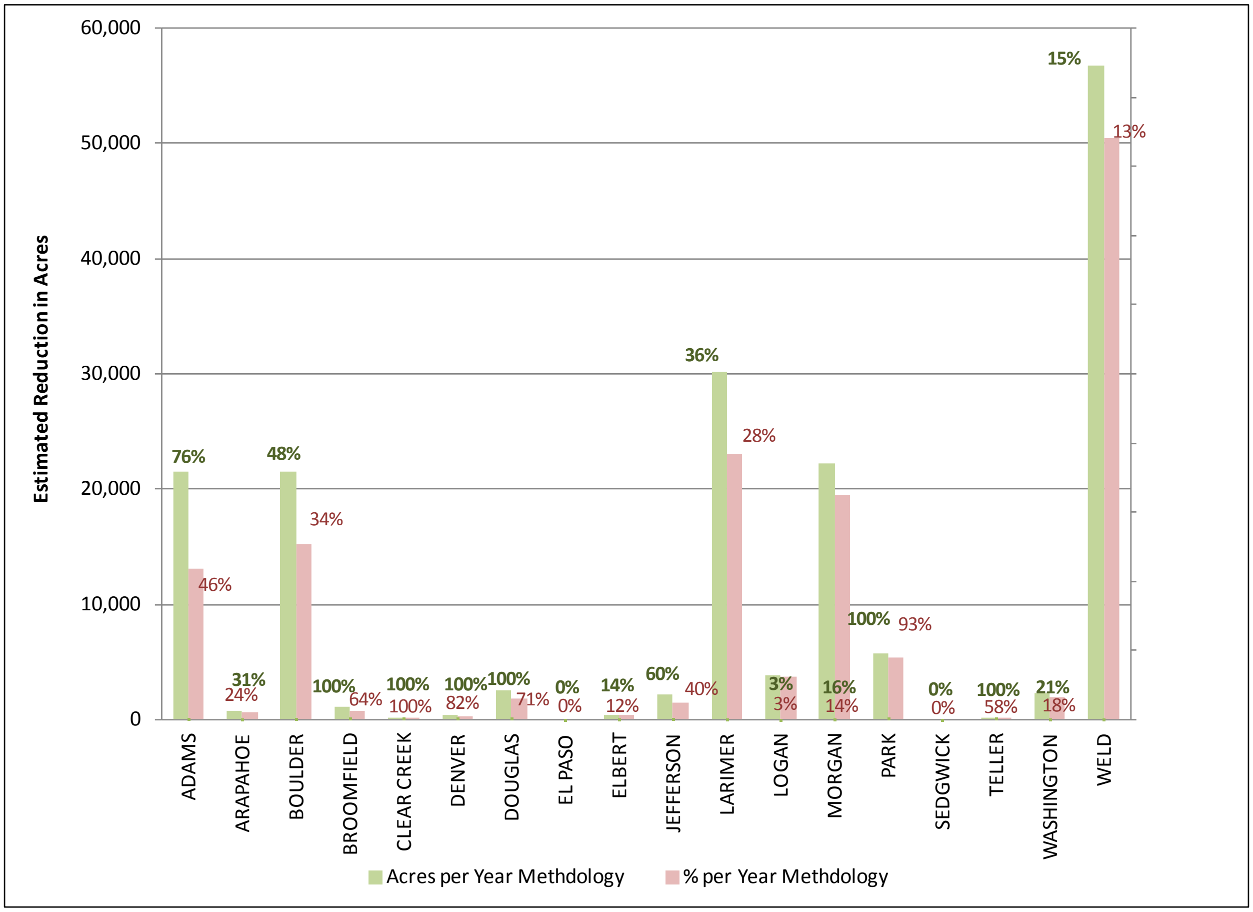


Figure 1-4 Map of Projected Dry-Up for the "Acres per Year" Methodology

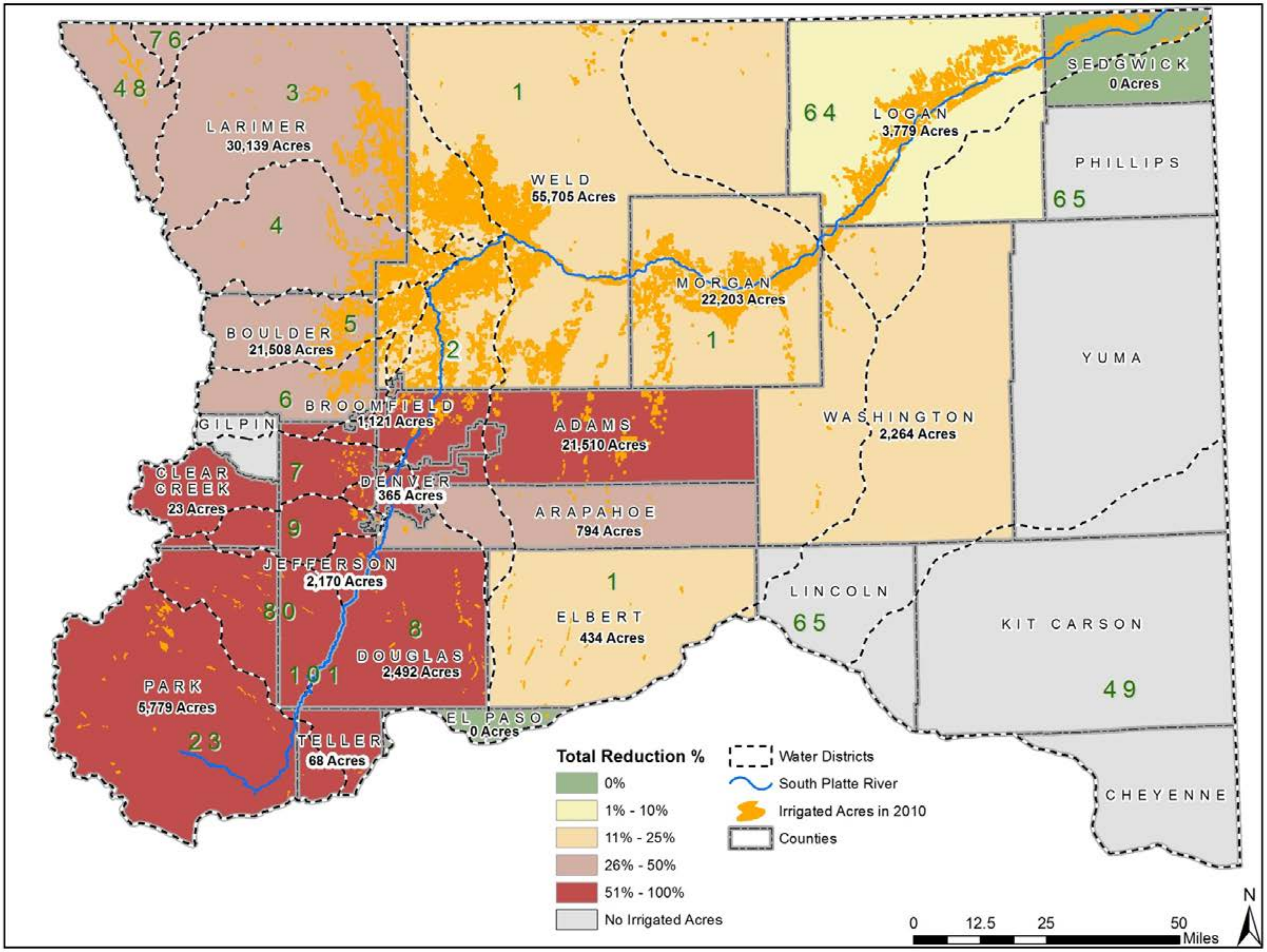
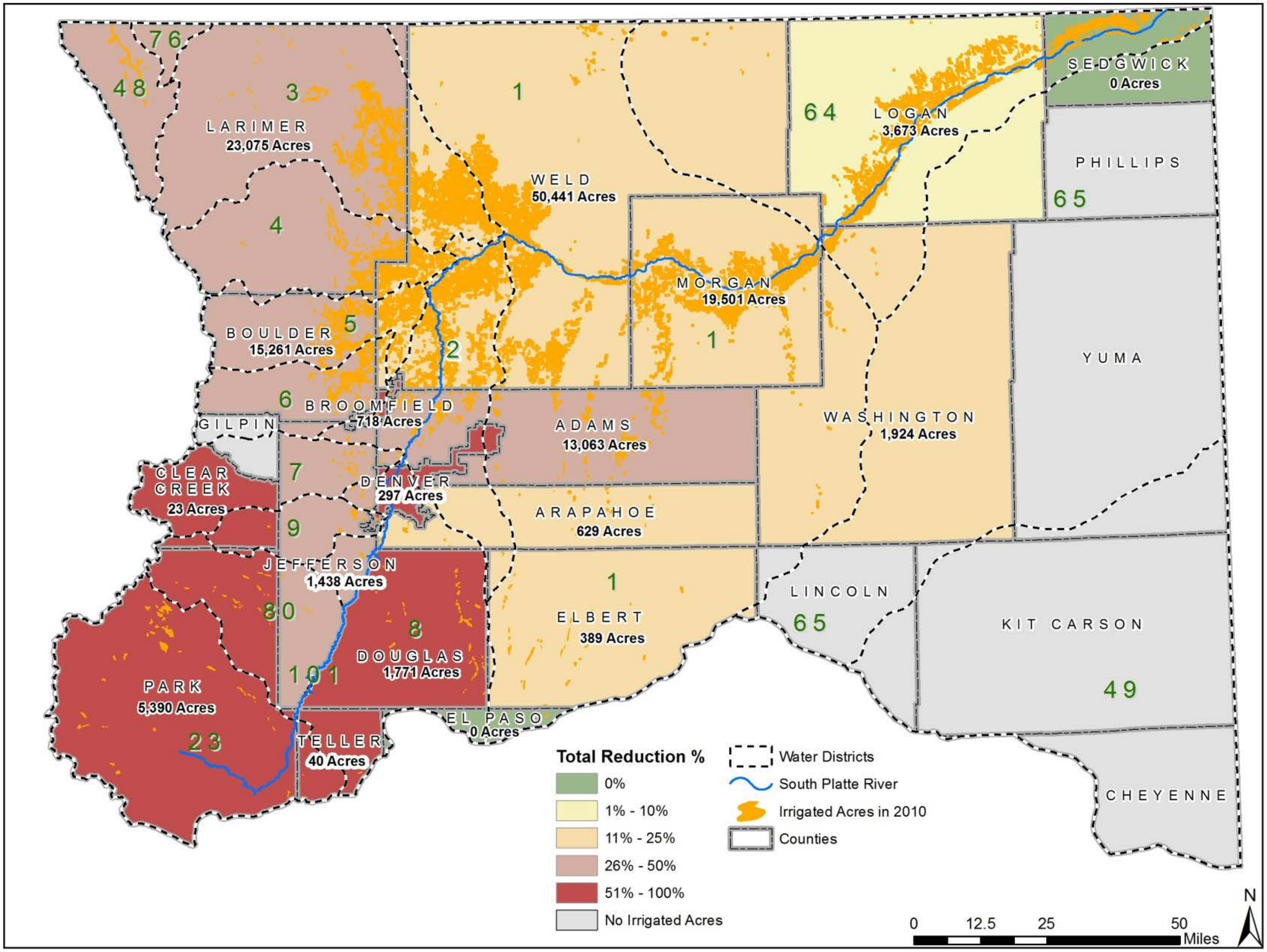


Figure 1-5 Map of Projected Dry-Up for the "% per Year" Methodology



1.3 Comparison with SWSI's Estimates of Irrigation Dry-Up

SWSI 2010 developed estimates of agricultural dry-up through 2010. These results are summarized in Table 2-3. The reductions in irrigated acres associated with urbanization [column 3] and agricultural to municipal transfers to meet the gap [column 6] were quantified based on projections of population and the M&I gap in 2050. The remaining reductions [columns 4 and 5] were based on interviews throughout the South Platte and Metro Basins. With exception to urbanization, which was assessed at a county-level, the SWSI projections in Table 2-3 were conducted on a basin-level. Additional information on the specific methodologies applied to develop these estimates is described in Appendix I of SWSI 2010.

Table 1-3 SWSI 2010 Estimates of Irrigation Dry-up in 2050

Basins [1]	Current Irrigated Acres [2]	Decrease in Irrigated Acres Due to Urbanization* [3]		Decrease in Irrigated Acres Due to Agricultural to Municipal Transfers [4]	Decreases in Irrigated Acres Due to Other Reasons [5]	Decreases in Irrigated Acres Due to Ag Transfers to Meet Gap** [6]		2050 Irrigated Acres Decreases [7]	
		Low	High			Low	High	Low	High
Metro South Platte Basin	831,000	46,939	58,425	19,000	14,000	82,157	144,287	162,157	235,287
Republican Basin	550,000	262	506	0	109,000	0	0	109,262	109,506
SWSI 2010 Total	**1,381,000**	**47,202**	**58,931**	**19,000**	**123,000**	**82,157**	**144,287**	**271,359**	**345,218**

Source: Table 4-9 SWSI 2010 South Platte Basin Report Basinwide Consumptive and Con-consumptive Water Supply Needs

* The decrease in irrigated acres due to urbanization was updated to match the county-wide assessment of irrigated dry-up due to urbanization. (CDM, Excel file: All Basins Urbanization Irrigated Acres Calculations(SMTedits060410).xlsx).

**The dry-up of acres due to agricultural transfers to meet the gap has been updated since the SWSI 2010 publication to correct a former spreadsheet error.

As shown in Table 2-4, the BIP projection using historical trends is less than SWSI's 2010 projections. Therefore, the SWSI 2010 numbers were allocated based upon the SWSI 2010.

Table 1-4 Comparison of the SWSI 2010 and BIP Historical Trend Results for the Metro South Platte Basin

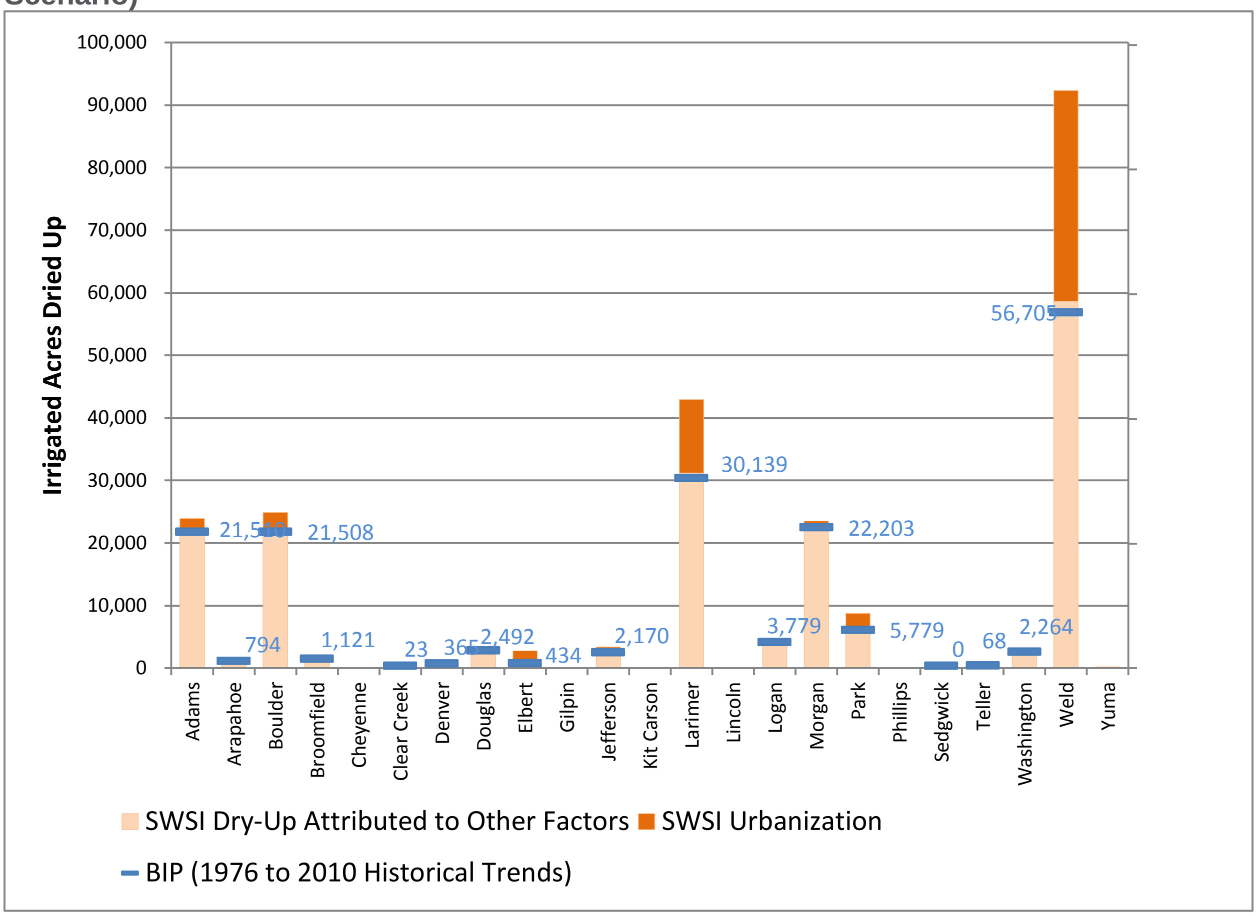
Source	2050 Irrigated Acres Decreases	
	Low	High
SWSI 2010	162,157	235,287
BIP (1976 to 2010 trends)	137,634	171,354

Note: These data do not include the Republican Basin.

Figure 2-6 further refines the BIP and SWSI 2010 projections on a county level showing the amount of SWSI 2010 dry-up acres due to urbanization, the BIP historical projections (using the acres per year methodology) and SWSI's additional estimates of dry-up (itemized in Table 2-3) that do not including urbanization. SWSI's estimate of dry-up (with the exception of urbanization) was prorated on a county-basis using the BIP's county projections of dry-up relative to the total number of acres dried up in the Basin.

This figure provides a possible indication of how many acres might be lost due to urbanization using SWSI's county urbanization data. The figure further indicates the amount of dry-up that might occur if the rates observed for the historical period between 1976 to 2010 continue. Please note, this figure is based upon the proration of SWSI data and individual estimate of dry-up (with the exception of urbanization) has not been done on an individual county level.

Figure 1-6 Comparison of the SWSI 2010 and BIP Historical Trend Results (High Scenario)



1.4 Potential Impacts on Environmental and Recreational Attributes Due to Irrigation Dry-Up Trends

This analysis shows the possible location of future dry-up based upon historical trends. Additional work may be done in further BIP work after the DRAFT BIP to investigate the impacts of these trends. In general, those areas with significant amounts of potential agricultural dry-up could see a reduction in river flows due to changes in water rights out of the area for use in more urbanized areas. While return flows must be maintained for downstream senior calling water rights, those return flows do not need to be replaced if there is not a calling right within a reach of concern. Less agricultural consumptive use downstream could result in reduced streamflows due to the changed water use no longer using the river system to convey the historical agricultural water to the historical agricultural users. Additional work to assess some of these impacts may be done for the revision of the BIP. In addition, increased agricultural dry-up could impact wildlife habitat and wetlands which exist in certain areas as a result of irrigation practices.