



Appendix A – Draft SWSI Glossary

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin
Roundtable

April 17, 2015



The following is an excerpt from the DRAFT SWSI 2016 Glossary with definitions specific to the South Platte Basin Implementation Plan and changes indicated by strikethroughs/brackets and italics.

1 DRAFT SWSI GLOSSARY:

Municipal and Industrial Related Terms:

- **Municipal and Industrial (M&I) Demand:** Water demand for municipal and industrial uses within a municipal distribution system that can be potable, raw and/or reuse water. This includes residential (single family and multi-family) and non-residential (commercial, industrial, institutional) uses of water within a water provider's service area in addition to water loss present in the distribution system.
- **Current M&I Water Demands:** Current treated water deliveries reflective of a typical water year.
- **M&I Water Usage Rate:** gallons per capita per day
- **Municipal and Industrial (M&I) Water Efficiency:** Water efficiency includes the practices, techniques and technologies that extend water supplies either directly through water savings or through substituting alternative supplies such as reuse. M&I water efficiency includes both system demands and customer water demands within a water provider's system.
- **Passive Conservation:** Reductions to the M & I water demand from the natural replacement of indoor plumbing fixtures due to the impacts of plumbing codes, ordinances and standards that change the marketplace and improve the efficiency of water use.
- **Future Population Projection:** One of the low, medium or high population projections dependent on which scenario is used.
- **Future Municipal and Industrial (M&I) Demand:** Water demands for municipal and industrial uses in 2050. This will vary for low, medium, and high project[ion]s dependent on the drivers in the scenarios. This variable is defined by M&I water usage rates applied to future population projections while subtracting passive conservation.
- **M&I Identified Projects and Processes (IPPs):** IPPs must meet the following criteria
 - o The project or method has a project or method proponent.
 - o When the proponent is a retail water provider, the project or method is being used to meet the water supply needs of its customers by 2050.
 - o When the project proponent is a wholesale water provider, at least one retail water provider must express interest in writing and plan on using the project or method to meet the water supply needs of its customers by 2050.
 - o The project or method must have at least preliminary planning, design, conditional or absolute water rights, rights of way, and/or negotiations

captured in writing with local governments that the water project could affect.

- o The water supply needs must be identified and included in the Basin Implementation Plans and/or SWSI documents.
- **M&I Gap:** The amount of future M&I demands not met by *[IPPs and passive conservation]* ~~the no and low regrets~~. This varies both by scenario and by how much the *[IPPs]* ~~no and low regrets~~ are implemented.

Self Supplied Industrial Related Terms

- **Self Supplied Industrial (SSI) Needs:** Water needs for self supplied industrial uses in 2050. This includes demands for large industry, snowmaking, thermoelectric power generation, energy development, and other extraction industries. This will vary for low, medium, and high projects dependent on the drivers in the scenarios.
- **SSI Identified Projects and Processes (IPPs):** IPPs must meet the following criteria
 - o The project or method has a project or method proponent.
 - o The proponent plans for the project or method to be used to meet the water supply needs of its SSI needs by 2050.
 - o The project or method must have at least preliminary planning, design, conditional or absolute water rights, rights of way, and/or negotiations captured in writing with local governments which the water project could effect.
 - o The water supply needs must be identified and included in the Basin Implementation Plans and/or SWSI documents.
- **SSI Gap:** The amount of future SSI needs not met by the SSI IPPs. This varies both by scenario and by how much the IPPs are implemented.

Agricultural Related Terms

- **Current Irrigated Acres:** Acres under irrigation by either surface or groundwater as identified by the most recent inventory.
- **Future Irrigated Acres:** Anticipated acres under irrigation by either surface or groundwater.
- **Irrigation Water Requirement:** Volume of irrigation water required from surface or ground water diversions to completely satisfy a crop's consumptive needs associated with a specific acreage. Calculated as potential evapotranspiration less effective precipitation and stored winter precipitation.
- **Water Supply Limited Consumptive Use:** The amount of water actually used by the crop, limited by water availability; both legal and physical.
- **Agricultural Irrigation ~~Shortage~~ [Gap]:** The difference between Water Supply Limited Consumptive Use and Irrigation Water Requirement. A shortage reflects the fact that consumption to the full extent of IWR was not realized, and reveals

the difference between what could be achieved if yields and irrigable acreage were maximized and what is actually produced under existing legal and physical conditions.

- **Non-irrigation Agricultural Demand:** Agricultural demand that is not directly associated with crop consumption that includes three other types of consumptive use that are associated with agricultural activity: 1) livestock consumptive use, 2) stockpond evaporation, 3) losses incidental to delivering irrigation water (incidental losses).
- **Current Agricultural Demand:** The average amount of water consumptively used by crops on lands currently under irrigation.
- **Future Agricultural Demand:** The average amount of water projected to be consumptively used by crops on lands expected to be under irrigation at some point in the future.
- **Agricultural IPPs (for both irrigation and non-irrigation demand):** IPPs must meet the following criteria:
 - o The project or method has a project or method proponent.
 - o When the proponent is a retail water provider, the project or method is being used to meet the water supply needs of its customers by 2050.
 - o When the project proponent is a wholesale water provider, at least one retail water provider must express interest in writing and plan on using the project or method to meet the water supply needs of its customers by 2050.
 - o The project or method must have at least preliminary planning, design, conditional or absolute water rights, rights of way, and/or negotiations captured in writing with local governments that the water project could affect.
 - o The water supply needs must be identified and included in the Basin Implementation Plans and/or SWSI documents.

Total Consumptive Needs Related Terms

- **Total ~~Consumptive~~ [M&I and SSI] Needs:** Water needs for municipal and industrial (M&I); ~~[and]~~ self supplied industrial (SSI); ~~and agriculture~~ in 2050. This will vary for low, medium, and high project~~ion~~s dependent on the drivers in the scenarios.
- **Total ~~Consumptive~~ Identified Projects and Processes (IPPs):** The sum of IPPs for M&I; ~~[and]~~ SSI, ~~and agriculture~~.
- **Total ~~Consumptive Needs~~ [M&I and SSI] Gap:** The amount of future ~~consumptive~~ [M&I and SSI] needs not met by the IPPs or ~~[passive conservation]~~ ~~no and low regrets~~. This varies both by scenario and by how much the IPPs ~~and~~ ~~no and low regrets~~ are implemented.

Scenario Planning Relate[d] Terms:

- **Scenarios:** Plausible alternative futures
- **Portfolios:** Different combinations of strategies to address future M&I demands
- **Drivers:** Drivers are forces or the factors beyond the control of the water community that will likely have the greatest influence on the future state or scenario of Colorado and thereby Colorado's water management over time. Because not all driving forces influence the system to the same degree or contribute the same level of uncertainty, primary drivers that represent the most uncertain and are of the most importance were developed. Primary drivers are water supply, water demand, and social values. Secondary drivers influence the primary drivers and include population growth, climate change, and other influencing factors.

BIP Related Terms *[per CWCB]*

- **Goals:** Broad objectives each basin would like to accomplish in order to meet its consumptive and nonconsumptive needs as well as other topics critical to the basin.
- **Measurable Outcomes:** How each goal can be measurably achieved.

Water Supply Related Terms

- **Climate Change:** Climate change refers to a change in the state of the climate (e.g. temperature, precipitation, or hydrology) that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.
- **Climate Variability:** Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forces (external variability).
- **Historical hydrology:** Recorded streamflows from the observed time period.
- **Climate-adjusted Hydrology:** An adjustment to the historical natural streamflow regime to reflect conditions that may occur under an altered climate.
- **Surface Water Supply Availability:** Water that is legally and physically available to meet current or future consumptive or nonconsumptive water needs.

The availability of water varies depending on whether a scenario is considering 20th century observed hydrology, hot and dry climate change, or somewhere in between the two.

- **Groundwater Supply Availability:** Water located below ground that is legally and physically available to meet current or future consumptive or nonconsumptive water needs.

Nonconsumptive Related Terms:

- **Nonconsumptive Attribute:** An environmental or recreational value, such as species, community of species, or other value deemed as important to the basin roundtable. Examples include Colorado cutthroat trout, important fishing area, rare wetland plant community, and important boating area.
- **Nonconsumptive Need:** The physical and chemical demand needed to sustain a nonconsumptive attribute in a specific location defined by the basin roundtables as being important. This could include flow, channel morphology, or temperature levels.
- **Focus Area:** A stream reach or watershed identified by the basin roundtables as having important nonconsumptive attributes.
- **Nonconsumptive IPP:** Nonconsumptive IPPs must have the following criteria:
 - o The project or method has a project or method proponent.
 - o The project proponent plans to utilize the project to meet nonconsumptive needs by 2050.
 - o The project or method must have at least one of the following: preliminary planning, design, conditional or absolute water rights, rights of way, and/or negotiations captured in writing with local governments or consumptive water users that the project could affect.
 - o The nonconsumptive needs must be identified and included in the Basin Implementation Plans and/or SWSI documents.
- **Nonconsumptive New Proposed Project or Method:** Additional projects and methods identified by the roundtables that could meet future water needs, but don't meet the criteria of IPPs.
- **Nonconsumptive Gap:** The difference between what the basin indicates it wants to achieve with regard to meeting its nonconsumptive needs, as defined in its goals and measurable outcomes, and what projects and methods it has determined could be implemented to meet those needs.



Appendix B – Environmental and Recreational Focus Area Mapping Update

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin
Roundtable

April 17, 2015

Contents

Environmental and Recreational Focus Area Mapping Update	1
1 SWSI 2010 Focus Area Mapping	1
2 Updates to SWSI 2010 Focus Area Mapping	7
2.1 Linking Focus Areas to Other Data Sources	7
2.2 Addition of Focus Areas	7
2.2.1 Canyon Mouth Focus Areas	7
2.2.2 Park County Focus Areas	8
3 BIP Focus Area Mapping	8

Tables

Table 2-2-1- SWSI 2010 South Platte Focus Areas Table	4
Table 4-1 – Updated South Platte Focus Areas Table	10

Figures

Figure 2-2-1 - SWSI 2010 South Platte Focus Area Map	3
Figure 4-1 - Updated South Platte Environmental and Recreational Focus Areas Map	9
Figure 4-2 –South Platte Environmental and Recreational Focus Areas Map - Upper Mountain Region	13
Figure 4-3 - South Platte Environmental and Recreational Focus Areas Map – Northern South Platte Region	14
Figure 4-4 - South Platte Environmental and Recreational Focus Areas Map – Metro Region	15
Figure 4-5 - South Platte Environmental and Recreational Focus Areas Map – Lower South Platte Region	16
Figure 4-6 - South Platte Environmental and Recreational Focus Areas Map – High Plains Region	17

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Environmental and Recreational Focus Area Mapping Update

The Focus Areas developed in Statewide Water Supply Initiative (SWSI) 2010 for the South Platte Basin were updated for inclusion into the South Platte Basin Implementation Plan. The methodology for the update of the focus area mapping is described in detail in this technical memorandum.

1 SWSI 2010 Focus Area Mapping

As part of the Water for the 21st Century Act, the basin roundtables were required to complete Nonconsumptive Needs Assessments (NCNAs). The SWSI efforts have produced some NCNAs and mapping of environmental and recreational attributes. This effort has included an extensive inventory, analysis, and synthesized mapping effort that built upon the SWSI 2 environmental and recreational attribute mapping as a common technical platform for the basin roundtables. The basin roundtables have utilized environmental and recreational mapping to identify where the nonconsumptive focus areas exist within the basin. The basin roundtables' nonconsumptive focus areas and further study efforts are intended to facilitate the identification of projects and methods to address environmental and recreational water needs.

Reference Documents

The following discussion is based upon:

[SWSI 2010 South Platte Basin Report Basinwide Consumptive and Nonconsumptive Water Supply Needs Assessments-South Platte Basin Needs Assessment and Appendix C of SWSI 2010](#)

The Focus Area maps developed by each basin roundtable are based on a common set of environmental and recreational attributes representing where Colorado's important water-based environmental and recreational attributes are located. The maps are reflective of stakeholder input for the focus areas and also reflect stream reaches and subwatersheds with higher concentrations of environmental and recreational qualities. These maps were generated to provide information to the basin roundtables on important environmental and recreational areas in their basins but were not intended to dictate future actions. It should be noted, and as will be shown in this section, that this effort has not identified all streams as important. The NCNAs are not intended to create a water right for the environment and will not diminish, impair, or cause injury to existing absolute or conditional water rights. The CWCB and basin roundtable developed the environmental and recreational focus area mapping for the following purposes:

- The maps are intended to provide useful information for water supply planning so that future conflicts over environmental and recreational needs can be avoided.
- The maps can assist in identifying environmental and recreational water needs status, such as where needs are being met, where additional future study may need to take place, or where implementation projects in the basin are needed.

- The maps can help basins plan for the water needs of species of special concern so that they do not become state or federally-listed as endangered or threatened in the future.
- The maps can provide opportunity for collaborative efforts for future multi-objective projects.

The South Platte Basin Roundtable and Metro Roundtable reviewed all available data layers for their basin, and based on stakeholder knowledge and outreach, selected stream reaches that represented the majority of environmental and recreational activity in their basins. The environmental and recreational data layers for each basin were selected using the SWSI 2 GIS data layers as a starting point. The basin roundtables reviewed the available data layers compiled during SWSI 2 and then suggested and contributed additional data layers as deemed appropriate for each basin. The SWSI 2010 Report's Appendix C contains the Nonconsumptive Needs Assessment Focus Mapping Final Report that provides the detailed methodology utilized by each basin roundtable in developing their focus area map.

The South Platte Basin examined their collected environmental and recreational data layers and utilized a stakeholder process to establish what the environmental and recreational Focus Areas should be for their respective basins. The basin roundtables summarized their environmental and recreational attributes on a map and created a table summarizing why the segment was included as a focus area and important attributes for each segment.

The South Platte Basin NCNA subcommittee opted to use the term "Candidate Focus Areas" for its major segments with environmental, recreational, and environmental and recreational nonconsumptive water attributes. The South Platte Basin also divided the basin into the following sub-basins—High Plains, Lower South Platte, Northern, Denver Metro, Upper Mountain, and South Metro.

More information regarding the methodology used by CDM and CWCB to produce the original focus areas can be found in the South Platte Basin Needs Assessment and Appendix C of SWSI 2010. Included below are the Focus Area map and table from Appendix C of SWSI 2010.

Figure 1-1 - SWSI 2010 South Platte Focus Area Map

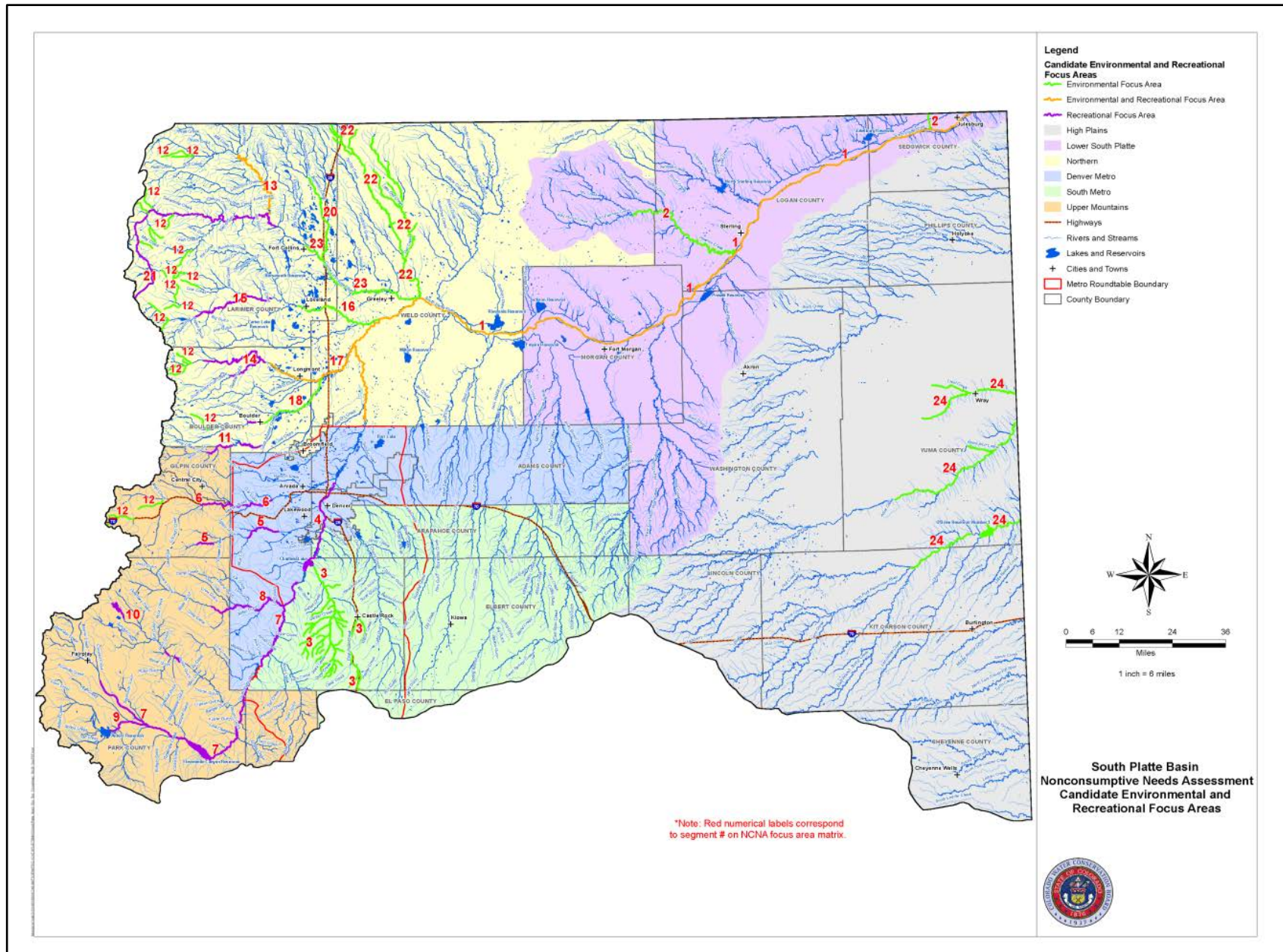


Table 1-1- SWSI 2010 South Platte Focus Areas Table

South Platte Nonconsumptive Needs Assessment Focus Reaches					DRAFT
GEOGRAPHIC AREA	Segment #	Segment Description	Environmental	Recreational	RATIONALE FOR CONSIDERATION
Lower South Platte/Northern	1	South Platte River: South boundary of Weld County to state line.	X	X	Waterfowl Hunting and Viewing Recreation. Habitat for plains fish that are listed as state endangered, threatened and species of concern. This segment contains rare or imperiled riparian plant communities.
Lower South Platte	2	Lodgepole Creek and Pawnee Creek.	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern.
South Metro	3	Plum Creek Watershed, including East and West Plum Creek and all tributaries	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern. This segment contains rare or imperiled riparian plant communities.
Denver Metro/South Metro	4	South Platte River: Below Chatfield Reservoir to Sand Creek		X	Whitewater Boating. Municipal Recreational Corridor
Upper Mountain/Denver Metro	5	Bear Creek: Truesdell to Indian Creek and Evergreen Lake to Bear Creek Lake		X	Fishing. Whitewater Boating
Upper Mountain/Denver Metro	6	Clear Creek: Idaho Springs to Golden Whitewater Park		X	Whitewater Boating. Fishing
Upper Mountain/Denver Metro/ South Metro	7	South Platte River: Middle and South Fork Confluence to Chatfield Reservoir. Middle Fork: Upstream end of Gold Medal reach to confluence with South Fork South Platte River		X	Gold Medal Fisheries. Whitewater Boating.

Upper Mountain	8	North Fork South Platte River: Bailey to confluence with South Platte River		X	Fishing. Whitewater Boating.
Upper Mountain	9	South Fork South Platte River below Antero Res.		X	Fishing
Upper Mountain	10	Michigan Creek and Taryall Creek. Those segments within State Wildlife Areas		X	Fishing
Northern/Upper Mountain	11	South Boulder Creek: Gamble Gulch to Shadow Canyon		X	Fishing. Whitewater Boating
Northern/Upper Mountain	12	All mountain tributaries with Greenback Cutthroat Trout populations.	X		Habitat for federal/state threatened species.
Northern	13	North Fork Poudre River: Dale Creek to confluence with Poudre River	X	X	Fishing recreation. Habitat for plains fish that are listed as state endangered, threatened and species of concern.
Northern	14	North Saint Vrain Creek: Horse Creek to Hwy 36. South Saint Vrain: from Middle Saint Vrain to confluence with North Saint Vrain.		X	Whitewater Boating. Fishing
Northern	15	Big Thompson River: Estes Park to mouth of canyon.		X	Fishing. Whitewater Boating
Northern	16	Big Thompson River: Just above Big Thompson Ditch #2 to confluence with South Platte.	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern.

DRAFT 7/01/2009

Northern	17	Saint Vrain Creek: James Ditch to confluence with South Platte River.	X	X	Habitat for plains fish that are listed as state endangered, threatened and species of concern. Municipal Recreational Corridor, RICDs
Northern	18	Boulder Creek: Hwy 36 to confluence with Saint Vrain Creek.	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern. Municipal Recreational Corridor
Northern	19	Boulder Creek: Fourmile Creek to Hwy 36		X	Whitewater Boating. Municipal Recreational Corridor. Fishing
Northern	20	Boxelder Creek	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern.
Northern	21	Cache la Poudre River: Headwaters to Lewstone Creek		X	Recreation. Whitewater boating. The Upper Poudre contains rare or imperiled riparian plant communities.
Northern	22	Lonetree Creek Drainage	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern.
Northern	23	Poudre River: Hwy 287 to confluence with South Platte	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern. Municipal Recreational Corridor.
High Plains	24	Republican Drainage Arikaree River: Adler Creek to state line. Black Wolf Creek. Chief Creek. North Fork Republican River. South Fork Republican River: Hell Creek to state line.	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern. The Arikaree contains rare or imperiled riparian plant communities.

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2 Updates to SWSI 2010 Focus Area Mapping

The SWSI 2010 Focus Area mapping needed to be updated to include data links to other data sources, as well as to include additional focus areas that were approved by the South Platte and Metro Basin Roundtables.

2.1 Linking Focus Areas to Other Data Sources

The evaluation of the existing data to determine environmental and recreational needs and opportunities used the SWSI 2010 data and the new data sets supplied by CWCB. The evaluation included use of two separate data sources, 1) the GIS shapefiles which contains spatial information regarding focus areas attributes and projects, and 2) the MS Access database, which contains more detailed information on some attributes and projects and allows for detailed analysis of the nexus of the focus areas and projects. The SWSI 2010 Focus Segments have numeric and descriptive labels. The GIS data contains both the numeric and descriptive label for each SWSI 2010 focus segment. The MS Access database provided by CWCB contained the descriptive labels but not the numeric label. Both databases have a common data field labeled “COMID”. The COMIDs also have a specific length associated with each COMID. These two data sources were joined adding the numeric label to the descriptive labels in the MS Access database. The joined database could then be used to evaluate the attributes within each individual Focus Area to better address the priorities set by the South Platte BRT and Nonconsumptive Needs Subcommittee.

2.2 Addition of Focus Areas

The SWSI 2010 NCNA mapping approved by the Basin Roundtables (BRTs) included the selection of 24 river Focus Areas. Since SWSI 2010 was released, the South Platte and Metro BRTs have approved several new Focus Areas. The new Focus Areas include reaches in Park County and several reaches along the Front Range rivers and streams that connect the mountain river Focus Areas to the plains river Focus Areas. These focus areas were added using the following methodology.

Due to the various sources of data received, multiple steps must be taken to include the Focus Areas in the GIS shapefiles and the MS Access database. In general, those steps required work including digitizing map layers and preparing the data fields for the new Focus Areas for use in the analysis. It was necessary to add common data labels for each new data set for relational queries with the existing databases. In addition, the Focus Area numeric labels were linked to the numeric descriptors of the Focus Area in a table added to the MS Access database.

2.2.1 Canyon Mouth Focus Areas

The South Platte and Metro Roundtables approved the inclusion of several focus areas that connect Focus Areas in the foothills and mountains to the plains river Focus Areas, areas in and near the mouths of several canyons. These Focus Areas are located along the Big Thompson River, the North Fork of the Big Thompson River (and tributaries),

Cache la Poudre River, South Boulder Creek, Middle Boulder Creek, and Left Hand Creek. The Focus Areas were approved for inclusion by the BRTs in Spring 2011.

Through this BIP effort, the Focus Areas were added to the GIS shapefiles and are in the process of being added to the MS Access database. These data were initially provided to the consultant as email correspondence between Colorado Parks and Wildlife (CPW) staff and the nonconsumptive subcommittee. CPW digitized the focus areas approved by the BRTs in ArcGIS to create a shapefile of the areas. The specific rationale and Focus Area information was added to the GIS shapefile attribute tables from the email information by the consultants. The CPW data included many segments that were not approved by the BRTs, only the segments that were approved were included. The information for these Focus Areas will then be added to the NCNA database to ensure the Focus Areas will be included in all data assessments utilizing the database queries.

2.2.2 Park County Focus Areas

The South Platte Roundtable approved the inclusion of several Focus Areas in Park County with significant riparian communities. These Focus Areas were approved by the South Platte Basin Roundtable in January 2014. The Park County Focus Areas were added to the GIS and are in the process of being added to the MS Access database. These data were initially provided to the consultant as a pdf of the additional and associated table of rationale. The consultants digitized the pdf map in ArcGIS to create a shapefile of the areas. The specific rationale and Focus Area information was added to the GIS shapefile attribute tables. The information for these Focus Areas will then be added to the NCNA database to ensure the Focus Areas will be included in all data assessments utilizing the database queries.

3 BIP Focus Area Mapping

The Focus Areas used in the preparation of the South Platte Basin Implementation Plan (SP-BIP) include the updates described above. The SP-BIP Mapping and associated Focus Area table are shown on the following pages and available electronically.

Figure 3-1 - Updated South Platte Environmental and Recreational Focus Areas Map

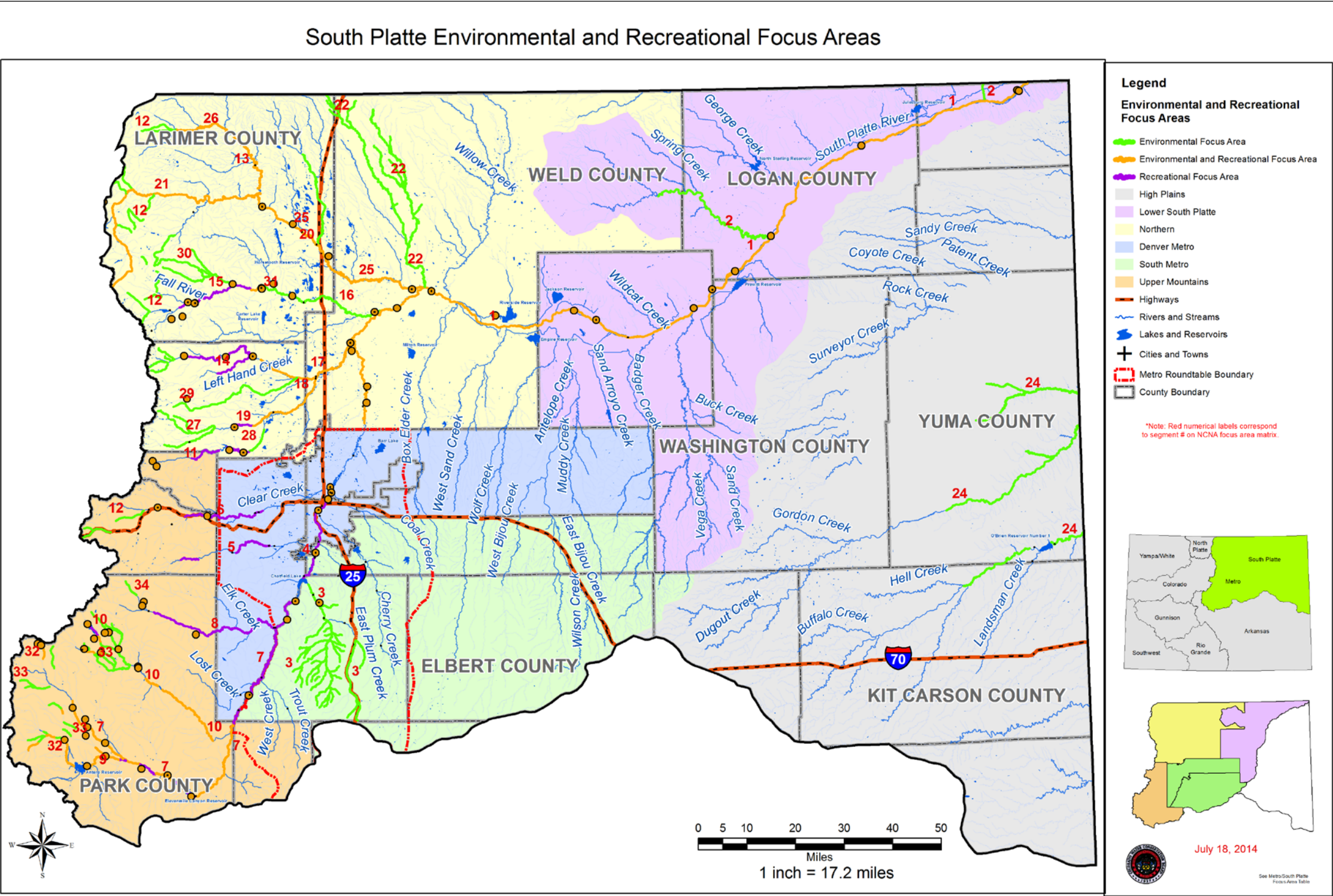


Table 3-1 – Updated South Platte Focus Areas Table

Geographic Area	Segment #	Segment Description	Environmental	Recreational	Rationale
Lower South Platte Northern	1	South Platte River South boundary of Weld County to state line	X	X	Waterfowl Hunting and Viewing Recreation. Habitat for plains fish that are listed as state endangered, threatened and species of concern. This segment contains rare or imperiled riparian plant communities.
Lower South Platte	2	Lodgepole Creek and Pawnee Creek	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern.
South Metro	3	Plum Creek Watershed including East and West Plum Creek and all tributaries	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern. This segment contains rare or imperiled riparian plant communities.
Denver Metro South Metro	4	South Platte River Below Chatfield Reservoir to Sand Creek		X	Whitewater Boating. Municipal Recreational Corridor.
Upper Mountain Denver Metro	5	Bear Creek Truesdell to Indian Creek and Evergreen Lake to Bear Creek Lake		X	Fishing. Whitewater Boating.
Upper Mountain Denver Metro	6	Clear Creek Idaho Springs to Golden Whitewater Park		X	Whitewater Boating. Fishing.
Upper Mountain Denver Metro South Metro	7	South Platte River: Middle and South Fork Confluence to Chatfield Reservoir Middle Fork: From Crooked Creek confluence to confluence with South Fork South Platte River	X	X	Gold Medal Fisheries. Whitewater Boating. State Wildlife Areas, Eleven Mile Canyon National Forest Recreation Area. Imperiled & rare riparian/wetland plant species & plant communities
Upper Mountain	8	North Fork South Platte River: Camp Santa Maria from just below Geneva Creek confluence to confluence with South Platte River.		X	Fishing. Whitewater Boating.
Upper Mountain	9	South Fork South Platte River below Antero Reservoir.	X	X	Fishing. Waterfowl hunting/viewing. State Wildlife Areas. Significant riparian/wetland plant communities.
Upper Mountain	10	Michigan Creek, Tarryall Creek and tributaries.	X	X	Fishing. Waterfowl hunting/viewing. State Wildlife Areas. Significant riparian/wetland plant communities.
Northern Upper Mountain	11	South Boulder Creek Gamble Gulch to Shadow Canyon		X	Fishing. Whitewater Boating.

Table 3-1 – Updated South Platte Focus Areas Table

Geographic Area	Segment #	Segment Description	Environmental	Recreational	Rationale
Northern Upper Mountain	12	All mountain tributaries with Greenback Cutthroat Trout populations	X		Habitat for federal/state threatened species.
Northern	13	North Fork Poudre River Dale Creek to confluence with Poudre River	X	X	Fishing recreation. Habitat for plains fish that are listed as state endangered, threatened and species of concern.
Northern	14	North Saint Vrain Creek Horse Creek to Hwy 36 South Saint Vrain from Middle Saint Vrain to confluence with North Saint Vrain		X	Whitewater Boating. Fishing.
Northern	15	Big Thompson River Estes Park to mouth of canyon		X	Fishing. Whitewater Boating.
Northern	16	Big Thompson River Just above Big Thompson Ditch 2 to confluence with South Platte	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern.
Northern	17	Saint Vrain Creek James Ditch to confluence with South Platte River	X	X	Habitat for plains fish that are listed as state endangered, threatened and species of concern. Municipal Recreational Corridor. RICDs.
Northern	18	Boulder Creek Hwy 36 to confluence with Saint Vrain Creek	X	X	Habitat for plains fish that are listed as state endangered, threatened and species of concern. Municipal Recreational Corridor.
Northern	19	Boulder Creek Fourmile Creek to Hwy 36		X	Whitewater Boating. Municipal Recreational Corridor. Fishing.
Northern	20	Boxelder Creek	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern.
Northern	21	Cache la Poudre River Headwaters to Lewstone Creek	X	X	Wild and Scenic River. Recreation. Whitewater boating. The Upper Poudre contains rare or imperiled riparian plant communities.
Northern	22	Lonetree Creek Drainage	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern.
Northern	23	Poudre River Hwy 287 to confluence with South Platte	X	X	Habitat for plains fish that are listed as state endangered, threatened and species of concern. Municipal Recreational Corridor. Additional Greenway benefit.

Table 3-1 – Updated South Platte Focus Areas Table

Geographic Area	Segment #	Segment Description	Environmental	Recreational	Rationale
High Plains	24	Republican Drainage Arikaree River Adler Creek to state line Black Wolf Creek Chief Creek North Fork Republican River South Fork Republican River Hell Creek to state line	X		Habitat for plains fish that are listed as state endangered, threatened and species of concern. The Arikaree contains rare or imperiled riparian plant communities.
Northern	25	Cache la Poudre River Canyon mouth to confluence of South Platte River	X	X	Habitat for plains fish that are listed as state endangered, threatened and species of concern. Fishing. Boating.
Northern	26	Cache la Poudre River Halligan Reservoir to Sheep Creek	X	X	Fishing. State Wildlife Areas.
Northern Upper Mountain	27	All mountain tributaries with Greenback Cutthroat Trout populations	X		Habitat for federal and state endangered, threatened and species of concern including cutthroat trout and lake chub.
Northern Upper Mountain	28	South Boulder Creek: Coverage extended to Baseline Reservoir	X		Habitat for state endangered, threatened and species of concern including native minnow species and trout.
Northern	29	Left Hand Creek	X		Habitat for state endangered, threatened and species of concern including common shiner, stonecat, and brassy minnow.
Northern Upper Mountain	30	North Fork Big Thompson and tributaries (West Creek, Miller Fork, Dunraven- Glade)	X		Habitat for federal and state endangered, threatened and species of concern including cutthroat trout.
Northern	31	Big Thompson River upstream Loveland to Cedar Creek	X	X	Habitat for state endangered, threatened and species of concern including trout. Fishing. Whitewater Boating.
Upper Mountain	32	Middle & South Forks of the South Platte and tributaries	X	X	Fishing. State Wildlife Areas. Significant, imperiled & rare wetland/riparian plant species and plant communities
Upper Mountain	33	South Fork of the South Platte & tributaries above Antero Reservoir, Upper Middle Fork tributaries, Upper Tarryall Creek & tributaries	X		Significant, imperiled & rare wetland/riparian plant species and plant communities.
Upper Mountain	34	Portion of Geneva Creek	X		Significant & imperiled rare wetland/riparian plant species and plant communities.

Figure 3-2 –South Platte Environmental and Recreational Focus Areas Map - Upper Mountain Region

South Platte Environmental and Recreational Focus Areas - Upper Mountain Region

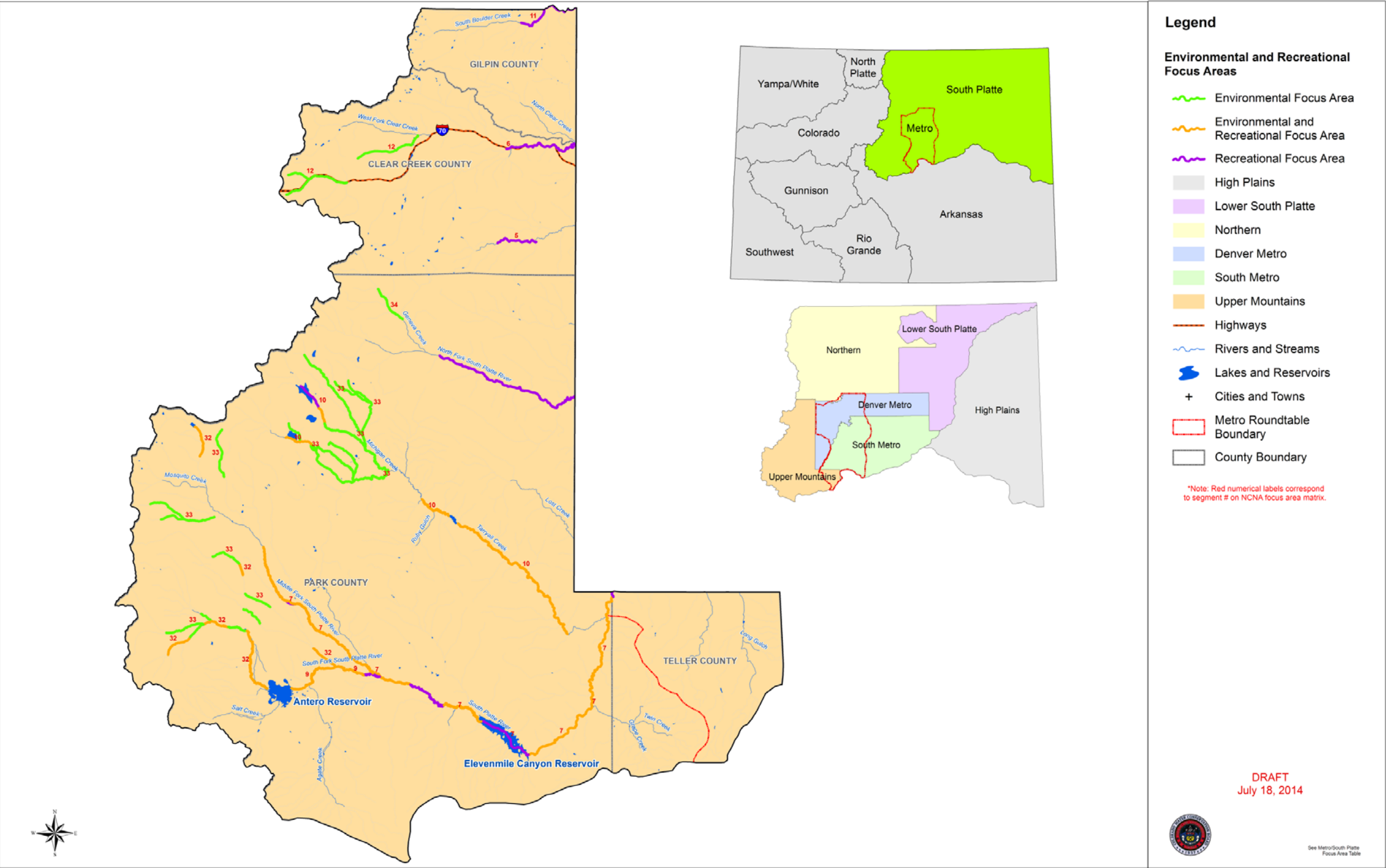


Figure 3-3 - South Platte Environmental and Recreational Focus Areas Map – Northern South Platte Region

South Platte Environmental and Recreational Focus Areas - Northern South Platte Region

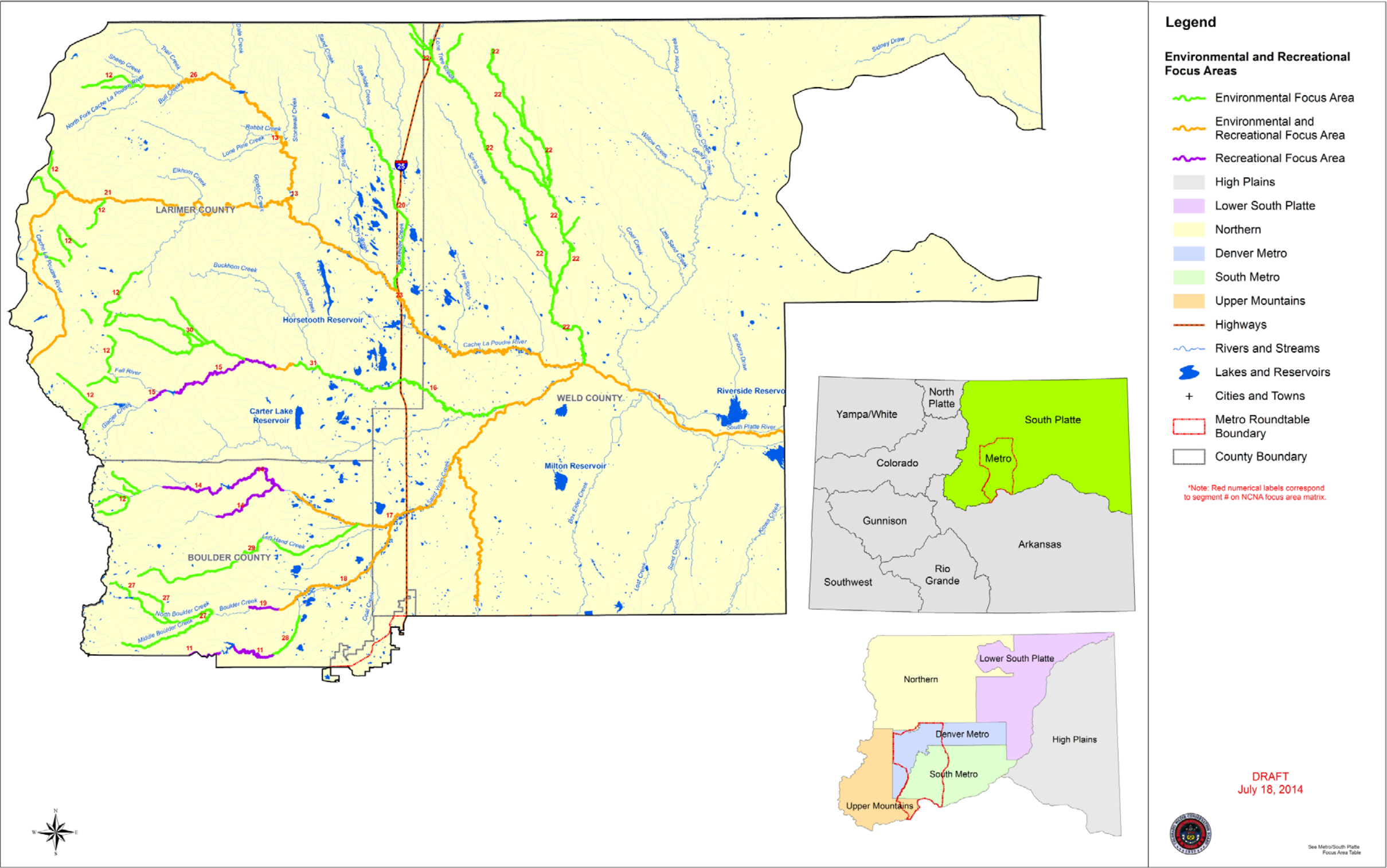


Figure 3-4 - South Platte Environmental and Recreational Focus Areas Map – Metro Region

South Platte Environmental and Recreational Focus Areas - Metro Region

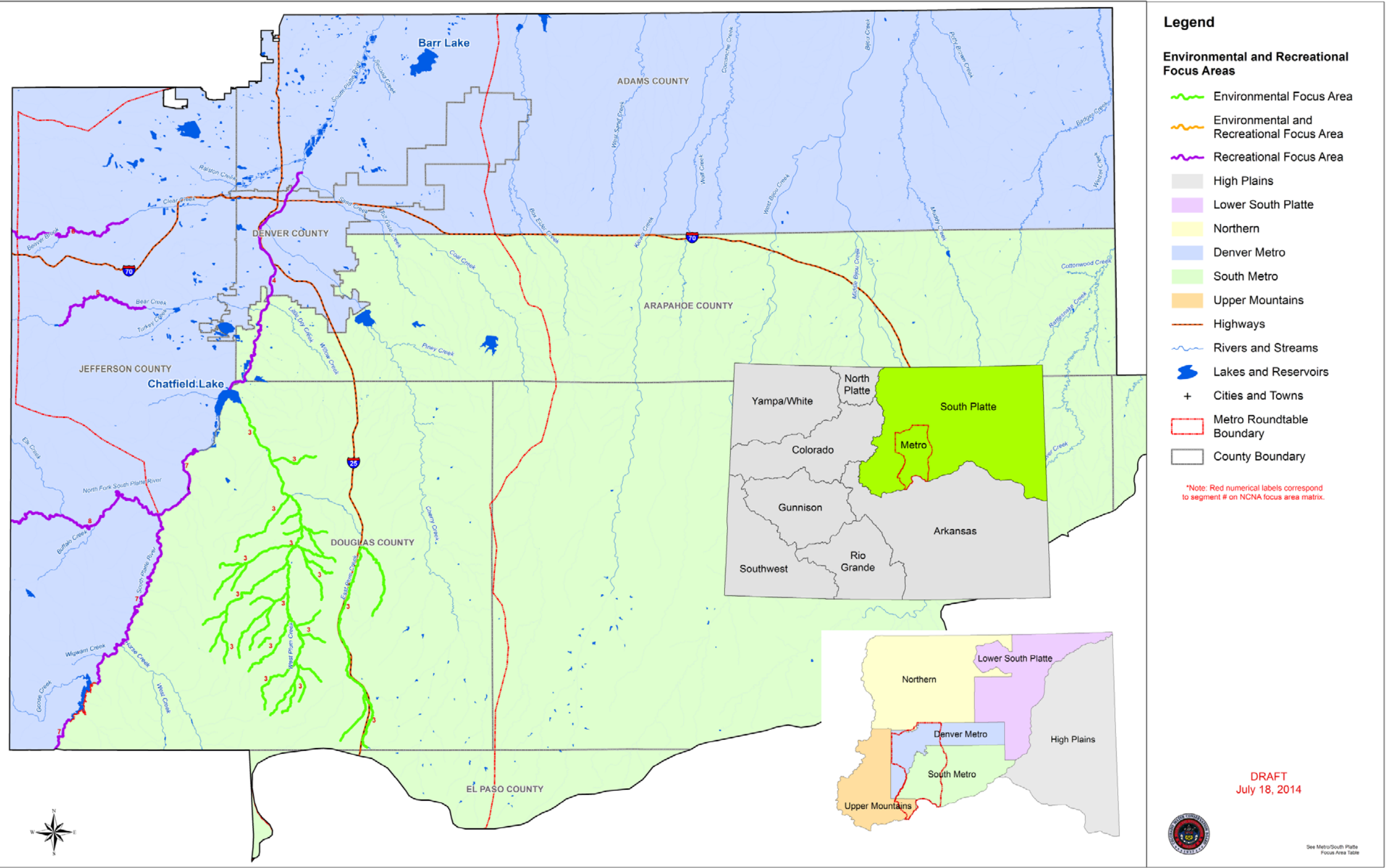


Figure 3-5 - South Platte Environmental and Recreational Focus Areas Map – Lower South Platte Region

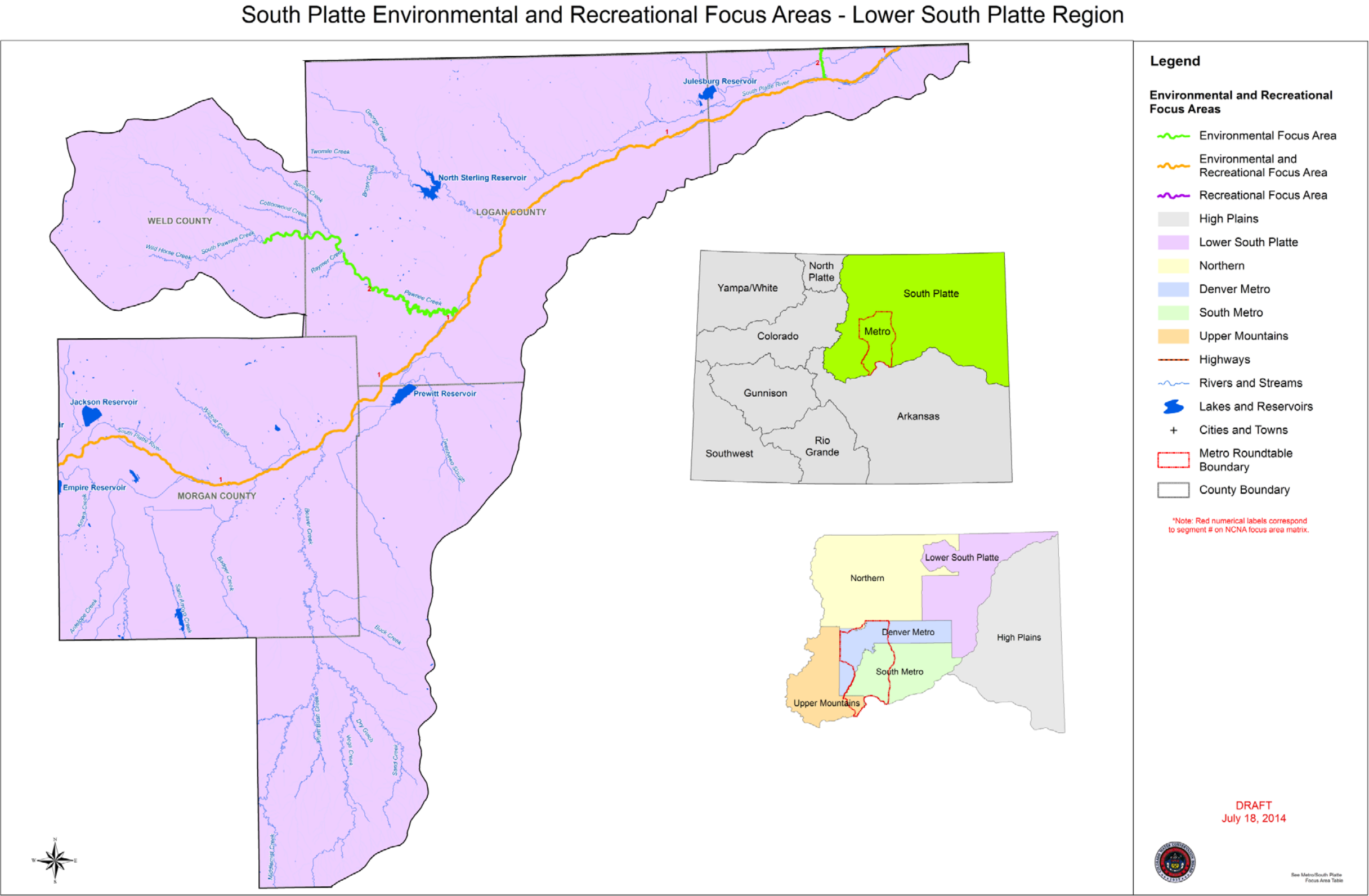
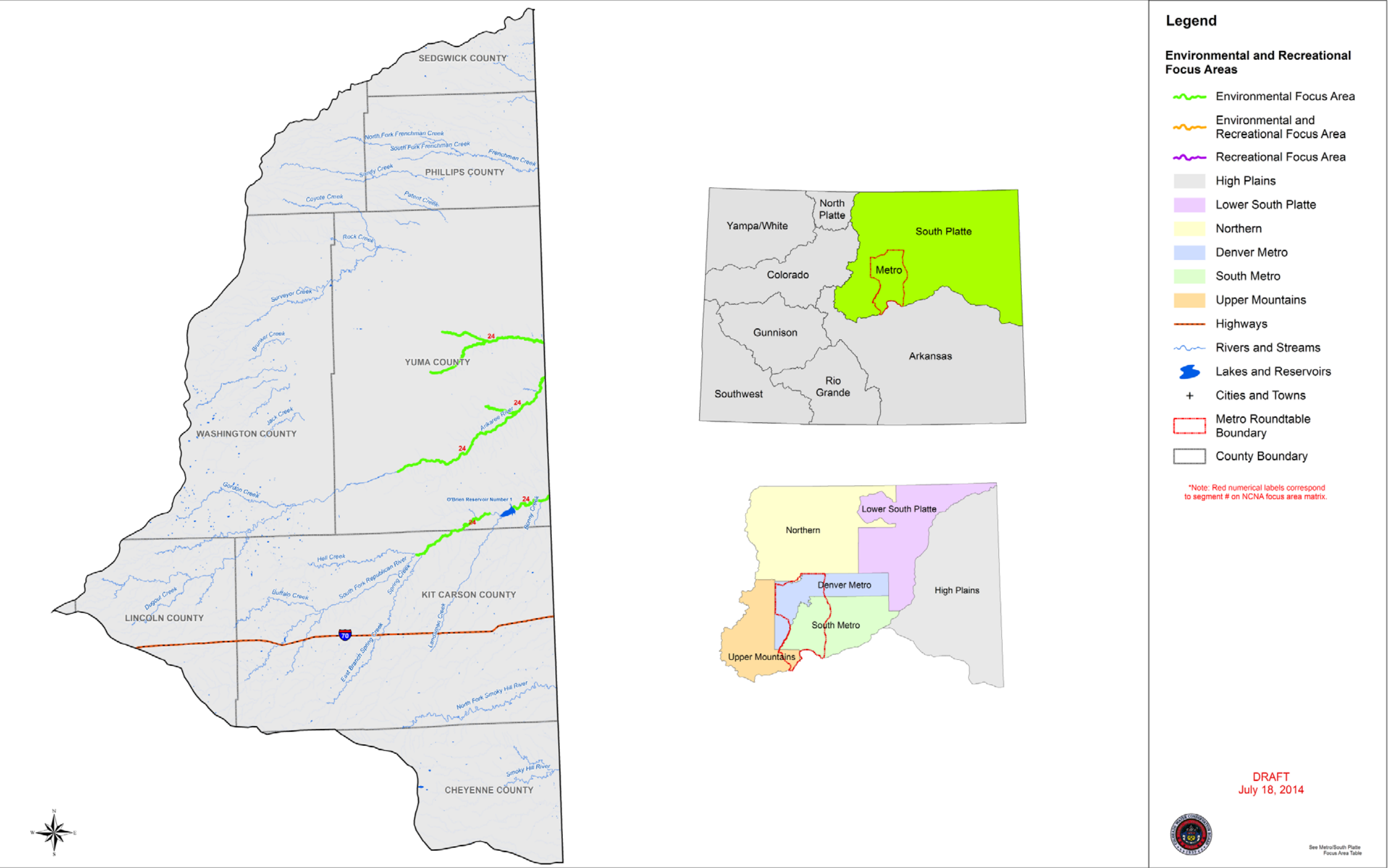
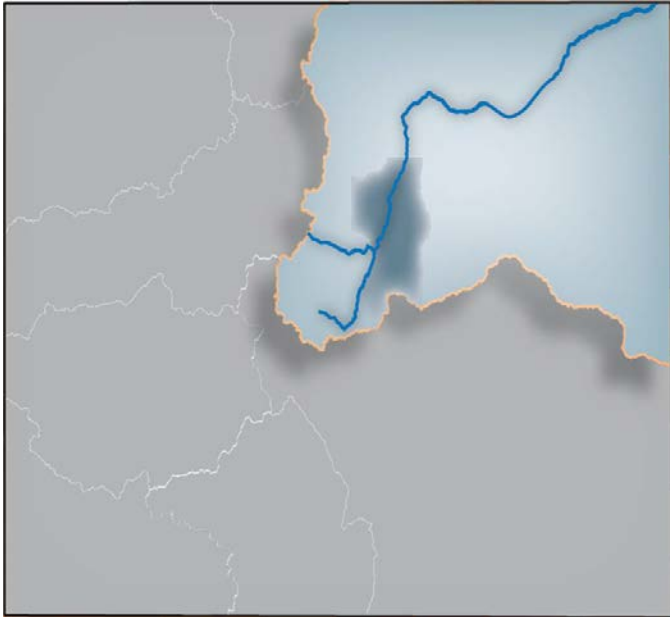


Figure 3-6 - South Platte Environmental and Recreational Focus Areas Map – High Plains Region

South Platte Environmental and Recreational Focus Areas - High Plains Region





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

Environmental and Recreational Impact from Agricultural and Urbanization Trends	1
1 Agricultural Dry-Up Trends	1
1.1 Historical Trends	1
1.2 Projection of Future Agricultural Dry-Up	6
1.3 Comparison with SWSI's Estimates of Irrigation Dry-Up	10
1.4 Potential Impacts on Environmental and Recreational Attributes Due to Irrigation Dry-Up Trends	12

Tables

Table 2-1 - Historical Irrigated Acres by County	1
Table 2-2 Rates of Irrigated Acre Dry-Up from 1976 to 2010	4
Table 2-3 SWSI 2010 Estimates of Irrigation Dry-up in 2050	10
Table 2-4 Comparison of the SWSI 2010 and BIP Historical Trend Results for the Metro South Platte Basin	10

Figures

Figure 2-1 Irrigated Acreages by County and Year (based on CDSS GIS coverages)	3
Figure 2-2 Dry-Up of Irrigated Acres from 1976 to 2010	5
Figure 2-3 Projected Dry-up of Irrigated Acres Based on Historical Trends	7
Figure 2-4 Map of Projected Dry-Up for the “Acres per Year” Methodology	8
Figure 2-5 Map of Projected Dry-Up for the “% per Year” Methodology	9
Figure 2-6 Comparison of the SWSI 2010 and BIP Historical Trend Results (High Scenario)	11

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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.

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.

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.

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

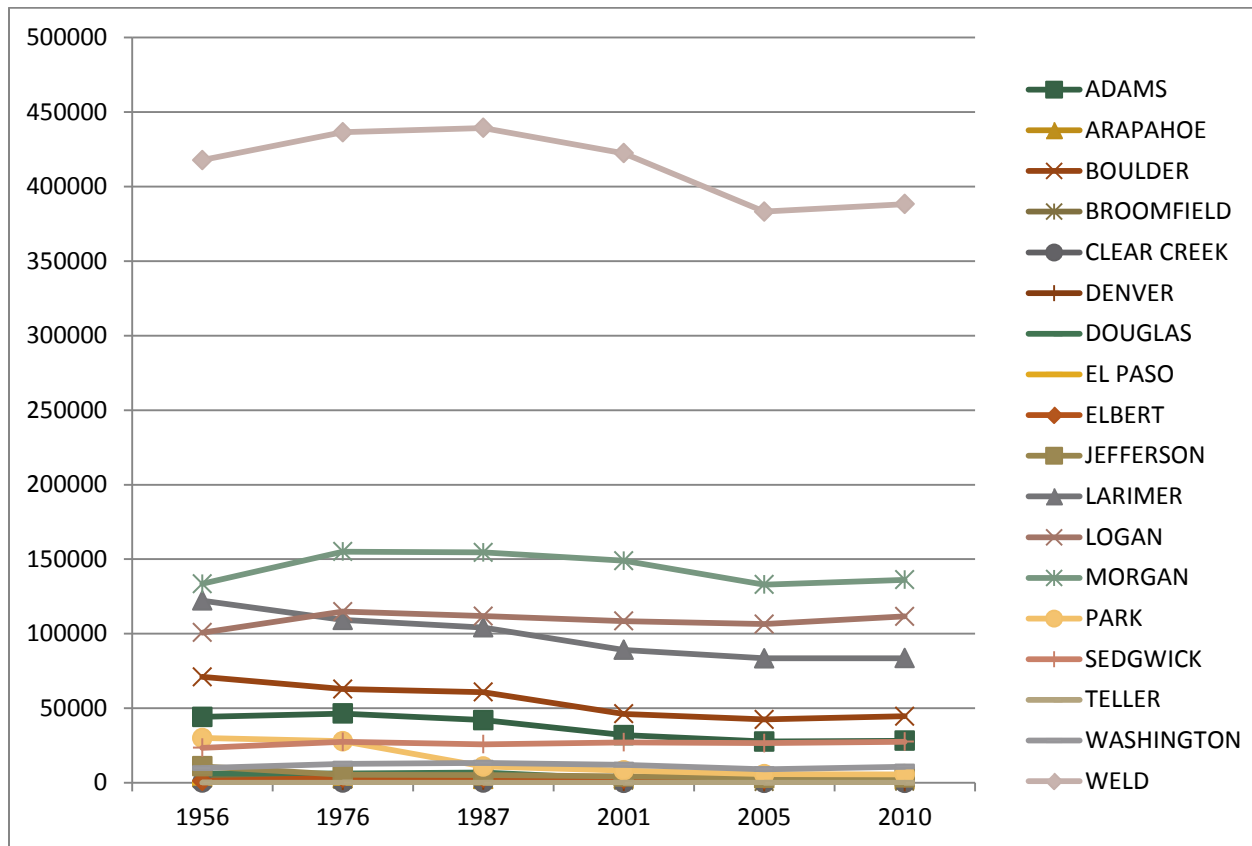
Counties	1956	1976	1987	2001	2005	2010
Douglas	6,434	6,295	6,994	2,666	2,180	2,492
El Paso	-	8	253	135	133	142
Elbert	1,279	3,532	3,406	2,732	2,323	3,163
Jefferson	11,111	5,468	5,227	4,374	3,431	3,623
Larimer	122,236	109,302	104,195	89,186	83,480	83,684
Logan	100,769	114,854	111,869	108,548	106,486	111,642
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.

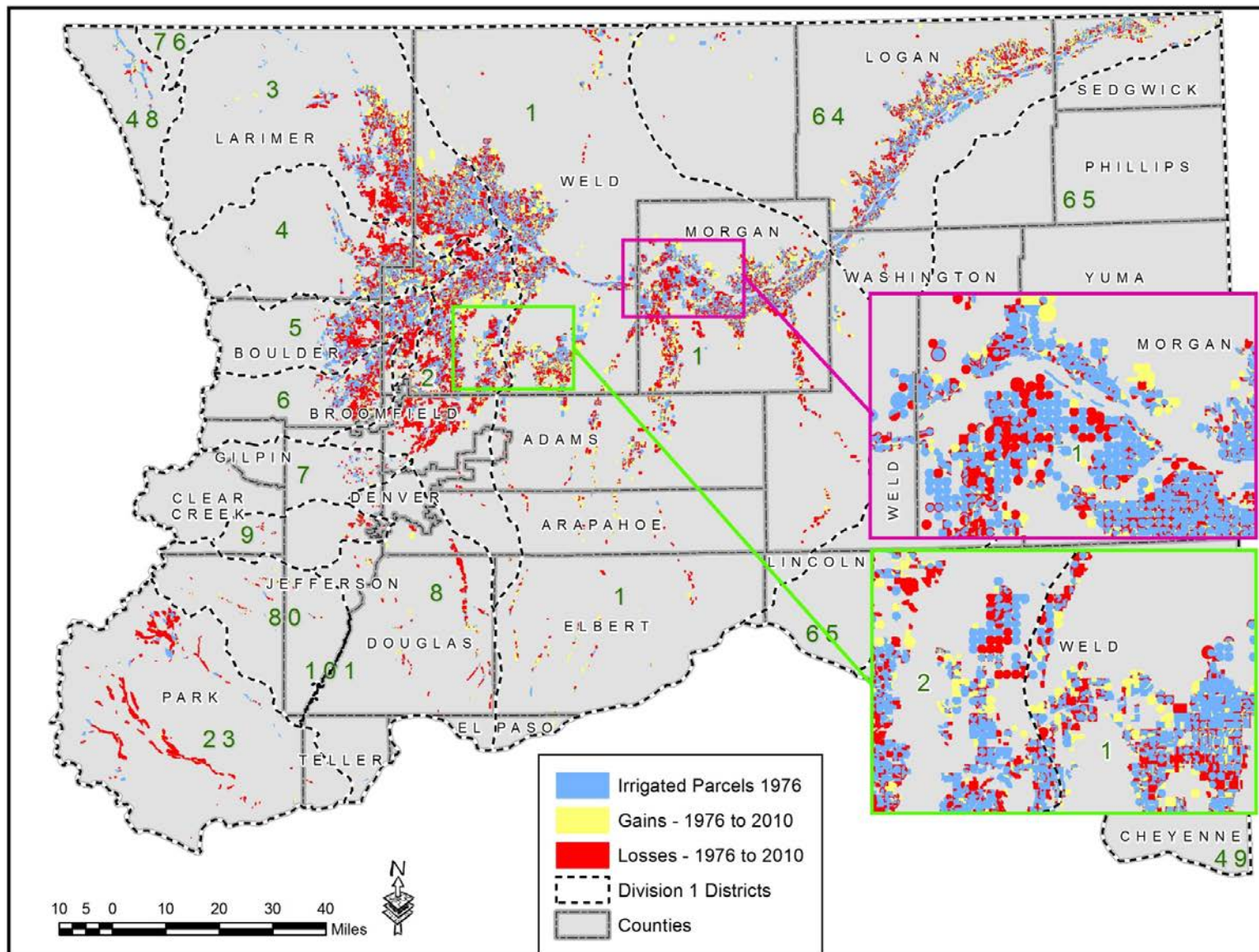
Figure 2-2 shows the changes in irrigated acres in the South Platte and Metro Basins from 1976 to 2010. The areas highlighted in yellow and red, show the areas where new irrigation was developed and where formerly irrigated areas were dried up, respectively. Table 2-2 shows the average annual rate of 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

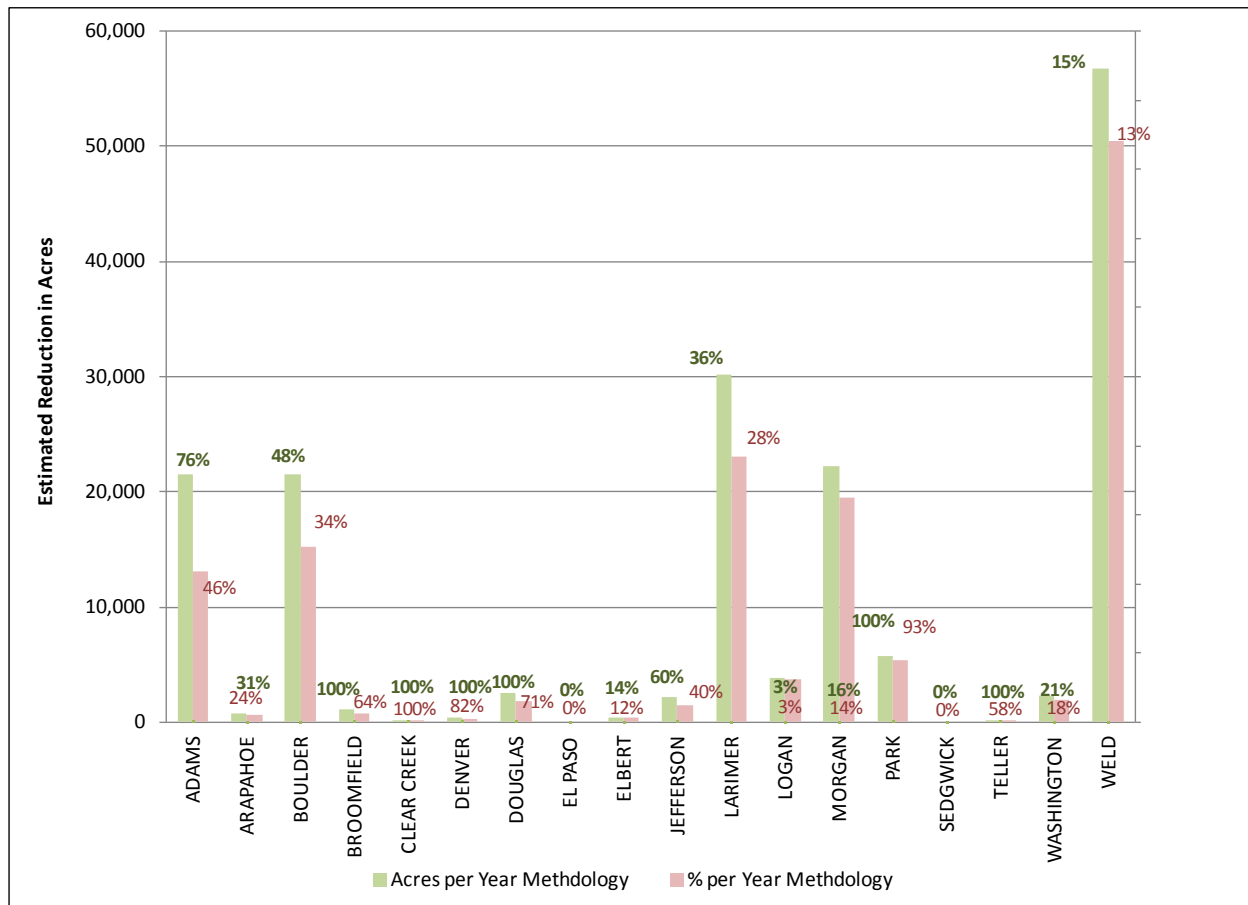


Figure 1-4 Map of Projected Dry-Up for the “Acres per Year” Methodology

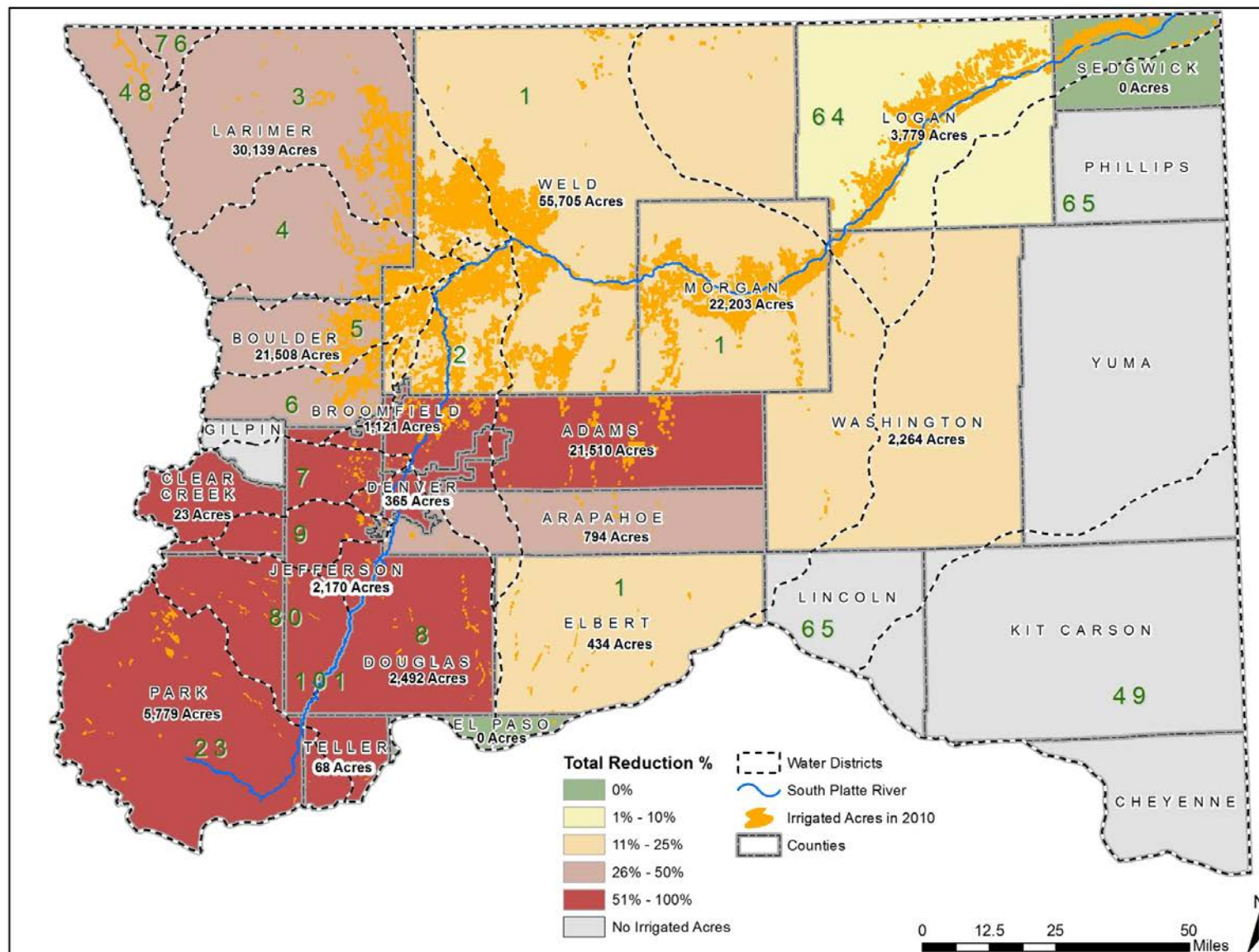
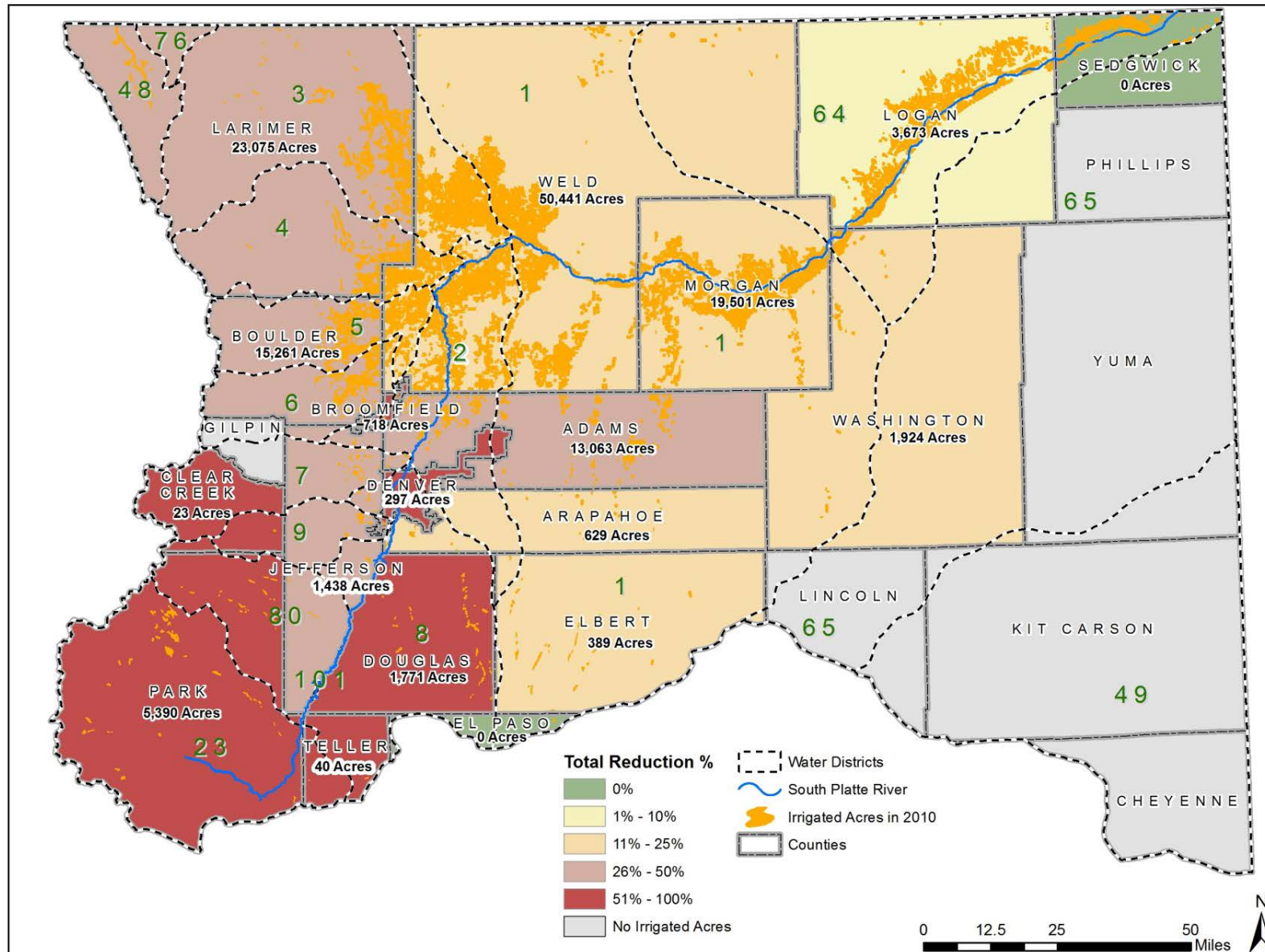


Figure 1-5 Map of Projected Dry-Up for the “% per Year” Methodology



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

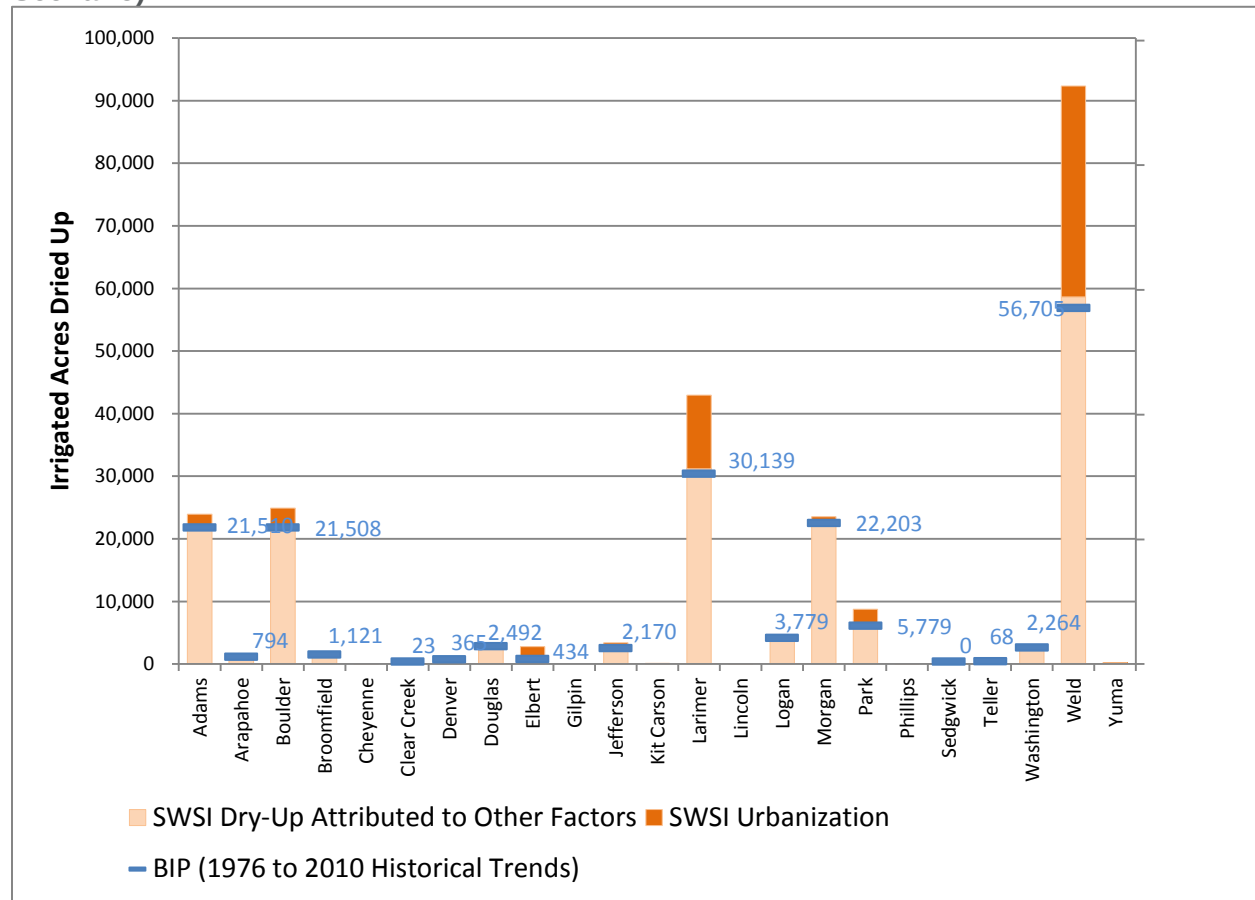
Source	2050 Irrigated Acres Decreases	
	Low	High
SWSI 2010	162,157	235,287
BIP (1976 to 2010 trends)	137,634	171,354

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.

Appendix D-1 - Stream Mile Representation Framework Overview

South Platte Basin Implementation Plan Memorandum

TO: South Platte Basin and Metro Roundtables'
Environmental and Recreational Subcommittee
West Sage Water Consultants

FROM: Steve Malers (Open Water Foundation)

DATE: March 31, 2015

RE: Stream Mile Representation Framework Overview

Introduction

This memorandum provides an overview of the Stream Mile Representation Framework (SMRF) approach that has been implemented for the South Platte Basin Implementation Plan (BIP). Earlier drafts of this memorandum were provided to Colorado Division of Water Resources staff and others to vet the approach. This memorandum provides an overview of the approach that was implemented for the BIP and other memoranda describe details of that approach.

Statewide Water Supply Initiative (SWSI) Nonconsumptive Needs Assessment (NCNA) Review and Limitations

During Phase 1 of the South Platte BIP, the consulting team attempted to utilize previous SWSI NCNA data products, including Geographic Information System (GIS) layers, NCNA Microsoft Access database, and spreadsheets. This effort identified significant limitations in the data and approach, which posed barriers to using the SWSI data products for BIP analysis:

- Spatial data utilized the National Hydrograph Dataset (NHD) as the stream layer onto which other data were referenced. The NHD "COMID" identified was used as a database unique identifier for stream reaches and database relationships. The use of COMID has the following limitations:
 - Stream segments represented in data are limited to the NHD digitized segments, which have arbitrary lengths
 - COMID is not recommended for user-facing data because values are volatile and may change in different NHD versions
 - COMID is not present in more recent versions of NHD and therefore there is a lack of continuity between legacy SWSI NCNA data and new work
- Work products based on GIS typically resulted in PDF maps with colored lines for focus areas, attributes, projects, etc. These maps can be difficult for stakeholders to interpret, especially at a local level.
- Stakeholders generally have access to Microsoft Excel but not GIS or Microsoft Access. Stakeholders generally do not have GIS or database software skills. Consequently, data products ideally should be provided in a more accessible format such as Excel, Google Earth, and similar.
- Attempts to show tabular lists of data queried from GIS and the Microsoft Access NCNA database resulted in long Excel lists that did not have context for stakeholders and were disconnected from the spatial representations (maps). For example, project lists did not have

APPENDIX D – 1 – Stream Mile Representation Framework Overview

data that were clear to stakeholders and therefore data were difficult to quality control and update.

- Projects and methods meant to indicate protections did not actually indicate true protection in the river (wet water). For example, a segment of the river with an instream flow may receive no additional water due to senior consumptive rights having first right to the water. Analysis of the river must analyze measured or estimated streamflow at specific locations in order to determine how well environmental flow requirements are being met.
- Previous data analysis was based on GIS and/or Microsoft Access database queries that resulted in aggregated results such as “focus area X is 100 miles long and 30 miles have adequate productions for attribute Y”. These results are difficult to relate to local stream reach conditions necessary to produce measureable outcomes.

A new Stream Mile Representation Framework approach was implemented in order to overcome the above issues and also allow analysis of goals and measurable outcomes. The approach was vetted in concept through numerous conversations with stakeholders and subsequently was recommended to the South Platte/Metro Nonconsumptive Needs Committee on Oct 28, 2014. Based on positive feedback, the approach was implemented in the South Platte BIP Phase 2 in early 2015, focusing on several example areas that are discussed in the BIP. The remainder of this document provides an overview of the new SMRF approach.

Stream Mile Representation Framework Concept

The fundamental concept of the SMRF approach is to represent the river as relatively short segments that allow for reasonable precision for visualization and analysis, in particular to represent multiple data layers in an overlapping fashion. A .1-mile segment length was chosen based on review of other efforts and feedback from stakeholders. In the final output, each river or stream is represented as a column in Excel and each row corresponds to the .1-mile segment. Additional columns in Excel represent data layers such as focus area, environmental and recreational (E&R) attributes, project and methods, etc. Figure 1 illustrates the SMRF Excel workbook resulting from the BIP project, in this case highlighting the Saint Vrain Creek example area.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	FMEAS	TMEAS	Geographic	FocusArea	Type	Rationale	Foc	BaldEagle	BrassyMinnow	ComGarnerSnake			
861	00205012	Saint Vrain Creek	00205012_025.2	25.2	25.3	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes				
862	00205012	Saint Vrain Creek	00205012_025.3	25.3	25.4	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes				
863	00205012	Saint Vrain Creek	00205012_025.4	25.4	25.5	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes				
864	00205012	Saint Vrain Creek	00205012_025.5	25.5	25.6	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes				
865	00205012	Saint Vrain Creek	00205012_025.6	25.6	25.7	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes				
866	00205012	Saint Vrain Creek	00205012_025.7	25.7	25.8	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes				
867	00205012	Saint Vrain Creek	00205012_025.8	25.8	25.9	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes				
868	00205012	Saint Vrain Creek	00205012_025.9	25.9	26.0	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes				
869	00205012	Saint Vrain Creek	00205012_026.0	26.0	26.1	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes	Yes			
870	00205012	Saint Vrain Creek	00205012_026.1	26.1	26.2	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes	Yes			
871	00205012	Saint Vrain Creek	00205012_026.2	26.2	26.3	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes	Yes			
872	00205012	Saint Vrain Creek	00205012_026.3	26.3	26.4	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes	Yes			
873	00205012	Saint Vrain Creek	00205012_026.4	26.4	26.5	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes	Yes			
874	00205012	Saint Vrain Creek	00205012_026.5	26.5	26.6	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes	Yes			
875	00205012	Saint Vrain Creek	00205012_026.6	26.6	26.7	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes	Yes			
876	00205012	Saint Vrain Creek	00205012_026.7	26.7	26.8	Northern	Saint Vrain	Environmental	Habitat fo 17			Yes	Yes			

Figure 1. Example of Stream Mile Representation Framework Excel Worksheet (only a few columns are shown)

The stream mile is a geographic coordinate system commonly referred to as a linear measure. Instead of X,Y coordinates, reference points such as the state line and stream confluences are used for the zero coordinate and distance is measured upstream from these points. Using this coordinate system requires standardized linework representing the streams because all other data are referenced to this linework. Fortunately, DWR staff recently produced a stream data layer called the Source Water Route Framework (SWRF) which uses linework from NHD data and uniquely identifies significant water source streams in Colorado. See: <http://cdss.state.co.us/GIS/Pages/AllGISData.aspx>. The SWRF layer uses the federal GNIS (Geographic Names Information System) identifier for each stream and DWR staff have quality controlled the data for Colorado. For example, “Saint Vrain Creek” is a single line in the data layer, rather than many short lines in the original NHD. The SWRF layer was used as the basis for all linework in the BIP SMRF approach. For more information about the SWRF, see the DWR memorandum “Source Water Route Framework and Stream Mile Processing”, December 2014.

The SMRF has the following benefits:

- The river can be represented in a simple tabular format in Excel
- Input data layers can be collected and managed using normal practices – using the data in the stream mile analysis involves steps explained in this document but do not impact stakeholder management of the original data
- River segments are identified with stream (river) identifier, name, and stream mile, rather than abstract data like “COMID” or other internal GIS data
- Overlapping data layers are clearly indicated as columns and values within columns
- Analysis of each row/segment can occur with simple Excel formulas using agreed-upon metrics and science-based analysis
- Stakeholders that have familiarity with a stream reach can focus on everything that is occurring in that reach, rather than trying to extract analysis results for their reach from complex data queries
- The framework supports inclusion of organizational jurisdictional extent and master plan extent, which will allow integration of local planning and project efforts with other data
- Additional features can be placed on the river by assigning a stream mile either by processing with GIS similar to the BIP Phase II processing or by adding directly to the Excel workbook
- The stream mile can be recalculated if new input are made available (such as new version of SWRF layer from DWR)
- A variety of spatial data layers can be assembled to create the Excel file

Limitations of this representation are:

- Using .1-mile segments is arbitrary and introduces some error in analysis; however, many data layers are imprecise, and tenths of a mile precision have been used elsewhere with success (e.g., Colorado and San Juan Fish Recovery Programs, transportation mileage)
- Intermediate features that do not fall at .1-mile boundaries will not be precisely located for analysis, although precise locations can be indicated in the output (this has been done for stream gages and diversions)
- Changes in the stream layer that is used as a basis for the stream miles, for example due to a stream channel moving from a flood, will cause the stream miles to be different in the future – this is viewed as part of normal data maintenance and the stream miles in the analysis are used to align data, not as an absolute framework

Stream Mile Representation Framework Overview

The SMRF implemented for the South Platte BIP Phase II project is illustrated in Figure 2 below. The SMRF represents streams as .1-mile segments, with overlapping environmental and recreational (E&R) attributes, projects and methods, and other data. This approach allows a large amount of data to be spatially represented in Excel to .1-mile resolution, which allows E&R stakeholders to visualize data local to a stream reach of interest, and perform analysis.

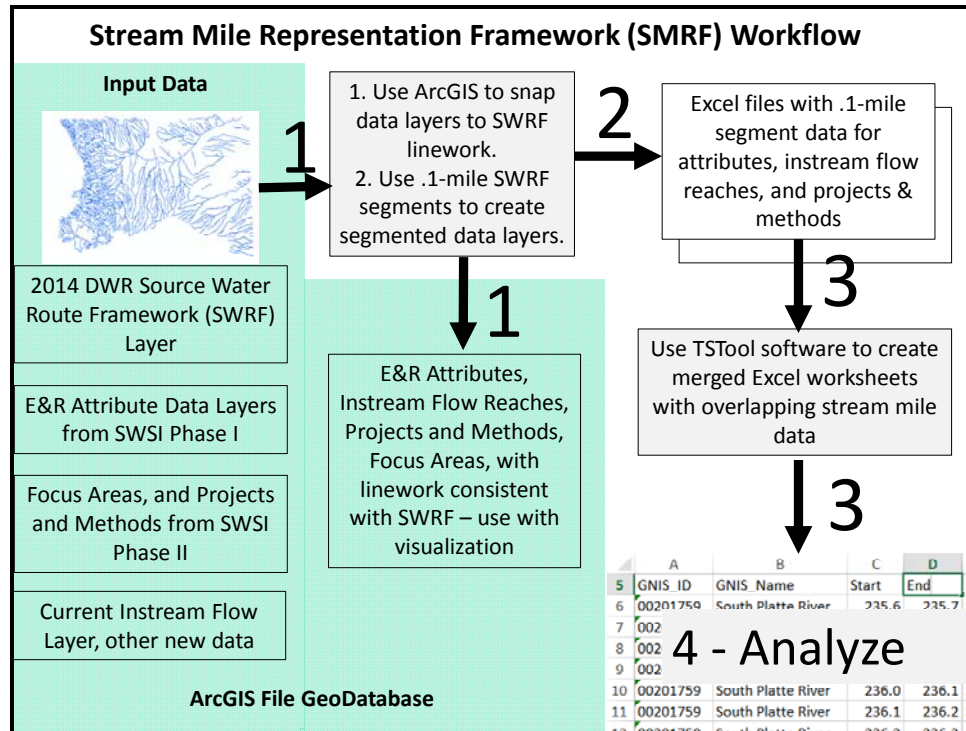


Figure 2. Stream Mile Representation Framework Workflow Overview

ArcGIS software is used in steps 1 and 2 in Figure 2 to manage and process spatial data from multiple sources. GIS processing is described in the BIP memorandum “Stream Mile Representation GIS Workflow Processing,” March, 2015. Spatial data used in the analysis were inventoried in an Excel workbook, managed in an ArcGIS file geodatabase, and include the following:

- DWR SWRF layer
- all of the original data layers from the SWSI NCNA Phase I and II efforts, including focus areas, E&R attributes, and projects and methods
- recent instream flow reach layer from the CWCB
- historical and real-time stream gage locations from HydroBase
- key diversion structures, from HydroBase

The SWRF layer and “mile marker” layer showing .1-mile segments were also exported in KML format for visualization and to provide a reference to demonstrate how stakeholder data can be included. Figure 3 illustrates such data for the Saint Vrain example area, from a simple Google Maps prototype.

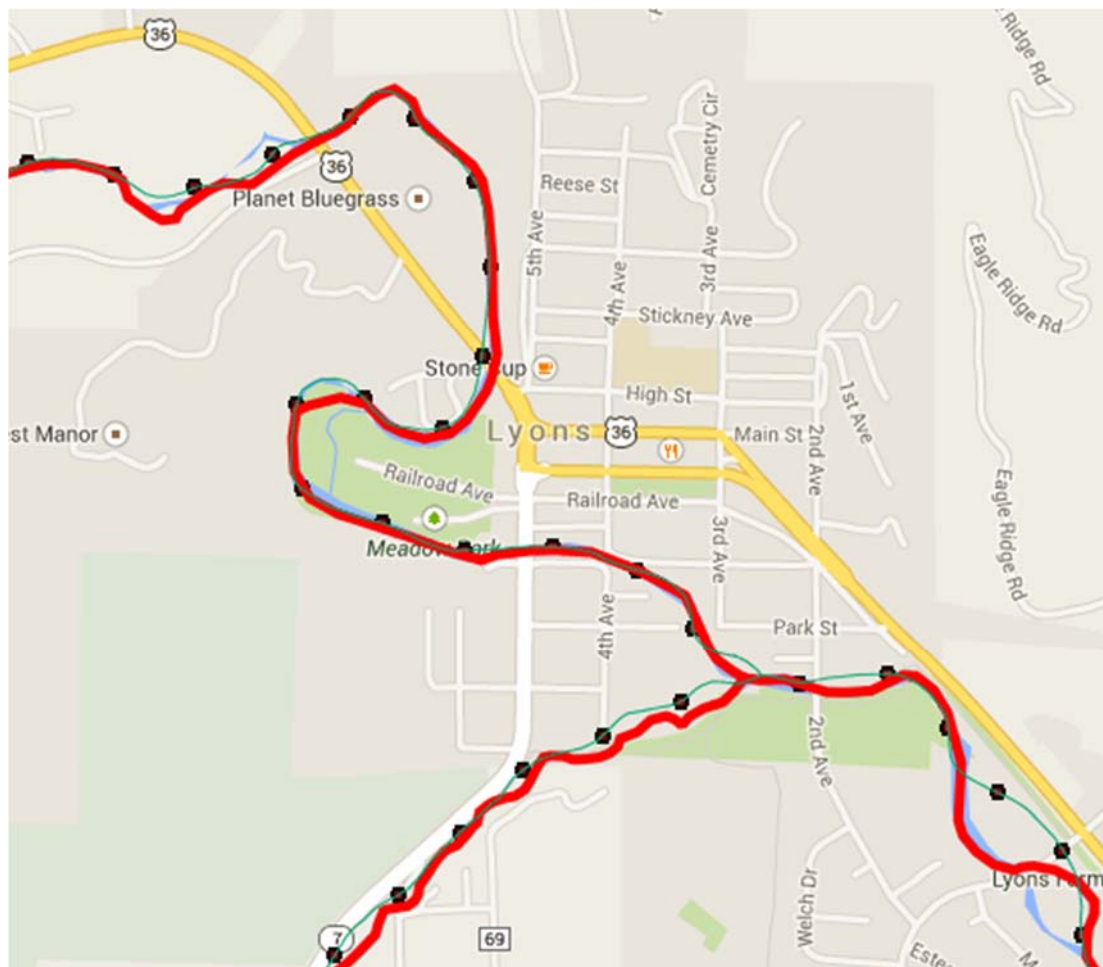


Figure 3. Example of SMRF data layers (circles represent .1-mile segment endpoints)

TSTool software developed for Colorado’s Decision Support Systems (CDSS) was used for step 3 in Figure 2 to assemble spatial data tables into the final Excel workbook as shown in Figure 1. The TSTool process is described in the BIP memorandum “Stream Mile Representation Framework TSTool Workflow Processing”, March 2015. GIS data layers that were intersected are detailed in the attached data inventory table.

The result of the GIS and TSTool processes is an Excel workbook (step 4 in Figure 2) that includes E&R data, where rows represent .1-mile stream segments and columns are included for E&R attributes, instream flow reaches, projects and methods, locations of stream gages and diversion structures, and other data, as illustrated in Figure 1.

The BIP results provide a framework for visualizing and understanding E&R data, and providing a platform for analysis. For example, daily streamflow time series can be analyzed to determine if available “wet water” is meeting the flow requirements for E&R attributes. The SMRF provides a platform to spatially represent E&R requirements at a local level to represent a variety of E&R data along stream reaches. This framework can be enhanced and applied to further understand E&R

requirements and the challenges in meeting those requirements at a local scale. The framework can also provide a means for stakeholders to provide input, as described in the BIP memorandum “Stream Mile Representation Framework Stakeholder Data Input”, March 2015.

Comments and Recommendations

The SMRF implemented for the South Platte BIP provides a framework to represent E&R attributes, master plans, projects and methods, and other spatially-referenced data. Although this framework does require GIS and other processing to create data that are merged into the baseline SMRF Excel workbook, the concepts used in the SMRF, and the format of the Excel workbook are straightforward and encourage additional of stakeholder data. The following specific recommendations are made:

1. **Scale SMRF to wider area.** The BIP project has resulted in a SMRF that demonstrates utility in managing and visualizing E&R data. However, the SMRF is a prototype applied to several example areas in the South Platte. It is recommended that the State invest resources to fully implement the SMRF approach throughout the South Platte Basin and perhaps statewide, including:
 - a. **Review and enhance SMRF processes.** The BIP effort implemented data processing procedures necessary to meet the BIP deadlines. An entirely new framework was implemented in several months, benefitting from the use of automated procedures. Although normal care was taken when performing the work, additional review should occur before expanding the SMRF approach to a wider area.
 - b. **Focus on automation and quality control.** The amount of data included in the SMRF is large. Scaling the approach to a larger area will require that data processing and quality control are automated. Consequently, tools and approaches developed for the BIP effort should be enhanced to ensure that automation continues to be used for the greatest efficiency.
2. **Integrate the SMRF with quantitative analysis of E&R needs and gap.** The SMRF provides a framework to spatially integrate many data types to a .1-mile resolution. This framework can be effective in understanding the relative impacts of water use and projects, in particular to provide a straightforward tool that can be used by stakeholders. However, full understanding of E&R issues will not be possible until “wet water” environmental flow requirements are better understood. Therefore, it is recommended that analysis of streamflow and other data occur and be referenced to the SMRF. Modeling such as Colorado’s Decision Support Systems (CDSS) basin models and point flow models could provide estimates of flows at locations intermediate to stream gages and such data could likewise be referenced to the SMRF. The integration of wet water analysis with spatial context to .1-mile resolution will provide a powerful tool for evaluating E&R needs and gaps, and the impacts of projects such as Identified Projects and Processes (IPPs).

Appendix D-2 - Stream Mile Representation Framework GIS Workflow Processing

South Platte Basin Implementation Plan Memorandum

TO: South Platte Basin and Metro Roundtables'
Environmental and Recreational Subcommittee

REVIEWED BY: West Sage Water Consultants

FROM: Paul Schwindt (Simple Survey Mapping, LLC) and Steve Malers (Open Water Foundation)

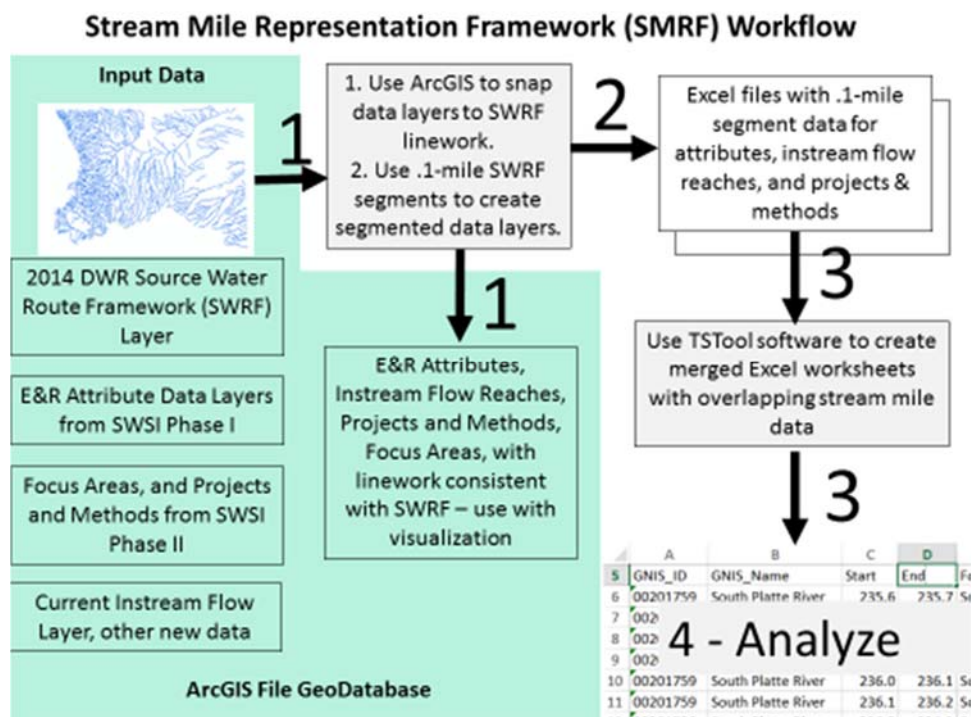
DATE: March 17, 2015

RE: Stream Mile Representation Framework GIS Workflow Processing

Introduction

This technical memorandum documents the geographic information system (GIS) work performed in Phase II of the South Platte Basin Implementation Plan (BIP), in particular data processing necessary to create the new Stream Mile Representation Framework (SMRF) to support environmental and recreational (E&R) gap analysis. This document details input data sources, changes to pertinent layers, challenges encountered and how they were handled, technical details of workflows, naming conventions, and locations of output layers. This memorandum includes technical GIS language but also provides general explanations where possible.

The SMRF approach is summarized in the following figure. This memorandum focuses on the data and steps for 1 and 2. The overall concept of the SMRF is to process input data layers such as E&R attributes into a form that can be represented as .1-mile segments using standard stream linework. The .1-mile segments can then be aligned in Microsoft Excel, GIS, and other tools to allow for localized consideration of all spatially-related data. The BIP project has applied this approach for the first time in the context of E&R data analysis.



The SMRF approach utilizes the Source Water Route Framework (SWRF) layer provided by the Colorado Division of Water Resources (DWR) for stream linework and stream mile reference. The SWRF is created by processing the National Hydrography Dataset (NHD) into linework that is more relevant to water administration by DWR, is smaller in size than NHD, and easier to use. The SWRF framework greatly simplifies using the linework from NHD and it overcomes technical issues. For example, the NHD layer was used in the Statewide Water Supply Initiative (SWSI) to provide a spatial reference for E&R data. However, this was accomplished by using the NHD “COMID” as the unique identifier for stream segments. COMID is no longer available in current versions of NHD and consequently use of earlier SWSI data referenced to COMID for analysis is challenging. These technical issues contributed to the need to adopt an alternative framework, and the SMRF was created. See the DWR memorandum “Source Water Route Framework and Stream Mile Processing,” December 2014 for background on the SWRF layer. The current SWRF layer was not available at the time that the BIP analysis began; however, recent changes are understood to be minor. The layer Strm_Route provided by DWR was used for the workflows. Strm_Route was made available to the BIP Team by DWR in November 2014 and SWRF was not officially released until the end of January 2015. In this document, the SWRF phrase is used to reference the framework, but Strm_Route was identified for that role in the technical details and actually used in the analysis. The terms are mostly interchangeable, but see Appendix D for detailed differences between the layers.

The following discussion involves GIS processing based on two important concepts: “snapping” and “linear referencing”. Snapping refers to moving the coordinates of features in one layer to match those of another layer. In the context of the SMRF, snapping is used to move original input data (such as linework for streams different than the SWRF layer) to the SWRF linework from DWR. This ensures that all stream linework is consistent. Linear referencing is the practice of spatially defining features by providing a measure from one end of a line. In other words, a line can be defined as a subset of another line by providing the measures of each end. For the SMRF, snapping and linear referencing are used to align data layers with the DWR SWRF layer such that the stream mile values are also consistent with SWRF and provide a common framework. For the SWRF and SMRF, stream mile is measured upstream from the State line and stream confluences on tributaries.

In the following discussion, it is easy to confuse E&R “attributes” with GIS layer “attribute table”. Consequently, verbose language is used to ensure clarity.

1-Construction of the .1-Mile Markers and Segmented SWRF Layers

The SWRF layer provided by DWR is not segmented. Each Geographic Names Information System (GNIS) identifier (ID) corresponds to only one line segment (representing the reach) that spans the entire stream length. To achieve the structure for SMRF, points needed to be created on SWRF linework at .1-mile increments. These points were used for two reasons. First, the ArcGIS software can segment lines using the point locations which results in the segmented linework for the data layers. Second, these points are the “Mile Markers” (spaced at .1-mile increments) containing the distance measurements in the point layer’s attribute table. These Mile Markers can be viewed in Google Earth or other viewer when exported, as a reference for locating stakeholder-supplied data.

1.1-Creation of .1-Mile Markers

The workflow to create .1-mile markers uses a simple spreadsheet and linear referencing to construct points at .1-mile increments for the entire SWRF layer. This created ~3.4 million Mile Markers which can be cumbersome to the software and quality control (QC) efforts. To speed up processing, a subset of SWRF was built that only contained reaches included in the South Platte E&R focus areas (FAs). This subset layer is more manageable at ~23,000 features.

- The simple spreadsheet (Figure 1) was compiled by inputting .1-mile (160.9344 meters) increments starting in row 1, and continuing through 3520 (arbitrary number that is longer than any reach in SWRF...the South Platte has more than 3400 .1-mile reaches). Meters were used because they are consistent with the layer's coordinate system, but processing outputs utilize U.S. measures.

	A
1	TenthMiles
2	160.9344
3	321.8688
4	482.8032
5	643.7376

Figure 1

TenthMiles	Strm_Route	Strm_Route GNIS Name
160.9344	00178247	Little James Creek
160.9344	00020001	Brewers Gulch
160.9344	00020002	Hoffman Gulch
160.9344	00020003	Graflin Slough
160.9344	00040001	Carwyle Gulch

Figure 2

- This simple table was used as input to the GIS software to build another table that applied the increments from the input table to each GNIS ID (each stream). See Figure 2.
- This second table was then used as the input for linear referencing. Each row is an “event” along that GNIS stream. A linear referencing tool can then “locate” that event, and create a point feature at the given measurement.

1.2-Creation of .1-Mile Segmented SWRF Layer

This workflow uses the .1-mile marker layer just created and divides the original SWRF layer into .1-mile line segments. The resulting layer is used to intersect with the FA layer to complete the migration of Phase I FAs created with a NHD COMID framework, to a .1-mile segmented layer consistent with SMRF.

2-Construction of Focus Area (FA) Base Layer for BIP Phase II

Early SWSI E&R work utilized spatial data layers for E&R attributes and other data. However, the large amount of spatial data was difficult to manage and review, especially when E&R stakeholders have local interests. Consequently, “focus areas” were defined as a subset of the overall E&R dataset. The rationale for each focus area varies, but, in concept, a focus area is a geographic subset of the stream system that is related to specific E&R attributes. The focus area layer serves as the base layer for BIP Phase II analysis. It retains the extents and attribute table information of FAs determined in BIP Phase I, integrates the DWR standardized linework and reach identification system of the new SWRF layer, and is intersected with E&R attribute extents, Projects and Studies (P&S) on the FA reaches, and instream flow (ISF) reaches. Additionally, the FA layer is segmented into .1-mile segments to be consistent with the SMRF.

2.1-Preparation of the FA Base Layer for Linear Referencing

The initial FA input layer for BIP Phase II work was the final layer from the BIP Phase I work and includes SWSI 2010 focus areas and several new focus areas. This section briefly details the status of the input FA layer, and preparatory steps for linear referencing.

- **Status of the FA layer from Phase I**

- The initial FA layer contains the FAs finalized in BIP Phase I for the South Platte Basin (Figure 3). Note that some of the reaches seem to have missing segments. The linework in Figure 3 is simply the extent of Phase I FAs, not necessarily a contiguous representation of each reach. These missing segments (light blue linework in Figure 4) were imported from the SWRF linework when migrating the FA extents to SMRF for the Phase II layers. This was done without altering the extents of the FAs and allows for analysis on the outside borders of FAs. Some Phase I FA reaches are not in SWRF and therefore are not included in this FA Base Layer. Data for these excluded areas are still available (notated in Appendix D); however, coordination with DWR to add to the SWRF in the future would ensure consistency.

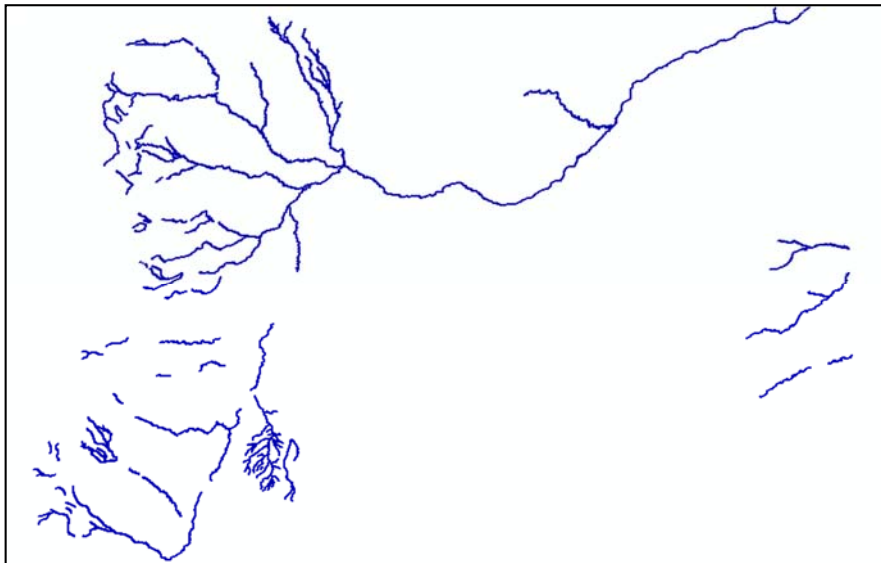


Figure 3. Linework of focus areas from BIP Phase I, based on NHD linework.

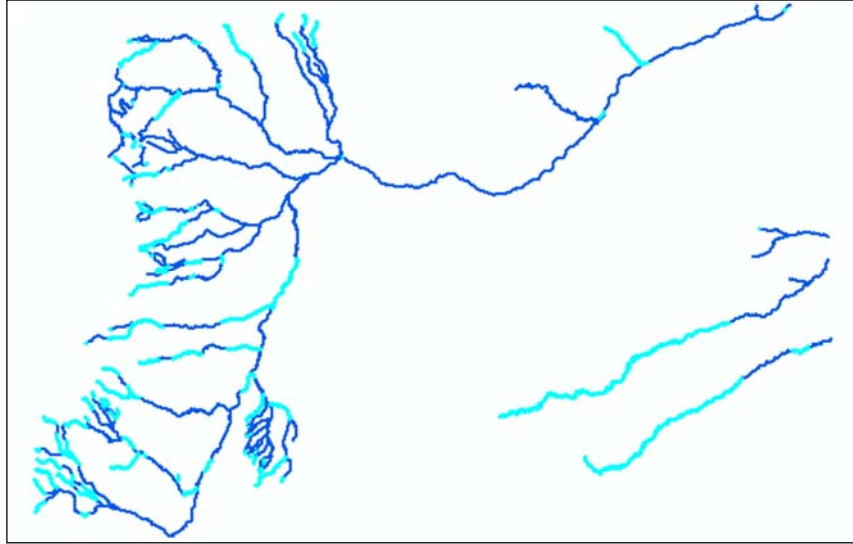


Figure 4. Linework of BIP Phase II focus Areas, based on SWRF Layer (dark blue), and additional SWRF linework to make reaches contiguous (light blue).

- One of the shortcomings of the Phase I FA layer was that the extents of E&R attributes were populated based on NHD COMID which created misrepresentations of habitats because COMID length varied (see Figures 5 and 6).

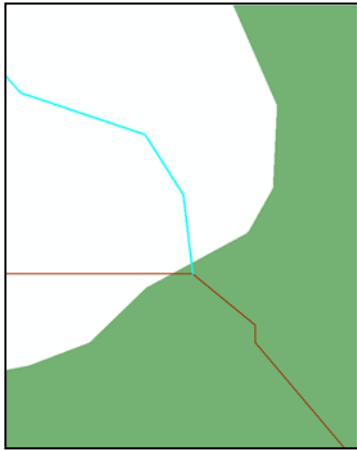


Figure 5

For BIP Phase I FAs, Figure 5 illustrates a case where a COMID line segment overlaps the green, Brassy Minnow Habitat by only 20'. Therefore, all 13,000' of the COMID segment were populated as habitat (Figure 6). With the SMRF, the max overlap is .1-mile (528').

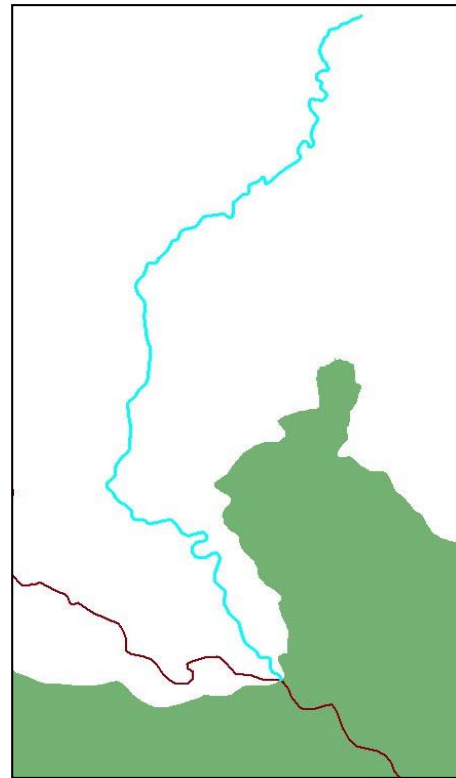


Figure 6

- **Preparatory Steps for Linear Referencing**

- For the input FA layer, data in the 37 SWSI NCNA “categories” columns were deleted. These column's headings were NOT descriptive and one required a key to decipher their E&R value. New descriptive column headings are added as the individual E&R attribute layers are intersected.
- GNIS_ID and GNIS_Name columns in the Phase I FA layer were incomplete and were populated appropriately in the Phase II FA layer. These are required for unique identification of the reaches.
- There are some ArcGIS tools that aid snapping one line to the next, but the input layers provide too much spatial deviation from SWRF to achieve consistent results. Because of this, points were created at the start and end points of all the COMID's linework (Figure 7).

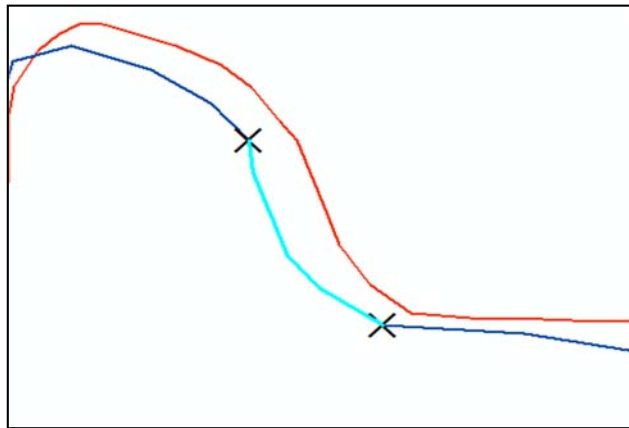


Figure 7. SWRF linework is red, Phase I FA is dark blue, and the COMID extent is light blue. The “X” points represent the start and end of the COMID.

- These points were then transferred (snapped) to the SWRF linework (Figure 8).

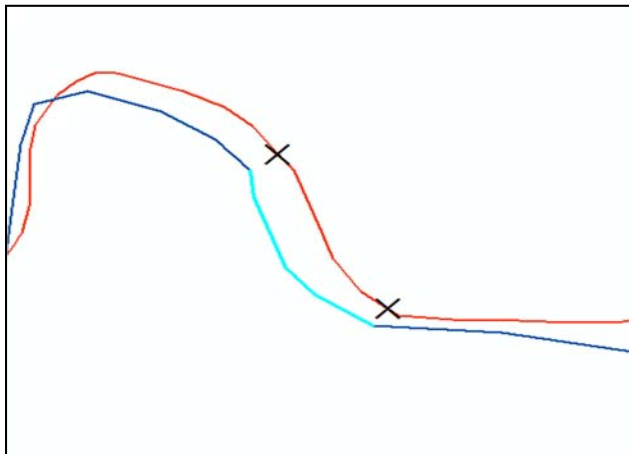


Figure 8. Illustration of snapping start and end points onto SWRF

- The snapping was done in two iterations. The first ensured confluence points were snapped to the appropriate SWRF confluences instead of the stream linework closest to the point (Figure 9). If this confluence point was merely snapped to the nearest reach, a gap in the data would exist between that snapping point and the confluence. The second iteration snapped the remaining points upstream of the confluence to the nearest SWRF reach.
- The snapping procedure cannot account for all spatial layouts representing stream networks. Some input data were outside of the snapping tolerance of the ArcGIS automated tools, and some points were snapped to the incorrect GNIS_ID because the original linework was closer in proximity to the incorrect GNIS in the SWRF (Figure 10). When investigating these limitations, care must be taken manually snapping coincident start/end points. If separated, they will create overlaps or gaps in the resulting data. Once quality controlled (QC), all start/end points are located on SWRF, and are ready to be linear referenced. The workflows in the appendix identify when manual QC work was performed.

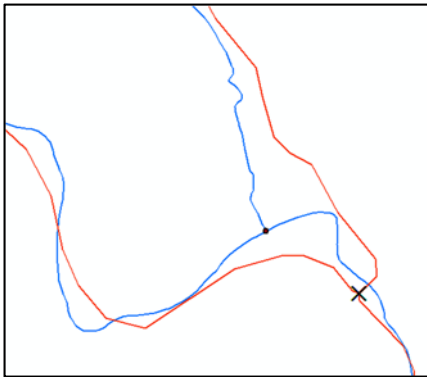


Figure 9. ArcGIS snapping tool would snap the point (X) to the closest blue linework if the confluence was not taken into account, but it clearly needs to snap to the confluence point (•).

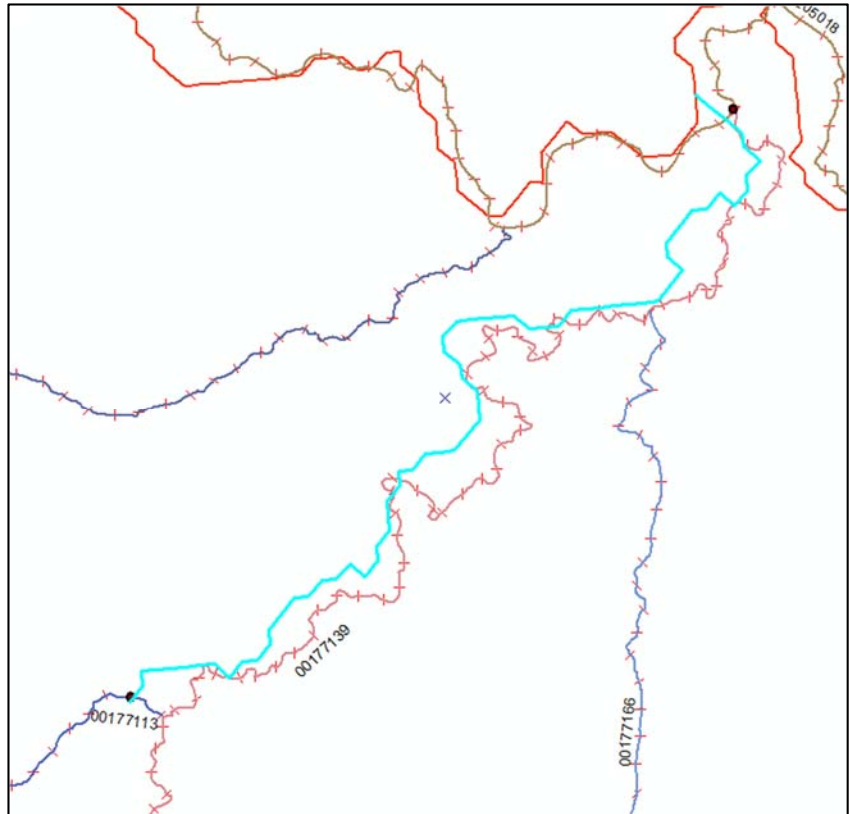


Figure 10. Original E&R linework (light blue line) can deviate greatly from SWRF (hash marked linework). In this case, the endpoint of the light blue line is closest to its tributary's linework, requiring manual QC to clean up.

2.2-Linear Referencing the FA layer

Linear referencing is the process of measuring the distance of an event or feature along a line or route, and recording that measurement. The SWRF layer is organized in actual miles from its confluence (mile 0), to the headwaters (mile x, where x is length of river). DWR incorporated this convention, which provides a useful framework for linear referencing, and for migrating data layers from previous work to the new SWRF linework. With the start and end points transferred to the SWRF linework, they can now be “located” using linear referencing relative to SWRF stream reaches and have the measurements written to the FA attribute table. Geographic coordinates are inherent in GIS when describing features, but measurements along a river or route specified as a linear reference measure need be calculated by processing the linework layer.

- Out of the box tools in ArcGIS (specified in the appendix workflows) perform linear referencing; however, the data needs to be organized for the tools to be effective. These tools add the measures as columns in the data layer's attribute table (Figure 11). FMEAS is the distance from the reach's origin (usually a confluence), to the start point of the .1-mile line segment, and TMEAS is the distance from the origin to the end point of that segment.

GNIS_ID	GNIS_Name	FMEAS	TMEAS	
00201759	South Platte River	161.5	161.6	L
00201759	South Platte River	161.6	161.7	L
00201759	South Platte River	161.7	161.8	L
00201759	South Platte River	161.8	161.9	L
00201759	South Platte River	161.9	162	L

Figure 11. Example of linear reference measures for .1-mile segments.

- The ArcGIS linear referencing tool Make Route Event Layer creates new linework between the start and end point measures that follow the SWRF layer. The newly created linework is identical to SWRF and contains the original attribute table data from Phase I FA layer. The attribute table data retained in the new layer are FA name, segment number (a unique number corresponding to the FA), E&R type, segment description (focus area description), and rationale.

2.3-Finalizing the FA layer

Segmenting the entire SWRF into .1-mile segments creates ~3.4 million features for the layer. To speed up processing and QC, a subset of SWRF was built that only contains reaches overlapped by the FAs. It is more manageable at ~23,000 features and is overlaid with the new FA linework. This overlay finalized the transfer of FA table attributes to the .1-mile segmented, SWRF linework.

3-Intersection of Environmental & Recreational Attributes with Final BIP Phase II FA Base Layer

This workflow determines if E&R attributes are coincident with .1-mile segments corresponding to FAs. If they are coincident, the process indicates so by writing a "Yes" to the FA layer's attribute table for the respective E&R attribute for the .1-mile segment. New, descriptive column headings were added to the FA attribute table to help make each attribute column more explanatory. Compare the headings in Figures 12 (SWSI NCNA Phase II) and 13 (SMRF). The extent of E&R attributes in SWSI was indicated either by Hydrologic Unit Code (HUC) polygon layers, polyline stream layers (e.g., boating reaches), or point layers (e.g., bald eagle nest sites).

categor_25	categor_26	categor_27	categor_28	categor_29	categor
0	0	0	0	0	
0	1	0	0	1	
0	1	0	0	1	

Figure 12. Nondescript column headings of E&R attributes from BIP Phase I spreadsheets and tables.

erness	BaldEagle	BirdArea	BorealToad	BrassyMinnow	ComGarterSnake
	<Null>	<Null>	<Null>	Yes	<Null>
	<Null>	<Null>	<Null>	Yes	<Null>
	<Null>	<Null>	<Null>	Yes	<Null>

Figure 13. Descriptive column headings of E&R attributes for BIP Phase II.

The intersection of E&R attributes for polylines is much more complex than the polygon layers. Similar to the FA base layer workflow, the polyline layers needed to have their start/end points transferred to SWRF to determine their extent. The polygon layers are simply coincident with SWRF reaches, or these reaches are outside of the E&R polygon (see Figure 15).

3.1-Intersection of E&R Attributes (Polylines) and FA Base Layer

The linework of the E&R attributes is significantly different than that of SWRF. Figure 14 displays this characteristic, and deviations in linework as high as a half mile have been found. This is due to the E&R attribute data being digitized from stream data with lower resolution and various agencies creating this input data with no standard process. This complexity presented many scenarios that automation could not account for (especially at confluences), and QC was important for the polyline layers with numerous features.

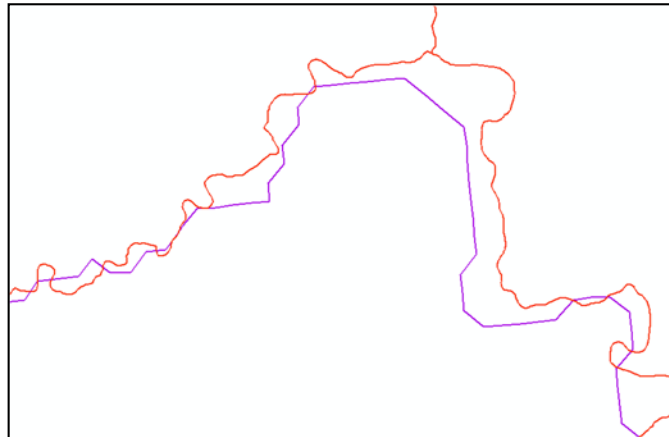


Figure 14. Purple line is the Rafting attribute, and red line is SWRF.

- Similar to the creation of the FA base layer, points were created at the start/end of the attribute's extents defined in their respective layers. However, the input layers had multipart geometry, which complicated this process. This multipart geometry would create unnecessary quantities of start/end points. For example, a single, one mile reach could be comprised of 3 COMID's and would have 3 start and 3 stop points created for the single E&R attribute. Only one start point, and one stop point are needed to define the extent. To simplify the layer in preparation for linear referencing, the layers had the Unsplit Tool executed on them to unsplit their geometry. This part of the workflow created singlepart geometry to define the extent of the E&R attribute.
- These newly created points are then transferred (snapped) to the FA base layer linework which is coincident with SWRF and segmented every .1-mile. The resulting points are then located by the linear referencing tool Locate Features Along Route. This tool uses GNIS_ID and the mile marker measure to describe that point's location. These values are recorded in the FA base layer attribute table.
- The Make Route Event Tool uses this newly created table to construct new linework for the E&R attributes that is coincident with SWRF. The GIS software can easily interpret the extents of this

coincident linework in relation to the SWRF layer. This relationship is then recorded in the FA base layer attribute table as “Yes” for being present in that .1-mile segment.

3.2 Intersection of Environmental and Recreational Attributes (Polygons) and FA Base Layer

Polygon attribute extents are used in cases where original attribute data were indicated by HUC basins or other polygons. Processing of polygon attribute data is much simpler than processing polylines. Basically, if FA base layer linework intersects the polygon, the attribute table is populated for the intersecting line segments. In Figure 15, the blue line is populated with a “Yes” as having that E&R attribute present, and purple line does not correspond to that E&R attribute.

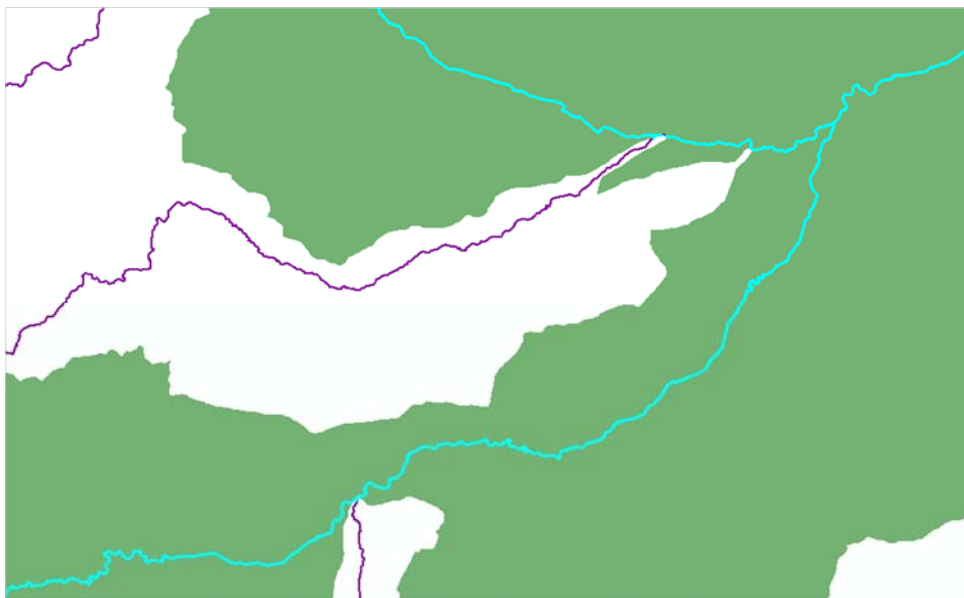


Figure 15. The Brassy Minnow Habitat is the green polygon. The GIS software differentiates reaches within (blue), and those outside of the Habitat (purple).

4-Intersection of Instream Flow, and Projects and Studies Layers with Final BIP Phase II FAs

Both the instream flow (ISF), and the projects and studies (P&S) layers have polyline geometry. The same polyline approach used for the E&R attributes was used to intersect these two layers with the FA base layer. Details of that workflow are not discussed in the subsections below, as they are described in section 3.1. However, a quick summary is start/end points are created for each feature, they are snapped to the SWRF linework, located along that linework, and used to define the extents of their existence by populating the FA base layer table with a “Yes” in the appropriate column.

The FA base layer already has the extents of the E&R attributes written in its attribute table, and with the intersection detailed in this section, a comprehensive resource is created for the essential E&R data for FAs in the South Platte Basin.

4.1-Intersection of ISFs and FA Base Layer

The current ISF layer was downloaded from the Colorado’s Decision Support Systems (CDSS) website (see appendix for URL). It was updated January of 2015 and is mostly coincident with SWRF linework because the ISF reaches have been created by linearly referencing NHD, which is also the source for the SWRF layer. If the two layers were 100% coincident, the linear referencing tool could determine the stream mile measures directly. However, there was some deviation in the linework and the workflow for the E&R attributes was executed on the ISF layer. Additionally, multiple ISFs are decreed or pending for the same stream segment in some cases. This creates overlaps in the linework (a maximum of 10 overlaps exist in the ISF layer, see Figure 16), which complicates displaying this additional data within the already large FA base layer attribute table. In an attempt to keep this table a manageable size, a second reference table was created to store the multiple ISF IDs present on any given .1-mile segment. Subsequently, a user of the data would check the FA table to verify that there is a “Yes” in the ISF column of that stream segment, then use that GNIS_ID and .1-mile marker to look up the particular ISF ID in the reference table. The TSTool software was used to process these tables into a final Excel workbook product (see BIP memorandum “Stream Mile Representation Framework TSTool Workflow Processing”, March 2015).

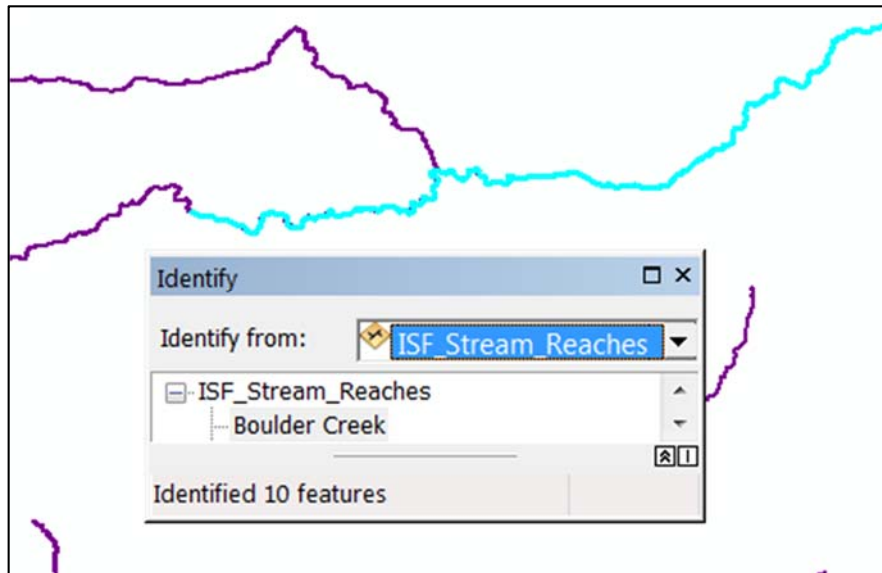


Figure 16. When investigating ISFs on Boulder Creek, 10 overlapping features are present on the single visible blue line. Although every reach does not have this characteristic, the workflow accommodates by retaining all pertinent data for a given reach. This is a characteristic of the Projects and Studies layer also, having a maximum of 40 overlaps.

- The FA base layer's ISF column was populated as described in section 3.1 for the E&R attributes. New ISF linework was also constructed similarly.
- To retain all of the ISF IDs from the overlapping situations, a second table was created to display this information for each .1-mile segment. A user of this data can cross reference the GNIS_ID and .1-mile marker in this second table which identifies each ISF ID present.
- Finally, a third table was created containing pertinent data relative to the ISF IDs, such as case number, type, and status. To use this table, cross reference the ISF ID with the same ID in the table for the relevant information. These second and third tables were created to limit the number of columns in the FA base layer attribute table.

4.2-Intersection of the Projects and Studies layer and FA Base Layer

The P&S layer was the same one used for Phase I BIP. It is the largest layer intersected with ~9700 line segments. As with the E&R attributes, the linework is not coincident with SWRF and the same workflow was followed detailed in section 3.1. Multiple projects and studies often occur on a common stream segment. This is represented in the layer with overlapping linework similar to the ISF layer (see Figure 16), and is also handled by creating two additional tables to keep the size of the FA base layer attribute table manageable.

- As noted, this layer was processed similar to the E&R attribute layers, but, due to its size, time did not allow for manual QC. Therefore, tables were created containing the P&Ss that did not transfer to the SWRF linework, and not incorporated into the FA base layer (see Appendix C, Manual QC of Section 4.1 Workflow).
- P&Ss that are newer than this P&S layer were not processed. The locational information provided for these new P&Ss was varied and mostly not specific. Additional time is needed to interpret these locations, incorporate into a GIS format, and then input into these processes for inclusion in SMRF.

5-Linear Referencing Gages and Diversions to be Incorporated into the Stream Mile Representation Framework

Point data is relatively simple for GIS linear referencing tools to handle. Both gages and diversions layers have this point geometry. The linear referencing performed for these layers is similar to the prior workflows for start/end points. It locates the points and writes the measure of that feature along each GNIS to a new table. With this newly derived information, the data are in the standard format required to be incorporated into the SMRF. One difference between this workflow and the previous linear references, is that these points are not snapped to the SWRF. The GIS software can still locate them and writes an additional column which is populated with the distance each respective point is away from the SWRF linework.

5.1-The Gage Layer

- The gage layer was downloaded from the CDSS website on February 4, 2015. Both historic and real-time layers were processed (see Appendix A for URL).
- To begin this workflow, point features outside of the South Platte Basin were filtered out of these layers. The remaining point features were only those within the South Platte Basin and comprised the gage layer that was run through this workflow. The workflow populated the column for measures of the gages and allowed for inclusion to SMRF.
- An additional layer was created containing only the 4 gages that were used to define the focal points of the 4 Example Areas for BIP Phase II.

5.2-The Diversion Layer

- The diversions layer was downloaded from the CDSS website on May 4, 2014 by (see Appendix A for more detail).
- West Sage Water Consultants filtered this layer and created 4 tables identifying the diversions of interest in near proximity to the Example Area Gages defined in section 5.1.
- These 4 sublayers of the diversion layer were run through the linear referencing workflow. This populated the column for measures of the diversions and allowed for inclusion to SMRF.

Appendix A-Data Sources and Directory

Overall database structure – This appendix details the structure of the database and sources of input data that are not defined in the workflows in Appendix C.

Location of database: *Dropbox/NBIP Team/Phase II/Data-Spatial/*

- *BIPphaseII_SMRF.gdb*-Workspace containing inputs and outputs of workflows. Also contains all of the geodatabase tables output by the workflows. This is the default workspace for all BIP Phase II GIS work, unless otherwise noted.
 - *METRO_SP_ATTRIBUTES* - Feature dataset containing mostly input layers. Original sources of these input layers are:
 - All layers beginning with “**ATTRIBUTE**”, all layers beginning with “**MetroSplatteBasin**” (except the two “**Projects**” layers), **SouthPlatte_Subbasins**, and **metro_RT_bound_Dissolve**: *Dropbox/NBIP Team/Mapping/Attributes Data/SWSI_NCNA_PH1_BASIN_DATA.gdb/METRO_SOUTHPLATTE*
 - **MetroSplatteBasin_Counties**...deleted slivers from Chaffee, Lake, Summit,

Grand, and Jackson Counties...all on West side of basin...most likely remnants from a clip performed before BIP Phase II.

- **div1_diversions:** West Sage Water Consultants acquired via email. The email was from Amec Foster Wheeler and stated it was downloaded “off the CDSS website on 5/2/2014.”
- **FocusAreas2014V3:** Was imported from **2014FocusAreasV3.shp** located in this directory, *Dropbox/NBIP Team/Mapping/NEW GIS/2014FocusAreasV3 w numbers/*
- **BasinExtent_SP:** The South Platte Basin was selected from **DIV3CO.shp** and exported to the workspace. **DIV3CO.shp** is the download titled “Division Boundaries” from the CDSS GIS data website <http://cdss.state.co.us/GIS/Pages/AllGISData.aspx>.
- **GagesHistoric_SP, GagesRealtime_SP, and ISF_SP_2015:** Respectively downloaded “Surface Water Gages - Historic (with Period of Record)”, “Surface Water Gages - Real Time (current conditions)”, and “Instream Flow Reaches – Decreed and pending reaches” from the CDSS GIS data website <http://cdss.state.co.us/GIS/Pages/AllGISData.aspx>. These shapefiles were filtered to only include data within the South Platte Basin (used **BasinExtent_SP**), and exported to a feature class in this feature dataset.
- **MetroSplatteBasin_All_Projects** and **MetroSplatteBasin_All_Projects_Studies** (**MetroSplatteBasin_All_Projects** was not processed in BIP Phase II, as all its data already exist in **MetroSplatteBasin_All_Projects_Studies**): *Dropbox/NBIP Team/Mapping/SWSI/SWSI_GIS/SWSI 2010 and 2016 GIS/NCNA/Geodatabase/SWSI_NCNA_PH2_BASIN_DATA.gdb/METRO_SOUTHPLATTE*
- **NHDWaterbody:** Downloaded from USGS website <http://nhd.usgs.gov/data.html> in December 2014.
- **METRO_SP_ATTRIBUTES_onSWRF** – Feature dataset containing layers with geometry coincident with SWRF linework. Intermediate and finalized layers reside here, and some have the .1-mile segmented geometry. The following layers were acquired as indicated and the remainder of layers in this feature dataset are outputs of processing detailed in Appendix C:
 - **Strm_Route** and **Strm_Mile_Con_Pnts:** DWR provided via email on November 13, 2014. **Strm_Route** is an early version of **SWRF** and **Strm_Mile_Con_Pnts** is a point layer of confluences.
 - **SWRF_SP:** This FC was filtered to only include data within the South Platte Basin (used **BasinExtent_SP**). Its source is the CDSS GIS data website <http://cdss.state.co.us/GIS/Pages/AllGISData.aspx>. The link for the download is titled “Source Water Route Framework” and was downloaded February 2015.
- **METRO_SP_ATTRIBUTES_OUTPUTS** – Feature dataset mostly containing intermediate outputs used in creating finalized layers. Details of a layer’s construction are in Appendix C if not detailed here:
 - **Strm_Route_Buffer:** Layer is a 1000’ buffer of **Strm_Route** used by the WriteGNIS_ID MB Tool.
- **Geodatabase Tables** – Most of the tables in the geodatabase are defined in their respective workflows from Appendix C. Here are sources of the additional tables.
 - **Diversions_Balzac_ex_area, Diversions_Chatfield_ex_area, Diversions_Elevenmile_ex_area, and Diversions_St_Vrain_ex_area:** West Sage Water Consultants filtered **div1_diversions** and created 4 tables identifying the diversions of interest in near proximity to the Example Area Gages defined in section 5.1. These are the tables after being imported to the workspace from their native format of .xlsx.

Appendix B-Description of Model Builder (MB) Tools

- **WriteGNIS_ID** – This tool is for polyline features and uses a 1000' buffer of SWRF GNIS_ID's (**Strm_Route_Buffer**). As it iterates through each buffer in the layer, it checks to see if a polyline from the input layer is "completely within" the buffer. If there is, the tool writes that buffer's GNIS_ID to the attribute table of the input layer's identified feature. This tool has its shortcomings. In the case where a line segment or COMID (shown as the yellow line in figure 17) is relatively short, multiple GNIS_ID buffers can be coincident and the incorrect ID can be written. In the case of figure 17, the COMID was assigned 00204956 instead of 00177820. Also, it cannot account for linework that deviates more than 1000' from SWRF. QC is generally needed for the larger layers this tool is executed on because some reaches need to be split due to one line segment traversing two or more separate GNIS_IDs, and some reaches of input linework are not even included in SWRF.

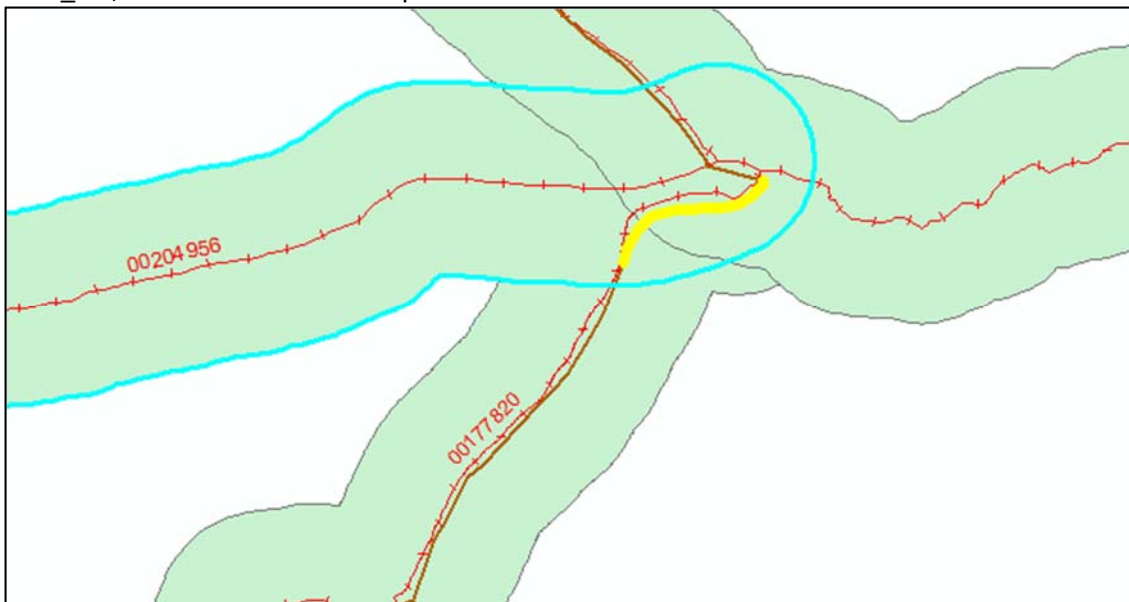


figure 17

- **DefineExtentsFromTo** – This tool is for polyline features whose geometry is singlepart. It utilizes the Add Geometry Attributes Tool to write xy-coordinates of all the features' start and end locations. Next, two Event Layers are created with the xy-data: one has start points and one has end points. Finally, it deletes the xy-fields from the FCs.
- **SnapEvents (Advanced License Only)** – This tool has a two tiered snapping process. The first snaps any start/end points within 85 meters of **Strm_Mile_Con_Pnts** (**Strm_Route** confluence points), to **Strm_Mile_Con_Pnts**. Second, any unsnapped point within 150 meters of **Strm_Route**, is snapped to **Strm_Route**.
- **FMEASLocateEvents (start points)** and **TMEASLocateEvents (end points)** – This tool locates events (start/end points) along reaches and writes the GNIS_ID they were located on, and the corresponding .1-mile marker distance along the stream to a new event table. Additionally, it deletes records (start/end points) in that table that were located on a GNIS_ID that it did not natively belong to.
- **JoinStartEndMakeRoute** - This tool joins two input events tables based on the field Line_ID, and creates linework coincident with SWRF in between the start and end point pairs. This tool only creates

linework coincident to Strm_Route_FA, not the entire Strm_Route. This was done to limit time spent QC-ing by only processing FA locales.

- **FAoverlayLines** – This tool takes the E&R attribute layers with SWRF linework (**filename_onSWRF**), and creates a new field with a heading describing its correlating E&R attribute. Next, it Selects by Location all features from **FocusAreas_onSWRF_TenthMiles** that Share a Line Segment With the E&R attribute input layer. With that selection, the Calculate Field writes a value of “Yes” to its respectively named field.
- **FAoverlayPolys** – This tool starts by running the Dissolve Tool on the original E&R attribute layers. This tool dissolves the boundaries between adjacent polygons. This eliminates extra start/end points from being created and will simplify creating linework for the polygon ranges. This tool also creates a new field with a heading describing its correlating E&R attribute. Next, it Selects by Location all features from **FocusAreas_onSWRF_TenthMiles** that Intersect the E&R attribute input layer. With that selection, the Calculate Field writes a value of “Yes” to its respectively named field.

Appendix C-Technical Details of GIS Workflows

MB Tools are only referenced in this section, but details of their processes are outlined in Appendix B. The naming convention **filename_GISprocess** is used in this appendix where **filename** is the actual name of the individual layer, and **GISprocess** is the descriptive text indicating the specific step in the workflow the layer represents. The introductory section numbers (e.g., 1.1) correspond to the sections in the body of this document.

ArcGIS information: All workflows were performed with the ArcGIS Basic License unless otherwise specified, 10.2.2 was the version, all settings were default unless otherwise specified.

FC-Feature Class

MB-Model Builder

1.1-Workflow for the Creation of the .1-Mile Markers Layer

1. Created a new spreadsheet **TenthMiles.xls** (figure 1) with .1-mile (160.9344 meters) increments starting in row 1, and continuing through 3520 (arbitrary number that is longer than any reach in SWRF). Meters were used because the native coordinate system of the data is also in meters.
2. Loaded **TenthMiles.xls** into workspace and kept name **TenthMiles**. Used Make Query Table Tool to populate each GNIS_ID with these .1-mile measures for the entire length of each reach. Input tables were **Strm_Route** and **TenthMiles**. Check mark fields TenthMiles.OBJECTID, TenthMiles.TenthMiles, Strm_Route.GNIS_ID, and Strm_Route.GNIS_Name. Select ADD_VIRTUAL_KEY_FIELD from Key Field Options, and named table **QueryTableTenthMiles**. This table is temporary and is the input for the Table to Table Tool to create a permanent copy of the same name.
3. Ran tool Make Route Event Layer with Input Route Features as **Strm_Route**, and selected GNIS_ID as the RID. Input Event Table is **QueryTableTenthMiles**, and its RID is Strm_Route_GNIS_ID. The Measure Field is TenthMiles_TenthMiles. This creates an Event Layer that will be used as input for segmenting **Strm_Route** into .1-mile segments, and act as .1-Mile Markers for the framework. The Event Layer is temporary and named **TenthMileMarkers**. This layer is the input for FC to FC Tool to create a permanent copy of the same name.
4. **TenthMileMarkers** has ~3.4 million features and this step created a sublayer to speed up processing. Summarized the field GNIS_ID in **FocusAreas** to create the table **GNIS_IDs_inFA**. In **TenthMileMarkers**

Selected by Attributes from the field GNIS_ID using this expression: GNIS_ID in (select GNIS_ID from **GNIS_IDs_inFA**). With this selection, ran FC to FC Tool to create the subset of **TenthMileMarkers** which was called **TenthMileMarkers_FA** (~23,000 features).

5. Ran Add Field Tool for **TenthMileMarkers_FA** and named it MileMarker. Ran Calculate Field Tool on field MileMarker using the expression: [TenthMiles_TenthMiles]*.000621371192237334. This is the equation to convert meters to miles. Additionally, in **TenthMileMarkers_FA** FC, Add Fields GNIS_ID and GNIS_Name. Populated these fields with the values from Strm_Route_GNIS_ID and Strm_Route_GNIS_Name respectively. Finally, Deleted Fields TenthMiles_TenthMiles, TenthMiles_OBJECTID, Strm_Route_GNIS_ID, and Strm_Route_GNIS_Name.

1.2- Workflow for the Creation of the .1-Mile Segmented SWRF Layer

1. Ran Split Line at Points Tool (Advanced License only). Input Features were **Strm_Route_FA**, and Point Features were **TenthMileMarkers**. Must use a small search radius: 1 meter or so...even though points were “created on the line,” this tool will not find all of them with a 0 radius. Output FC was **Strm_Route_FA_Split**.
2. In **Strm_Route_FA_Split**, created two fields and titled FMEAS and TMEAS. With the Field Calculator and using Python, FMEAS was populated with the expression “round (!Shape!.firstPoint.M *.000621371192237334, 1)” and TMEAS was populated with the same expression, except changed the word “first” to “last” in the expression.

2-Workflow for the Construction of the Focus Area Base Layer (Sections 2.1-2.3)

1. **2014FocusAreasV3.shp** was imported as **FocusAreas2014V3** into the workspace. A copy of this FC was made and renamed to **FocusAreas** and moved to the *METRO_SP_ATTRIBUTES_OUTPUTS* feature dataset in the default workspace. In the **FocusAreas** FC, the Delete Field Tool was used to delete the 37 “categories” fields and the data within them.
2. **FocusAreas** FC was an input to the WriteGNIS_ID MB Tool. This tool writes the appropriate value to the GNIS_ID field. Once executed, empty GNIS_ID values were investigated (see Manual QC for step 2 below).
3. In **FocusAreas** FC, created and populated a static, unique Line_ID field that will be used to associate respective start and end point FCs after these points have been snapped to SWRF. The field was populated with the values from OBJECTID (OBJECTID is a dynamic, indexing field, where its values can change unnoticed and automatically by the software).
4. Ran DefineExtentsFromTo MB Tool on **FocusAreas** FC. This tool creates two FCs: one for start points, and one for end points of every feature in the input layer. Output FCs: **FocusAreas_EndPts** and **FocusAreas_StartPts**. These layers were duplicated and **_Presnap** was appended to their file names. These presnap layers preserve the native location of start and end points, as these points are relocated in the next step.
5. Ran SnapEvents MB Tool (Advanced License only) on **FocusAreas_StartPts** and **FocusAreas_EndPts** FCs. This tool only snaps points that are within 150 meters. Then, investigated points that did not snap, or snapped to the wrong GNIS_ID (see Manual QC for step 5 below).
6. Ran FMEASLocateEvents (on **FocusAreas_StartPts**) and TMEASLocateEvents (on **FocusAreas_EndPts**). These MB Tools locate events (start/end points) along reaches, and writes the distance measurement and GNIS_ID the point was located on to a new table. It also deletes records (start/end points) that were located on a GNIS_ID that the record did not natively belong to. The output tables were named **FocusAreas_StartPts_Events_Table** and **FocusAreas_EndPts_Events_Table**.

7. Ran JoinStartEndMakeRoute MB Tool with **FocusAreas_StartPts_Events_Table** and **FocusAreas_EndPts_Events_Table** as inputs. This tool joined the two input events tables based on the field Line_ID, and created linework coincident with SWRF in between the start and end point pairs. This linework is stored in the output FC **FocusAreas_onSWRF**. This completes the migration of phase I FA attribute table data to linework coincident with SWRF.
8. Ran FC to FC Tool on **FocusAreas_onSWRF** and output **FocusAreas_onSWRF_Done** to preserve an original layer. In the Field Map, fields FMEAS, TMEAS, COMID, GNIS_Name, and Line_ID were deleted. Also, the field Rationale had its length increased to 500 characters, and the contents of field Rationale2 were appended to Rationale using the Merge Rule of Join. Finally, field Rationale2 was deleted.
9. A new layer needs to be constructed that extracts the linework from the **Strm_Route** FC that is outside of the FAs. Summarized GNIS_IDs in **FocusAreas** which created a table with this information called **GNIS_IDs_inFA**. Then Selected by Attributes from **Strm_Route** those GNIS_IDs in FAs with the expression “GNIS_ID in (select GNIS_ID from **GNIS_IDs_inFA**)”. With this selection, ran FC to FC Tool making **Strm_Route_FA**. The linework from a few extra GNIS_IDs were included due to incorrect GNIS_IDs from the input **FocusAreas**. See 00171011 in **FocusAreas**...it should be South Platte's GNIS_ID, 00201759. These extra IDs only add a small amount of linework, and were preserved in the layer. Also, non-FA segments in between FAs, AND on the same GNIS_ID were also retained to allow analysis on the borders of FAs. **Strm_Route_FA** is also split in .1-mile segments. See 1.2 for workflow.
10. Ran Spatial Join Tool. Target: **Strm_Route_FA_Split**. Join Features: **FocusAreas_onSWRF**. Output FC: **FocusAreas_onSWRF_TenthMiles_BaseLayer**. Match Option: SHARE_A_LINE_SEGMENT_WITH. In the Field Map: Delete Fields Shape_Length , FMEAS_1, COMID, GNIS_ID_1, GNIS_Name_1, Line_ID, TMEAS_1, and Shape_Length_1. This finalizes the FA layer which contains FA table data, SWRF linework, and a .1-mile segmented framework.
11. Duplicated **FocusAreas_onSWRF_TenthMiles_BaseLayer** and renamed **FocusAreas_onSWRF_TenthMiles**. This retains a “base layer” for future use or reference, while creating a layer that will be used to append the new, descriptive E&R attribute fields to, and populate with their extents.

Manual QC of Section 2 Workflow (FA Base Layer)

- **Step 2** – Some GNISs were not completely within the GNIS buffer. The following GNISs were not written correctly with the automated tool. Line IDs 58, 62, 334, 347, 510, 519, 520, 531, 536, 663, 983, 1149, 1152, 1153, 1254-1256, 1330, 1374, 1501, 1513.
- **Step 5** -- Selected by Location points within 4 meters, then switched selection to investigate why points weren't snapped to Strm_Route, or were snapped to the incorrect GNIS_ID. The following had to be manually snapped to SWRF. These Line_IDs were from Start Pts 2-4, 27, 31-33, 76, 220, 226, 252, 330, 336, 347, 383, 415, 431, 432, 595, 663, 713, 750-754, 767, 768, 770, 771, 773, 777, 786, 793-796, 801, 818-823, 825, 826, 845, 859, 863, 894, 895, 983, 1068, 1097, 1119-1122, 1124, 1135, 1136, 1147, 1207, 1208, 1210-1212, 1214-1217, 1218, 1221-1223, 1225-1227, 1251, 1252, 1254-1256, 1267, 1268, 1507. These Line_IDs were from End Pts 2, 3, 25, 27, 28, 30, 31, 33, 220, 221, 251, 288, 322, 329, 336, 337, 339, 368, 381, 404, 430, 431, 534, 593, 594, 714, 750-754, 768-771, 773, 774, 779, 787, 794-797, 802, 819, 821-826, 858, 864, 894, 900, 901, 1104, 1069, 01119-1125, 1134, 1136, 1138, 1143, 1207, 1210, 1213, 1215-1217, 1219, 1221-1224, 1226-1228, 1251, 1254-1256, 1257, 1266, 1267, 1514.

3.1-Workflow for the Intersection of Polyline E&R Attributes and FA Base Layer

1. This workflow was performed on the polyline E&R attribute layers beginning with the all caps word

“ATTRIBUTE” and are contained in the workspace’s feature dataset *METRO_SP_ATTRIBUTES*.

- **ATTRIBUTE4_MetroSplatteBasin_PendingStreams_2010**, **ATTRIBUTE4_isfstreams2005_SP**, and **ATTRIBUTE4_isfstreams_2010** were NOT intersected because their data were represented in the current ISF layer that was downloaded from CDSS’s GIS page (see Appendix A for URL).
2. Ran Unsplit Tool (Advanced License only) on each E&R attribute. This converts the multipart geometry to singlepart and the outputs were respectively named **filename_Unsplit**.
 3. Ran WriteGNIS_ID MB Tool on **filename_Unsplit** to populate GNIS_ID field (some E&R attributes needed a GNIS_ID field to be created). This tool writes the appropriate value to the GNIS_ID field. Once executed, empty GNIS_ID values were investigated and populated manually (see Manual QC for step 3 below).
 4. In **filename_Unsplit** FC, created and populated a static, unique Line_ID field that will be used to associate respective start and end point FCs after these points have been snapped to SWRF. The field was populated with the unique values from OBJECTID (OBJECTID is a dynamic, indexing field, where its values can change automatically by the software).
 5. Ran DefineExtentsFromTo MB Tool on **filename_Unsplit** FC. This tool creates two FCs: one for start points, and one for end points of every feature in the input layer. Output FCs: **filename_EndPts** and **filename_StartPts**. These layers were duplicated and **_Presnap** was appended to their file names. These presnap layers preserve the native location of start and end points, as these points are relocated (snapped) in the next step.
 6. Ran SnapEvents MB Tool (Advanced License only) on **filename_StartPts** and **filename_EndPts** FCs. This tool only snaps points that are within 150 meters of **Strm_Route** (see Manual QC for step 6 below).
 7. Ran the MB Tools FMEASLocateEvents (on **filename_StartPts**) and TMEASLocateEvents (on **filename_EndPts**). These tools locate events (start/end points) along reaches, and writes the distance measurement, and GNIS_ID that the point was located on, to new tables. The output tables were named **filename_StartPts_Events_Table** and **filename_EndPts_Events_Table**. If these tables had a differing number of records, not all complete pairs of start and end points were located, and manual investigation was needed (see Manual QC for step 7 below).
 8. Ran JoinStartEndMakeRoute MB Tool with **filename_StartPts_Events_Table** and **filename_EndPts_Events_Table** as inputs. This tool joined the two input events tables based on the field Line_ID, and created linework coincident with SWRF in between the start and end point pairs. This linework is stored in the output FC **filename_onSWRF**. This completes the migration of original E&R attribute linework, to linework coincident with SWRF.
 9. The **RICDs** layer only has 5 short lines that are perpendicular to SWRF linework. This layer was handled differently than the other polylines. Selected by Location from **FocusAreas_onSWRF_TenthMiles** all features that were within 20 meters of **RICDs**’ features. With this selection, Calculated Field on **RICDs** “Yes”.
 10. Finally, FAoverlayLines MB Tool was executed on **filename_onSWRF**. This tool creates the field with a descriptive heading indicating its respective E&R attribute, and Selects by Location features in **FocusAreas_onSWRF_TenthMiles** that Share a Line Segment With **filename_onSWRF**. With this selection, Calculated Field (on the newly created attribute field) with “Yes”. By repeating this process with all the E&R attribute polyline layers, the **FocusAreas_onSWRF_TenthMiles**’ table is appended to, and populated with these attribute’s ranges.

Manual QC of Section 3.1 Workflow (Polyline E&R attributes)

- **Step 3 – ATTRIBUTE4_additional_wilderness_area_waters** (OBJECTID 39 was split...linework spanned

two GNIS_IDs). **ATTRIBUTE4_CO_outstanding_and_wilderness_area_waters** (OBJECTIDs 268, 450, and 398 were split...linework spanned two GNIS_IDs).

- **Step 6 --** The following are PreLine_IDs that needed to have their linework split, as their linework spanned two different GNIS_IDs: **ATTRIBUTE4_CO_Outstanding_Waters_SP** (217, 360, 665, 689, 707, 763, 769).
- **Step 7 --** Some of the linework represented lakes in the original E&R attribute polyline layers. This scenario is not applicable to linear referencing and were filtered out of these processes. The following are Line_IDs of start/end points that were snapped to the incorrect GNIS_ID, or they were too far from the SWRF linework: **ATTRIBUTE4_CO_Outstanding_Waters_SP** (StartPts 31, 105, 316, 349, 645, 703, 708, 723, 759 & EndPts 92, 93, 106, 219, 239, 372, 567, 645, 663, 694, 759).

3.2-Workflow for the Intersection of Polygon E&R Attributes and FA Base Layer

1. FAoverlayPolys MB Tool processes the E&R attribute polygon layers to be represented in their respective fields in FC **FocusAreas_onSWRF_TenthMiles** with a value of “Yes” if they exist on that .1-mile segment. See FAoverlayPolys MB Tool for details.

4.1-Workflow for the Intersection of ISFs and FA Base Layer

1. Selected from **ISF_Stream_Reaches.shp** all features that Intersect the South Platte Basin. With this selection, ran FC to FC Tool and named the output **ISF_SP_2015** and saved to the default workspace.
2. Selected by Location from **ISF_SP_2015** that Share a Line Segment with **SWRF_FA_Split**. This filters out ISFs outside of FAs. With this selection, ran FC to FC Tool to create **ISF_SPFA_2015**.
3. Ran WriteGNIS_ID MB Tool on **ISF_SPFA_2015**. Investigated records that had no GNIS_ID value and manually typed in the correct GNIS_ID.
4. In **ISF_SPFA_2015** FC, created and populated a static, unique Line_ID field that will be used to associate respective start and end point FCs after these points have been snapped to SWRF. The field was populated with the unique values from OBJECTID (OBJECTID is a dynamic, indexing field, where its values can change automatically by the software).
5. The features in **ISF_SPFA_2015** were not singlepart geometry, but were made up of numerous parts per feature. This characteristic would create start/end points based on these parts, instead of the whole feature itself. To dissolve these multiple parts into one, the Dissolve Tool was executed on **ISF_SPFA_2015**. The output FC was named **ISF_SPFA_2015Dissolve**.
6. Ran DefineExtentsFromTo MB Tool on **ISF_SPFA_2015Dissolve** which created the two FCs **ISF_SPFA_2015Dissolve_StartPts** and **ISF_SPFA_2015Dissolve_Endpts**. Most of the linework from this current ISF layer was coincident with SWRF and the snap automation was not needed (see Manual QC for step 6 below).
7. Ran FMEASLocateEvents and TMEASLocateEvents MB Tools on **ISF_SPFA_2015Dissolve_StartPts** and **ISF_SPFA_2015Dissolve_EndPts** respectively. Output tables were named **ISF_SPFA_2015Dissolve_StartPts_Events_Table** and **ISF_SPFA_2015Dissolve_EndPts_Events_Table**.
8. Used the events tables created in Step 7 as input to the JoinStartEndMakeRoute MB Tool and named the output **ISF_SPFA_2015onSWRF**.
9. Ran the FAoverlayLines MB Tool on **ISF_SPFA_2015onSWRF**.
10. To account for overlapping features, a spatial join was executed to record all ISF IDs that were present for each .1-mile segment. Step 9 merely confirmed with a “Yes” the existence or not, of at least one ISF ID.

- Ran Spatial Join Tool. Target: **FocusAreas_onSWRF_TenthMiles_BaseLayer**. Join Features: **ISF_SPFA_2015onSWRF**. Output FC: **FocusAreas_onSWRF_TenthMiles_ISFdataJoin**. Match Option: **SHARE_A_LINE_SEGMENT_WITH**. In the Field Map: Delete Fields **FMEAS_1**, **GNIS_ID_1**, **Line_ID**, **TMEAS_1**, **ISF_Type**, **Case_Number**, **Status**, and **Shape_Length_1**. For field ID: set length to 500, Merge Rule of Join, Delimiter of “,” (i.e., a comma).
 - Duplicated **FocusAreas_onSWRF_TenthMiles_ISFdataJoin** and renamed **FocusAreas_onSWRF_TenthMiles_ISFdata**.
 - In FC **FocusAreas_onSWRF_TenthMiles_ISFdata**, selected all records where JoinCount = 0 and deleted...no ISF is present on those line segments.
 - Rename ID field to **ISF_ID**
 - Add Field Basin and populate with “South Platte”.
11. Finally, a third table was generated for users of the data to cross reference from the ISF input layer by using **ISF_ID**. The reference data included in this table are the fields **ISF_Type**, **Case_Number**, and **Status**.
- Run Summary Statistics on **ISF_SP_2015**. Statistics Field is ID and Statistics Type is COUNT. Case Fields are ID, **ISF_Type**, **Case_Number**, and **Status**. Output table is **ISF_SP_2015IDreferenceTable**.

Manual QC of Section 4.1 Workflow (ISFs)

- **Step 6** – Line_IDs that were not already coincident with SWRF and were manually snapped: 50, 58, 69, 73, 79, 131, 174, 427.

4.2-Workflow for the Intersection of Projects and Studies, and FA Base Layer

1. The input layer **MetroSplatteBasin_All_Projects_Studies** was the largest intersecting layer and had linework that deviated greatly from SWRF.
2. Ran WriteGNIS_ID MB Tool on **MetroSplatteBasin_All_Projects_Studies**.
3. In **MetroSplatteBasin_All_Projects_Studies** FC, created and populated a static, unique **Line_ID** field that will be used to associate respective start and end point FCs after these points have been snapped to SWRF. The field was populated with the unique values from OBJECTID (OBJECTID is a dynamic, indexing field, where its values can change automatically by the software).
4. Ran DefineExtentsFromTo MB Tool on **MetroSplatteBasin_All_Projects_Studies** which created the two FCs **MetroSplatteBasin_All_Projects_Studies_StartPts** and **MetroSplatteBasin_All_Projects_Studies_Endpts**.
5. Ran SnapEvents MB Tool (Advanced License only) on the start/end point FCs created in previous step.
6. Ran FMEASLocateEvents and TMEASLocateEvents MB Tools on **MetroSplatteBasin_All_Projects_Studies_StartPts** and **MetroSplatteBasin_All_Projects_Studies_EndPts** respectively. Output tables were named **MetroSplatteBasin_All_Projects_Studies_StartPts_Events_Table** and **MetroSplatteBasin_All_Projects_Studies_EndPts_Events_Table**.
7. Used the events tables created in Step 6 as input to the JoinStartEndMakeRoute MB Tool and named the output **MetroSplatteBasin_AllProjStud_onSWRF**.
8. Ran the FAoverlayLines MB Tool on **MetroSplatteBasin_AllProjStud_onSWRF**.
9. To account for overlapping features, a spatial join was executed to record all Project IDs that were present for each .1-mile segment. Step 8 merely confirmed with a “Yes” the existence or not, of at

least one Project ID.

- Ran Spatial Join Tool. Target: **FocusAreas_onSWRF_TenthMiles_BaseLayer**. Join Features: **MetroSplatteBasin_AllProjStud_onSWRF**. Output FC: **FocusAreas_onSWRF_TenthMiles_AllProjStudDataJoin**. Match Option: **SHARE_A_LINE_SEGMENT_WITH**. In the Field Map: Delete Fields FMEAS_1, COMID, FDATE, RESOLUTION, Shape_Length, GNIS_ID_1, LENGHTKM, REACHCODE, FLOWDIR, WBARECOMI, FTYPE, FCODE, SO, SC, CUMDRAINAG, Length_Miles_Calc, Basin, InFocusArea, FirstOfOriginalContactID, FirstOfContactEmail, FirstOfContactOrganization, FirstOfContactOrganizationWebsite, Line_ID, TMEAS_1, Shape_Length_1, ProjectLocation, ProjectName, ProjectCategory, ProjectType, ProjectStatus, ProjectNote, and ProjectContact. For field ProjectID: set length to 500, Merge Rule of Join, Delimiter of “,” (just type a comma).
 - Duplicated **FocusAreas_onSWRF_TenthMiles_AllProjStudDataJoin** and renamed **FocusAreas_onSWRF_TenthMiles_AllProjStudData**.
 - In FC **FocusAreas_onSWRF_TenthMiles_AllProjStudData**, selected all records where JoinCount = 0 and deleted...no Project ID is present on those line segments.
 - Add Field Basin and populate with “South Platte”.
10. Finally, a third table was generated for users of the data to cross reference from the Projects and Studies input layer by using ProjectID. The reference data included in this table are the fields ProjectLocation, ProjectName, ProjectCategory, ProjectType, ProjectStatus, ProjectNote, ProjectID and ProjectContact.
- Run Summary Statistics on **MetroSplatteBasin_All_Projects_Studies**. Statistics Field is ID and Statistics Type is COUNT. Case Fields are ProjectLocation, ProjectName, ProjectCategory, ProjectType, ProjectStatus, ProjectNote, ProjectID and ProjectContact. Output table is **MetroSplatteBasin_All_ProjStud_IDreferenceTable**.

Manual QC of Section 4.1 Workflow (P&S)

All Steps -- Minimal QC was performed due to its size (9702 features) and the large amount of time needed to investigate all situations not accommodated by the automated workflows. The automated processes described in this workflow captured 6953 of the 9702 features in **MetroSplatteBasin_All_Projects_Studies**. The table **ProjStudNOTonSWRF** was created by exporting all of the features in **MetroSplatteBasin_All_Projects_Studies**, that were not in **MetroSplatteBasin_AllProjStud_onSWRF**. This table is in the default workspace.

5.1-Workflow to Incorporate Gages into SMRF

1. This workflow was performed on both gages layers called **SurfaceWaterRealTime.shp** and **SurfaceWaterRealPOR.shp**. Ran the Clip Tool on both layers using the South Platte Basin’s extent as the Clipping Feature. This results in two layers with only gages in the Basin and are named **GagesRealtime_SP** and **GagesHistoric_SP** respectively.
2. Ran Locate Features Along Routes Tool on **GagesRealtime_SP** and **GagesHistoric_SP**. These two FCs were the Input Features. Input Route Features: **Strm_Route_SP**. Route Identifier Field is GNIS_ID, Search Radius of 50 meters, Output Event Tables were named **GagesRealtime_SPEvents** and **GagesHistoric_SPEvents** respectively. Change Route Identifier Field from RID to GNIS_ID and uncheck box Keep only the closest route location.

3. Added two fields to each event table and titled them MEAS_ACT and MEAS_ACTtrun. Field Calculator on MEAS_ACT = [MEAS] * .000621371192237334. Field Calculator on MEAS_ACTtrun = int(!MEAS_ACT!*(10.0**1))/(10.0**1) (with Python selected).

Manual QC of Section 5.1 Workflow

All Steps – No QC of the outputs were performed.

5.2-Workflow to Incorporate Example Area Diversions into SMRF

1. This workflow was specific to the BIP Phase II Example Areas and used the following tables as inputs: **Diversions_Balzac_ex_area.xlsx**, **Diversions_Chatfield_ex_area.xlsx**, **Diversions_Elevenmile_ex_area.xlsx**, and **Diversions_St_Vrain_ex_area.xlsx**. They will be referred **DivTable** in this section, and all processes were executed on each of the tables.
2. The 4 **DivTables** were imported into the workspace after converting them to .dbf files.
3. Selected by Attributes from **div1_diversions** with the expression “HTMMLINK in (Select HTMMLINK from **DivTable**)” With this selection, ran Locate Features Along Route Tool to create an event table for each of the 4 Example Areas and **_Events** was appended to the respective output file name. The Input Features for this tool were **div1_diversions**, the Input Route Features were **SWRF_SP**, Route Identifier Field was GNIS_ID, Search Radius of 400 meters, and changed the second Route Identifier Field to GNIS_ID from RID (used search radius of 1000 meters for Elevenmile and St. Vrain Example Areas).
4. Added two fields to each event table and titled them MEAS_ACT and MEAS_ACTtrun. Field Calculator on MEAS_ACT = [MEAS] * .000621371192237334. Field Calculator on MEAS_ACTtrun = int(!MEAS_ACT!*(10.0**1))/(10.0**1) (with Python selected).
5. To create a FC with these identified diversions, Selected by Attributes (in Add to Selection mode) from **div1_diversions** with the expression “HTMMLINK in (Select HTMMLINK from **DivTable**)” This selected all diversions from the 4 tables. With this selection ran FC to FC Tool and named the output **ExampleAreasDiversions**.

Manual QC of Section 5.2 Workflow

All Steps – Some diversions got located twice and created duplicates in the **_Events** tables. These tables were small enough for this to be noticed easily and the duplicates were deleted.

Appendix D-Miscellaneous

- SWRF linework not in Strm_Route – Since most of the GIS processing was done with **Strm_Route**, a table was created indicating the features added to **Strm_Route** in creating **SWRF**. Selected by Location reaches in **SWRF_SP** that share a line segment with **Strm_Route**. After switching the selection, exported the table to the workspace and titled **SWRF_SPvsStrm_Route**. 17 features were different between the layers, but none of them are in the FAs. There are a few that have a confluence with FA reaches.
- Focus Areas not in SWRF -- Some FA reaches are not in **Strm_Route** or **SWRF** as they did not meet DWRs standards for inclusion. A layer was created to retain these features and its workflow was manual. Spatially and visually scanned for the reaches in **FocusAreas** that were not coincident with **Strm_Route**. Manually selected these reaches and ran FC to FC Tool. Named resulting FC **FAsNOT_inStrm_Route**.

Appendix D-3 - Stream Mile Representation Framework TSTool Workflow Processing

South Platte Basin Implementation Plan Memorandum

TO: South Platte Basin and Metro Roundtables'
Environmental and Recreational Subcommittee

REVIEWED BY: West Sage Water Consultants

FROM: Steve Malers (Open Water Foundation)

DATE: March 31, 2015

RE: Stream Mile Representation Framework TSTool Workflow Processing

Introduction

This memorandum provides an overview of using the TSTool software workflow processes to create the Stream Mile Framework (SMRF) Excel workbook, which is used to visualize and analyze environmental and recreational (E&R) data.

Approach

The SMRF implemented for the South Platte Basin Implementation Plan (BIP) Phase II project is illustrated in Figure 1. The SMRF represents streams as .1-mile segments, with overlapping environmental and recreational (E&R) attributes, projects and methods, and other data. This approach allows a large amount of data to be spatially represented in Excel to .1-mile resolution, which allows E&R stakeholders to visualize data local to a stream reach of interest, and perform analysis.

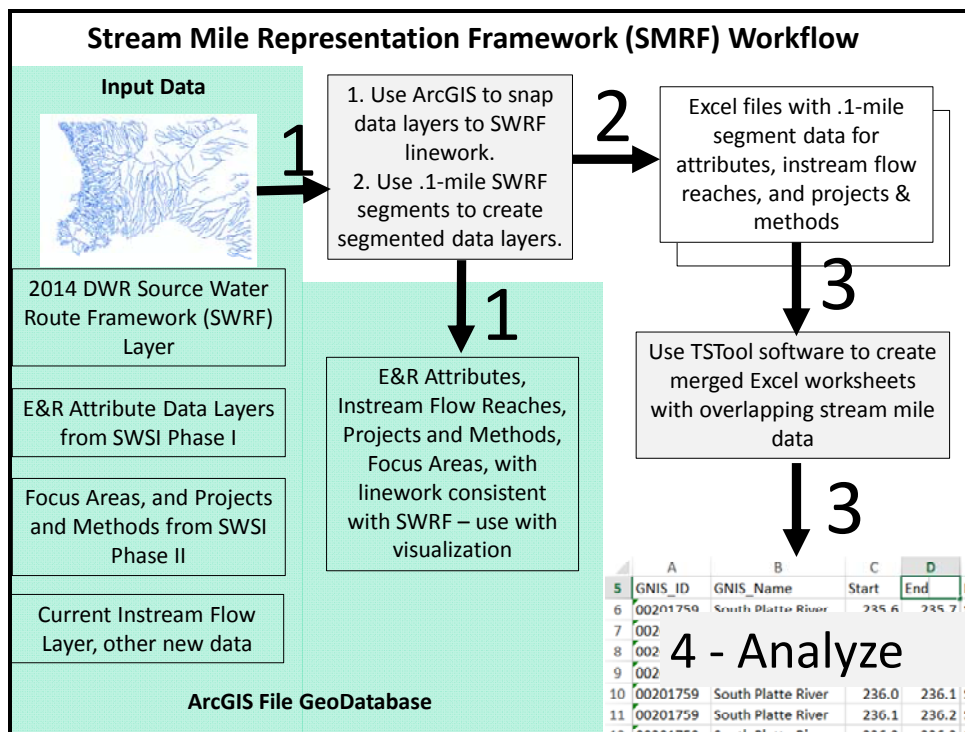


Figure 1. Stream Mile Representation Framework Workflow Overview

ArcGIS software is used to manage and process spatial data from multiple sources. Geographical Information System (GIS) processing is described in the BIP memo “Stream Mile Representation Framework GIS Workflow Processing,” March, 2015. The results of GIS processing (output from step 2 in Figure 1) are several Excel files. Figures 2-9 are provided in Appendix A of this memorandum to illustrate the data.

- FAonSWRFandAttribute.xlsx – contains .1-mile stream segments that overlap focus areas (FA) and E&R attributes (forms the foundation of the SMRF data) – see Figure 2
- ISF_Data.xlsx – contains .1-mile stream segments that overlap instream flow reaches (is joined to the SMRF data, as described in this memorandum) – see Figure 3
- ISF_IDReference.xlsx – contains additional instream flow reach data corresponding to ISF_Data.xlsx (included in the SMRF Excel workbook as comments) – see Figure 4
- ProjStud_Data.xlsx – contains .1-mile stream segments with overlapping E&R projects and methods data (is joined to the SMRF data, as described in this memorandum) – see Figure 5
- ProjStud_IDreference.xlsx – contains additional projects and methods data corresponding to ProjStud_Data.xlsx (included in the SMRF Excel workbook as comments) – see Figure 6
- GagesHistoric_SP.xls – stream gages with historical data, indicated in corresponding stream segment – see Figure 7
- GagesRealtime_SP.xls – stream gages with real-time data, indicated in corresponding stream segment – see Figure 8
- Diversions_St_Vrain_ex_area_Events.xlsx – key diversion structures for Saint Vrain – see Figure 9 (other BIP example areas have similar data)

The TSTool software, which was originally developed as part of Colorado’s Decision Support Systems (CDSS) has been enhanced over time to include functionality to automate processing of time series and tabular data, as well reading/writing Excel files. The SMRF GIS data processing steps export E&R data from layer attribute tables into Excel files. TSTool is able to read these files and automate processing into the final SMRF workbook. Consequently, changes to input data can be reprocessed with minimal effort and changes to approach can be implemented as needed and data reprocessed. Significant enhancements to TSTool were implemented for the BIP project to automate processing of E&R data and create the final Excel workbook containing SMRF data.

The TSTool command file “SouthPlatte-Examples-StreamMileAnalysis.TSTool” (see Appendix B of this memorandum) is run to process the Excel files exported by the GIS process. This process is configured to process the data for the South Platte BIP but could be modified to process other data. The main steps in the command file are as follows:

1. Read the Excel files listed above into TSTool tables.
2. For each input data table, format a unique identifier for stream segments by concatenating the GNIS_ID (stream identifier) and starting stream mile. For example, a .1-mile segment of the South Platte is uniquely identified with “00201759_000.1”. This text identifier simplifies sorting table rows and joining data from multiple tables.
3. Join additional data to the FA/attribute data:
 - a. Join the FAonSWRFandAttributes table (which contains FAs and attributes) with the ISF_Data table (instream flow reaches) – instream flow case numbers in a .1-mile

- segment can overlap and are indicated by a comma-separated list of case numbers in a table column “ISF_ID”
- b. Join the FAonSWRFandAttributes table with the ProjStud_Data table (projects and methods) – projects and methods in a .1-mile segment can overlap and are indicated by a comma-separated list of case numbers in a table column “ProjectID”
 - c. Join the FAonSWRFandAttributes table with the GagesHistoric_SP table (stream gage locations)
 - d. Join the FAonSWRFandAttributes table with LowerSouthPlatte_Diversion_Table_Events, St_Vrain_Diversions_Events, SouthPlatteMountain_DiversionTable_Events, and MetroCorridor_Diversion_Table_Events tables (diversion structure locations). If more than one diversion structure exists in a .1-mile segment, multiple columns are added.
4. For each BIP example area:
 - a. Copy the stream segments for the example area into a new table appropriate for the BIP example area (e.g., “MetroCorridor”)
 - b. Split the “ISF_ID” column containing comma-separated list of ISF identifiers into separate columns so that each ISF reach is unique to the column – column headings are set to ISF_1, ISF2, etc.
 - c. Split the “ProjectID” column containing comma-separated list of project identifiers into separate columns so that each project/method is unique to the column. Column headings are set to PRJ_1, PRJ_2, etc.
 5. For each BIP example area:
 - a. Create the initial Excel worksheet and populate with the joined data from above
 - b. For each ISF identifier (ISF_1, ISF_2, ...):
 - i. Set the column heading comment by formatting matching data from the ISF_IDreference table. A comment is used because otherwise the main SMRF Excel worksheet would become very wide.
 - c. For each project/method identifier (PRJ_1, PRJ_2,...):
 - i. Set the column heading comment by formatting matching data from the ProjStud_IDreference table. A comment is used because otherwise the main SMRF Excel worksheet would become very wide.
 - d. Set the worksheet formatting to freeze panes for the leftmost columns and topmost rows, to help with navigation.
 6. Close the Excel workbook

The resulting workbook contains all the SMRF data for the example areas, as shown in Figure 10. Each row corresponds to a .1-mile stream segment and each column corresponds to an attribute, instream flow right, project, or method, etc.

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	FMEAS	TMEAS	Geographic	FocusArea_Type	Rationale	FocusAreaID	BaldEagle	BrassyMinnow				
2	00178190	North Saint Vrain Creek	00178190_000.0	0.0	0.1	Northern	North Saint Recreational	Whitewat 14		Yes					
3	00178190	North Saint Vrain Creek	00178190_000.1	0.1	0.2	Northern	North Saint Recreational	Whitewat 14		Yes					
4	00178190	North Saint Vrain Creek	00178190_000.2	0.2	0.3	Northern	North Saint Recreational	Whitewat 14		Yes					
5	00178190	North Saint Vrain Creek	00178190_000.3	0.3	0.4	Northern	North Saint Recreational	Whitewat 14		Yes					
6	00178190	North Saint Vrain Creek	00178190_000.4	0.4	0.5	Northern	North Saint Recreational	Whitewat 14		Yes					
7	00178190	North Saint Vrain Creek	00178190_000.5	0.5	0.6	Northern	North Saint Recreational	Whitewat 14		Yes					
8	00178190	North Saint Vrain Creek	00178190_000.6	0.6	0.7	Northern	North Saint Recreational	Whitewat 14		Yes					
9	00178190	North Saint Vrain Creek	00178190_000.7	0.7	0.8	Northern	North Saint Recreational	Whitewat 14		Yes					
10	00178190	North Saint Vrain Creek	00178190_000.8	0.8	0.9	Northern	North Saint Recreational	Whitewat 14		Yes					
11	00178190	North Saint Vrain Creek	00178190_000.9	0.9	1.0	Northern	North Saint Recreational	Whitewat 14		Yes					
12	00178190	North Saint Vrain Creek	00178190_001.0	1.0	1.1	Northern	North Saint Recreational	Whitewat 14		Yes					
13	00178190	North Saint Vrain Creek	00178190_001.1	1.1	1.2	Northern	North Saint Recreational	Whitewat 14		Yes					
14	00178190	North Saint Vrain Creek	00178190_001.2	1.2	1.3	Northern	North Saint Recreational	Whitewat 14		Yes					
15	00178190	North Saint Vrain Creek	00178190_001.3	1.3	1.4	Northern	North Saint Recreational	Whitewat 14		Yes					

Figure 10. SMRF Excel Workbook with integrated data by .1-mile segments

Comments and Recommendations

TSTool was originally developed to process time series. However, enhancements over the past few years to add table processing and Excel integration has resulted in TSTool being able to automate processing of a large amount of tabular data. New TSTool software features were required to process the SMRF data, which are included in TSTool version 11.00.00, and additional enhancements may be needed in the future if the SMRF is implemented beyond the BIP Phase II example areas. The prototype TSTool command file can be enhanced to include other areas. It is recommended that the TSTool automation be utilized in conjunction with automated GIS processing to ensure that the SMRF approach can be updated and used efficiently to analyze E&R requirements and gaps. Additional integration can also occur if historical streamflow time series and modeling results are used to create metrics to evaluate E&R gap. Specific enhancement recommendations for the SMRF workflow processing include:

1. Legacy E&R data available for analysis provides limited project and method data. With additional resources, it would be possible to add links to published master plans or other documents that describe projects.
2. The SMRF workbook does not provide instream flow water right decreed flow values. Such information could be queried from the instream flow database or spatial data layer attributes. This would allow a basic review of flow requirements.
3. Limited integration with streamflow historical data has been implemented. Analysis of streamflow data against instream flow or other environmental flow requirements could be included as metrics on the SWRF Excel worksheets.
4. Land use and land ownership are not included as columns in the final Excel workbook, but could be added with additional resources. The legacy SWSI data included land ownership in projects and methods, for example as “Stewardship” projects.
5. Wetlands data for areas adjoining streams has not been included but could be added to provide an understanding of the extended ecosystem outside of stream channels.
6. Stakeholder-supplied data can be added to the SMRF Excel worksheets. However, an automated method to merge stakeholder-supplied data needs to be implemented. See the memo “Stream Mile Representation Framework Stakeholder Data Input,” March 2015.
7. If sufficient data and analysis are implemented, the cells in the SMRF worksheets can be color-coded to indicate gap. Because of the complexity of overlapping data, multiple evaluation metrics and associated color coding will likely be needed.
8. Additional investment in the TSTool software and data processing processes will be required to implement a full production version of the SMRF.

9. Basic web visualization of the SMRF using Google Maps has been prototyped to demonstrate the potential for linking the tabular data with spatial data. Additional investment in such visualization tools is needed to provide a user-friendly tool.

Appendix A – Figures Illustrating SMRF Data Inputs for Workflow Processing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	GNIS_ID	GNIS_Name	FMEAS	TMEAS	Geographic	Segment	Type	Rationale	Segment_No	AddWilderness	BaldEagle	BirdArea	BorealToad	BrassyMinnow
2	00835484	Arikaree River	0	0.1	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
3	00835484	Arikaree River	0.1	0.2	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
4	00835484	Arikaree River	0.2	0.3	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
5	00835484	Arikaree River	0.3	0.4	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
6	00835484	Arikaree River	0.4	0.5	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
7	00835484	Arikaree River	0.5	0.6	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
8	00835484	Arikaree River	0.6	0.7	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
9	00835484	Arikaree River	0.7	0.8	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
10	00835484	Arikaree River	0.8	0.9	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
11	00835484	Arikaree River	0.9	1	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
12	00835484	Arikaree River	1	1.1	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
13	00835484	Arikaree River	1.1	1.2	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
14	00835484	Arikaree River	1.2	1.3	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
15	00835484	Arikaree River	1.3	1.4	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
16	00835484	Arikaree River	1.4	1.5	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
17	00835484	Arikaree River	1.5	1.6	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
18	00835484	Arikaree River	1.6	1.7	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes
19	00835484	Arikaree River	1.7	1.8	High Plains	Republican Drain Environmental	Habitat for state list	24						Yes

Figure 2. FAonSWRFandAttributes.xls worksheet (note Segment_No = focus area number)

	A	B	C	D	E	F	G
1	GNIS_ID	GNIS_Name	FMEAS	TMEAS	Segment_No	ISF_ID	Basin
2	00060001	Como Creek	5.8	5.9	27	08/1/A-001	South Platte
3	00060001	Como Creek	3.5	3.6	27	08/1/A-001	South Platte
4	00060001	Como Creek	4	4.1	27	08/1/A-001	South Platte
5	00060001	Como Creek	5	5.1	27	08/1/A-001	South Platte
6	00060001	Como Creek	4.5	4.6	27	08/1/A-001	South Platte
7	00060001	Como Creek	5.5	5.6	27	08/1/A-001	South Platte
8	00060001	Como Creek	2.7	2.8	27	08/1/A-001	South Platte
9	00060001	Como Creek	6	6.1	27	08/1/A-001	South Platte
10	00060001	Como Creek	3.7	3.8	27	08/1/A-001	South Platte
11	00060001	Como Creek	3.2	3.3	27	08/1/A-001	South Platte
12	00060001	Como Creek	4.2	4.3	27	08/1/A-001	South Platte
13	00060001	Como Creek	4.7	4.8	27	08/1/A-001	South Platte
14	00060001	Como Creek	2.4	2.5	27	08/1/A-001	South Platte
15	00060001	Como Creek	5.7	5.8	27	08/1/A-001	South Platte

Figure 3. ISF_Data.xls worksheet containing data needed to link to SMRF (note Segment_No = focus area number)

	A	B	C	D
1	ID	ISF_Type	Case_Numbe	Status
2	02/1/A-003	Appropriated	1-02CW373	Decreed
3	02/1/ACQ-01	Acquired	02/1/ACQ-01	Decreed
4	02/1/ACQ-02A	Acquired	02/1/ACQ-02A	Decreed
5	02/1/ACQ-02B	Acquired	02/1/ACQ-02B	Decreed
6	02/1/ACQ-02C	Acquired	02/1/ACQ-02C	Decreed
7	02/1/ACQ-03A	Acquired	02/1/ACQ-03A	Decreed
8	02/1/ACQ-03B	Acquired	02/1/ACQ-03B	Decreed
9	02/1/ACQ-04A	Acquired	02/1/ACQ-04A	Decreed
10	02/1/ACQ-04B	Acquired	02/1/ACQ-04B	Decreed
11	02/1/ACQ-04C	Acquired	02/1/ACQ-04C	Decreed
12	02/1/ACQ-05A	Acquired	02/1/ACQ-05A	Decreed
13	02/1/ACQ-05B	Acquired	02/1/ACQ-05B	Decreed

Figure 4. ISF_IDreference.xls Worksheet containing additional instream flow read data

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

	A	B	C	D	E	F	G
1	GNIS_ID	GNIS_Name	FMEAS	TMEAS	Segment_No	ProjectID	Basin
2	00060001	Como Creek	1.2	1.3	27	08/1/A-001,169	South Platte
3	00060001	Como Creek	1.3	1.4	27	08/1/A-001,169	South Platte
4	00060001	Como Creek	1.4	1.5	27	08/1/A-001,169	South Platte
5	00060001	Como Creek	1.5	1.6	27	08/1/A-001,169	South Platte
6	00060001	Como Creek	1.6	1.7	27	08/1/A-001,169	South Platte
7	00060001	Como Creek	1.7	1.8	27	08/1/A-001,169	South Platte
8	00060001	Como Creek	1.8	1.9	27	08/1/A-001,169	South Platte
9	00060001	Como Creek	1.9	2	27	08/1/A-001,169	South Platte
10	00060001	Como Creek	2	2.1	27	08/1/A-001,169	South Platte
11	00060001	Como Creek	2.1	2.2	27	08/1/A-001,169	South Platte
12	00060001	Como Creek	2.2	2.3	27	08/1/A-001,169	South Platte
13	00060001	Como Creek	2.3	2.4	27	08/1/A-001,169	South Platte

Figure 5. ProjStud_Data.xlsx worksheet containing data to link to SMRF

	A	B	C	D	E	F	G	H
1	ProjectLocation	ProjectName	ProjectCategory	ProjectType	ProjectStatus	ProjectNote	ProjectID	ProjectContact
2		Black Hollow Creek	ISF	Appropriated	Completed		10/1/A-001	
3		Como Creek	ISF	Appropriated	Completed		08/1/A-001	
4		Stewardship Protection	Stewardship	Project	Completed	0.937424212887	Stewardship_21884	
5		Stewardship Protection	Stewardship	Project	Completed	0.970433275425	Stewardship_22579	
6		Stewardship Protection	Stewardship	Project	Completed	0.977059441229	Stewardship_22605	
7		Stewardship Protection	Stewardship	Project	Completed	0.979179700896	Stewardship_21933	
8		Stewardship Protection	Stewardship	Project	Completed	0.982728585182	Stewardship_22606	
9		Stewardship Protection	Stewardship	Project	Completed	0.984057682368	Stewardship_21935	
10		Stewardship Protection	Stewardship	Project	Completed	0.98996142916	Stewardship_22212	
11		Stewardship Protection	Stewardship	Project	Completed	0.990451048902	Stewardship_22589	
12		Stewardship Protection	Stewardship	Project	Completed	0.995413155346	Stewardship_25699	
13		Stewardship Protection	Stewardship	Project	Completed	0.995681606512	Stewardship_22138	
14		Stewardship Protection	Stewardship	Project	Completed	0.996978158621	Stewardship_21889	
15		Stewardship Protection	Stewardship	Project	Completed	0.99709643144	Stewardship_22598	

Figure 6. ProjStud_IDreference.xlsx worksheet containing additional project and studies data

	A	B	C	D	E	F	G	H	I	J	K	W	X
1	OBJECTID	GNIS_ID	MEAS	Distance	moreinfo	statname	dwrabbrev	widid	usgsstatid	datasource	status	MEAS_ACT	MEAS_ACTrmd
2	1	00183164	62519.05	42.66696694	http://www.dwr.nf	SOUTH PLATTE F NORGenco			06706000	USGS	Historic	38.8475351	38.8
3	2	00183164	512.405	-12.0894441	http://www.dwr.nf	SOUTH PLATTE F NORSOPCO			06707000	USGS	Historic	0.31839368	0.3
4	3	00183363	7193.732	-1.24985325	http://www.dwr.pl	PLUM CREEK AT TIT PLUTIRCO			06709530	USGS	Active	4.46997754	4.5
5	4	00201759	384879.2	38.57717099	http://www.dwr.th	THIRTY-SIXTH STRE THISIXCO			06714100	USGS	Historic	239.152839	239.2
6	5	00201759	379760.9	15.34822434	http://www.dwr.sl	SOUTH PLATTE R APLASIXCO			06714215	USGS	Active	235.972456	236
7	6	00181545	22325.51	7.94168553	http://www.dwr.ra	RALSTON CREEK AERALARECO			06719740	USGS	Historic	13.8724268	13.9
8	7	00201759	361682.5	11.18260444	http://www.dwr.sp	SOUTH PLATTE RIVE PLAHENCO			06720500	DWR	Active	224.739066	224.7
9	8	00181231	13475.07	24.94836479	http://www.dwr.wa	WALNUT CREEK AT WALROCCO			06720780	USGS	Historic	8.37301824	8.4
10	9	00201759	333146.3	-14.2659486	http://www.dwr.sp	SOUTH PLATTE RIVE PLALUPCO			06721000	USGS	Active	207.007535	207
11	10	00178354	979.5106	-30.6016548	http://www.dwr.bo	BOULDER CREEK A BOCLONCO			06730500	USGS	Historic	0.60863967	0.6

Figure 7. GagesHistoric_SP.xls worksheet containing historical stream gage data (many columns omitted from figure, MEAS_ACT is stream mile)

	A	B	C	D	E	F	G	H	I	J	AB	AC
1	OBJECTID	GNIS_ID	MEAS	Distance	moreinfo	statname	dwrabbrev	widid	usgsstatid		MEAS_ACT	MEAS_ACTrmd
2	1	00180974	26527.0755	-6.230015314	http://www.dwr.south	BOULDER CREEK BELOW (BOCBGRCO			06729450		16.48316051	16.5
3	2	00180974	17278.8361	-32.20729698	http://www.dwr.south	BOULDER CREEK NEAR ELI BOCELSCO					10.73657099	10.7
4	3	00180974	17282.5529	-32.20729698	http://www.dwr.south	BOULDER CREEK NEAR ELI BOCELSCO					10.73888047	10.7
5	4	00180974	17283.4873	-31.85110243	http://www.dwr.south	BOULDER CREEK DIVERSI BOSDELCO			0600564		10.73946109	10.7
6	5	00205019	59879.9004	-38.21514033	http://www.dwr.char	HANSEN FEEDER CANAL HFCBBSO			0400691		37.2076451	37.2
7	6	00178246	33256.2557	-33.56154014	http://www.dwr.left	HAND DIVERSION NEAR WAFLETHDCO			0502000		20.66447927	20.7
8	7	00177961	45323.2397	-24.3331896	http://www.dwr.little	THOMPSON RIVER AT CANY LTCANYCO					28.16255551	28.2
9	8	00201759	415041.948	-16.06780416	http://www.dwr.south	PLATTE RIVER BELOW CH PLACHACO					257.8951101	257.9
10	9	00183164	62655.61	47.80649788	http://www.dwr.north	FORK SOUTH PLATTE RIVEI PLAGRACO					38.9323911	38.9
11	10	00201759	553248.289	-4.492728594	http://www.dwr.south	PLATTE RIVER ABOVE SPI PI ASPICO			2302903	06694920	343.775488	343.8

Figure 8. GagesRealtime_SP.xls worksheet containing real-time stream gage data (many columns omitted from figure, MEAS_ACT is stream mile)

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

	A	B	C	I	F	G	H	I	J	K	L	M	N	O
1	GNIS_ID	MEAS_ACT	MEAS_ACTtrunc	WD	ID	NAME	CIU	DIV	COUNTY	ST	WATER_SRC	UTM_X	UTM_Y	
2	00178190	8.426125353	8.4	5	511	LONGMONT NORTH PIPELINE	A	1	BOULDER	CO	N F ST VRAIN CREEK	470572	4453265	
3	00178190	4.07335492	4	5	512	LYONS PIPELINE	A	1	BOULDER	CO	N F ST VRAIN CREEK	474755.8	4455519.5	
4	00178190	1.044818196	1	5	516	LYONS DITCH	U	1	BOULDER	CO	N F ST VRAIN CREEK	476827.6	4452938.4	
5	00178246	2.875907796	2.8	5	518	HALL N&S DITCHES S FORK	I	1	BOULDER	CO	S F ST VRAIN CREEK	474141	4450368.4	
6	00178246	0.84225206	0.8	5	519	REESE STILES DITCH	A	1	BOULDER	CO	S F ST VRAIN CREEK	476356	4451468	
7	00178246	1.009339458	1	5	520	SOUTH LEDGE DITCH	A	1	BOULDER	CO	S F ST VRAIN CREEK	476291	4451269	
8	00178190	1.044818196	1	5	521	MEADOW DITCH	A	1	BOULDER	CO	S F ST VRAIN CREEK	476827.6	4452938.4	
9	00178246	0.78419095	0.7	5	522	LONGMONT SOUTH PIPELINE	A	1	BOULDER	CO	S F ST VRAIN CREEK	476405	4451535	
10	00205012	31.62379336	31.6	5	526	HIGHLAND DITCH	A	1	BOULDER	CO	ST VRAIN CREEK	477935	4451697	
11	00205012	31.13303153	31.1	5	527	ROUGH READY DITCH	A	1	BOULDER	CO	ST VRAIN CREEK	478485	4451370	
12	00205012	31.12560664	31.1	5	528	ST VRAIN PALMERTON DITCH	A	1	BOULDER	CO	ST VRAIN CREEK	478496	4451365	

Figure 9. Diversions_St_Vrain_ex_area_Events.xls worksheet containing key diversion structure data (many columns omitted from figure, MEAS_ACT is stream mile)

Appendix B – TSTool Command File

The following TSTool command file “SouthPlatte-Examples-StreamMileAnalysis.TSTool” is used to process the GIS output into the final SMRF Excel file. The following is a version from a point in time and a newer version may be in use subsequent to publication of this memorandum.

```
# Use log file name that is ignored by Dropbox
StartLog(LogFile="$SouthPlatte-Examples-StreamMileAnalysis.TSTool.log")
# South Platte/Metro Basin Implementation Plan Stream Mile Analysis
#-----
# History:
# 2015-03-03 Steve Malers, Open Water Foundation
# - add tabs for attributes and focus area definitions
# - set comment width to 6 columns to try to minimize wrap, which causes comment box to cut off
  for long text
# - use updated stream gage data that has truncated instead of rounded stream mile, now start
  segment is always correct
# 2015-03-01 Steve Malers, Open Water Foundation
# - add comments for ISF and projects reflecting related data.
# 2015-02-08 Steve Malers, Open Water Foundation
# - full version containing focus areas, attributes, ISF reaches, projects, and gage locations
#
#-----
# This command file processes the GIS output of .1-mile segmented stream segments and creates an
  Excel workbook and worksheets,
# each of which match an example area for the South Platte/Metro BIP.
#
# Read the main data sets and join them to create a full .1-mile segmented data set:
# - Read the focus area list
# - Read the attribute list
# - Read the focus area/attribute stream mile segment data from Excel
# - Read the instream flow stream mile segment data from Excel and join
# - Read the project/study stream mile segment data from Excel and join
# - Read historical stream gage location data from Excel and join (note this is just locations,
  not streamflow analysis)
# - Read diversion structure locations from Excel and join (deal with multiple diversions in .1-
  mile segment)
# - Read real-time stream gage location data from Excel and join (note this is just locations,
  not streamflow analysis)
#
# Filter the joined data set and create worksheets for each example area of interest:
# - Filter the joined data set by focus area, stream mile, etc.
# - Output to an Excel worksheet
#
# Add additional data to the workbook:
# - History
# - Definitions for focus areas, attributes, etc.
# - Linked data that does not fit well in the main worksheets (more data for projects, etc.)
#
#-----
# Focus area and attribute lists - definitions that are passed through to final workbook
```

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

```
ReadTableFromExcel(TableID="FocusAreas0",InputFile="..\From-BIP-Phase1\Focus Areas Table 7-28-14-
EditedForSMF.xlsx",ExcelAddress="B3:G47",ExcelColumnNames=FirstRowInRange,ExcelIntegerColumns="Se
gment #")
CopyTable(TableID="FocusAreas0",NewTableID="FocusAreas",ColumnMap="Segment
Description:FocusAreaName,Segment #:FocusAreaID",ColumnExcludeFilters="Segment Description:")
# E&R Attributes
ReadTableFromExcel(TableID="E&RAttributes",InputFile="..\From-BIP-Phase1\Attributes and
Categories - 5-8-14_WJM edits w percent-
EditedForSMF.xlsx",Worksheet="Categories",ExcelAddress="A4:D51",ExcelColumnNames=FirstRowInRange)
# BIP Example Areas
ReadTableFromExcel(TableID="BIPEXampleAreas",InputFile="..\From-BIP-
Phase2\BIPEXampleAreas.xlsx",ExcelAddress="A1:B5",ExcelColumnNames=FirstRowInRange)
# Focus areas and attributes - from GIS work that joined attributes with SWRF layer
# First read the full table that contains stream mile data overlaid with attributes, for all
focus areas.
# Also clear out the rows that have blank segment number (focus area number).
# This is an artifact of processing (TODO: will Paul remove in the GIS script?).
ReadTableFromExcel(TableID="FAonSWRFandAttributes",InputFile="..\From-SWRF-
GISProcessing\FAonSWRFandAttributes2.xls",Worksheet="FAonSWRFandAttributes",ExcelColumnNames=Firs
tRowInRange)
# Create a column that joins GNIS_ID and FMEAS to create a unique value that can be sorted.
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="FAonSWRFandAttributes",InputColumns="GNIS_ID,FMEAS",Format="%s_%05.1f"
,OutputColumn="GNIS_ID_FMEAS",InsertBeforeColumn="FMEAS")
# ReadTableFromDBF(TableID="BIPph1FocusAreasTable",InputFile="BIPph1FocusAreasTable.dbf")
#
CopyTable(TableID="BIPph1FocusAreasTable",NewTableID="BIPph1FocusArea1Table_NonBlankSegmentNo",Co
lumnExcludeFilters="Segment_No:")
# Copy the initial table into a new copy that will be manipulated
# Rename a few columns to be more appropriate for the final result
CopyTable(TableID="FAonSWRFandAttributes",NewTableID="SouthPlatteStreamMileSegments",ColumnMap="S
egment:FocusArea,Segment_No:FocusAreaID")
#-----
# ISF reaches - from CWCB ISF reach layer
# Read the data where ISF reaches are listed in one column, comma-separated
ReadTableFromExcel(TableID="ISF_IDs",InputFile="..\From-SWRF-
GISProcessing\ISF_Data.xls",Worksheet="ISF_Data",ExcelColumnNames=FirstRowInRange)
# The following was read using the GIS table where Paul Schwindt did manual work to create ID1,
ID2, etc. columns
#
ReadTableFromExcel(TableID="ISF_IDs",InputFile="FAonSWRFandAttributes2.xls",Worksheet="ISF_IDs",E
xcelColumnNames=FirstRowInRange)
# Create a column that joins GNIS_ID and FMEAS to create a unique value that can be sorted.
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="ISF_IDs",InputColumns="GNIS_ID,FMEAS",Format="%s_%05.1f",OutputColumn=
"GNIS_ID_FMEAS",InsertBeforeColumn="FMEAS")
# Now join the SWRF/focus area/attribute table with the SWRF/ISF table (will do the same below
with projects)
JoinTables(TableID="SouthPlatteStreamMileSegments",TableToJoinID="ISF_IDs",JoinColumns="GNIS_ID_F
MEAS:GNIS_ID_FMEAS",JoinMethod=JoinIfInBoth)
# Read ISF reach additional data to be joined to stream mile segments
ReadTableFromExcel(TableID="ISF_IDReference",InputFile="..\From-SWRF-
GISProcessing\ISF_IDReference.xls",Worksheet="ISF_IDReference",ExcelColumnNames=FirstRowInRange)
#-----
# Projects / methods / studies - from previous NCNA geodatabase
# Read the data where Project IDs are listed in one column, comma-separated
ReadTableFromExcel(TableID="Project_IDs",InputFile="..\From-SWRF-
GISProcessing\ProjStud_Data.xls",Worksheet="ProjStud_Data",ExcelColumnNames=FirstRowInRange)
# Create a column that joins GNIS_ID and FMEAS to create a unique value that can be sorted.
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="Project_IDs",InputColumns="GNIS_ID,FMEAS",Format="%s_%05.1f",OutputCol
umn="GNIS_ID_FMEAS",InsertBeforeColumn="FMEAS")
# Now join the SWRF/focus area/attribute table with the project/study table
JoinTables(TableID="SouthPlatteStreamMileSegments",TableToJoinID="Project_IDs",JoinColumns="GNIS_
ID_FMEAS:GNIS_ID_FMEAS",JoinMethod=JoinIfInBoth)
# Read project and methods additional data to be joined to stream mile segments
ReadTableFromExcel(TableID="ProjStud_IDReference",InputFile="..\From-SWRF-
GISProcessing\ProjStud_IDReference.xls",Worksheet="ProjStud_IDReference",ExcelColumnNames=FirstRo
wInRange)
#-----
```

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

```
# Stream gages with historical data - from CDSS website
ReadTableFromExcel(TableID="StreamGageHistorical_IDs", InputFile="..\From-SWRF-
GISProcessing\GagesHistoric_SP.xls", Worksheet="GagesHistoric_SP", ExcelColumnNames=FirstRowInRange
)
# Create a column that joins GNIS_ID and MEAS_ACTtrun to create a unique value that can be
sorted.
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="StreamGageHistorical_IDs", InputColumns="GNIS_ID, MEAS_ACTtrun", Format="%
s_%05.1f", OutputColumn="GNIS_ID_FMEAS", InsertBeforeColumn="MEAS")
# Now join the SWRF/focus area/attribute table with the historical streamgage table
JoinTables(TableID="SouthPlatteStreamMileSegments", TableToJoinID="StreamGageHistorical_IDs", JoinC
olumns="GNIS_ID_FMEAS:GNIS_ID_FMEAS", IncludeColumns="usgsstatid, dwrabbrev, statname, meas_act", Colu
mnMap="usgsstatid:SGHist_usgsstatid, dwrabbrev:SGHist_dwrabbrev, statname:SGHist_statname, meas_act:
SGHist_meas_act", JoinMethod=JoinIfInBoth)
#-----
# Stream gages with real-time data - from CDSS website
ReadTableFromExcel(TableID="StreamGageRT_IDs", InputFile="..\From-SWRF-
GISProcessing\GagesRealtime_SP.xls", Worksheet="GagesRealtime_SP", ExcelColumnNames=FirstRowInRange
)
# Create a column that joins GNIS_ID and MEAS_ACTtrun to create a unique value that can be
sorted.
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="StreamGageRT_IDs", InputColumns="GNIS_ID, MEAS_ACTtrun", Format="%s_%05.1
f", OutputColumn="GNIS_ID_FMEAS", InsertBeforeColumn="MEAS")
# Now join the SWRF/focus area/attribute table with the real-time streamgage table
JoinTables(TableID="SouthPlatteStreamMileSegments", TableToJoinID="StreamGageRT_IDs", JoinColumns="
GNIS_ID_FMEAS:GNIS_ID_FMEAS", IncludeColumns="usgsstatid, dwrabbrev, statname, meas_act", ColumnMap="u
sgsstatid:SGReal_usgsstatid, dwrabbrev:SGReal_dwrabbrev, statname:SGReal_statname, meas_act:SGReal_m
eas_act", JoinMethod=JoinIfInBoth)
#-----
# Diversion structures - hand-selected list of key diversions in basin
# One diversion input file for each example area
# Example Area 1
# Lower South Platte: (example area = South Platte at Balzac gage)
ReadTableFromExcel(TableID="LowerSouthPlatte_Diversion_Table_Events", InputFile="..\From-SWRF-
GISProcessing\Diversions_Balzac_ex_area_Events.xls", Worksheet="Diversions_Balzac_ex_area_Event", E
xcelColumnNames=FirstRowInRange)
# Create a column that joins GNIS_ID and MEAS_ACTtrun to create a unique value that can be
sorted.
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="LowerSouthPlatte_Diversion_Table_Events", InputColumns="GNIS_ID, MEAS_AC
Ttrun", Format="%s_%05.1f", OutputColumn="GNIS_ID_FMEAS", InsertBeforeColumn="MEAS_ACT")
# Now join the SWRF/focus area/attribute table with the diversion structure table
JoinTables(TableID="SouthPlatteStreamMileSegments", TableToJoinID="LowerSouthPlatte_Diversion_Tabl
e_Events", JoinColumns="GNIS_ID_FMEAS:GNIS_ID_FMEAS", IncludeColumns="ID_LABEL7, NAME, MEAS_ACT", Colu
mnMap="ID_LABEL7:DivWDID, NAME:DivName, MEAS_ACT:DivMEAS_ACT", JoinMethod=JoinIfInBoth, HandleMultipl
eJoinMatchesHow=NumberColumns)
# Example Area 2
# Northern Region/Transitional: (example area = St Vrain @ Lyons Gage)
# One diversion input file for each example area
ReadTableFromExcel(TableID="St_Vrain_Diversion_Table_Events", InputFile="..\From-SWRF-
GISProcessing\Diversions_St_Vrain_ex_area_Events.xls", Worksheet="St_Vrain_Diversion_Table_Events"
, ExcelColumnNames=FirstRowInRange)
# Create a column that joins GNIS_ID and MEAS_ACTtrun to create a unique value that can be
sorted.
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="St_Vrain_Diversion_Table_Events", InputColumns="GNIS_ID, MEAS_ACTtrun", F
ormat="%s_%05.1f", OutputColumn="GNIS_ID_FMEAS", InsertBeforeColumn="MEAS_ACT")
# Now join the SWRF/focus area/attribute table with the diversion structure table
JoinTables(TableID="SouthPlatteStreamMileSegments", TableToJoinID="St_Vrain_Diversion_Table_Events
", JoinColumns="GNIS_ID_FMEAS:GNIS_ID_FMEAS", IncludeColumns="ID_LABEL7, NAME, MEAS_ACT", ColumnMap="I
D_LABEL7:DivWDID, NAME:DivName, MEAS_ACT:DivMEAS_ACT", JoinMethod=JoinIfInBoth, HandleMultipleJoinMat
chesHow=NumberColumns)
# Example Area 3
# Upper South Platte/Mountain: (example area = South Platte Below Elevenmile Gage)
ReadTableFromExcel(TableID="SouthPlatteMountain_Diversion_Table_Events", InputFile="..\From-SWRF-
GISProcessing\Diversions_Elevenmile_ex_area_Events.xls", Worksheet="Diversions_Elevenmile_ex_area_
E", ExcelColumnNames=FirstRowInRange)
# Create a column that joins GNIS_ID and MEAS_ACTtrun to create a unique value that can be
sorted.
```

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

```
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="SouthPlatteMountain_Diversion_Table_Events",InputColumns="GNIS_ID,MEAS
_ACTtrun",Format="%s_%05.1f",OutputColumn="GNIS_ID_FMEAS",InsertBeforeColumn="MEAS_ACT")
# Now join the SWRF/focus area/attribute table with the diversion structure table
JoinTables(TableID="SouthPlatteStreamMileSegments",TableToJoinID="SouthPlatteMountain_Diversion_T
able_Events",JoinColumns="GNIS_ID_FMEAS:GNIS_ID_FMEAS",IncludeColumns="ID_LABEL7,NAME,MEAS_ACT",C
olumnMap="ID_LABEL7:DivWDID,NAME:DivName,MEAS_ACT:DivMEAS_ACT",JoinMethod=JoinIfInBoth,HandleMult
ipleJoinMatchesHow=NumberColumns)
# Example Area 4
# Metro Corridor: (example area = South Platte Below Chatfield Gage)
ReadTableFromExcel(TableID="MetroCorridor_Diversion_Table_Events",InputFile="..\From-SWRF-
GISProcessing\Diversions_Chatfield_ex_area_Events.xls",Worksheet="Diversions_Chatfield_ex_area_Ev
",ExcelColumnNames=FirstRowInRange)
# Create a column that joins GNIS_ID and MEAS_ACTtrun to create a unique value that can be
sorted.
# This avoids the issue of roundoff with floating point stream mile.
FormatTableString(TableID="MetroCorridor_Diversion_Table_Events",InputColumns="GNIS_ID,MEAS_ACTtr
un",Format="%s_%05.1f",OutputColumn="GNIS_ID_FMEAS",InsertBeforeColumn="MEAS_ACT")
# Now join the SWRF/focus area/attribute table with the diversion structure table
JoinTables(TableID="SouthPlatteStreamMileSegments",TableToJoinID="MetroCorridor_Diversion_Table_E
vents",JoinColumns="GNIS_ID_FMEAS:GNIS_ID_FMEAS",IncludeColumns="ID_LABEL7,NAME,MEAS_ACT",ColumnM
ap="ID_LABEL7:DivWDID,NAME:DivName,MEAS_ACT:DivMEAS_ACT",JoinMethod=JoinIfInBoth,HandleMultipleJo
inMatchesHow=NumberColumns)
#-----
# Example Area 1
# Lower South Platte: (example area = South Platte at Balzac gage)
# Focus Area 1
# Gage location is in the gagesII_9322_sept30_2011 shapefile on the server, FID = 4966, STAID =
06760000; as this focus area runs nearly the full length of the lower river it is located in
COMID 3561770
# Would like to look at least 6 miles up and downstream from this point, more if time permits as
gage moved ~5 miles in 1987.
CopyTable(TableID="SouthPlatteStreamMileSegments",NewTableID="ExampleArea1_LowerSouthPlatte",Colu
mnFilters="FocusAreaID:1")
# Split the ISF_ID column into separate columns for each ISF reach - done here because only a
small number of output columns will result
SplitTableColumn(TableID="ExampleArea1_LowerSouthPlatte",ColumnToSplit="ISF_ID",Delimiter=",",Out
putColumns="ISF_[1:]",OutputColumnOrder=UniqueValuesSorted,InsertBeforeColumn="ISF_ID",DeleteOrig
inalColumn=False)
# Split the Project_ID column into separate columns for each project - done here because only a
small number of output columns will result
SplitTableColumn(TableID="ExampleArea1_LowerSouthPlatte",ColumnToSplit="ProjectID",Delimiter=",",
OutputColumns="PRJ_[1:]",OutputColumnOrder=UniqueValuesSorted,InsertBeforeColumn="ProjectID",Dele
teOriginalColumn=False)
# Sort by the GNIS_ID and FMEAS so output will be by stream and then segment in stream
SortTable(TableID="ExampleArea1_LowerSouthPlatte",SortColumns="GNIS_ID_FMEAS")
#-----
# Example Area 2
# Northern Region/Transitional: (example area = St Vrain @ Lyons Gage)
#   Focus Areas 14 (and 17 downstream) (see more below re: gap)
#   Gage location is in the gagesII_9322_sept30_2011 shapefile on the server, FID = 4938, STAID
= 06724000; FID = 4966, STAID = 06760000; located in COMID 2888628 or COMID 2888654
#   This is where there is a section of the St Vrain missing from the Focus Areas, it appears
COMID 2889866 (and maybe COMID 2889630) should have been both Env and Rec from version 2, but
not included in V3, so Paul, please check this in the latest Focus Areas layer.
#   Would like to look at least 5 miles up and downstream from this point, more if time permits
as there are lots of different attributes in this area.
# Doing the filter by focus areas does not work well here. Just grab all the Saint Vrain Creeks
#
CopyTable(TableID="SouthPlatteStreamMileSegments",NewTableID="ExampleArea2_NorthernTransitional",
ColumnFilters="FocusAreaID:14")
#
CopyTable(TableID="SouthPlatteStreamMileSegments",NewTableID="ExampleArea2_NorthernTransitional_F
A17",ColumnFilters="FocusAreaID:17")
#
AppendTable(TableID="ExampleArea2_NorthernTransitional",AppendTableID="ExampleArea2_NorthernTrans
itional_FA17")
CopyTable(TableID="SouthPlatteStreamMileSegments",NewTableID="ExampleArea2_NorthernTransitional",
ColumnFilters="GNIS_Name:*Saint Vrain Creek*")
```

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

```
# Split the ISF_ID column into separate columns for each ISF reach - done here because only a
small number of output columns will result
SplitTableColumn(TableID="ExampleArea2_NorthernTransitional",ColumnToSplit="ISF_ID",Delimiter=",",
,OutputColumns="ISF_[1:]",OutputColumnOrder=UniqueValuesSorted,InsertBeforeColumn="ISF_ID",Delete
OriginalColumn=False)
# Split the Project_ID column into separate columns for each project - done here because only a
small number of output columns will result
SplitTableColumn(TableID="ExampleArea2_NorthernTransitional",ColumnToSplit="ProjectID",Delimiter=
",",OutputColumns="PRJ_[1:]",OutputColumnOrder=UniqueValuesSorted,InsertBeforeColumn="ProjectID",
DeleteOriginalColumn=False)
# Sort by the GNIS_ID and FMEAS so output will be by stream and then segment in stream
SortTable(TableID="ExampleArea2_NorthernTransitional",SortColumns="GNIS_ID_FMEAS")
#-----
# Example Area 3
# Upper South Platte/Mountain: (example area = South Platte Below Elevenmile Gage)
#   Focus Area 7
#   Gage location is in the gagesII_9322_sept30_2011 shapefile on the server, FID = 4895, STAID
= 06695000; located in COMID 5241238
#   Would like to look at least 5 miles up and downstream from this point, more if time permits
due to varying attributes.
CopyTable(TableID="SouthPlatteStreamMileSegments",NewTableID="ExampleArea3_SouthPlatteMountain",C
olumnFilters="FocusAreaID:7")
# Split the ISF_ID column into separate columns for each ISF reach - done here because only a
small number of output columns will result
SplitTableColumn(TableID="ExampleArea3_SouthPlatteMountain",ColumnToSplit="ISF_ID",Delimiter=",",
,OutputColumns="ISF_[1:]",OutputColumnOrder=UniqueValuesSorted,InsertBeforeColumn="ISF_ID",Delete
OriginalColumn=False)
# Split the Project_ID column into separate columns for each project - done here because only a
small number of output columns will result
SplitTableColumn(TableID="ExampleArea3_SouthPlatteMountain",ColumnToSplit="ProjectID",Delimiter=
",",OutputColumns="PRJ_[1:]",OutputColumnOrder=UniqueValuesSorted,InsertBeforeColumn="ProjectID",D
eleteOriginalColumn=False)
# Sort by the GNIS_ID and FMEAS so output will be by stream and then segment in stream
SortTable(TableID="ExampleArea3_SouthPlatteMountain",SortColumns="GNIS_ID_FMEAS")
#-----
# Example Area 4
# Metro Corridor: (example area = South Platte Below Chatfield Gage)
#   Focus Area 4
#   The gage location is NOT in the gagesII_9322_sept30_2011 shapefile on the server, the gage
there is simply a placeholder for a quick map. Please add the location from the DNR data:
(Location - Lat. N39°33'45"; Long. W105°03'35" (NAD83) in Jefferson County, CO Hydrologic Unit
10190002. Gage is located on the left bank 815 ft. downstream from the outlet works of Chatfield
Reservoir. ) COMID likely 188657 or 188319
#   Would like to look at least 5 miles downstream from the reservoir, more if time permits due
to different attributes/tributaries in area. Perhaps even extend this down to the South Platte
Below Union @ Englewood Gage, for two stream flow points, if time permits.
CopyTable(TableID="SouthPlatteStreamMileSegments",NewTableID="ExampleArea4_MetroCorridor",ColumnF
ilters="FocusAreaID:4")
# Split the ISF_ID column into separate columns for each ISF reach - done here because only a
small number of output columns will result
SplitTableColumn(TableID="ExampleArea4_MetroCorridor",ColumnToSplit="ISF_ID",Delimiter=",",Output
Columns="ISF_[1:]",OutputColumnOrder=UniqueValuesSorted,InsertBeforeColumn="ISF_ID",DeleteOrigina
lColumn=False)
# Split the Project_ID column into separate columns for each project - done here because only a
small number of output columns will result
SplitTableColumn(TableID="ExampleArea4_MetroCorridor",ColumnToSplit="ProjectID",Delimiter=",",Out
putColumns="PRJ_[1:]",OutputColumnOrder=UniqueValuesSorted,InsertBeforeColumn="ProjectID",DeleteO
riginalColumn=False)
# Sort by the GNIS_ID and FMEAS so output will be by stream and then segment in stream
SortTable(TableID="ExampleArea4_MetroCorridor",SortColumns="GNIS_ID_FMEAS")
#-----
# Create an Excel workbook with worksheets for each Example Area
NewExcelWorkbook(OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheets="E&RAttributes,FocusAreas,BIPExampleAreas,LowerSouthPlatte,MetroCorrido
r,SouthPlatteMountain,NorthernTransitional",KeepOpen=True)
#-----
WriteTableToExcel(TableID="FocusAreas",OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="FocusAreas",ExcelAddress="A1",ExcelColumnNames=FirstRowInRange,KeepOpen
=True,ColumnWidths="Default:Auto")
```

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

```
WriteTableToExcel(TableID="E&RAttributes",OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="E&RAttributes",ExcelAddress="A1",ExcelColumnNames=FirstRowInRange,KeepO
pen=True,ColumnWidths="Default:Auto")
WriteTableToExcel(TableID="BIPEXampleAreas",OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="BIPEXampleAreas",ExcelAddress="A1",ExcelColumnNames=FirstRowInRange,Ke
epOpen=True,ColumnWidths="Default:Auto")
#-----
# 1. LowerSouthPlatte
WriteTableToExcel(TableID="ExampleArea1_LowerSouthPlatte",OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="LowerSouthPlatte",ExcelAddress="A1",ExcelColumnNames=FirstRowInRange,Ke
epOpen=True,ColumnWidths="Default:Auto,EmptyColumns:128,FocusArea:2400,Rationale:2200,ProjectID:2
200",ColumnDecimalPlaces="FMEAS:1,TMEAS:1")
# Set the project column heading to include each project's data
For(Name="ForLowerSouthPlatteProject",IteratorProperty="Project_Count",List="PRJ_1,PRJ_2,PRJ_3,PR
J_4,PRJ_5,PRJ_6,PRJ_7,PRJ_8,PRJ_9,PRJ_10,PRJ_11,PRJ_12,PRJ_13,PRJ_14,PRJ_15,PRJ_16,PRJ_17,PRJ_18,
PRJ_19,PRJ_20,PRJ_21,PRJ_22,PRJ_23,PRJ_24,PRJ_25,PRJ_26,PRJ_27,PRJ_28,PRJ_29,PRJ_30,PRJ_31,PRJ_32
,PRJ_33,PRJ_34,PRJ_35,PRJ_36,PRJ_37,PRJ_38,PRJ_39,PRJ_40,PRJ_41,PRJ_42,PRJ_43,PRJ_44,PRJ_45,PRJ_4
6,PRJ_47,PRJ_48,PRJ_49,PRJ_50,PRJ_51,PRJ_52,PRJ_53,PRJ_54,PRJ_55,PRJ_56,PRJ_57,PRJ_58,PRJ_59,PRJ_
60,PRJ_61,PRJ_62,PRJ_63,PRJ_64,PRJ_65,PRJ_66,PRJ_67,PRJ_68,PRJ_69,PRJ_70,PRJ_71,PRJ_72,PRJ_73,PRJ
_74,PRJ_75,PRJ_76,PRJ_77,PRJ_78,PRJ_79,PRJ_80,PRJ_81,PRJ_82,PRJ_83,PRJ_84,PRJ_85,PRJ_86,PRJ_87,PR
J_88,PRJ_89,PRJ_90,PRJ_91,PRJ_92,PRJ_93,PRJ_94,PRJ_95,PRJ_96,PRJ_97,PRJ_98,PRJ_99")
#For(Name="ForLowerSouthPlatteProject",IteratorProperty="Project_Count",List="PRJ_1")
# First join the project information (for PRJ_1 for example), naming joined columns with leading
"X_" to indicate not written
JoinTables(TableID="ExampleArea1_LowerSouthPlatte",TableToJoinID="ProjStud_IDReference",JoinColum
ns="{Project_Count}:ProjectID",ColumnMap="ProjectLocation:X_{Project_Count}_ProjectLocation,Pro
jectName:X_{Project_Count}_ProjectName,ProjectCategory:X_{Project_Count}_ProjectCategory,Projec
tType:X_{Project_Count}_ProjectType,ProjectStatus:X_{Project_Count}_ProjectStatus,ProjectNote:X
_{Project_Count}_ProjectNote,ProjectContact:X_{Project_Count}_ProjectContact")
# Next format a property from the joined columns - this is the project comment text
SetPropertyFromTable(TableID="ExampleArea1_LowerSouthPlatte",Column="{Project_Count}",ColumnExcl
udeFilters="X_{Project_Count}_ProjectName:",PropertyName="ProjectID")
SetPropertyFromTable(TableID="ExampleArea1_LowerSouthPlatte",Column="X_{Project_Count}_ProjectNa
me",ColumnExcludeFilters="X_{Project_Count}_ProjectName:",PropertyName="ProjectName")
SetPropertyFromTable(TableID="ExampleArea1_LowerSouthPlatte",Column="X_{Project_Count}_ProjectLo
cation",ColumnExcludeFilters="X_{Project_Count}_ProjectLocation:",PropertyName="ProjectLocation")
)
SetPropertyFromTable(TableID="ExampleArea1_LowerSouthPlatte",Column="X_{Project_Count}_ProjectCa
tegory",ColumnExcludeFilters="X_{Project_Count}_ProjectCategory:",PropertyName="ProjectCategory")
)
SetPropertyFromTable(TableID="ExampleArea1_LowerSouthPlatte",Column="X_{Project_Count}_ProjectTy
pe",ColumnExcludeFilters="X_{Project_Count}_ProjectType:",PropertyName="ProjectType")
SetPropertyFromTable(TableID="ExampleArea1_LowerSouthPlatte",Column="X_{Project_Count}_ProjectSt
atus",ColumnExcludeFilters="X_{Project_Count}_ProjectStatus:",PropertyName="ProjectStatus")
SetPropertyFromTable(TableID="ExampleArea1_LowerSouthPlatte",Column="X_{Project_Count}_ProjectNo
te",ColumnExcludeFilters="X_{Project_Count}_ProjectNote:",PropertyName="ProjectNote")
SetPropertyFromTable(TableID="ExampleArea1_LowerSouthPlatte",Column="X_{Project_Count}_ProjectCo
ntact",ColumnExcludeFilters="X_{Project_Count}_ProjectContact:",PropertyName="ProjectContact",De
faultValue="Blank")
FormatStringProperty(InputProperties="ProjectID,ProjectName,ProjectLocation,ProjectCategory,Proje
ctType,ProjectStatus,ProjectNote,ProjectContact",Format="ProjectID:%s\nName:%s\nLocation:%s\nCate
gory:%s\nType:%s\nStatus:%s\nNote:%s\nContact:%s",OutputProperty="ProjectComment")
SetExcelCell(OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="LowerSouthPlatte",KeepOpen=True,IncludeColumns="{Project_Count}",Rows=
"1",Comment="{ProjectComment}",CommentWidth="6")
EndFor(Name="ForLowerSouthPlatteProject")
SetExcelWorksheetViewProperties(OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="LowerSouthPlatte",FreezePaneColumnRightOfSplit=D,FreezePaneRowBelowSpli
t=2,KeepOpen=True)
# 2. NorthernTransitional
WriteTableToExcel(TableID="ExampleArea2_NorthernTransitional",OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="NorthernTransitional",ExcelAddress="A1",ExcelColumnNames=FirstRowInRang
e,KeepOpen=True,ColumnWidths="Default:Auto,EmptyColumns:128,FocusArea:2400,Rationale:2200,Project
ID:2200",ColumnDecimalPlaces="FMEAS:1,TMEAS:1")
# Set the instream flow reach column heading to include each ISF's data
For(Name="ForNorthernTransitionalISF",IteratorProperty="ISF_Count",List="ISF_1,ISF_2,ISF_3,ISF_4,
ISF_5")
# For(Name="ForNorthernTransitionalISF",IteratorProperty="ISF_Count",List="ISF_1")
# First join the ISF information (for ISF_1 for example), naming joined columns with leading "X_"
to indicate not written
```


APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

```
JoinTables(TableID="ExampleArea2_NorthernTransitional", TableToJoinID="ISF_IDReference", JoinColumns="X_${ISF_Count}:ID", ColumnMap="ID:X_${ISF_Count}_ISFID, ISF_Type:X_${ISF_Count}_ISFType, Case_Number:X_${ISF_Count}_ISFCaseNumber, Status:X_${ISF_Count}_ISFStatus")
# Next format a property from the joined columns - this is the ISF comment text
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${ISF_Count}_ISFID", ColumnExcludeFilters="X_${ISF_Count}_ISFID:", PropertyName="ISFID")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${ISF_Count}_ISFType", ColumnExcludeFilters="X_${ISF_Count}_ISFType:", PropertyName="ISFType")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${ISF_Count}_ISFCaseNumber", ColumnExcludeFilters="X_${ISF_Count}_ISFCaseNumber:", PropertyName="ISFCaseNumber")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${ISF_Count}_ISFStatus", ColumnExcludeFilters="X_${ISF_Count}_ISFStatus:", PropertyName="ISFStatus")
FormatStringProperty(InputProperties="ISFID, ISFType, ISFCaseNumber, ISFStatus", Format="ISFID:%s\nISFType:%s\nISFCaseNumber:%s\nISFStatus:%s", OutputProperty="ISFComment")
SetExcelCell(OutputFile="SouthPlatte-StreamMile-Analysis.xlsx", Worksheet="NorthernTransitional", KeepOpen=True, IncludeColumns="X_${ISF_Count}", Rows="1", Comment="X_${ISFComment}", CommentWidth="6")
EndFor(Name="ForNorthernTransitionalISF")
# Set the project column heading to include each project's data
For(Name="ForNorthernTransitionalProject", IteratorProperty="Project_Count", List="PRJ_1, PRJ_2, PRJ_3, PRJ_4, PRJ_5, PRJ_6, PRJ_7, PRJ_8, PRJ_9, PRJ_10, PRJ_11, PRJ_12, PRJ_13, PRJ_14, PRJ_15, PRJ_16, PRJ_17, PRJ_18, PRJ_19, PRJ_20, PRJ_21, PRJ_22, PRJ_23, PRJ_24")
# For(Name="ForNorthernTransitionalProject", IteratorProperty="Project_Count", List="PRJ_1")
# First join the project information (for PRJ_1 for example), naming joined columns with leading "X_" to indicate not written
JoinTables(TableID="ExampleArea2_NorthernTransitional", TableToJoinID="ProjStud_IDReference", JoinColumns="X_${Project_Count}:ProjectID", ColumnMap="ProjectLocation:X_${Project_Count}_ProjectLocation, ProjectName:X_${Project_Count}_ProjectName, ProjectCategory:X_${Project_Count}_ProjectCategory, ProjectType:X_${Project_Count}_ProjectType, ProjectStatus:X_${Project_Count}_ProjectStatus, ProjectNote:X_${Project_Count}_ProjectNote, ProjectContact:X_${Project_Count}_ProjectContact")
# Next format a property from the joined columns - this is the project comment text
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${Project_Count}", ColumnExcludeFilters="X_${Project_Count}_ProjectName:", PropertyName="ProjectID")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${Project_Count}_ProjectName", ColumnExcludeFilters="X_${Project_Count}_ProjectName:", PropertyName="ProjectName")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${Project_Count}_ProjectLocation", ColumnExcludeFilters="X_${Project_Count}_ProjectLocation:", PropertyName="ProjectLocation")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${Project_Count}_ProjectCategory", ColumnExcludeFilters="X_${Project_Count}_ProjectCategory:", PropertyName="ProjectCategory")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${Project_Count}_ProjectType", ColumnExcludeFilters="X_${Project_Count}_ProjectType:", PropertyName="ProjectType")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${Project_Count}_ProjectStatus", ColumnExcludeFilters="X_${Project_Count}_ProjectStatus:", PropertyName="ProjectStatus")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${Project_Count}_ProjectNote", ColumnExcludeFilters="X_${Project_Count}_ProjectNote:", PropertyName="ProjectNote")
SetPropertyFromTable(TableID="ExampleArea2_NorthernTransitional", Column="X_${Project_Count}_ProjectContact", ColumnExcludeFilters="X_${Project_Count}_ProjectContact:", PropertyName="ProjectContact", DefaultValue="Blank")
FormatStringProperty(InputProperties="ProjectID, ProjectName, ProjectLocation, ProjectCategory, ProjectType, ProjectStatus, ProjectNote, ProjectContact", Format="ProjectID:%s\nName:%s\nLocation:%s\nCategory:%s\nType:%s\nStatus:%s\nNote:%s\nContact:%s", OutputProperty="ProjectComment")
SetExcelCell(OutputFile="SouthPlatte-StreamMile-Analysis.xlsx", Worksheet="NorthernTransitional", KeepOpen=True, IncludeColumns="X_${Project_Count}", Rows="1", Comment="X_${ProjectComment}", CommentWidth="6")
EndFor(Name="ForNorthernTransitionalProject")
SetExcelWorksheetViewProperties(OutputFile="SouthPlatte-StreamMile-Analysis.xlsx", Worksheet="NorthernTransitional", FreezePaneColumnRightOfSplit=D, FreezePaneRowBelowSplit=2, KeepOpen=True)
# 3. SouthPlatteMountain
WriteTableToExcel(TableID="ExampleArea3_SouthPlatteMountain", OutputFile="SouthPlatte-StreamMile-Analysis.xlsx", Worksheet="SouthPlatteMountain", ExcelAddress="A1", ExcelColumnNames=FirstRowInRange, KeepOpen=True, ColumnWidths="Default:Auto, EmptyColumns:128, FocusArea:2400, Rationale:2200, ProjectID:2200", ColumnDecimalPlaces="FMEAS:1, TMEAS:1")
# Set the instream flow reach column heading to include each ISF's data
For(Name="ForSouthPlatteMountainISF", IteratorProperty="ISF_Count", List="ISF_1")
# For(Name="ForSouthPlatteMountainISF", IteratorProperty="ISF_Count", List="ISF_1")
# First join the ISF information (for ISF_1 for example), naming joined columns with leading "X_" to indicate not written
```

```

JoinTables(TableID="ExampleArea3_SouthPlatteMountain", TableToJoinID="ISF_IDReference", JoinColumns
="{ISF_Count}:ID", ColumnMap="ID:X_${ISF_Count}_ISFID, ISF_Type:X_${ISF_Count}_ISFType, Case_Numbe:
X_${ISF_Count}_ISFCaseNumber, Status:X_${ISF_Count}_ISFStatus")
# Next format a property from the joined columns - this is the ISF comment text
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${ISF_Count}_ISFID", Col
umnExcludeFilters="X_${ISF_Count}_ISFID:", PropertyName="ISFID")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${ISF_Count}_ISFType", C
olumnExcludeFilters="X_${ISF_Count}_ISFType:", PropertyName="ISFType")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${ISF_Count}_ISFCaseNum
ber", ColumnExcludeFilters="X_${ISF_Count}_ISFCaseNumber:", PropertyName="ISFCaseNumber")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${ISF_Count}_ISFStatus"
, ColumnExcludeFilters="X_${ISF_Count}_ISFStatus:", PropertyName="ISFStatus")
FormatStringProperty(InputProperties="ISFID, ISFType, ISFCaseNumber, ISFStatus", Format="ISFID:%s\nIS
FType:%s\nISFCaseNumber:%s\nISFStatus:%s", OutputProperty="ISFComment")
SetExcelCell(OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx", Worksheet="SouthPlatteMountain", KeepOpen=True, IncludeColumns="{ISF_Count}", Rows="
1", Comment="{ISFComment}", CommentWidth="6")
EndFor(Name="ForSouthPlatteMountainISF")
# Set the project column heading to include each project's data
For(Name="ForSouthPlatteMountainProject", IteratorProperty="Project_Count", List="PRJ_1, PRJ_2, PRJ_3
, PRJ_4, PRJ_5, PRJ_6, PRJ_7, PRJ_8, PRJ_9, PRJ_10, PRJ_11, PRJ_12, PRJ_13, PRJ_14, PRJ_15, PRJ_16, PRJ_
17, PRJ_18, PRJ_19, PRJ_20, PRJ_21, PRJ_22, PRJ_23, PRJ_24, PRJ_25, PRJ_26, PRJ_27, PRJ_28, PRJ_29, PRJ_30, PRJ_31, PRJ_
32, PRJ_33, PRJ_34, PRJ_35, PRJ_36, PRJ_37, PRJ_38, PRJ_39")
# For(Name="ForSouthPlatteMountainProject", IteratorProperty="Project_Count", List="PRJ_1")
# First join the project information (for PRJ_1 for example), naming joined columns with leading
"X_" to indicate not written
JoinTables(TableID="ExampleArea3_SouthPlatteMountain", TableToJoinID="ProjStud_IDReference", JoinCo
lumn="{Project_Count}:ProjectID", ColumnMap="ProjectLocation:X_${Project_Count}_ProjectLocation,
ProjectName:X_${Project_Count}_ProjectName, ProjectCategory:X_${Project_Count}_ProjectCategory, Pro
jectType:X_${Project_Count}_ProjectType, ProjectStatus:X_${Project_Count}_ProjectStatus, ProjectNot
e:X_${Project_Count}_ProjectNote, ProjectContact:X_${Project_Count}_ProjectContact")
# Next format a property from the joined columns - this is the project comment text
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${Project_Count}", ColumnE
xcludeFilters="X_${Project_Count}_ProjectName:", PropertyName="ProjectID")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${Project_Count}_Projec
tName", ColumnExcludeFilters="X_${Project_Count}_ProjectName:", PropertyName="ProjectName")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${Project_Count}_Projec
tLocation", ColumnExcludeFilters="X_${Project_Count}_ProjectLocation:", PropertyName="ProjectLocati
on")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${Project_Count}_Projec
tCategory", ColumnExcludeFilters="X_${Project_Count}_ProjectCategory:", PropertyName="ProjectCatego
ry")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${Project_Count}_Projec
tType", ColumnExcludeFilters="X_${Project_Count}_ProjectType:", PropertyName="ProjectType")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${Project_Count}_Projec
tStatus", ColumnExcludeFilters="X_${Project_Count}_ProjectStatus:", PropertyName="ProjectStatus")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${Project_Count}_Projec
tNote", ColumnExcludeFilters="X_${Project_Count}_ProjectNote:", PropertyName="ProjectNote")
SetPropertyFromTable(TableID="ExampleArea3_SouthPlatteMountain", Column="X_${Project_Count}_Projec
tContact", ColumnExcludeFilters="X_${Project_Count}_ProjectContact:", PropertyName="ProjectContact"
, DefaultValue="Blank")
FormatStringProperty(InputProperties="ProjectID, ProjectName, ProjectLocation, ProjectCategory, Proje
ctType, ProjectStatus, ProjectNote, ProjectContact", Format="ProjectID:%s\nName:%s\nLocation:%s\nCate
gory:%s\nType:%s\nStatus:%s\nNote:%s\nContact:%s", OutputProperty="ProjectComment")
SetExcelCell(OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx", Worksheet="SouthPlatteMountain", KeepOpen=True, IncludeColumns="{Project_Count}", Ro
ws="1", Comment="{ProjectComment}", CommentWidth="6")
EndFor(Name="ForSouthPlatteMountainProject")
SetExcelWorksheetViewProperties(OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx", Worksheet="SouthPlatteMountain", FreezePaneColumnRightOfSplit=D, FreezePaneRowBelowS
plit=2, KeepOpen=True)
# 4. MetroCorridor
WriteTableToExcel(TableID="ExampleArea4_MetroCorridor", OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx", Worksheet="MetroCorridor", ExcelAddress="A1", ExcelColumnNames=FirstRowInRange, KeepO
pen=True, ColumnWidths="Default:Auto, EmptyColumns:128, FocusArea:2400, Rationale:2200, ProjectID:2200
", ColumnDecimalPlaces="FMEAS:1, TMEAS:1")
# Set the project column heading to include each project's data
For(Name="ForMetroCorridorProject", IteratorProperty="Project_Count", List="PRJ_1, PRJ_2, PRJ_3, PRJ_4
, PRJ_5, PRJ_6, PRJ_7, PRJ_8, PRJ_9, PRJ_10, PRJ_11, PRJ_12, PRJ_13, PRJ_14")
# For(Name="ForMetroCorridorProject", IteratorProperty="Project_Count", List="PRJ_1")

```

APPENDIX D – 3 – Stream Mile Representation Framework TSTool Workflow Processing

```
# First join the project information (for PRJ_1 for example), naming joined columns with leading
"X_" to indicate not written
JoinTables(TableID="ExampleArea4_MetroCorridor",TableToJoinID="ProjStud_IDReference",JoinColumns=
"${Project_Count}:ProjectID",ColumnMap="ProjectLocation:X_${Project_Count}_ProjectLocation,Proje
ctName:X_${Project_Count}_ProjectName,ProjectCategory:X_${Project_Count}_ProjectCategory,ProjectTy
pe:X_${Project_Count}_ProjectType,ProjectStatus:X_${Project_Count}_ProjectStatus,ProjectNote:X_${
Project_Count}_ProjectNote,ProjectContact:X_${Project_Count}_ProjectContact")
# Next format a property from the joined columns - this is the project comment text
SetPropertyFromTable(TableID="ExampleArea4_MetroCorridor",Column="${Project_Count}",ColumnExclude
Filters="X_${Project_Count}_ProjectName:",PropertyName="ProjectID")
SetPropertyFromTable(TableID="ExampleArea4_MetroCorridor",Column="X_${Project_Count}_ProjectName"
,ColumnExcludeFilters="X_${Project_Count}_ProjectName:",PropertyName="ProjectName")
SetPropertyFromTable(TableID="ExampleArea4_MetroCorridor",Column="X_${Project_Count}_ProjectLocat
ion",ColumnExcludeFilters="X_${Project_Count}_ProjectLocation:",PropertyName="ProjectLocation")
SetPropertyFromTable(TableID="ExampleArea4_MetroCorridor",Column="X_${Project_Count}_ProjectCateg
ory",ColumnExcludeFilters="X_${Project_Count}_ProjectCategory:",PropertyName="ProjectCategory")
SetPropertyFromTable(TableID="ExampleArea4_MetroCorridor",Column="X_${Project_Count}_ProjectType"
,ColumnExcludeFilters="X_${Project_Count}_ProjectType:",PropertyName="ProjectType")
SetPropertyFromTable(TableID="ExampleArea4_MetroCorridor",Column="X_${Project_Count}_ProjectStatu
s",ColumnExcludeFilters="X_${Project_Count}_ProjectStatus:",PropertyName="ProjectStatus")
SetPropertyFromTable(TableID="ExampleArea4_MetroCorridor",Column="X_${Project_Count}_ProjectNote"
,ColumnExcludeFilters="X_${Project_Count}_ProjectNote:",PropertyName="ProjectNote")
SetPropertyFromTable(TableID="ExampleArea4_MetroCorridor",Column="X_${Project_Count}_ProjectConta
ct",ColumnExcludeFilters="X_${Project_Count}_ProjectContact:",PropertyName="ProjectContact",Defau
ltValue="Blank")
FormatStringProperty(InputProperties="ProjectID,ProjectName,ProjectLocation,ProjectCategory,Proje
ctType,ProjectStatus,ProjectNote,ProjectContact",Format="ProjectID:%s\nName:%s\nLocation:%s\nCate
gory:%s\nType:%s\nStatus:%s\nNote:%s\nContact:%s",OutputProperty="ProjectComment")
SetExcelCell(OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="MetroCorridor",KeepOpen=True,IncludeColumns="${Project_Count}",Rows="1"
,Comment="${ProjectComment}",CommentWidth="6")
EndFor(Name="ForMetroCorridorProject")
SetExcelWorksheetViewProperties(OutputFile="SouthPlatte-StreamMile-
Analysis.xlsx",Worksheet="MetroCorridor",FreezePaneColumnRightOfSplit=D,FreezePaneRowBelowSplit=2
,KeepOpen=True)
#
CloseExcelWorkbook(OutputFile="SouthPlatte-StreamMile-Analysis.xlsx")
```

Environmental and Recreational
Spatial Data Inventory

General Information (compiled from SWSI NCNA data and documents)										SWSI NCNA Phase 1 GeoDatabase (SWSI NCNA PH1 BASIN DATA)	
Layer Group	Layer Name, Descriptive (Spatial Unit)	Content	SWSI Attribute Category	SWSI Dependency	SWSI/BIP Attribute Group	SWSI/BIP Attribute	SWSI/BIP Attribute Category	Stream Proximity	Water-related Measureable Outcome	Feature Class	Geometry Type
Attribute	Bald Eagles (Sites)	Active nesting sites				Active Bald Eagle Nests	NA	Near stream	Streamflow	ATTRIBUTE1_Bald_Eagle_Active_Nestsites_SP	Polygon
Attribute	Birding (Sites)	National Audobon Society birding areas				Audobon Important Bird Areas	Waterfowl Hunting/Viewing	Near Stream	Streamflow	ATTRIBUTE7_Audobon_Bird_Areas_SP	Point
Attribute	Birding (HUCs)	12-digit HUC distribution for National Audobon Society birding areas				Audobon Important Bird Areas	Waterfowl Hunting/Viewing	Near Stream	Streamflow	ATTRIBUTE7_huc12_nrcs_Audobon_Bird_Areas_SP	Polygon
Attribute	Boating, Flatwater (Lakes)	Boatable waters				Flatwater Boating	Recreation	In Lake	Lake Level	ATTRIBUTE5_CO_Boatable_Waters_SP	Polygon
Attribute	Boating, Kayaking (Stream Reaches)	Kayaking reaches				Whitewater Boating	Recreation	In Stream	Streamflow	ATTRIBUTE5_SouthPlatteKayaking	Line
Attribute	Boating, Rafting (Stream Reaches)	Rafting reaches				Whitewater Boating	Recreation	In Stream	Streamflow	ATTRIBUTE5_SouthPlatteRafting	Line
Attribute	Boreal Toad (Sites)	Known breeding sites		1		Boreal Toad	State Endangered, Threatened, Species of Concern	Near stream	Wetland?	ATTRIBUTE1_BorealToad_SP	Point
Attribute	Boreal Toad (HUCs)	12-digit HUC distribution for species		1		Boreal Toad	State Endangered, Threatened, Species of Concern	Near stream	Wetland?	ATTRIBUTE1_huc12_nrcs_BorealToad_SP	Polygon
Attribute	Brassy Minnow (HUCs)	12-digit HUC distribution for species		2		Brassy Minnow	Plains Fish State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_Brassy_Minnow_SP	Polygon
Attribute	Common Garter Snake (Sites)	Breeding sites? No metadata.		4		Common Garter Snake	State Endangered, Threatened, Species of Concern	Near stream	Streamflow	ATTRIBUTE1_CommonGarterSnake_SP	Point
Attribute	Common Garter Snake (HUCs)	12-digit HUC distribution for species		4		Common Garter Snake	State Endangered, Threatened, Species of Concern	Near stream	Streamflow	ATTRIBUTE1_huc12_nrcs_CommonGarterSnake_SP	Polygon
Attribute	Common Shiner (HUCs)	12-digit HUC distribution for species		2		Common Shiner	Plains Fish State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_Common_Shiner_SP	Polygon
Attribute	Ducks Unlimited Projects (Sites)	Ducks Unlimited Projects				Ducks Unlimited Projects	Waterfowl Hunting/Viewing	Near Stream	Wetland?	ATTRIBUTE7_Ducks_Unlimited_Projects_SP	Point
Attribute	Ducks Unlimited Projects (HUCs)	12-digit HUC distribution for Ducks Unlimited Projects				Ducks Unlimited Projects	Waterfowl Hunting/Viewing	Near Stream	Wetland?	ATTRIBUTE7_huc12_nrcs_Ducks_Unlimited_Projects_SP	Polygon
Attribute	Fishing, Reservoir (Lakes)	Reservoir fishing				Reservoir and Lake Fishing	Fishing	In lake	Lake Level	ATTRIBUTE6_Reservoir_Lake_Fishing	Polygon
Attribute	Fishing, Stream (Stream Reaches)	Stream fishing				River and Stream Fishing	Fishing	In stream	Streamflow	ATTRIBUTE6_River_Stream_Fishing	Line
Attribute	Gold Medal Fishing (Lakes)	Gold Medal fishing lakes				Gold Medal Trout Lakes	Fishing	In lake	Lake Level	ATTRIBUTE6_Gold_Medal_Lakes	Polygon
Attribute	Gold Medal Fishing (Stream Reaches)	Gold Medal fishing streams				Gold Medal Trout Streams	Fishing	In stream	Streamflow	ATTRIBUTE6_Gold_Medal_Streams	Polygon
Attribute	Greenback Cutthroat Trout (Lakes)	Lakes with Greenback Cutthroat		1		Greenback Cutthroat Trout	Greenback Cutthroat Trout	In lake	Lake Level	ATTRIBUTE1_GreenbackCutthroatTrout_Lakes_SP	Polygon
Attribute	Greenback Cutthroat Trout (Stream Reaches)	Streams with Greenback Cutthroat		1		Greenback Cutthroat Trout	Greenback Cutthroat Trout	In stream	Streamflow	ATTRIBUTE1_GreenbackCutthroatTrout_Streams_SP	Line
Attribute	Instream Flow Reaches, 2005 (Stream Reaches)	Instream flow reaches, 2005.				CWCB Instream Flow Rights	NA	In stream	Streamflow	ATTRIBUTE4_isfstreams2005_SP	Line
Attribute	Instream Flow Reaches, 2010 (Stream Reaches)	Instream flow reaches, 2010.				CWCB Instream Flow Rights	NA	In stream	Streamflow	ATTRIBUTE4_isfstreams_2010_SP	Line
Attribute	Instream Flow Reaches, 2010 pending (Stream Reaches)	Instream flow reaches, 2010, pending				CWCB Instream Flow Rights	NA	In stream	Streamflow	ATTRIBUTE4_MetroSplatteBasins_PendingStreams_2010_SP	Line
Attribute	Iowa Darter (HUCs)	12-digit HUC distribution for species				Iowa Darter	Plains Fish State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_Iowa_Darter_SP	Polygon
Attribute	Lake Chub (Lakes)	Lakes with Lake Chub		3		Lake Chub	State Endangered, Threatened, Species of Concern	In lake	Streamflow	ATTRIBUTE1_LakeChub_Lakes_SP	Polygon
Attribute	Lake Chub (Stream Reaches)	Stream Reaches with Lake Chub		3		Lake Chub	State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_LakeChub_Streams_SP	Line
Attribute	Lake Levels, 2005 (Lakes)	CWCB protected lakes, as of 2005				CWCB Natural Lake Level Water Rights	NA	In lake	Lake Level	ATTRIBUTE4_isflakes2005_SP	Polygon
Attribute	Lake Levels, 2005 (HUCs)	12-digit HUC distribution for CWCB protected lakes, as of 2005				CWCB Natural Lake Level Water Rights	NA	In lake	Lake Level	ATTRIBUTE4_huc12_nrcs_isflakes2005_SP	Polygon
Attribute	Lake Levels, 2006 (Lakes)	CWCB protected lakes, as of 2006				CWCB Natural Lake Level Water Rights	NA	In lake	Lake Level	ATTRIBUTE4_isflakes2006_SP	Polygon

Environmental and Recreational
Spatial Data Inventory

General Information (containing TA.gdb/METRO_SOUTHPLATTE)			SWSI NCNA Phase 2 GeoDatabase (SWSI NCNA_PHS2_BASIN_DATA.gdb/METRO_SOUTHPLATTE)				BIP Phase 1 (many SWSI NCNA_PH1_BASIN_DATA.gdb feature classes exported)	
Layer Group	Source	Note	Feature Class	Geometry Type	Source	Note	Shapefile or Feature Class	Note
Attribute	CDOW	Locations are circles representing buffers around sites, essentially points.					ATTRIBUTE1_Bald_Eagle_Active_Nestsites_SP.shp	
Attribute	National Audubon Society	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE7_Audubon_Bird_Areas_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW						ATTRIBUTE7_huc12_nrcs_Audubon_Bird_Areas_SP.shp	
Attribute	CO State Parks						ATTRIBUTE5_CO_Boatable_Waters_SP.shp	
Attribute	?						ATTRIBUTE5_SouthPlatteKayaking.shp	
Attribute	?						ATTRIBUTE5_SouthPlatteRafting.shp	
Attribute	CDOW	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE1_BorealToad_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE1_huc12_nrcs_BorealToad_SP.shp	
Attribute	CDOW						ATTRIBUTE1_Brassy_Minnow_SP.shp	
Attribute	CDOW	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE1_CommonGarterSnake_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE1_huc12_nrcs_CommonGarterSnake_SP.shp	
Attribute	CDOW						ATTRIBUTE1_Common_Shiner_SP.shp	
Attribute	Ducks Unlimited?	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE7_Ducks_Unlimited_Projects_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA						ATTRIBUTE7_huc12_nrcs_Ducks_Unlimited_Projects_SP.shp	
Attribute	?						ATTRIBUTE6_Reservoir_Lake_Fishing.shp	
Attribute	USGS, CDOW						ATTRIBUTE6_River_Stream_Fishing.shp	
Attribute	CDOW						ATTRIBUTE6_Gold_Medal_Lakes.shp	
Attribute	CDOW						ATTRIBUTE6_Gold_Medal_Streams.shp	
Attribute	CDOW						ATTRIBUTE1_GreenbackCutthroatTrout_Lakes_SP.shp	
Attribute	CDOW						ATTRIBUTE1_GreenbackCutthroatTrout_Streams_SP.shp	
Attribute	CWCB	Can get most recent data from bottom of page: http://cdss.state.co.us/GIS/Pages/DataBaseCategory.aspx					ATTRIBUTE4_isfstreams2005_SP.shp	
Attribute	CWCB	Can get most recent data from bottom of page: http://cdss.state.co.us/GIS/Pages/DataBaseCategory.aspx					ATTRIBUTE4_isfstreams_2010.shp	
Attribute	CWCB	Need to get the latest ISF reach layer.					ATTRIBUTE4_MetroSplatteBasin_PendingStreams_2010.shp	
Attribute	CDOW						ATTRIBUTE1_Iowa_Darter_SP.shp	
Attribute	CDOW						ATTRIBUTE1_LakeChub_Lakes_SP.shp	
Attribute	CDOW						ATTRIBUTE1_LakeChub_Streams_SP.shp	
Attribute	CWCB	Need to get latest version from CWCB.					ATTRIBUTE4_isflakes2005_SP.shp	
Attribute	CWCB	Need to get latest version based on above.					ATTRIBUTE4_huc12_nrcs_isflakes2005_SP.shp	
Attribute	CWCB	Need to get latest version from CWCB.					ATTRIBUTE4_isflakes2006.shp	

Environmental and Recreational
Spatial Data Inventory

General Information (containing BIP Phase 2 New Data)					BIP Phase 2 Stream Mile Representation				
Layer Group	Layer or Feature Class	Geometry Type	Source	Note	Layer or Feature Class Referenced to SWRF	Feature Class Attribute Name(s)	Geometry Type	Layer or Feature Class with Mile Markers to Export to Excel	Note
Attribute					ATTRIBUTE1_Bald_Eagle_Active_Nestsites_SP.shp	BaldEagle	Polygon		
Attribute					ATTRIBUTE7_Audubon_Bird_Areas_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE7_huc12_nrcs_Audubon_Bird_Areas_SP.shp	BirdArea	Polygon		
Attribute					ATTRIBUTE5_CO_Boatable_Waters_SP.shp	FlatwaterBoating	Polygon		
Attribute					ATTRIBUTE5_SouthPlatteKayaking.shp	KayakWhitewater	Line		
Attribute					ATTRIBUTE5_SouthPlatteRafting.shp	RaftWhitewater	Line		
Attribute					ATTRIBUTE1_BorealToad_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE1_huc12_nrcs_BorealToad_SP.shp	BorealToad	Polygon		
Attribute					ATTRIBUTE1_Brassy_Minnow_SP.shp	BrassyMinnow	Polygon		
Attribute					ATTRIBUTE1_CommonGarterSnake_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE1_huc12_nrcs_CommonGarterSnake_SP.shp	ComGarterSnake	Polygon		
Attribute					ATTRIBUTE1_Common_Shiner_SP.shp	ComShiner	Polygon		
Attribute					ATTRIBUTE7_Ducks_Unlimited_Projects_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE7_huc12_nrcs_Ducks_Unlimited_Projects_SP.shp	DucksUnProjects	Polygon		
Attribute					ATTRIBUTE6_Reservoir_Lake_Fishing.shp	LakeFishing	Polygon		
Attribute					ATTRIBUTE6_River_Stream_Fishing.shp	StreamFishing	Line		
Attribute					ATTRIBUTE6_Gold_Medal_Lakes.shp	GMTroutLake	Polygon		
Attribute					ATTRIBUTE6_Gold_Medal_Streams.shp	GMTroutStream	Polygon		
Attribute					ATTRIBUTE1_GreenbackCutthroatTrout_Lakes_SP.shp	GBCuttLake	Polygon		
Attribute					ATTRIBUTE1_GreenbackCutthroatTrout_Streams_SP.shp	GBCuttStream	Line		
Attribute					ATTRIBUTE4_isfststreams2005_SP.shp		Line		
Attribute					ATTRIBUTE4_isfststreams_2010.shp		Line		
Attribute					ATTRIBUTE4_MetroSplatteBasin_PendingStreams_2010.shp		Line		
Attribute					ATTRIBUTE1_Iowa_Darter_SP.shp	IowaDarter	Polygon		
Attribute					ATTRIBUTE1_LakeChub_Lakes_SP.shp	LakeChubLake	Polygon		
Attribute					ATTRIBUTE1_LakeChub_Streams_SP.shp	LakeChubStream	Line		
Attribute					ATTRIBUTE4_isflakes2005_SP.shp		Polygon		
Attribute					ATTRIBUTE4_huc12_nrcs_isflakes2005_SP.shp		Polygon		
Attribute					ATTRIBUTE4_isflakes2006.shp		Polygon		

Environmental and Recreational
Spatial Data Inventory

General Information (compiled from SWSI NCNA data and documents)										SWSI NCNA Phase 1 GeoDatabase (SWSI NCNA PH1 BASIN DATA)	
Layer Group	Layer Name, Descriptive (Spatial Unit)	Content	SWSI Attribute Category	SWSI Dependency	SWSI/BIP Attribute Group	SWSI/BIP Attribute	SWSI/BIP Attribute Category	Stream Proximity	Water-related Measureable Outcome	Feature Class	Geometry Type
Attribute	Municipal Recreational Corridors (Stream Reaches)	Municipal recreational corridors (trails next to streams)				?		Near stream		ATTRIBUTE8_Municipal_Rec_Corridors_SP	Line
Attribute	Northern Cricket Frog (Sites)	Sites with Northern Cricket Frog				Northern Cricket Frog	State Endangered, Threatened, Species of Concern	In stream?	Streamflow	ATTRIBUTE2_Northern_Cricket_Frog_SP	Point
Attribute	Northern Cricket Frog (HUCs)	12-digit HUC distribution for species				Northern Cricket Frog	State Endangered, Threatened, Species of Concern	In stream?	Streamflow	ATTRIBUTE2_huc12_nrcs_Northern_Cricket_Frog_SP	Polygon
Attribute	Northern Leopard Frog (Sites)	12-digit HUC distribution for species		4		Northern Leopard Frog	State Endangered, Threatened, Species of Concern	In stream?	Streamflow	ATTRIBUTE2_Northern_Leopard_Frog_SP	Point
Attribute	Northern Leopard Frog (HUCs)	12-digit HUC distribution for species		4		Northern Leopard Frog	State Endangered, Threatened, Species of Concern	In stream?	Streamflow	ATTRIBUTE2_huc12_nrcs_Northern_Leopard_Frog_SP	Polygon
Attribute	Northern Redbelly Dace (HUCs)	12-digit HUC distribution for species		3		Northern Redbelly Dace	Plains Fish State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_Northern_Redbelly_Dace_SP	Polygon
Attribute	Outstanding and Wilderness Area Waters (Stream Reaches)	Special value waters.				Wilderness Waters	NA	In stream	Streamflow	ATTRIBUTE4_CO_Outstanding_and_wilderness_area_waters_SP	Line
Attribute	Outstanding Waters (Stream Reaches)	Special value waters.				Colorado Outstanding Waters	NA	In stream	Streamflow	ATTRIBUTE4_CO_Outstanding_Waters_SP	Line
Attribute	Plains Leopard Frog (Sites)	Sites with Plains Leopard Frog				Plains Leopard Frog	State Endangered, Threatened, Species of Concern	In stream?	Streamflow	ATTRIBUTE2_Plains_Leopard_Frog_SP	Point
Attribute	Plains Leopard Frog (HUCs)	12-digit HUC distribution for species				Plains Leopard Frog	State Endangered, Threatened, Species of Concern	In stream?	Streamflow	ATTRIBUTE2_huc12_nrcs_Plains_Leopard_Frog_SP	Polygon
Attribute	Plains Minnow (HUCs)	12-digit HUC distribution for species		3		Plains Minnow	Plains Fish State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_Plains_Minnow_SP	Polygon
Attribute	Plains Orangethroat Darter (HUCs)	12-digit HUC distribution for species		4		Plains Orangethroat Darter	Plains Fish State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_Orangethroat_Darter_SP	Polygon
Attribute	Preble's Meadow Jumping Mouse (Range)	Sites with Preble's Meadow Jumping Mouse		1		Preble's Meadow Jumping Mouse	State Endangered, Threatened, Species of Concern	Near stream	?	ATTRIBUTE1_pjm_occupied_range_SP	Polygon
Attribute	Preble's Meadow Jumping Mouse (Overall Range)	Preble's Meadow Jumping Mouse Overall Range		1		Preble's Meadow Jumping Mouse	State Endangered, Threatened, Species of Concern	Near stream	?	ATTRIBUTE1_pjm_overall_range_SP	Polygon
Attribute	RICDs (Stream Reaches)	Recreational In-Channel Diversions (RICDs)				Recreational In-Channel Diversion Structures	Recreation	In stream	Streamflow	ATTRIBUTE5_RICDs_SP	Line
Attribute	Riparian Habitat (Sites)	Important riparian habitat sites.				Rare Aquatic-Dependent Plants	Important Riparian Habitat	Near stream	Streamflow	ATTRIBUTE3_ARW_PLANTS3pts_20061207_Feat_SP	Point
Attribute	Riparian Habitat (HUCs)	Important riparian habitat sites.				Rare Aquatic-Dependent Plants	Important Riparian Habitat	Near stream	Streamflow	ATTRIBUTE3_huc12_nrcs_ARW_PLANTS3pts_20061207_Feat_SP	Polygon
Attribute	Riparian Plants (Sites)	Significant riparian wetland plant community sites.				Significant Plant Communities	Important Riparian Habitat	Near stream	Wetland	ATTRIBUTE3_SignificantRiparianWetlandPlantComms_SP	Point
Attribute	Riparian Plants (HUCs)	Significant riparian wetland plant community sites.				Significant Plant Communities	Important Riparian Habitat	Near stream	Wetland	ATTRIBUTE3_huc12_nrcs_SignificantRiparianWetlandPlantComms_SP	Polygon
Attribute	River Otter (Sites)	Sites with confirmed River Otter sightings.		3		River Otter	State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_RiverOtter_ConfirmedSightings_SP	Point
Attribute	River Otter (HUCs)	12-digit HUC distribution for species		3		River Otter	State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_huc12_nrcs_RiverOtter_ConfirmedSightings_SP	Polygon
Attribute	Stonecat (HUCs)	12-digit HUC distribution for species		3		Stonecat	Plains Fish State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_Stonecat_SP	Polygon
Attribute	Suckermouth Minnow (HUCs)	12-digit HUC distribution for species		3		Suckermouth Minnow	Plains Fish State Endangered, Threatened, Species of Concern	In stream	Streamflow	ATTRIBUTE1_Suckermouth_Minnow_SP	Polygon
Attribute	Waterfowl (Sites)	Sites with waterfowl hunting and viewing				Waterfowl Hunting/Viewing	Waterfowl Hunting/Viewing	Near stream	Wetlands?	ATTRIBUTE7_Waterfowl_Hunting_Viewing_SP	Polygon
Attribute	Wild and Scenic, Poudre (Stream Reaches)	Poudre River Wild and Scenic.				Wilderness Waters	NA	In stream	Streamflow	ATTRIBUTE4_Poudre_Wild_Scenic_SP	Line
Attribute	Wild and Scenic, Potential New (Stream Reaches)	Potential additions to Wild and Scenic.				Wilderness Waters	NA	In stream	Streamflow	ATTRIBUTE4_Potential_Additions_to_Wild_and_Scenic_SP	Line
Attribute	Wild and Scenic, South Platte Eligible (Stream Reaches)	South Platte eligible Wild and Scenic areas.				Eligible Wild and Scenic	NA	In stream	Streamflow	ATTRIBUTE4_SPBasin_Eligible_Wild_Scenic	Line

Environmental and Recreational
Spatial Data Inventory

General Information (containing TA_gdb/METRO_SOUTHPLATTE)			SWSI NCNA Phase 2 GeoDatabase (SWSI NCNA_PHS2_BASIN_DATA_gdb/METRO_SOUTHPLATTE)			BIP Phase 1 (many SWSI NCNA_PH1_BASIN_DATA_gdb feature classes exported)		
Layer Group	Source	Note	Feature Class	Geometry Type	Source	Note	Shapefile or Feature Class	Note
Attribute	CDOW						ATTRIBUTE8_Municipal_Rec_Corridors.shp	
Attribute	USDA, CDOW	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE2_Northern_Cricket_Frog_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE2_huc12_nrcs_Northern_Cricket_Frog_SP.shp	
Attribute	USDA, CDOW	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE2_Northern_Leopard_Frog_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE2_huc12_nrcs_Northern_Leopard_Frog_SP.shp	
Attribute	CDOW						ATTRIBUTE1_Northern_Redbelly_Dace_SP.shp	
Attribute	BLM						ATTRIBUTE4_CO_outstanding_and_wilderness_area_waters.shp	
Attribute	BLM						ATTRIBUTE4_CO_Outstanding_Waters_SP.shp	
Attribute	USDA, CDOW	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE2_Plains_Leopard_Frog_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE2_huc12_nrcs_Plains_Leopard_Frog_SP.shp	
Attribute	CDOW						ATTRIBUTE1_Plains_Minnow_SP.shp	
Attribute	CDOW						ATTRIBUTE1_Orangethroat_Darter_SP.shp	
Attribute	?						ATTRIBUTE1_pjm_occupied_range_SP.shp	
Attribute	?						ATTRIBUTE1_pjm_overall_range_SP.shp	
Attribute	CWCB	Need to get updated layer					ATTRIBUTE5_RICDs_SP.shp	
Attribute	CDOW?	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE3_ARW_PLANTSL3pts_20061207_Feat_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE3_huc12_nrcs_ARW_PLANTSL3pts_20061207_Feat_SP.shp	
Attribute	CDOW?	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE3_SignificantRiparianWetlandPlantComms_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE3_huc12_nrcs_SignificantRiparianWetlandPlantComms_SP.shp	
Attribute	USDA, CDOW	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE1_RiverOtter_ConfirmedSightings_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE1_huc12_nrcs_RiverOtter_ConfirmedSightings_SP.shp	
Attribute	CDOW						ATTRIBUTE1_Stonecat_SP.shp	
Attribute	CDOW						ATTRIBUTE1_Suckermouth_Minnow_SP.shp	
Attribute	CDOW						ATTRIBUTE7_Waterfowl_Hunting_Viewing_Parcel.shp	
Attribute	USGS, CDOW						ATTRIBUTE4_Poudre_Wild_Scenic.shp	
Attribute	USGS, CDOW						ATTRIBUTE4_Potential_Additions_to_Wild_and_Scenic_SP.shp	
Attribute	USGS, CDOW						ATTRIBUTE4_SPBasin_Eligible_Wild_Scenic.shp	

Environmental and Recreational
Spatial Data Inventory

General Information (cont BIP Phase 2 New Data)					BIP Phase 2 Stream Mile Representation				
Layer Group	Layer or Feature Class	Geometry Type	Source	Note	Layer or Feature Class Referenced to SWRF	Feature Class Attribute Name(s)	Geometry Type	Layer or Feature Class with Mile Markers to Export to Excel	Note
Attribute					ATTRIBUTE8_Municipal_Rec_Corridors.shp	RecCorridor	Line		
Attribute					ATTRIBUTE2_Northern_Cricket_Frog_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE2_huc12_nrcs_Northern_Cricket_Frog_SP.shp	NCrickFrog	Polygon		
Attribute					ATTRIBUTE2_Northern_Leopard_Frog_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE2_huc12_nrcs_Northern_Leopard_Frog_SP.shp	NLeopFrog	Polygon		
Attribute					ATTRIBUTE1_Northern_Redbelly_Dace_SP.shp	NRedbellyDace	Polygon		
Attribute					ATTRIBUTE4_CO_outstanding_and_wilderness_area_waters.shp	OutWildWaters	Line		
Attribute					ATTRIBUTE4_CO_Outstanding_Waters_SP.shp	OutstWaters	Line		
Attribute					ATTRIBUTE2_Plains_Leopard_Frog_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE2_huc12_nrcs_Plains_Leopard_Frog_SP.shp	PlaLeoFrog	Polygon		
Attribute					ATTRIBUTE1_Plains_Minnow_SP.shp	PlaMinnow	Polygon		
Attribute					ATTRIBUTE1_Orangethroat_Darter_SP.shp	OrngthDarter	Polygon		
Attribute					ATTRIBUTE1_pjm_occupied_range_SP.shp	OccPrebMouse	Polygon		
Attribute					ATTRIBUTE1_pjm_overall_range_SP.shp	OvrPrebMouse	Polygon		
Attribute					ATTRIBUTE5_RICDs_SP.shp	RICDs	Line		
Attribute					ATTRIBUTE3_ARW_PLANTSL3pts_20061207_Feat_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE3_huc12_nrcs_ARW_PLANTSL3pts_20061207_Feat_SP.shp	RarePlants	Polygon		
Attribute					ATTRIBUTE3_SignificantRiparianWetlandPlantComms_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE3_huc12_nrcs_SignificantRiparianWetlandPlantComms_SP.shp	SigPlants	Polygon		
Attribute					ATTRIBUTE1_RiverOtter_ConfirmedSightings_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE1_huc12_nrcs_RiverOtter_ConfirmedSightings_SP.shp	RivOtterSight	Polygon		
Attribute					ATTRIBUTE1_Stonecat_SP.shp	Stonecat	Polygon		
Attribute					ATTRIBUTE1_Suckermouth_Minnow_SP.shp	SuckermMinnow	Polygon		
Attribute					ATTRIBUTE7_Waterfowl_Hunting_Viewing_Parcel.shp	Waterfowl	Polygon		
Attribute					ATTRIBUTE4_Poudre_Wild_Scenic.shp	PoudreScenic	Line		
Attribute					ATTRIBUTE4_Potential_Additions_to_Wild_and_Scenic_SP.shp	PotAddsW_S	Line		
Attribute					ATTRIBUTE4_SPBasin_Eligible_Wild_Scenic.shp	EligibleScenic	Line		

Environmental and Recreational
Spatial Data Inventory

General Information (compiled from SWSI NCNA data and documents)										SWSI NCNA Phase 1 GeoDatabase (SWSI NCNA_PH1_BASIN_DATA)	
Layer Group	Layer Name, Descriptive (Spatial Unit)	Content	SWSI Attribute Category	SWSI Dependency	SWSI/BIP Attribute Group	SWSI/BIP Attribute	SWSI/BIP Attribute Category	Stream Proximity	Water-related Measureable Outcome	Feature Class	Geometry Type
Attribute	Wilderness Area Waters, Additional (Stream Reaches)	Special value waters.				Wilderness Waters	NA	In stream	Streamflow	ATTRIBUTE4_additional_wilderness_area_waters_SP	Line
Attribute	Wood Frog (Sites)	Sites with Wood Frog				Wood Frog	State Endangered, Threatened, Species of Concern	In stream?	Streamflow	ATTRIBUTE2_Wood_Frog_SP	Point
Attribute	Wood Frog (HUCs)	12-digit HUC distribution for species				Wood Frog	State Endangered, Threatened, Species of Concern	In stream?	Streamflow	ATTRIBUTE2_huc12_nrcs_Wood_Frog_SP	Polygon
Attribute	Yellow Mud Turtle (Sites)	Sites with Yellow Mud Turtle		3		Yellow Mud Turtle	State Endangered, Threatened, Species of Concern	Near stream	Wetland?	ATTRIBUTE1_YellowMudTurtle_SP	Point
Attribute	Yellow Mud Turtle (HUCs)	12-digit HUC distribution for species		3		Yellow Mud Turtle	State Endangered, Threatened, Species of Concern	In stream?	Wetland?	ATTRIBUTE1_huc12_nrcs_YellowMudTurtle_SP	Polygon
Stream	DWR Source Water Route Framework (SWRF)	Streams that are sources for CO water rights, based on NHD, but linework merged so 1 feature = 1 GNIS ID.									
Focus Area	Focus Area (Stream Reaches)	Focus areas referenced to NHD.						In Stream		Phase1_SouthPlatte_Focus_Segments_2010	Line
Focus Area	Focus Area (Polygons)	Focus areas polygons near the stream reaches.						In Stream		Phase1_SouthPlatte_Focus_Segments_2010_Polygons	Polygon
Focus Area	Park County Final Focus Segments (Line)	Focus Segments designated by Park County for BIP Phase I						In Stream			
Focus Area	Additional Focus Areas mostly from the Northern Subbasin (Line)	Focus Areas were interpreted from a string of emails saved in "CPW new focus areas 2011.pdf"						In Stream			
Focus Area	Final Focus Areas layer from BIP Phase I	Layer is a merge of ApprovedReaches.shp, ParkCoFinalFocusSegments.shp and Phase1_SouthPlatte_Focus_Segments_2010.shp									
Projects											
Projects & Studies											
Focus Areas joined to Projects											
Focus Areas joined to Studies											
Focus Areas joined to Projects and Studies											
Base	South Platte Subbasins									SWSI_NCNA_PH1_BASIN_DATA.gdb/METRO_SOUTH_PLATTE/SouthPlatte_Subbasins	

Environmental and Recreational
Spatial Data Inventory

General Information (containing TA.gdb/METRO SOUTHPLATTE)			SWSI NCNA Phase 2 GeoDatabase (SWSI NCNA_PHS2_BASIN_DATA.gdb/METRO SOUTHPLATTE)				BIP Phase 1 (many SWSI NCNA_PH1_BASIN_DATA.gdb feature classes exported)	
Layer Group	Source	Note	Feature Class	Geometry Type	Source	Note	Shapefile or Feature Class	Note
Attribute	NCNA Committee	Some streams are not in the SWRF layer (no water rights) and some are on the West Slope.					ATTRIBUTE4_additional_wilderness_areas_waters.shp	
Attribute	USDA, CDOW	All point layers were not processed. All of their features were present in their respective polygon layers.					ATTRIBUTE2_Wood_Frog_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE2_huc12_nrcs_Wood_Frog_SP.shp	
Attribute	CDOW						ATTRIBUTE1_YellowMudTurtle_SP.shp	All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute	USDA, CDOW	Need to confirm process to create HUC layer from sites.					ATTRIBUTE1_huc12_nrcs_YellowMudTurtle_SP.shp	
Stream								
Focus Area	Various	Focus areas based on NCNA committee input.	Phase1_SouthPlatte_Focus_Segments_2010	Line	SWSI NCNA Phase I	Same as Phase 1?	Phase1_SouthPlatte_Focus_Segments_2010	
Focus Area	Various	Focus areas in addition to stream channels.	Phase1_SouthPlatte_Focus_Segments_2010_Polygons	Polygon	SWSI NCNA Phase I	Same as Phase 1?	N/A	
Focus Area							ParkCoFinalFocusSegments.shp	See BIPphaseGISworkflow.pdf for more details
Focus Area							ApprovedReaches.shp	See BIPphaseGISworkflow.pdf for more details
Focus Area							2014FocusAreasV3.shp	See BIPphaseGISworkflow.pdf for more details
Projects			MetroSplatteBasin_All_Projects	Line	SWSI NCNA Phase II	All projects. Steve recommends we start with this, ignoring stewardship projects and merging linework on Project_ID.	MetroSplatteBasin_All_Projects	See BIPphaseGISworkflow.pdf for more details
Projects & Studies			MetroSplatteBasin_All_Projects_Studies	Line	SWSI NCNA Phase II	All projects and studies. Steve recommends we start with this, ignoring stewardship projects and merging linework on Project_ID.	MetroSplatteBasin_All_Projects_Studies	See BIPphaseGISworkflow.pdf for more details
Focus Areas joined to Projects			MetroSplatteBasin_Focus_Areas_Projects	Line	SWSI NCNA Phase II	All projects joined to focus areas.		
Focus Areas joined to Studies			MetroSplatteBasin_Focus_Areas_Studies	Line	SWSI NCNA Phase II	All studies joined to focus areas.		
Focus Areas joined to Projects and Studies			MetroSplatteBasin_Focus_Areas_Projects_Studies	Line	SWSI NCNA Phase II	All projects and studies joined to focus areas.		
Base								

Environmental and Recreational
Spatial Data Inventory

General Information (containing BIP Phase 2 New Data)					BIP Phase 2 Stream Mile Representation				
Layer Group	Layer or Feature Class	Geometry Type	Source	Note	Layer or Feature Class Referenced to SWRF	Feature Class Attribute Name(s)	Geometry Type	Layer or Feature Class with Mile Markers to Export to Excel	Note
Attribute					ATTRIBUTE4_additional_wilderness_area_waters.shp	AddWilderness	Line		
Attribute					ATTRIBUTE2_Wood_Frog_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE2_huc12_nrcs_Wood_Frog_SP.shp	WoodFrog	Polygon		
Attribute					ATTRIBUTE1_YellowMudTurtle_SP.shp		Point		All point layers were not processed. All of their features were present in their respective polygon layers.
Attribute					ATTRIBUTE1_huc12_nrcs_YellowMudTurtle_SP.shp	YMudTurtle	Polygon		
Stream	Div1_Strm_Mile_Model.gdb/Model/Strm_Route	Line	DWR - Chris Brown	This is the basis for the stream mile linework.		GNIS_NAME, GNIS_ID			
Focus Area						FA_ID, FA_NAME			
Focus Area						FA_ID, FA_NAME			
Focus Area									
Focus Area									
Focus Area	2014FocusAreasV3.shp	Line	BIP Phase I	See BIPphaseI GISworkflow.pdf for more details		COMID, Segment_No		FocusAreas_on SWRF_TenthMiles	See BIPphaseI GIS_TechMemo.pdf for more details
Projects	MetroSplatteBasin_All_Projects	Line	SWSI NCNA Phase II geodatabase		N/A				This layer was not processed as all features were contained in MetroSplatteBasin_All_Projects_Studies
Projects & Studies	MetroSplatteBasin_All_Projects_Studies	Line	SWSI NCNA Phase II geodatabase		MetroSplatteBasin_All_Projects_Studies	Project_ID	Line	FocusAreas_on SWRF_TenthMiles	Additional reference table is needed to display Project_ID: MetroSplatteBasin_All_ProjStud_IDreferenceTable
Focus Areas joined to Projects						P1_ID, P1_NAME			
Focus Areas joined to Studies						P1_ID, P1_NAME			
Focus Areas joined to Projects and Studies						P1_ID, P1_NAME			
Base									

Appendix D-4 - Stream Mile Representation Framework Stakeholder Data Input

South Platte Basin Implementation Plan Memorandum

TO: South Platte Basin and Metro Roundtables'
Environmental and Recreational Subcommittee

REVIEWED BY: West Sage Water Consultants

FROM: Steve Malers (Open Water Foundation)

DATE: March 31, 2015

RE: Stream Mile Representation Framework Stakeholder Data Input

Introduction

This memorandum provides recommendations for how to incorporate stakeholder data in the Stream Mile Representation Framework (SMRF), which is used to present and analyze environmental and recreational (E&R) data. In this context, stakeholder is defined as any person or group that submits foundational data (e.g., E&R attributes from Colorado Parks and Wildlife) or supplemental data that increases the completeness of the analysis at a local scale (e.g., projects and methods for a local river reach).

The SMRF implemented for the South Platte Basin Implementation Plan (BIP) Phase II project is illustrated in Figure 1 below. The SMRF represents streams as .1-mile segments, with overlapping environmental and recreational (E&R) attributes, projects and methods, and other data. This approach allows a large amount of data to be spatially represented in Excel to .1-mile resolution, which allows E&R stakeholders to visualize data local to a stream reach of interest, and perform analysis.

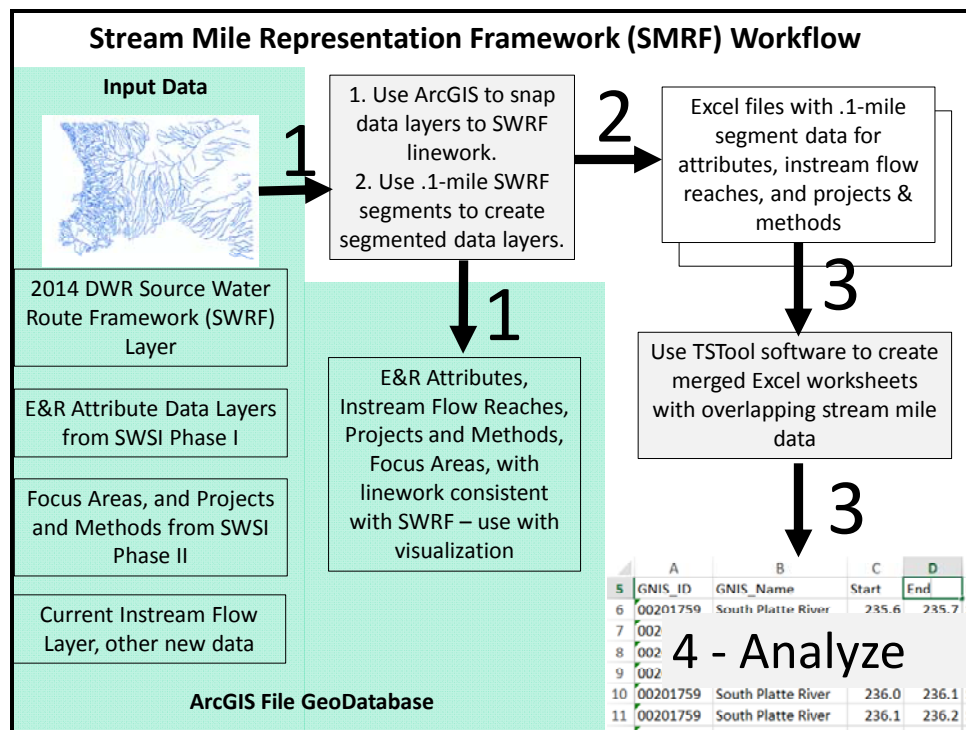


Figure 1. Stream Mile Representation Framework Workflow Overview

APPENDIX D – 4 – Stream Mile Representation Framework Overview

ArcGIS software is used to manage and process spatial data from multiple sources. Geographical Information System (GIS) processing for steps 1 and 2 in Figure 1 is described in the BIP memo “Stream Mile Representation GIS Workflow Processing,” March, 2015. TSTool processing for step 3 in Figure 1 is described in the memorandum “Stream Mile Representation Framework TSTool Workflow Processing,” March 2015. The result of the GIS and TSTool processes are an Excel workbook that includes E&R data, where rows represent .1-mile stream segments and columns are included for E&R attributes, instream flow reaches, projects and methods, locations of stream gages and diversion structures, and other data, as illustrated in Figure 2.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	FMEAS	TMEAS	Geographic	FocusArea_Type	Rationale	FocusAreaID	BaldEagle	BrassyMinnow				
2	00178190	North Saint Vrain Creek	00178190_000.0	0.0	0.1	Northern	North Saint Recreational	Whitewat 14		Yes					
3	00178190	North Saint Vrain Creek	00178190_000.1	0.1	0.2	Northern	North Saint Recreational	Whitewat 14		Yes					
4	00178190	North Saint Vrain Creek	00178190_000.2	0.2	0.3	Northern	North Saint Recreational	Whitewat 14		Yes					
5	00178190	North Saint Vrain Creek	00178190_000.3	0.3	0.4	Northern	North Saint Recreational	Whitewat 14		Yes					
6	00178190	North Saint Vrain Creek	00178190_000.4	0.4	0.5	Northern	North Saint Recreational	Whitewat 14		Yes					
7	00178190	North Saint Vrain Creek	00178190_000.5	0.5	0.6	Northern	North Saint Recreational	Whitewat 14		Yes					
8	00178190	North Saint Vrain Creek	00178190_000.6	0.6	0.7	Northern	North Saint Recreational	Whitewat 14		Yes					
9	00178190	North Saint Vrain Creek	00178190_000.7	0.7	0.8	Northern	North Saint Recreational	Whitewat 14		Yes					
10	00178190	North Saint Vrain Creek	00178190_000.8	0.8	0.9	Northern	North Saint Recreational	Whitewat 14		Yes					
11	00178190	North Saint Vrain Creek	00178190_000.9	0.9	1.0	Northern	North Saint Recreational	Whitewat 14		Yes					
12	00178190	North Saint Vrain Creek	00178190_001.0	1.0	1.1	Northern	North Saint Recreational	Whitewat 14		Yes					
13	00178190	North Saint Vrain Creek	00178190_001.1	1.1	1.2	Northern	North Saint Recreational	Whitewat 14		Yes					
14	00178190	North Saint Vrain Creek	00178190_001.2	1.2	1.3	Northern	North Saint Recreational	Whitewat 14		Yes					
15	00178190	North Saint Vrain Creek	00178190_001.3	1.3	1.4	Northern	North Saint Recreational	Whitewat 14		Yes					

Figure 2. SMRF Excel workbook with integrated data for .1-mile segments

The South Platte Basin Roundtable Environmental and Recreational Subcommittee and an extended group of stakeholders has served as the primary source of E&R data for Statewide Water Supply Initiative (SWSI) and BIP projects. SWSI data were previously collected in an ad hoc manner through meetings, interviews, and specific data requests/submissions. However, the collected data has been relatively inaccessible to stakeholders, with limited download and no web data viewing.

The SMRF as implemented for the BIP does make use of an Esri ArcGIS file geodatabase to manage spatial data because this allows efficient processing of spatial data into the SMRF. However, many stakeholders do not have access to ArcGIS software or the skills to manipulate the geodatabase. This is one reason why the SMRF uses Excel as the final output – because most stakeholders do have access to Excel software and have the ability to use Excel for analysis.

There is a need to accept E&R data from stakeholders on an ongoing basis so that CWCB staff, contractors, and stakeholders themselves can utilize the data in E&R needs and gap analysis. The following approach describes options for managing such data submissions.

Approach

Stakeholder data that are useful in E&R data analysis include, but are not limited to the following:

- E&R attribute data (many layers have been collected through SWSI but others may be added)
- Spatial data sets maintained by a specific organization (e.g., wetlands inventory maintained by Colorado Natural Heritage Program, wildfire burn areas)
- Organizational extent (e.g., program area for a watershed conservation organization)

- Master plan extent (e.g., river reaches considered in stream restoration efforts of watershed coalition groups)
- Project extent (spatial extent of specific projects)
- Physical features useful for context (e.g., location of physical feature that is commonly used for reference on maps)

It is not efficient to manually digitize the above data, for example by marking up hardcopy maps of E&R focus areas. Instead, a protocol needs to be implemented to collect spatially-referenced data from stakeholders, even if they do not have ArcGIS capabilities. It is likely that a standard cannot be fully pushed onto stakeholders and their organizations; however, general guidelines can be implemented that will allow stakeholder data to be ingested into the SMRF analysis process, and such guidelines might eventually cause organizations to evolve their data standards.

Spatial Data

Before evaluating options for collecting data, it is useful to review the SMRF Excel workbook to understand how the data may be used. The Excel workbook represents streams by uniquely identifying a stream with its GNIS_ID (federal Geographic Names Information System) and the starting stream mile of the .1-mile segment (e.g., 00178190_000.1), which allows stream segments to be grouped and sorted. Consequently, at a minimum, the GNIS_ID and stream mile for spatial data need to be determined. One issue is that the stream mile that has been used in the SMRF is based on the Source Water Route Framework (SWRF) stream layer provided by the Colorado Division of Water Resources (see: <http://cdss.state.co.us/GIS/Pages/AllGISData.aspx>), and this layer may change over time, for example, when floods move rivers. Consequently the stream mile is not an absolute reference that will never change. For this reason, it is important that stakeholder-supplied data also be provided with geographic coordinates (or projected coordinates if data are provide in GIS formats such as shapefiles), so that the source data can be intersected with the SWRF layer after updates. It is recommended that stakeholder data should be provided with the following at a minimum:

- Geographic coordinates (or projected coordinates if in GIS format) for data endpoints on a stream reach, point data, or polygon data, as appropriate for the data type
- GNIS_ID of stream
- Start (and end) stream miles for the .1-mile segments that overlap supplied data, consistent with SMRF
- Identifier (see next section)
- Name

Ideally the information should be provided in an Excel file (or equivalent) with the above data clearly labeled in columns and/or named cell range. Additional information such as descriptions are also useful but will likely need to be evaluated on a case-by-case basis as improved data submission guidelines are developed over time.

A simple Google Maps prototype has been developed as part of the BIP project to facilitate determination of spatial data. Figure 3 illustrates a map for the Saint Vrain Basin and shows the SWRF linework for focus areas, and stream mile markers from the SMRF. A stakeholder can use such a tool as follows:

1. Visit the website. The current prototype is at the following URL but if a production tool is implemented in the future it will have different address: <http://s3.amazonaws.com/owf-proj-bip/StreamMileFramework/Web-StakeholderDataEntry/SMRF-StakeholderDataEntry.html>
2. Zoom in to a region appropriate for stakeholder data.
3. Click on a stream mile marker (circle) to display the GNIS_ID and stream mile for the location. This information can be provided with stakeholder-supplied data to spatially reference the data to the SMRF.
4. Double-click on the map at a specific point to display a popup box with latitude and longitude. This is a simple tool that can be made more sophisticated in the future. This information can also be provided with stakeholder data so that the raw coordinates can be used to recalculate stream mile if the SMRF data changes.

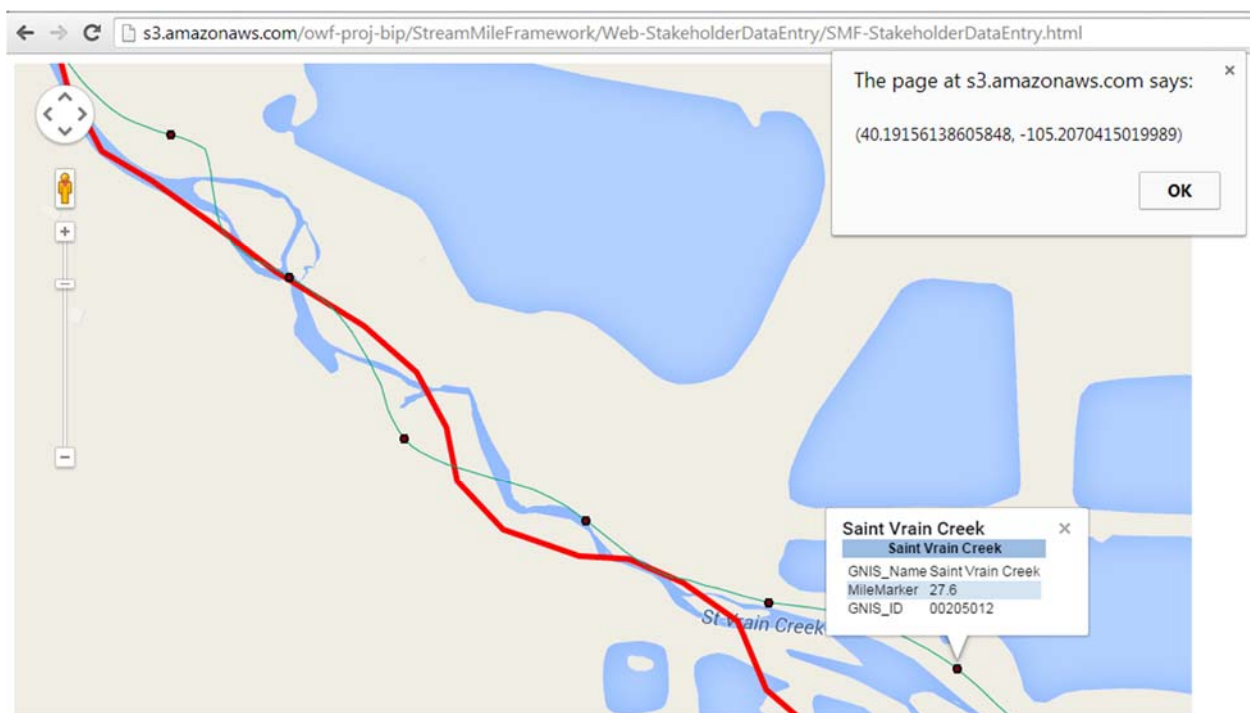


Figure 3. Simple prototype showing how stream mile data can be accessed for stakeholder data

An alternate approach to the above is to provide downloads for SMRF spatial data layers in GIS-friendly formats such as KML and shapefiles. KML files could then be used with Google Earth similar to the above example. One issue is that the latitude and longitude cannot be determined from Google Earth without first placing a marker on the map.

Open Data – Unique Identifiers

Ideally the stakeholder's E&R data being provided also will be publicly available on an organization's website. This allows transparency and simplifies the data flow from organizations to the State. Open data require that data resources can be uniquely identified. Unique identifiers are a guideline

recommended by the Sunlight Foundation in its open data guidelines (see: <http://sunlightfoundation.com/opendataguidelines>).

Each E&R data resource needs a unique identifier that is human-readable. This is in addition to internal unique identifiers that may get assigned in the GIS or other data management system. The previous SWSI work assigned unique identifiers that in some cases had little meaning to stakeholders (e.g., project “803”). This coupled with limited metadata makes it difficult to track the data back to the original source. Therefore, it is recommended that unique identifiers be constructed using a protocol that has clear meaning. For example, identifiers could be formed using the organization and the organization’s project identifier, such as “CPAW-2014-1234”. The protocol that is used should be documented so that it has meaning from the stakeholder perspective for their data management and the State’s perspective for its data management.

In the context of stakeholder-supplied data where the stakeholder does not utilize formal data management, it may be necessary to develop guidelines and provide a learning experience. More robust data management will evolve and data sharing will become easier over time.

In summary, stakeholder data should include some type of unique identifier that has meaning for their organization. This identifier should be used in the SMRF, potentially by adding additional information to the identifier, such as organization abbreviation. This will allow the data to be used in the SMRF and be tracked back to the original data provider. It will also allow stakeholder-supplied data to be accessed via the web should such capabilities be implemented.

Stakeholder Use of the SMRF

The Excel workbook resulting from the SMRF processing could be used directly by stakeholders. To do so:

1. Download the SMRF Excel workbook (location on the web is pending release of the final BIP products).
2. Create a new column in the worksheet for an area of interest. Label the column appropriately so as to not confuse with data from the SMRF.
3. Use existing data in the SMRF Excel worksheet to spatially locate segments that overlap the stakeholder data and/or use mapping tools such as discussed above.
4. Scroll to the appropriate stream mile row and enter information, for example the name of a data item or “Yes” to indicate that the item exists (if the heading clearly indicates the item).
5. Copy the value to as many rows as are appropriate.
6. Modify and/or add formulas to compute metrics or perform analysis. Ideally such analysis will be consistent with best practices identified by the E&R scientific community and leverage additional data.

Ideally stakeholder data that has value to others will be submitted to the State to enhance the core data in the SMRF, if data submission protocols are implemented and/or data are publicly available. In any case, stakeholders can independently use the SMRF tool to visualize and manage their own data.

Comments and Recommendations

The SMRF implemented for the South Platte BIP provides a framework that supports using stakeholder data such as environmental attributes, master plans, projects and methods, and other spatially-referenced data. Although this framework does require GIS and other processing to create data that are merged into the baseline SMRF Excel workbook, the concepts used in the SMRF, and the format of the Excel workbook are straightforward and encourage additional of stakeholder data. The following specific recommendations are made:

1. **Engage stakeholders to submit data and use the SMRF.** The SMRF prototype used existing SWSI E&R data, CWCBI instream flow reaches, data layers from DWR, and other data to demonstrate the SMRF concept. However, additional data layers were identified that would help understand needs, challenges, and opportunities. For example, land use, land ownership, wetlands, organizational extent, master plan extent, and other spatial information could be included in the SMRF to enhance its value. The following actions are recommended:
 - a. **Develop data submission standards.** This memorandum has highlighted several technical issues that need to be addressed to utilize stakeholder data in the SMRF. Additional effort is needed to more fully consider these and other issues to encourage efficient submission and use of stakeholder data.
 - b. **Provide open access to SMRF data and products.** The input data for the SMRF consist primarily of openly available data layers. The products generated from the SMRF include map layers referenced to the State's SWRF layer, mile marker layer, and SMRF Excel workbook. All of these products should be openly provided on a website, with appropriate metadata and documentation.
 - c. **Evaluate effectiveness of SMRF in addressing stakeholder needs.** Initial feedback on the SMRF approach and products has been positive. However, the true measure of usefulness will be whether stakeholders are able to access and use the tool as a platform for the work that they do. Effectiveness will likely require some level of involvement by the State to maintain the core tools, and an ability for stakeholders to combine their data with the Excel workbook. It is recommended that training and outreach with a key stakeholder group occur to evaluate the effectiveness of the SMRF. Such an effort should involve the Roundtable's Environmental and Recreational Subcommittee; however, working directly with various organizations such as The Nature Conservancy and watershed coalitions should also be pursued.
2. **Integrate local stakeholder data with larger analysis.** The overall SMRF analysis can be utilized to help the State evaluate E&R requirements, challenges, and opportunities to meeting those requirements. Local stakeholder data can contribute to the overall analysis, and regional/state programs can benefit local efforts by providing a platform of accessible data and tools. An integrated approach should be implemented in the next update of the Statewide Water Supply Initiative (SWSI).

Appendix D-5 - Instream Flow Protections in the South Platte Basin

South Platte Basin Implementation Plan Memorandum

TO: South Platte Basin and Metro Roundtables'
Environmental and Recreational Subcommittee
West Sage Water Consultants

FROM: Pete Conovitz (Colorado Parks and Wildlife)

DATE: January 9, 2015

RE: Instream Flow Protections in the South Platte Basin

Instream Flow Protections in the South Platte Basin.

The health of most if not all of the environmental and recreational (E&R) attributes identified within the South Platte Basin Implementation Plan are closely tied to streamflow. It is widely accepted that a river's flow regime, or the range and variability of streamflow over time (including both high and low flows), is critical to sustaining biodiversity and ecological integrity, and controls many physical and biological processes and characteristics of the river ecosystem. It is also widely understood that alterations in the flow regime results in changes that often negatively impact the river's ecological function, and by extension negatively impacting the E&R attributes it supports. Therefore, an effective strategy to preserve and enhance many E&R attributes should include actions designed to restore, maintain or enhance existing flow regimes within the South Platte River and its tributaries.

In Colorado, the primary mechanism to protect existing streamflow is through the Colorado Water Conservation Board's (CWCB) Instream flow (ISF) Program. In 1973, The CWCB was granted the exclusive authority to protect streamflow through a given reach of stream and has appropriated instream flow water rights on various rivers and streams throughout Colorado including those located within the South Platte Basin. More recently, The CWCB has also been authorized to improve the natural environment of a river system by adding water to streams or restoring native flows through acquisition or lease of water, water rights, or interests in water.

In order to appropriate an ISF water right, the CWCB must make three specific findings – that a natural environment exists, that a certain amount of water is needed to preserve that natural environment, and that water is available for the instream flow appropriation. To date, the CWCB has primarily relied upon the R2CROSS methodology to quantify instream flow requirements. The R2CROSS method models streamflow at a particular location and calculates key hydraulic parameters, such as wetted perimeter, depth and velocity, needed to maintain a minimum flow across a stream riffle (the shallowest and most critical low flow habitat type). Most ISF water rights in Colorado are based on the presence of a cold water fishery as an indicator of a functioning natural environment and it is assumed that if an adequate flow is maintained through the riffle habitat then the resulting flow will be sufficient to sustain fish and macro-invertebrates in all other parts of a stream reach. The CWCB primarily utilizes the R2CROSS method because it is cost effective, easy to use and produces consistent and reproducible results. It also has been upheld by the Colorado Water Courts as an accepted method for quantifying instream flow amounts. A limitation of the R2CROSS method is that it does not consider ecological components other

than the hydraulics of a riffle and only yields a two stage flow recommendation (summer and winter). Therefore this method is associated with the protection of minimum flows. The CWCB is not limited to using the R2CROSS method exclusively to evaluate instream flow requirements and has the ability to utilize other quantification methods better suited for the protection of other riverine habitat types (pools, glides, side channels, etc.) and/or natural environment indicators other than cold water fisheries.

Regardless of the method, once the instream flow needs are quantified for a new appropriation the CWCB must determine whether water is physically and legally available to meet those needs. Like all water rights in Colorado, ISF water rights appropriated by the CWCB are subject to the prior appropriation system and are junior to existing decreed water rights, and therefore do not affect or injure existing uses on a given stream. Because of their junior priority, ISF rights are often limited by physical and legal water availability and are occasionally limited to stream reaches above existing diversions or are truncated at diversion structures that have historically dried up the stream thus causing a water availability limitation on the ISF water right.

The preservation of instream flows is critical for the future protection of environmental and recreational attributes whose health depends on streamflows. The CWCB ISF program has had 282 ISF water rights adjudicated in the South Platte and Republican Basins, representing over 1400 miles of protection. However, many environmental and recreation attributes identified in the South Platte BIP occur in transitional or low elevation stream environments where the majority of existing diversions occur. In these many of these areas a lack of water availability precludes a new ISF appropriation. Further, cold water fisheries which are the basis for most ISF appropriations are only one of many attributes identified in the BIP. Therefore, methodologies other than R2CROSS (as discussed above) and other ISF strategies (such as water leasing or acquisition to improve or restore flows) may be more productive in protecting and enhancing E&R attributes within the South Platte Basin. Multi-purpose storage projects with dedicated water for ISF maintenance or enhancement may also provide an effective tool for long term attribute protection.

Appendix D-6 - Review of South Platte Basin Master Plans

South Platte Basin Implementation Plan Memorandum

TO: South Platte Basin and Metro Roundtables'
Environmental and Recreational Subcommittee

REVIEWED BY: West Sage Water Consultants

FROM: Katy Reagan (Sunbird Biological Consultants)

DATE: March 18, 2015

SUBJECT: Review of South Platte Basin Master Plans

Introduction

This memo summarizes available statewide, watershed, municipality, or regional planning documents pertinent to the South Platte Basin Implementation Plan (BIP). Planning documents were supplied by Environment and Recreation subcommittee members or the South Platte BIP contractor. In order to maintain consistency across the wide range of stakeholders and water related planning efforts in the South Platte Basin, a review of previously approved planning documents was completed. Documents were reviewed for relevancy to BIP goals, focus areas, and projects. Document review, including the document title, contact organization, year of publication, geographic coverage, source, summary, and plan outline are provided below for eighteen planning documents. The BIP content portion of the review indicates whether information from the planning document should be included in the BIP stream mile representation analysis (plan has specific location information), the BIP project list (plan has specific projects, project locations, and project sponsors), or if the information from the plan will be incorporated into an appendix of the BIP (no location or project specifics but plan and/or organization is acknowledged). An in-depth review was conducted on the following plans:

- Colorado Parks and Wildlife Statewide Strategies for Wetland and Riparian Conservation
- Coalition for the Upper South Platte Revised Watershed Plan
- Mosquito Range Heritage Initiative Strategic Plan
- St. Vrain Watershed Master Plan
- The River South Greenway Master Plan
- Big Thompson River Restoration Master Plan
- Poudre River Downtown Master Plan
- Upper Clear Creek Watershed Plan Update
- The Waldo Canyon Fire Master Plan for Watershed Restoration & Sediment Reduction
- The Trail Creek Watershed Master Plan for Stream Restoration & Sediment Reduction
- Chatfield Watershed Plan
- Cherry Creek Basin Water Quality Authority Watershed Plan 2012
- Bear Creek Watershed Plan
- The Lower Bear Creek Watershed Plan
- 2007 Clear Creek Watershed Report: Exploring Watershed Sustainability
- Boxelder Creek Regional Stormwater Master Plan
- Left Hand Creek Watershed Master Plan
- Big Thompson State of the Watershed 2010 Report

Plan Review

Statewide Strategies for Wetland and Riparian Conservation, Strategic Plan for the Wetland Wildlife Conservation Program	
<u>BIP Content</u>	Add to BIP Appendix. P2 directly relates to cooperation on water planning and BIP process, however no specific locations or projects are identified.
<u>Contact</u>	Terrestrial Habitat Conservation Program, Terrestrial Section, Wildlife Programs Branch, Colorado Parks and Wildlife
<u>Year</u>	July 2011, Version 2.0
<u>Geographic Coverage</u>	Colorado
<u>Source</u>	http://cpw.state.co.us/Documents/LandWater/WetlandsProgram/CDOWWetlandsProgramStrategicPlan110804.pdf
<u>Summary</u> This plan is intended to describe the specific types of conservation plans to be implemented • Location of those actions • Scale of those actions • Expected outcome of those actions for species' populations Statewide goals to statewide strategies and tasks to support these broad goals Due to lack of geospatial data and wetland assessments, it is not yet possible to characterize Colorado's wetland and riparian habitat resources at a statewide scale. This will be done systematically for smaller, basin-scale planning units as information becomes available. Specific conservation objectives (e.g.: specific habitat conservation goals and strategies) will be developed at this scale. It is expected stand-alone implementation plans will evolve for individual basins as additional planning tasks are completed and specific conservation objectives are developed.	
<u>Plan Outline</u> <i>Spatial Planning Units:</i> Program developed 10 major river basins in Colorado as planning units for wetland and riparian habitat conservation <i>Priority Wildlife Species:</i> Priority wetland/riparian wildlife species include 1) waterfowl (primarily ducks) which provide valuable recreational opportunity for hunting and viewing; and 2) declining or at-risk species that are dependent on wetland or riparian areas during part or all of their life cycle <i>Plan goals</i> 1) Improve the distribution and abundance of ducks, and opportunities for public waterfowl hunting a. Maintain or increase the quantity and quality of spring migration and duck breeding habitat, and duck breeding populations and production in breeding areas important to Colorado Eastern plains are one of the geographic areas of emphasis for spring migration areas which include seasonal marshes and riparian zones with dynamic hydroperiods that support seed-producing annual plants and "pulses" of invertebrate production; habitats must be flooded during the migration period (managed flooding systems are often necessary); low human disturbance b. Improve the quantity and quality of fall migration and wintering habitat to attract and support increased duck numbers, particularly on public areas. Eastern plains (lower South Platte River corridor, lower Arkansas River corridor, Republican River corridor, eastern plains playas, Front Range reservoirs and streams) are one of the	

geographic areas of emphasis. Habitats include those listed above as well as sloughs and reservoirs that provide open water for roosting during winter. c. Improve public access to waterfowl hunting in Colorado by increasing the number and diversity of public hunting opportunities. This goal is statewide for all ducks in appropriate habitats for duck hunting. 2) Improve the status of declining or at-risk species associated with wetlands and riparian areas Statewide Strategies and Tasks Biological Planning Conservation Design Habitat Delivery Monitoring Research Partnership Funding Granting Education and Outreach

Coalition for the Upper South Platte Revised Watershed Plan	
<u>BIP Content</u>	Add to BIP Appendix; no specific locations or projects are identified.
<u>Contact</u>	Coalition for the Upper South Platte
<u>Year</u>	2006?
<u>Geographic Coverage</u>	Upper South Platte; Strontia Springs Reservoir and reaches Continental Divide
<u>Source</u>	http://cusp.ws/ (report not found online)
<u>Summary</u> Mission of the group is to protect the water quality and environmental health of the Upper South Platte Watershed, through the cooperative efforts of watershed stakeholders, with emphasis on community values and economic sustainability.	
<u>Plan Outline</u> Potential Contaminants 1. Sediment 2. Nutrients, particularly phosphorus 3. Metals/acid mine drainage 4. Microorganisms Strategies for the Future Organizational Values Protection of ecological health and water quality • The power of coalition • Community • Voluntary action • Economic sustainability • People are our most important resource Driving Forces Strategic Imperatives Five Year Goals and Objectives Five Year Watershed Work Plan • High Priority Issues:	

• Agriculture • Wildfire • Land Use and Development • Mining • Recreation • Transportation • Water Rights • Water Systems Operations • Invasive Species Low Priority Issues: • Natural pollution sources • Solid and hazardous waste • Stormwater runoff • Small scale mining operations • Spills/illegal dumping • Underground storage tanks • Wastewater treatment plants/septic systems Watershed protection, conservation, non-point source reduction and monitoring

Mosquito Range Heritage Initiative Strategic Plan	
<u>BIP Content</u>	Add to BIP Appendix. Specific reaches and potential funding sources for recreational and environmental projects are identified; however no specific project locations are provided.
<u>Contact</u>	Alma Foundation, Park County Community Development and Tourism, The Trust for Public Land
<u>Year</u>	June 2005
<u>Geographic Coverage</u>	North to south from Hoosier Pass to Weston Pass and east to west from the Middle Fork of the South Platte River to the Park County line
<u>Source</u>	http://www.mrhi.org/images/mrstrategicplan.pdf
<u>Summary</u> Vision and Goals- Stakeholders envision the conservation of unique natural areas, preservation of historic and cultural sites and structures, a diversity of recreation uses, and new community economic opportunities. Partner's intention to work toward creative solutions that benefit all stakeholders and both private and community interests.	
<u>Plan Outline</u> Planning Area Description • Cultural and Historic Legacy • Recreation Opportunities • Important Plants and Wildlife Stakeholder Involvement Vision and Goals • Cultural and Historic Resources • Recreation Resources • Natural Resources Existing Land Ownership • Pike National Forest	

• Bureau of Land Management • Alma State Wildlife Area • Stewardship Trust • Cemetery Loop Open Space • Fourteeners and other private lands Mapping Analysis- Setting Priorities Stream Corridors • Middle Fork of the South Platte River – Montgomery Reservoir to Wheeler Lake • Middle Fork of the South Platte River – Fairplay to Alma • Buckskin Creek • Sacramento Creek • Fourmile Creek and Southern Planning Areas Alpine Areas • Hoosier Pass • Mosquito Pass Road • Pennsylvania Mountain • Mount Sherman • Mount Bross, Lincoln, and Democrat Implementing the Plan Four Implementation Goals Cooperative Leadership Staff Coordinator Implementation on Multiple Fronts • Historic and cultural resource protection • Trail and greenway projects • Land conservation • Education and interpretation • Recreation • Heritage tourism • Water quality • Wildlife crossings and corridors Case Studies • Paris Mill • Town of Alma Riverwalk Trail • Mineral Belt National Recreational Trail

St. Vrain Watershed Master Plan	
<u>BIP Content</u>	Add to stream mile representation analysis and project list.
	Reach 1: confluence of St. Vrain Creek with Boulder Creek and ends at the eastern corporate limits of Longmont; Alternative 1- Split Channel, Alternative 2- Minor Stabilization
	Reach 2: begins at the eastern corporate limits of the City of Longmont and ends at Airport Road; two different alternatives evaluated but a formal alternative analysis was not completed, continued potential project evaluation continuing in this reach

APPENDIX D – 6 – Review of South Platte Basin Master Plans

	Reach 3: begins at Airport Road and ends at Highway 36 near Lyons; drainageway crossings, pond breaches, channel restoration
	Reach 4: begins at Highway 36, continuing upstream through Lyons along both South and North St. Vrain Creeks. North St. Vrain Creek for the upstream-most Apple Valley Bridge to the confluence, the South St. Vrain River from just upstream of the Andesite Quarry downstream to the confluence, and on the main stem of St. Vrain Creek from the confluence downstream through the Town of Lyons to Highway 36 Reach 4a- North St. Vrain, channel alignment Reach 4b- South St. Vrain, channel alignment Reach 4c- St. Vrain Creek, McConnell Ponds reconstruction
	Reach 5: runs along North St. Vrain Creek and begins at Apple Valley and ends at Buttonrock Reservoir; lateral channel migration and bank erosion, sediment deposition/aggradation, sediment erosion/degradation, debris blockage throughout reach and at drainage crossings, some damage to Highway 36 and Longmont Dam Road, and damage to drainageway crossings
	Reach 6: runs along South St. Vrain Creek and begins at the choke in the canyon (just upstream of Andesite Quarry) and ends at Riverside; bank erosion, sediment deposition/aggradation, sediment erosion/degradation, debris blockages throughout the reach and at drainageway crossings, some damage to Highway 7, and damage to drainageway crossings (3.5 miles upstream of the beginning of this reach); preservation of riparian areas
	Reach 7: South St. Vrain Creek begins upstream of Riverside and continues through Raymond to the upstream limit of the Planning Area; bank erosion, sediment deposition/aggradation, sediment erosion/degradation, debris blockage throughout the reach and at drainageway crossings, some damage to Riverside Drive, and damage to drainageway crossings The plan also provides a Potential Funding Matrix
<u>Contact</u>	The St. Vrain Creek Coalition
<u>Year</u>	November 25, 2014
<u>Geographic Coverage</u>	St. Vrain Creek Watershed including the following creeks: South St. Vrain Creek, Middle St. Vrain Creek, North St. Vrain Creek, and the main stem of St. Vrain Creek; St. Vrain watershed covers 546 square miles and 54 miles of creek; begins at the continental divide and ends at the start of the western edge of the plains
<u>Source</u>	http://tiny.cc/stvraincreek
<u>Summary</u> Purpose of the master plan is to identify actions that, if implemented, will lead to a more resilient creek corridor. The master plan focused on flood risk, ecological enhancements, and community values using best available science, expertise and public and diverse stakeholder input.	
<u>Plan Outline</u> Introduction Planning Objectives Planning Area Description Data Collection Data Development Interviews with Coalition Members	

• Creek corridor evaluation and risk assessments • Geomorphological assessments • Flood risk assessments • Supplemental flood hazard analysis Unmet Needs/Recommendations • Flood hazard modeling and mapping needs • Recommendations for addressing flood hazard needs Public Engagement Process Alternative Development & Evaluation Recommendations & Conceptual Design Strategies Conceptual design strategies • Incorporate/stabilize a low flow/bankfull channel section and floodplain bench Site-specific considerations • Bank protection • Breach repairs • Increasing in-stream habitat complexity • Stream crossings <i>Reach 1:</i> confluence of St. Vrain Creek with Boulder Creek and ends at the eastern corporate limits of Longmont <i>Reach 2:</i> begins at the eastern corporate limits of the City of Longmont and ends at Airport Road <i>Reach 3:</i> begins at Airport Road and ends at Highway 36 near Lyons <i>Reach 4:</i> begins at Highway 36, continuing upstream through Lyons along both South and North St. Vrain Creeks. North St. Vrain Creek for the upstream-most Apple Valley Bridge to the confluence, the South St. Vrain River from just upstream of the Andesite Quarry downstream to the confluence, and on the main stem of St. Vrain Creek from the confluence downstream through the Town of Lyons to Highway 36 <i>Reach 5:</i> runs along North St. Vrain Creek and begins at Apple Valley and ends at Buttonrock Reservoir <i>Reach 6:</i> runs along South St. Vrain Creek and begins at the choke in the canyon (just upstream of Andesite Quarry) and ends at Riverside <i>Reach 7:</i> South St. Vrain Creek begins upstream of Riverside and continues through Raymond to the upstream limit of the Planning Area Prioritization & Implementation Prioritization and phasing of projects Floodplain management Permitting Implementation

The River South Greenway Master Plan	
<u>BIP Content</u>	Southern Platte Valley Regional Park (W. Dartmouth Avenue (southern city limits) to W. Mississippi Avenue): create regional park that serves as an anchor for the South Platte Greenway, as well as a gateway into the City and County of Denver
	Commercial Greenway Corridor (W. Mississippi Avenue to S. Tejon Street): increase visual and physical connectivity between Vanderbilt Park, Johnson Habitat Park and the River and to lessen the visual and noise impacts caused by Santa Fe Drive and I-25

APPENDIX D – 6 – Review of South Platte Basin Master Plans

	Urban Greenway Corridor (S. Tejon Street to W. 13th Avenue): provide greater residential community focus on the River by improving access and connectivity between the River, Sun Valley residences and neighborhoods farther to the west
	Central Platte Valley Event District (W. 13 th Avenue to 20th Street): extend the existing vitality and energy that characterizes Confluence Park to the north and south along the River
<u>Contact</u>	The Greenway Foundation
<u>Year</u>	January 18, 2010
<u>Geographic Coverage</u>	3.5 miles of the South Platte River within the River North Corridor
<u>Source</u>	http://www.greenwayfoundation.org/enhancements/pdf/riso.pdf
<u>Summary</u> Establishes new vision for the reach of the River, also recommends guidelines for parks; recreational, environmental, and flood control enhancements; expanded public open space; aesthetic enhancements and improved water quality within the River's channel.	
<u>Plan Outline</u> Chapter 1: The River South Greenway Master Plan Purpose and Mission of the Plan Goals The River South Greenway Vision • Southern Platte Valley Regional Park: extends from the southern city limits to W. Mississippi Avenue • Commercial Greenway Corridor: extends between W. Mississippi Avenue and S. Tejon Street • Urban Greenway Corridor: located between S. Tejon Street and W. Colfax Avenue to the north • Central Platte Valley Event District: extends between W. Colfax Avenue and 20th Street Summary of Recommendations • River health • Transportation and roadways • Public River edge • Parks and public open space • Multi-use trails and River connections • In-River recreation • Safety and security • Implementation tools Chapter 2: The Process Acknowledgements The Planning Process Objectives • Healthy • Habitable • Connected Planning Principles Next Steps Chapter 3: Existing Conditions and Opportunities River South Greenway Identity	

Existing Land Use and Ownership
Existing River Health
Existing Water Quality
Existing Riparian Habitat
Existing Aquatic Habitat
Existing Transportation and Roadways
Existing Parks and Public Open Spaces
Multi-Use Trails and River South Greenway Connections
In-River Recreation
River Safety and Security
Opportunities
Existing Conditions Maps
Opportunities Maps
Chapter 4: Detailed Recommendations
River Health
Transportation and Roadways
Public River Edge
Parks and Open Space
Proposed Parks and Public Open Space
Multi-use Trails and River Connections
In-River Recreation
Safety and Security
Implementation Tools
Summary of Recommended Projects

Big Thompson River Restoration Master Plan	
<u>BIP Content</u>	Add to BIP Appendix. No specific projects or locations identified in the plan.
<u>Contact</u>	Big Thompson River Restoration Coalition (BTRRC)
<u>Year</u>	September 23, 2014
<u>Geographic Coverage</u>	• Big Thompson River from Olympus Dam downstream to County Road 3 east of I-25 • North Fork of the Big Thompson River from the northern end of North Fork Road to the confluence with the main stem • Fish Creek from the western extents of Fox Creek Road to the confluence with the North Fork • West Creek from approximately 1/2 mile west of Devils Gulch Road along West Creek Road to the confluence with the North Fork, including approximately 1,000 feet of Devils Gulch
<u>Source</u>	http://bigthompsonriver.org/2014/10/13/full-draft-master-plan-for-the-big-thompson-river-restoration-coalition/
<u>Summary</u> Purpose of the plan is to guide stakeholders towards prioritization and implementation of stream rehabilitation projects that provide increased resiliency in our communities, economies, and river ecology. Objectives of the work include perform risk assessments and ecological improvement potential assessments; engage the various stakeholders throughout the master plan process; develop conceptual plans of proposed flood resiliency and restoration design treatments; and prioritize projects based on the assessments and approximate costs of each reach.	

Plan Outline

Introduction

Purpose of the Master Plan

Big Thompson River Restoration Coalition

Project Team

Stakeholder Engagement

Background

Project Extents

Corridor Settlement History

Hydrology

Flood Recovery

Master Plan Goals

Resiliency

Restoration

Assessments

Geomorphic Risk

Flood Risk

Aquatic Habitat Improvement Potential

Riparian Ecological Improvement Potential

Multi-Criterion Decision Analysis (MCDA)

Reach Designations

Reach Scores

Ranking and Potential Uses

Proposed Conceptual Plans

Aquatic Restoration

Riparian Restoration

Armor

Walled or Elevated Road Section

Proposed Channel

High Flow Channel

Increase Capacity

Lower/Regrade

Armored Overflow

Floodplain Bench

Improve Conveyance

Applied Treatments

Costs

Management Guidelines

Current Floodplain Management Context

Updating Technical Tools and Date for Future Floodplain Management

Floodplain Management Moving Forward

Access Bridges to Private Properties

Data Gaps

Geographic Information System (GIS) Data

Flood Risk Assessment

Moving Forward

References

Poudre River Downtown Master Plan	
<u>BIP Content</u>	Add to stream mile representation analysis.
	Reach 1: Shields Street to Salyer Natural Area
	Reach 2: Lee Martinez Park to the Museum of Discovery
	Reach 3: Museum of Discover to BNSF Railroad
	Reach 4: BNSF Railroad to Linden Street
	Reach 5: Linden Street to Lincoln Avenue
	Reach 6: Lincoln Avenue to Mulberry Street
<u>Contact</u>	City of Fort Collins
<u>Year</u>	October 2014
<u>Geographic Coverage</u>	Cache la Poudre River downtown Fort Collins reach- section from Shields Street to Mulberry (nearly 3 miles)
<u>Source</u>	http://www.fcgov.com/poudre-downtown/pdf/final-plan.pdf
<u>Summary</u> This plan integrates improvements to support many high-quality and safe recreational experiences, better protection against flood damage, and restored habitat connectivity for optimal river health and resiliency. The project is intended to design and facilitate a beautiful river corridor that provides recreation and flood mitigation, while also restoring and preserving vital habitat.	
<u>Plan Outline</u> Master Plan Overview Project Mission Stewardship-Experience-Sustainability-Education Primary Objectives Habitat • Purchase land from willing sellers • Conserve and restore the existing riparian ecosystem to promote river health and resiliency • Deliver continuous, connected aquatic and riparian habitat for fish, wildlife, trees and plants • Achieve and maintain diverse and sustainable native fish, wildlife and plant populations Recreation • As a guiding principle, trails will be located and designed with the goal of minimizing or eliminating negative impacts or damage to the environment. • Provide a mix of active and passive recreational amenities both in and along the river which encourage a safe, healthy, outdoor lifestyle. • Provide community gathering places and promote connectivity between recreational opportunities along the river corridor. Flood Mitigation • Improve public safety and protect properties from damaging floods. • Eliminate 100-year flood overtopping of College Avenue and, if possible, eliminate the 100-year flow split along Vine Drive. • Reconnect the river to its floodplain while maximizing the beneficial environmental and recreational uses of the river corridor. Outreach and Engagement Relationship to Other Planning Documents Supporting Studies Land Use Transitions	

Character Zones
 Overview of the Poudre River Downtown Master Plan
 Master Plan by Reach
 Reach 1: Shields Street to Salyer Natural Area
 Reach 2: Lee Martinez Park to the Museum of Discovery
 Reach 3: Museum of Discover to BNSF Railroad
 Reach 4: BNSF Railroad to Linden Street
 Reach 5: Linden Street to Lincoln Avenue
 Reach 6: Lincoln Avenue to Mulberry Street
 Visual Glossy/Design Guidelines
 Project Formulation, Phasing and Costs
 Appendix

Upper Clear Creek Watershed Plan Update

<u>BIP Content</u>	Add to stream mile representation analysis and project list. High Priority – Idaho Springs (HUC-0207) - o Provide effective sediment control in Trail Creek, Hukill Gulch, Virginia Canyon, and - o Spring Gulch - o Control erosion, off-site sedimentation, and dust from the Frei Quarry - o Implement CDOT SCAP Moderate-High Priority Clear Creek Headwaters (HUC-0102) - o Conduct recommended study assessments and develop mitigation projects - o Implement CDOT SCAP and USFS Watershed Restoration EA - o Remove accumulated sediment from Georgetown Lake lagoon and forebay on South - o Clear Creek - o Install passive groundwater treatment system in Silver Plume Moderate-High Priority West Clear Creek (HUC-0103) - o Conduct recommended study assessments and develop mitigation projects - o Complete SCAP implementation for U.S. 40 Berthoud Pass East and Horseshoe Bend F - o Mitigate and prevent future channel erosion from Berthoud Pass Ditch - o Control sedimentation and non-point source pollution from mines in Lion Creek - o Implement CDOT SCAP and USFS Watershed Restoration EA Moderate-High Priority North Clear Creek (HUC-0206) - o Conduct recommended study assessments and develop mitigation projects - o Control sediment impacts from Russell Gulch - o Control sediment impacts from Frei Quarry on North Clear Creek - o Steam habitat and brown trout fishery restoration - o Implement remaining OU4 remedy All Moderate and Moderate-Low Impacted HUC Areas

APPENDIX D – 6 – Review of South Platte Basin Master Plans

	- o Conduct recommended study assessments and develop mitigation projects - o Complete mine drainage treatment and reclamation at Waldorf - o Remove accumulated sediment from forebay on South Clear Creek - o Control impacts from historic mining and implement mitigation BMPs in Soda Creek - o Implement CDOT SCAP and USFS Watershed Restoration EA
<u>Contact</u>	Upper Clear Creek Watershed Association
<u>Year</u>	April 2014
<u>Geographic Coverage</u>	394 square mile drainage basin from the headwaters on the Continental Divide to the canyon mouth at the City of Golden
<u>Source</u>	Upper Clear Creek Water Association
<u>Summary</u> The plan enhances and updates the original 2006 Plan that provided a framework for the development of nonpoint source controls for key trace metals. This updated Plan expands the water quality variables beyond trace metals to provide a more comprehensive evaluation of water quality conditions in the watershed. This report uses new studies and reports since 2006 to define priority areas and potential projects that will result in overall water quality improvements in Clear Creek. This Watershed Plan update: 1) Summarizes Upper Clear Creek trace metal conditions since the previous 2006 plan 2) Expands the water quality constituent assessment to include sediment and nutrients 3) Summarizes recent studies and water quality planning documents 4) Details the current status of water quality in Clear Creek 5) Develops maps of priority areas and lists potential water quality improvement projects 6) Provides an updated Emergency Notification System list (ENS or “call down list”)	
<u>Plan Outline</u> Introduction and Background Watershed Description Previous 2006 Watershed Plan for Trace Metals Recent Studies and Planning Documents Sediment, Nutrients and Metals Clear Creek Watershed Management Agreement Sediment and Associated Contaminants Storm Event Conditions Water Quality Status Summary Stakeholder Comments and Recommendations for Water Quality Improvement Watershed Priorities for Water Quality Improvement References	
The Waldo Canyon Fire Master Plan for Watershed Restoration & Sediment Reduction	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations or projects are identified.
<u>Contact</u>	Coalition for the Upper South Platte (CUSP)
<u>Year</u>	April 26, 2013
<u>Geographic Coverage</u>	Waldo Canyon Fire area; 18,247 acres within the foothills and mountains of the Rampart Range immediately northwest of Colorado Springs in El Paso County

<u>Source</u>	http://cusp.ws/wp-content/uploads/2014/10/FinalWaldoCanyonFireMasterRestorationPlanComp.pdf
<u>Summary</u> A post-fire Watershed Assessment for River Stability and Sediment Supply (WARSSS) was completed for the Waldo Canyon Fire area. The goal of the WARSSS and master restoration plan is to direct restoration efforts in a timely manner to those watersheds and processes that represent the highest significant risk for post-fire runoff and sediment yield and potential associated downstream damage.	
<u>Plan Outline</u> Introduction Summary of the Waldo Canyon Fire WARSSS Study Restoration Design Approach & Objectives Restoration Goals and Objectives Restoration Recommendations: Hillslope Processes Restoration Treatment for Rills (Hand Work) Restoration Treatment for Exposed Soil (Hand Work or Mechanical) Restoration Treatment for Direct Sediment Routing (Hand Work or Mechanical) Surface Erosion Summary Restoration Treatments: Roads & Trails • Relocate Roads that are within Drainageways • Road Surface & Ditch-Line Erosion • Drainage Structures • Fill Erosion • Headcut Channels Intercepted by Road • Increase Maintenance Frequency • ORV Roads & Trails • Unauthorized Trails and Closed Roads • Roads & Trail Summary Restoration Concepts for Channel Processes • Stream Type Succession • Streambank Erosion • Channel Incision & Headcuts Stream Restoration Objectives Restoration Concepts Natural Channel Design (NCD) Methodology for Channel Processes Design Decision Process Typical Design Scenarios & Restoration Details for Channel Processes Flow-Related Sediment Design Scenario 1: D4 to C4 Stream Type Conversion Design Scenario 2: F4 to B4c Stream Type Conversion Design Scenario 3: G4 to B4 Stream Type Conversion Design Scenario 4: C4 Poor to C4 Stable Conversion Design Scenario 5: Tributary A4, F4b, or G4 to D4 Stream Type Conversion Design Scenario 6: Tributary F4b to B4 Stream Type Conversion Design Scenario 7: Tributary A4a+ or A4 Poor to A4a+ or A4 Stable Conversion Design Scenario 8: Tributary A4a+ or A4 to B4a Stream Type Conversion Recommendations for Hand Crew Treatments: Channel Processes	

Summary of Proposed Sediment Reduction Due to Restoration
Structures in Natural Channel Design
Developing the Restoration Master Plan
WARSSS Results
Master Plan for Hillslope Processes
Master Plan for Roads and Trails
Master Plan for Channel Processes
Summary of Sediment Reductions with the Master Plan
Discussion & Summary
References

The Trail Creek Watershed Master Plan for Stream Restoration & Sediment Reduction	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations or projects are identified.
<u>Contact</u>	Coalition for the Upper South Platte
<u>Year</u>	April 22, 2011
<u>Geographic Coverage</u>	The Trail Creek Watershed involves nearly 16mi ² of drainage area within the South Platte River drainage
<u>Source</u>	http://cusp.ws/wp-content/uploads/2014/10/TrailCreek_MasterPlanComp.pdf
<u>Summary</u> Developed for the Trail Creek Watershed to reduce the accelerated sediment yields following the Hayman Fire of 2002 based on the Watershed Assessment and River Stability and Sediment Supply (WARSSS). This plan documents the restoration objectives, priorities, various design scenarios for a diversity of sediment problems, structure designs, and earthwork computations for the various restoration scenarios.	
<u>Plan Outline</u> The Trail Creek Watershed Master Plan for Stream Restoration & Sediment Reduction Location & Description Sediment Sources by Process • Hillslope Processes • Channel Processes Restoration Design Approach, Assumptions & Objectives • Restoration Assumptions • Restoration Objectives Riparian Re-establishment Structures in Natural Channel Design Restoration Plan for Hillslope Processes Restoration Plan for Hydrologic Processes Restoration Plan for Channel Processes Typical Design Scenarios & Restoration Details for Channel Processes Typical Design Scenario 1: D4 to C4 Stream Type Conversion Typical Design Scenario 2: F4 to B4 Stream Type Conversion Typical Design Scenario 3: G4 to B4 Stream Type Conversion Typical Design Scenario 4: C4 Poor to C4 Stable Conversion Typical Design Scenario 5: Tributary F4b to D4 Conversion Typical Design Scenario 6: Tributary F4b to B4 Conversion Typical Design Scenario 7: Tributary A4a+ Poor to A4a+ Stable Typical Design Scenario 8: Tributary A4a+ to D4 Conversion	

APPENDIX D – 6 – Review of South Platte Basin Master Plans

Typical Design Scenario 9: Tributary A4a+ to B4a Conversion
Summary of Sediment Reductions with the Master Plan
Discussion & Summary
Acknowledgements
References

Chatfield Watershed Plan	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations or projects are identified.
<u>Contact</u>	Chatfield Watershed Authority
<u>Year</u>	September 2014
<u>Geographic Coverage</u>	Chatfield Reservoir is 15 miles southwest of Denver, Colorado. The Chatfield Watershed (Watershed), spans parts of Jefferson, Douglas, and El Paso Counties and includes municipalities, towns and other populated areas such as Castle Rock, Castle Pines, Larkspur, Littleton, Louviers, Perry Park, Roxborough Park, and Sedalia.
<u>Source</u>	http://chatfieldwatershedauthority.org/wp-content/uploads/2013/07/Item-2-Chatfield-Watershed-Plan_09-10-14_redlined-Final-Draft.pdf
<u>Summary</u> Watershed conditions ultimately affect the Chatfield Reservoir which serves as a flood control, water supply, fishery and recreational waterbody. TP and chl-a are known pollutants of concern in the Chatfield Reservoir the Chatfield Watershed, water quality issues related to nutrients, sedimentation, and bacteria have been attributed to nonpoint sources including: • Stormwater runoff, • Erosion from degraded stream banks, • Runoff from wildfire burn areas, • Runoff from agricultural lands, and • Leachate from poorly functioning or unmaintained septic systems.	
<u>Plan Outline</u> Executive Summary 1. Watershed Goals and Objectives 2. Watershed Description 3. Regulatory and Agency Overview 4. Water Quality and Hydrologic Conditions 5. Pollutant Source Assessment and Linkage to Water Quality 6. Identification of Management Strategies 7. Implementation Program 8. References 9. Annotated Bibliography	

Cherry Creek Basin Water Quality Authority Watershed Plan 2012	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations or projects are identified.
<u>Contact</u>	Cherry Creek Basin Water Quality Authority
<u>Year</u>	October 18, 2012
<u>Geographic Coverage</u>	Source of the Cherry Creek drainage is on the Palmer Divide, approximately 40 miles south of Cherry Creek Reservoir. The watershed is about 386mi ² , located

APPENDIX D – 6 – Review of South Platte Basin Master Plans

	primarily in Douglas County with smaller portions in Arapahoe, Elbert, and El Paso Counties
<u>Source</u>	http://www.cherrycreekbasin.org/wp-content/uploads/2014/03/Watershed-Plan-2012.pdf
<u>Summary</u> The Watershed Plan is driven by the Authority’s vision “water quality on Cherry Creek Reservoir and Watershed that optimizes beneficial uses for the public” and mission “protect beneficial uses by preserving, enhancing, and balancing water quality in Cherry Creek Reservoir and Cherry Creek Watershed.	
<u>Plan Outline</u> Chapter 1 covers the vision, mission, goals, and objectives • Understand watershed and reservoir • Preserve beneficial uses • Build projects. Implement programs. • Prevent and minimize negative water quality impacts • Invest resources wisely • Achieve numeric standard Chapter 2 reviews the watershed’s history Chapter 3 summarizes Regulation 72 Chapter 4 evaluates existing and projected conditions in the watershed Chapter 5 proposes potential management strategies Potential Pollutant Sources: agricultural operations, animal wastes, goose droppings, individual sewage disposal systems, point sources-wastewater treatment plants, stormwater- regulated, water development implications, stream erosion, point sources- other discharges Chapter 6 considers funding issues Chapter 7 describes priorities and an implementation strategy A Bibliography & Acronyms are found at the end	

Bear Creek Watershed Plan	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations or projects are identified.
<u>Contact</u>	Bear Creek Watershed Association
<u>Year</u>	Updated regularly
<u>Geographic Coverage</u>	Bear Creek watershed
<u>Source</u>	http://www.bearcreekwatershed.org/Watershed%20Plan.htm
<u>Summary</u> Bear Creek Watershed Plan is comprised of multiple documents maintained electronically (BCWA Policy 28). This Watershed Plan is being continually updated to add links to all BCWA documents as maintained in a new Master Index List. Master Index List (MIL) is listing of Program Documents that Comprise many of the Elements of the BCWA Watershed Plan - BCWA Policies, Maps, Fact Sheets, Technical Memorandum, Informational Sheets, Standard Review Papers, Rulemaking Hearing Statements, Primary Program Spreadsheets, Annual Reports, and Data Reports. It will also contain links to other sites, other PDF documents and references.	
<u>Plan Outline</u> Chapter 1- Watershed & Regulatory Framework Watershed Approach to Manage Water Resources History and Background Bear Creek Watershed Features	

Bear Creek Watershed Land Use and Demographics
Association Integration With Other Planning Efforts
Impaired Waters & Potential Use Impaired Waters
Threatened or Endangered Species
Regulatory Framework, Issues, and Processes
Chapter 2- Watershed Organization
BWCA Stakeholders and Organization
Outreach Activities and Technical Assistance
Chapter 3- Scope of Bear Creek Watershed Efforts
Pollutants of Concerns
Indicators to Measure Success
Mission and Vision of watershed Organization
Targets
Chapter 4- Information, Monitoring & Data Inventories
Information Sources and References
Monitoring Program
Existing data Inventory
Chapter 5- Data Analyses and Characteristics
Data sets and data management
Established Analysis Methodologies
Water Quality and Environmental Models and Modeling
Adopted Total Maximum Annual Load Strategy
Quantify Pollutant Loads and Load Reductions
Other Environmental Data Analysis & Characterization
Chapter 6- Management Action Strategies & Programs
Existing Management Strategies/Programs
Lakewood BCR Aeration System and Operations
EGL Operations
Stormwater Management
Invasive Species
Adaptive Management Program
Watershed Approach
Watershed Appropriate Best Management Practices
Chapter 7- Association Implementation Programs
Monitoring Plan
TMDL Program
Technical Assistance
Watershed Measures of Progress and Success
Financial Plan
Information and Education Plan
Association Annual Reports and Documents
Chapter 8- Association Adaptive Management Plan
Checklist Association Management Plan Elements
Adaptive Management Program
Reporting Processes
Total Maximum Daily Load Implementation
Concerns and Issues by Membership & Partners

APPENDIX D – 6 – Review of South Platte Basin Master Plans

The Lower Bear Creek Watershed Plan	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations or projects are identified.
<u>Contact</u>	Groundwork Denver
<u>Year</u>	Plan is under development
<u>Geographic Coverage</u>	Bear Creek is a major tributary of the South Platte River that flows from its headwaters on Mount Evans about 42 miles until it meets the South Platte in Sheridan.
<u>Source</u>	http://groundworkcolorado.org/projects/bear-creek-watershed/
<u>Summary</u> Bear Creek offers a great recreational resource to neighborhoods throughout the Denver-metro area, with extensive parks, natural areas and a paved multi-use path. Unfortunately, Lower Bear Creek is considered “impaired” for recreational use due to E. coli contamination. It is also threatened by trash, oil and grease, and nutrient pollution.	
<u>Plan Outline</u> A watershed plan for Lower Bear Creek was financially and technically supported by the Water Quality Control Division at the Colorado Department of Public Health and Environment. With the assistance of the National Park Service RTCA, Groundwork Denver facilitated a steering committee of stakeholders to guide the watershed planning effort from 2012 to 2014. Our work includes water quality and watershed data collection, stakeholder engagement through volunteerism, and community outreach and education. The watershed plan will be available online upon approval by the Colorado Department of Public Health and Environment.	

2007 Clear Creek Watershed Report: Exploring Watershed Sustainability	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations or projects are identified.
<u>Contact</u>	Clear Creek Watershed Foundation
<u>Year</u>	November 19, 2007
<u>Geographic Coverage</u>	Clear Creek Watershed west of Denver, 575mi ² from mountain peaks at its western edge on the Continental Divide down to the urbanized plains at its confluence with the South Platte River just north of Denver
<u>Source</u>	http://www.clearcreekwater.org/pdfs/CCWF-2007-report-optimized.pdf
<u>Summary</u> Documents and examines general watershed conditions and sustainable watershed management techniques that have been applied to the Clear Creek Watershed. The document is both a roadmap for the way forward and an example of real world techniques that might be applied by other watersheds throughout the arid mountain west. Our underlying thesis is: If cleaner water is good, there must be a viable market in producing sustainable results.	
<u>Plan Outline</u> Executive Summary Key Definitions Purpose of Report Introduction Water Quality and Water Quantity in the Clear Creek Watershed: An Overview Ecological Perspective Societal Perspective Economic Perspective Utilizing A Valuation Technique to Assess the Triple Bottom Line Value of Projects	

Applying Sustainable Watershed Management to the Clear Creek Watershed
Major Findings

Boxelder Creek Regional Stormwater Master Plan	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations or projects are identified.
<u>Contact</u>	Boxelder Stormwater Authority, Larimer County, Boxelder Creek Regional Alliance
<u>Year</u>	October 2006
<u>Geographic Coverage</u>	Boxelder Creek Watershed represents a vast, relatively undeveloped part of northeastern Larimer County. The drainage basins in this watershed cover approximately 260mi ² and extend from southeast Fort Collins north into Wyoming. The Boxelder Creek Watershed includes the entire Town of Wellington, a portion of the City of Fort Collins, and areas adjacent to the towns of Windsor and Timnath.
<u>Source</u>	https://larimer.org/engineering/stormwater/boxelder/History_Master_Plan.htm http://www.boxelderauthority.org/news.php?category=5
<u>Summary</u> The Master Plan for Boxelder Creek Regional Stormwater initially outlined several different approaches in addressing the flooding issues throughout the lower portions of the Boxelder Creek Basin. In a comparative analysis, the design detail and estimated costs of all the alternatives were limited since in-depth analyses of each alternative would make an all-encompassing Master Plan cost-prohibitive. Based on this limitation, the approved Master Plan included the proposal of a three-phase approach of identifying the needed improvements with the realization that modifications were likely to occur as projects were implemented and closely evaluated.	
<u>Plan Outline</u> Boxelder Watershed Area Historical Flooding Need for Improvements Addressing the Need Boxelder Stormwater master Plan Elements Phase I Improvements (1-5 years) 1. Coal Creek Flood Mitigation Project 2. Edson Stormwater Detention Facility/ Edson Reservoir 3. Middle Boxelder Creek Stream Improvements/ Middle Basin Improvements Phase II Improvements (3-8 years) These improvements are not a part of the Stormwater Authority projects: • Construction of a siphon structure along the Larimer and Weld Canal at Boxelder Creek to reduce overtopping; • Construction of an I-25 Split Flow Diversion Channel that would protect CR 42E and remove approximately 300 additional acres from the floodplain; • Improvements to Prospect Rd west of I-25; • Construction of a spillway structure on Boxelder Creek and a channel to the Cache la Poudre River. Phase III Improvements (5-15 years) These improvements are not a part of the Stormwater Authority projects • Middle Boxelder Creek road crossing improvements; and	

APPENDIX D – 6 – Review of South Platte Basin Master Plans

Cooper Slough/Mulberry Street and Lake Canal improvements Implementation Timing of Improvements

Left Hand Creek Watershed Master Plan	
<u>BIP Content</u>	Add to BIP Appendix. Specific reaches identified but no specific projects are identified.
<u>Contact</u>	Left Hand Creek Master Plan Coalition
<u>Year</u>	December 9, 2014
<u>Geographic Coverage</u>	The Planning Area for the LHCWMP was the geographic area for data collection, analysis, and all other planning activities. The Planning Area was defined in the following manner: - Left Hand Creek from its headwaters near the base of Niwot Ridge, to its confluence with James Creek; - James Creek from its headwaters near the Town of Ward (including Little James Creek east of the Sky Ranch Estates subdivision), to above the confluence with Left Hand Creek; - The main stem of Left Hand Creek below the James Creek confluence, to its confluence with St. Vrain Creek in the City of Longmont; and - That portion of the South St. Vrain Creek Watershed above the trans-basin diversion in R73W T2N Sec 36. On the plains, neither the Dry Creek north of Left Hand Creek, nor the Dry Creek south of Left Hand Creek were included in the Planning Area.
<u>Source</u>	http://lwog.org/resources/reports/Lefthand%20Watershed%20Plan.pdf
<u>Summary</u>	The Left Hand Creek Watershed Master Plan (LHCWMP) was written to address and coordinate the response to key restoration issues in the planning area in the aftermath of the September 2013 floods along the Colorado Front Range.
<u>Plan Outline</u>	Executive Summary Introduction Planning Process Watershed Background and Description Risk Assessment Project Recommendations Next Steps

Big Thompson State of the Watershed 2010 Report	
<u>BIP Content</u>	Add to BIP Appendix. No specific locations and no specific projects are identified.
<u>Contact</u>	Big Thompson Watershed Forum
<u>Year</u>	Feb 4, 2011
<u>Geographic Coverage</u>	Big Thompson watershed is located approximately 50 miles northwest of Denver, covering more than 900 mi ² east of the Continental Divide
<u>Source</u>	http://www.coloradowater.org/documents/BTWF%20State%20of%20Watershed%20Report_Final.pdf

APPENDIX D – 6 – Review of South Platte Basin Master Plans

Summary

Report presents current State of the Watershed for rivers, streams, and canals in the Big Thompson watershed. The report supports the Forum's efforts to identify and evaluate strategies for watershed management and protection in the process of maintaining a comprehensive watershed management plan.

Plan Outline

Executive Summary

1 Introduction and Background

2 Dataset and Data Treatment

3 Data Analysis

4 Findings and Recommendations

5 References

Appendix D-7 – EXCEL Output of SMRF for Example Areas

South Platte Basin Implementation Plan Output

The printouts show a small portion of each example area from the Stream Mile Representation Framework output. Additional information is available from the spreadsheet available at:

SouthPlatteBasin.com

South Platte Basin Implementation Plan Output

Stream Mile Representation Framework Output for St. Vrain Creek at Lyons.

SMRF Output
St. Vrain Creek at Lyons

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	FMEAS	TMEAS	Geographic	FocusArea	Type	Rationale	FocusAreaID	BaldEagle
00178190	North Saint Vrain Creek	00178190_000.0	0.0	0.1	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178190	North Saint Vrain Creek	00178190_000.1	0.1	0.2	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178190	North Saint Vrain Creek	00178190_000.2	0.2	0.3	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178190	North Saint Vrain Creek	00178190_000.3	0.3	0.4	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178190	North Saint Vrain Creek	00178190_000.4	0.4	0.5	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178190	North Saint Vrain Creek	00178190_000.5	0.5	0.6	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178190	North Saint Vrain Creek	00178190_000.6	0.6	0.7	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178190	North Saint Vrain Creek	00178190_000.7	0.7	0.8	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178190	North Saint Vrain Creek	00178190_000.8	0.8	0.9	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178246	South Saint Vrain Creek	00178246_000.0	0.0	0.1	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178246	South Saint Vrain Creek	00178246_000.1	0.1	0.2	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178246	South Saint Vrain Creek	00178246_000.2	0.2	0.3	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178246	South Saint Vrain Creek	00178246_000.3	0.3	0.4	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178246	South Saint Vrain Creek	00178246_000.4	0.4	0.5	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00178246	South Saint Vrain Creek	00178246_000.5	0.5	0.6	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	
00178246	South Saint Vrain Creek	00178246_000.6	0.6	0.7	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	
00178246	South Saint Vrain Creek	00178246_000.7	0.7	0.8	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	
00178246	South Saint Vrain Creek	00178246_000.8	0.8	0.9	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	
00205012	Saint Vrain Creek	00205012_031.4	31.4	31.5	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	
00205012	Saint Vrain Creek	00205012_031.5	31.5	31.6	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	
00205012	Saint Vrain Creek	00205012_031.6	31.6	31.7	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	
00205012	Saint Vrain Creek	00205012_031.7	31.7	31.8	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	
00205012	Saint Vrain Creek	00205012_031.8	31.8	31.9	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00205012	Saint Vrain Creek	00205012_031.9	31.9	32.0	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00205012	Saint Vrain Creek	00205012_032.0	32.0	32.1	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00205012	Saint Vrain Creek	00205012_032.1	32.1	32.2	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes
00205012	Saint Vrain Creek	00205012_032.2	32.2	32.2	Northern	North Saint Vrain Creek	H Recreational	Whitewater Boating Fishing	14	Yes

SMRF Output
St. Vrain Creek at Lyons

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	BrassyMinnow	ComGarterSnake	ComShiner	I	I	InstreamFlow	IowaDarter	KayakWhitewater	LakeChubStream	NLeopFrog
00178190	North Saint Vrain Creek	00178190_000.0						Yes		Yes		Yes
00178190	North Saint Vrain Creek	00178190_000.1						Yes		Yes		Yes
00178190	North Saint Vrain Creek	00178190_000.2						Yes		Yes		Yes
00178190	North Saint Vrain Creek	00178190_000.3						Yes		Yes		Yes
00178190	North Saint Vrain Creek	00178190_000.4						Yes		Yes		Yes
00178190	North Saint Vrain Creek	00178190_000.5						Yes		Yes		Yes
00178190	North Saint Vrain Creek	00178190_000.6						Yes		Yes		Yes
00178190	North Saint Vrain Creek	00178190_000.7						Yes		Yes		Yes
00178190	North Saint Vrain Creek	00178190_000.8						Yes		Yes		Yes
00178246	South Saint Vrain Creek	00178246_000.0						Yes				
00178246	South Saint Vrain Creek	00178246_000.1						Yes				
00178246	South Saint Vrain Creek	00178246_000.2						Yes				
00178246	South Saint Vrain Creek	00178246_000.3						Yes				
00178246	South Saint Vrain Creek	00178246_000.4						Yes				
00178246	South Saint Vrain Creek	00178246_000.5						Yes				
00178246	South Saint Vrain Creek	00178246_000.6						Yes				
00178246	South Saint Vrain Creek	00178246_000.7						Yes				
00178246	South Saint Vrain Creek	00178246_000.8						Yes				
00205012	Saint Vrain Creek	00205012_031.4	Yes	Yes	Yes				Yes		Yes	Yes
00205012	Saint Vrain Creek	00205012_031.5	Yes	Yes	Yes				Yes		Yes	Yes
00205012	Saint Vrain Creek	00205012_031.6	Yes	Yes	Yes				Yes		Yes	Yes
00205012	Saint Vrain Creek	00205012_031.7	Yes	Yes	Yes				Yes		Yes	Yes
00205012	Saint Vrain Creek	00205012_031.8	Yes	Yes	Yes				Yes		Yes	Yes
00205012	Saint Vrain Creek	00205012_031.9	Yes	Yes	Yes				Yes		Yes	Yes
00205012	Saint Vrain Creek	00205012_032.0	Yes	Yes	Yes				Yes		Yes	Yes
00205012	Saint Vrain Creek	00205012_032.1	Yes	Yes	Yes				Yes		Yes	Yes
00205012	Saint Vrain Creek	00205012_032.2	Yes	Yes	Yes				Yes		Yes	Yes

SMRF Output
St. Vrain Creek at Lyons

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	NRedbellyDace	OccPrebMouse	OvrPrebMouse	RaftWhitewater	RivOtterSight	SigPlants	Stonecat	StreamFishing	WoodFrog
00178190	North Saint Vrain Creek	00178190_000.0			Yes	Yes	Yes	Yes		Yes	Yes
00178190	North Saint Vrain Creek	00178190_000.1			Yes	Yes		Yes		Yes	Yes
00178190	North Saint Vrain Creek	00178190_000.2			Yes	Yes		Yes		Yes	Yes
00178190	North Saint Vrain Creek	00178190_000.3			Yes	Yes		Yes		Yes	Yes
00178190	North Saint Vrain Creek	00178190_000.4			Yes	Yes		Yes		Yes	Yes
00178190	North Saint Vrain Creek	00178190_000.5			Yes	Yes		Yes		Yes	Yes
00178190	North Saint Vrain Creek	00178190_000.6			Yes	Yes		Yes		Yes	Yes
00178190	North Saint Vrain Creek	00178190_000.7			Yes	Yes		Yes		Yes	Yes
00178190	North Saint Vrain Creek	00178190_000.8			Yes	Yes		Yes		Yes	Yes
00178246	South Saint Vrain Creek	00178246_000.0			Yes		Yes			Yes	
00178246	South Saint Vrain Creek	00178246_000.1			Yes		Yes			Yes	
00178246	South Saint Vrain Creek	00178246_000.2			Yes		Yes			Yes	
00178246	South Saint Vrain Creek	00178246_000.3			Yes		Yes			Yes	
00178246	South Saint Vrain Creek	00178246_000.4			Yes		Yes			Yes	
00178246	South Saint Vrain Creek	00178246_000.5			Yes		Yes			Yes	
00178246	South Saint Vrain Creek	00178246_000.6			Yes		Yes			Yes	
00178246	South Saint Vrain Creek	00178246_000.7			Yes		Yes			Yes	
00178246	South Saint Vrain Creek	00178246_000.8			Yes		Yes			Yes	
00205012	Saint Vrain Creek	00205012_031.4	Yes	Yes	Yes				Yes	Yes	
00205012	Saint Vrain Creek	00205012_031.5	Yes	Yes	Yes				Yes	Yes	
00205012	Saint Vrain Creek	00205012_031.6	Yes	Yes	Yes				Yes	Yes	
00205012	Saint Vrain Creek	00205012_031.7	Yes	Yes	Yes				Yes	Yes	
00205012	Saint Vrain Creek	00205012_031.8	Yes	Yes	Yes				Yes	Yes	
00205012	Saint Vrain Creek	00205012_031.9	Yes	Yes	Yes				Yes	Yes	
00205012	Saint Vrain Creek	00205012_032.0	Yes	Yes	Yes				Yes	Yes	
00205012	Saint Vrain Creek	00205012_032.1	Yes	Yes	Yes				Yes	Yes	
00205012	Saint Vrain Creek	00205012_032.2	Yes	Yes	Yes		Yes		Yes	Yes	

SMRF Output
St. Vrain Creek at Lyons

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	Segment_No	ISF_3	ISF_4	ISF_5	ISF_ID	Basin	PRJ_4	PRJ_5	PRJ_8	ProjectID	SGHist_usgss
00178190	North Saint Vrain Creek	00178190_000.0	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178190	North Saint Vrain Creek	00178190_000.1	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178190	North Saint Vrain Creek	00178190_000.2	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178190	North Saint Vrain Creek	00178190_000.3	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178190	North Saint Vrain Creek	00178190_000.4	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178190	North Saint Vrain Creek	00178190_000.5	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178190	North Saint Vrain Creek	00178190_000.6	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178190	North Saint Vrain Creek	00178190_000.7	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178190	North Saint Vrain Creek	00178190_000.8	14		1-87CW282		1-87CW282	South Platte	1-87CW282		803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.0	14			1-87CW283	1-87CW283	South Platte		1-87CW283	803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.1	14			1-87CW283	1-87CW283	South Platte		1-87CW283	803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.2	14			1-87CW283	1-87CW283	South Platte		1-87CW283	803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.3	14			1-87CW283	1-87CW283	South Platte		1-87CW283	803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.4	14			1-87CW283	1-87CW283	South Platte		1-87CW283	803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.5	14			1-87CW283	1-87CW283	South Platte		1-87CW283	803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.6	14			1-87CW283	1-87CW283	South Platte		1-87CW283	803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.7	14	1-87CW278		1-87CW283	1-87CW283	South Platte		1-87CW283	803	803,1-87C	
00178246	South Saint Vrain Creek	00178246_000.8	14	1-87CW278			1-87CW278	South Platte		1-87CW283	803	803,1-87C	
00205012	Saint Vrain Creek	00205012_031.4	14					South Platte			803	803,803	
00205012	Saint Vrain Creek	00205012_031.5	14					South Platte			803	803	
00205012	Saint Vrain Creek	00205012_031.6	14					South Platte			803	803	
00205012	Saint Vrain Creek	00205012_031.7	14					South Platte			803	803,803	
00205012	Saint Vrain Creek	00205012_031.8	14					South Platte			803	803	06724000
00205012	Saint Vrain Creek	00205012_031.9	14					South Platte			803	803,803	
00205012	Saint Vrain Creek	00205012_032.0	14					South Platte			803	803	
00205012	Saint Vrain Creek	00205012_032.1	14					South Platte			803	803	
00205012	Saint Vrain Creek	00205012_032.2	14					South Platte			803	803	

SMRF Output
St. Vrain Creek at Lyons

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	SGHist_dwra	SGHist_statname	SGHist_meas_act	SGReal_usgsstatid	SGReal_dwrabbrev
00178190	North Saint Vrain Creek	00178190_000.0					
00178190	North Saint Vrain Creek	00178190_000.1					
00178190	North Saint Vrain Creek	00178190_000.2					
00178190	North Saint Vrain Creek	00178190_000.3					
00178190	North Saint Vrain Creek	00178190_000.4					
00178190	North Saint Vrain Creek	00178190_000.5					
00178190	North Saint Vrain Creek	00178190_000.6					
00178190	North Saint Vrain Creek	00178190_000.7					
00178190	North Saint Vrain Creek	00178190_000.8					
00178246	South Saint Vrain Creek	00178246_000.0					
00178246	South Saint Vrain Creek	00178246_000.1					
00178246	South Saint Vrain Creek	00178246_000.2					
00178246	South Saint Vrain Creek	00178246_000.3					
00178246	South Saint Vrain Creek	00178246_000.4					
00178246	South Saint Vrain Creek	00178246_000.5					
00178246	South Saint Vrain Creek	00178246_000.6					
00178246	South Saint Vrain Creek	00178246_000.7					
00178246	South Saint Vrain Creek	00178246_000.8					
00205012	Saint Vrain Creek	00205012_031.4					
00205012	Saint Vrain Creek	00205012_031.5					
00205012	Saint Vrain Creek	00205012_031.6					
00205012	Saint Vrain Creek	00205012_031.7					
00205012	Saint Vrain Creek	00205012_031.8	SVCLYOCO	ST. VRAIN CREEK AT LYONS, CO.	31.807484	06724000	SVCLYOCO
00205012	Saint Vrain Creek	00205012_031.9					
00205012	Saint Vrain Creek	00205012_032.0					
00205012	Saint Vrain Creek	00205012_032.1					
00205012	Saint Vrain Creek	00205012_032.2					

SMRF Output
St. Vrain Creek at Lyons

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	SGReal_statname	SGReal_meas_act	DivWDID	DivName	DivMEAS_ACT	DivWDID_2
00178190	North Saint Vrain Creek	00178190_000.0			0501040	MILLER DIVERSION	0.093695	
00178190	North Saint Vrain Creek	00178190_000.1						
00178190	North Saint Vrain Creek	00178190_000.2						
00178190	North Saint Vrain Creek	00178190_000.3						
00178190	North Saint Vrain Creek	00178190_000.4						
00178190	North Saint Vrain Creek	00178190_000.5						
00178190	North Saint Vrain Creek	00178190_000.6						
00178190	North Saint Vrain Creek	00178190_000.7						
00178190	North Saint Vrain Creek	00178190_000.8						
00178246	South Saint Vrain Creek	00178246_000.0						
00178246	South Saint Vrain Creek	00178246_000.1						
00178246	South Saint Vrain Creek	00178246_000.2						
00178246	South Saint Vrain Creek	00178246_000.3						
00178246	South Saint Vrain Creek	00178246_000.4						
00178246	South Saint Vrain Creek	00178246_000.5						
00178246	South Saint Vrain Creek	00178246_000.6						
00178246	South Saint Vrain Creek	00178246_000.7						
00178246	South Saint Vrain Creek	00178246_000.8						
00205012	Saint Vrain Creek	00205012_031.4						
00205012	Saint Vrain Creek	00205012_031.5						
00205012	Saint Vrain Creek	00205012_031.6			0500526	LONGMONT SOUTH PIPELINE	0.784191	
00205012	Saint Vrain Creek	00205012_031.7			0500519	REESE STILES DITCH	0.842252	
00205012	Saint Vrain Creek	00205012_031.8	SAINT VRAIN CREEK AT LYONS, CO	31.807484				
00205012	Saint Vrain Creek	00205012_031.9						
00205012	Saint Vrain Creek	00205012_032.0			0502408	BOULDER FEEDER TO SUPPLY CANAL	32.038546	
00205012	Saint Vrain Creek	00205012_032.1						
00205012	Saint Vrain Creek	00205012_032.2						

SMRF Output
St. Vrain Creek at Lyons

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	DivName_2	DivMEAS_ACT_2	DivMEAS_ACT_6	
00178190	North Saint Vrain Creek	00178190_000.0				
00178190	North Saint Vrain Creek	00178190_000.1				
00178190	North Saint Vrain Creek	00178190_000.2				
00178190	North Saint Vrain Creek	00178190_000.3				
00178190	North Saint Vrain Creek	00178190_000.4				
00178190	North Saint Vrain Creek	00178190_000.5				
00178190	North Saint Vrain Creek	00178190_000.6				
00178190	North Saint Vrain Creek	00178190_000.7				
00178190	North Saint Vrain Creek	00178190_000.8				
00178246	South Saint Vrain Creek	00178246_000.0				
00178246	South Saint Vrain Creek	00178246_000.1				
00178246	South Saint Vrain Creek	00178246_000.2				
00178246	South Saint Vrain Creek	00178246_000.3				
00178246	South Saint Vrain Creek	00178246_000.4				
00178246	South Saint Vrain Creek	00178246_000.5				
00178246	South Saint Vrain Creek	00178246_000.6				
00178246	South Saint Vrain Creek	00178246_000.7				
00178246	South Saint Vrain Creek	00178246_000.8				
00205012	Saint Vrain Creek	00205012_031.4				
00205012	Saint Vrain Creek	00205012_031.5				
00205012	Saint Vrain Creek	00205012_031.6	HIGHLAND DITCH LEFT IN S	31.615406		
00205012	Saint Vrain Creek	00205012_031.7				
00205012	Saint Vrain Creek	00205012_031.8				
00205012	Saint Vrain Creek	00205012_031.9				
00205012	Saint Vrain Creek	00205012_032.0				
00205012	Saint Vrain Creek	00205012_032.1				
00205012	Saint Vrain Creek	00205012_032.2				

South Platte Basin Implementation Plan Output

Stream Mile Representation Framework Output for the South Platte River above Elevenmile Reservoir.

SMRF Output
South Platte River above Elevenmile

[illegible]

SMRF Output
South Platte River above Elevenmile

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	GMTTroutStream	IowaDarter	LakeLevel	RarePlants	StreamFishing	Waterfowl	Segment_No	Basin	PRJ_20
00201759	South Platte River	00201759_334.5	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_334.6	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_334.7	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_334.8	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_334.9	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.0	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.1	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.2	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.3	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.4	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.5	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.6	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.7	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.8	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_335.9	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_336.0	Yes	Yes		Yes	Yes		7	South Platte	
00201759	South Platte River	00201759_336.1	Yes	Yes		Yes	Yes	Yes	7	South Platte	
00201759	South Platte River	00201759_336.2	Yes	Yes		Yes	Yes	Yes	7	South Platte	
00201759	South Platte River	00201759_336.3	Yes	Yes		Yes	Yes	Yes	7	South Platte	
00201759	South Platte River	00201759_336.4	Yes	Yes		Yes	Yes	Yes	7	South Platte	
00201759	South Platte River	00201759_336.5	Yes	Yes	Yes	Yes	Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_336.6	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_336.7	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_336.8	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_336.9	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_337.0	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_337.1	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_337.2	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_337.3	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_337.4	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104
00201759	South Platte River	00201759_337.5	Yes	Yes	Yes		Yes	Yes	7	South Platte	CDOW_104

SMRF Output
South Platte River above Elevenmile

[illegible]

SMRF Output
South Platte River above Elevenmile

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	SGHist_dwrabbrev	SGHist_statname	SGHist_meas_act	SGReal_usgsstatid	SGReal_dwrabbrev
00201759	South Platte River	00201759_334.5					
00201759	South Platte River	00201759_334.6					
00201759	South Platte River	00201759_334.7					
00201759	South Platte River	00201759_334.8					
00201759	South Platte River	00201759_334.9					
00201759	South Platte River	00201759_335.0					
00201759	South Platte River	00201759_335.1					
00201759	South Platte River	00201759_335.2					
00201759	South Platte River	00201759_335.3					
00201759	South Platte River	00201759_335.4					
00201759	South Platte River	00201759_335.5					
00201759	South Platte River	00201759_335.6					
00201759	South Platte River	00201759_335.7					
00201759	South Platte River	00201759_335.8					
00201759	South Platte River	00201759_335.9					
00201759	South Platte River	00201759_336.0	PLAHARCO	S PLATTE RIV AB 11-MILE CANYON RES, NR HARTSEL, CO	336.077464	06695000	PLAHARCO
00201759	South Platte River	00201759_336.1					
00201759	South Platte River	00201759_336.2					
00201759	South Platte River	00201759_336.3					
00201759	South Platte River	00201759_336.4					
00201759	South Platte River	00201759_336.5					
00201759	South Platte River	00201759_336.6					
00201759	South Platte River	00201759_336.7					
00201759	South Platte River	00201759_336.8					
00201759	South Platte River	00201759_336.9					
00201759	South Platte River	00201759_337.0					
00201759	South Platte River	00201759_337.1					
00201759	South Platte River	00201759_337.2					
00201759	South Platte River	00201759_337.3					
00201759	South Platte River	00201759_337.4					
00201759	South Platte River	00201759_337.5					

SMRF Output
South Platte River above Elevenmile

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	SGReal_statname	SGReal_meas_act	DivWDID	DivName	DivMEAS_ACT
00201759	South Platte River	00201759_334.5					
00201759	South Platte River	00201759_334.6					
00201759	South Platte River	00201759_334.7			2300715	COMO JIM DITCH	334.724171
00201759	South Platte River	00201759_334.8					
00201759	South Platte River	00201759_334.9					
00201759	South Platte River	00201759_335.0					
00201759	South Platte River	00201759_335.1					
00201759	South Platte River	00201759_335.2					
00201759	South Platte River	00201759_335.3					
00201759	South Platte River	00201759_335.4					
00201759	South Platte River	00201759_335.5					
00201759	South Platte River	00201759_335.6					
00201759	South Platte River	00201759_335.7					
00201759	South Platte River	00201759_335.8					
00201759	South Platte River	00201759_335.9					
00201759	South Platte River	00201759_336.0	SOUTH PLATTE RIVER ABOVE ELEVENMILE RESERVOIR	336.077464			
00201759	South Platte River	00201759_336.1					
00201759	South Platte River	00201759_336.2			2300714	ROGERS NORTH DITCH	336.231343
00201759	South Platte River	00201759_336.3					
00201759	South Platte River	00201759_336.4					
00201759	South Platte River	00201759_336.5					
00201759	South Platte River	00201759_336.6					
00201759	South Platte River	00201759_336.7					
00201759	South Platte River	00201759_336.8					
00201759	South Platte River	00201759_336.9			2300713	ROGERS SOUTH DITCH	336.944705
00201759	South Platte River	00201759_337.0					
00201759	South Platte River	00201759_337.1					
00201759	South Platte River	00201759_337.2					
00201759	South Platte River	00201759_337.3					
00201759	South Platte River	00201759_337.4					
00201759	South Platte River	00201759_337.5					

South Platte Basin Implementation Plan Output

Stream Mile Representation Framework Output for the South Platte River below Chatfield Reservoir.

SMRF Output
South Platte River below Chatfield

[illegible]

SMRF Output
South Platte River below Chatfield

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	ComShiner	DucksUnProjects	FlatwaterBoating	IowaDarter	LakeFishing	NLeopFrog	NRedbellyDace	OvrPrebMouse	RaftWhitewater
00201759	South Platte River	00201759_255.4	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_255.5	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_255.6	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_255.7	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_255.8	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_255.9	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.0	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.1	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.2	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.3	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.4	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.5	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.6	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.7	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.8	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_256.9	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_257.0	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_257.1	Yes			Yes				Yes	Yes
00201759	South Platte River	00201759_257.2	Yes			Yes				Yes	
00201759	South Platte River	00201759_257.3	Yes			Yes				Yes	
00201759	South Platte River	00201759_257.4	Yes			Yes				Yes	
00201759	South Platte River	00201759_257.5	Yes			Yes				Yes	
00201759	South Platte River	00201759_257.6	Yes			Yes				Yes	
00201759	South Platte River	00201759_257.7	Yes			Yes				Yes	
00201759	South Platte River	00201759_257.8	Yes			Yes				Yes	
00201759	South Platte River	00201759_257.9	Yes			Yes				Yes	
00201759	South Platte River	00201759_258.0	Yes			Yes				Yes	
00201759	South Platte River	00201759_258.1	Yes	Yes		Yes	Yes	Yes	Yes	Yes	
00201759	South Platte River	00201759_258.2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

SMRF Output
South Platte River below Chatfield

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	RarePlants	RecCorridor	SigPlants	Segment_No	Basin	PRJ_7	PRJ_8	PRJ_9	PRJ_10	PRJ_11	PRJ_12
00201759	South Platte River	00201759_255.4	Yes	Yes									
00201759	South Platte River	00201759_255.5	Yes	Yes									
00201759	South Platte River	00201759_255.6	Yes	Yes									
00201759	South Platte River	00201759_255.7	Yes	Yes									
00201759	South Platte River	00201759_255.8	Yes	Yes									
00201759	South Platte River	00201759_255.9	Yes	Yes									
00201759	South Platte River	00201759_256.0	Yes	Yes									
00201759	South Platte River	00201759_256.1	Yes	Yes									
00201759	South Platte River	00201759_256.2	Yes	Yes									
00201759	South Platte River	00201759_256.3	Yes	Yes									
00201759	South Platte River	00201759_256.4	Yes	Yes									
00201759	South Platte River	00201759_256.5	Yes	Yes									
00201759	South Platte River	00201759_256.6	Yes	Yes									
00201759	South Platte River	00201759_256.7	Yes	Yes									
00201759	South Platte River	00201759_256.8	Yes	Yes		4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_256.9	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.0	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.1	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.2	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.3	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.4	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.5	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.6	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.7	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.8	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_257.9	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_258.0	Yes			4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_258.1	Yes		Yes	4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35
00201759	South Platte River	00201759_258.2	Yes		Yes	4	South Platte	290	291	CDOW_31	CDOW_32	CDOW_34	CDOW_35

SMRF Output
South Platte River below Chatfield

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	PRJ_13	ProjectID	SGHist_usgsstatid	SGHist_dwrabbrev	SGHist_statname	SGHist_meas_act	...
00201759	South Platte River	00201759_255.4							
00201759	South Platte River	00201759_255.5							
00201759	South Platte River	00201759_255.6							
00201759	South Platte River	00201759_255.7							
00201759	South Platte River	00201759_255.8							
00201759	South Platte River	00201759_255.9							
00201759	South Platte River	00201759_256.0							
00201759	South Platte River	00201759_256.1							
00201759	South Platte River	00201759_256.2							
00201759	South Platte River	00201759_256.3							
00201759	South Platte River	00201759_256.4							
00201759	South Platte River	00201759_256.5							
00201759	South Platte River	00201759_256.6							
00201759	South Platte River	00201759_256.7							
00201759	South Platte River	00201759_256.8		290,CDOW					
00201759	South Platte River	00201759_256.9		290,CDOW					
00201759	South Platte River	00201759_257.0		290,CDOW					
00201759	South Platte River	00201759_257.1		290,CDOW					
00201759	South Platte River	00201759_257.2		290,CDOW					
00201759	South Platte River	00201759_257.3		290,CDOW					
00201759	South Platte River	00201759_257.4		290,CDOW					
00201759	South Platte River	00201759_257.5		290,CDOW					
00201759	South Platte River	00201759_257.6		290,CDOW					
00201759	South Platte River	00201759_257.7		290,CDOW					
00201759	South Platte River	00201759_257.8		290,CDOW		PLACHACO	SOUTH PLATTE RIVER BELOW CHATFIELD RESERVOIR	257.895110	
00201759	South Platte River	00201759_257.9		CDOW_34					
00201759	South Platte River	00201759_258.0		CDOW_34					
00201759	South Platte River	00201759_258.1		CDOW_34					
00201759	South Platte River	00201759_258.2	Stewardship_22290	Stewardsh					

SMRF Output
South Platte River below Chatfield

GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	DivWDID	DivName	DivMEAS_ACT	DivWDID_2	DivName_2	DivMEAS_ACT_2
00201759	South Platte River	00201759_255.4						
00201759	South Platte River	00201759_255.5	0801999	LITTLETON BOAT CHUTE NO 4	255.533628			
00201759	South Platte River	00201759_255.6						
00201759	South Platte River	00201759_255.7						
00201759	South Platte River	00201759_255.8						
00201759	South Platte River	00201759_255.9						
00201759	South Platte River	00201759_256.0						
00201759	South Platte River	00201759_256.1						
00201759	South Platte River	00201759_256.2						
00201759	South Platte River	00201759_256.3						
00201759	South Platte River	00201759_256.4	0801019	ENGLEWOOD PUMP PLANT	256.497522			
00201759	South Platte River	00201759_256.5						
00201759	South Platte River	00201759_256.6						
00201759	South Platte River	00201759_256.7	0801997	LITTLETON BOAT CHUTE NO 10	256.716711			
00201759	South Platte River	00201759_256.8						
00201759	South Platte River	00201759_256.9						
00201759	South Platte River	00201759_257.0						
00201759	South Platte River	00201759_257.1	0801023	SOUTH PLATTE PUMP	257.122285			
00201759	South Platte River	00201759_257.2						
00201759	South Platte River	00201759_257.3						
00201759	South Platte River	00201759_257.4						
00201759	South Platte River	00201759_257.5						
00201759	South Platte River	00201759_257.6						
00201759	South Platte River	00201759_257.7						
00201759	South Platte River	00201759_257.8						
00201759	South Platte River	00201759_257.9						
00201759	South Platte River	00201759_258.0	0801007	LAST CHANCE DITCH 2	258.046842	0801009	NEVADA DITCH	258.042676
00201759	South Platte River	00201759_258.1	0802914	LAST CHANCE DITCH 2 LEFT	258.152092			
00201759	South Platte River	00201759_258.2	0801008	CITY DITCH PL	258.270117	0802648	CHATFIELD FISH UNIT AUG	258.297068

South Platte Basin Implementation Plan Output

Stream Mile Representation Framework Output for the South Platte River at Balzac.

SMRF Output
South Platte River at Balzac

[illegible]

SMRF Output
South Platte River at Balzac

GNIS_ID	ComGar	Snake	(Ducks	UnProjects	IowaDarter	I	(	(	PlaMinnow	I	SigPlants	:	Waterfowl	Segment_No	Basin	PRJ_1	PRJ_2	PRJ_3	PRJ_6	PRJ_7
00201759	Yes		Yes		Yes				Yes					1	South Platte	309	310	311	CDOW_31	CDOW_32
00201759	Yes		Yes		Yes				Yes					1	South Platte	309	310	311	CDOW_31	CDOW_32
00201759	Yes		Yes		Yes				Yes					1	South Platte	309	310	311	CDOW_31	CDOW_32
00201759	Yes		Yes		Yes				Yes					1	South Platte	309	310	311	CDOW_31	CDOW_32
00201759	Yes		Yes		Yes				Yes					1	South Platte	309	310	311	CDOW_31	CDOW_32
00201759	Yes		Yes		Yes				Yes					1	South Platte	309	310	311	CDOW_31	CDOW_32
00201759	Yes		Yes		Yes				Yes					1	South Platte	309	310	311	CDOW_31	CDOW_32
00201759	Yes		Yes		Yes				Yes					1	South Platte	309	310	311	CDOW_31	CDOW_32
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Source Water Route Framework And Stream Mile Processing

TO: DWR File
FROM: Chris Brown, GIS Program Manager, Colorado Division of Water Resources
SUBJECT: Source Water Route Framework and Stream Mile Processing
DATE: December 2014
CC: Doug Stenzel

1. Introduction

The Colorado Division of Water Resources has produced the Source Water Route Framework for use as a base GIS layer to standardize the calculation of stream mile location for diversion structures, stream gages, stream confluences and other water features related to water administration. This dataset is comprised of a direct extract from the National Hydrography Dataset (NHD) with some added content to facilitate the building of the routes. This document will discuss the following topics related to the development and use of this dataset...

- *Production of the Source Water Route Framework*
- *Placing of features along the Source Water Route Framework*
- *Stream Mile calculation results*
- *Maintenance and Refresh Strategy*

2. Production of the Source Water Route Framework

The Source Water Route Framework essentially an extract of certain NHDFlowline features from the National Hydrography Dataset (NHD). In particular, CDWR used the 'High Resolution' (1:24k) version of this dataset dated 5/16/2014. The following discusses the development of the dataset:

2.1. Selection of the National Hydrography Dataset Version

CDWR is the steward of the High Resolution version of the NHD in Colorado. As a result, CDWR has a vested interest in the use of this version of the dataset. In being the steward, CDWR knows when the dataset is updated, when certain global maintenance activities are performed and a general overall sense of the quality of this version of the dataset.

2.1.1 Extraction of NHDFlowline Data

Part of the native schema of the NHD includes two fields, GNIS_Name and GNIS_ID. These attributes are from the Board of Geographic Names database which is the official repository for names of geographic features in the United States. Within the data, GNIS_Name is not unique. However, GNIS_ID is unique and allows for the distinction between like named features. To begin the building of the Source Water Route Framework, all named NHDFlowline features in the sub category of 'stream/river' within the State of Colorado are extracted to a draft file geodatabase (FGB). In addition, a number of unnamed stream/river features that have been identified as water right source waters are also extracted and imported to the draft file geodatabase. These features are unnamed because they represent

hypographic features (i.e. gulches, draws, canyons) and not hydrographic features. Currently, only hydrographic features can be named in the official version of the NHD.

2.1.2 Attribution of Unnamed Features

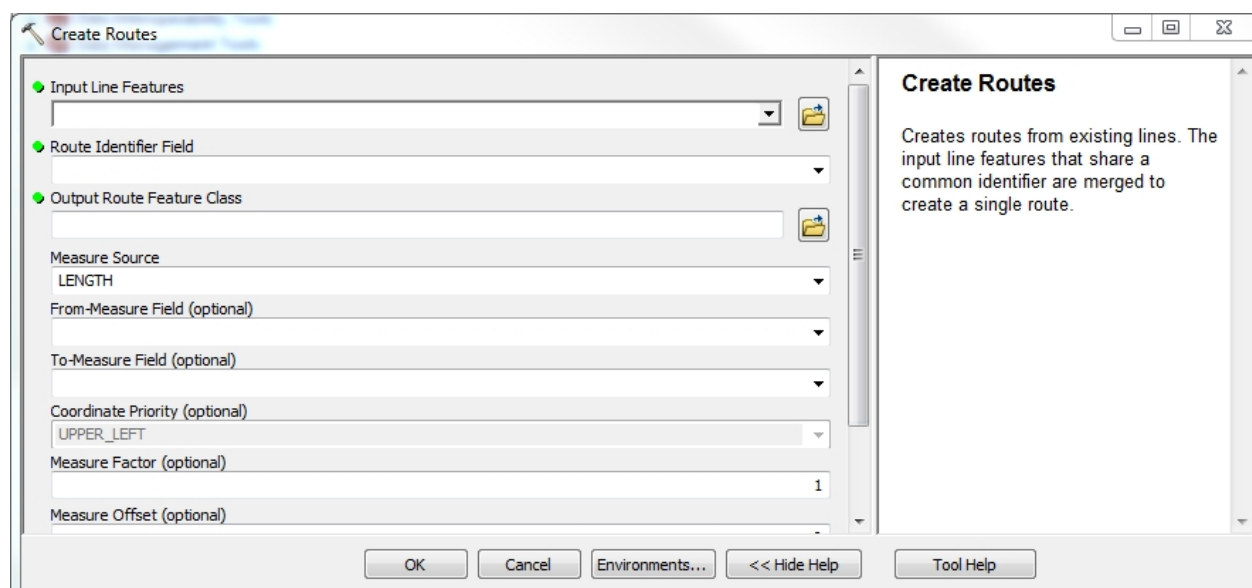
In many cases, an official name exists for the unnamed features within the NHDFlowline extract. Generally, if the feature is named on the 1:24k USGS map, it will have an official GNIS_Name and GNIS_ID. Where this case is applicable, CDWR has used the hypographic GNIS_Name and GNIS_ID to name the NHDFlowline in the draft dataset. In other cases, unnamed features do not have an official GNIS_Name or GNIS_ID. In these cases, CDWR has attributed those NHDFlowlines with an artificial GNIS_Name and GNIS_ID. The GNIS_Name is derived from water right decrees in the vicinity of the NHDFlowline feature which name their source water stream. GNIS_ID is attributed with a fake GNIS_ID that mimics the 8 character string format of actual GNIS_IDs. Once this attribution is complete and there are no unnamed stream segments in the draft dataset, the route data can be built.

2.2 Explanation of Route Data

Route data in ArcGIS are composed of Polyline M features. Polyline M features contain 'measures' in the data that allow for a calculation of distance along a polyline. The values depend on the orientation of the line and increment from the beginning to the end of the line. Routes are defined by Route ID (RID) that defines the breadth of an individual route. Features can be placed along a route and attributed with a measure showing its sequential location on the route.

2.2.1 Building of Route Data

Route data is built using the Linear Referencing Tool / Create Routes. Input Line Features are the extracted and attributed NHDFlowline features. Route Identifier Field is GNIS_ID. Output Route Feature Class is a previously defined Polyline M feature class within the draft FGB. Measure Source is the native length of the polyline which in this case is calculated in meters. The optional parameters are left as is.

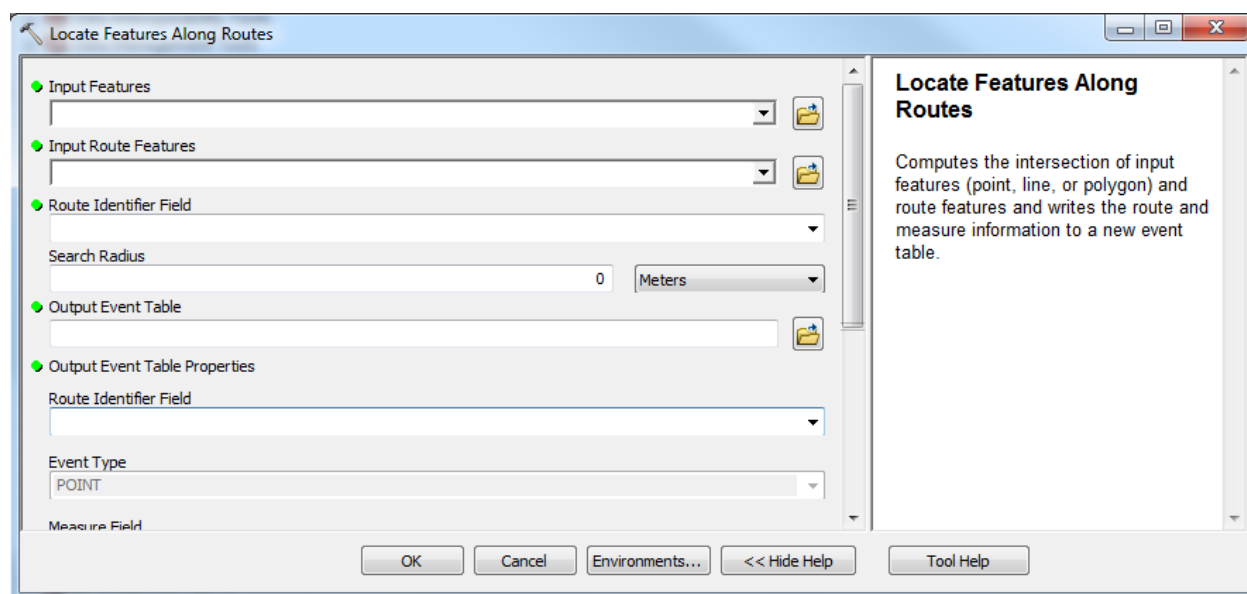


The result of using this tool creates new line features as route data which can be described as many individual line features dissolved by their common attribute (GNIS_ID) into one singular line feature with dynamic distance measures incrementing along the line from beginning to end.

After the initial draft dataset is completed, the routes need to be checked for correct alignment and in many cases, a route maybe flowing in the wrong direction. This is simply fixed by flipping the route feature and re-setting the measure of the downstream end to zero. Once this draft route data has been quality controlled, it is loaded into a fresh FGB for locating of features along the routes.

3. Locating of Features along Routes

Point features can be located along routes using the using the Linear Referencing Tool / Locate Features Along Routes. Input Features are the points to be located along the route. Input Route Features is the route layer to locate the point along. Route Identifier Field is GNIS_ID within the route layer table. Search radius is left to zero for features snapped to the route data.



A table is produced as a result of running this tool. Three fields are appended to the front of the input feature data's table...RID, MEAS and Distance. RID is the route id (GNIS_ID) of the route feature. MEAS is the measured location of the feature on the route and Distance is the distance of the point, in a straight line, to the route.

3.1 Locating of CDWR Data along Routes

CDWR point data may or may not fall directly on the generated route features. As a result, CDWR developed a custom ArcGIS tool that locates CDWR point data by first selecting the route feature the CDWR point is related to and determining its stream mile location. The tool iterates through the data, making these associations to choose the correct source water for each point. This is necessary because the basic tool will snap points to the closest route regardless of whether that route is the actual source water for a particular water right.

3.2 Stream Mile Confluence Points Dataset

CDWR has produced a companion dataset to the Source Water Route Framework. The Stream Mile Confluence point dataset is composed of a set of points used to generate the stream mile location of confluence points between main streams and their tributary streams. These points are snapped to the Source Water Route Framework and are attributed with stream mile location using the 'Locate Features Along Routes' tool in ArcGIS.

4. Stream Mile Calculation Results

Stream mile calculation results are delivered as a table in the file geodatabase. Three fields are appended to the front of the input point feature's data schema as mentioned above. In DWR's case, the 'MEAS' field is calculated in meters. The value is converted to miles and the resulting value is captured in the field 'Strm_Mile'. The 'Distance' field can be used as a quality control metric since this value is a calculation of the distance a point traveled to be snapped to its source water. CDWR will use this value to either potentially update the location of a feature or evaluate if the feature has been coded with the correct water source. The farther a feature is from its source water, the accuracy of the feature's location or coded source water is more suspect.

5. Maintenance and Refresh Strategy

As new water right source waters are identified, new routes will be added to the Source Water Route Framework. The process is simple. A new source water stream is identified and the data is extracted from the NHD. A determination is made regarding the GNIS_Name and GNIS_ID of the source water as whether to use an existing GNIS_Name and GNIS_ID or create a DWR version. Once the matter is settled, a single route is developed from the native data and loaded into the Source Water Route Framework. If the stream is tributary to another stream, a confluence point is generated to calculate the stream mile of that confluence. At this point, the route is fully incorporated into the Source Water Route Framework.

As the NHD evolves and more accurate data is developed, the Source Water Route Framework will need to be refreshed from time to time. CDWR will know when wholesale changes have been made to the native NHD that necessitate a refresh of the Source Water Route Framework. Depending on the breadth of change, CDWR will either refresh the whole dataset or portions.



Appendix D – Environmental and Recreational Assessment Methodology and Framework

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin
Roundtable

April 17, 2015



Contents

1	Environmental and Recreational Protections Assessment Methodology	5
2	Projects Assessment.....	5
3	Discussion of Methodology and Framework	6
3.1	General Basin-Wide Methodology	7
3.2	Stream Mile Representation Framework.....	16
3.3	Stream Mile Representation Framework Overview	18
4	Projects.....	19
4.1	Instream Flows	20
4.2	Channel Restoration.....	20
4.3	Stewardship Projects.....	20
4.4	Species Reintroduction	21
4.5	Cooperative and Multi-Purpose Projects.....	22
4.6	South Platte Basin Master Plans.....	22
4.7	Sufficiency of Projects	22
5	Project Examples	23
5.1	Northern Colorado Region	23
5.1.1	Example Projects – Northern Region.....	24
5.1.2	Example Area Analysis – St. Vrain Creek at Lyons	26
	Stream Mile Representation Analysis.....	26
	Streamflow Analysis.....	28
	General Discussion and Recommendations.....	41
5.2	Upper Mountain Region (Headwaters Areas)	42
5.2.1	Example Projects – Upper Mountain Region	42
5.2.2	Example Area Analysis – South Platte River above Elevenmile Reservoir	45
	Stream Mile Representation Analysis.....	45
	Streamflow Analysis.....	48
	General Discussion and Recommendations.....	60
5.3	Metro Region	61
5.3.1	Example Projects – Metro Region.....	61
5.3.2	Example Area Analysis – South Platte River below Chatfield Reservoir	63
	Stream Mile Representation Framework	63
	Streamflow Analysis.....	65
	General Discussion and Recommendations.....	75
5.4	Plains (Lower South Platte Region)	76
5.4.1	Example Projects – Lower South Platte Region	77
5.4.2	Example Area Analysis – South Platte River at Balzac	80
	Stream Mile Representation Framework	80
	Streamflow Analysis.....	82
	General Discussion and Recommendations.....	94
5.5	Project Example Summary.....	95
6	Environmental and Recreational Projects List	95
7	Additional Analyses Needed	111
8	Challenges to Assessment.....	112
9	Data Gaps	112
9.1	Data Limitations.....	112
9.2	Recommendations	114
	References.....	116

Tables

Table 1 - South Platte Basin Attributes	8
Table 2 - South Platte Basin Percent Occurrence by Attribute in Focus Areas.....	10
Table 3 - Attributes by Category	13
Table 4 - St. Vrain Creek at Lyons - General Flow Recommendations (in cfs)	30
Table 5 - South Platte River above Elevenmile - General Flow Recommendations (in cfs)	49
Table 6 - South Platte River below Chatfield - General Flow Recommendations (in cfs)	67
Table 7 - South Platte River at Balzac - General Flow Recommendations (in cfs)	84
Table 8 - Environmental and Recreational Projects (based on SWSI 2010).....	96
Table 9 - Additional Identified Environmental and Recreational Projects	108

Figures

Figure 2-1 Nonconsumptive (Environmental and Recreational) Projects and Methods Decision Tree	6
Figure 3-1 - Relationship between Environmental Attributes.....	11
Figure 3-2 - Relationship between Recreational Attributes	12
Figure 3-3- Illustration of General Basin-Wide Methodology	15
Figure 3-4 - Measurable Outcome Quantification	15
Figure 3-5 - Stream Mile Representation Framework Workflow Overview.....	18
Figure 5-1. South Platte Northern Environmental and Recreational Enhancements	25
Figure 5-2 - St. Vrain at Lyons Example Area Map	27
Figure 5-3 – Time Series Hydrograph of St. Vrain Creek at Lyons (Gage: SVCLYOCO, 06724000)	29
Figure 5-4 - Hydrograph comparison to available environmental and recreational flow information - 2002	32
Figure 5-5 - Hydrograph comparison to available environmental and recreational flow information - 2003	33
Figure 5-6 - Hydrograph comparison to available environmental and recreational flow information - 2004	34
Figure 5-7 - Time Series Raster Plot - St Vrain Creek at Lyons - Minimum Decreed Instream Flows.....	36
Figure 5-8 - Time Series Raster Plot - St Vrain Creek at Lyons - Flushing Flows (248cfs)	38
Figure 5-9 - Time Series Raster Plot - St Vrain Creek at Lyons - Recreational Flows April through September (230cfs-615cfs).....	40
Figure 5-10. Park County Important Riparian Habitat.....	44
Figure 5-11 - Elevenmile Example Area Map	46
Figure 5-12 - Time Series Hydrograph of South Platte above Elevenmile (PLAHARCO, 06695000)	48
Figure 5-13 - Hydrograph comparison to available environmental and recreational flow information – 1977	51
Figure 5-14 - Hydrograph comparison to available environmental and recreational flow information – 1978	52
Figure 5-15 - Hydrograph comparison to available environmental and recreational flow information – 2002	53
Figure 5-16 - Hydrograph comparison to available environmental and recreational flow information - 2003	54

Figure 5-17 - Hydrograph comparison to available environmental and recreational flow information - 2004	55
Figure 5-18 - Time Series Raster Plot – South Platte above Elevenmile - Minimum Recommended Flows	57
Figure 5-19 - Time Series Raster Plot - South Platte above Elevenmile - Flushing Flows (190cfs)	58
Figure 5-20 - Time Series Raster Plot – South Platte above Elevenmile - Recreational Flows April through September (200cfs)	59
Figure 5-21. South Platte Metro Corridor Environmental and Recreational Enhancements	62
Figure 5-22 - Metro Region Example Area Map	64
Figure 5-23 – Time Series Hydrograph of South Platte below Chatfield (Gage: PLACHACO).....	66
Figure 5-24 - Hydrograph comparison to available environmental and recreational flow information - 1999	69
Figure 5-25 - Hydrograph comparison to available environmental and recreational flow information - 2002	70
Figure 5-26 - Hydrograph comparison to available environmental and recreational flow information - 2003	71
Figure 5-27 - Hydrograph comparison to available environmental and recreational flow information - 2004	72
Figure 5-28 - Time Series Raster Plot – South Platte below Chatfield - Minimum Recommended Flows.....	73
Figure 5-29 - Time Series Raster Plot – South Platte River below Chatfield - Flushing Flows (268cfs)	74
Figure 5-30 - Time Series Raster Plot – South Platte River below Chatfield - Recreational Flows April through September (100cfs)	75
Figure 5-31 - Lower South Platte Plains Fish Habitat.....	79
Figure 5-32 – Lower South Platte Region Example Area Map	81
Figure 5-33 – Time Series Hydrograph of South Platte at Balzac (Gage: PLABALCO)	83
Figure 5-34 - Hydrograph comparison to available environmental and recreational flow information - 1999	86
Figure 5-35 - Hydrograph comparison to available environmental and recreational flow information - 2002	87
Figure 5-36 - Hydrograph comparison to available environmental and recreational flow information - 2003	88
Figure 5-37 - Hydrograph comparison to available environmental and recreational flow information - 2004	89
Figure 5-38 - Time Series Raster Plot – South Platte at Balzac - Minimum Recommended Flows.....	91
Figure 5-39 - Time Series Raster Plot – South Platte River and Balzac - Flushing Flows (993 cfs).....	93

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1 Environmental and Recreational Protections Assessment Methodology

In order to assess the protections existing in environmental and recreational focus areas as well as determine and assess goals and measurable outcomes, a complex methodology and framework were developed which can be used to assess the overlap of focus areas, attributes, protections or projects and potential habitat. The implementation of M&I projects and methods, whether represented in the analysis data as IPPs or other projects, increasingly must consider the impacts on other parts of the water system, including environment, recreation, and agriculture, in particular if multi-purpose projects are being evaluated. The methodology and framework developed to assess the protections and the impacts of projects on environmental and recreational attributes are described in detail in this Appendix.

2 Projects Assessment

While the Statewide Water Supply Initiative (SWSI) 2010 considered each demand component, including M&I, agriculture, environmental and recreational, the level of detail for M&I needs was much higher than other considerations. There are two fundamental approaches to answer the question “How will Project or Method X impact the environment, in particular environmental and recreational focus areas and attributes?” The first approach is to evaluate each M&I project and method for potential impacts (positive and negative), including some level of impact. For example, “Project X may decrease flows in Stream Y” or “Project X may decrease flows in Stream Y by 10 CFS during the period May-Sep”. If permitting is required, then such evaluations are already occurring as part of permitting processes.

For other projects, an evaluation of impacts could be included in project data, in particular if there is motivation for a multi-purpose project. Although project proponents may be aware of specific values that need protection, they may not be tracking such information consistent with the SWSI Non-Consumptive Needs Assessment (NCNA) attributes, and there may only be a data gap for NCNA attributes when an attribute is omitted from an area. The second option for analysis is to evaluate for each focus area or attribute what might be the impacts of each planned project. It is likely that advocates for focus areas (such as conservation organizations operating in the area) monitor potential impacts of NCNA attributes and take action accordingly. However, detailed analysis and monitoring may be difficult and more general goals of maintaining and improving water quality, streamflows, or habitat extent, may be easier metrics to evaluate. Advocacy may be absent if no organization exists in the area of concern, although State or Federal agencies may be present.

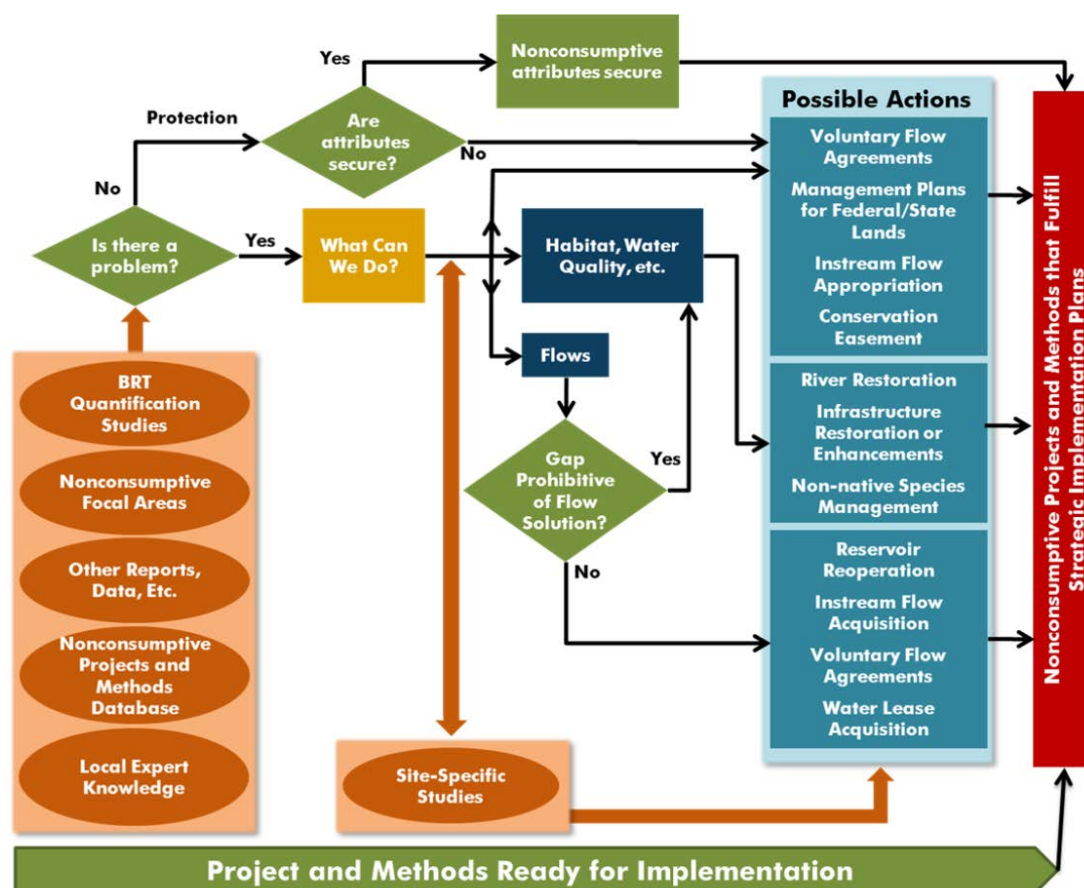
Reference Documents

The following discussion is based upon:

[SWSI 2010 South Platte Basin Report Basinwide Consumptive, Nonconsumptive Water Supply Needs Assessments, and SWSI Nonconsumptive Toolbox](#)

The SWSI Nonconsumptive Toolbox includes a decision tree for evaluating and planning “nonconsumptive” projects.¹ The decision tree is shown in Figure 2-1.

Figure 2-1 Nonconsumptive (Environmental and Recreational) Projects and Methods Decision Tree



The toolbox focuses on new projects to address an existing environmental and/or recreational need. However, a similar decision tree could be used to address the impacts of a planned M&I (or agricultural) project. In this case, the initial question of “Is there a problem?” is asked through the lens of “What impact will Project X have?” The toolbox could therefore be utilized to evaluate enhancing any project, perhaps converting the project into a multi-purpose project.

3 Discussion of Methodology and Framework

In order to assess whether or not a project is needed in a particular focus area, a methodology and framework based on data regarding attributes and projects were developed. A general basin-wide methodology was developed in Phase I of the South Platte BIP work and a stream mile representation framework was developed in Phase II. The evaluation of the existing data to determine environmental and recreational needs

¹ Nonconsumptive Toolbox, CWCB, 2011

and opportunities used the SWSI 2010 data as well as the new data sets supplied by CDM, the SWSI consultant for the CWCB. The evaluation and methodology described herein implements queries and analyses of two separate data sources, 1) GIS shapefiles, which contain spatial information regarding focus areas, attributes, and projects, and 2) the MS Access Nonconsumptive Needs Assessment (NCNA) database, which contains more detailed information on some attributes, projects, and protection categories for the projects. The GIS shapefiles were created for SWSI, however, the MS Access database was used for project and protection data analysis.

3.1 General Basin-Wide Methodology

A general basin-wide methodology was developed in Phase I of the South Platte BIP to generally assess the available data, resulting in broad determination such as “there are X miles of stream habitat suitable for species Y and Z miles are sufficiently protected with projects and methods”. However, BIP Phase I scope and data limitations did not allow for development of a robust method for the assessments of attributes or sufficiency of projects. Based on a review of both data sources during the BIP project, significant differences were found between the data contained in the GIS data and NCNA database that preclude a complete analysis of focus areas, attributes, projects and protections. The one common variable that could be used to crosslink both data bases is the COMID. This is a unique identifier for smaller stream segments taken from the National Hydrography Dataset (NHD). Some of the differences between the NCNA database and the GIS shapefiles have been rectified to be able to conduct some preliminary analyses, however, additional work is needed to fully incorporate new focus area and project data into the Access database to ensure consistency between the database and GIS. Steps were taken in Phase I of the South Platte BIP to develop the methodology as a method to incorporate some of this data in the future.

For the general basin-wide analysis, a method was devised to link the Focus Area identifier (a unique number) with the MS Access database. The GIS shapefiles contained the unique identifier included for all Focus Areas. The GIS data included a COMID for all stream segments in each Focus Area and the narrative description of the Focus Area. The Focus Area identifiers and names are being added to the MS Access database and additionally a table relating Focus Area to segment are also being added to relate the focus areas to existing data in the database. This data joining provides a means to link the common variable of COMID in the MS Access and GIS data. A number of queries could be executed if the MS Access database is fully updated to list focus area, attribute, segment, and project combinations details and summaries.

The attributes evaluated for each Focus Area in the South Platte Basin were approved by the South Platte and Metro Roundtables (BRTs) in 2010 (Table 1) as part of the SWSI process. The SWSI 2010 Focus Segments have numeric and descriptive labels. The GIS database contains both the numeric and descriptive label for each SWSI 2010 focus segment.

Table 1 - South Platte Basin Attributes

South Platte Attributes	Attribute Type		Data Availability		Attribute Inclusion Approved	
	Environmental	Recreational	SWSI 2010 shapfile	Quantitative data	Yes/No	Date
Boreal Toad	X		Y	Y	Y	SWSI 2010
Greenback Cutthroat Trout	X		Y	Y	Y	SWSI 2010
Brassy Minnow	X		Y	Y	Y	SWSI 2010
Common Shiner	X		Y	Y	Y	SWSI 2010
Lake Chub	X		Y	Y	Y	SWSI 2010
Northern Redbelly Dace	X		Y	Y	Y	SWSI 2010
Plains Minnow	X		Y	Y	Y	SWSI 2010
River Otter	X		Y	Y	Y	SWSI 2010
Stonecat	X		Y	Y	Y	SWSI 2010
Suckermouth Minnow	X		Y	Y	Y	SWSI 2010
Yellow Mud Turtle	X		Y	Y	Y	SWSI 2010
Iowa Darter	X		Y	Y	Y	SWSI 2010
Northern Leopard Frog	X		Y	Y	Y	SWSI 2010
Plains Orangethroat Darter	X		Y	Y	Y	SWSI 2010
Colorado Outstanding Waters		X	Y	Y	Y	SWSI 2010
CWCB Instream Flow Water Rights	X		Y	Y	Y	SWSI 2010
CWCB Natural Lake Level Water Rights	X		Y	Y	Y	SWSI 2010
Ducks unlimited projects		X	Y	Y	Y	SWSI 2010
Eligible Wild and Scenic	X		Y	Y	Y	SWSI 2010
Flatwater Boating		X	Y	Y	Y	SWSI 2010
Gold Medal Trout Lakes		X	Y	Y	Y	SWSI 2010
Gold Medal Trout Streams		X	Y	Y	Y	SWSI 2010
Northern Cricket Frog	X		Y	Y	Y	SWSI 2010
Plains Leopard Frog	X		Y	Y	Y	SWSI 2010
Rare Aquatic-dependent plants	X		Y	Y	Y	SWSI 2010
Recreational In-Channel Diversion Structures		X	Y	Y	Y	SWSI 2010
Reservoir and Lake Fishing		X	Y	Y	Y	SWSI 2010
River and stream fishing		X	Y	Y	Y	SWSI 2010
Waterfowl Hunting / Viewing		X	Y	Y	Y	SWSI 2010
Whitewater Boating		X	Y	Y	Y	SWSI 2010
Preble's Meadow Jumping Mouse	X		Y	Y	Y	SWSI 2010
Common Garter Snake	X		Y	Y	Y	SWSI 2010
Active Bald Eagle Nests	X		Y	Y	Y	SWSI 2010
Audubon important bird areas	X		Y	Y	Y	SWSI 2010
Significant Plant Communities	X		Y	Y	Y	SWSI 2010
Wilderness Waters	X		Y	Y	Y	SWSI 2010
Wood Frog	X		Y	Y	Y	SWSI 2010

The NCNA attributes also are listed in each Focus Area by the COMID label. The total reach length for each attribute within a Focus Area was used to determine the amount of each attribute (length and percent) by Focus Area in the South Platte Basin. These data can provide the existing amount of the attribute in the Focus Area. In addition, the data contains some information regarding the current protections in the Focus Areas, although significantly more information is needed. Analyses to determine where the focus areas, attributes and projects overlap can allow for the possible determination of the amount of potential increase for a given attribute and the potential for future projects and protections. Additional species specific analyses can determine the extent of potential habitat.

For example, Focus Area 12 has the descriptive label “all mountain tributaries with greenback cutthroat trout”. These tributaries include 122 miles of streams. Greenback

cutthroat trout are present in 89 miles (69%) of the Focus Area. Protections in the Focus Area include CWCB instream flow (ISF) protections. There are 56 miles (45%) of the Focus Area protected by CWCB ISF.

If available, the data for each Focus Segment can be used in the future to set more specific measurable goals and outcomes for attributes in the South Platte Basin based on the priorities of the BRT. The data for the occurrence of each attribute by Focus Segment can be used to quantify each attribute. One goal in the South Platte is to maintain the attributes at their present levels and if possible increase the attributes. Additional specific analyses can determine the extent of potential habitat.

Table 2 shows the percent occurrence in the basin by attribute in all focus areas as described in Appendix B, based solely upon the data available in the GIS shapefiles regarding location of attributes. These percent occurrences do not necessarily demonstrate the vitality or lack of habitat of a species. Current habitat may be sufficient to maintain species if such habitat is not degraded, or additional habitat or connectivity may be needed. Some species are micro-habitat specific and may occur throughout the basin in appropriate areas, or may need additional habitat to thrive. Location specific studies and analyses are needed to fully determine the species habitat, potential habitat and sufficiency of protections for the species.

Table 2 - South Platte Basin Percent Occurrence by Attribute in Focus Areas

<i>State Endangered, Threatened, and Species of Concern</i>			<i>Special Value Waters</i>		
	Greenback Cutthroat Trout	5%		Colorado Outstanding Waters	5%
	Brassy Minnow	47%		Eligible/Suitable Wild and Scenic	12%
	Common Shiner	27%		CWCB Instream Flow Water Rights	27%
	Iowa Darter	47%		CWCB Natural Lake Level Water Rights	4%
	Lake Chub	3%		Wilderness Area Waters	6%
	Northern Redbelly Dace	14%	<i>Whitewater and Flatwater Boating</i>		
	Plains Orangethroat Darter	8%		Whitewater Boating	20%
	Plains Minnow	7%		Flatwater Boating	1%
	Suckermouth Minnow	8%		Recreational In-Channel Diversion Structures	0%
	Stonecat	8%	<i>Important Cold and Warm-Water Fishing</i>		
	Boreal Toad	4%		Gold Medal Streams and Lakes	4%
	Bald Eagle Active Nest Sites	3%		River and Stream Fishing	21%
	River Otter Confirmed Sightings	2%		Reservoir and Lake Fishing	2%
	Yellow Mud Turtle	2%	<i>Waterfowl Hunting/Viewing</i>		
	Common Garter Snake	10%		Audubon Important Bird Areas	3%
	Preble's Meadow Jumping Mouse	53%		Waterfowl Hunting/Viewing Parcels	14%
	Northern Leopard Frog	19%		Ducks Unlimited Projects	20%
	Northern Cricket Frog	4%	<i>High Recreation Areas</i>		
	Plains Leopard Frog	3%		High Recreation Corridors	4%
	Wood Frog	1%			
<i>Rare Plants and Significant Plant Communities</i>					
	Rare Plants	20%			
	Significant Plant Communities	49%			

The attributes were grouped into subcategories in SWSI 2010 Table 3. These subcategories can simplify the analysis. Figure 3-1 and Figure 3-2 illustrate the grouping for environmental and recreational attributes. These subsets were obtained from the CWCB database distributed in December 2013 and refined by the nonconsumptive subcommittee in 2014 to more clearly categorize the attributes. The categorization of the attributes is shown in Table 3.

Figure 3-1 - Relationship between Environmental Attributes

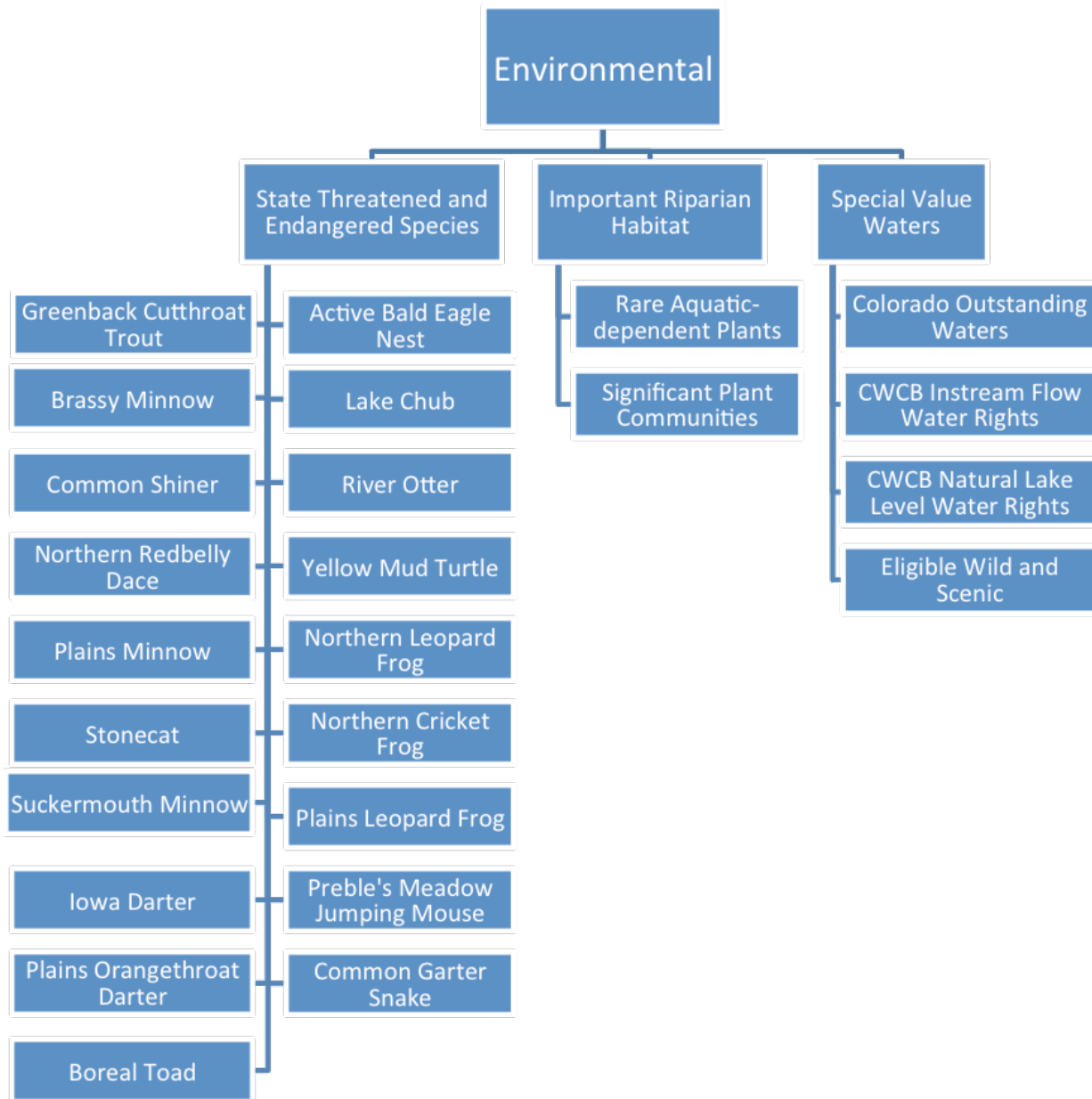


Figure 3-2 - Relationship between Recreational Attributes

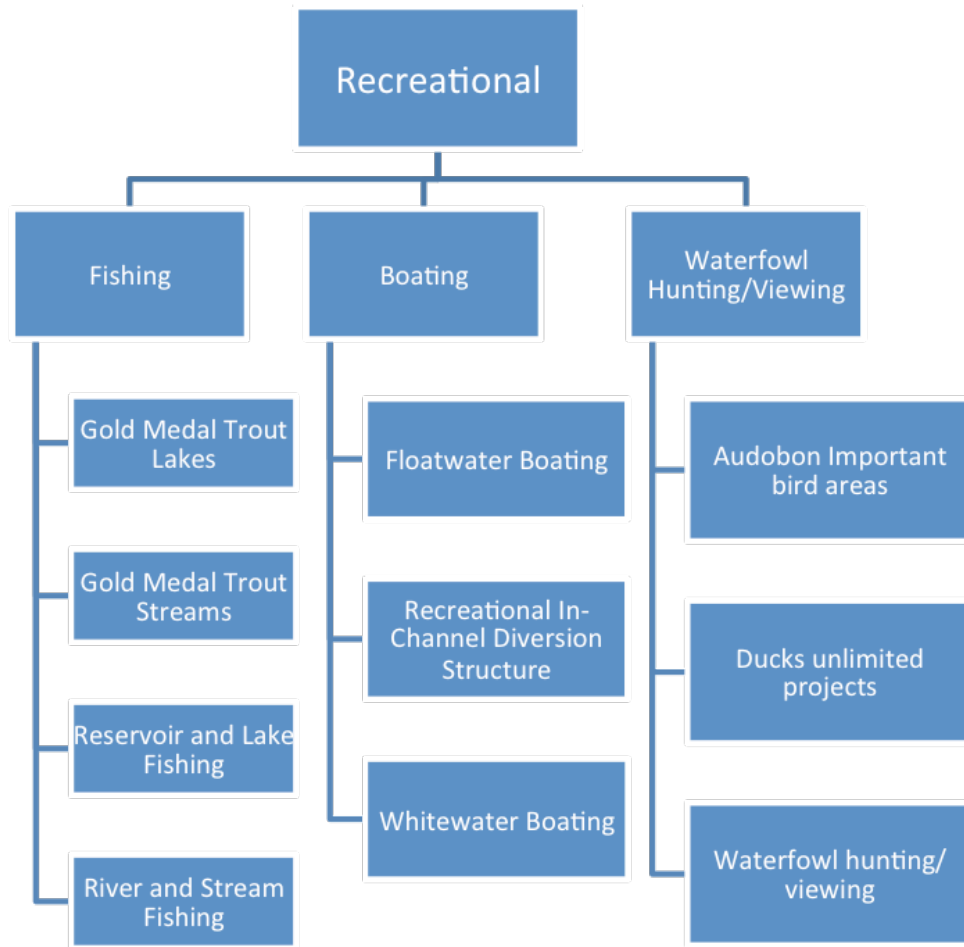


Table 3 - Attributes by Category

Attributes	Category
Gold Medal Trout Lakes	Fishing
Gold Medal Trout Streams	Fishing
Reservoir and Lake Fishing	Fishing
River and stream fishing	Fishing
Greenback Cutthroat Trout	Greenback Cutthroat Trout
Rare Aquatic-dependent plants	Important Riparian Habitat
Significant Plant Communities	Important Riparian Habitat
Brassy Minnow	Plains Fish State Endangered, Threatened, Species of Special Concern
Common Shiner	Plains Fish State Endangered, Threatened, Species of Special Concern
Northern Redbelly Dace	Plains Fish State Endangered, Threatened, Species of Special Concern
Plains Minnow	Plains Fish State Endangered, Threatened, Species of Special Concern
Stonecat	Plains Fish State Endangered, Threatened, Species of Special Concern
Suckermouth Minnow	Plains Fish State Endangered, Threatened, Species of Special Concern
Iowa Darter	Plains Fish State Endangered, Threatened, Species of Special Concern
Plains Orangethroat Darter	Plains Fish State Endangered, Threatened, Species of Special Concern
Flatwater Boating	Recreation
Recreational In-Channel Diversion Structures	Recreation
Whitewater Boating	Recreation
Boreal Toad	State Endangered, Threatened, Species of Special Concern
Lake Chub	State Endangered, Threatened, Species of Special Concern
River Otter	State Endangered, Threatened, Species of Special Concern
Yellow Mud Turtle	State Endangered, Threatened, Species of Special Concern
Northern Leopard Frog	State Endangered, Threatened, Species of Special Concern
Northern Cricket Frog	State Endangered, Threatened, Species of Special Concern
Plains Leopard Frog	State Endangered, Threatened, Species of Special Concern
Preble's Meadow Jumping Mouse	State Endangered, Threatened, Species of Special Concern
Common Garter Snake	State Endangered, Threatened, Species of Special Concern
Wood Frog	State Endangered, Threatened, Species of Special Concern
Waterfowl Hunting / Viewing	Waterfowl Hunting/Viewing
Ducks unlimited projects	Waterfowl Hunting/Viewing
Audubon important bird areas	Waterfowl Hunting/Viewing
Colorado Outstanding Waters	
CWCB Instream Flow Water Rights	
CWCB Natural Lake Level Water Rights	
Eligible Wild and Scenic	
Active Bald Eagle Nests	
Wilderness Waters	

Since SWSI 2010, the Greenback Cutthroat Trout has been determined to only be located in the Arkansas Basin, with what was previously considered the Greenback Cutthroat Trout actually being another native cutthroat trout. This categorization and attribute will be updated with the new native cutthroat trout species name, once determined. (*Historical stocking data and 19th century DNA reveal human-induced changes to native diversity and distribution of cutthroat trout*. Metcalf, Stowell, Kennedy, Rogers, McDonald, Epp, Keepers, Cooper, Austin, and Martin. Molecular Ecology, Vol 21, Issue 21, pages 5194-5207, Nov 2012.)

The addition of the Focus Area number to the CWCB database provides a means to quantify the attributes by Focus Area. This approach provides a means to determine the approximate extent of each attribute in each Focus Area but does not create a spatial reference for the attribute's occurrence. For example, the database queries summarized stream segments to give totals for focus area, attribute, and project but do not indicate

when project protections overlap at a COMID stream segment level. The spatial linkage must be made using the COMID and attributes. The COMID values are one of the existing limitations to using this general approach. COMID values can be changed by the NHD in the future, which would cause errors in data retrievals from the existing data sets. A new framework with fixed spatial location data was needed for long term data integrity and analysis but beyond the scope of Phase I.

The spatial locations can be used to determine where there are gaps in the projects and protections for each attribute or group of attributes. A generic example of this is shown in Figure 3-3.

The MS Access database includes the list of current and planned projects within the South Platte basin. Several queries were made on the database to extract the list of projects by Focus Area and attribute. The entire list includes projects listed at “Stewardship” and “Instream Flow”. These types of projects cover large portions of the South Platte Basin but may not have specific protections to address threats to the attributes. For example, an instream flow right does not ensure adequate streamflow because such rights are typically junior to other water rights, and water flowing through public lands (considered stewardship) simply means that there is some level of land stewardship, as discussed below. These types of projects cover broad areas for the purpose of a general protection of aquatic attributes.

The database can also be queried for all projects in the South Platte Basin, excluding Stewardship and Instream Flow projects. The queries run to date result in fewer projects, which could be compared to attributes. Database queries can provide the total amount of the Focus Area covered by the project but not the location. The spatial location of each project can be identified using GIS.

The general basin-wide methodology is illustrated in Figure 3-3 and Figure 3-4. Due to the difficulties with data issues encountered in the general basin-wide methodology utilized in Phase I of the South Platte BIP and described above, a stream mile representation framework was developed in Phase II.

Figure 3-3- Illustration of General Basin-Wide Methodology

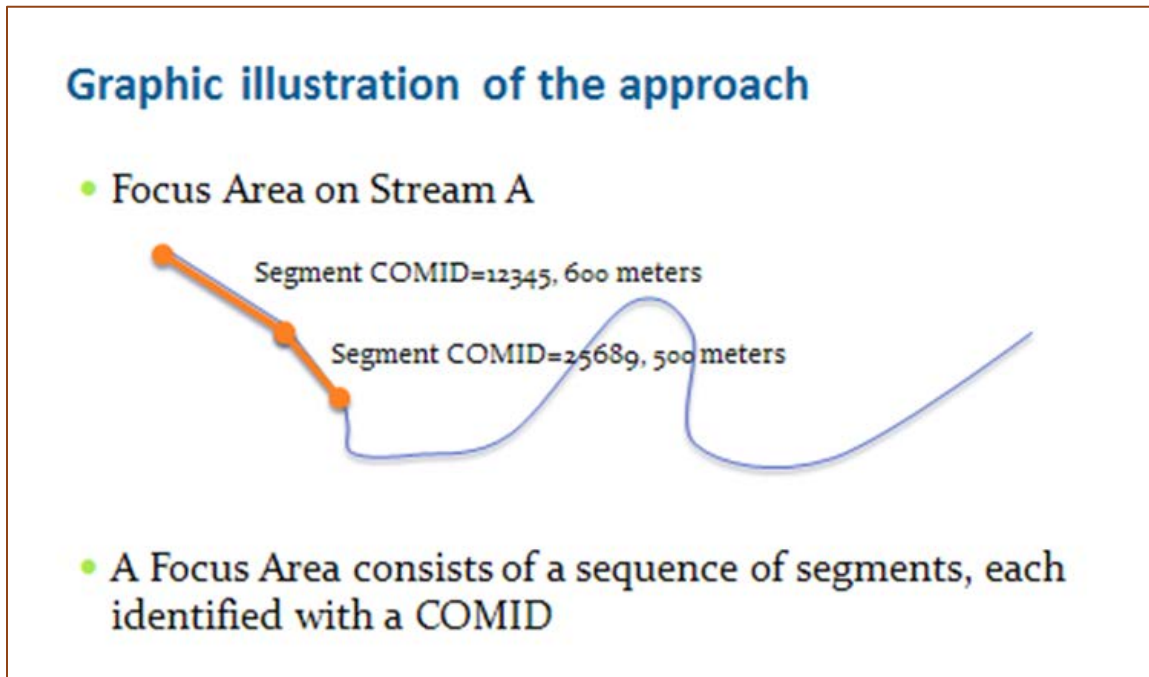
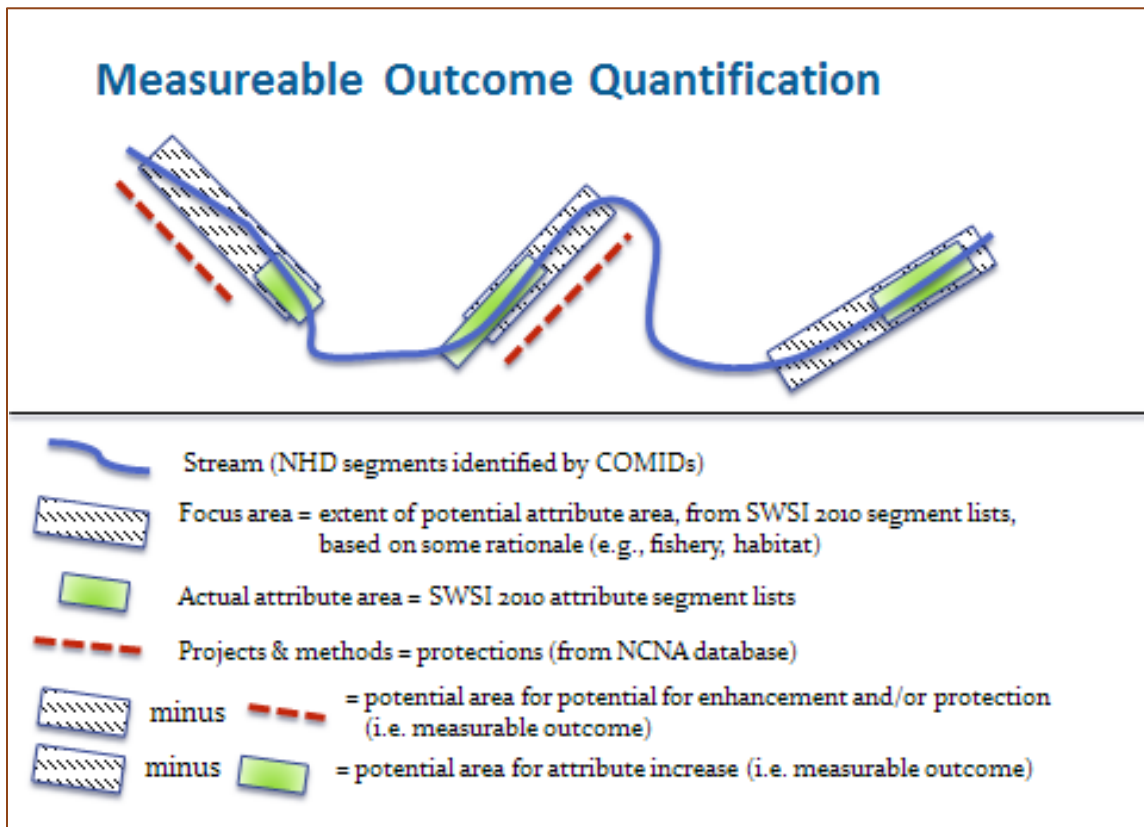


Figure 3-4 - Measurable Outcome Quantification



3.2 Stream Mile Representation Framework

In order to better assess the attributes, projects and protections in place or needed within the basin, a stream mile representation framework was developed during Phase II of the South Platte BIP. The Stream Mile Representation Framework allows for a fixed spatial analysis framework and a more streamlined assessment of attributes and projects at distinct spatial locations when the data needed for assessment is available.

For the general basin-wide methodology developed in Phase I of the South Platte BIP, significant time was spent attempting to utilize previous CWCB “Nonconsumptive Needs Analysis” data products, including GIS layers, NCNA Microsoft Access database, and spreadsheets. This effort identified significant limitations in the data and approach, which severely limit the effectiveness of analysis. The stream mile representation framework was developed to address the following limitations. The full list of limitations is included in the Stream Mile Representation Framework Overview Tech Memo attached as Appendix D-1. Some of these limitations include:

- Spatial data utilized the National Hydrograph Dataset (NHD) as the stream layer onto which other data were referenced. The NHD “COMID” identified was used as a database unique identifier for stream reaches and database relationships. The use of COMID results in stream segments with arbitrary lengths, COMID values may change based on the NHD version, and COMID is being phased out of the NHD datasets.
- Access to GIS or Microsoft Access is not as wide-spread as access to Excel and other user friendly interfaces.
- Extracted lists from the GIS and Access database were not tied to spatial information such as maps, making interpretation more difficult.
- The general Basin-Wide Methodology data analysis queries resulted in aggregated results such as “focus area X is 100 miles long and 30 miles have adequate productions for attribute Y”. These results are difficult to relate to local stream reach conditions and assessments.

A new Stream Mile Representation Framework approach was implemented in order to overcome the above issues and to allow analysis of goals and measurable outcomes in the future. The approach was vetted in concept through numerous conversations with stakeholders and subsequently was recommended to the South Platte/Metro Nonconsumptive Needs Committee on Oct 28, 2014. Based on positive feedback, the approach was implemented in the South Platte BIP Phase 2 in early 2015, focusing on several example areas that are discussed in this Appendix.

The Stream Mile Representation Framework represents the river in a spreadsheet format as relatively short segments that allow for a reasonable level of analysis. The segment length used in the framework was 0.1 mile long segments. The framework was completed for discrete stream reaches in the basin that coincide with streamflow gages for additional analysis, as is discussed in this appendix. In the final output of the framework for the example areas, each river or stream is represented as a column in Excel and each row corresponds to a 0.1-mile segment. Additional columns in Excel

represent data layers such as focus area, environmental and recreational attributes, project and methods, etc.

The Stream Mile Representation Framework allows anyone with simple spreadsheet tools to be able to access the data, without the need for database and GIS tools. Along with the stream of interest, additional data layers are represented in the framework, including focus areas, environmental attributes, projects, streamflow gages, and diversions. Additional detailed discussion regarding the development of the SMRF is included in the Stream Mile Representation Framework Overview Tech Memo attached as Appendix D-1. The benefits of the SMRF include:

- The river can be represented in a simple tabular format in Excel.
- Input data layers can be collected and managed using normal practices – using the data in the stream mile analysis involves steps explained in Appendix D-1 but do not impact stakeholder management of the original data.
- River segments are identified with stream (river) identifier, name, and stream mile, rather than abstract data like “COMID” or other internal GIS data.
- Overlapping data layers are clearly indicated as columns and values within columns.
- Analysis of each row/segment can occur with simple Excel formulas using agreed-upon metrics and science-based analysis
- Stakeholders that have familiarity with a stream reach can focus on everything that is occurring in that reach, rather than trying to extract analysis results for their reach from complex data queries.
- The framework supports inclusion of organizational jurisdictional extent and master plan extent, which will allow integration of local planning and project efforts with other data.
- Additional features can be placed on the river by assigning a stream mile either by processing with GIS or by adding to the Excel workbook.
- The stream mile can be recalculated if new input are made available (such as new version of SWRF layer from DWR).
- A variety of spatial data layers can be assembled to create the Excel file.
- The framework can be used to examine data anywhere within the South Platte Basin that has the appropriate data.

Limitations of the use of the stream mile representation include:

- The segment length of 0.1 miles is arbitrary and may introduce some error in analysis; however, many data layers are imprecise, and tenths of a mile precision have been used elsewhere with success (e.g., Colorado and San Juan Fish Recovery Programs, transportation mileage).
- Intermediate features that do not fall at .1-mile boundaries will not be precisely located for analysis, although precise locations can be indicated in the output (this has been done for stream gages and major diversions).
- Changes in the stream layer that is used as a basis for the stream miles, for example due to a stream channel moving from a flood, will cause the stream miles to be different in the future – this is viewed as part of normal data maintenance and the stream miles in the analysis are used to align data, not as

an absolute framework. This alignment will require similar GIS and database work in the future that was used to produce the SMRF for the example areas.

3.3 Stream Mile Representation Framework Overview

The SMRF workflow that was used to develop the South Platte Basin Implementation Plan (BIP) Phase II project is illustrated in Figure 3-5 below.

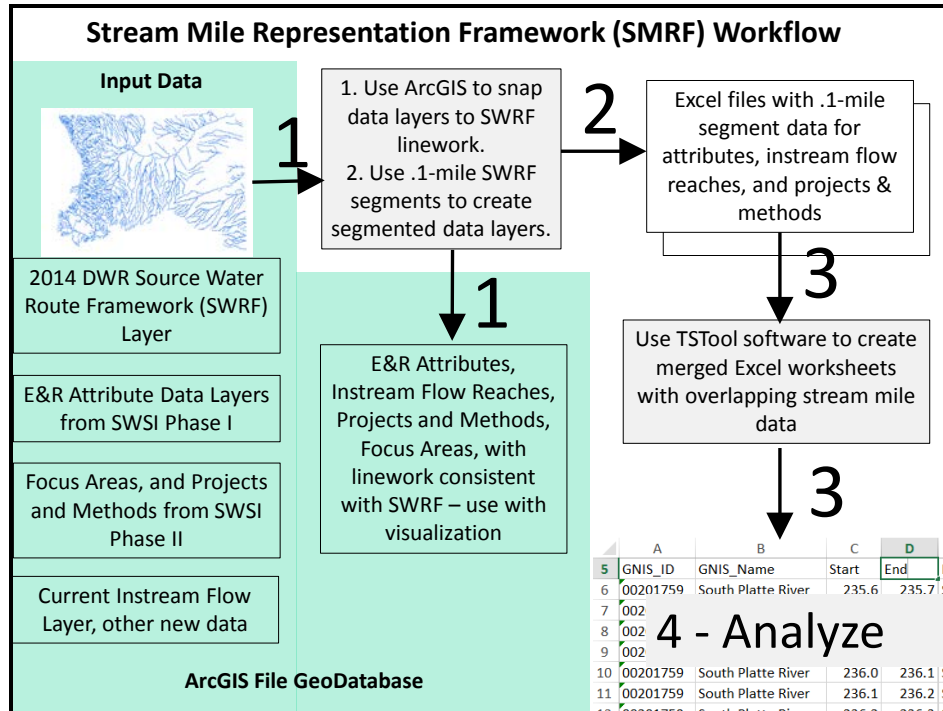


Figure 3-5 - Stream Mile Representation Framework Workflow Overview

ArcGIS software is used in steps 1 and 2 in Figure 3-5 to manage and process spatial data from multiple sources. Geographical Information System (GIS) processing is described in the BIP memorandum “Stream Mile Representation GIS Workflow Processing,” March, 2015, attached as Appendix D-2. Spatial data used in the analysis were inventoried in an Excel workbook, managed in an ArcGIS file geodatabase, and include the following:

- DWR SWRF layer
- all of the original data layers from the SWSI NCNA Phase I and II efforts, including focus areas, environmental and recreational attributes, and projects and methods
- recent instream flow reach layer from the CWCB
- historical and real-time stream gage locations from HydroBase
- major diversion structures located near the gage, from HydroBase

TSTool software developed for Colorado’s Decision Support Systems (CDSS) was used for step 3 in Figure 3-5 to assemble spatial data tables into the final Excel workbook. The TSTool process is described in the BIP memorandum “Stream Mile Representation

Framework TSTool Workflow Processing”, March 2015, attached as Appendix D-3. GIS data layers that were intersected are detailed in the data inventory table attached to Appendix D-3.

The result of the GIS and TSTool processes is an Excel workbook (step 4 in Figure 3-5) that includes environmental and recreational data, where rows represent 0.1-mile stream segments and columns are included for environmental and recreational attributes, instream flow reaches, projects and methods, locations of stream gages and diversion structures, and other data, as illustrated in Appendix D-1, showing the SMRF output for all example areas.

The BIP results provide a framework for visualizing and understanding environmental and recreational data and providing a platform for analysis. For example, daily streamflow time series can be analyzed to determine if available “wet water” is meeting the flow requirements for environmental and recreational attributes where flow data is available. The SMRF provides a framework to spatially represent environmental and recreational requirements at a local level to represent a variety of environmental and recreational data along stream reaches. This framework can be enhanced and applied to further understand environmental and recreational requirements and the challenges in meeting those requirements at a local scale. The framework can also provide a means for stakeholders to provide input, as described in the BIP memorandum “Stream Mile Representation Framework Stakeholder Data”, March 2015, attached as appendix D-4. Discussion of the use of the framework and related flow analyses for specific example locations is discussed in detail below in the Project Examples section.

4 Projects

There are various types of projects which protect or enhance environmental and recreational attributes. These projects include CWCB instream flows, channel restoration, stewardship, species re-introductions, and cooperative or multi-purpose projects.

Future projects and protections can be evaluated using the general approaches discussed above with the addition of other data. These other data include diversion structures, dry-up locations, flow and other project data. Diversion structures can be impediments to upstream migration by many of the fish species listed in the attribute table. The species have both downstream and upstream migration requirements in the life cycle. The young, larval fish drift downstream as they develop. The older life stages of fish move upstream during their life cycle. Any barriers to movement disrupt these migrations and can be a factor in decreasing population sizes. An example of a project that provides protection for these fish species is modification of diversions to accommodate fish passage. These modifications may range from change to the physical configuration of the structure to allow fish to swim upstream of the structure or the complete removal of structures that are no longer needed for diversion of the water. Two recent projects that illustrate these examples are the modification of the Green Ditch Diversion on Boulder Creek and the removal of the Josh Ames Diversion on the Cache la Poudre River. These individual projects may be very localized and change the physical

features on a very short section of river but allow the aquatic species access to many additional miles of rivers.

Another type of future project that can provide protections for the environmental attributes is the modification of dry-up points in the rivers. Like the diversion projects above, dry-up points can impact much larger river reaches. Projects that work to modify dry-up points provide continuous segments of habitat where discontinuous habitat now exists. Ideally, some additional streamflow monitoring stations could be implemented at river locations to determine flows in the river and facilitate administration of diversions and bypass flows.

Additional types of projects are listed below.

4.1 Instream Flows

Instream flow water rights and lake level water rights can only be held by the Colorado Water Conservation Board (CWCB). These water rights allow for the CWCB to hold a water right for a specific amount of instream flow within a specified reach or a specified lake level to assist in protecting the environment. An instream flow water right (ISF) is a relatively junior water right that can call for water to benefit instream flows within a specified reach. However, instream flow water rights can also be donated to the CWCB and converted for instream flow use. The donation of water rights can allow for more senior priorities to be used for instream flow purposes. The Colorado Water Trust is a non-profit organization that raises funds to buy water rights in identified reaches with needed flows that can be changed in water court and donated to the CWCB for instream flow purposes. The presence of an instream flow right in a reach does not guarantee streamflows, however, and does not necessarily translate into adequate protection in the reach. Additional detailed information is described by Pete Conovitz of Colorado Parks and Wildlife in the Instream Flow Protections in the South Platte Basin Technical Memorandum (January 2015), attached as Appendix D-5.

4.2 Channel Restoration

Channel restoration projects can benefit both in-stream aquatic habitat and species as well as riparian species such as wetlands and significant plant communities. In addition stream restoration can also benefit recreational uses such as fishing, flatwater boating, and kayaking. Channel restoration projects can also help to improve water quality in certain areas.

4.3 Stewardship Projects

Stewardship projects have protections that include areas near stream riparian areas and protect stream attributes for multiple uses. Examples of stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations (NGOs). These protections may cover multiple attributes in the areas where they are in place.

During the SWSI 2010 process, CWCB incorporated data from the Southwest Regional Gap Analysis Project (SRGAP)², coordinated by U.S. Geological Survey (USGS) into the projects and methods database. The SRGAP created GIS data layers of land cover, native terrestrial vertebrate species, land stewardship, and management status values. The management status values quantify the relationship between land management and biodiversity throughout the state of Colorado. The four management status values are as described below (USGS 2010):

- Status 4 lands are where there are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout.
- Status 3 lands comprise areas having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging) or localized intense type (e.g., mining). It also confers protection to federally listed endangered and threatened species throughout the area.
- Status 2 lands are areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.
- Status 1 lands include areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

The stewardship projects currently included in the NCNA database have little information regarding which attributes the “stewardship” project is intended to protect. The only direct protections indicated by the stewardship projects are to riparian habitats, with all other attributes included as being indirectly protected. As the stewardship projects are land-focused and not stream focused, the level of protection afforded any specific attribute with respect to streamflows cannot be determined without significant additional work identifying and quantifying specific possible protections from specific stewardship projects.

4.4 Species Reintroduction

Species reintroduction projects allow for species to be reintroduced to habitat areas where their numbers may have declined. At times additional projects are needed to ensure protection along with species reintroduction projects. Examples of species reintroductions in the South Platte Basin include various projects that include reintroductions of the Boreal toad, cutthroat trout, and plains fish species.

² United States Geological Survey. 2010. Southwest Regional Gap Analysis Project. <http://fwsnmcwru.nmsu.edu/swregap/Stewardship/Categorization.htm>

4.5 Cooperative and Multi-Purpose Projects

There are various other types of projects that can assist in protecting or enhancing environmental and recreational attributes. Many of these projects include multipurpose projects and partnerships which can assist in the cooperative operation and construction of projects. Project proponents of M&I projects and new Colorado River supply projects can work with environmental and recreational interests to potentially identify additional funding sources to construct projects that enhance attributes in the project area. Irrigation of agricultural lands and return flows from such irrigation often provide habitat or streamflows that can benefit environmental and recreational uses. Opportunities also exist for cooperative operation, optimization and enhancement of infrastructure to assist in enhancing environmental and recreational attributes. Some examples of cooperative or multi-purpose projects include:

- Recharge projects which provide wetland areas and wildlife habitat, specifically various Ducks Unlimited programs throughout the basin.
- Environmental or recreational pools or cooperative agreements with respect to storage reservoirs, providing streamflows that enhance or protect recreational or environmental instream flow needs.
- Diversion structure modification to continue operations benefiting the consumptive use, while maintaining flows or connectivity for environmental and recreational attributes near the diversion structure.

4.6 South Platte Basin Master Plans

There are various master plans throughout the South Platte Basin. These plans often include various projects that will assist in protecting or enhancing environmental and recreational flows. These plans include mechanisms for watersheds to work together in planning efforts. A brief review of the Master Plans was done in conjunction with the BIP, and the review is included in the Review of South Platte Basin Master Plans Memorandum (March 2015), attached as Appendix D-6.

4.7 Sufficiency of Projects

The sufficiency of the protections for many projects is unknown. The protection for a specific project and the attribute targeted is not included in either the GIS database or MS Access database. It appears from the previous work on SWSI 2010 and recent work completed by the CWCB contractors that the terms “projects” and “protections” were considered synonymous. If a project is present in a Focus Area then it is assumed that a protection was in place. An example of this is the attribute of CWCB instream flow, which can also be considered a protection. The sufficiency of the protection from the ISF is directly related to whether it can protect the streamflows during times of low flow. If there are water rights on the same stream reach that are senior to the ISF, these water rights may legally reduce flow below the specified minimum and therefore the ISF would not result in a physical protection of flows. Evaluation of these types of protections requires an analysis of streamflows at specific locations in the focus area. The analysis of the sufficiency of the protection was completed in specific reaches to the extent that data was available, using the stream mile representation framework and other data analyses.

Similar analyses could be completed in various other areas with significant additional resources, and additional data.

5 Project Examples

The proposed general basin-wide methodology and stream mile representation framework were applied in a limited manner to highlight example projects in each geographic area to illustrate how the attributes (or categories) and projects can meet the over-arching environmental and recreational goals. In the general basin-wide methodology there were discrepancies between the GIS data and the MS database with regards to projects (i.e. protection) as they relate to attributes within each Focus Area. The total stream miles generated using both data sources for a common attribute in a single Focus Area does not match. For example, a summary of the “Ducks Unlimited Projects” attribute generated from the GIS data base (SWSI 2010) results in identification of 161.5 miles in Focus Area 1 (lower South Platte River) with the attribute present. The query on the MS Access database for the “Ducks Unlimited Projects” resulted in no miles in Focus Area 1 (lower South Platte River) with the attribute present. Ducks Unlimited Projects appear to be attributes, not projects in the database. This is one example of the discrepancies between the older and newer databases that should be reconciled to ensure that the data contained in the newest database is correct.

For both the general basin-wide methodology and stream mile representation framework, there also exists a data gap for background data to determine the project status, project proponent, and the specific environmental or recreational benefit intended from the project. The level of detail available for the analysis is typically limited to a single line in a spreadsheet or data base with no citation to background data or original contact, interviewer, or proponent. These data should be provided to the BRT by CWCB or its contractor. The acquisition of these types of data is not in the scope of the current BIP.

The following sections include examples demonstrating a range of projects that have the potential to maintain or enhance environmental and recreational attributes in the candidate focus areas. Included is a general discussion of example projects based on the basin-wide methodology from Phase I. The section also contains additional descriptions of the Stream Mile Representation Framework and associated analyses. Some of the data needed for a complete analysis and evaluation are missing; however, professional judgment was used to review some of the examples to illustrate the process for environmental and recreational benefits. Additional examples could be analyzed in the future with specific direction from the environmental and recreational subcommittee and BRTs and additional data a funding resources.

5.1 Northern Colorado Region

There are various types of focus areas in the Northern Region with multiple project types in place, planned or needed to protect or enhance the environmental and recreational attributes. Nineteen of the 34 focus areas in the South Platte located in the Northern Region. The descriptions of focus areas in the region include:

- Environmental attributes including: Habitat for federal and state endangered, threatened and species of concern including plains fish, native minnow species,

common shiner, stonecat, and brassy minnow, cutthroat trout and lake chub; rare or imperiled riparian plant communities; and Wild and Scenic River designation.

- Recreational attributes including: Fishing, whitewater and flatwater boating, municipal recreational corridors, RICDs, State Wildlife Areas, Wild and Scenic River designation, and additional greenway benefits.

There are various projects throughout the Northern Region addressing environmental and recreational needs. Project types in the region include stream and riparian restoration, fish passage projects, species reintroduction, instream flows, streamflow agreements, and various types of studies.

To demonstrate the types of projects within the Northern Region, specific existing projects are highlighted. In addition, the stream mile representation framework previously discussed was used to generally analyze the environmental and recreational needs and the existing and future project types within that area that may address the gap.

5.1.1 Example Projects – Northern Region

An example project in the Northern Region that includes protection to both environmental and recreational attributes is the diversion structure modification project in the Cache La Poudre River from near the mouth of Poudre Canyon to the eastern edge of Fort Collins. Several individual projects are planned or ongoing to modify existing diversion structures in this section of river for fish passage. Some projects are removing structures that are no longer needed for diversion. Each structure modified provides additional miles of continuous aquatic habitat or recreational opportunities. The modification of the structures provides the opportunity for native non-game species to have continuous habitat connectivity. While these individual projects may open several miles of the river, other structures are still present and could be modified in the future. Many of these species are on the state threatened and endangered list. The continuous habitat provides additional protection for these attributes. In addition, the removal of structures and some modifications provide additional flat water boating opportunities in the urban corridor of the river. These projects directly address both environmental and recreational goals.

Some examples of these projects throughout the basin include the Green Ditch on Boulder Creek and the Josh Ames Ditch on the Cache la Poudre River.

Figure 5-1 shows the environmental and recreational focus areas and locations of the rare fish habitat, and recreational boating areas in part of the Northern region of the South Platte Basin. The data to evaluate the function of each structure in terms of fish or recreational passage is not in the current database and is beyond the scope of this BIP. Additional analyses using the Stream Mile Representation Framework could be completed in the future to evaluate these projects.

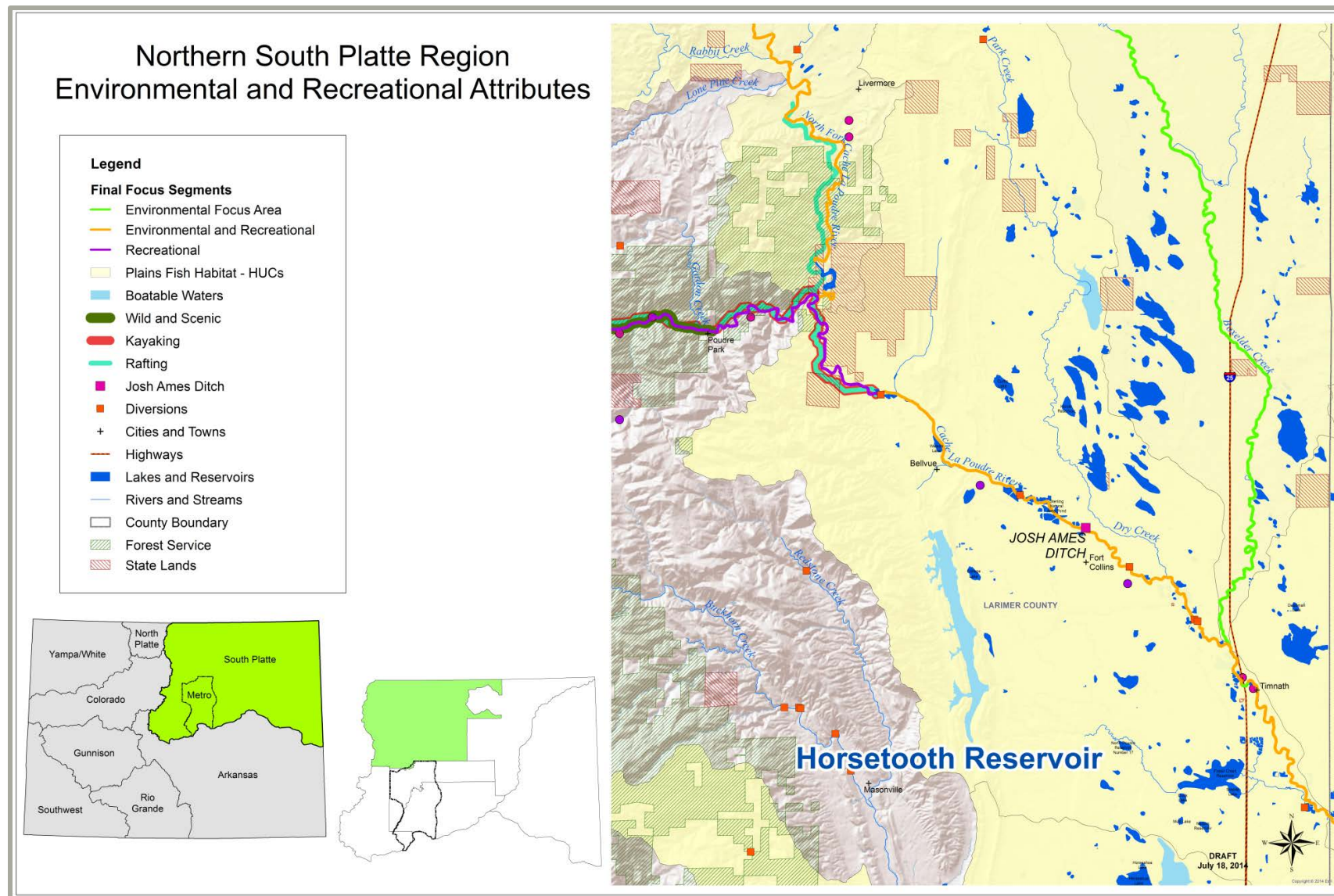


Figure 5-1. South Platte Northern Environmental and Recreational Enhancements

5.1.2 Example Area Analysis – St. Vrain Creek at Lyons

To demonstrate the stream mile representation framework described earlier in Appendix, the example area analyzed for the Northern Region is located on St. Vrain Creek near Lyons, Colorado.

Stream Mile Representation Analysis

The gage analyzed within this reach is the St. Vrain Creek at Lyons gage (SVCLYOCO, 06724000). The section of river analyzed includes an approximately 7 mile stretch on St. Vrain Creek from the confluence of South St. Vrain Creek and North St. Vrain Creek. It also includes approximately 6 miles on both the South and North St. Vrain Creeks. The example area is shown in the map in **Figure 5-2**.

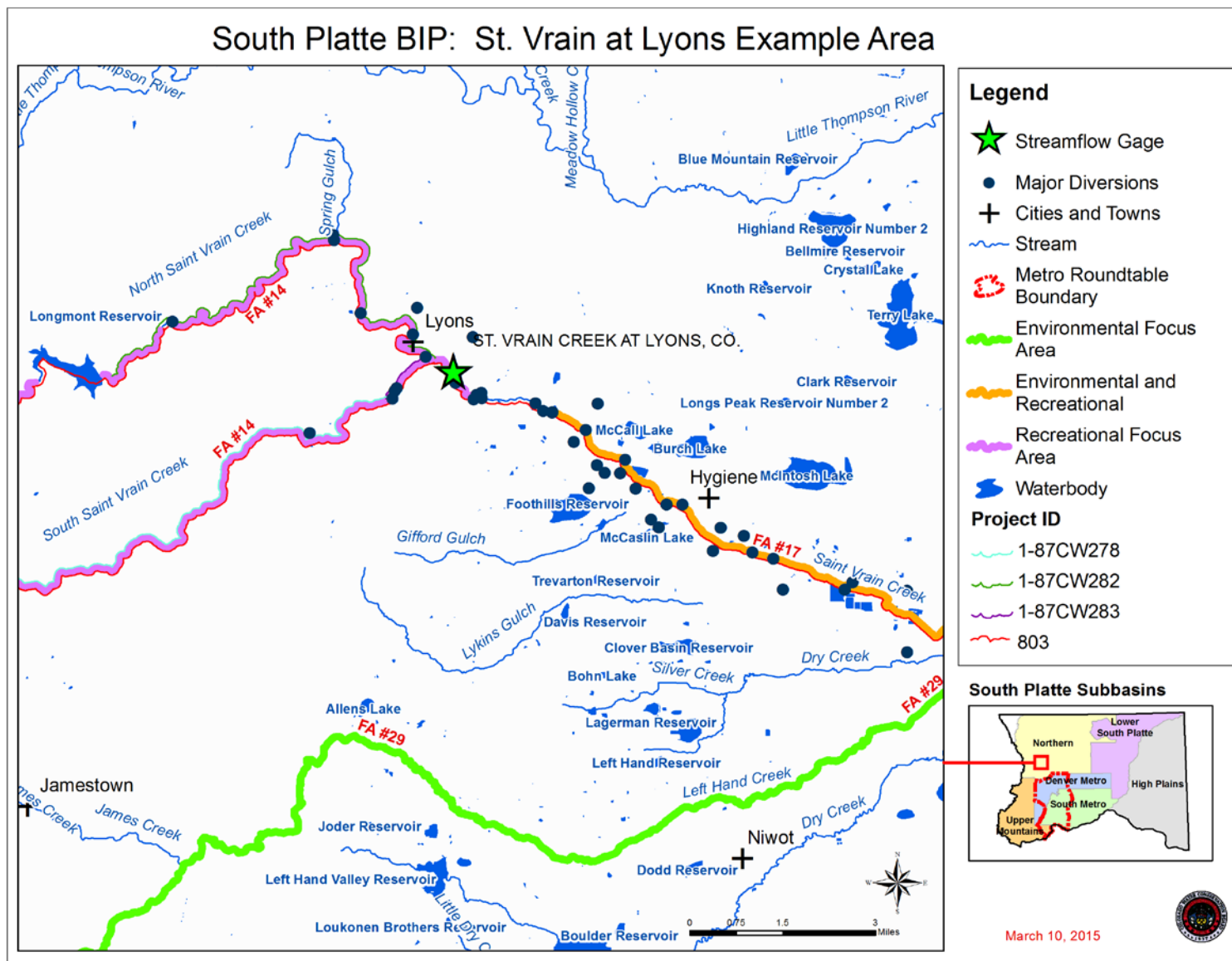


Figure 5-2 - St. Vrain at Lyons Example Area Map

The portion of the stream mile representation framework spreadsheet for this stretch of river is shown in Appendix D-7, with the full spreadsheet available on SouthPlatteBasin.com. A brief summary of the items shown in the stream mile representation follows.

The attribute categories located in the example area include:

- Environmental:
 - o Plains Fish State Endangered, Threatened, Species of Special Concern
 - o State Endangered, Threatened, Species of Special Concern
 - o Important Riparian Habitat
- Recreational:
 - o Fishing
 - o Recreation (boating)

The example area includes portions of Focus Area 14, a recreational focus area which includes North Saint Vrain Creek, from Horse Creek to Highway 36 and South Saint Vrain Creek from Middle Saint Vrain Creek to the confluence with the North Saint Vrain. The streamflow gage data analyzed in this example is within Focus Area 14. The example area also includes portions of Focus Area 17, an environmental and recreational focus area which includes Saint Vrain Creek from the James Ditch to the confluence of the Saint Vrain with the South Platte River. The example area also includes a short segment that is not in a focus area between Focus Areas 14 and 17 on Saint Vrain Creek.

Based upon the stream mile representation and available project data with available spatial data, the projects upstream and downstream from the streamflow gage include:

- Streamflow Enhancement Project (803) – The St. Vrain Creek Corridor Committee releases 1000 acre-feet per year to benefit minnows.
- Decreed Minimum Instream Flows – Including Division One Case Nos. 78W9362, 78W9363, 87CW278, 87CW281, 87CW282, and 87CW283.
- Stewardship Projects – Stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations. These projects typically provide riparian habitat protection rather than streamflow benefits.

There are various diversions in the area, as shown in the map. These diversions include diversions for the Cities of Longmont and Lyons, as well as many other diversions for agriculture and municipal and industrial uses.

Streamflow Analysis

To analyze the streamflow available to the various attributes at the gage location, streamflows were analyzed in various ways.

The period of record for the Lyons gage analyzed extended from 1900 until 2013. The general hydrograph over the period of record is shown in **Figure 5-3**.

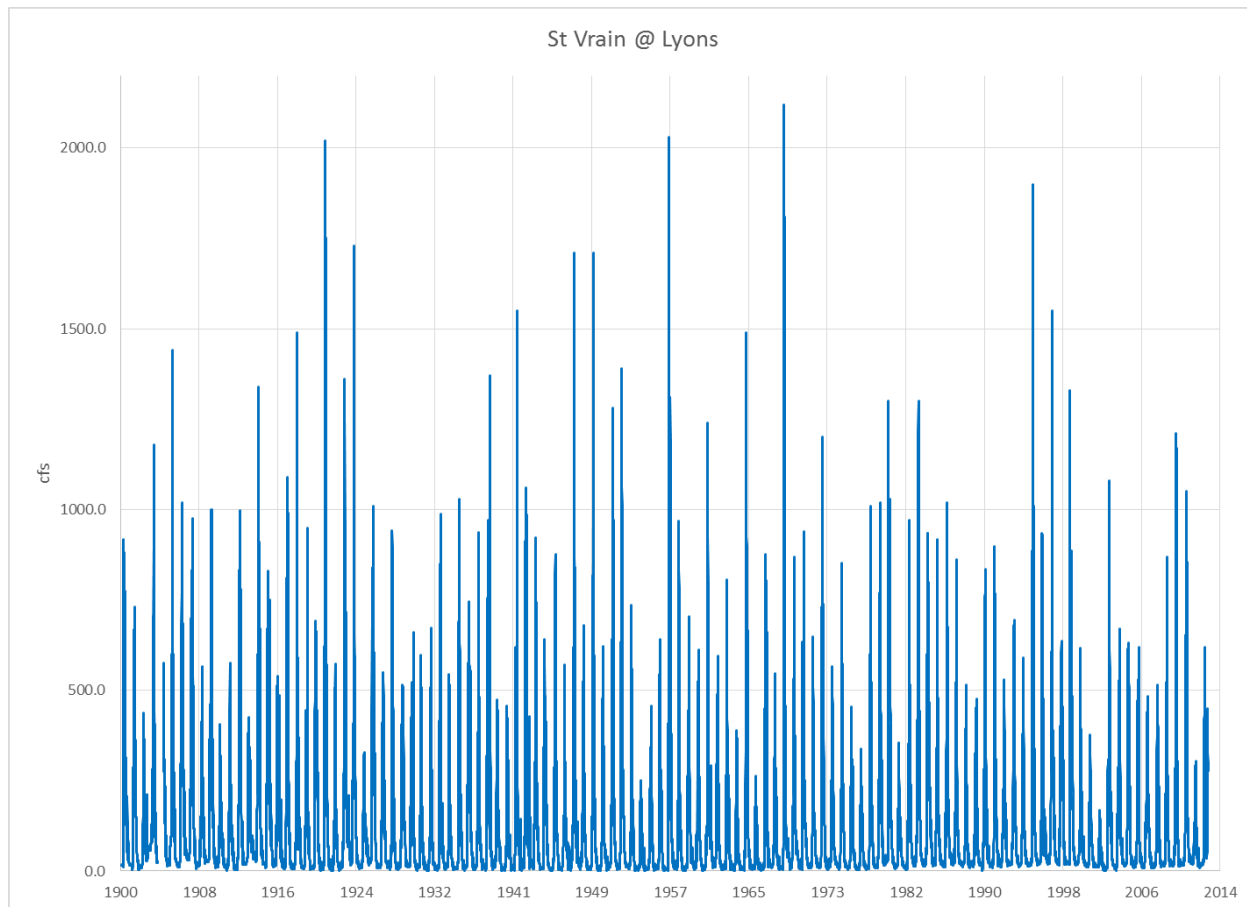


Figure 5-3 – Time Series Hydrograph of St. Vrain Creek at Lyons (Gage: SVCLYOCO, 06724000)

The hydrograph was disaggregated on a yearly basis to examine certain flow requirements for environmental and recreational needs.

Site and species specific studies are needed to determine the minimum flow needed to sustain the native species. Flow regimes necessary to support aquatic species are extremely site specific, and the flow regimes can change significantly with a change in channel shape and function. No studies have been completed regarding specific flow requirements within the example area since the significant channel changes resulting from the September 2013 floods,. Results from hydraulic modeling must be assessed in conjunction with biologic assessments of the study area. If such studies become available, the streamflow requirements for aquatic and riparian needs can be added into the analysis.

The environmental minimum flows shown in the table below are based upon the minimum instream flows decreed in the reaches of the South and North Forks of the St. Vrain immediately above the gage. The minimum instream flows for the North and South Forks were combined to analyze the flow at the gage. The decreed instream flows should be compared to environmental flow recommendations if they become available. The minimum instream flows for the North Fork of the St. Vrain were decreed in Division 1 Case No. 87CW282. The minimum instream flows decreed in the South Fork segment

closest to the confluence with the North Fork were decreed in Division 1 Case No. 87CW283.

There were no studies specifically indicating required flushing flows in the area. Flushing flows are needed to move sediment downstream, creating diverse aquatic habitat, as well as to aid in life cycle functions of species. Therefore general recommendations based on the Tennant method for flushing flows of 200% of the annual mean flow were determined. The mean flow based solely on the gage data was 124cfs, therefore a recommended flushing flow of 248 cfs was included in the analysis.³ The flow rate and duration of flushing flows should be determined from additional hydraulic analyses based on specific channel characteristics at the project locations.

There are no studies suggesting specific recreational flow recommendations in the South Platte basin, nor in this reach. However, there is information anecdotally available on American Whitewater's website regarding flows within specific reaches. There are anecdotal recommendations for both the North and South Forks of St. Vrain Creek above the confluence of these two forks. The recommendations were summed to estimate the range of anecdotally acceptable whitewater boating flows at the gage.

Table 4 shows the recommendations based on these sources. Refinements should be made with site-specific studies before using these values to plan or implement projects.

Table 4 - St. Vrain Creek at Lyons - General Flow Recommendations (in cfs)

Month	Minimum Instream Flow			Flushing Flows	Anecdotal Recreational Minimum Flow			Anecdotal Recreational Maximum Flow		
	S Fork	N Fork	Combined at gage		S Fork	N Fork	Combined at gage	S Fork	N Fork	Combined at gage
January	4	3	7							
February	4	3	7							
March	4	3	7							
April	20	8	28							
May	20	21	41	~248	150	80	230	300	315	615
June	20	21	41	~248	150	80	230	300	315	615
July	20	21	41		150	80	230	300	315	615
August	20	14	34							
September	20	8	28							
October 1-14		8	20							
15-24	12	6	18							
25-31		4	16							
November	12	3	15							
December	4	3	7							

These general recommendations were compared to specific annual hydrographs, as well as the time series data. The decreed minimum instream flows are indicated by the red line in the following graphs. The flushing flows are indicated by the yellow line in the

³ Tennant method or "Montana" method for determining flushing flows. General description of the Tennant Method can be found in *The flushing flow problem: Defining and evaluating objective*, Kondolf, Wilcox, (Water Resources Research, August 1996) and *Hydrological Low Flow Indices and their Uses*, Pyrcie (Watershed Science Center, 2004). Additional literature states the annual natural streamflow should be used and additional analyses should be used to determine appropriate flushing flows.

following graphs. The recreational flows are indicated in the green and blue lines, for the minimum recreational recommended flow and maximum recreational flow, respectively. The annual hydrographs for 2002 through 2004 are shown in **Figure 5-4** through **Figure 5-5**.

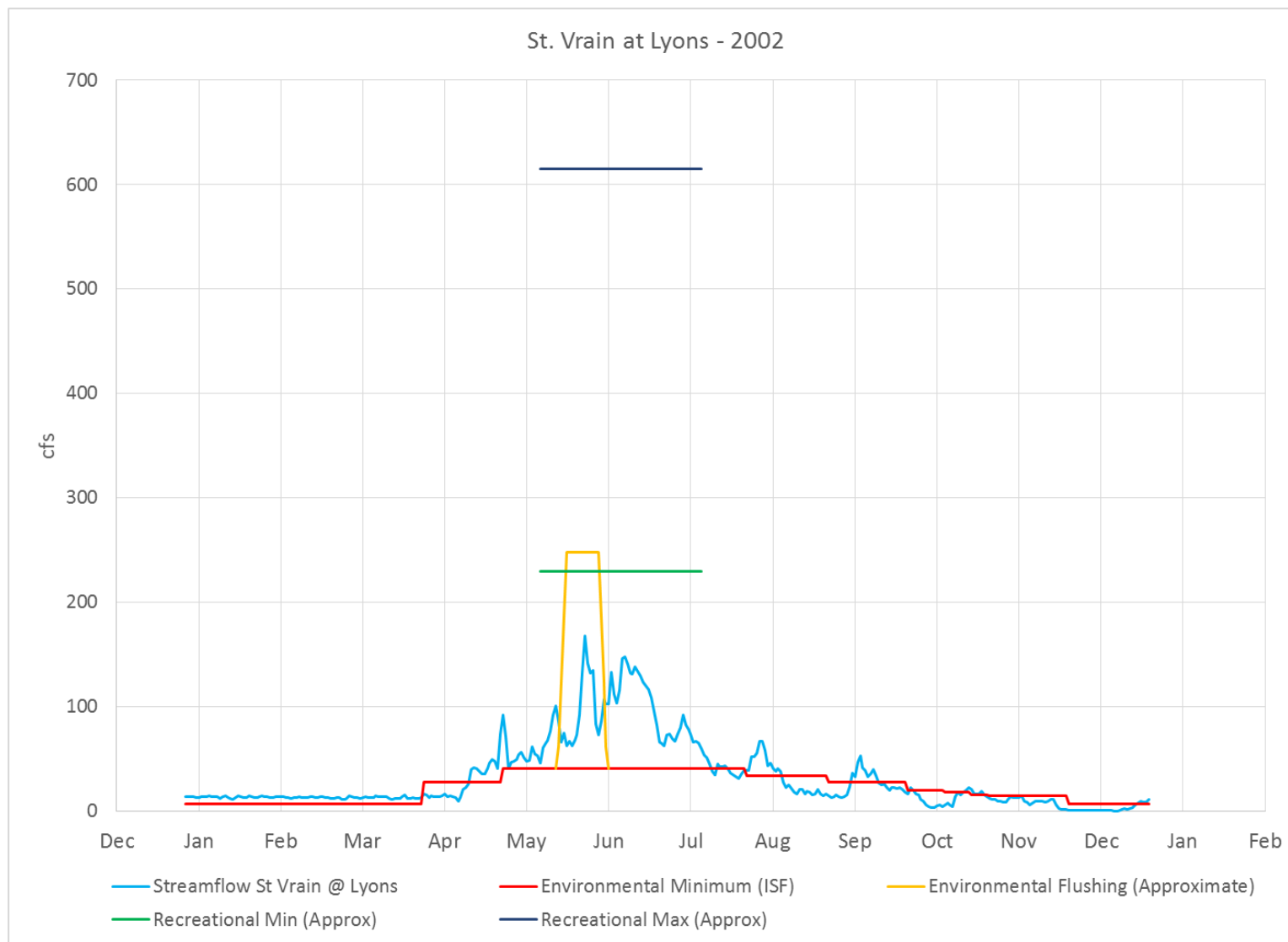


Figure 5-4 - Hydrograph comparison to available environmental and recreational flow information - 2002

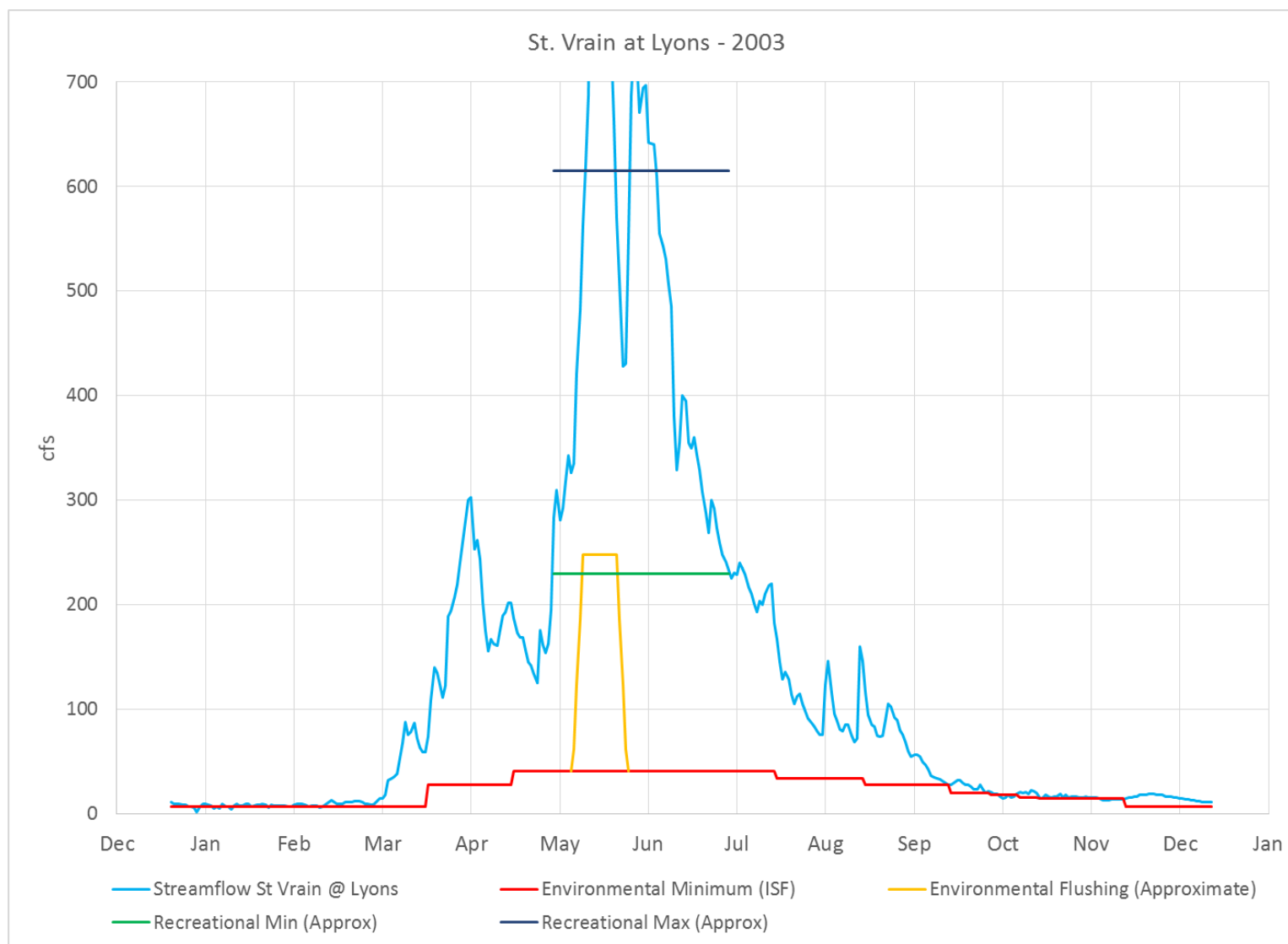


Figure 5-5 - Hydrograph comparison to available environmental and recreational flow information - 2003

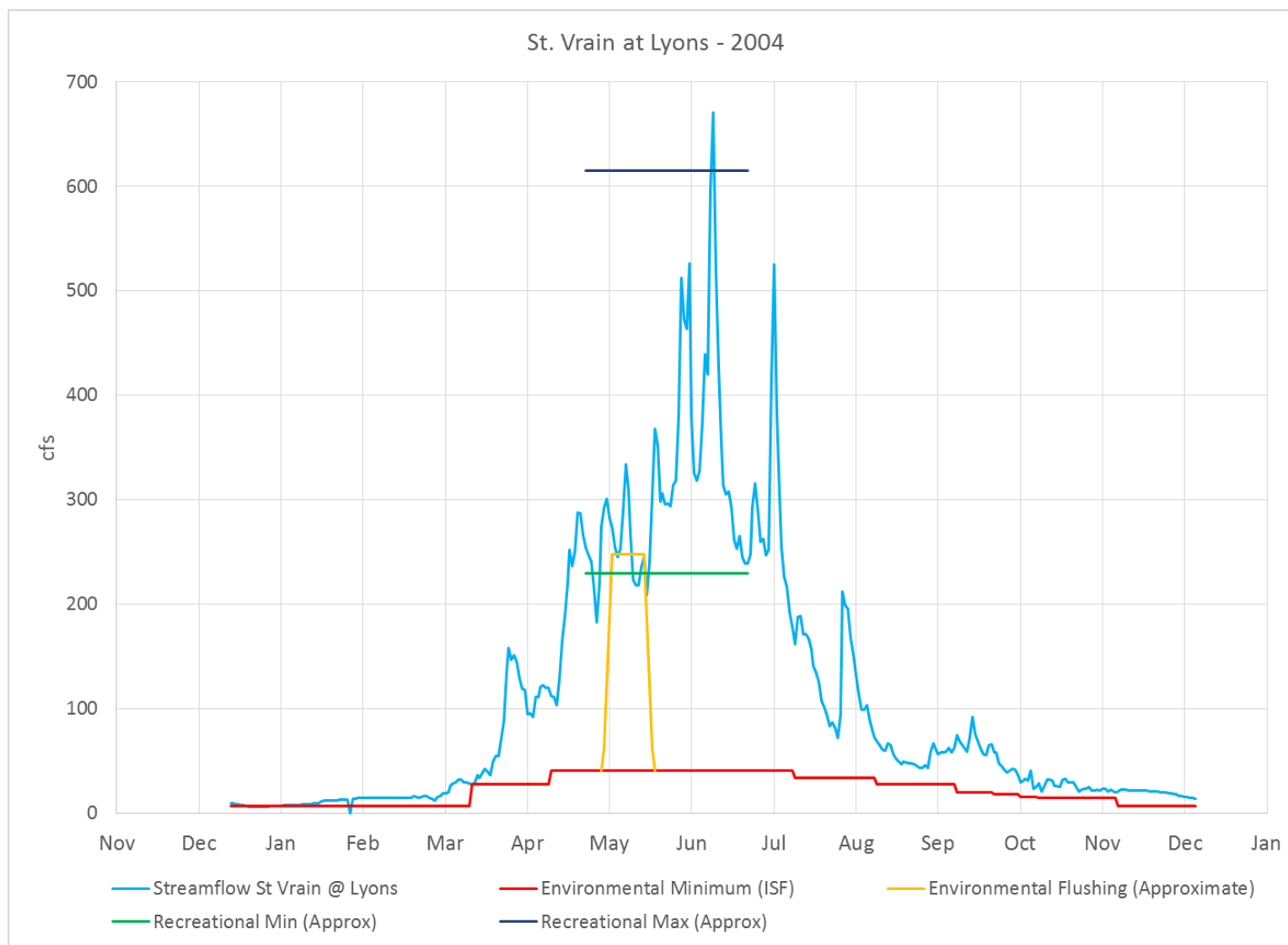


Figure 5-6 - Hydrograph comparison to available environmental and recreational flow information - 2004

In addition to comparing the flows in the St. Vrain in specific years, time series raster plots were developed to demonstrate the flows over the period of record. A raster plot can show flows as different colors, based on specific parameters that take the flow recommendations into consideration. A time-series raster plot can assist in giving planners a quick snapshot of flows with respect to certain environmental and recreational considerations. The time series raster plots shown below were developed to graphically demonstrate how the various general flow recommendations described above are met based on the time series data for the gage.

To demonstrate the times when the minimum instream flows from the CWCB decrees are met or not met by the available streamflows, a time-series raster plot was developed, as shown in **Figure 5-7**. The days when the minimum decreed instream flow rates were not met are indicated in red on the raster plot. The flows above the minimum instream flow rates are indicated in yellow on days on which streamflows were greater than the minimum instream flow rate. The minimum instream flows were decreed in 1988. Accordingly, the time series generally shows fewer days that the minimum flows were not met as compared to earlier in the period. This plot shows times when there are opportunities to potentially increase the flows in the river to meet the instream flow requirements. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.

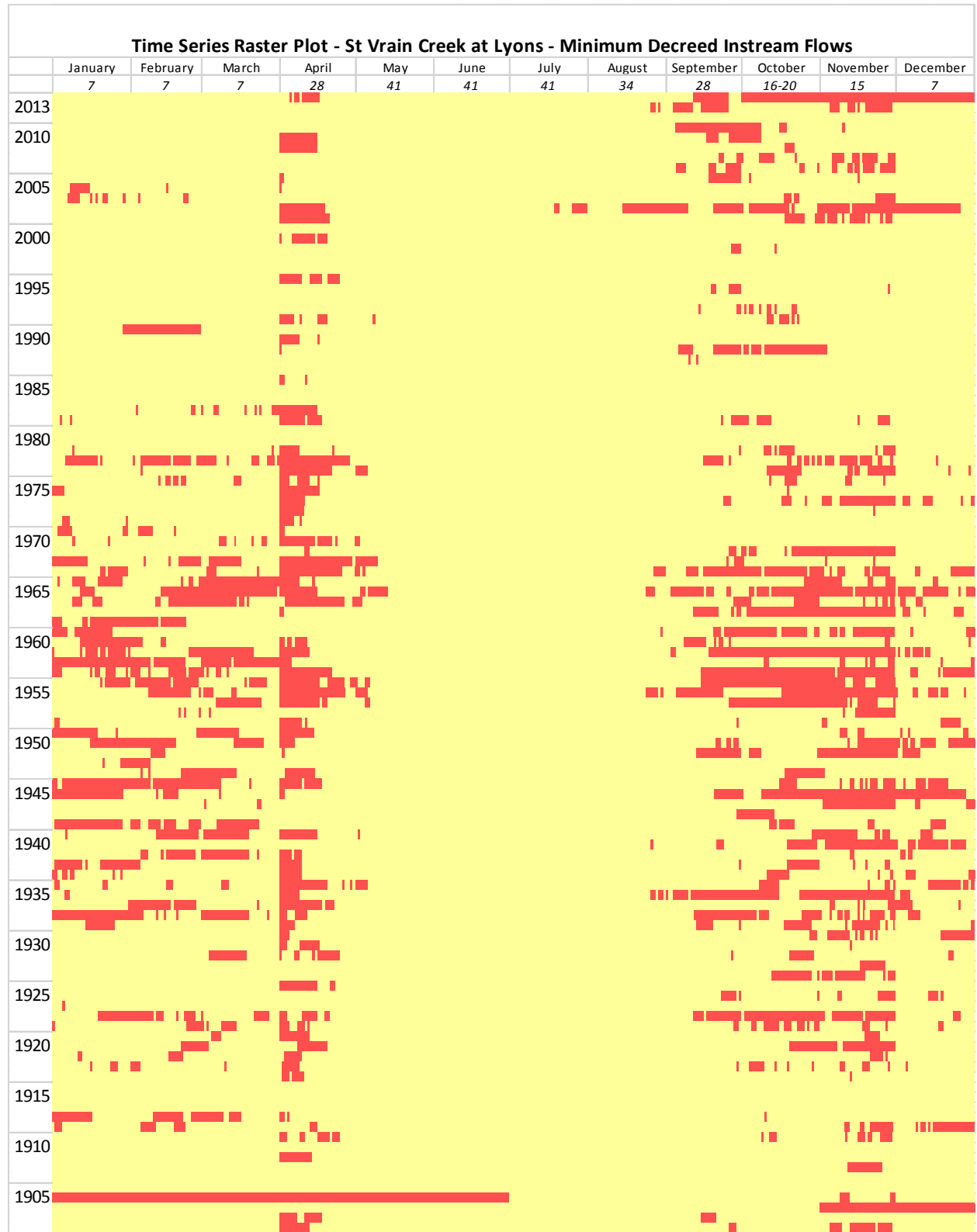


Figure 5-7 - Time Series Raster Plot - St Vrain Creek at Lyons - Minimum Decreed Instream Flows

To demonstrate the times when the flushing flows recommendations are met or not met, a time-series raster plot was developed, as shown in **Figure 5-8**. The yellow on the plot shows times when the flow is greater than the generally recommended flushing flows. The red in the plot shows times when the flow is less than the generally recommended flushing flows. In general, in most years there appears to be flushing flows available in this area, based on the Tennant method. Additional work to determine the required flushing flow rates, duration and frequency is needed. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.

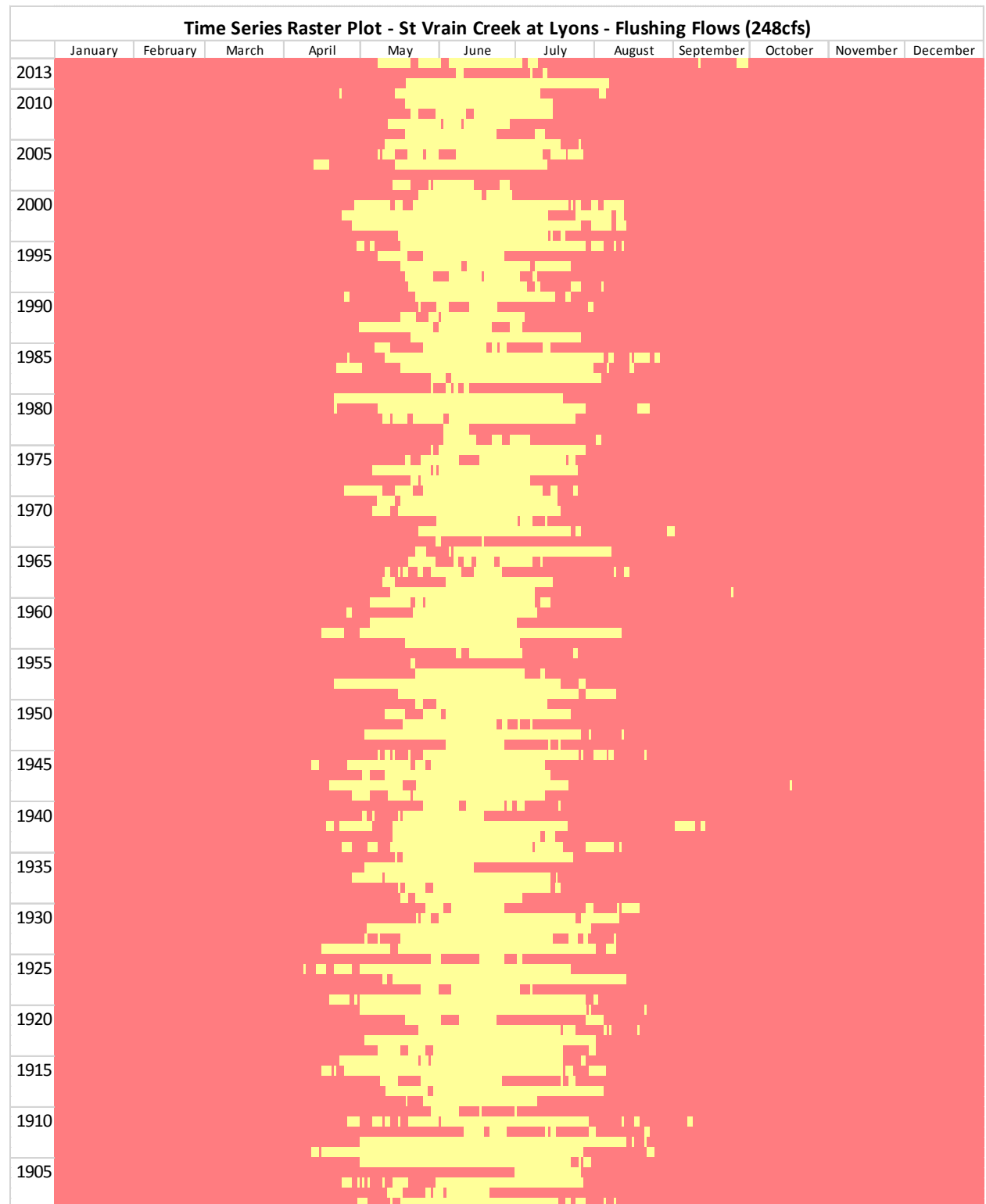


Figure 5-8 - Time Series Raster Plot - St Vrain Creek at Lyons - Flushing Flows (248cfs)

To demonstrate the times when the anecdotal recreational flows are met or exceeded, a time-series raster plot was developed, as shown in **Figure 5-9**. The green on the plot shows times when the flow is between the generally recommended recreational flows of 230 cfs to 615 cfs from April through October. The red in the plot shows times when the flow is less than the generally recommended minimum recreational flows. The yellow in the plot shows times when the flow is greater than the generally recommended maximum recreational flows. This plot shows times when there are opportunities to potentially increase the flows in the river to meet recreational needs. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of recreational uses determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess recreational flows of the stream.

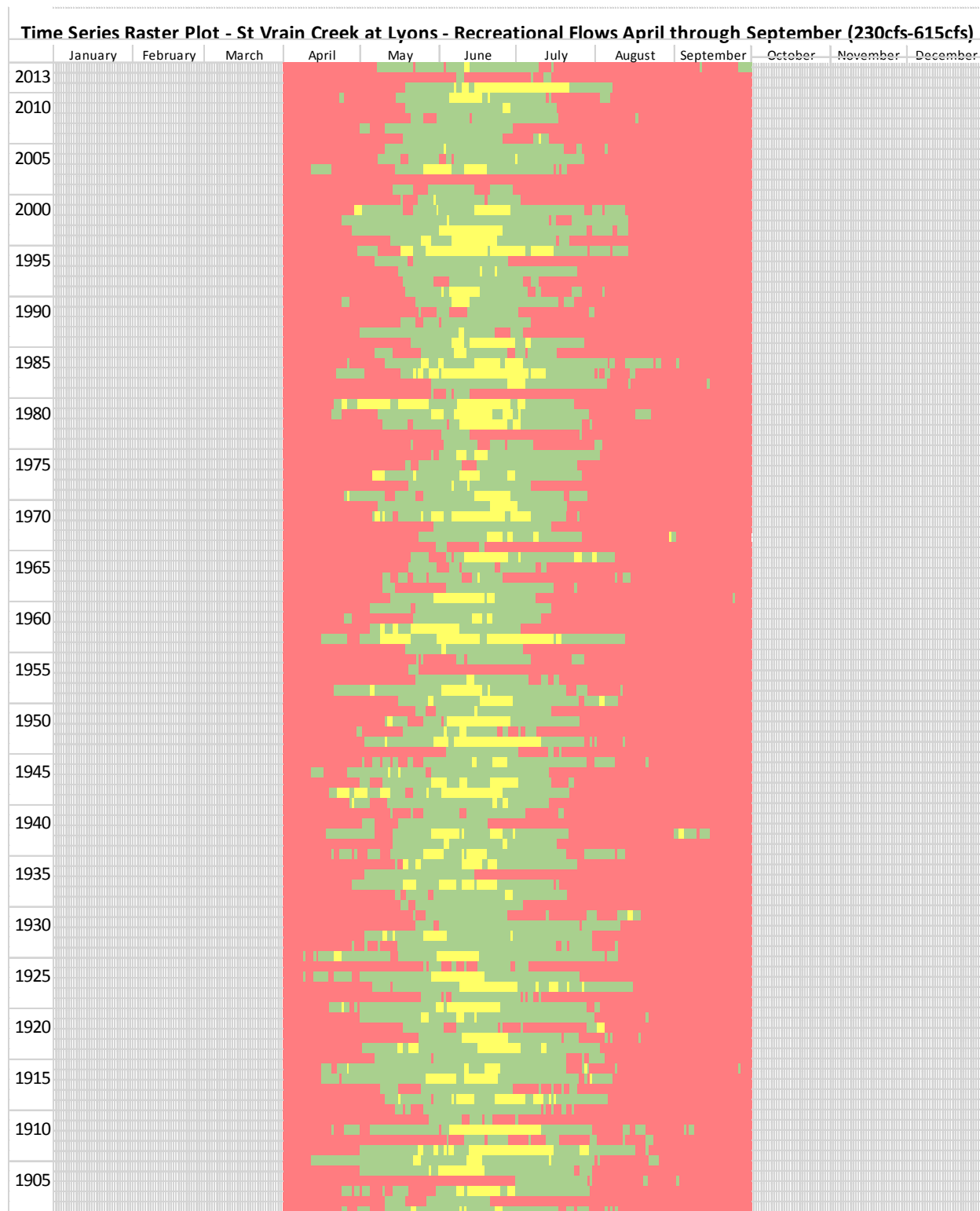


Figure 5-9 - Time Series Raster Plot - St Vrain Creek at Lyons - Recreational Flows April through September (230cfs-615cfs)

General Discussion and Recommendations

In general, the analysis of streamflows on the St. Vrain at Lyons indicates the streamflows may be present in this area to meet the very general flow recommendations presented above. However, significant additional flow study information is necessary to determine if these recommendations are adequate for environmental and recreational protection.

There is a great amount of additional data needed to fully assess the environmental and recreational protections that exist and may be needed in the example area on the St. Vrain. Studies that relate the channel form and function to the streamflows can make assessment of flows in the area more robust. With the significant changes in the channel after the September 2013 floods, assessments should be made regarding the requirements of aquatic and riparian ecosystems in the area. In addition, streamflows necessary for recreational needs should be assessed.

The time-series raster plots are also helpful in assessing what flows may be needed or available for additional municipal and industrial projects. The Surface Water Availability Analysis (detailed in Appendix G) shows that there is potentially availability for surface water development at times in the St. Vrain at Lyons. Comparing to the raster plots once additional work has been done to fully assess the flows required for environmental and recreational needs can show times when additional diversions may not negatively impact the minimum flows, flushing flows or recreational flows. It appears that times of lengthy flushing flows, greater than preferred recreational flows and adequate minimum instream flows may coincide with times of legal and physical availability. Additional daily analysis and comparison should be done to ensure the times generally shown in the raster plot and the summarized annual availability coincide, before determination is made that additional diversions may not impact environmental and recreational flows.

Specific types of projects that may help to protect or enhance the environmental and recreational flows in the area include:

- Stream channel modifications – Particularly following the September 2013 floods on the St. Vrain, channel restoration could significantly benefit the aquatic and riparian habitat in the example area. The St. Vrain Master Plan indicated various types and locations of specific stream channel modifications that may benefit environmental and recreational needs as well as assist in future flood mitigation.
- Fish Passage – There are various examples of fish passageways near the example area. Additional diversion structures could be modified in the future to assist with stream channel connectivity in the area.
- Operational Flow Agreements - There are some examples of operational flow agreements in the example area. The St. Vrain Creek Corridor Committee releases 1000 acre-feet per year to benefit minnows. Additional operational agreements could be pursued in the future to assist with minimum flows, flushing flows and recreational flows. Studies to determine the amount of beneficial flow should be conducted to assist with determining how these operational agreements could benefit the environmental and recreational attributes.

Additional projects should be added into the stream mile representation for analysis of the effect of projects within the area. Specific spatial data, as well as specific flow data

and completion date would be beneficial in determining when and to what degree these projects have benefited the example area.

The minimum instream flows shown in this analysis are specifically from settled upon decreed CWCB instream flows. The actual needs of the aquatic and riparian habitat should be specifically studied in this area if additional project recommendations are to be made to protect and enhance the environmental attributes in this reach. In addition, the minimum instream flows are located on two tributaries upstream of the subject gage. Aggregating the instream flows to compare against the gage data may not reliably show if the instream flows were met previously, as there are diversion structures upstream of the gage, but downstream of the minimum instream flow reaches. These diversions could be taken into account in future work to fully assess the flows at the gage location.

5.2 Upper Mountain Region (Headwaters Areas)

There are various types of focus areas in the Upper Mountain Region with multiple project types in place, planned or needed to protect or enhance the environmental and recreational attributes. Fourteen of the 34 focus areas in the South Platte located in the Upper Mountain Region. The types of focus areas in the region include:

- Environmental attributes including: Significant, imperiled and rare wetland and riparian plant species and plant communities, habitat for federal and state endangered, threatened and species of concern including native minnow species, trout, cutthroat trout and lake chub;.
- Recreational attributes including: Fishing including Gold Medal Fisheries, whitewater boating, State Wildlife Areas, Eleven Mile Canyon National Forest Recreation Area, and waterfowl hunting and viewing.

The rationale for inclusion of many of these Focus Areas is the presence of significant, imperiled and rare/wetland plant species and plant communities. These plant communities are the result of the natural stream systems in the area, topography, and geology.

There are various projects throughout the Upper Mountain Region addressing environmental and recreational needs. Project types in the region include stream and riparian restoration, stewardship projects, instream flows, streamflow agreements, and various types of studies.

To demonstrate the types of projects within the Upper Mountain Region, specific existing projects are highlighted. In addition, the stream mile representation framework previously discussed was used to generally analyze the environmental and recreational needs and the existing and future projects within that area that may address the gap.

5.2.1 Example Projects – Upper Mountain Region

Examples of projects in the Upper Mountain Region addressing rare plant communities include CPW, CWCB, NCNA interviewed, stewardship, and ISF in Park County are present in most of the Park County Focus Areas. There are a total of 325 miles of the South Platte Basin with the rare plant communities attribute present and a total of 156 miles in the Park County Focus Areas. However, the sufficiency of these projects for protecting the attributes has not been assessed.

These projects may provide protection for the rare plants and significant plant communities attributes in the following ways. Future projects that can provide protections to these plant communities include maintaining the hydrologic conditions that formed and support these plant communities. These protections include continued irrigation on parcels where the plant communities may be irrigation-dependent due to lowering groundwater tables in the area and maintaining the natural surface water–groundwater interactions where those natural characteristics protect the plant communities. These types of projects can also provide benefit to recreational uses in the area, including fishing and boating.

Some examples of current projects that currently provide some protections to these plant communities include stewardship programs in the area, instream flow water rights, stream restoration projects (including Lower Tarryall Creek, Middle Fork at Buffalo Peaks State Wildlife Area, and Five-Mile Creek), and the South Platte Protection Plan. There are other similar planned projects in the area.

These types of projects address the goals of maintaining and enhancing important wetland and riparian plant communities. Figure 5-10 shows the environmental and recreational focus areas and locations of the rare aquatic-dependent plants in Park County.

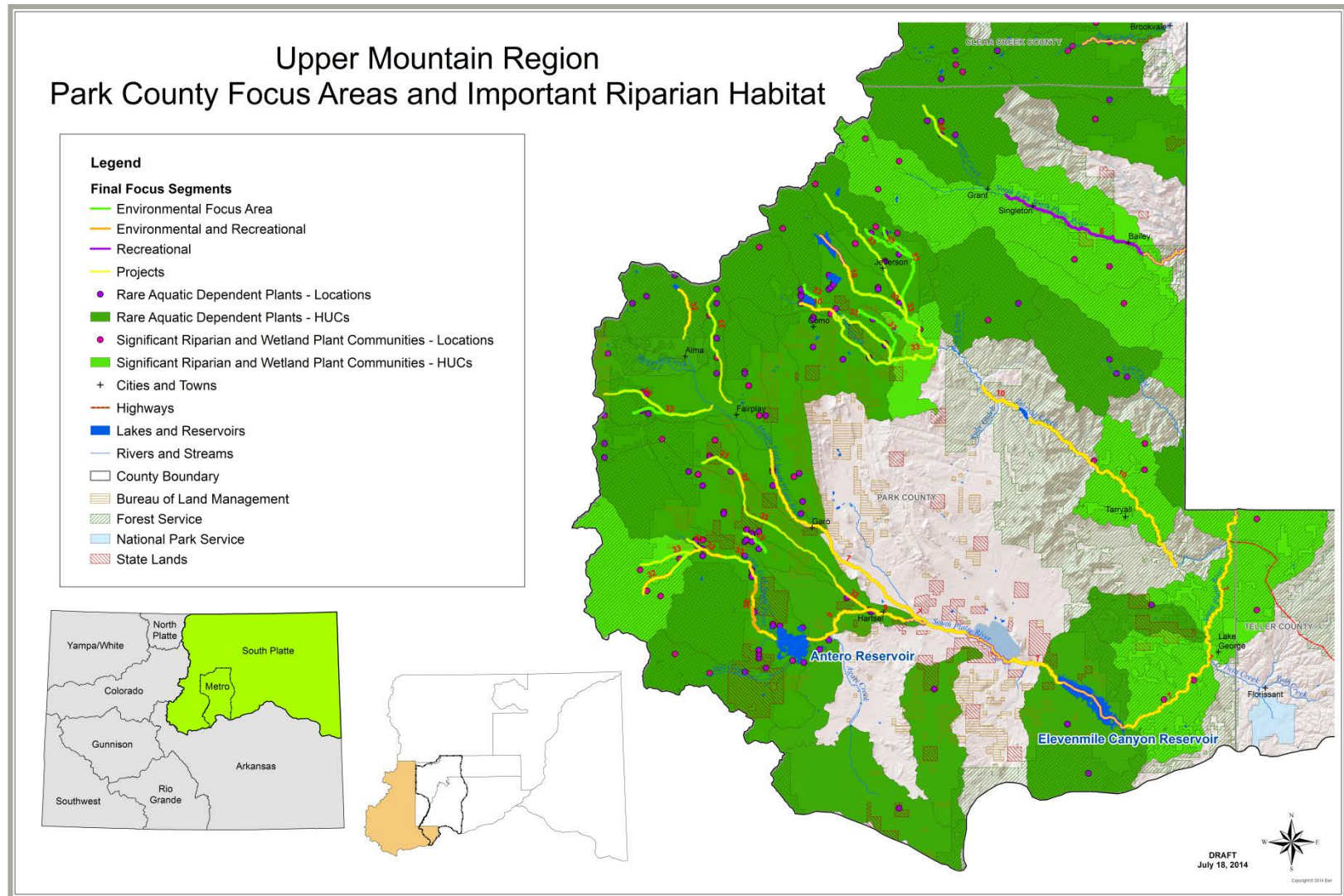


Figure 5-10. Park County Important Riparian Habitat

5.2.2 Example Area Analysis – South Platte River above Elevenmile Reservoir

To demonstrate the stream mile representation methodology described earlier in this Appendix, the example area analyzed for the Upper Mountain Region is located on the South Platte River, above Elevenmile Reservoir.

Stream Mile Representation Analysis

The gage analyzed within this reach is the South Platte above Elevenmile gage (PLAHARCO, 06695000). The section of river analyzed includes an approximately 12 mile stretch on the South Platte River including Spinney Reservoir and Elevenmile Reservoir. The example area is shown in the map in Figure 5-11.

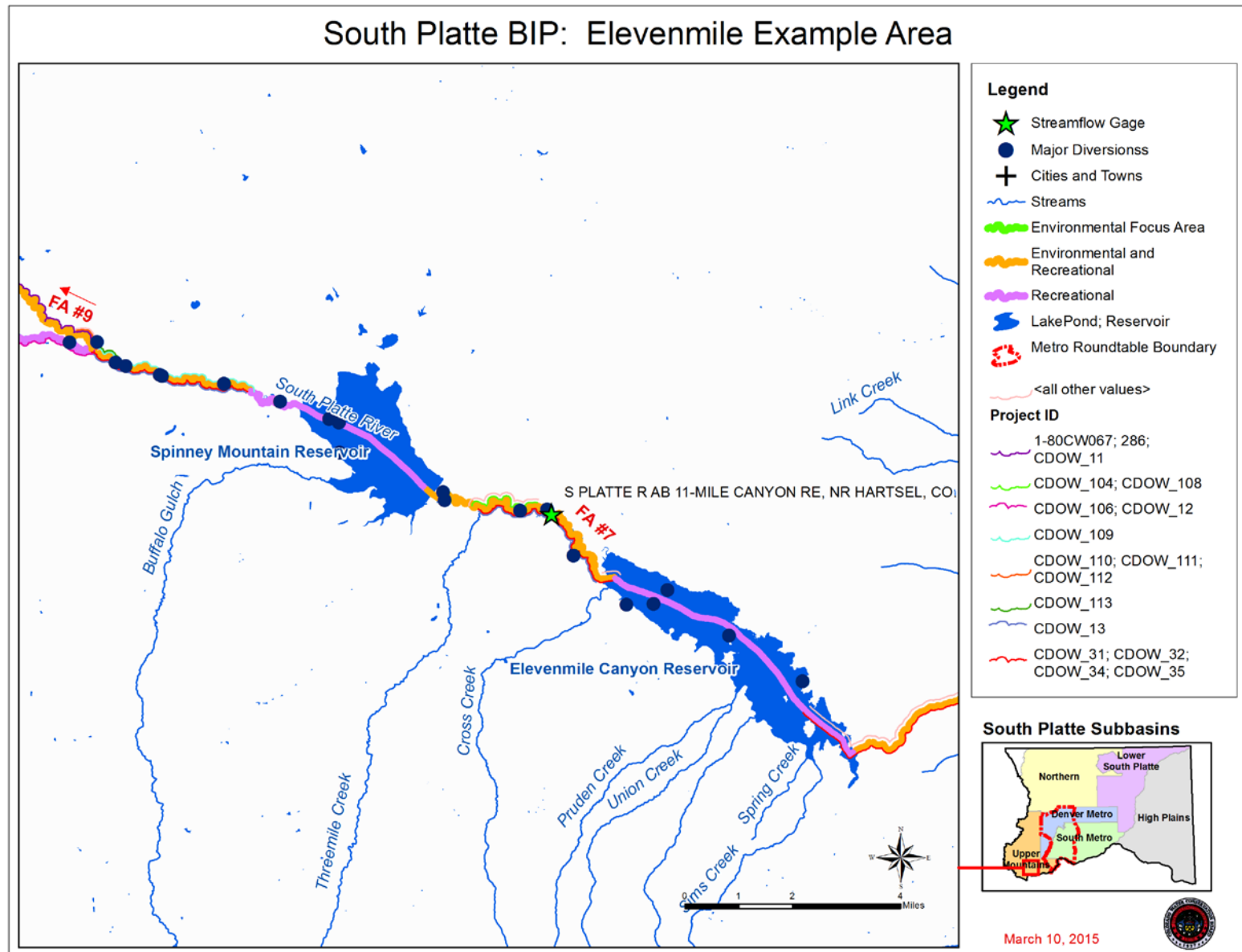


Figure 5-11 - Elevenmile Example Area Map

The portion of the stream mile representation framework spreadsheet for this stretch of river is shown in Appendix D-7, with the full spreadsheet available on SouthPlatteBasin.com. A brief summary of the items shown in the stream mile representation follows.

The attribute categories located in the example area include:

- Environmental:
 - o Plains Fish State Endangered, Threatened, Species of Special Concern
 - o State Endangered, Threatened, Species of Special Concern
 - o Important Riparian Habitat, including Significant Plant Species
- Recreational:
 - o Fishing (including Gold Medal Streams and Lakes)
 - o Recreation (boating)

The example area includes portions of Focus Area 7, an environmental and recreational focus area which includes portions of the South Platte River from the Middle and South Fork Confluence to Chatfield Reservoir. Focus Area 7 also includes portions of the Middle Fork from the Crooked Creek confluence to the confluence with the South Fork of the South Platte River. The streamflow gage data analyzed in this example is within Focus Area 7. Focus Area 9, an environmental and recreational focus area located upstream of the example area on the South Fork of the South Platte River below Antero Reservoir.

Based upon the stream mile representation and available project data with available spatial data, the projects upstream and downstream from the streamflow gage include:

- The South Platte Protection Plan – Includes flow recommendations for environmental and recreational needs, operational agreements, and some restoration and channel work.
- Various Restoration Projects – including the Hayman Fire Restoration, Trumbull Trout Habitat Restoration, Happy Meadow's/Sportsman's Paradise River Restoration, Buffalo Peaks Ranch Fish Habitat, Santa Maria Ranch Riparian Restoration, Five Mile Creek Channel Reconstruction, South Fork Project, Middle Fork South Platte Restoration, Dream Stream Projects, Upper South Platte Stream Restoration.
- Fish Habitat Projects - including identification of and modification to barriers to fish passage on the South Platte and tributaries, and species reintroduction.
- Decreed Minimum Instream Flow – Division One Case No. 80CW067, on the Middle Fork of the South Platte River.
- Stewardship Projects – Stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations. These projects typically provide riparian habitat protection rather than streamflow benefits.

There are various diversions in the area, as shown in the map. These diversions include various diversions for agriculture and municipal and industrial uses. There are also two on-channel reservoirs in the area, Spinney Reservoir and Elevenmile Reservoir.

Streamflow Analysis

To analyze the streamflow available to the various attributes at the gage location, streamflows were analyzed in various ways.

The period of record for the South Platte at Elevenmile gage analyzed extended from 1939 until 2013. The general hydrograph over the period of record is shown in Figure 5-12.

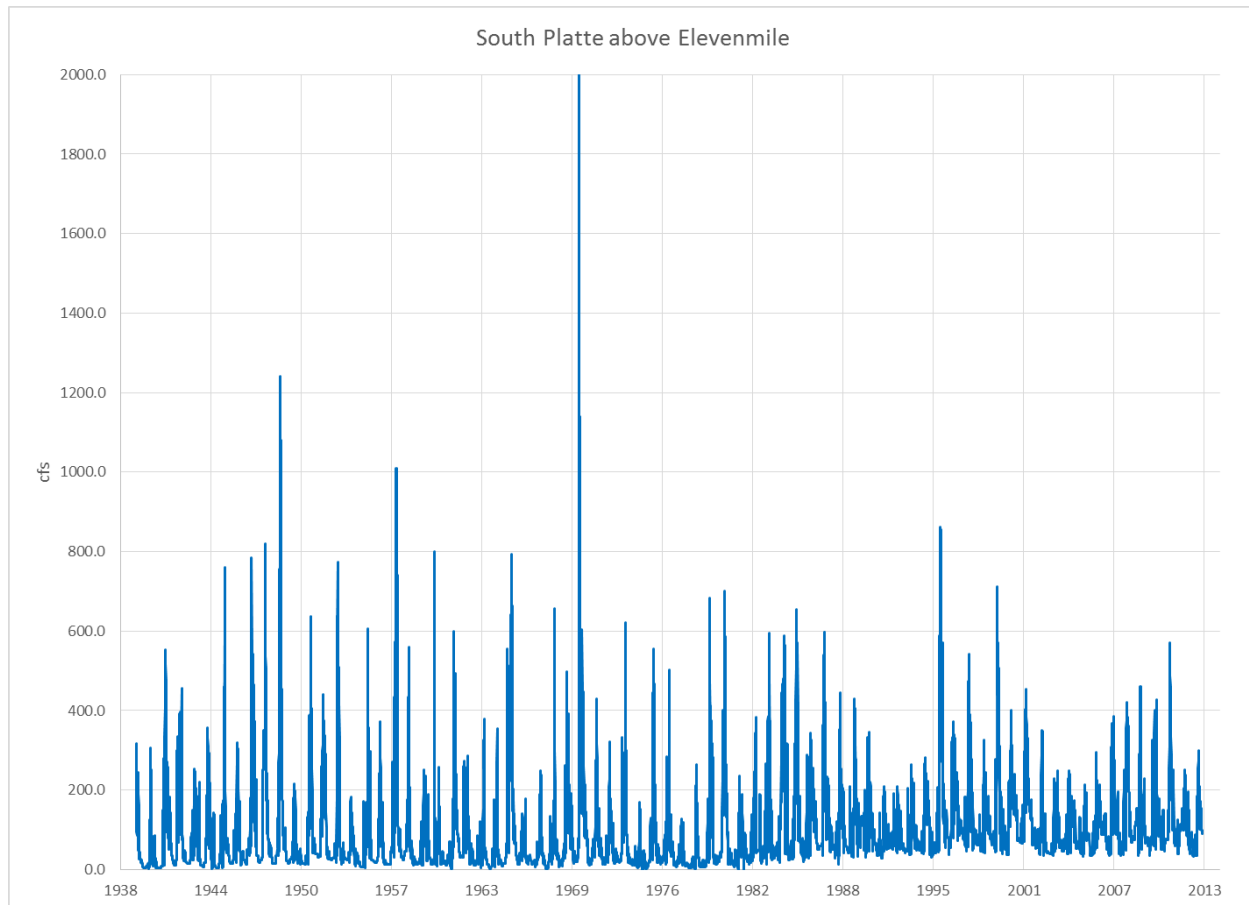


Figure 5-12 - Time Series Hydrograph of South Platte above Elevenmile (PLAHARCO, 06695000)

The hydrograph was disaggregated on a yearly basis to examine certain flow requirements for environmental and recreational needs.

The environmental minimum flows shown in the table below are based upon the information presented in the South Platte Protection Plan.

Site and species specific studies are needed to determine the minimum flow needed to sustain the native species. Flow regimes necessary to support aquatic species are extremely site specific, and the flow regimes can change significantly with a change in channel shape and function. Results from hydraulic modeling must be assessed in conjunction with biologic assessments of the study area. Currently the flows shown in the analysis are based upon the recommended flows of 50-100 cfs, with a minimum of 32 cfs based upon the South Platte Protection Plan. If additional studies become, the additional streamflow requirements for aquatic and riparian needs can be added into the analysis.

There were also no studies specifically indicating required flushing flows in the area. Flushing flows are needed to move sediment downstream, creating diverse aquatic habitat, as well as to aid in life cycle functions of species. Therefore general recommendations based on the Tennant method for flushing flows of 200% of the annual mean flow were determined. The mean flow during the non-winter months was determined to be 95 cfs, therefore a recommended flushing flow of 190 cfs was included in the analysis.⁴ The flow rate and duration of flushing flows should be determined from additional hydraulic analyses based on specific channel characteristics at the project locations.

There are no studies suggesting specific recreational flow recommendations in the South Platte basin, nor in this reach. However, there is information anecdotally available from the South Platte Protection Plan and from information on American Whitewater's website regarding flows near the gage.

Table 5 - South Platte River above Elevenmile - General Flow Recommendations (in cfs) Table 5 below shows the general recommendations based on these sources. Refinements should be made with site-specific studies before using these values to plan or implement projects.

Table 5 - South Platte River above Elevenmile - General Flow Recommendations (in cfs)

Month	Recommended Environmental Flow			Flushing Flows	Anecdotal Recreational Minimum Flow	Anecdotal Recreational Maximum Flow
	Env Minimum	Env Range Minimum	Env Range Higher			
January	32	50	150			
February	32	50	150			
March	32	50	150			
April	32	50	150			
May	32	50	150	~190	200	1000
June	32	50	150	~190	200	1000
July	32	50	150		200	1000
August	32	50	150			
September	32	50	150			
October	32	50	150			
November	32	50	150			
December	32	50	150			

These general recommendations were compared to specific annual hydrographs, as well as the time series data. The environmental minimum operational flow from the South Platte Protection Plan are indicated by the dashed orange line in the following graphs. The recommended range of flows are indicated by the red line (lower end of range) and the brown line (higher end of range) in the following graphs. The flushing flows are indicated by the yellow line in the following graphs. The minimum recreational recommended flow is indicated by the green line, and the maximum is not shown on the scale of the graphs. The annual hydrographs for 1977, 1978, and 2002 through 2004 are shown in Figure 5-13 through Figure 5-17. Spinney Reservoir was built in 1981, therefore

⁴ Tennant method or "Montana" method for determining flushing flows. General description of the Tennant Method can be found in *The flushing flow problem: Defining and evaluating objective*, Kondolf, Wilcox, (Water Resources Research, August 1996) and *Hydrological Low Flow Indices and their Uses*, Pyrcie (Watershed Science Center, 2004). Additional literature states the annual natural streamflow should be used and additional analyses should be used to determine appropriate flushing flows.

the hydrographs from 1977 and 1978 demonstrate the flows prior to the upstream reservoir being completed.

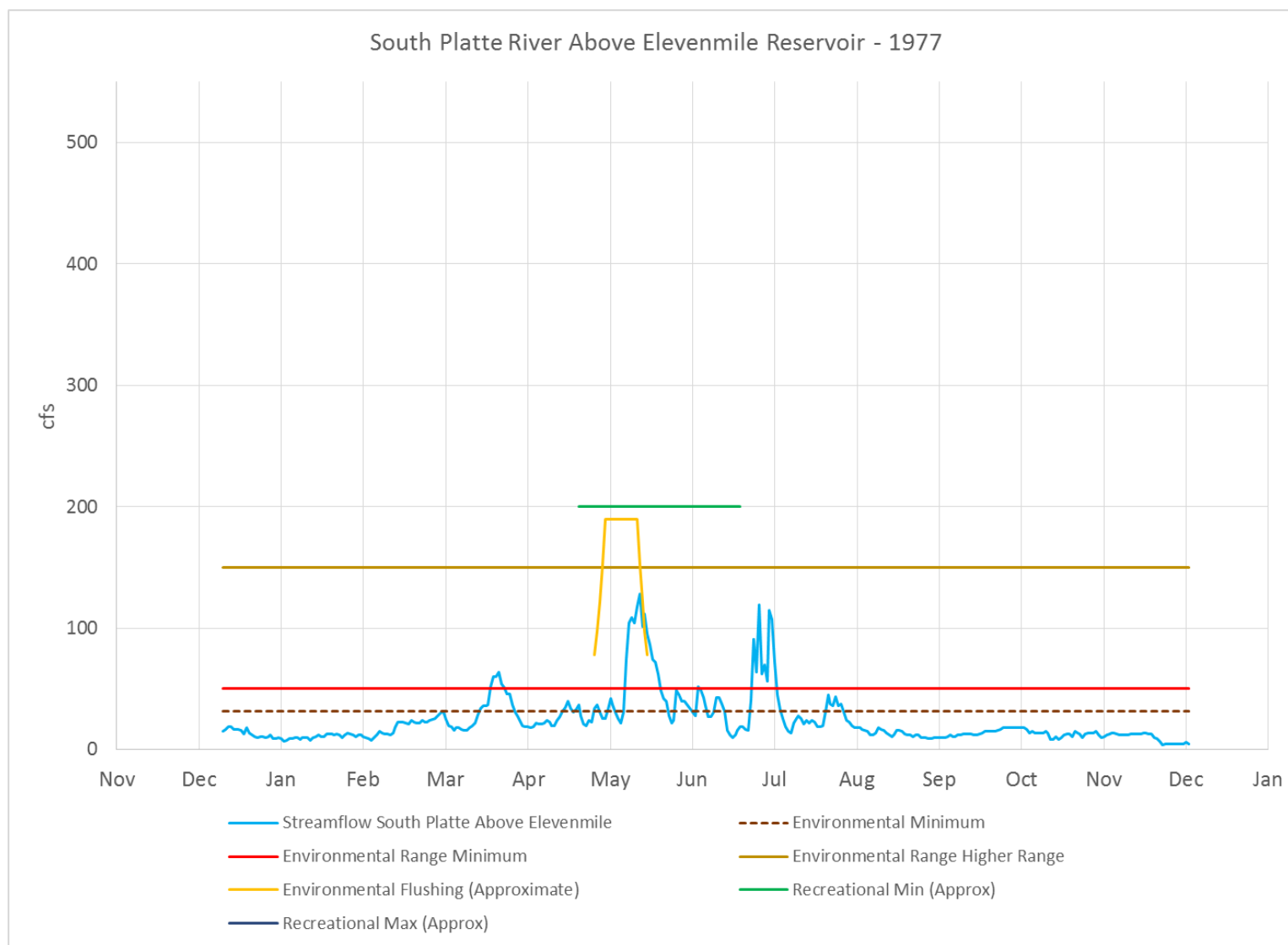


Figure 5-13 - Hydrograph comparison to available environmental and recreational flow information – 1977

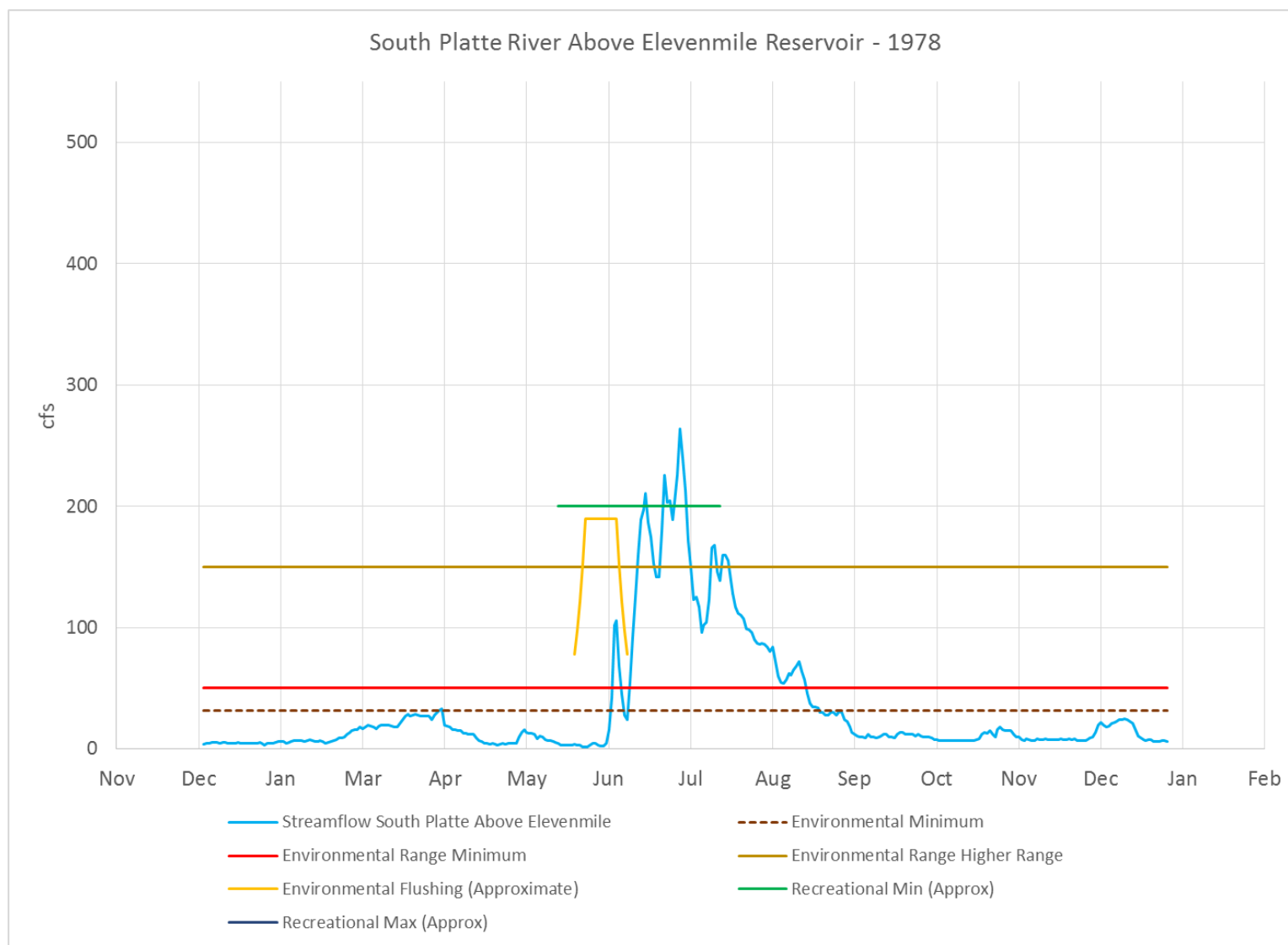


Figure 5-14 - Hydrograph comparison to available environmental and recreational flow information – 1978

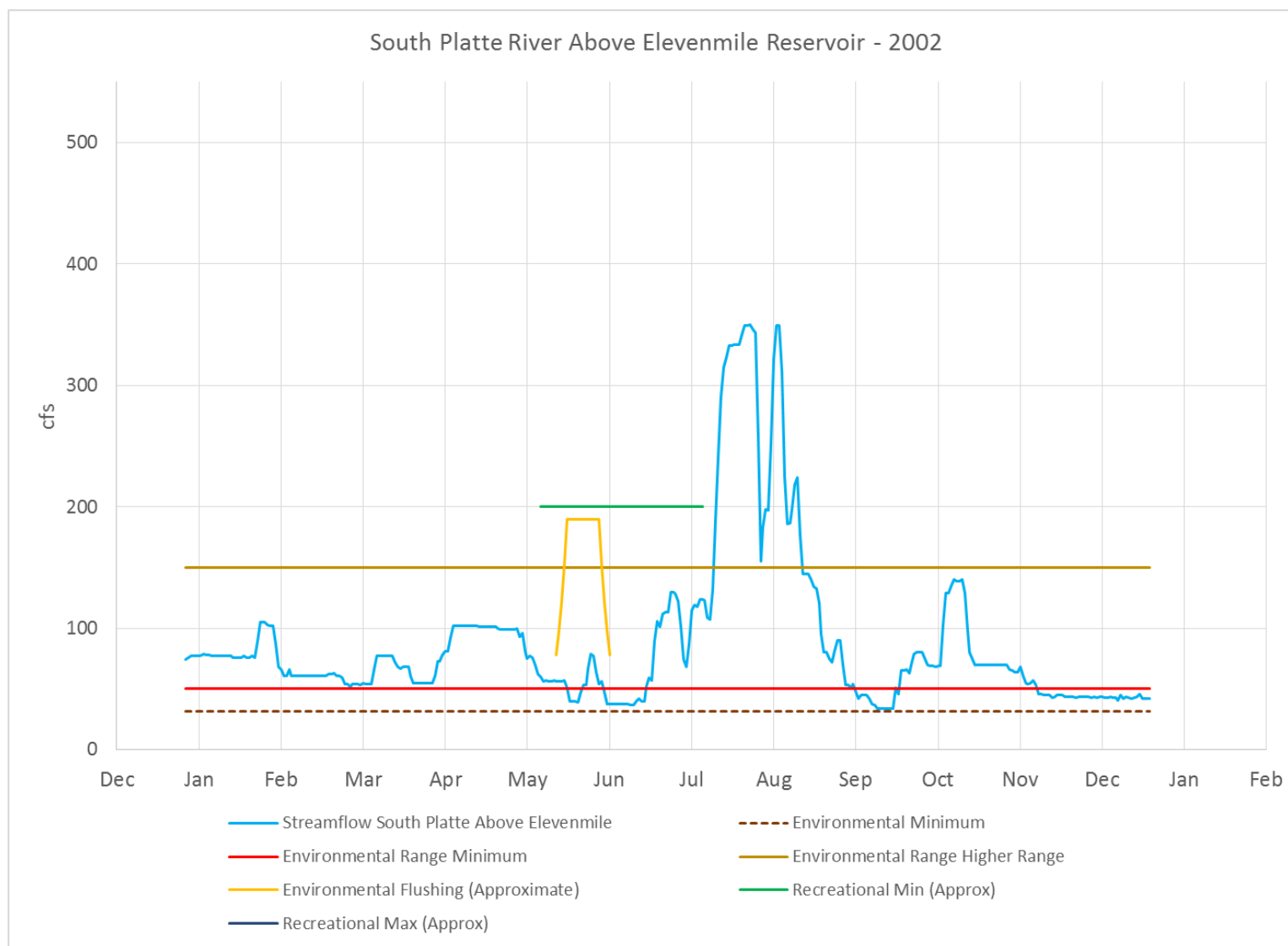


Figure 5-15 - Hydrograph comparison to available environmental and recreational flow information – 2002

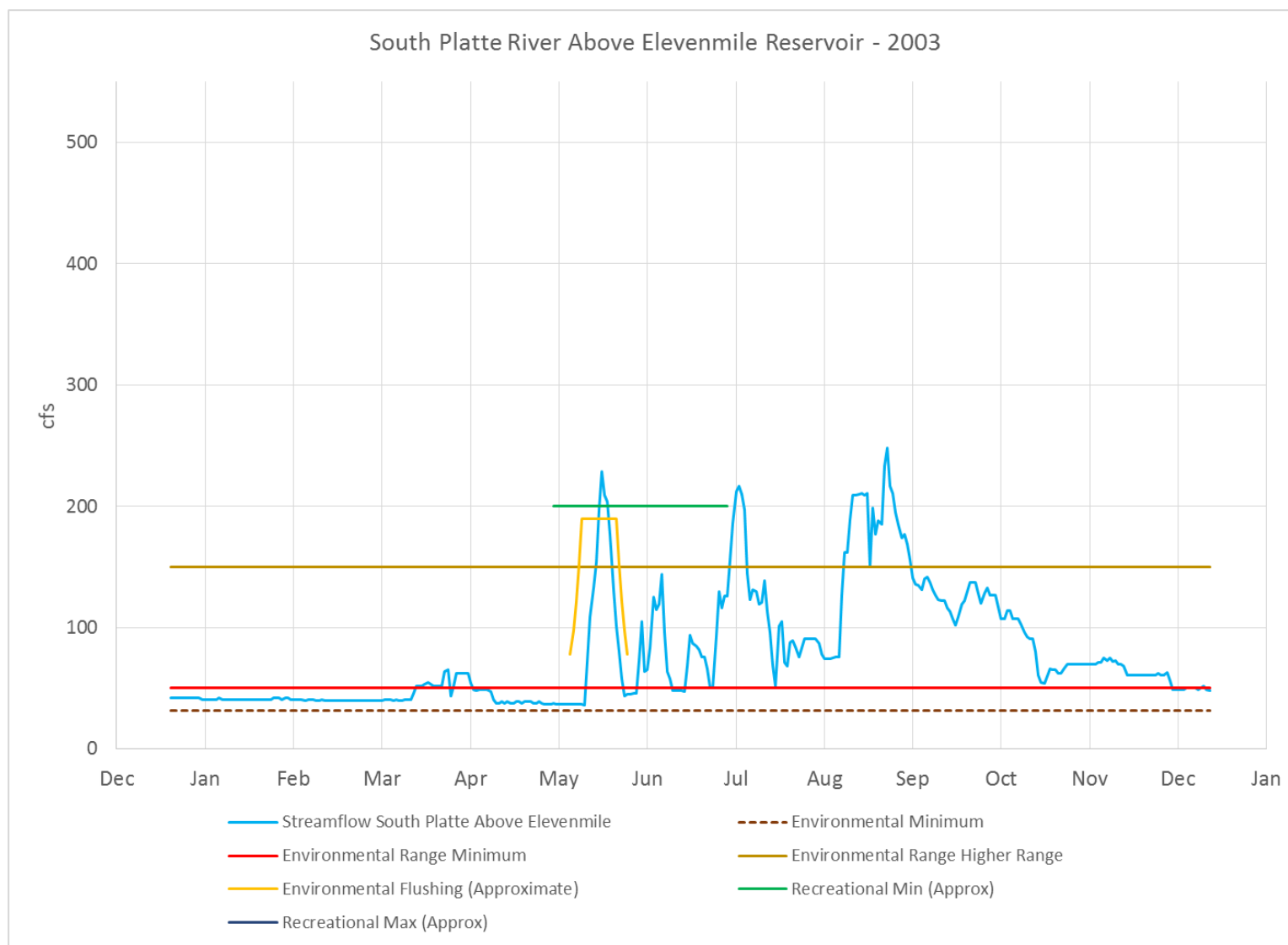


Figure 5-16 - Hydrograph comparison to available environmental and recreational flow information - 2003

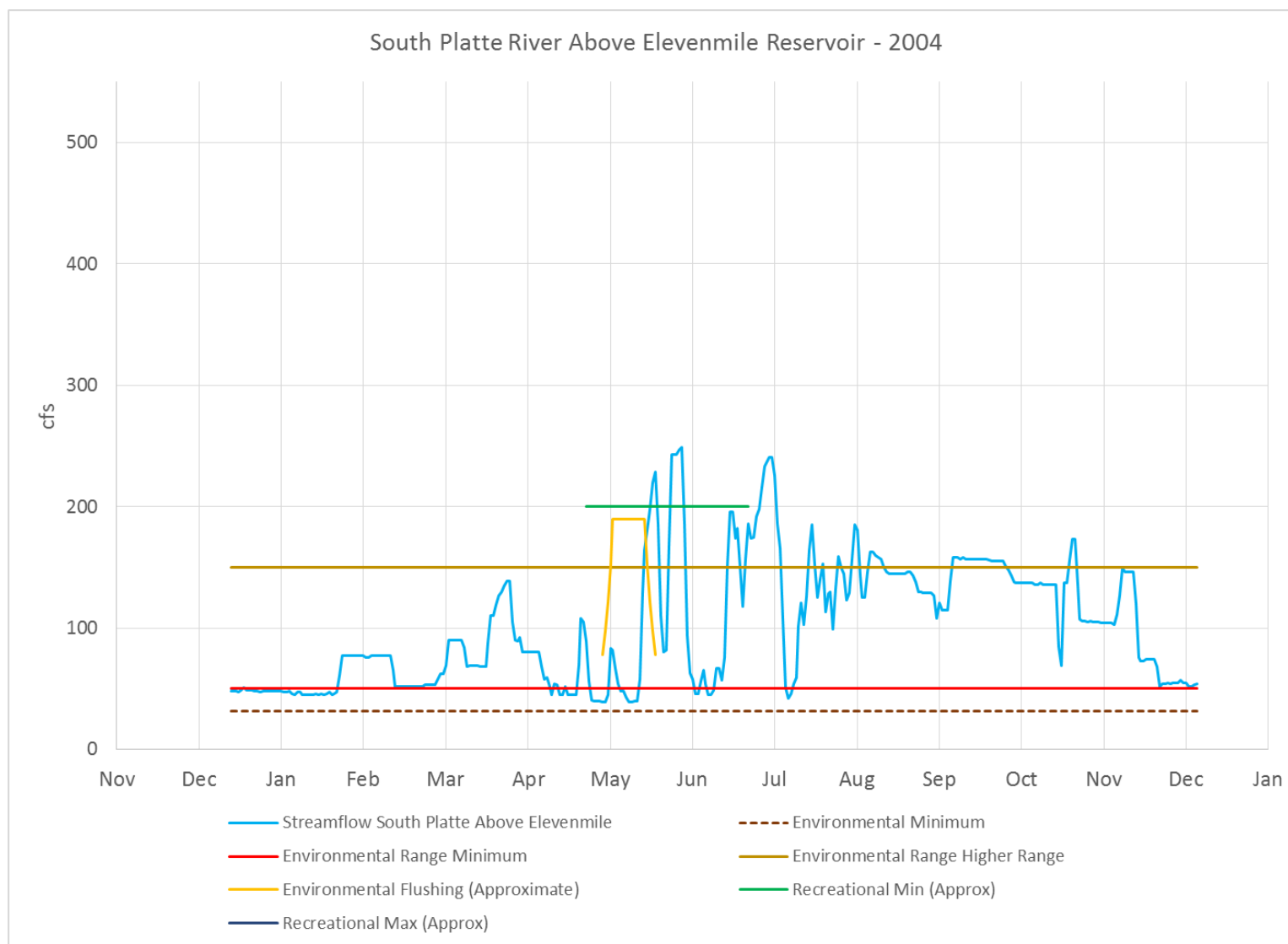


Figure 5-17 - Hydrograph comparison to available environmental and recreational flow information - 2004

In addition to comparing the flows in the South Platte in South Park in specific years, time series raster plots were developed to demonstrate the flows over the period of record. A raster plot shows flows as different colors, based on specific parameters that take the flow recommendations into consideration. A time-series raster plot can assist in giving planners a quick snapshot of flows with respect to certain environmental and recreational considerations. The time series raster plots shown below were developed to graphically demonstrate how the various general flow recommendations described above are met based on the time series data for the gage.

To demonstrate the times when the various minimum flows from the South Platte Operational Agreement are met or not met by the available streamflows, a time-series raster plot was developed, as shown in Figure 5-18. The days when the minimum flow rates were not met are indicated in red on the raster plot. The flows between the recommended range of 50-150cfs are shown in green on the plot. The flows between the minimum of 32cfs and 50cfs are shown in orange on the plot. The flows above the recommended flow rates are indicated in blue on the plot.

Spinney Reservoir upstream of the gage was completed in 1981, at which time some winter flows began to improve. In the late 1980s, there was cooperation regarding stream flows and operations in the area, prior to the South Platte Protection Plan being finalized. Accordingly, the time series generally shows fewer days that the minimum flows were not met as compared to earlier in the period. This plot shows times when there are opportunities to potentially increase the flows in the river to fall into the recommended range more frequently. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.

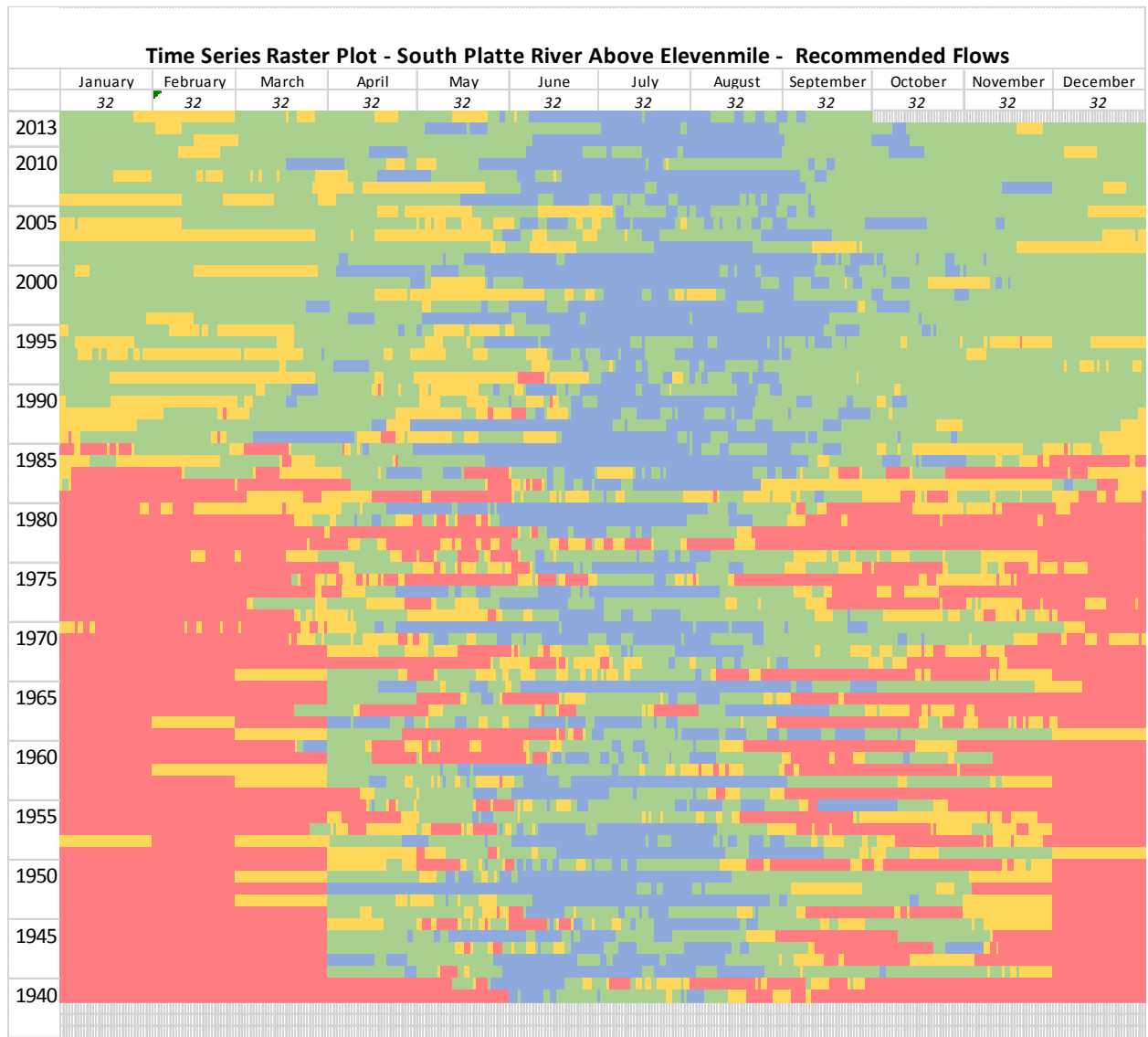


Figure 5-18 - Time Series Raster Plot – South Platte above Elevenmile - Minimum Recommended Flows

To demonstrate the times when the flushing flows recommendations are met or not met, a time-series raster plot was developed, as shown in Figure 5-19. The yellow indicates days when the flow is greater than the generally recommended flushing flows. The red in the plot shows times when the flow is less than the generally recommended flushing flows. In general, in most years there appears to be flushing flows available in this area, based on the Tennant method, although the duration may not be of long enough duration in some years. Additional work to determine the required flushing flow rates, duration and frequency is needed. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.



Figure 5-19 - Time Series Raster Plot - South Platte above Elevenmile - Flushing Flows (190cfs)

To demonstrate the times when the anecdotal recreational flows are met or exceeded, a time-series raster plot was developed, as shown in Figure 5-20. The green shows days when the flow is between the generally recommended recreational flows of greater than 200 cfs from April through October. The red in the plot shows times when the flow is less than the generally recommended minimum recreational flows. The blue in the plot shows days when the flow is greater than the generally recommended maximum recreational flows. This plot shows times when there are opportunities to potentially increase the flows in the river to meet recreational needs. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of recreational uses determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess recreational flows of the stream.



Figure 5-20 - Time Series Raster Plot – South Platte above Elevenmile - Recreational Flows April through September (200cfs)

General Discussion and Recommendations

In general, the analysis of streamflows on the South Platte River above Elevenmile Reservoir indicates that at times, streamflows may be present in this area to meet the general flow recommendations presented above. However, significant additional flow study information is necessary to determine if these recommendations are adequate for environmental and recreational protection.

There is a great amount of additional data needed to fully assess the environmental and recreational protections that exist and may be needed in the example area on the South Platte above Elevenmile. Studies that relate the channel form and function to the streamflows can make assessment of flows in the area more robust. In addition, streamflows necessary for recreational needs should be more fully assessed.

The time-series raster plots are helpful in assessing what flows may be needed or available for additional environmental, recreational or municipal and industrial projects. The plots demonstrate how the addition of Spinney Reservoir generally allows the minimum instream flows to be met more of the time, generally demonstrate the flushing flows are available in most years and for longer durations, and recreational preferred flows also exist for longer durations.

Specific types of projects that may help to protect or enhance the environmental and recreational flows in the area include:

- o Stream Channel Modifications – There are various ongoing and planned projects in the example area to restore stream channels and riparian habitat. Continuing these projects in specific areas where habitat restoration is needed is important to sustain the environmental and recreational attributes in the area.
- o Fish Passage – There are various examples of fish passageways near the example area. Additional diversion structures could be modified in the future to assist with stream channel connectivity in the area.
- o Operational Flow Agreements – The South Platte Protection Plan suggests operational flows that help to meet minimum flows in the example area. Additional operational agreements could be pursued in the future to assist with minimum flows, flushing flows and recreational flows. Studies to determine the amount of beneficial flow should be conducted to assist with determining how these operational agreements could benefit the environmental and recreational attributes.

Additional projects have been indicated by members of the environmental and recreational subcommittee. These projects should be added into the stream mile representation for analysis of the effect of projects within the area. Specific spatial data, as well as specific flow data and completion date would be beneficial in determining when and to what degree these projects have benefited the example area.

The minimum flows shown in this analysis are based on suggested flows from the South Platte Protection Plan. The actual needs of the aquatic and riparian habitat should be specifically studied in this area if additional project recommendations are to be made to protect and enhance the environmental attributes in this reach.

5.3 Metro Region

There are various types of focus areas in the Metro Region with multiple project types in place, planned or needed to protect or enhance the environmental and recreational attributes. Five of the 34 focus areas in the South Platte located in the Metro Region. The types of focus areas in the region include:

- Environmental attributes including: Habitat for federal and state endangered, threatened and species of concern; and rare or imperiled riparian plant communities.
- Recreational attributes including: Fishing, whitewater boating, municipal recreational corridor, and State Wildlife Areas.

There are various projects throughout the Metro Region addressing environmental and recreational needs. Project types in the region include stream and riparian restoration, streamflow agreements, and various types of studies.

To demonstrate the types of projects within the Metro Region, specific existing projects are highlighted. In addition, the stream mile representation framework previously discussed was used to generally analyze the environmental and recreational needs and the existing and future projects within that area that may address the gap.

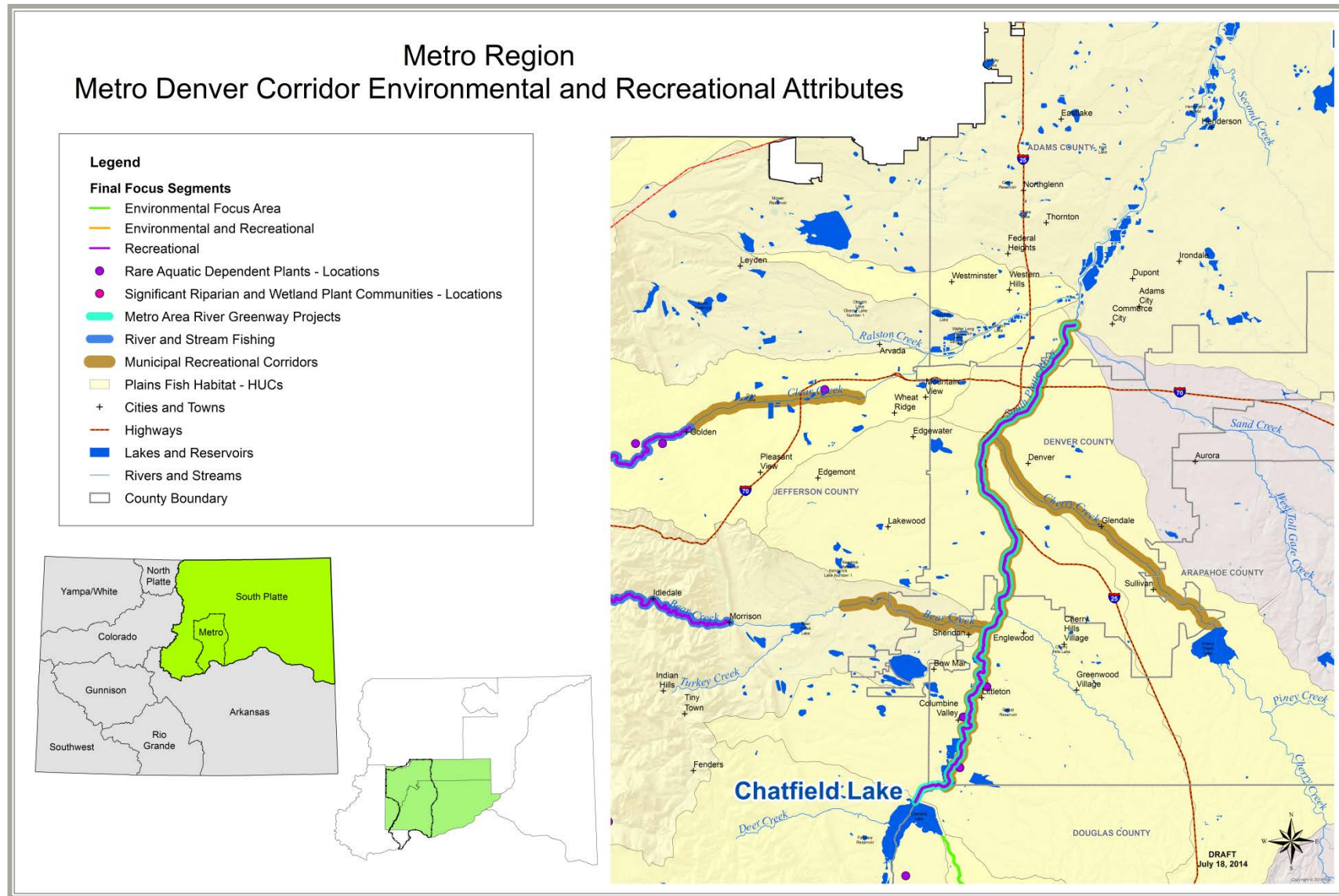
5.3.1 Example Projects – Metro Region

There are several projects in the Metro Corridor that focus on the Metro Denver Greenways. These projects range from recreational and riparian improvements along the South Platte to flow protection with Chatfield Reallocation. Specific projects from the GIS data include Chatfield Reallocation Program, expansion/enhancement to Confluence Park, recreational and riparian improvements along the South Platte, River North Greenway Master Plan, River South Greenway Master Plan, and Westerly Creek Greenway Master Plan.

The projects listed above account for a total of approximately 15 miles in the Metro Corridor with restoration programs out of a total of approximately 23 miles in the South Denver Metro Corridor Focus Area. These types of projects provide protections for multiple attributes including riparian plant communities, recreation, and fishing. These projects also directly address the recreational goals of the plan as well as water quality concerns along the Metro Corridor.

Some specific examples of these types of projects include:

- The Big Dry Creek Greenway Project which included creek corridor clean up and bank stabilization, habitat rehabilitation, access to parks as well as wetland and riparian forest enhancements. The project does not specifically state which attributes would be the focal point of the project, however, attributes such as rare aquatic dependent plants, fishing and recreational corridors would likely benefit.
- Stream habitat work at the Carson Nature Center, which helps to improve riparian conditions. This project enhances plant, fish and wildlife attributes, as well as greenway usage along the stream corridor. Figure 5-21 shows the environmental and recreational focus areas and locations of the rare aquatic-dependent plant, fishing and recreational corridors in the Metro Corridor.



5.3.2 Example Area Analysis – South Platte River below Chatfield Reservoir

To demonstrate the stream mile representation methodology described earlier in this Appendix, the example area analyzed for the Metro Region is located on the South Platte River, below Chatfield Reservoir.

Stream Mile Representation Framework

The gage analyzed within this reach is the South Platte River below Chatfield gage (PLACHACO). The section of river analyzed includes an approximately 12 mile stretch on South Platte River from Chatfield Reservoir downstream. The example area is shown in the map in Figure 5-22.

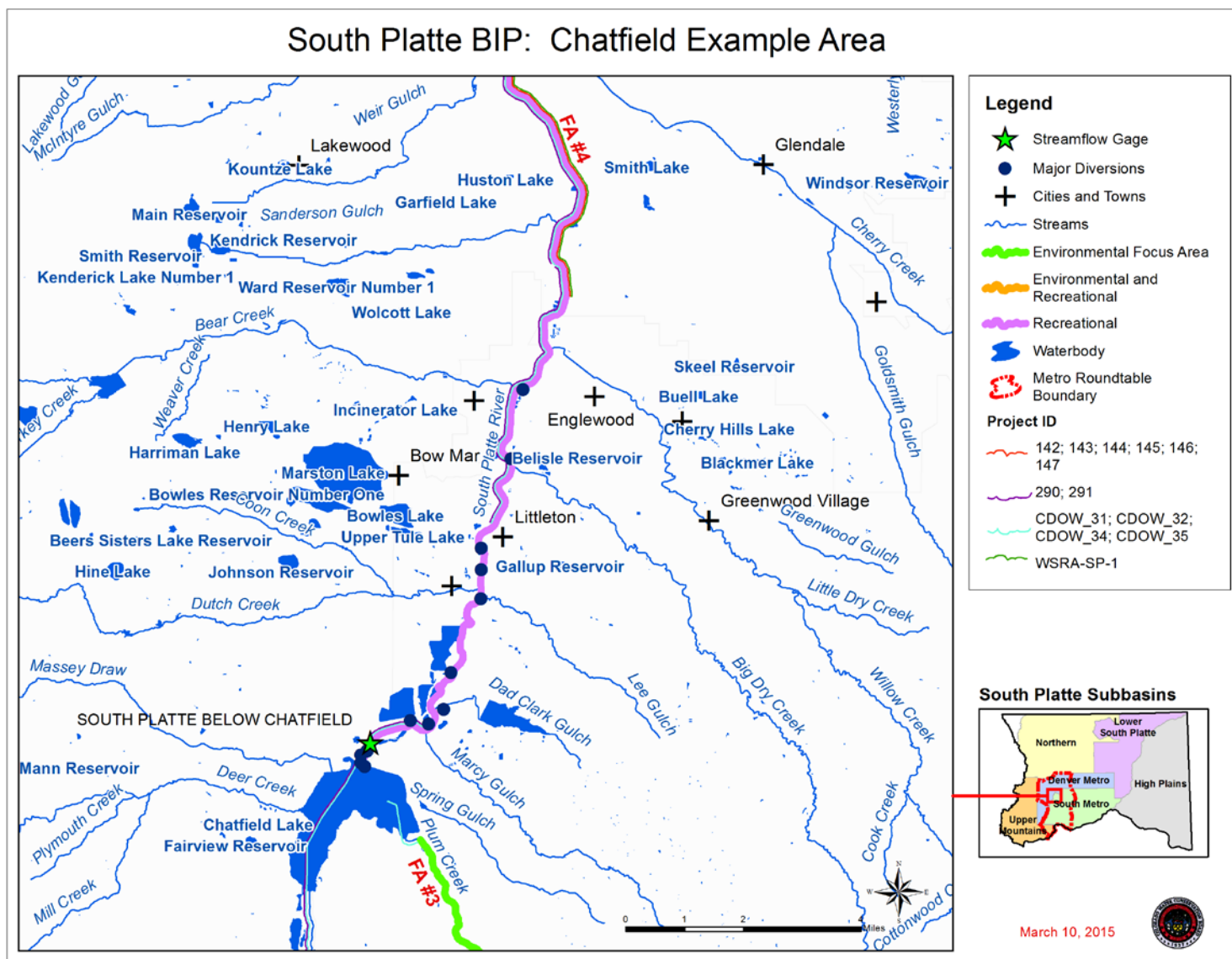


Figure 5-22 - Metro Region Example Area Map

The portion of the stream mile representation framework spreadsheet for this stretch of river is shown in Appendix D-7, with the full spreadsheet available on SouthPlatteBasin.com. A brief summary of the items shown in the stream mile representation follows.

The attribute categories located in the example area include:

- Environmental:
 - o Plains Fish State Endangered, Threatened, Species of Special Concern
 - o State Endangered, Threatened, Species of Special Concern
 - o Important Riparian Habitat
- Recreational:
 - o Fishing
 - o Recreation (boating)

The example area includes portions of Focus Area 4, a recreational focus area which includes the South Platte River from Chatfield downstream to Sand Creek. The streamflow gage data analyzed in this example is within Focus Area 4.

Based upon the stream mile representation and available project data with available spatial data, the projects upstream and downstream from the streamflow gage include:

- Stream Channel Restoration Projects – Including Greenway Master Plans, Confluence Park enhancement and expansion, and various other planned restoration projects.
- Chatfield Reallocation Project – Includes potential dedicated storage for environmental needs downstream.
- Fish Habitat Projects including Plains Fish Monitoring, Identification of and modification to barriers to fish passage on the South Platte and tributaries, and species reintroduction.
- Stewardship Projects – Stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations. These projects typically provide riparian habitat protection rather than streamflow benefits.

There are various diversions in the area, as shown in the map. These diversions include diversions for the Cities of Englewood, Littleton, and Denver, as well as many other diversions for agriculture and municipal and industrial uses.

Streamflow Analysis

To analyze the streamflow available to the various attributes at the gage location, streamflows were analyzed in various ways.

The period of record for the South Platte below Chatfield gage analyzed extended from 1986 until 2013. The general hydrograph over the period of record is shown in Figure 5-23.

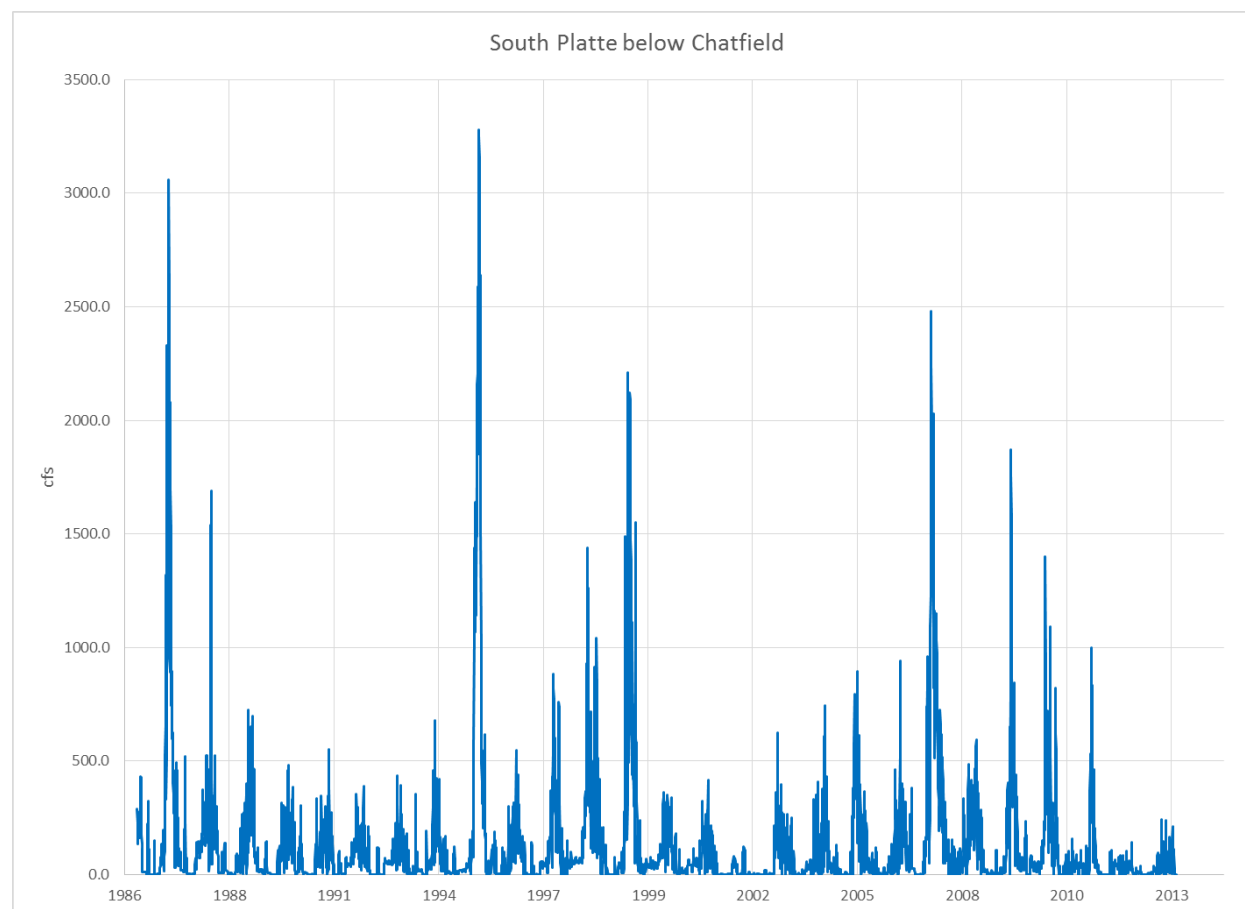


Figure 5-23 – Time Series Hydrograph of South Platte below Chatfield (Gage: PLACHACO)

The hydrograph was disaggregated on a yearly basis to examine certain flow requirements for environmental and recreational needs.

Site and species specific studies are needed to determine the minimum flow needed to sustain the native species. Flow regimes necessary to support aquatic species are extremely site specific, and the flow regimes can change significantly with a change in channel shape and function. Results from hydraulic modeling must be assessed in conjunction with biologic assessments of the study area. The environmental minimum flows shown in the table below are based upon the minimum recommended flows from two studies done in the area. One study was completed By Miller and Associates to review the recommendations for the Chatfield Reallocation Project⁵, and one study done by Ecological Resource Consultants, Inc. (ERC) for a reach below Chatfield comparing required flows in conjunction with a stream restoration project⁶. The minimum flow study indicated a flow requirement of approximately 30 cfs. The recommended flows by the Miller and Associates report indicated flows below Chatfield of 30cfs would be adequate

⁵ *A Minimum Flow Study of the South Platte River, Downstream of Chatfield Reservoir*; prepared for Centennial Water and Sanitation District, prepared by W.J.Miller and Associates (May 1991).

⁶ Technical Memorandum regarding South Platte River - Minimum Instream Flow Calculations, prepared for Denver Trout Unlimited, prepared by Ecological Resources Inc. (April 2014).

at most transects studied. If additional studies become available in the future, the streamflow requirements for aquatic and riparian needs can be added into the analysis.

There were no studies specifically indicating required flushing flows in the area. Flushing flows are needed to move sediment downstream, creating diverse aquatic habitat, as well as to aid in life cycle functions of species. Therefore general recommendations based on the Tennant method for flushing flows of 200% of the annual mean flow were determined. The mean flow during the non-winter months was determined to be approximately 228cfs, therefore a recommended flushing flow of 268 cfs was included in the analysis.⁷ The duration of flushing flows would be determined from additional hydraulic analyses based on specific channel characteristics at the project locations.

There are no studies found suggesting specific recreational flow recommendations in the South Platte basin, nor in this reach. However, there is two decreed boat chutes in the example area, Boat Chute #4 and Boat Chute # 10, decreed by the City of Littleton for 100cfs in Case No. 94CW273. This is the minimum recreational flow used for this example analysis. If additional recreational studies become available, these flows can be added into the analysis.

The table below shows the general recommendations based on these sources. Refinements should be made with site-specific studies before using these values to plan or implement projects.

Table 6 - South Platte River below Chatfield - General Flow Recommendations (in cfs)

Month	Recommended Environmental Flow		Flushing Flows	Boat Chute Recreational Minimum	Anecdotal Recreational Maximum
	Miller and Associates Study	ERC Study (2012 Channel)			
January	30	35			
February	30	35			
March	30	35			
April	30	35			
May	30	160	~268	100	3000
June	30	160	~268	100	3000
July	30	160		100	3000
August	30	160			
September	30	160			
October	30	35			
November	30	35			
December	30	35			

These recommendations were compared to specific annual hydrographs, as well as the time series data. The minimum flows are indicated by the red line in the following graphs. The flushing flows are indicated by the yellow line in the following graphs. The recreational flows are indicated in the green and blue lines, for the minimum recreational recommended flow and maximum recreational flow, respectively. The annual

⁷ Tennant method or “Montana” method for determining flushing flows. General description of the Tennant Method can be found in *The flushing flow problem: Defining and evaluating objective*, Kondolf, Wilcox, (Water Resources Research, August 1996) and *Hydrological Low Flow Indices and their Uses*, Pyrcie (Watershed Science Center, 2004). Additional literature states the annual natural streamflow should be used and additional analyses should be used to determine appropriate flushing flows.

hydrographs for 1999, and 2002 through 2004 are shown in Figure 5-24 through Figure 5-27.

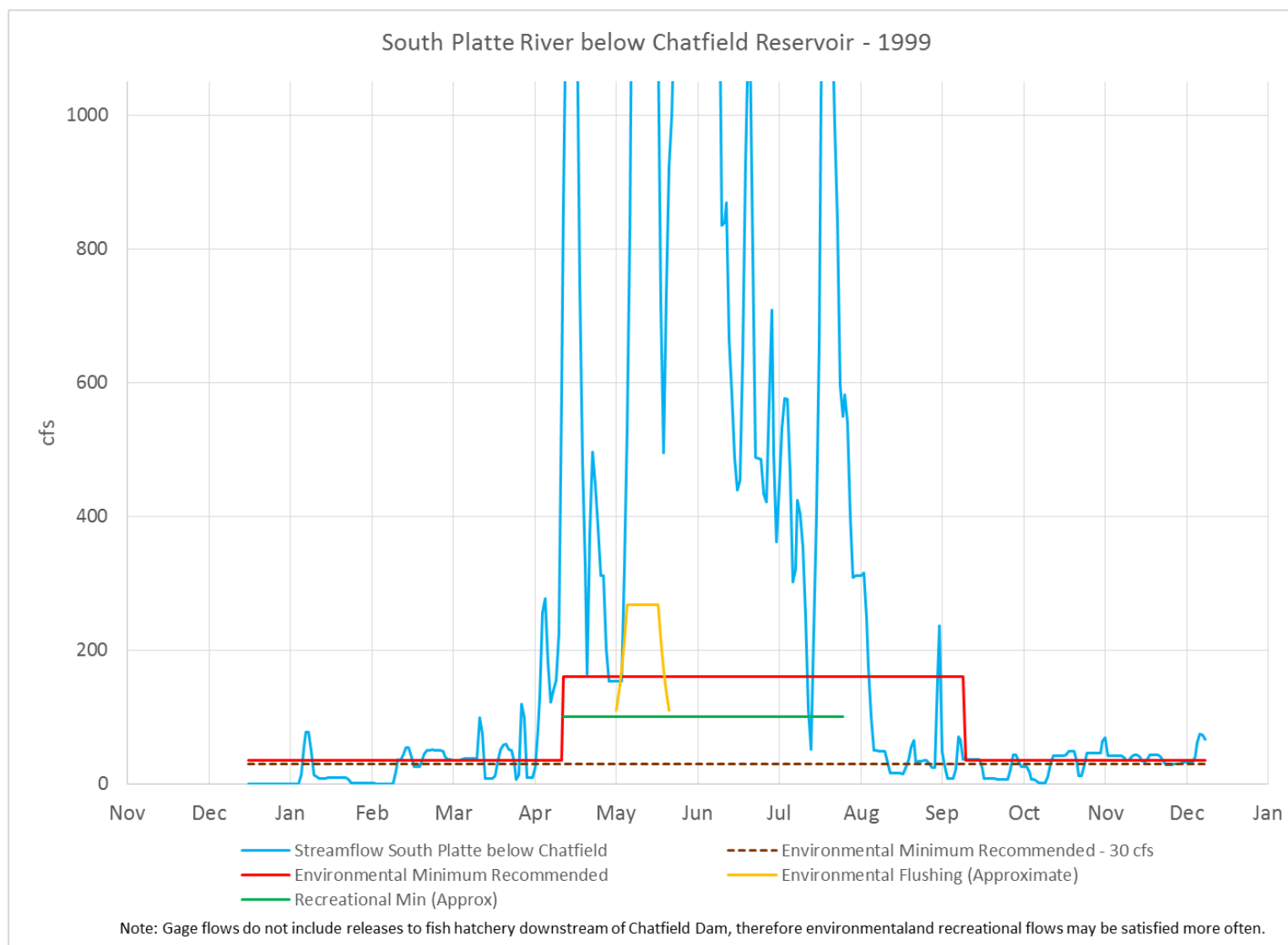


Figure 5-24 - Hydrograph comparison to available environmental and recreational flow information - 1999

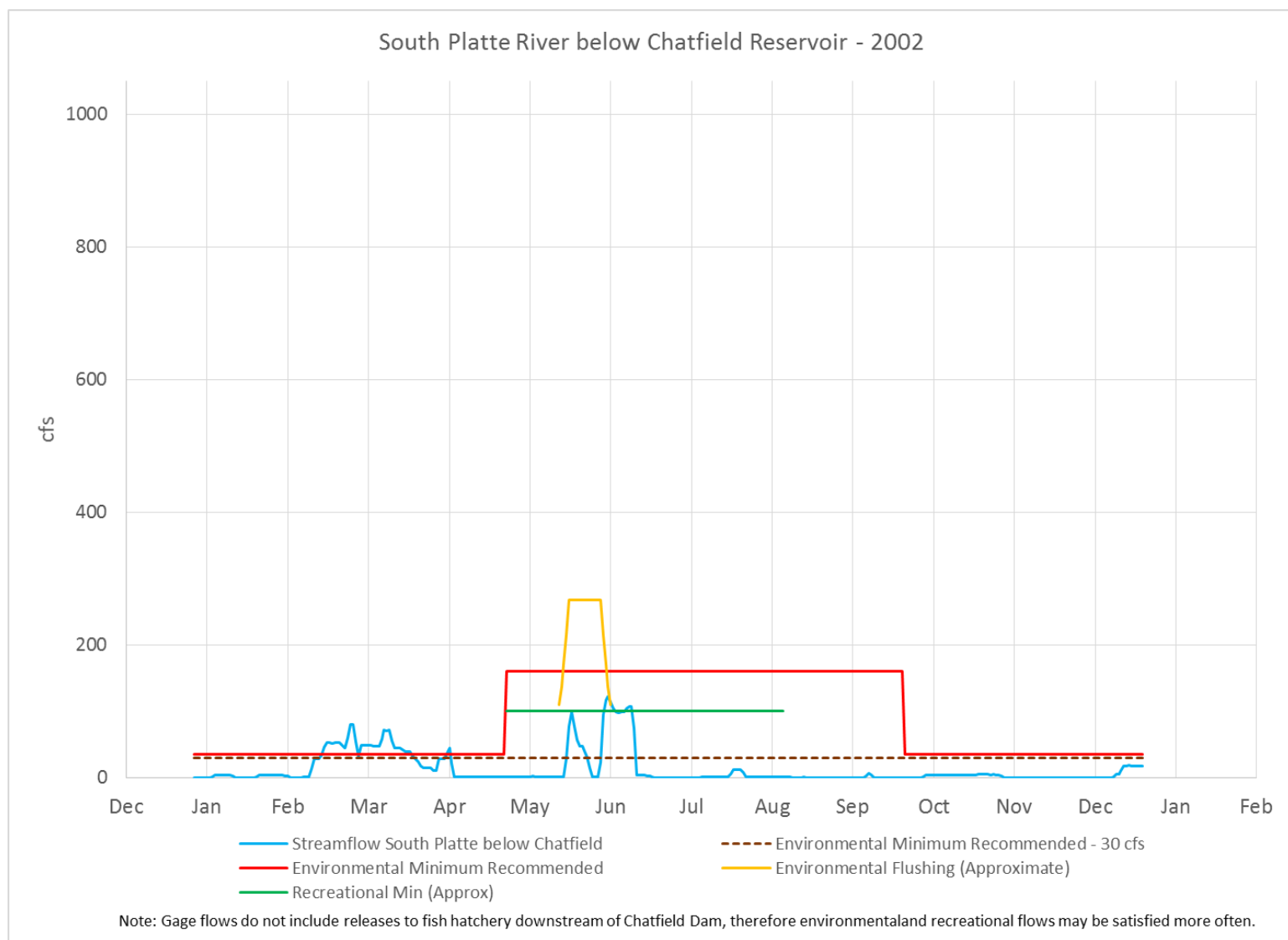


Figure 5-25 - Hydrograph comparison to available environmental and recreational flow information - 2002

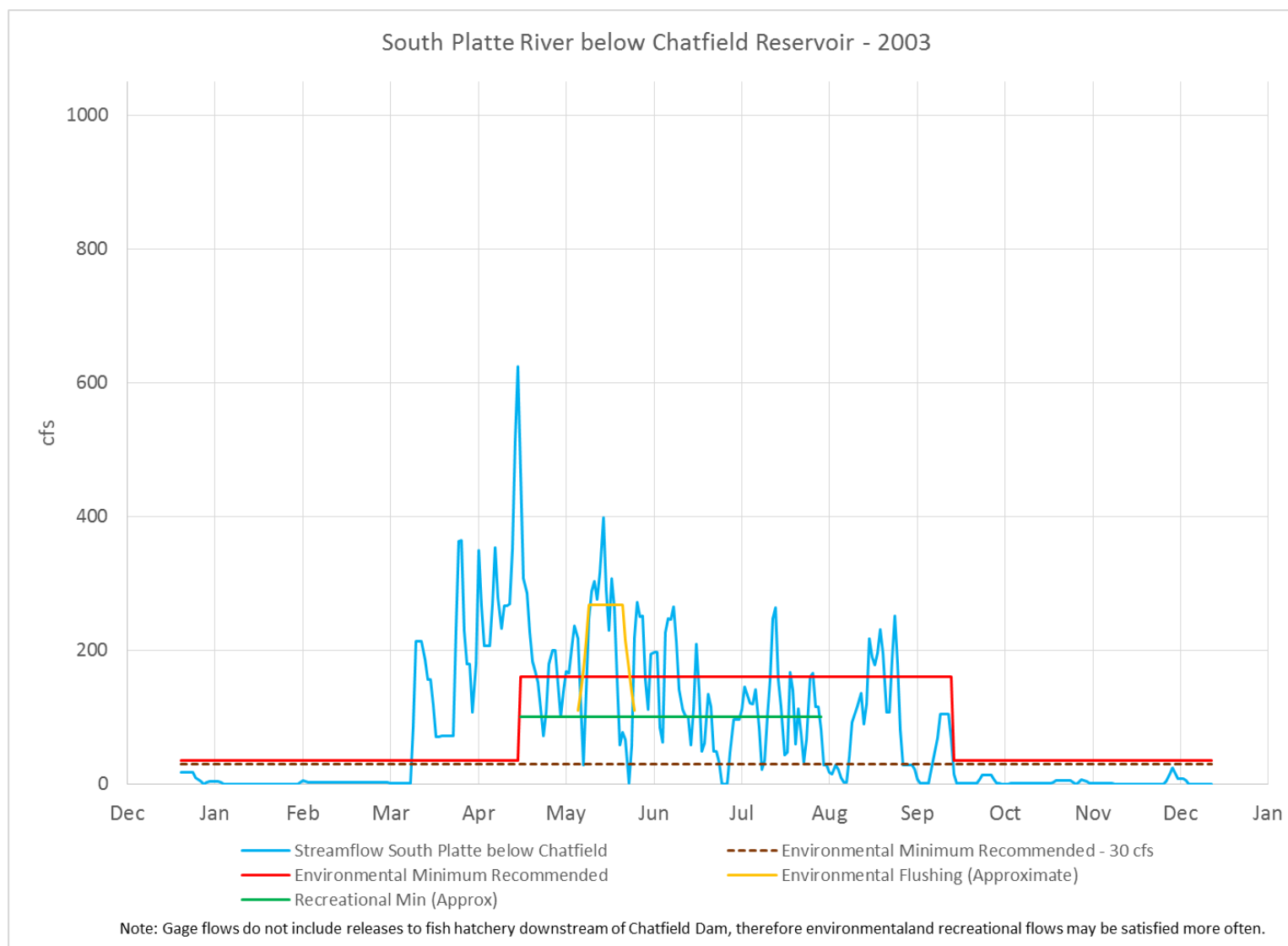


Figure 5-26 - Hydrograph comparison to available environmental and recreational flow information - 2003

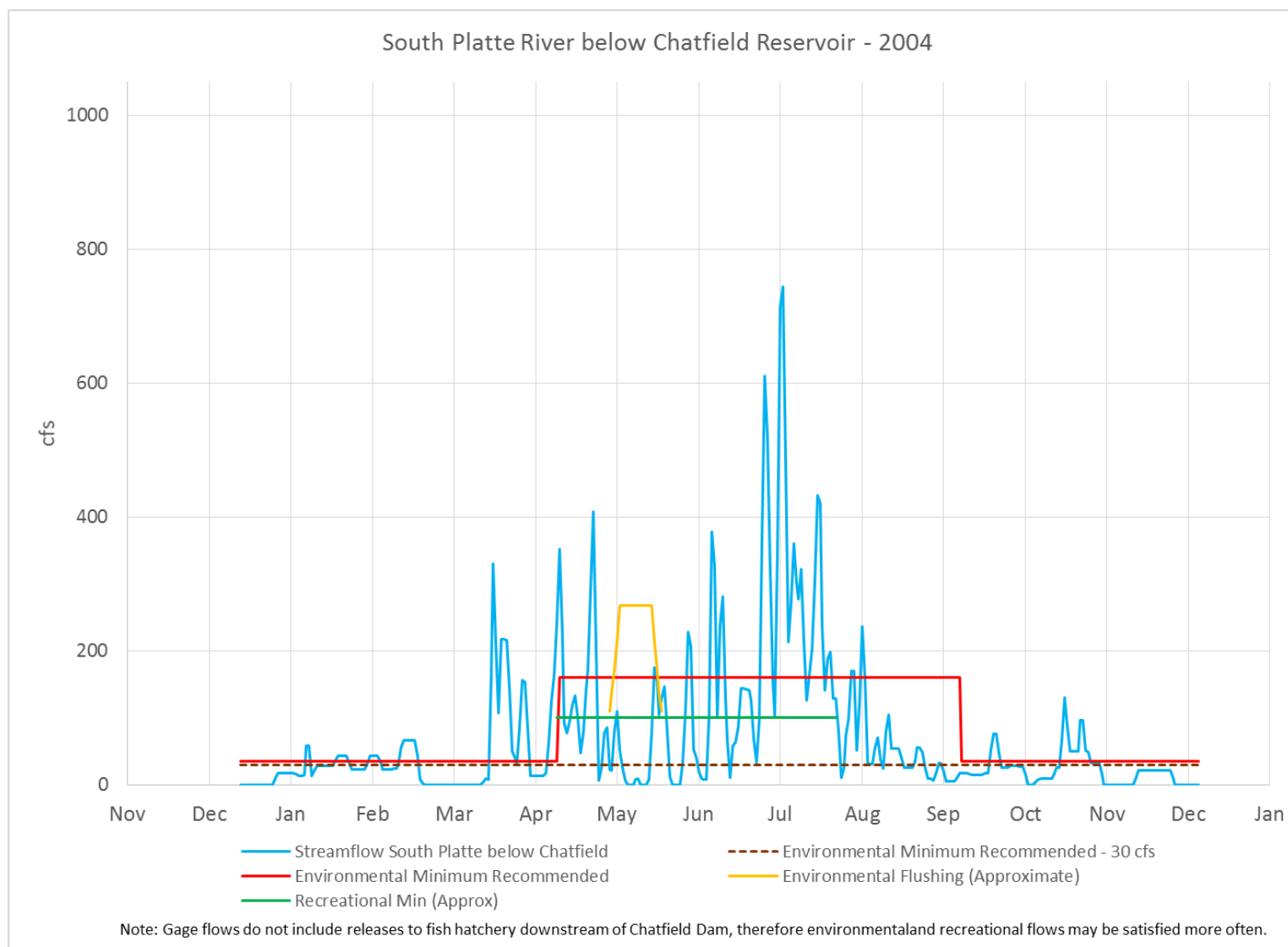


Figure 5-27 - Hydrograph comparison to available environmental and recreational flow information - 2004

In addition to comparing the flows in the South Platte below Chatfield in specific years, time series raster plots were developed to demonstrate the flows over the period of record. A raster plot shows flows as different colors, based on specific parameters that take the flow recommendations into consideration. A time-series raster plot can assist in giving planners a quick snapshot of flows with respect to certain environmental and recreational considerations. The time series raster plots shown below were developed to graphically demonstrate how the various general flow recommendations described above are met based on the time series data for the gage.

To demonstrate days when the recommended minimum flows are met or not met by the available streamflows, a time-series raster plot was developed, as shown in Figure 5-28. The days when the minimum decreed instream flow rates were not met are indicated in red on the raster plot. The flows above the minimum flow rates are indicated in yellow on the raster plot. The minimum recommended flows shown are from the ERC report compared to the channel in 2012. In the ERC report the channel restoration allowed for significantly lower flows to adequately provide flows in low flow times, for only one test transect. However, the gage at this location does not include the flows released from Chatfield for the fish hatchery downstream of the dam. The releases to the hatchery should be added in for assessment of locations below the location where the flows from the hatchery re-join the South Platte. Additional studies are needed to determine the needed flows throughout the example area. This plot shows times when there are opportunities to potentially increase the flows in the river to meet the environmental needs. If additional required flow studies and information become available, similar plots could be used to compare the streamflows to the more specific needs of aquatic and riparian habitat determined by such studies in additional locations. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.

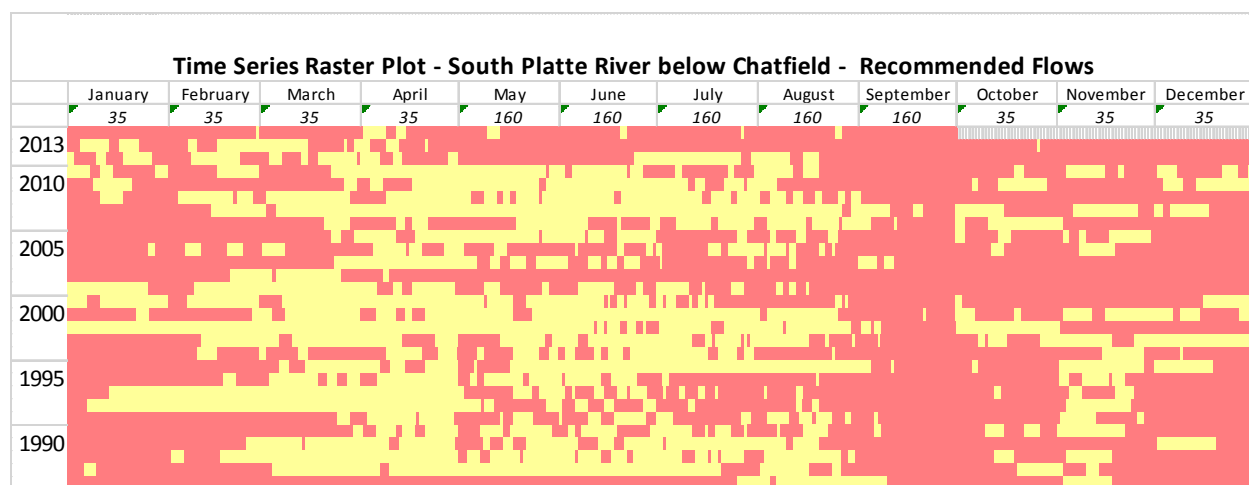


Figure 5-28 - Time Series Raster Plot – South Platte below Chatfield - Minimum Recommended Flows

To demonstrate the times when the flushing flows recommendations are met or not met, a time-series raster plot was developed, as shown in Figure 5-29. The yellow on the plot indicates days when the flow is greater than the generally recommended flushing flows. The red in the plot shows times when the flow is less than the generally recommended flushing flows. In general, there appears to be flushing flows available in this area in some years, based on the general Tennant method. Additional work to determine the required flushing flow rates, duration and frequency is needed.

If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. Additionally the needed occurrences of these flows should be determined. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.

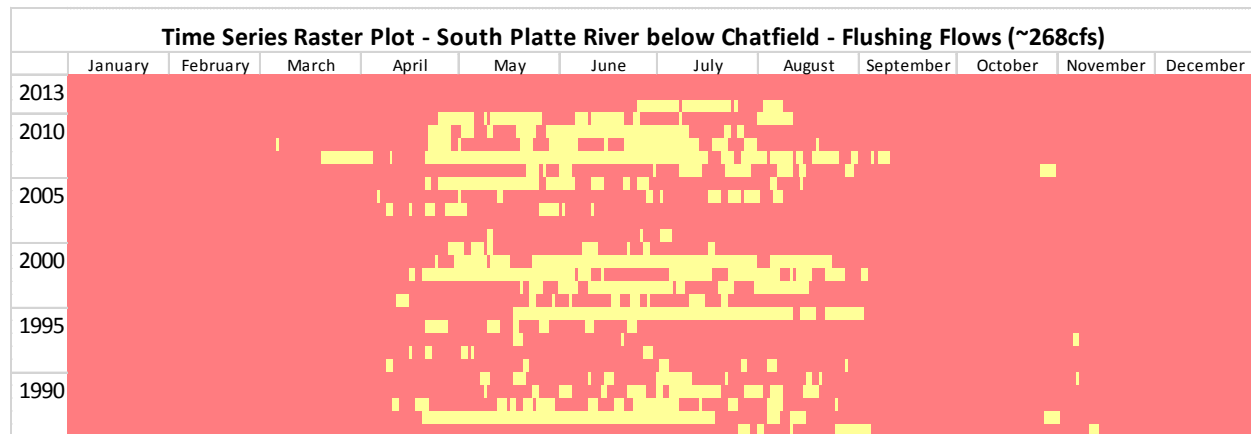


Figure 5-29 - Time Series Raster Plot – South Platte River below Chatfield - Flushing Flows (268cfs)

To demonstrate the times when the recommended recreational flows are met or exceeded based on the City of Littleton Boat Chute decree, a time-series raster plot was developed, as shown in Figure 5-30. The yellow in the plot indicates days when the flows are greater than the Littleton Boat Chute decreed rate of 100 cfs from April through October. The red in the plot shows times when the flow is less than the recommended recreational flows. This plot shows times when there are opportunities to potentially increase the flows in the river to meet recreational needs. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of recreational uses determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess recreational flows of the stream.

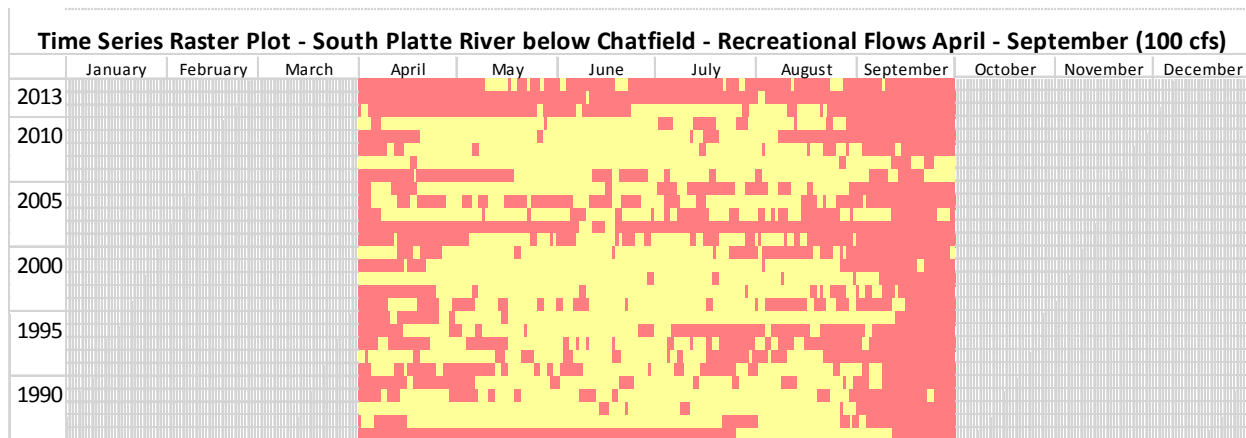


Figure 5-30 - Time Series Raster Plot – South Platte River below Chatfield - Recreational Flows April through September (100cfs)

General Discussion and Recommendations

In general, the analysis of streamflows on the South Platte below Chatfield indicates the streamflows may be present in this area to meet the very general flow recommendations presented above. However, significant additional flow study information is necessary to determine if these recommendations are adequate for environmental and recreational protection.

There is a great amount of additional data needed to fully assess the environmental and recreational protections that exist and may be needed in the example area on the South Platte. Studies that relate the channel form and function to the streamflows can make assessment of flows in the area more robust. a. In addition, streamflows necessary for recreational needs should be assessed.

The time-series raster plots are helpful in assessing what flows may be needed or available for additional municipal and industrial projects. The Surface Water Availability Analysis (detailed in Appendix G) shows that there is potentially availability for surface water development at times in the South Platte below Chatfield. Comparing to the raster plots once additional work has been done to fully assess the flows required for environmental and recreational needs can show times when additional diversions may not negatively impact the minimum flows, flushing flows or recreational flows. It appears

that times of lengthy flushing flows, more than preferred recreational flows and adequate minimum instream flows may coincide with times of legal and physical availability. Additional daily analysis and comparison should be done to ensure the times generally shown in the raster plot and the summarized annual availability coincide, before determination is made that additional diversions may not impact environmental and recreational flows.

Specific types of projects that may help to protect or enhance the environmental and recreational flows in the area include:

- Stream Channel Modifications – The Greenway projects and other channel restoration projects have helped to enhance this reach. As shown in the flow evaluation study by ERC, the environmental flow needs can be lessened if the proper channel restoration is put into place. However for these projects to work throughout the example area they must link together to create continuous habitat that is benefitted by environmental flows.
- Operational Flow Agreements – There is currently planned operational and multi-purpose agreements being considered as part of the Chatfield reallocation project. Additional operational agreements could be pursued in the future to assist with minimum flows, flushing flows and recreational flows. Studies to determine the amount of beneficial flow should be conducted to assist with determining how these operational agreements could benefit the environmental and recreational attributes.

Additional projects should be added into the stream mile representation for analysis of the effect of projects within the area. Specific spatial data, as well as specific flow data and completion date would be beneficial in determining when and to what degree these projects have benefited the example area.

The minimum flows shown in this analysis are specifically from recommendations from location specific studies of needed environmental flows. The actual needs of the aquatic and riparian habitat should be specifically studied in this area if additional project recommendations are to be made to protect and enhance the environmental attributes in this reach. In addition, the flows shown in the streamflow analysis do not include flows from the fish hatchery, these should be included in any assessment downstream of where the fish hatchery flows back into the South Platte River.

5.4 Plains (Lower South Platte Region)

There are various types of focus areas in the Lower South Platte Region with multiple project types in place, planned or needed to protect or enhance the environmental and recreational attributes. Two of the 34 focus areas in the South Platte located in the Lower South Platte Region. The types of focus areas in the region include:

- Environmental attributes including: Habitat for federal and state endangered, threatened and species of concern including plains fish; and rare or imperiled riparian plant communities.
- Recreational attributes including: Wildlife viewing and hunting.

There are various projects throughout the Lower South Platte Region addressing environmental and recreational needs. Project types in the region include species reintroduction, and various types of studies.

To demonstrate the types of projects within the Lower South Platte Region, specific existing projects are highlighted. In addition, the stream mile representation framework previously discussed was used to generally analyze the environmental and recreational needs and the existing and future projects within that area that may address the gap.

5.4.1 Example Projects – Lower South Platte Region

There are various example projects in the Lower South Platte, including recharge projects, reservoirs and a species reintroduction project. The Colorado Parks and Wildlife (CPW) Tamarack recharge project retimes water flows that occur during high flow periods to times when flows are needed to meet Colorado's requirements under the Three States Agreement for the Platte River Recovery and Implementation Program (PRRIP). The (PRRIP) allows for water users within Colorado to continue to develop new supplies while still meeting the needs of downstream federally listed endangered species. The Ducks Unlimited recharge projects throughout the area cooperatively provide replacement water to wells in augmentation plans while also providing wildlife habitat and recharge flows that can benefit environmental and recreational needs. These and various other recharge projects in the region have the potential to increase wetland habitat and streamflows in the area. The Ducks Unlimited projects are currently indicated in the available data to affect the stream reaches in approximately 161 miles of the 212 miles present in the focus area in this region.⁸ Julesburg Reservoir and North Sterling Reservoir are examples of water supply reservoirs for agricultural users on the lower South Platte River that also provide flatwater boating and waterfowl hunting and viewing.

The plains fish reintroduction project in the lower South Platte reintroduces several species, including common shiner, brassy minnow, plains minnow and suckermouth minnow to the lower South Platte where they are not currently present. These species are all on the state threatened and endangered species list. Based on the GIS data available, the common shiner is currently shown in 19 miles out of the total 212 miles in the lower South Platte focus area. Plains minnow is currently shown in 61 miles out of 212 miles. This project is intended to increase the habitat available to these species. The plains fish reintroduction is listed in 172 miles of the focus areas.

The reintroduction project alone may not fully protect the species. Additional protections could be provided by addressing the habitat fragmentation caused by diversion structures and dry-up points (Figure 5-31). These types of physical features can limit the amount of habitat available to plains fish species. These fish species require contiguous, year round habitat to complete their life cycle. Features that prevent fish movement disrupt their life cycle and can result in lower population sizes. Possible projects that could address the habitat fragmentation include cooperatively coordinated fish

⁸ The Ducks Unlimited Project data is indicated as being present in the entire HUC. This highlights the stream reach associated with that HUC. The actual project may affect fewer stream miles based on location of the project within the HUC and other hydrological operations in the area. The project may also affect more stream miles due to the increased streamflows downstream of the recharge project.

passageways and other structural solutions including storage and recharge to limit the number of days of dry-up on the river.

The recharge projects, including the Ducks Unlimited Projects, directly address the goal for enhancing water bird and waterfowl viewing and hunting. The various reservoirs throughout the area directly address flatwater boating goals and indirectly address wildlife habitat and waterfowl viewing and hunting goals. The plains fish reintroduction project directly addresses the environmental goal for state threatened and endangered species. Figure 5-31 shows the focus areas and locations of the DU projects, recharge sites, reservoirs, rare fish habitat, dry-up points and diversion structures in the Lower South Platte Basin. The data to specifically evaluate the hydrology and tradeoffs for environmental flows, recreational uses and wildlife habitat is not currently available within the existing databases. The evaluation of the hydrology is not currently in the scope of this BIP. Additional work could be undertaken in the future in priority focus areas to determine the hydrology and potential possible impacts and benefits, if such data is available. Additional analyses may assist in future decisions regarding tradeoffs in managing this area which has historically been highly managed and modified from natural flows. Additional analysis may allow for consideration of tradeoffs including costs, engineering, feasibility, and water rights administration of such projects. The methodology described in Appendix D can be used to assess where projects may benefit attributes in the future when sufficient data becomes available.

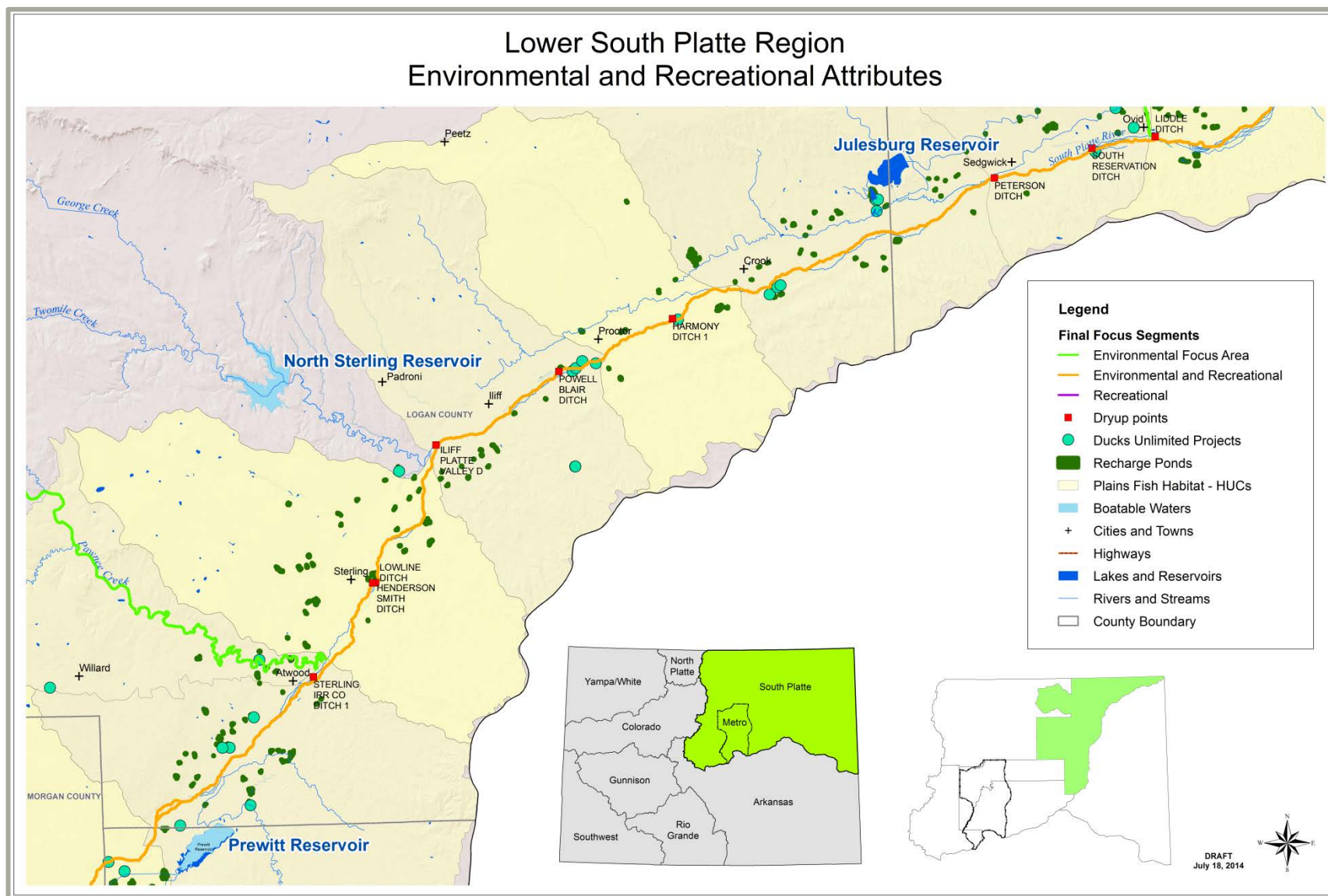


Figure 5-31 - Lower South Platte Plains Fish Habitat

5.4.2 Example Area Analysis – South Platte River at Balzac

To demonstrate the stream mile representation methodology described earlier in this Appendix, the example area analyzed for the Lower South Platte Region is located on the South Platte River at Balzac.

Stream Mile Representation Framework

The gage analyzed within this reach is the South Platte River below Chatfield gage (PLABALCO , 06759910). The section of river analyzed includes an approximately 20 mile stretch on South Platte River from approximately Snyder downstream to the Sterling No. 1 Ditch. The example area is shown in the map in Figure 5-32.

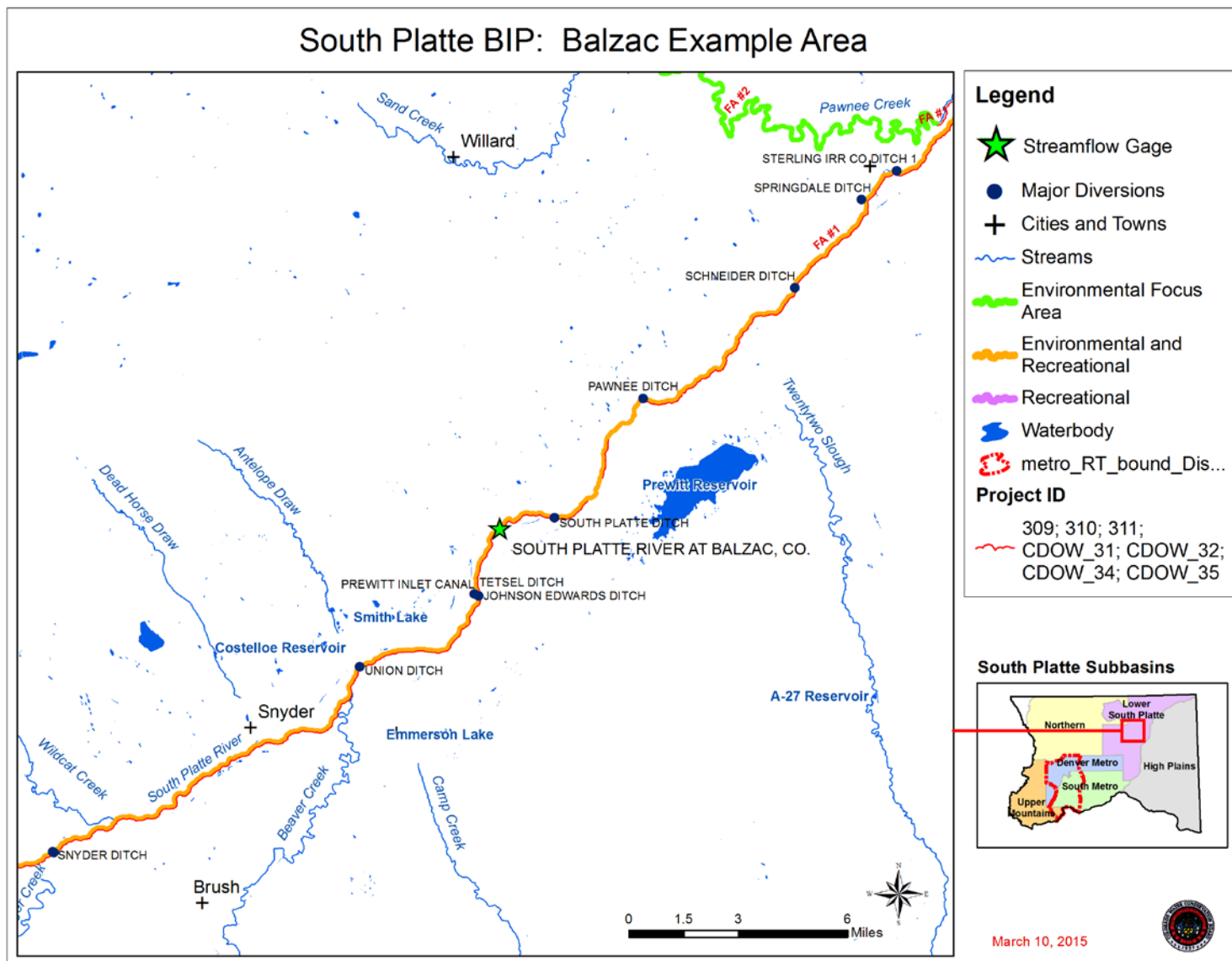


Figure 5-32 – Lower South Platte Region Example Area Map

The portion of the stream mile representation framework spreadsheet for this stretch of river is shown in Appendix D-7, with the full spreadsheet available on SouthPlatteBasin.com. A brief summary of the items shown in the stream mile representation follows.

The attribute categories located in the example area include:

- Environmental:
 - o Plains Fish State Endangered, Threatened, Species of Special Concern
 - o State Endangered, Threatened, Species of Special Concern
 - o Important Riparian Habitat
- Recreational:
 - o Fishing
 - o Recreation (wildlife viewing and hunting, boating)

The example area includes portions of Focus Area 1, an environmental and recreational focus area which includes the South Platte River from the South Boundary of Weld County to the State Line. The streamflow gage data analyzed in the Lower South Platte Region example is within Focus Area 1.

Based upon the stream mile representation and available project data with available spatial data, the projects upstream and downstream from the streamflow gage include:

- Land Conservation Projects - Ducks Unlimited has easements along river, additional land conservation projects
- Wetland Restoration Projects – Ducks unlimited has partnered with agricultural users to provide wetland habitat in conjunction with recharge projects, additional wetland restoration projects.
- Tamarack Project – Recharge project developed to help meet the needs of downstream endangered species.
- Fish Habitat Projects including Plains Fish Monitoring, Identification of and modification to barriers to fish passage on the South Platte and tributaries, and species reintroduction.
- Stewardship Projects – Stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations. These projects typically provide riparian habitat protection rather than streamflow benefits.

There are various diversions in the area, as shown in the map. These diversions include diversions for the North Sterling and Prewitt Reservoirs, as well as many other diversions for agriculture uses.

Streamflow Analysis

To analyze the streamflow available to the various attributes at the gage location, streamflows were analyzed in various ways.

The period of record for the South Platte at Balzac gage analyzed extended from 1917 until 2013. The gage is currently located at the Cooper Bridge. In October of 1987, the

gage was moved to its present location at the Cooper Bridge from the previous location approximately 5 miles downstream, known as the Balzac Bridge. Diversions from Prewitt Reservoir and a few small irrigation ditches occur between the old Balzac Bridge and Cooper Bridge locations. The general hydrograph over the period of record is shown in Figure 5-33. The red line on the hydrograph shows when the gage moved upstream.

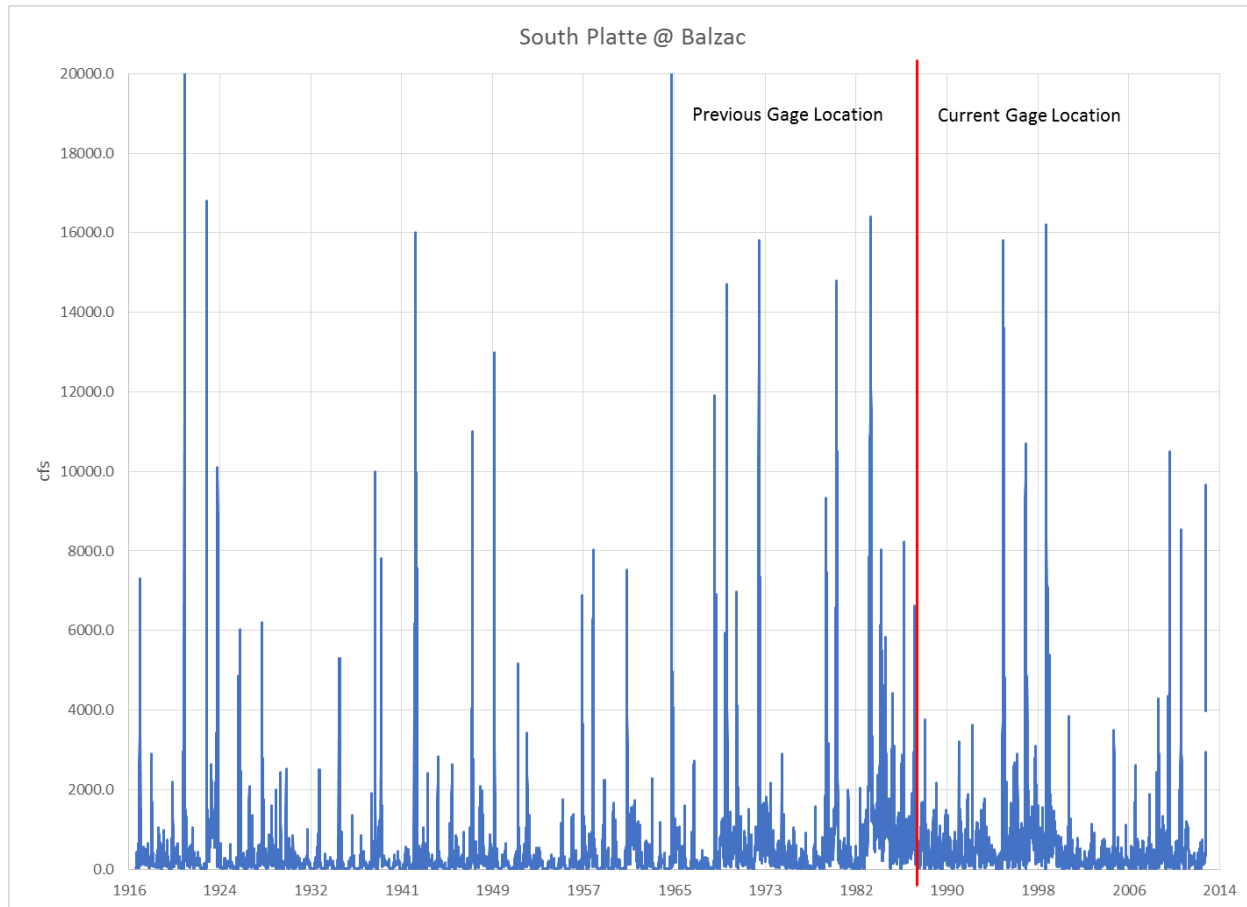


Figure 5-33 – Time Series Hydrograph of South Platte at Balzac (Gage: PLABALCO)

The hydrograph was disaggregated on a yearly basis to examine certain flow requirements for environmental and recreational needs.

Site and species specific studies are needed to determine the minimum flow needed to sustain the native species. Flow regimes necessary to support aquatic species are extremely site specific, and the flow regimes can change significantly with a change in channel shape and function. Results from hydraulic modeling must be assessed in conjunction with biologic assessments of the study area. There are no studies indicating specific environmental flows in the example gage location. The environmental minimum flows shown in the table below are based upon general information regarding plains fish species⁹. The minimum flow study indicated depths of 7.9 to 11.8 inches and velocities of

⁹ *Plains Minnow (Hybognathus placitus): A Technical Conservation Assessment*; prepared for the USDA Forest Service, Rocky Mountain Region, prepared by Miller Ecological Consultants, Inc. Peer Review Administered by American Fisheries Society, (May 2005)

0.3 to 1.3 feet per second for suitable habitat. The study indicates the fish move into deeper pools during higher or lower flows. At the gage location, based on discharge measurements, it appears the higher end of the range is achieved at this location at approximately 20cfs. However, the nature of the sand bed of the river in this area greatly impacts the channel cross-section. Additionally, based on the Tennant Method for very general required environmental flows, approximately 30% of the mean annual flow is required at a minimum for good habitat. This flow rate would be approximately 149cfs. If additional studies become available in the future, the streamflow requirements for aquatic and riparian needs can be added into the analysis.

There were no studies specifically indicating required flushing flows in the area. Flushing flows are needed to move sediment downstream, creating diverse aquatic habitat, as well as to aid in life cycle functions of species. Therefore general recommendations based on the Tennant method for flushing flows of 200% of the annual mean flow were determined.¹⁰ The mean flow during the non-winter months was determined to be approximately 496 cfs, therefore a recommended flushing flow of 993 cfs was included in the analysis. The duration of flushing flows would be determined from additional hydraulic analyses based on specific channel characteristics at the project locations.

There are no studies found suggesting specific recreational flow recommendations in the South Platte basin, nor in this reach. Therefore, no recreational flows were compared for this example area. If additional recreational studies become available, these flows can be added into the analysis.

The table below shows the general recommendations based on these sources. Refinements should be made with site-specific studies before using these values to plan or implement projects.

Table 7 - South Platte River at Balzac - General Flow Recommendations (in cfs)

<i>Month</i>	Recommended Environmental Flow		Flushing Flows
	Based on Plains Fish Habitat	Based on Tennant Method	
<i>January</i>	20	149	
<i>February</i>	20	149	
<i>March</i>	20	149	
<i>April</i>	20	149	
<i>May</i>	20	149	~993
<i>June</i>	20	149	~993
<i>July</i>	20	149	
<i>August</i>	20	149	
<i>September</i>	20	149	
<i>October</i>	20	149	
<i>November</i>	20	149	
<i>December</i>	32	50	

¹⁰ Tennant method or “Montana” method for determining flushing flows. General description of the Tennant Method can be found in *The flushing flow problem: Defining and evaluating objective*, Kondolf, Wilcox, (Water Resources Research, August 1996) and *Hydrological Low Flow Indices and their Uses*, Pyrcie (Watershed Science Center, 2004). Additional literature states the annual natural streamflow should be used and additional analyses should be used to determine appropriate flushing flows.

These recommendations were compared to specific annual hydrographs, as well as the time series data. The minimum flows are indicated by the red line in the following graphs. The flushing flows are indicated by the yellow line in the following graphs. The annual hydrographs for 1999 and 2002 through 2004 are shown in Figure 5-34 through Figure 5-37.

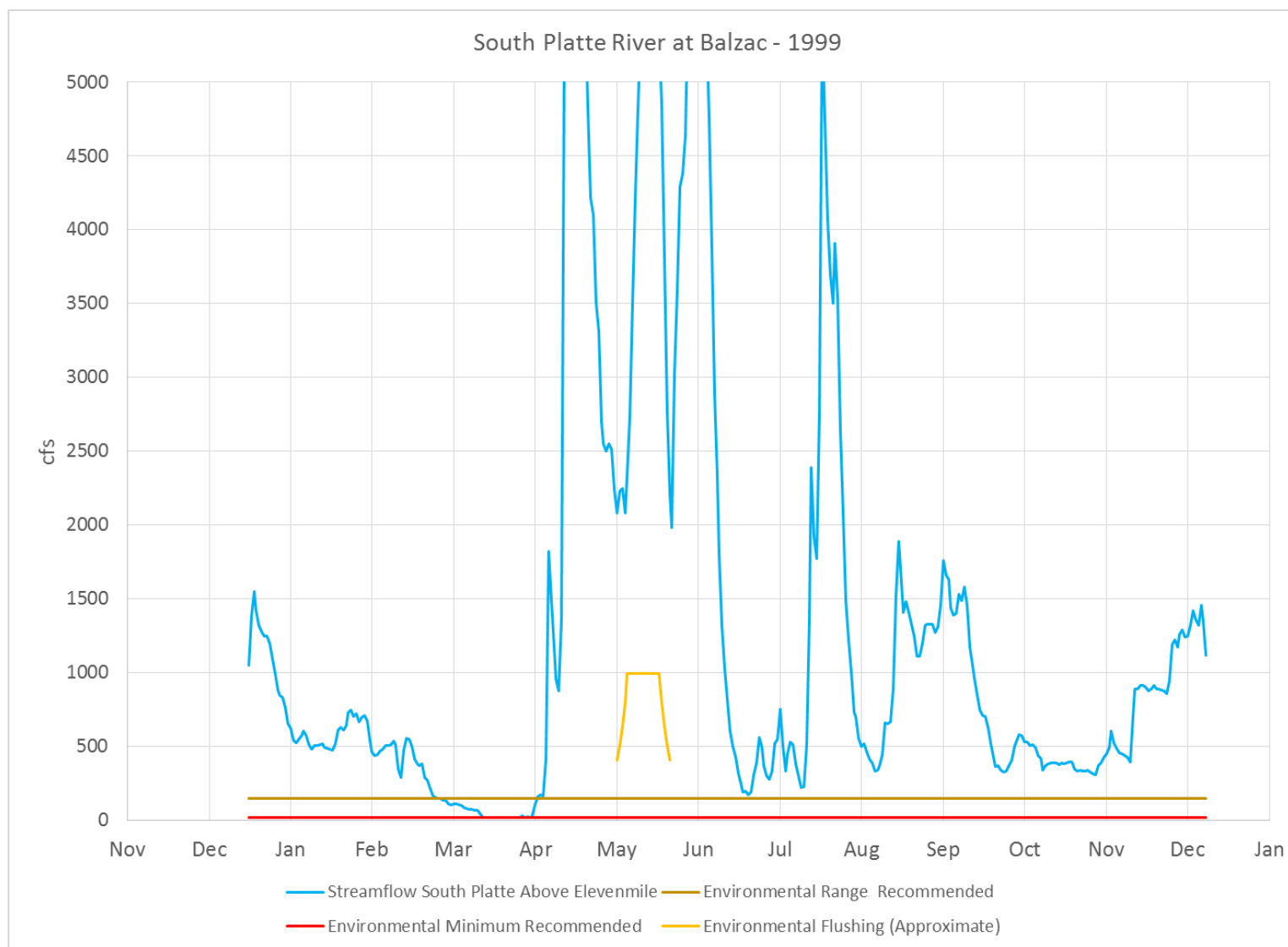


Figure 5-34 - Hydrograph comparison to available environmental and recreational flow information - 1999

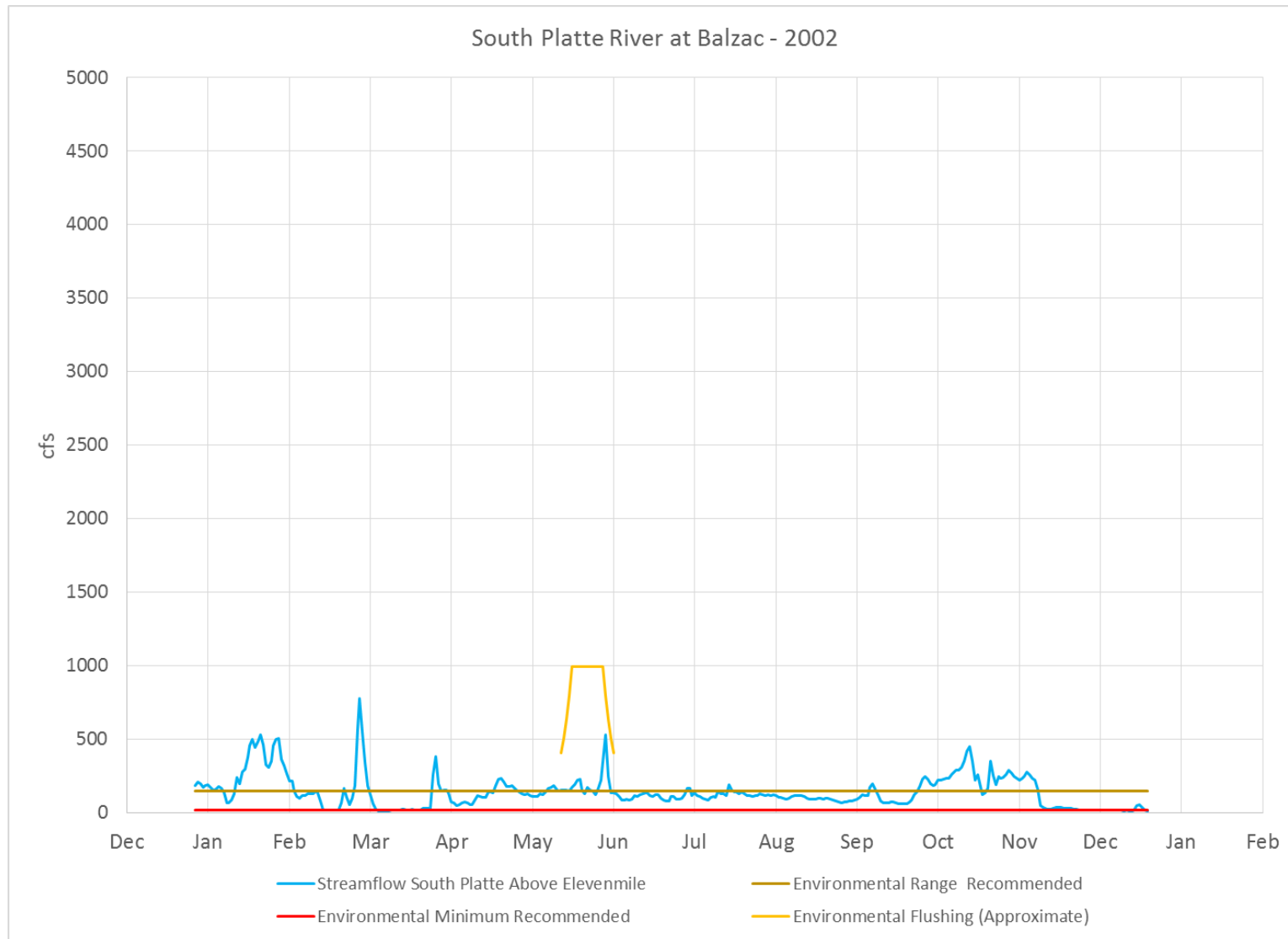


Figure 5-35 - Hydrograph comparison to available environmental and recreational flow information - 2002

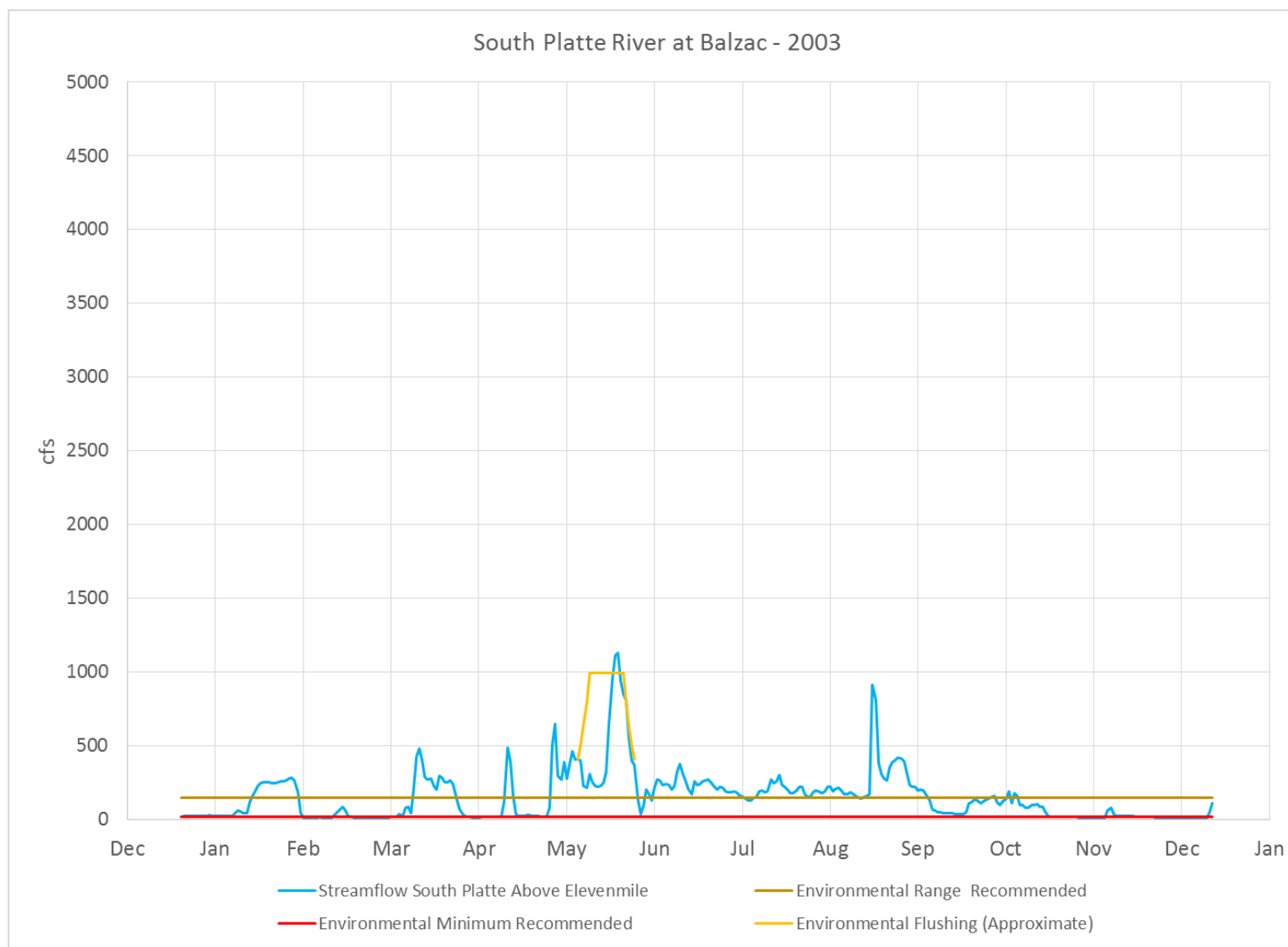


Figure 5-36 - Hydrograph comparison to available environmental and recreational flow information - 2003

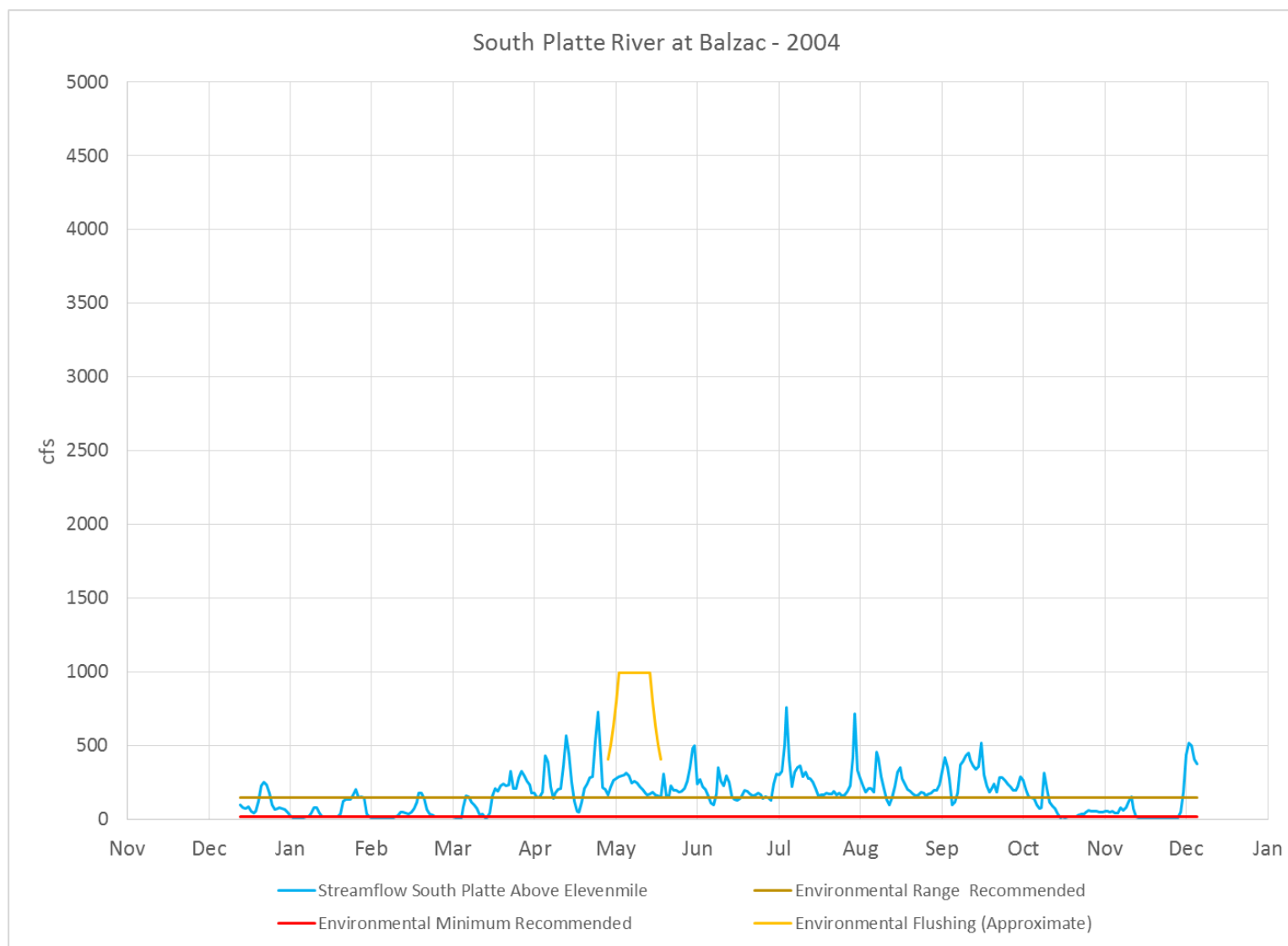


Figure 5-37 - Hydrograph comparison to available environmental and recreational flow information - 2004

In addition to comparing the flows in the South Platte at Balzac in specific years, time series raster plots were developed to look at the flows over the period of record. A raster plot demonstrates flows as different colors, based on specific parameters that take the flow recommendations into consideration. A time-series raster plot can assist in giving planners a quick snapshot of flows with respect to certain environmental and recreational considerations. The time series raster plots shown below were developed to graphically demonstrate how the various general flow recommendations described above are met based on the time series data for the gage.

To demonstrate the times when the recommended minimum flows are met or not met by the available streamflows, a time-series raster plot was developed, as shown in Figure 5-38. The days when the minimum flow rates were not met are indicated in red on the raster plot. The days when the flows between the minimum from the plains fish species and the minimum based on the Tennant method are shown in orange. The flows above the minimum flow rates are indicated in green on the plot.

Additional studies are needed to determine the needed flows throughout the example area. This plot shows times when there are opportunities to potentially increase the flows in the river to meet the environmental needs. If additional required flow studies and information become available, similar plots could be used to compare the streamflows to the more specific needs of aquatic and riparian habitat determined by such studies in additional locations. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.

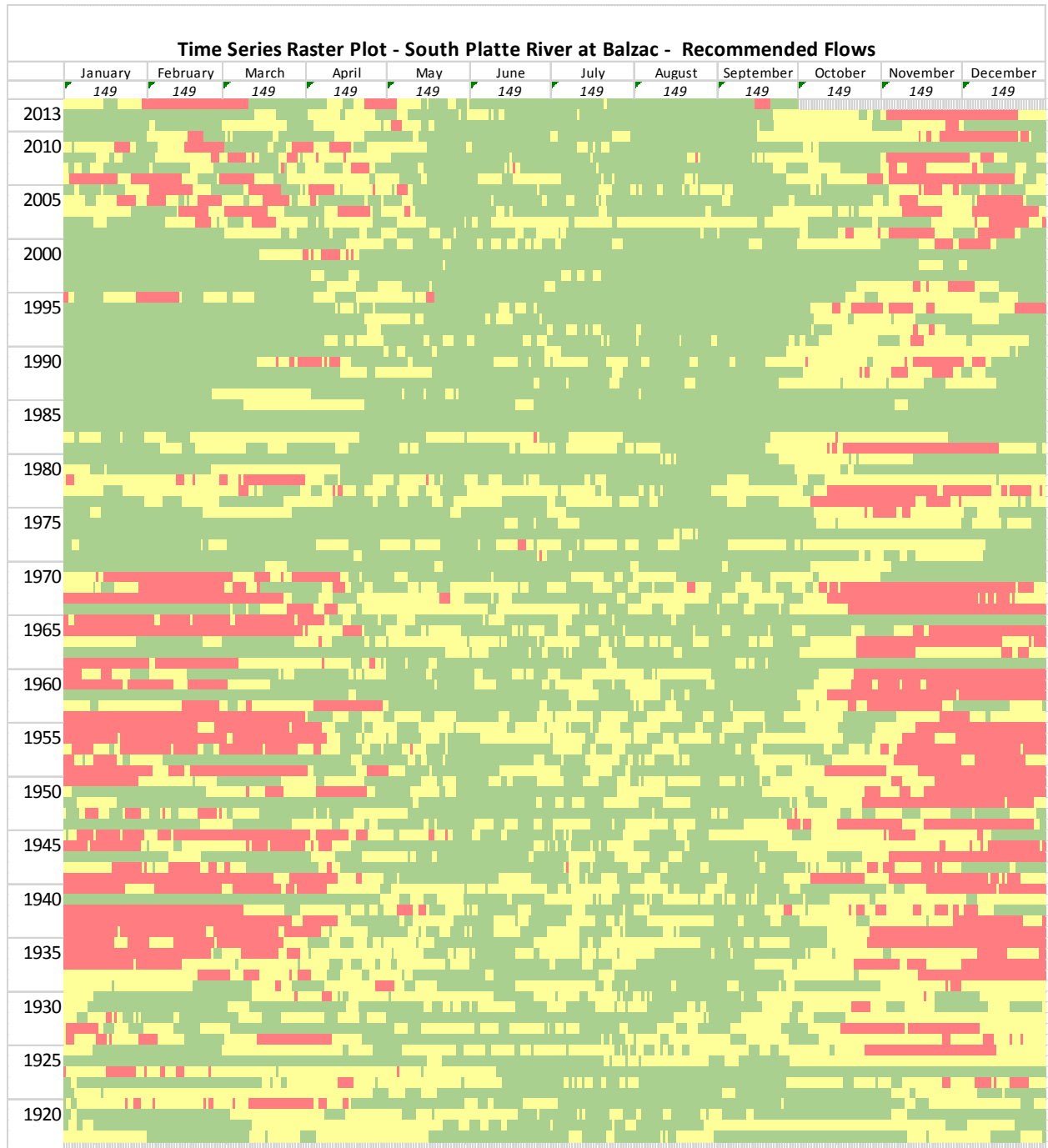


Figure 5-38 - Time Series Raster Plot – South Platte at Balzac - Minimum Recommended Flows

To demonstrate the times when the flushing flows recommendations are met or not met, a time-series raster plot was developed, as shown in Figure 5-39. The yellow in the plot shows days when the flow is greater than the generally recommended flushing flows. The red in the plot shows times when the flow is less than the generally recommended flushing flows. In general, in many years there appears to be flushing flows available in this area, based on the general Tennant method. Additional work to determine the required flushing flow rates, duration and frequency is needed.

If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.

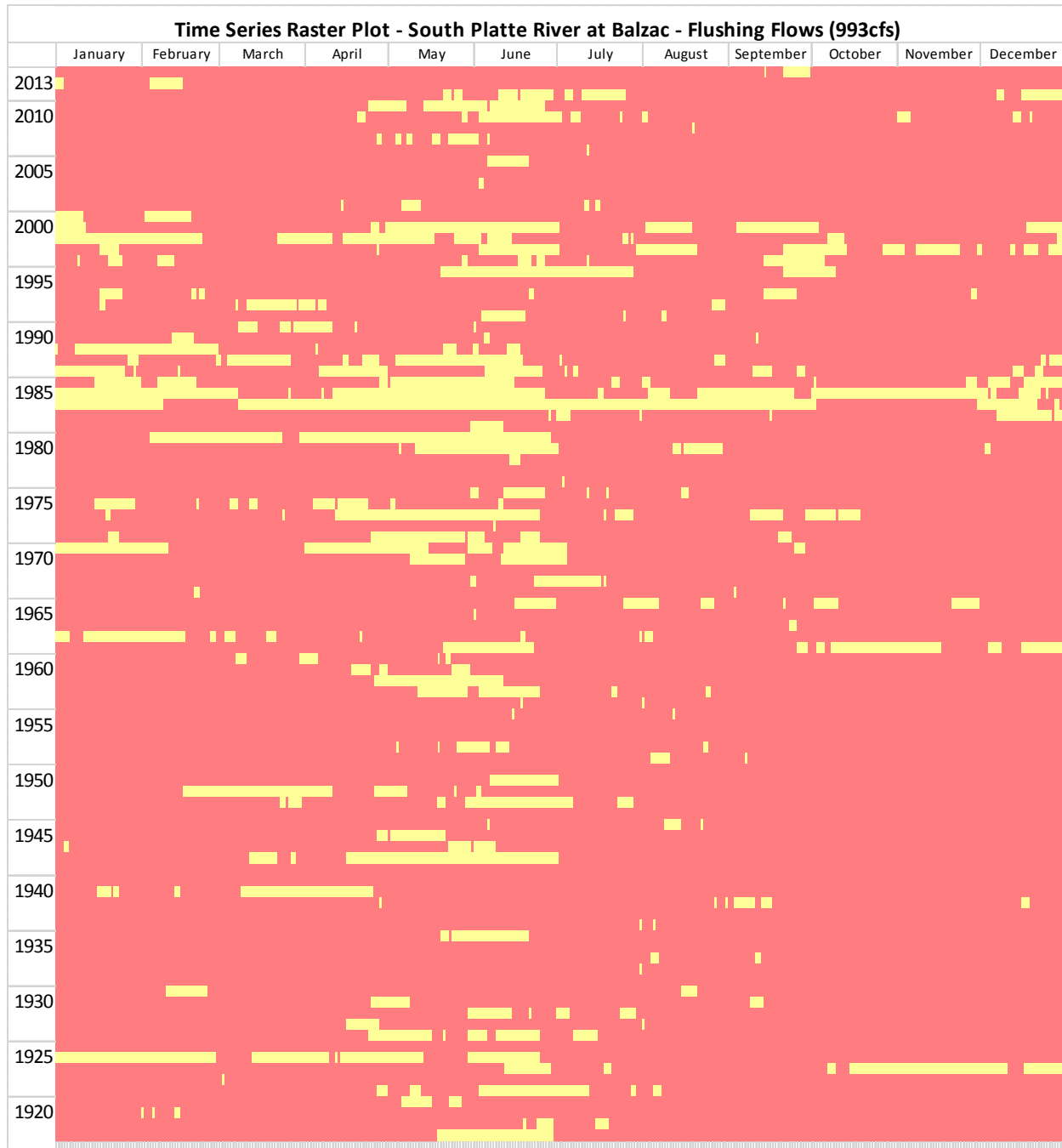


Figure 5-39 - Time Series Raster Plot – South Platte River and Balzac - Flushing Flows (993 cfs)

If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs or recreational uses determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess recreational flows of the stream.

General Discussion and Recommendations

In general, the analysis of streamflows on the South Platte at Balzac indicates the streamflows may, at times, be present in this area to meet the very general flow recommendations presented above. However, significant additional flow study information is necessary to determine if these recommendations are adequate for environmental and recreational protection.

There is a great amount of additional data needed to fully assess the environmental and recreational protections that exist and may be needed in the example area on the South Platte. Studies that relate the channel form and function to the streamflows can make assessment of flows in the area more robust. In addition, streamflows necessary for recreational needs should be assessed.

The time-series raster plots are helpful in assessing what flows may be needed or available for additional municipal and industrial projects. The Surface Water Availability Analysis (detailed in Appendix __) shows that there is potentially availability for surface water development at times in the South Platte at Balzac. Comparing to the raster plots once additional work has been done to fully assess the flows required for environmental and recreational needs can show times when additional diversions may not negatively impact the minimum flows, flushing flows or recreational flows. It appears that times of lengthy flushing flows and adequate minimum instream flows may coincide with some years during which the Surface Water Availability Analysis shows times of legal and physical availability. Additional daily analysis and comparison should be done to ensure the times generally shown in the raster plot and the summarized annual availability coincide, before determination is made that additional diversions may not impact environmental and recreational flows.

Specific types of projects that may help to protect or enhance the environmental and recreational flows in the area include:

- o Fish Passage – Various diversions in the area dry-up the river, cooperative operational agreements to assist in fish passage around or through these diversion points in the future may help with stream connectivity.
- o Operational Flow Agreements – One of the conceptual projects is intended to assist with flows in the lower river for agricultural users, cooperative operational agreements could be made to deliver such water at times when this could benefit both agricultural and environmental uses.
- o Land Conservations and Habitat Restoration – Many of the projects in the area help to maintain environmental attributes including cooperative recharge projects and maintaining agriculture in the area.

Additional projects should be added into the stream mile representation for analysis of the effect of projects within the area. Specific spatial data, as well as specific flow data and completion date would be beneficial in determining when and to what degree these projects have benefited the example area. The actual needs of the aquatic and riparian habitat should be specifically studied in this area if additional project recommendations are to be made to protect and enhance the environmental attributes in this reach.

5.5 Project Example Summary

The methodology and stream mile representation framework described in detail in this section can be used in other locations throughout the South Platte Basin or the State. Hydrological data and flow studies are essential in assessing the environmental and recreational gap and the projects needed to maintain or enhance the environmental and recreational attributes. This framework can assist the BRTs and others in assessing these items.

6 Environmental and Recreational Projects List

Environmental and recreational projects in the South Platte Basin based upon SWSI 2010 are listed in Table 8. Some refinements to the projects list from SWSI 2010 have been included, although more refinements to the list and specificity of the projects are needed. All projects should include spatial data and additional descriptions of the projects to assist in identifying sufficiency of protections in the future. Additional projects have been included in Table 9 and include those recommended for inclusion by members of the environmental and recreational subcommittee of the Metro and South Platte Basin Roundtables during the BIP process.

Table 8 - Environmental and Recreational Projects (based on SWSI 2010)

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
231	West Gold Remediation	NCNA Interviewed	Project	"Chicago Creek, upstream of confluence with Clear Creek"	Completed	Christine Crouse	Built water diversion to separate drainage from mine tailings to protect water quality in Chicago Creek
223	Lombard Mine Cleanup and Mill Site Removal	NCNA Interviewed	Project	"Cumberland Gulch, upstream of confluence with Fall River"	Completed	Christine Crouse	Reshaping two mine dumps and burying wood waste from mill building
232	Minnesota Mine Remediation	NCNA Interviewed	Project	"Lion Creek, above confluence with West Fork Clear Creek"	Planned	Christine Crouse	"Spring seeping contaminated water from underground collapsed mine, plan to use passive remediation using an alkaline barrier to neutralize iron, zinc, and aluminum flowing out of spring"
309	Land conservation	NCNA Interviewed	Project		Ongoing		DU holds many easements on the river
310	Land conservation	NCNA Interviewed	Project		Planned		"Plan to protect additional 27,000 acres, which would include the water rights"
311	Seasonal wetland habitat restoration	NCNA Interviewed	Project		Ongoing		"Needs programs to control noxious weeds, lower priority than main stem."
312	Riparian habitat improvement education and outreach	NCNA Interviewed	Project		Ongoing		
313	South Platte Protection Plan	NCNA Interviewed	Information		Completed	Becky Long, South Platte Enhancement Board, David*	Implemented in 1997 to protect values in lieu of USFS making a W&S determination.
335	Tarryall Reservoir Enlargement	CPW	Project		Planned	CDOW	Presented in concept
336	Montgomery Reservoir Enlargement	NCNA Interviewed	Project		Planned	CDOW	Presented in concept
337	Tamarack Project	CPW	Project		Completed	CDOW	
801	Riparian restoration project	NCNA Interviewed					
803	St. Vrain Creek Corridor Committee releases 1000 AF/yr to benefit minnows	NCNA Interviewed	flow protection				
176	Bard Creek Instream Habitat Structures	NCNA Interviewed	Project	Bard Creek	Completed	Carl Chambers	Instream Fish Habitat Structures
chr_f_51	River Restoration - Riparian Re-vegetation	CWCB	Project	Bear Creek	Planned	"Wendy Hawthorne, Groundwork Denver"	

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
cwrp_13	River Restoration Design	CWCB	Plan	below Chatfield	Planned	"Cecily Mui, South Suburban Parks and Recreation"	South Suburban Park
CDOW_5	Channel Restoration	CDOW	Stream and Riparian Restoration	Big T at Glade Park	completed	Ben Swigle - CDOW	
CDOW_6	Channel Restoration	CDOW	Stream and Riparian Restoration	Big Thompson at Narrows SWA	Planned	Ben Swigle - CDOW	
CDOW_39	Big Thompson Stream Restoration Phase 1	CDOW	Restoration	.1 segment upstream of the Mall Street Bridge below Olympus Dam	Completed	CDOW	Channel Restoration (0.1 miles) including vortex structures, pool excavation, boulder clusters
168	Big Thompson River Instream Fish Habitat Project	NCNA Interviewed	Project	Big Thompson River above Waltonia	Completed	Carl Chambers	ADA fishing access and Instream Fish Habitat Improvements
282	Minimum flow releases from Olympus Dam - BOR and NCWCD	NCNA Interviewed	Flow Protection	Big Thompson River from Estes Park to Dillon Tunnel	Ongoing	Larry Howard	Flows are specified by season and are defined as the lesser of the specified flow or the inflow into Lake Estes
263	Barrier Construction	NCNA Interviewed	Project	Black Hollow Creek	Completed	Kelly Larkin	Barrier construction for Greenbacks
CDOW_28	Fish Passage study	CDOW	Study	Boulder Creek	Ongoing	Ashley Ficke - CU Boulder	Study on ability of different fish species to pass through diversion structures under varying flows and temperatures.
162	Bull Pond Livestock Fencing Project	NCNA Interviewed	Project	Bull Pond	Completed	Carl Chambers	Livestock Fencing to promote wetland recovery
268	Investigating operations change	NCNA Interviewed	Flow Protection	Cache La Poudre	Planned	Amy Beatie	"Planning effort, looking at different operation efforts to leave more water in the river; next to new GOCO-funded path"
45	Cache la Poudre bank stabilization	NCNA Interviewed	Water Quality Protection	Cache la Poudre (near I-25)	Completed	Becky Pierce	Created wetlands and excavated sediment
166	Dutch George bank Stabilization	NCNA Interviewed	Project	Cache La Poudre River at Dutch George	Completed	Carl Chambers	Bank Stabilization
167	Kelly Flats Campground Bank Stabilization	NCNA Interviewed	Project	Cache La Poudre River at Kelly Flats Campground	Completed	Carl Chambers	Bank Stabilization
165	Mountain Park Campground Fish Habitat Project	NCNA Interviewed	Project	Cache La Poudre River at Mountain Park Campground	Completed	Carl Chambers	Instream Fish Habitat Structures
203	Cherry Creek Basin Water Quality Authority	NCNA Interviewed	Water Quality Protection	Cherry Creek Reservoir	Completed	Aurora Water Resources	water quality management and projects within to promote water quality downstream of Cherry Creek Reservoir
234	Courtney-Ryley-Cooper	NCNA Interviewed	Project	Clear Creek	Completed	Christine Crouse	"Rafting and fishing spot, habitat improvement and disabled access"

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
287	Golden Mile habitat improvement for fisheries - focused on brown trout mainly	NCNA Interviewed	Project	Clear Creek - Golden - just above RICD	Completed	David Nickum	
CDOW_25	Alvarado Bridge Replacement	CDOW	Project	Clear Creek @ Lawson	Completed	Clear Creek County	Replaced 4-culvert bridge with span, allowing movement of fish
218	McClellan Mine Remediation	NCNA Interviewed	Project	Clear Creek at Dumont	Completed	Christine Crouse	"McClellan: remediation of orphan mine site on Clear Creek. Material removed, remainder capped. Raft launching site built."
169	Como Creek Fishery Habitat Structures	NCNA Interviewed	Project	Como Creek	Completed	Carl Chambers	Instream Fish Habitat Structures
221	General Herkimer Mill Site	NCNA Interviewed	Project	Confluence of Clear Creek and Spring Gulch	Completed	Christine Crouse	"Mine waste remediation, controlling run-off"
156	Corral Creek fish Structures	NCNA Interviewed	Project	Corral Creek	Completed	Carl Chambers	Instream Fish Habitat Structures
CDOW_8	Craig Creek (VanHall Property)	CDOW	Project	Craig Creek	Planned	Freestone Aquatics	Channel improvements, sediment transport, Planned
186	Creedmore Lakes Livestock Fencing Project	NCNA Interviewed	Project	Creedmore Lakes	Completed	Carl Chambers	Livestock Fencing to promote wetland recovery
47	"East Plum Creek wetlands restoration, channel restoration work."	NCNA Interviewed	Project	East Plum Creek	Completed	Becky Pierce	"Created wetlands, and installed in-stream structure to re-channel stream for Prebles Jumping Mouse"
164	Elkhorn Creek Instream Fish Habitat	NCNA Interviewed	Project	Elkhorn Creek	Completed	Carl Chambers	Instream Fish Habitat Structures and Bank Stabilization
36	Five-Mile Creek Channel Reconstruction	NCNA Interviewed	Project	Five-Mile Creek	Completed	Mark Beardsley	Stream Restoration
cwrp_9	"River Restoration - channel reconfiguration, riparian re-vegetation"	CWCB	Project	Fourmile Creek	Completed	"Dieter Erdmann, Colorado Open Lands"	
24	Pettee Ranch Riparian Restoration	NCNA Interviewed	Project	Four-Mile Creek	Completed	Mark Beardsley	Riparian restoration of grazing impacts
25	Four-Mile Creek / Denver Water Channel Reconstruction	NCNA Interviewed	Project	Four-Mile Creek	Completed	Mark Beardsley	Reconstruction of 3 mile channelized creek to 5 mile meandering stream. Part of larger wetlands restoration project.
35	Four-Mile Creek / Denver Water Channel Reconstruction #2	NCNA Interviewed	Project	Four-Mile Creek	Completed	Denver Water	90 acre Wetlands restoration. Part of a larger restoration project
224	Silver Age/Ship Ahoy	NCNA Interviewed	Project	Gilson Gulch	Ongoing	Christine Crouse	"Clean water diversion project to prevent contamination of the headwaters from 40,000 cubic yard Silver Age mine waste pile"

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
225	Gilson Gulch	NCNA Interviewed	Project	Gilson Gulch	Ongoing	Christine Crouse	An erosion and sediment control project designed to protect Clear Creek from metals and acidity associated with mine waste in the upper portions of the watershed
226	Silver Cycle	NCNA Interviewed	Project	Gilson Gulch	Ongoing	Christine Crouse	A mine waste consolidation and reclamation project designed to remove mine waste and stabilize the channel of Gilson Gulch
227	Mine Drainage Treatment Demonstration Project	NCNA Interviewed	Project	Gilson Gulch	Planned	Christine Crouse	A planned project to treat the base flow of Gilson Gulch using state-of-the-art passive mine drainage treatment techniques
175	Grizzly Gulch Riparian Restoration	NCNA Interviewed	Project	Grizzly Gulch	Completed	Carl Chambers	Stream Stabilization and Riparian Restoration
235	Grizzly Gulch Habitat Improvement	NCNA Interviewed	Project	Grizzly Gulch	Completed	Christine Crouse	"Habitat improvement for greenback, mine remediation, maintenance of chemical barrier protecting greenbacks from Brook Trout"
CDOW_27	Reintroduction of Native Trout	CDOW	Project	Grizzly Gulch	Planned	Paul Winkle - CDOW	Planned introduction of Native Trout
148	Gross Reservoir Minimum Release	NCNA Interviewed	Flow Protection	Gross Reservoir	Completed	Denver Water	Denver Water Minimum Instream Flows
285	Potential Environmental Pool	NCNA Interviewed	Flow Protection	Gross Reservoir	Planned	David Nickum - Colorado Trout Unlimited	
283	Minimum release from Idylwyld Dam of 7.0 cfs	NCNA Interviewed	Flow Protection	Idylwyld Dam - City of Loveland USFS easement	Ongoing	Larry Howard - Larimer County Municipalities	
chr4_4	"River Restoration - riparian Re-vegetation, sedimentation mitigation"	CWCB	Project	James Creek	Completed	"Colleen Williams, James Creek Watershed Initiative"	
288	Improve fish habitat and recreational opportunities	NCNA Interviewed	Project	Jefferson County - one mile of stream along Highway 6	Planned	David Nickum	
150	L.C. Pump Station to Chatfield Reservoir instream flows	NCNA Interviewed	Flow Protection	L.C. Pump Station to Chatfield Reservoir	Completed	Denver Water	Denver Water Minimum Instream Flows
CDOW_15	Greenback Cutthroat Recovery Project	CDOW	Habitat	La Poudre Pass, Corral, Neota, Willow, Hague, Chapin Creeks as well as Baker Gulch and the upper South Fork of the Cache la Poudre.	Planned	USFS, CDOW	The USFS decision in the Long Draw EIS to protect and reclaim the headwaters of the Cache la Poudre for greenback cutthroat recovery. Planned
222	Dibbins Mill and Sydney	NCNA	Project	Leavenworth Creek	Completed	Christine	"Mine waste remediation, controlling run-

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
	Tunnels Remediation	Interviewed				Crouse	off"
CDOW_3 8	Left Hand Creek Restoration	CDOW	Restoration	Left Hand Creek	Completed	CDOW	Channel Restoration (0.9 miles)
sev_1	"River Restoration - riparian Re-vegetation, sedimentation mitigation"	CWCB	Project	Lefthand Creek	Completed	"Colleen Williams, James Creek Watershed Initiative"	
155	Little Beaver Creek Fish Structures	NCNA Interviewed	Project	Little Beaver Creek (Between Comanche Peak Wilderness and Confluence of the South Fork of the Cache La Poudre River)	Completed	Carl Chambers	Instream Fish Habitat Structures
177	Little James Creek Bank Stabilization	NCNA Interviewed	Project	Little James Creek	Completed	Carl Chambers	Bank Stabilization and Mine Tailings cleanup
CDOW_2 4	USACE flood control study	CDOW	Study	Lower Poudre River below Fort Collins	Ongoing	USACE	US Army Corps flood control study - Poudre River at Greeley.
CDOW_2 9	Tamarack Recharge Study	CDOW	Study	Lower South Platte at Tamarack SWA	Ongoing	John Stednick - CSU	Study on how recharge projects affect physical habitat during winter flow conditions.
14	Puma Hills River Ranch Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
15	Allen Ranch Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
16	Bennis Ranch Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
17	Tarryall State Wildlife Area Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
18	Tarryall Reservoir Outlet Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
CDOW_9	Lower Allen Ranch	CDOW	Project	Lower Tarryall Creek	Planned	Flywater	Channel improvements, sediment transport, riparian improvements, Planned
228	Lower Trail Creek Remediation	NCNA Interviewed	Project	Lower Trail Creek near confluence with Clear Creek	Ongoing	Christine Crouse	Abandoned mine remediation to project watershed
CDOW_1 1	Middle Fork South Platte Restoration	CDOW	Project	M Fk. South Platte	ongoing	CDOW - Matt Kondratieff	Adult Salmonid Habitat, channel improvements, sediment transport, riparian improvements, Ongoing and completed. See Attached List
142	River North Greenway	NCNA	Information	Metro Denver	Completed	Jeff Shoemaker	master plan for recreation use on the

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
	Master Plan	Interviewed		Greenways			Metro North South Platte
143	Westerly Creek Greenway Master Plan	NCNA Interviewed	Information	Metro Denver Greenways	Planned	Jeff Shoemaker	master plan for recreation use on Westerly Creek
144	Recreational and Riparian Improvements along the South Platte	NCNA Interviewed	Project	Metro Denver Greenways	Completed	Jeff Shoemaker	habitat enhancements and recreation enhancements along the Metro South Platte
145	Expansion / Enhancement to Confluence Park	NCNA Interviewed	Project	Metro Denver Greenways	Completed	Jeff Shoemaker	habitat enhancements and recreation enhancements to Confluence Park
146	Chatfield Reallocation Program	NCNA Interviewed	Flow Protection	Metro Denver Greenways	Planned	Jeff Shoemaker	storage water in Chatfield for releases into South Platte for recreation use
147	River South Greenway Master Plan	NCNA Interviewed	Information	Metro Denver Greenways	Completed	Jeff Shoemaker	master plan for recreation use on the Metro South Platte
20	McDaniel Ranch Riparian Restoration	NCNA Interviewed	Project	Michigan Creek	Completed	Mark Beardsley	Riparian Restoration of Ranching impacts
cwrp_3	"River Restoration - Channel reconfiguration, Riparian re-vegetation"	CWCB	Project	Middle Boulder Creek	Completed	"Roger Svendsen, Boulder Flycasters TU"	
CDOW_3	Channel Restoration	CDOW	Stream and Riparian Restoration	Middle Boulder Creek @ Rogers Park	Completed	Ben Swigle - CDOW	
CDOW_7	Channel Restoration	CDOW	Stream and Riparian Restoration	Middle Boulder Creek above Barker Reservoir	Planned	Ben Swigle - CDOW	
CDOW_4	Greenback Cutthroat Waters	CDOW	Study	Middle Boulder Creek from confluence with Boulder Creek to headwaters	Planned	Ben Swigle - CDOW	
286	Buffalo Peak Ranch fishery restoration - channel modification to provide better habitat restoration for brown trout	NCNA Interviewed	Project	Middle Fork at Buffalo Peaks SWA	Completed	David Nickum and Ecological Resource Consultants	
22	Buffalo Peaks Ranch Fish Habitat	NCNA Interviewed	Project	Middle Fork of South Platte	Completed	Mark Beardsley	"Fish Habitat in channel work, bank stabilization, public access"
23	Santa Maria Ranch Riparian Restoration	NCNA Interviewed	Project	Middle Fork of South Platte	Completed	Mark Beardsley	Riparian restoration and Channel reconstruction
21	Fairplay Beach Stream Restoration	NCNA Interviewed	Project	Middle Fork of South Platte in Fairplay	Completed	Mark Beardsley	Riparian Restoration of Placer mining impacts
170	Middle St. Vrain River Fish Structures	NCNA Interviewed	Project	Middle St. Vrain River at Camp Dick	Completed	Carl Chambers	Instream Fish Habitat Structures
CDOW_36	Habitat improvements projects	CDOW	Structural	NF Republican	Planned	CDOW	Habitat Improvement projects for Stonecat within the NF republican watershed

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
CDOW_30	Dr. Falke Study	CDOW	Study	NF Republican and Arikaree River	Completed	Jeff Falke - University of Oregon	Study on native fish population and habitat in NF Republican River Basin.
233	Aorta Mine Remediation	NCNA Interviewed	Project	North Empire Creek	Planned	Christine Crouse	"Seeping mine was draining into North Empire Creek, now goes into pipe under a landfill. Project will make improvements to inlet of that pipe"
CDOW_26	Realignment of State Highway 119	CDOW	Project	North Fork Clear Creek	Planned	Holly Huyck-CDOT	Treat mine wastes, cap tailings piles, improve fish habitat
1	Lazy River Stream Restoration	NCNA Interviewed	Project	North Fork of South Platte	Completed	David Bennet	Added vortex weirs
34	North Fork Fish Channel	NCNA Interviewed	Project	North Fork of South Platte (just below Antero)	Completed	Denver Water	Created alternate channel for fish movement
159	North Fork of the Cache La Poudre River Instream Fish Habitat	NCNA Interviewed	Project	North Fork of the Cache La Poudre River	Completed	Carl Chambers	Instream Fish Habitat Structures
289	Halligan-Seaman Shared Vision Planning	NCNA Interviewed	Project/Flow Protection	North Fork of the Poudre	Ongoing	City of Greeley, City of Ft. Collins	
163	North Lone Pine Creek Fencing Project	NCNA Interviewed	Project	North Lone Pine Creek	Completed	Carl Chambers	Livestock Fencing to promote wetland recovery
158	Pennock Creek Instream Fish Habitat	NCNA Interviewed	Project	Pennock Creek	Completed	Carl Chambers	Instream Fish Habitat Structures
CDOW_33	Boreal toad reintroduction	CDOW	Species reintroduction	Poudre River Basin from Big South Confluence to Headwaters	Ongoing	CDOW	Reintroduction of Boreal Toads in Cameron Pass Area
CDOW_19	Diversion structure modifications for bypass flows	CDOW	Structural	Poudre River - Watson hatchery to Fossil Creek	Planned	CDOW	Create ability to bypass low flows through diversion structures on Poudre river, including the CDOW Watson
CDOW_14	NISP EIS Impacts Study	CDOW	EIS Study	Poudre River below Canyon Mouth	Ongoing	NCWCD	An assessment of the Lower Poudre river corridor as the habitat changes relative to water levels for both riparian areas and fish habitat is currently underway associated with this project. Ongoing
CDOW_17	Anderson Engineering 2-D modeling	CDOW	Study	Poudre River below Canyon Mouth	Completed	NCWCD	Groundwater modeling in support of proposed NISP project
CDOW_21	JOP Enhancement	CDOW	Flow Agreement	Poudre River below Joe Wright Reservoir	Planned	CDOW	Exchange of Greeley owned Laramie Tunnel water into Chambers Lake to enhance existing wintertime JOP flows.
CDOW_23	Poudre River stream restoration - below Watson Lake diversion structure	CDOW	Restoration	Poudre River below Watson Lake SWA	Planned	CDOW	Channel restoration and design of low flow channel to improve habitat and channel function at low flow
CDOW_20	Minimum instream flows - Poudre River	CDOW	Flow Agreement	Poudre River in Fort Collins	Planned	CDOW	Potential agreement to maintain 25 cfs at the Poudre River Lincoln St. gage from Nov. - April

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
CDOW_16	Joint Operating Plan (JOP)	CDOW	Flow Agreement	Poudre River Mainstem	Completed	CDOW	Operating agreement between CDOW, Fort Collins and Greeley to provide minimum wintertime flows in Poudre River.
CDOW_18	Physical habitat modeling	CDOW	Study	Poudre River, North Fork	Completed	City of Greeley	Technical report by Bill Miller in support of proposed Halligan Seaman project
sev_22	River Restoration - Riparian Re-vegetation	CWCB	Project	Rock Creek	Planned	"Ed Self, Wildlands Restoration Volunteers"	
802	Various bank stabilization and riparian restoration projects	NCNA Interviewed	Restoration	S Boulder Creek			
CDOW_12	South Fork South Platte Restoration	CDOW	Project	S Fk. South Platte	Planned	CDOW - Matt Kondratieff	Adult Salmonid Habitat, channel improvements, sediment transport, riparian improvements, Planned and completed
46	Saint Vrain stream realignment and wetland enhancement	NCNA Interviewed	Project	Saint Vrain (near Longmont)	Completed	Becky Pierce	"Realigned stream channel, wetland mitigation and enhancement"
CDOW_2	South Boulder Creek Channel Restoration	CDOW	Stream and Riparian Restoration	South Boulder Creek between Pinecliff and Moffat Tunnel	Completed	Ben Swigle - CDOW	
172	Jumbo Mountain Picnic Ground Bank Stabilization	NCNA Interviewed	Project	South Boulder Creek at Jumbo Mountain Picnic Ground	Completed	Carl Chambers	Bank Stabilization and Instream Fish Habitat Structures
CDOW_1	Channel Restoration	CDOW	Restoration/Diversion Reconstruction	South Boulder Creek between South Boulder Road and 1 mile west of Hwy 36.	Completed	Ben Swigle - CDOW	
284	Fish passage on diversion structures	NCNA Interviewed	Project	South Boulder Creek from Gross Reservoir to Mouth	Completed	David Nickum - Colorado Trout Unlimited	
154	South Fork of Cache La Poudre River Fish Structures	NCNA Interviewed	Project	South Fork of Cache La Poudre River	Completed	Carl Chambers	Instream Fish Habitat Structures
CDOW_13	Upper South Platte Stream Restoration	CDOW	Project	South Platte	Planned	CDOW - Matt Kondratieff	Adult Salmonid Habitat, channel improvements, sediment transport, riparian improvements, Planned
CDOW_34	Identification and modification of barriers to fish passage on South Platte	CDOW	Study	South Platte	Planned	CDOW	Identification of South Platte mainstem and tributary diversion structures that are barriers to fish passage. Propose collaboration with structure owners to investigate feasibility and funding of structure modification to allow for fish passage.

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
26	South Platte Protection Plan #3 - Eleven Mile Reservoir	NCNA Interviewed	Flow Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Release of minimum instream flows necessary for fishery habitat
27	South Platte Protection Plan #4 – Cheesman Reservoir	NCNA Interviewed	Flow Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Release of minimum instream flows necessary for fishery habitat
28	South Platte Protection Plan #5 - Outflow Ramping from Eleven Mile / Cheesman Reservoir / Roberts Tunnel	NCNA Interviewed	Flow Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Outflow Ramping Agreement (ie reservoir outflow fluctuation agreements by percent of change)
29	South Platte Protection Plan #6 - Channel work on North Fork	NCNA Interviewed	Information	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Commitment to consult Colorado Division of Wildlife in any channel work and to maintain or enhance structural habitat for trout.
30	South Platte Protection Plan #7 - Planning meetings b/t Operators and fisheries and whitewater interests	NCNA Interviewed	Information	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Commitment to consult fisheries and recreation interests regarding upcoming operations.
31	South Platte Protection Plan #8 - New operating and monitoring equipment	NCNA Interviewed	Information	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	"Install low flow valve at Eleven Mile Reservoir, install stream temp. monitors at Eleven Mile and Cheesman Reservoirs, and SNOTEL gages in the basin"
32	South Platte Protection Plan #2 - Spinney Mountain Reservoir	NCNA Interviewed	Flow Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	City of Aurora	Release of minimum instream flows necessary for fishery habitat

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
33	South Platte Protection Plan #9 - Stream Channel Maintenance	NCNA Interviewed	Water Quality Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Planned	Kevin Bayer	"Monitor Sediment levels, and where necessary develop in-channel projects to stabilize banks and erosion resulting from the 2002 Hayman fire."
153	Happy Meadows/ Sportsman's Paradise River Restoration	NCNA Interviewed	Project	South Platte at Happy Meadows	Completed	Carol Ekarius	riparian and river restoration
131	Trumbull Trout Habitat Enhancement	NCNA Interviewed	Project	South Platte below Horse Creek	Completed	Steve Dougherty	Improve trout habitat in river and provide better public access
WSRA-SP-1	South Platte River Recreation and Habitat Feasibility Study	WSRA	Study	South Platte River	Ongoing	Eric	Restoration Study
chrif_22	Happy Meadows Campground River Restoration Design	CWCB	Plan	South Platte River near Lake George	Completed	"Carol Ekarius, Coalition for the Upper South Platte"	
103	Hayman Fire Restoration	NCNA Interviewed	Information	South Platte River upstream of Michigan Creek	Planned	Steve Dougherty	Doing Hydro assessment in regards to sediment impacts from the Hayman Fire. Also removal of low-head dam.
290	Chatfield Reallocation	NCNA Interviewed	Project/Flow Protection	South Platte through Metro Area	Ongoing	CWCB	
291	Metro Area River Restoration Proposals	NCNA Interviewed	Project	South Platte through Metro Area	Planned	CWCB	
CDOW_31	Plains Fish Monitoring	CDOW	Monitoring	South Platte/ Republican	Ongoing	CDOW	Ongoing monitoring of native fish populations in North Fork and Republican River basins.
CDOW_35	Plains fish reintroduction	CDOW	Species reintroduction	South Platte/ Republican	Planned	CDOW	Reintroduction of native plains fish species including Brassy Minnow, Northern Redbelly Dace, Common Shiner, Plains Minnow, Suckermouth Minnow
CDOW_32	Special Status Plains Fish Species - State Conservation Plan	CDOW	Monitoring/Study/Conservation Plan	South Platte/ Republican (& Arkansas)	Completed	CDOW	Plan for all designated State Threatened and State Endangered native plains fish.
48	Mayer Ranch Park mitigation project	NCNA Interviewed	Project	South Turkey Creek	Completed	Becky Pierce	Channel reconstruction to mitigate incised stream.
149	Strontia Springs Reservoir to L.C. Pump Station instream flows	NCNA Interviewed	Flow Protection	Strontia Springs Reservoir to L.C. Pump Station	Completed	Denver Water	Denver Water Minimum Instream Flows
12	Lazy River Stream Stabilization	NCNA Interviewed	Project	Tarryall Creek	Completed	Mark Beardsley	Stream Stabilization with Rock
13	Eagle Rock Ranch Stream Stabilization	NCNA Interviewed	Project	Tarryall Creek	Completed	Mark Beardsley	Stream Stabilization with Rock
CDOW_37	Tarryall Project	CDOW	Restoration	Tarryall Creek	Completed	CDOW	Channel and Riparian restoration (0.6 miles)

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
cwrp_1	River Restoration - Riparian Re-vegetation	CWCB	Project	Tarryall Creek near Jefferson	Completed	"Dieter Erdmann, Colorado Open Lands"	
CDOW_10	Trail Creek Restoration	CDOW	Project	Trail Creek	Planned	CUSP - Carol Ekarius	Channel improvements, sediment transport, riparian improvements, Planned
173	Tributary of West Fork of Clear Creek Bank Stabilization	NCNA Interviewed	Project	Tributary of West Fork of Clear Creek	Completed	Carl Chambers	Bank Stabilization and Instream Fish Habitat Structures
174	Reintroduction of Native Cutthroat Trout	NCNA Interviewed	Project	Tributary of West Fork of Clear Creek	Planned	Carl Chambers	Planned Reintroduction of Native Cutthroat Trout
chrf_42	River Restoration - Riparian Re-vegetation	CWCB	Project	Upper Rock Creek	Completed	"Ed Self, Wildlands Restoration Volunteers"	
19	Cline Ranch Riparian Restoration	NCNA Interviewed	Project	Upper Tarryall Creek	Completed	Mark Beardsley	Riparian Restoration of Ranching and Placer mining impacts
229	Upper Trail Creek Remediation	NCNA Interviewed	Project	Upper Trail Creek	Completed	Christine Crouse	Mine remediation to prevent acid mine drainage
CDOW_105	Knight-Imler Project, South Fork of South Platte River	CDOW	Restoration	Upstream: 415892E, 4324356N, Downstream: 416521E, 4322089N	Completed	CDOW	2002, 1.2mi
CDOW_102	Antero Project, South Fork of South Platte River	CDOW	Restoration	Upstream: 423008E, 4316108N, Downstream: 423513E, 4316072N	Completed	CDOW	1999, 0.7mi
CDOW_106	Hartsel Project, South Fork of South Platte River	CDOW	Restoration	Upstream: 429621E, 4319613N, Downstream: 430562E, 4319239N	Completed	CDOW	2002, 1mi
CDOW_111	Middle Fork of South Platte River (Phase 1)	CDOW	Restoration	Upstream: 435539E, 4318654N, Downstream: 435811E, 4318497N	Completed	CDOW	2007, 0.5mi
CDOW_110	Middle Fork side-channel Project, Middle Fork of South Platte River	CDOW	Restoration	Upstream: 435539E, 4318654N, Downstream: 435904E, 4318299N	Completed	CDOW	2006, 0.6mi
CDOW_112	Middle Fork of South Platte River (Phase 1 continued)	CDOW	Restoration	Upstream: 435811E, 4318497N, Downstream: 435918E, 4318290N	Completed	CDOW	2008, 0.2mi
CDOW_113	Dream Stream (Phase 1), South Platte River	CDOW	Restoration	Upstream: 436205E, 4317880N, Downstream: 436644E, 4317668N	Completed	CDOW	1991, 0.4mi

SWSI NCNA Database Projects (no ISF or Stewardship)							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
CDOW_107	Aurora Project, South Platte River	CDOW	Restoration	Upstream: 440995E, 4316473N, Downstream: 441837E, 4316347N	Completed	CDOW	2003, 1mi
CDOW_114	Buckley Ranch Project, South Platte River	CDOW	Restoration	Upstream: 446523E, 4313949N, Downstream: 446817E, 4313806N	Completed	CDOW	1993, 0.4mi
CDOW_101	Dream Stream (Phase 2), South Platte River	CDOW	Restoration	Upstream: 446817E, 4313806N, Downstream: 446897E, 4313763N	Completed	CDOW	1998, 0.2mi
CDOW_109	South Fork Project, South Fork of South Platte River	CDOW	Restoration	Upstream: 446897E, 4313763N, Downstream: 435955E, 4318057N	Completed	CDOW	2005, 1.7mi
CDOW_104	Dream Stream (Phase 3), South Platte River	CDOW	Restoration	Upstream: 446897E, 4313763N, Downstream: 447885E, 4313638N	Completed	CDOW	2001, 0.9mi
CDOW_103	Threemile Creek, Creek Project, Tributary to South Platte River	CDOW	Restoration	Upstream: 447474E, 4313277N, Downstream: 447592E, 4313211N	Completed	CDOW	2000, 0.5mi
CDOW_108	Dream Stream (Phase 4), South Platte River	CDOW	Restoration	Upstream: 447885E, 4313638N, Downstream: 448492E, 4313429N	Completed	CDOW	2004, 0.3mi
219	Little 6 #1	NCNA Interviewed	Project	Virginia Canyon upstream from confluence with Clear Creek	Completed	Christine Crouse	Offsite removal of mine waste and erosion control
220	Little 6 #2	NCNA Interviewed	Project	Virginia Canyon upstream from confluence with Clear Creek	Completed	Christine Crouse	"Mine waste remediation, controlling run-off"
230	Doctor Mine Remediation	NCNA Interviewed	Project	West Fork Clear Creek	Completed	Christine Crouse	"Habitat improvement for greenback, mine remediation, maintenance of chemical barrier protecting greenbacks from Brook Trout"
cwrp_7	Greenway Master Plan	CWCB	Plan	Westerly Creek	Ongoing	"Brian Hyde, Westerly Creek Connection"	

Table 9 - Additional Identified Environmental and Recreational Projects

Additional Identified Projects							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
	Whitney & Eaton Ditches Fish Passage Project	CPW	Fish Passage	Poudre River: Whitney & Eaton ditches near Frank SWA	Proposed	CPW	Stakeholders include Whitney Ditch Co., Eaton Ditch Co., CPW, Larimer County, Windsor, and Greeley
	Boxelder Ditch Fish Passage Project	CPW	Fish Passage	Poudre River: Boxelder Ditch / Fossil Creek Reservoir Diversion near ELC	Planned	CPW	Stakeholders include Fort Collins and CPW
	Big Valley Reach Fish Passage Project	USFWS	Fish Passage	Big Thompson River: Southside Ditch, Loudon Ditch, and George Rist Ditch	Proposed	CPW	Stakeholders include USFWS, Big Thompson River Restoration Coalition, CPW, private land owners, South Side Ditch Company
	Meadows & South Ledge Fish Passage Project	USFWS	Fish Passage	St. Vrain Creek: Meadows Ditch and S. Ledge Ditch	Proposed	CPW	Stakeholders include USFWS, Boulder County, ditch companies, Crane & Associates, and CPW
	Green Ditch Fish Passage Project	USFWS	Fish Passage	Boulder Creek: Green Ditch	Planned	CPW	Stakeholders include USFWS, Boulder Open Space and Mountain Parks, and CPW
	Greenback Cutthroat Recovery Project	CPW	Species reintroduction	Upper/Lower Square Tops Lake and Duck Creek	Proposed	CPW	Introduction of Native Trout
	Greenback Cutthroat Recovery Project	CPW	Species reintroduction	Rock Creek	Proposed	CPW	Introduction of Native Trout
	Middle Fork of South Platte River (Phase 2)	CPW	Restoration	Upstream: 435415E, 4318627N, Downstream: 436015E, 4318251N	Completed	CPW	2009, 0.2mi
	Middle Fork of South Platte River (Phase 3)	CPW	Restoration	Upstream: 435246E, 4318865N, Downstream: 435415E, 4318627N	Completed	CPW	2010, 0.3mi
	Middle Fork of South Platte River (Phase 4)	CPW	Restoration	Upstream: 435154E, 4318861N, Downstream: 435246E, 4318865N	Completed	CPW	2011, 0.3mi

Additional Identified Projects							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
	Clear Creek/Twin Tunnels Project, Clear Creek	CPW/CDOT	Restoration	Clear Creek	Ongoing	CPW	Stakeholders include CPW and CDOT
	Dream Stream (Phase 5), South Platte River	CPW	Restoration	Upstream: 448492E 4313429N, Downstream: 449579E 4313398N	Ongoing	CPW	Stakeholders include CPW and Park County, began Fall 2013, 1.5mi
	Greenback Cutthroat Recovery Project	CPW	Species reintroduction	Dry Gulch - trib to upper Clear Creek, Clear Cr. County	Planned	CPW	Introduction of Native Trout
	Greenback Cutthroat Recovery Project	CPW	Species reintroduction	Herman Gulch - trib to upper Clear Creek, Clear Cr. Co	Planned	CPW	Introduction of Native Trout
	Big Thompson Stream Restoration Phase 2	CDOW	Restoration	0.2 mile segment downstream of stream gage below Olympus dam	Completed	CDOW	Channel Restoration (0.2 miles) including vortex structures, pool excavation, boulder clusters, root wads, log spurs, spawning channel, riparian plantings, reduction of channel width with fill material
	Greeley Poudre Greenway		Project	Poudre	Planned	Becky Safraik , Greeley	Channel improvements, gravel pit storage, greenway
	Fort Collins Poudre River restoration and enhancement project		Stream and Riparian Restoration	Poudre	Planned	John Stokes, Fort Collins Natural Areas Director	Complete master plan and segments are being completed
	Josh Ames Dam Removal Project		Stream and Riparian Restoration	Poudre	Completed 2013	Fort Collins	Completed partially with WSRA grant
	North Fork Poudre Eagles Nest Restoration Project		Habitat Restoration	Poudre	Planned	CO Trout Unlimited, Larimer County Open Lands	Ongoing, long-term Rocky Mountain Flycasters (Colo Trout Unlimited) project in cooperation with Larimer county Open Lands (now part of Larimer Co. Dept Nat. Resources).
	Park County Prioritization Process		Flow/Lake Level	Park County	Planning	Park County Advisory Board on the Environment	Prioritization process of streams and natural lakes that could benefit from in-stream flow and natural lake level water rights.
	Sugar Creek Sediment Mitigation Project		Species Habitat	Sugar Creek Watershed in Douglas County			5-Year Plan Sugar Creek Watershed in Douglas County – confluence with SP River about 10 miles upstream from Strontia Springs - center of the project area is near coordinates 105°10'00" and 39°18'00" (NAD83). Preble's Meadow Jumping Mouse Habitat

Additional Identified Projects							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
	CUSP Projects			Upper South Platte			various projects, list being refined
	South Park Groundwater and Surface Water Quality Baseline Study		Study	Upper South Platte	Completed	Park County Land & Water Trust Fund	Develop a multi-year baseline of water quality in South Park before energy exploration & development.
	Mine Assessment Project in Headwaters of South Platte		Study	Upper South Platte	Completed	CWCB Healthy Rivers Fund grant, LWTF, & CUSP	Identified the water-quality impacts of historical mining and impacts from the acid rock drainage throughout the watershed. North Fork of the Upper South Platte – mines plus iron fens in Hall Valley & Geneva Creek areas Middle Fork of the Upper South Platte – mines, mills, settling ponds and surface water bodies in Montgomery, Buckskin and Mosquito Gulches South Fork of the Upper South Platte – Weston Pass Mining District and mines around Fourmile Creek headwaters
	Park County Land & Water Trust Fund Projects			Upper South Platte			various projects, list being refined
	Park County Trout Population Monitoring: Habitat Use and Migration Patterns in South Park Streams		Monitoring	Upper South Platte	In Progress	CPW, CO Trout Unlimited, EcoMetrics, South Park National Heritage Area, & LWTF	Provide a scientific basis for planning and designing stream restoration and habitat improvement projects that support quality trout stream fisheries in the Middle and South Forks from Fairplay to Antero & Spinney Reservoirs.
	Park County Water Resources Inventory and Strategic Plan: Assessment of Functional Condition and Identification of Priorities for Restoration and Protection		Study	North and Middle Forks of the South Platte and Tarryall Creek	In Progress	CWCB Healthy Rivers grant, CPW Wetlands Program, LWTF, SPNHA, CUSP	This is a basin-wide assessment that will rate the functional condition and restoration potential of stream and wetland habitats on the North and Middle Forks of the South Platte and Tarryall Creek. It will produce an organized set of priority preservation and restoration projects on properties where the causes of degradation or impairment can be resolved and where protection from future impacts is possible. The study team will include local, state and federal agencies. This project is an on-the-ground match for an EPA grant project by Colorado Natural Heritage Area to develop a web-based wetlands planning toolbox using Park County as an example area in the toolbox.

7 Additional Analyses Needed

The examples and projects discussed in this Appendix indicate some projects that may provide protections to environmental and recreational attributes. In addition to the presence or absence of protections in focus areas, various other items can impact the shortage or gap for environmental and recreational needs. Changes in river conditions due to climate change or increased uses in the basin could result in reduced streamflows and further impair wildlife habitat. Changes in channel form and function can both impact and benefit habitat. The trend of irrigated agricultural lands being dried up can impact the amount and location of environmental and recreational needs in the Basin. These trends and conditions can be further analyzed with the framework discussed in this section. Additional analyses to determine these impacts may be performed in the future.

There is significant additional information, data and analyses needed to better understand and quantify the environmental and recreational needs, the benefit from existing and planned projects, the potential impact from general trends and other projects, and the protections in place or needed to protect or enhance environmental and recreational attributes within the South Platte Basin. This Appendix and related sub-appendices discusses specific additional data needs and analysis constraints that should be addressed in the future. The additional information, data and analyses needed generally includes:

- Better data and information regarding attributes and projects, including spatial information, attribute assessments, habitat assessments, and recreational assessments.
- Better assessment of ecological habitat and streamflow requirements and preferred recreational flows.
- Integration of other existing and not yet available environmental and recreational data.
- Specific additional analyses with regard to the Stream Mile Representation Framework are detailed in the Overview in Appendix D-1 and include:
 - o Scale the SMRF to a wider area, including reviewing and enhancing the SMRF processes and focusing on automation and quality control.
 - o Integrate the SMRF with quantitative analysis of environmental and recreational needs and gap.

Generally, additional data, better data and better data management is needed basin-wide to adequately assess the needs of and requirements for maintaining and enhancing environmental and recreational attributes. Full understanding of environmental and recreational issues will not be possible until “wet water” environmental flow requirements are better understood. Therefore, it is recommended that analysis of streamflow and other data occur and be referenced to the SMRF. Modeling such as Colorado’s Decision Support Systems (CDSS) basin models and point flow models, once available, could provide estimates of flows at locations intermediate to stream gages and such data could likewise be referenced to the SMRF. The integration of wet water analyses similar to the analyses performed in the example areas in Section 5 of this Appendix, with spatial

context to 0.1-mile resolution will provide a powerful tool for evaluating environmental and recreational needs and gaps, and the impacts of projects such as Identified Projects and Processes (IPPs).

8 Challenges to Assessment

A number of challenges exist in the evaluation of the impacts of municipal and industrial projects on environmental and recreational attributes, including:

- The project is currently in the permitting process which limits the ability to evaluate the project independent of the permitting process.
- The project sponsor/proponent is concerned about serving its customers and not necessarily concerned about the impacts of project on other system components (environment, recreation, agriculture) and therefore is not considering a multi-purpose project.
- The project sponsor or proponents may not have previously worked with other organizations and/or do not know of such organizations which may be available to work cooperatively to benefit multiple purposes.
- The funding needed to consider impacts and ways to improve a project is not available.
- The data or analysis does not exist to sufficiently evaluate impacts or potential multi-purpose benefits of the project.
- The additional challenges and limitations listed above regarding the methodology and framework.

9 Data Gaps

Data gaps exist in the data sources needed to fully implement the methodology and framework described in this appendix. These data gaps include discrepancies between the GIS shapefiles and Microsoft Access databases. There is also additional data not included in these data sets such as detailed project descriptions, project objectives by attribute, implementation schedules, and expected outcomes. There are also areas where more information or studies are needed. Studies such as specific assessments of what is needed for specific environmental and recreational attributes at specific locations are needed. Additional studies could be performed under future projects to determine the sufficiency of projects to protect attributes.

9.1 Data Limitations

There are various data limitations for appropriately assessing the current state of the environmental and recreational attributes and projects, as well as assessing what is needed to maintain or enhance the attributes. These limitations include:

1. The current data for assessing projects and protections exists in the SWSI 2010 GIS data, the CWCB MS Access database and new focus areas approved by the BRTs, and provided by various sources. The main limitation for the analysis of attributes, Focus Areas, projects and protections is the lack of a common, consistent and

comprehensive database. The discrepancies found between the SWSI 2010 GIS data and the MS Access database demonstrates the need for a thorough, systematic and comprehensive review and correction of the data. While some limited database improvements have been made, a full database reconstruction is beyond the scope for the BIP and should be completed at the State level since it appears to the present in all basins. It is recommended that the discrepancies in the multiple data sources be reconciled in the near term.

2. The determination of measurable outcomes requires very specific data for the presence of attributes, any factors that currently limit the attribute, a quantification of what would be needed to remove the limitations and projects that specifically target the attribute or attributes. An example of such data is:

Attribute “A” exists in 20 miles out of Focus Area “XYZ”. Focus Area “XYZ” is 60 miles long. Attribute “A” requires 30 miles of contiguous, connected habitat to maintain a viable population. The objective of specific projects is to increase the presence of Attribute “A” by 10 miles to provide habitat to sustain the population. Project “ABC” is would remove a barrier to passage that would reconnect 5 miles of habitat to the existing 20 miles of habitat. An additional future project to connect another 5 miles of stream is needed to meet the goal of 30 miles of habitat.

The data needed for the above example would include:

- o Population estimates for the species by stream reach.
- o Identification of specific barriers that fragment habitat.
- o A determination of the amount of continuous habitat associated with each fragmentation point.
- o Determination of the flow requirements for the species throughout the reach.
- o Measurement of flows within the reach.
- o Identification of projects that could modify the barriers so passage is possible.
- o An implementation plan and schedule for each project.

With all available data, the Stream Mile Representation Framework and other hydrological assessments discussed above could be used to analyze the attributes at additional locations throughout the basin and the state.

3. The above types of data are not provided in the current database at the level of detail needed to determine whether a project provides sufficient protection to meet a measureable objective. In general, a protection can be inferred, however, sufficiency cannot. It is recommended that the background information from the NCNA interviews and project descriptions be acquired, documented and assimilated into a Meta data set to support the database. It is assumed that this information exists or did exist at one time when the SWSI 2010 report was completed.
4. New data was compiled as part of the BIP process. All newly compiled data should be subject to the same scrutiny and review as the existing database. Any new data should include as much detail as possible on the attributes, project objectives, project description and metadata to trace the data to the originating entity. If possible, any

hardcopy information should be converted to digital format (either searchable PDF, spreadsheet or database file format). A master list of all new data should be maintained with the existing database files to reduce the effort needed by contractors or BRTs to implement future versions of the BIP.

5. Additionally, recreational flows data is very limited for the South Platte Basin. Additional studies are needed to determine the flows needed for recreational use, and the economic benefit from such recreation. American Whitewater is developing a “boatable days” analysis that could provide the BRTs with a valid tool to evaluate baseline and future scenarios for a given river reach in the context of the “boatable days” metric developed by American Whitewater. The boatable days metric describes the number of days a river reach can be used for recreational boating based on a range of acceptable and optimal flow criteria (determined through standard flow-evaluation surveys of river users). Given the uncertainty of future hydrological scenarios, the tool allows the user to perform a simple sensitivity analysis using historic flow data. This can be done using a user-provided monthly percent reduction/increase file, or by reductions of the historic flows. The purpose of this is to help identify when a reach will see a noticeable reduction in boatable days as well as the general magnitude of flow reduction that causes a loss of recreational opportunities. Once determined, recreational flow recommendations can be used with the framework presented in this Appendix.

9.2 Recommendations

There are several recommendations to address the data limitations discussed above. These recommendations are discussed below for both short-term and long-term recommendations.

- Continue to document to the degree possible the discrepancies between the GIS database from SWSI 2010 and the MS Access database.
- Continue to document the current status of mapped focus areas and associated attributes.
- Continue to document limitations of using the current database for determination of sustainability.
- Continue to document the limitations of using the existing project data for determining the level of protection provided for the attributes by project.
- Continue to document the additional studies and assessments needed to fully understand existing environmental and recreational habitat extents, aquatic and riparian species needs and flow requirements.
- Comprehensive, systematic, review and update of the multiple databases to provide a complete data set for future evaluations.
- Develop and implement a quality assurance protocol for data entry, data analysis, and data documentation for all data in the database.
- Extend the Stream Mile Representation Framework to other example areas within the South Platte Basin, and potentially basin-wide, collecting the appropriate data and information needed.

- Continue to integrate the Stream Mile Representation Framework with specific quantitative analyses of the existing environmental and recreational habitat extents, aquatic and riparian species needs and flow requirements.

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Appendix E – Water Quality

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin Roundtable

Prepared by TDS Consulting, Inc.

April 17, 2015



Contents

South Platte River Basin Implementation Plan Water Quality and Watershed-Health Aspects	
	Executive Summary 1
1	Introduction..... 4
1.1	Background and Purpose..... 4
1.2	General Physical Setting..... 4
2	Approaches 4
3	Discussion 5
3.1	Basinwide Characterization..... 5
3.2	Upper South Platte River Basin 9
3.3	Chatfield (Reservoir) Basin 9
3.4	South Platte in the Denver Metropolitan Area..... 11
3.5	Bear Creek Watershed..... 14
3.6	Cherry Creek Basin 16
3.7	Upper Clear Creek Watershed/Standley Lake..... 16
3.8	Barr Lake/Milton Reservoir..... 18
3.9	St. Vrain Creek Watershed..... 19
3.10	Big Thompson River Watershed 20
3.11	Cache la Poudre River Watershed..... 20
3.12	Northern Plains Basin Tributaries (Lone Tree Creek & Crow Creek) 22
3.13	Southern Plains Basin Tributaries (Box Elder Creek, Kiowa Creek, and Bijou Creek)..... 23
3.14	Lower South Platte River Basin 23
3.15	Republican River Basin..... 23
4	Impaired and Threatened Waters 24
5	Summary and Conclusions 26
	References..... 30

Tables

Table 1 - EPA Integrated Report Categories 8
Table 2 - Summary of Watershed/Regional/Subbasin Organizations, South Platte River Basin 26

Figures

Figure 1 - Distribution of Population Centers, South Platte River Basin (Dennehy and others, 1998) 6
Figure 2 - CDPHE Fish-Tissue Monitoring Sites..... 8
Figure 3 - Chatfield (Reservoir) Basin (Source: Tetra Tech, Inc., 2013) 11
Figure 4 - Sampling along the South Platte River in the Denver Metropolitan Area (Source: SPCURE website)..... 12

Figure 5 - SPCURE Water quality Monitoring Sites (www.spcur.org)	13
Figure 6 - South Platte River, Northern Denver Metropolitan Area (Source: CDPHE-WQCD, 2012, p. D-13)	14
Figure 7 - Seasonal variations of Total-Phosphorus Concentrations, South Platte River (Strontia Springs) vs. Bear Creek (above Harriman Ditch), Averages of 2000-2010 Data (Source: Hydros Consulting, Inc., 2011, p. 9).....	15
Figure 8 - Barr Lake/Milton Reservoir Subarea (AMEC Earth & Environmental, 2008)	18
Figure 9 - Saint Vrain Watershed Catchments (Source: JW Associates).....	19
Figure 10 - Seasonal Variations in Dissolved-Oxygen Concentrations, Big Thompson River at Loveland, CO (Source: J.D. Stednick, Colorado State University, written communication, July 30, 2010).....	20
Figure 11 – Big Thompson – St. Vrain Watersheds Showing Wetland Sample Sites (Source: CDPHE-WQCD, 2012, p. 122).....	22
Figure 12 - Irrigation-Diversion Ditch, Lower South Platte River (Source: LSPWCD website)	23
Figure 4-1. South Platte 303d Listed Waterways	Error! Bookmark not defined.

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South Platte River Basin Implementation Plan

Water Quality and Watershed-Health Aspects

Executive Summary

A bibliographic review was conducted provide information on water quality and watershed “health”, based upon past and recent investigations completed in various watersheds of the South Platte River Basin or for the Basin in its entirety. A brief water quality overview is included for the Republican River Basin. This report summarizes study results and information available from a number of sources, including numerous websites and makes specific recommendations regarding information gaps and future water quality and water-related environmental issues facing the Basin’s stakeholders in the future.

Watershed resources management includes stormwater and flood control. Innovative projects are being developed in the Basin that provide water quality and flood control benefits. In addition, numerous studies have dealt with water quality characterization and/or management for large parts of the South Platte River Basin or for the entire Basin. One primary example is the U.S. Geological Survey’s study of the Basin’s water resources under the auspices of its National Water quality Assessment (NAWQA) Program. The Basin has been delineated into a total of 18 eight digit hydrologic unit codes (so-called HUCs). Only subareas approximately covering the first 12 HUCs are included this review, with descriptions of available information and data provided generally in an upstream-to-downstream order.

This review identifies the range of water quality monitoring data and related information available for the various subareas of the South Platte Basin. A number of the subareas surrounding the Denver metropolitan area, including plains and mountain tributaries, have watershed plans, monitoring reports, source water protection plans, and other investigation reports describing specific issues of concern in water quality or watershed health. The intent of this review was to highlight, subarea by subarea (watershed by watershed) conditions of concern for these attributes and, in some cases, remedial projects or mitigation measures for maintaining or improving these conditions. The concept of sustainable watershed water resources management underlies many of the watershed or subarea based studies cited in this review.

Sustainable management for environmental and recreational attributes is interrelated with water supply complexities and land use changes affecting water quality and land cover, the latter factor being especially critical in the forested, mountain tributary streams flowing into the South Platte River. In this respect, institutional consideration (e.g., Federal vs. private land ownership) plays a role. The role of land management Federal and State agencies, as well as the water resources and environmental protection agencies requiring compliance with the NEPA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Clean Water Act (CWA) regulations is critical to the goal of sustainable water- resources management. In

addition, the Colorado Department of Health and Environment (CDPHE) monitors water quality throughout the State.

From a water quality perspective in the South Platte Basin, the following examples demonstrate the diversity of concerns relative to current and future Statewide planning:

1. Wastewater treatment and reuse are important facets of the Basin's water supplies. Innovative systems are being developed in the Basin to increase water availability for various beneficial uses.
2. Water quality changes, generally beneficial, due to West Slope transfers of water into the Basin.
3. The occurrence and areal extent of agricultural related chemicals (nitrogen or phosphorus compounds, herbicides and insecticides) affecting shallow groundwater resources and eventually downstream streamflow quality.
4. Mountain communities relying upon bedrock wells, providing limited supplies and impacting in some areas by cross-contamination from individual wastewater treatment systems.
5. The threat of emerging contaminants (including pharmaceuticals and personal care products) being only partially removed by current state-of-the-art wastewater technologies and potentially being introduced into water bodies downstream of wastewater treatment facility discharges and septic systems. To date, these types of contaminants remain unregulated, due to low detection limits. However, water supply providers in the Basin are beginning to gather baseline information on these substances.
6. Forested areas of mountain tributaries of the South Platte Basin are being impacted by climate variability, diseases and disturbances affecting trees. This degradation of forested lands is resulting in increased wildfire potential, contribution of organic decomposition and nonpoint source nutrients, and challenges in tree-kill diseases and control of wildfires and increased nutrients.
7. A few of the mountain tributaries have been impacted by historical mining and mine-related activities. These cases (primarily involving the North Fork of the South Platte River, Clear Creek, Boulder Creek, and St. Vrain Creek watersheds), along with the presence of a mineralized zone transecting these watersheds, result in concerns of trace metals concentrations and controls to reduce these through various forms of remedial actions.
8. Cherry Creek and other plains streams move great quantities of sand through their respective watershed each year, increasing sediment and releasing phosphorus.
9. Water supplies provided by municipal water utility entities are regulated by the U.S. Environmental Protection Agency (EPA) and in recent years, these entities have been required to document the water quality of these supplies in annual reports. These reports are important, in that, from year to year, supply sources may well vary, depending on both surface water and groundwater sources.
10. Water resources management includes groundwater resources in the Basin, both alluvial systems interactive with streams and deeper groundwater systems. Bedrock

aquifers of the Denver Basin Aquifer system are a key part of overall supplies in the Denver metropolitan area. Bedrock aquifers in mountainous areas of the Basin provide sufficient supplies for individual wells. Water quality concerns with these groundwater sources may exist and should be taken into account.

11. There are salinity concerns related to wastewater treatment plant discharges and salted roads. These salinity issues can impact both surface water and groundwater supplies.
12. Changing regulatory temperature standards can create additional consumptive use for the additional cooling water needed to meet these standards.
13. Stormwater controls, the need to integrate Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) requirements, and impacts from individual sewage disposal systems (septic systems) are also concerns that merit future consideration.

This report review attempts to cover many, but not all, of the examples provided above. It is hoped that the information contained herein is sufficient to promote deliberations involving these topics, to help to prioritize future investments in maintaining or improving the water quality and watershed health of the South Platte Basin, and to contribute to the overall Statewide water planning process.

1 Introduction

1.1 Background and Purpose

This report, to be appended to the South Platte BIP, is intended to provide information on water quality and watershed “health”, based upon past and recent investigations completed in various watersheds of the South Platte River Basin or for the Basin in its entirety. This report summarizes study results and information available from a number of sources, including several websites. The report's last section summarizes the general present conditions involving water quality and watershed health and makes specific recommendations regarding information gaps and future water quality and water related environmental issues facing the Basin's stakeholders in the future.

1.2 General Physical Setting

The South Platte River Basin (Basin) comprises approximately 24,000 square miles (mi²) and is located principally in the northeastern quadrant of the State of Colorado. Relative small parts of the Basin are located in states of Nebraska and Wyoming. These minor areas impact the lower stream reaches of the South Platte River and are not included within the scope of this assessment. Also, the western part of the Republican River Basin is included in the areal extent of water quality/watershed health characterization effort documented herein.

2 Approaches

Through his professional experience and personal contacts, the principal investigator (PI) of this study is generally familiar with water quality conditions as well as watershed health issues facing many parts of the Basin. Information regarding these attributes has been supplemented through fairly intensive web-based searches for watershed- or subarea-based entities, data, and information dealing with the issues addressed in this study. The intent is to provide some indication of the range of water quality data, information, and studies providing a comprehensive water quality/watershed health depiction of the Basin's areal extent.

Numerous studies have dealt with water quality characterization and/or management for large parts of the South Platte River Basin or for the entire Basin. One primary example is the U.S. Geological Survey's study of the Basin's water resources under the auspices of its National Water quality Assessment (NAWQA) Program. Example highlights of several investigations are given later.

Also, the Basin has been delineated into a total of 18 eight digit hydrologic unit codes (HUCs); this delineation is used by the U.S. Geological Survey and other organizations for dealing with the various subareas of the major river basins of the U.S. Of these 18 HUCs, only subareas associated with the first 14 HUCs are considered within the scope of this study. In particular, relatively more interest and information is available for the first seven HUCs (for this Basin, identified as 10190001 through 10190014), located in the upstream (southern) and western (mountain tributaries) areas of the Basin. The

descriptions of available information and data for 12 of these HUCs are provided generally in an upstream-to-downstream order. No information was found for the downstream-most tributary HUCs 10190013 (Beaver Creek) and 10190014 (Pawnee Creek). The HUC-delineated methodology is a logical way to discuss water quality/watershed health conditions or issues; however, various water quality oriented stakeholder entities do not follow these delineations exactly. Accordingly, the details provided in this assessment generally follow the upstream-to-downstream sequence offered by the 12 HUCs of the Basin but are modified to include information for the various watershed or subarea based organizations dealing with conditions and issues for smaller subareas of the Basin.

3 Discussion

3.1 Basinwide Characterization

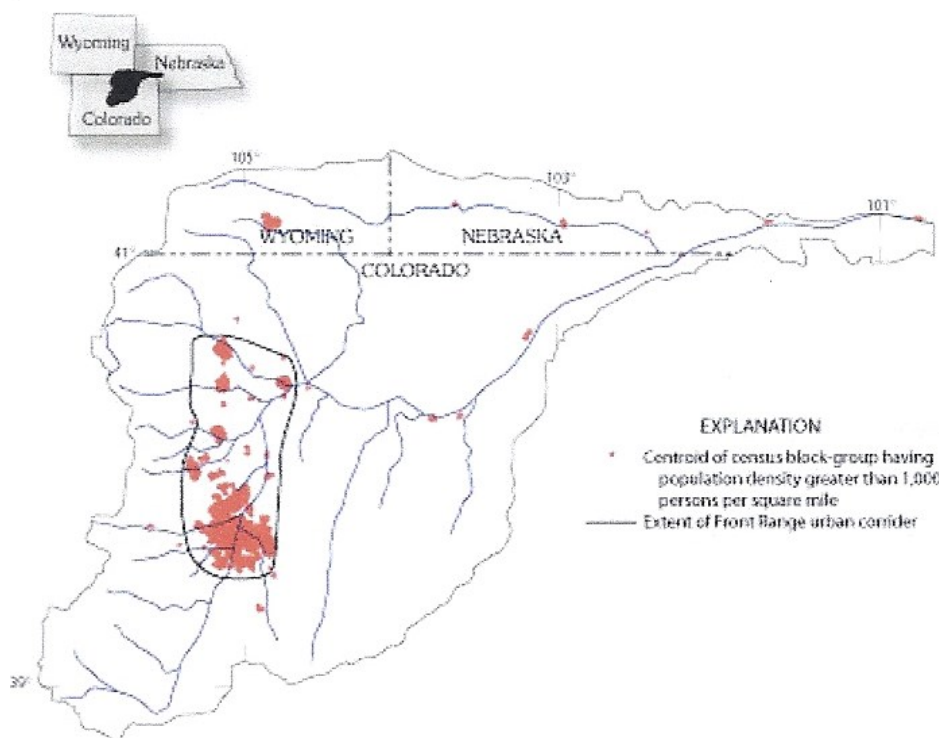
An overview of historical water quality conditions was provided in a broader South Platte River Basin assessment study for the Colorado Water Conservation Board by Woodward-Clyde Consultants (1982, pp. 35-40). A USGS bibliography (Dennehy and Ortiz-Zayas, 1993) provides a more extensive list of study reports. As noted above, a primary, more-recent source for the topic of this study is provided by the USGS' NAWQA Program. Many of the USGS studies under this program were completed in the 1990s; therefore, some of the topics addressed in several technical reports are proposed for updating. Nonetheless, water quality issues identified during these investigations are judged largely relevant today and in the future. Four examples of water quality issues were identified and warrant some consideration herein:

1. Water development and water quality.—Water development began in 1870 in the Basin (Dennehy and others, 1998, p. 8), when the first irrigation ditches were constructed. Over the past 140+ years, irrigated agriculture in the Basin and trans-basin water conveyance into the Basin has significantly altered the “natural” (historical) hydrologic system. These alterations, in addition to increased population growth with needs for water supply and wastewater treatment, have affected the quantity and quality of water in the South Platte River. Besides direct water quality impacts, changes have resulted in a substantial decrease in channel width of the South Platte River, to a greater degree prior to 1938. Considering ground water/surface water interactions is critical to effective water management, especially in the upper and lower stream reaches of the South Platte River.
2. Because agriculture accounts for about 37 percent of the land use in the Basin, impacts of agricultural chemicals (herbicides and pesticides) are of increasing concern. In the NAWQA study, it was estimated that 2 million pounds of active pesticide ingredients have been applied annual in the Basin (Dennehy and others, 1998, p. 16). This trend is due to greater water demands in populated zones (primarily the Denver metropolitan area), requiring innovative water exchange systems in alluvial recharge/withdrawal areas downgradient of these zones in which water is pumped, conveyed by pipeline, and treated for municipal water supplies. Addressing levels of agricultural chemicals, as well as other chemicals of concern,

will be of increasing importance to assure good water quality for potable water supplies.

3. Municipal wastewater treatment plants (WWTPs) are permitted to discharge limited amounts of nutrients. Over the recent two decades, largely due to the total maximum daily load (TMDL) assessment process by the CDPHE, nutrient discharge limits are becoming more stringent. In the basin in the 1990s, 25 WWTPs along the Front Range urban corridor discharged approximately 275 million gallons per day (gpd) of effluent, constituting about 95 percent of the total daily effluent discharge in the Basin (Dennehy and others, 1998, p. 18). About 7,000 tons of nitrogen and 1,200 tons of phosphorus were discharged by WWTPs into the Basin (Litke, 1996). These estimates have decreased in recent years, due to increased WWTP treatment through denitrification and phosphorus removal technologies (www.lewwtp.org/our-process/denitrification).

Figure 1 - Distribution of Population Centers, South Platte River Basin (Dennehy and others, 1998)



4. A NAWQA study examined the effects of different land uses (agriculture, forested, urban, and mixed urban/agriculture) on water quality, using a combination of physical, chemical, and biological information on streams and aquifers (Dennehy and others, 1998, p. 20). Customized ranking schemes and indices were used with each land use classification for assessing land use/water quality interactions impacting different categories of chemical constituents or physical/biological characteristics.

A recent Ph.D. dissertation completed at CSU (Haby, 2011) included an extensive use of available streamflow and water quality (dissolved solids) to assess areal variability and

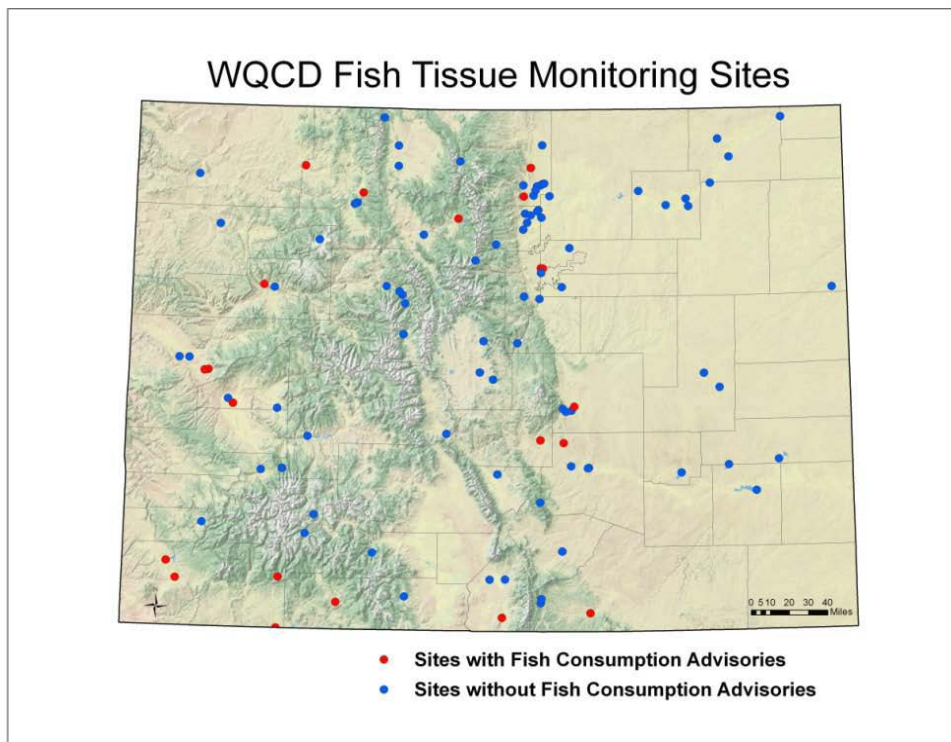
time trends in concentrations and loads of this indicator variable. Another, quite innovative CSU study evaluated the use of fauna species as indicators of groundwater quality (Ward and others, 1989), as applied to the South Platte River system.

A statewide water quality management plan (SWQMP) was developed (CDPHE, 2011) to provide a forum for water quality planning using a watershed based framework. This “living” document (presuming periodic updates are forthcoming as proposed by CDPHE-WQCD) is to assist water policymakers, managers, and others (stakeholders) in setting priorities, developing strategies, and evaluating progress in water quality protection and restoration efforts. Chapter 11 of this initial SWQMP document deals with the Platte River Basin (including the part of the North Platte River in Colorado). This is a useful compendium of information on water quality information as well as ecology, stream standards, and completed total maximum daily loads (TMDLs) assessment studies and plans for implementation. *[Note: These are separate phases in the TMDL process; few implementation plans are known to have been developed to date.]*

Many municipalities and water districts conduct their own water quality assessments. Some of those entities include Denver Water, Aurora Water, Northern Water, and Greeley.

One means of tracking progress of the goal of the SWQMP is through the Integrated Water quality Monitoring & Assessment Report – the most recent of a series of State of CO (305(b) reports in fulfillment of this section of the Clear Water Act (CDPHE, 2012). This document provides a broad range of water quality related information, including key topics such as impacts on wetlands, funded 319 grants for nonpoint source projects, approved TMDLs, and aquatic species. CDPHE fish tissue monitoring sites are indicated in the following map of Colorado:

Figure 2 - CDPHE Fish-Tissue Monitoring Sites



Finally, a section of this report summarizes assessment results for the South Platte River Basin (CDPHE, 2012, Appendix D, pp. 134-135), in terms of use support according to USEPA's system of five integrated report (IR) categories (CDPHE, 2012, pp. 5-8) for fully supporting water bodies in the state by basin:

Table 1 - EPA Integrated Report Categories

Table 25: Individual Use Summary for the South Platte River Basin.		
EPA IR Category	River Miles	Lake Acres
1 - Fully Supporting	7,042	19,248
2 - Some Uses Supporting	1,582	13,375
3 - Insufficient Data, including waters on the M&E list	10,214	68,410
4a – TMDL Completed and Approved	123	0
4b – Impaired no TMDL Necessary	0	0
4c - Impaired Naturally, Placed on the M&E list	0	0
5 - Impaired and TMDL Necessary	3,139	13,047

For example, category (IR) 1 means a stream reach is attaining water quality standards; for category 2, only some classified uses are attained, etc. Category 5 triggers the need for a TMDL.

A statewide strategic plan for the protection of wetlands and riparian areas has been developed by the Colorado Parks and Wildlife (CPW, 2011). An early South Platte conference (Woodring, 1993) focused on the theme of defining ecological and sociological integrity of the Basin. Institutional aspects of water quality management (Nichols and others, 1972) focused on the South Platte River Basin.

This information overview document now will describe a range of examples of water quality and watershed health study results on a watershed- or subarea-delineated basis, in a general upstream-to-downstream order. In the summary and conclusions section of this report, a tabulation of watershed/subarea based organizations and contact information is provided.

3.2 Upper South Platte River Basin

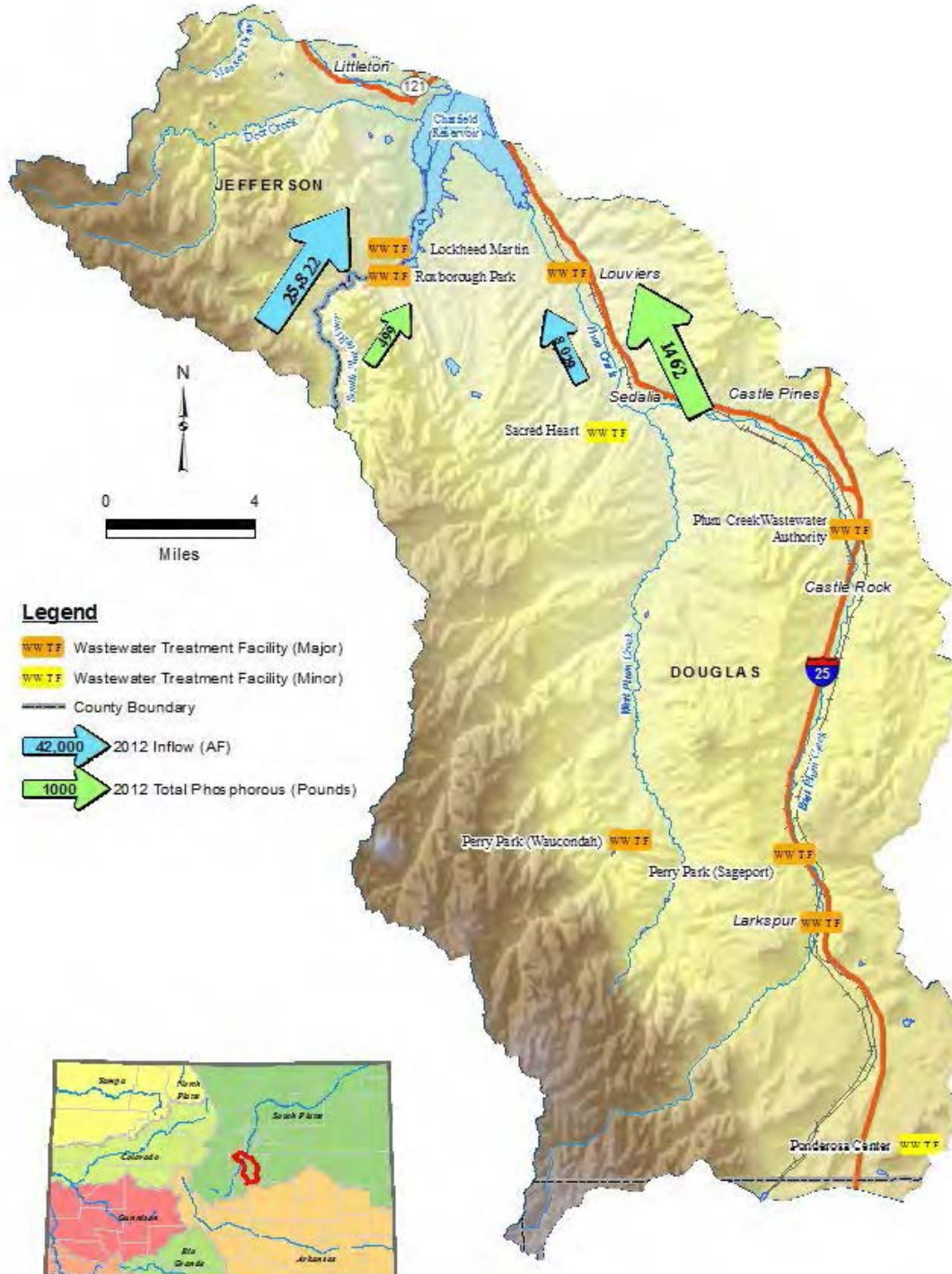
For water quality and watershed health purposes, the Coalition for the Upper South Platte (CUSP) was organized in 1998. Its areal extent covers a land area of 2,600 square miles (mi²) from the Continental Divide to Strontia Springs Reservoir southwest of the Denver metropolitan area. This area encompasses all of HUC 10190001 and part of HUC 10190002 (water.usgs.gov/GIS/huc-name.html#Region10). This upper Basin watershed is heavily used for recreation (fishing, camping, hiking, etc.) and supplies municipal water for about 3/4th of the State's residents (www.uppersouthplatte.org/watershed.html), including the Centennial Water & Sanitation District serving the Highlands Ranch (TDS Consulting Inc., 2001). The South Park area within this sub-basin has recently been the focus of oil and gas development (Johnson, 2012). A source water protection plan study is being developed for water supplies for downstream municipalities (Beth Nielsen, CUSP, *written communication*, March 24, 2014). A Water Quality Assessment of the Upper South Platte was conducted by consultants for Denver Water in September 2013. The study identified potential impacts to water quality from mine discharges, fires, and recreation (Denver Water, September 2013).

3.3 Chatfield (Reservoir) Basin

The Chatfield Watershed Authority (CWA) was created in 1984. A draft watershed plan for this area encompassing Chatfield Reservoir, the Plum Creek tributary subwatershed, and the reservoir South Platte inflow/outflow points has been prepared for the Chatfield Watershed Authority (CWA) (Tetra Tech, Inc., 2013). A related watershed planning process brochure outlines priority projects for this watershed. Historically, a long term monitoring program (since 1983) has collected data on surface water quality (in-Reservoir, inflows/outflow), as well as groundwater quality for some Plum Creek alluvial wells) (ASI, 1994). Annual water quality reports (CWA, 2013a) and a "roadmap" for attaining water quality goals (CWA, 2013b) are examples of watershed management. Also, a nonpoint source investigation has been completed for the Plum Creek subwatershed, and a water quality model application was done for Chatfield Reservoir. A

more recently completed environmental impact statement (EIS) involving evaluating impacts of designating a part of the Reservoir's volume for water supply (storage reallocation for its primary designation for flood control) was completed by the U.S. Army Corps of Engineers (2013); ambient water quality conditions as well as changes due to Reservoir operations by this reallocation were included in this NEPA impacts assessment. Two example of an upstream Plum Creek phosphorus study is given by Kunkel and Steele (1993) and TDS Consulting Inc. (2000). A summary of historical data is given in DRCOG (1997). Comparisons of total phosphorus-chlorophyll-a relationships for several Denver Metropolitan area reservoirs (Chatfield, Bear Creek, Cherry Creek, and Standley Lake) are reported in Steele and others (1991) and updated in Lorenz and others (1995). As part of the RCRA Part B regulations, groundwater quality conditions were evaluated at the Martin-Lockheed facility located southwest of Chatfield Reservoir (WCC, 1983).

Figure 3 - Chatfield (Reservoir) Basin (Source: Tetra Tech, Inc., 2013)



3.4 South Platte in the Denver Metropolitan Area

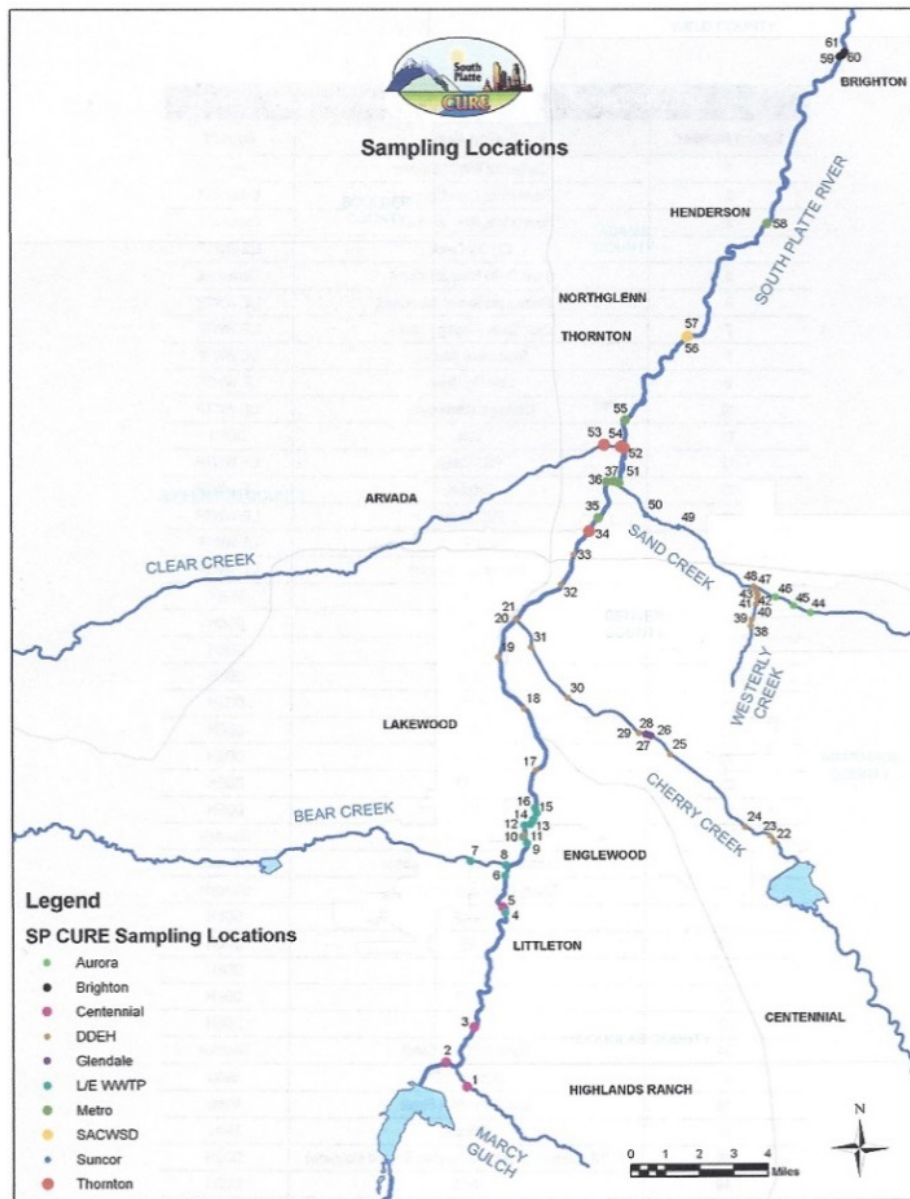
The primary water quality planning agency for this region/subarea is the South Platte Coalition for Urban River Education (SPCURE). Technical issues overseen by SPCURE

include water quality monitoring, modeling, TMDLs, load allocations (LAs), and wasteload allocations (WLAs). It works through coordination with other local governmental entities.

**Figure 4 - Sampling along the South Platte River in the Denver Metropolitan Area
(Source: SPCURE website)**



Figure 5 - SPCURE Water quality Monitoring Sites (www.spcur.org)



Beginning in this subarea and downstream along the South Platte River, nitrates in both streamflow and groundwater have been investigated by the USGS (Litke, 1996; McMahon and others, 1996). Pesticides also have been of concern (Kimbrough and Litke, 1996; 1998). Focus included assessing conditions in the South Platte River alluvial aquifer between Denver and Greeley, covering an area of about 75 mi². This critical resource is impacted by both WWTF discharges upstream and use of fertilizers on adjacent agricultural lands. The USGS study objective was to assess the extent to which naturally occurring processes in the aquifer might reduce nitrate concentrations, thereby decreasing the effects of irrigated agriculture on water quality of the South Platte River. Water-sediment chemistry along the South Platte River in the Denver Metropolitan Area has been characterized (Steele and Doerfer, 1983). Farther downstream along the South

Platte River, municipal water-supply pumpback schemes (Aurora Water, *undated*; CO District Court, 2011) have been developed or are being expanded).

Figure 6 - South Platte River, Northern Denver Metropolitan Area (Source: CDPHE-WQCD, 2012, p. D-13)



The USGS has conducted a recent, extensive evaluation of the Denver Basin aquifer system (Paschke, 2011), which includes a large middle part of the South Platte River Basin. This aquifer system is a key component of water management and water use activities in the Basin. Although the focus of this document is on water availability and management, the USGS NAWQA program for the South Platte Basin listed two studies for assessing groundwater quality in Denver Basin domestic and public supply wells (<http://co.water.usgs.gov/projects/CO255/index.html>). A series of USGS hydrologic atlases (Robson and Romero, 1981a; 1981b; Robson and others, 1981a; 1981b; Robson and Banta, 1995) include water quality data assessment of the four aquifer units comprising the Denver Basin bedrock system. Management of groundwater use from these units continues to be a challenge to water resources decision makers. More recently, conjunctive surface water/groundwater uses through recharge and subsequent withdrawals are being considered by several water providers.

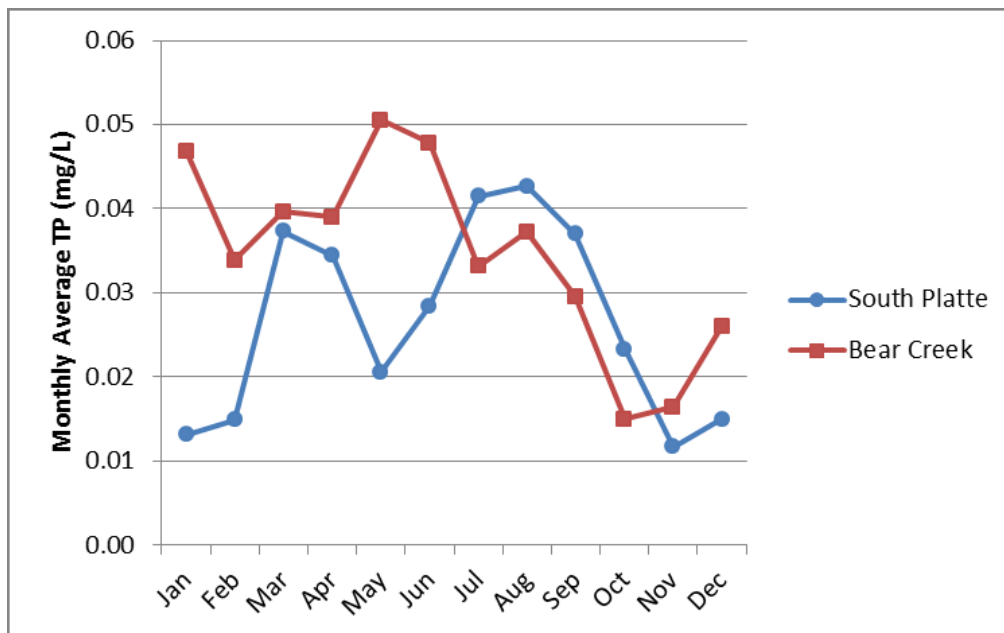
3.5 Bear Creek Watershed

The Bear Creek Watershed Authority (BCWA), established in 1981, “protects and restores water and environmental quality within the Bear Creek watershed ...” Its primary focus is on dealing with water quality upstream from Bear Creek Reservoir. The BCWA has conducted a long term monitoring program of inflow streams as well as in-Reservoir water quality conditions for areal characterization and evaluation of time trends. CDPHE-WQCD Control Regulation #74 designates the BWCA as the “water quality management” agency” and specified phosphorus targets (both concentration limits and loads) for

WWTF dischargers in the watershed. In addition, the BWCA submits annual reports to describe the watershed's water quality status.

Evergreen Lake was dredged in the 1980s (WCC, 1980). Hydros Consulting, Inc. (2011) conducted a water quality assessment and water treatment alternatives cost analysis of the Bear Creek/Turkey Creek watershed of behalf of the Denver Water Department (DWD). Two technical memoranda document their study findings. An example of seasonal (monthly) variations in total-phosphorus (TP) concentrations from the second report is given as follows:

Figure 7 - Seasonal variations of Total-Phosphorus Concentrations, South Platte River (Strontia Springs) vs. Bear Creek (above Harriman Ditch), Averages of 2000-2010 Data (Source: Hydros Consulting, Inc., 2011, p. 9)



Seasonal variations of Total Phosphorus Concentrations, South Platte River (Strontia Springs) vs. Bear Creek (above Harriman Ditch), Averages of 2000-2010 Data (Source: Hydros Consulting, Inc., 2011, p. 9)

A watershed plan is in progress for the lower reach of Bear Creek, downstream from Bear Creek Reservoir to the confluence with the South Platte River (groundworkcolorado.org website).

The Turkey/Bear Creek watershed, as well as several other mountain stream watersheds flowing into the South Platte River, has critical groundwater resources used primarily by mountain homes and small communities. A multiyear water quality monitoring program was conducted for CDOT for assessing during construction impacts of U.S. Highway 285 improvements along Turkey Creek (TDS Consulting Inc., 2003). An assessment was for the Turkey Creek watershed was completed for Jefferson County by its zoning department and the U.S. Geological Survey, comparing historical versus current (2001) water quality conditions (USGS and JeffCo, 2001, Table 1). Earlier studies investigated interactions between domestic wells and septic fields, indicating cases of *e-Coli* and nutrient contamination. An example of one study done in the Kinney Park area is given

by In-Situ (1986). These studies have resulted in recommended spacing between wells and septic systems to minimize the possibility of well contamination in fractured bedrock. A mountain area aquifer sustainability study (CDM, 2010) was conducted for the CWCB.

3.6 Cherry Creek Basin

The Cherry Creek Basin Water Quality Authority (CCBWQA) goals include achieving and maintaining a chlorophyll-a standard (18 ug/L) for Cherry Creek Reservoir, reducing sediment loads from the watershed, and maintaining and enhancing the overall diversity of habitat in the watershed (www.cherrycreekbasin.org/cc_goals.aspx). Its 2012 watershed plan (Leonard Rice Engineers, Inc., 2012) is in the process of being updated. Its monitoring program, begun in the early 1980s (Steele and others, 1989), has evolved over time, and data results and interpretation, along with other watershed protection and restoration activities, are incorporated in a series of annual reports (Advanced Sciences, Inc., 1994; Leonard Rice Engineers, Inc. and others, 2012). Examples of stormwater runoff projects and effectiveness are given by Mulhern and Steele, 1988; Kunkel and others, 1992; and Kunkel and Steele, 1992). Later reports on effectiveness of sediment detention basins are available.

3.7 Upper Clear Creek Watershed/Standley Lake

The Upper Clear Creek Watershed Association (UCCWA) was created in 1993; a primary function of this organization is to represent the watershed's "upper basin" stakeholders as well as to provide a forum for addressing water quality issues and concerns for downstream ("tributary basin" and "Standley Lake") entities. The framework for this coordination is through the Clear Creek/Standley Lake Watershed Agreement (Hydros Consulting, Inc., 2012, Appendix A). A watershed wide monitoring program began in February 1994; a monitoring plan was developed for describing monitoring sites, sample scheduling, and variables to be measured in the field or analyzed in the laboratory. The monitoring plan has been dynamic, with the most recent status comprising two components: one focusing on nutrients/sediment related/physical variables (Hydros Consulting, Inc., 2012, Appendix B); the second involving trace metals and supported by the USEPA. This separation into two monitoring components began in 2005. As with most watersheds, other water quality data are being collected in this watershed by other entities (Steele, 2012). Watershed agreement annual reports to the CDPHE's Water Quality Control Commission have included basic data appendices for both monitoring program components; however, recent reports have not included the trace metals data.

A useful "state-of-the-watershed" report on the upper Clear Creek watershed was prepared by Norbeck and Flinaeu (1997). Funded by the USEPA, a watershed advisory group (WAG) dealing with mine impacts existing in the late 1990s; the group's findings are given in a final report (Board of Upper Clear Creek Watershed Advisory Group, 2001). The original upper Clear Creek watershed plan (TDS Consulting Inc., 2006), which focused upon trace metals and associated stream standards and prioritization of mining related remediation projects, has been updated and enhanced by Clear Creek Consultants and Matrix Design Group (2014).

The Clear Creek Watershed Foundation (CCWF) was created to develop and implement projects in the watershed for the protection and restoration of water quality and watershed health. A watershed sustainability report outlined various management techniques applicable to the watershed (CCWF, 2007). Over the past two decades, a number of USEPA and 319 grants have been managed by the CCWF for improving conditions, primarily involving historical mine impacted areas.

Numerous study reports completed over the past two decades document a wide range of the watershed's water quality and watershed health conditions. Examples include the following:

- Advanced Sciences, Inc. (1993)–watershed/Standley Lake water quality data assessment
- Steele and Clayschulte (1997) – water quality assessment summary for the watershed
- Huyck and others (1999) – metals and fauna studies for mine site remediation
- Bell (1999) – collation of physical, chemical, and biological watershed data
- Herron and others (2001) – reclamation feasibility, Virginia Canyon
- Abel and Steele (2002) – seasonal variability in trace metals concentrations
- Woodling and Ketterlin (2002) – CDOW biological monitoring program update
- TDS Consulting Inc. (2002) – trace metals data assessment for CDPHE-HMWMD
- Szewczyk and Emerick (2002) – CSM study of stream habitat quality
- Wildeman and others (2003) – CSM mine waste-pile/sediment characterization study
- Medine (2004) – USEPA-funded model development and application, WASP4-Meta4
- Butler (2005) – CSM trace metals study of the North Fork Clear Creek
- Matrix Design Group (2013) – CDOT-funded sediment control action plan (SCAP)
- JW Associates, Inc. (2013) – watershed/wildfire assessment and prioritization study
- TDS Consulting Inc. (2013) – latest addendum, trace metals data/loads assessment

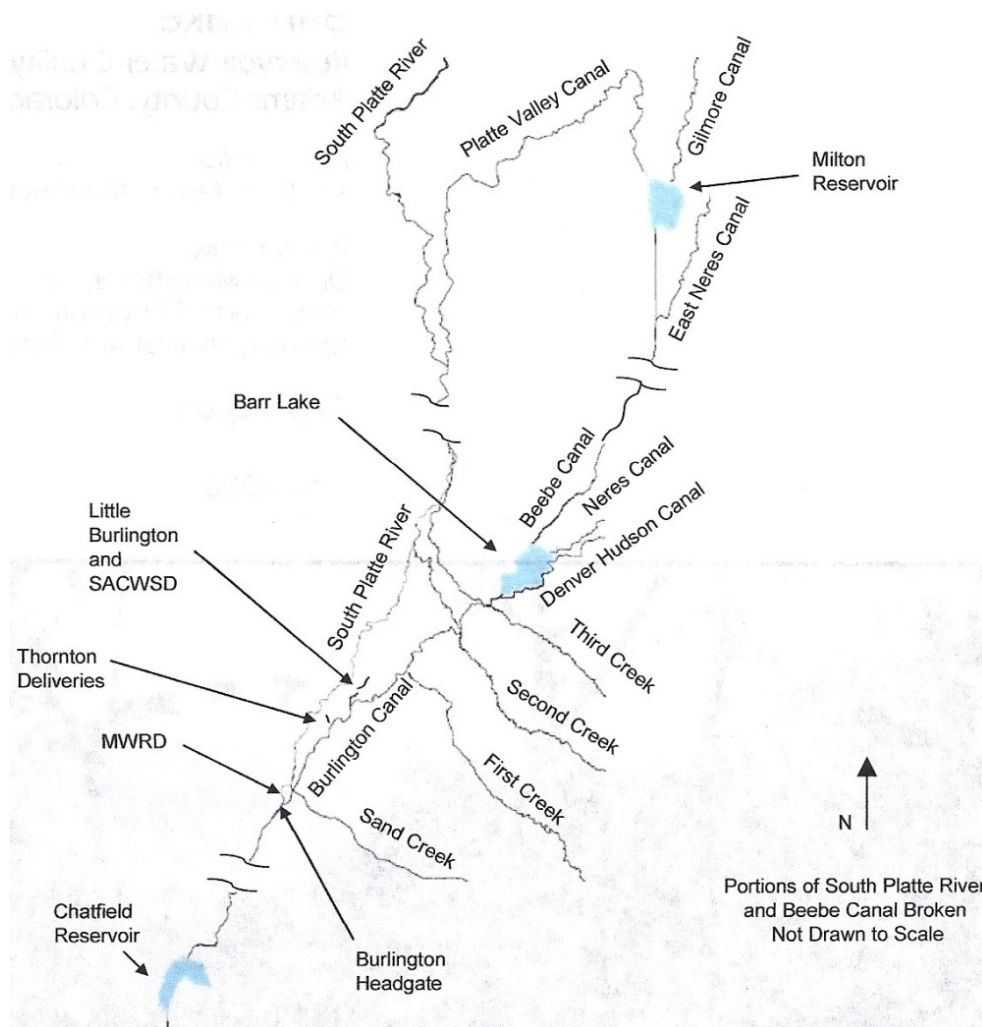
The remedial investigation/feasibility study project managed by CDPHE-HMWMD (Tetra Tech-RMC, 2004a; 2004b) addressed the final remediation work to be completed for Operable Unit 4 for the watershed as a Superfund site. There have been several iterations of QUAL2E model applications for the watershed. Other reports focus on issues associated with water quality and ecology of Standley Lake (Tetra Tech, Inc., 1994; Horn and others, 1996; Hydros Consulting, Inc., 2012). A source water protection plan for water users of Standley Lake was conducted by Buirgy (2010). Historical impacts of Rocky Flats on Woman Creek, which previously flowed into Standley Lake, are of interest (Advanced Sciences, Inc., 1992; Steele and others, 1993a; 1993b). A watershed restoration environmental assessment was conducted by the USDA (2013) for selected sites in the upper Clear Creek watershed. The mountain tributary aquifer sustainability study (CDM, 2010) was noted previously and applies to this watershed as

well. Other recent, relevant water quality presentations include Pierce and others (2010) and Steele and others (2012).

3.8 Barr Lake/Milton Reservoir

The Barr Lake-Milton Reservoir Watershed Association (BMWA) is a “consensus driven group dedicated to improving water quality through collaborative efforts” (Patten, 2009). A water quality assessment for Barr Lake was completed by AMEC Earth and Environmental (2008). A watershed plan for the entire Barr-Milton subarea has been completed (BMWA, 2008). This subarea is undergoing change, due to increased interest in a recharge/pumping project in the Beebe Draw area downgradient from Barr Lake by the United Water & Sanitation District on behalf of southeast Denver metropolitan area water providers. For water quality protection with an earlier water rights application involving this subarea, the settlement document is of interest (CO District Court, 2011). An amendment to this for a follow-on water rights case is pending.

Figure 8 - Barr Lake/Milton Reservoir Subarea (AMEC Earth & Environmental, 2008)

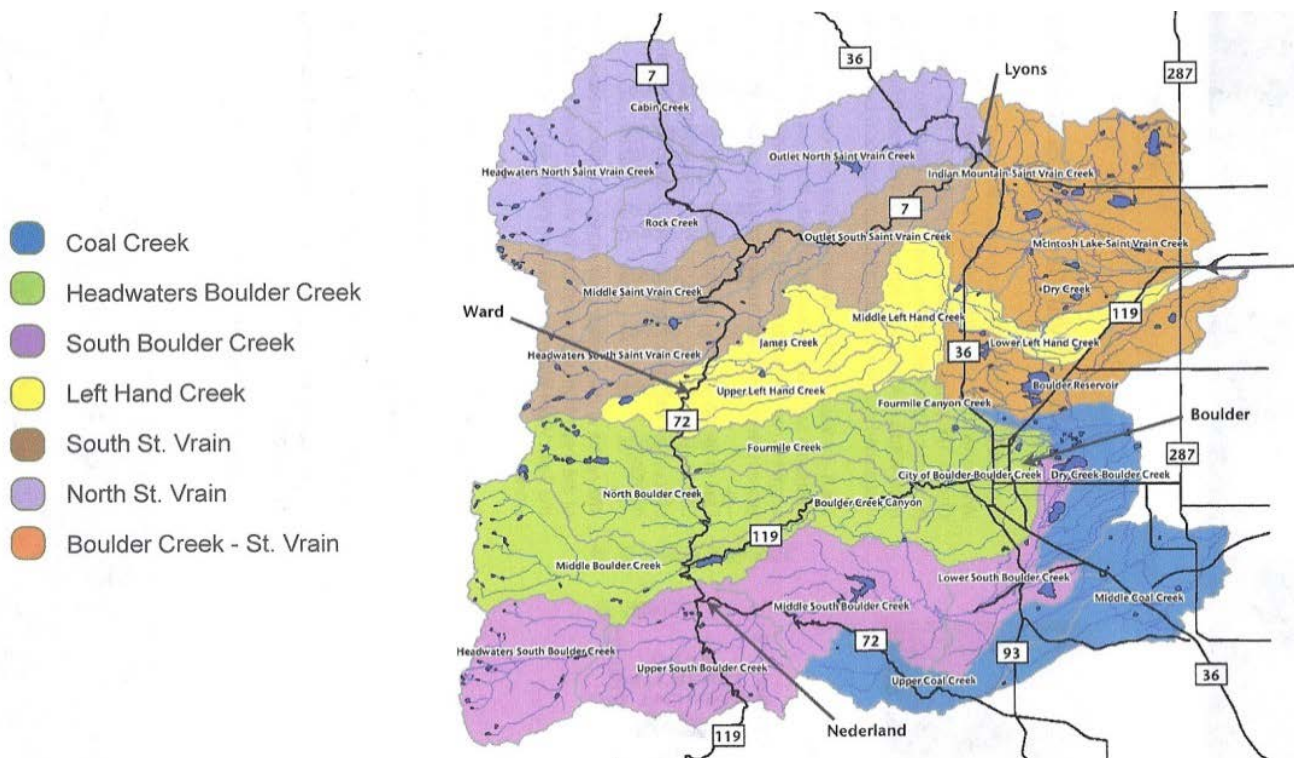


Water development in this subarea demonstrates the challenge of integrated management of surface water/groundwater resources for various beneficial uses and users. The benefits of the water quality monitoring efforts through SPCURE transfer to current and possible future impacts on water development in this subarea. Maintaining recreational and wildlife aspects of these impoundments also is a critical factor, benefitting the entire mid-South Platte River basin area.

3.9 St. Vrain Creek Watershed

The St. Vrain Creek watershed also encompasses several smaller mountain streams (north-to-south): Left Hand Creek, Boulder Creek, and Coal Creek. St. Vrain Creek then flows northeast into the Big Thompson River. An USEPA website provides a water quality assessment on a stream segment basis (www.iaspub.epa.gov/tmdl/waters10/...). One of the more critical subwatersheds is for Boulder Creek; a water quality assessment was made by the USGS in a state-of-the-watershed report (Murphy, 2006). JW Associates also include the St. Vrain Creek watershed in his series of watershed/wildfire assessments (www.jw-associates.org/saintvrain.html). The Colorado State Forest Service (CSFS, 2013) forest health status report included this as well as other mountain watersheds in the eastern part of the South Platte Basin. Mountain Pine Beetle and Spruce Beetle progression maps are provided and can be compared with previous years' (1996-2013) areal depictions of affected forest areas.

Figure 9 - Saint Vrain Watershed Catchments (Source: JW Associates)



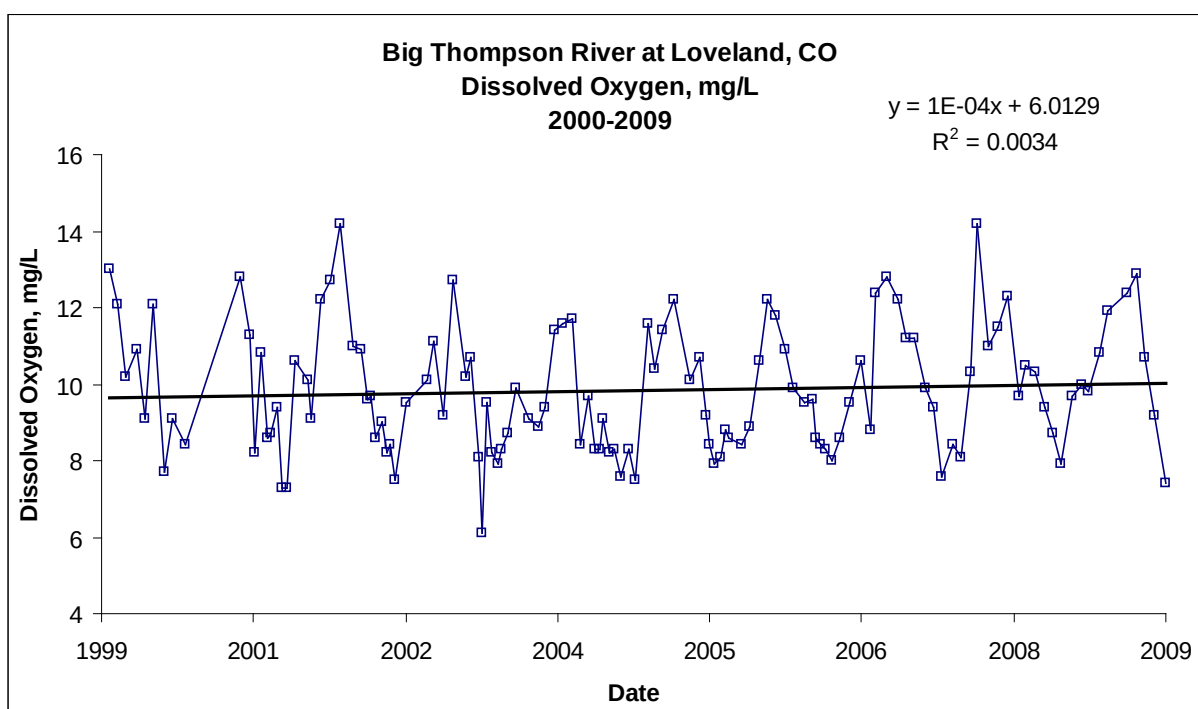
3.10 Big Thompson River Watershed

The Big Thompson Watershed Forum (BTWF) is the organization overseeing water quality and watershed health investigations for this watershed. A watershed management plan was completed by Buirgy (2007). JW Associates and JG Management System Inc. (2010) conducted a watershed assessment, focusing upon prioritization of watershed based hazards to water supplies. In 2013, the BTWF sponsored a nutrient pilot project involving the Sylvan Dale Guest Ranch (www.btwatershed.org).

Walsh and others (1978) assessed water quality recreational benefits, using Rocky Mountain National Park as a case study and based upon interviews with Park visitors. This study indicated a statistical relationship between benefits from water quality and patterns of participation in outdoor recreation activities, attitudes, and other socioeconomic variables.

CSU has collaborated with the BTWF on compiling and analyzing water quality data for this watershed (Haby and Loftis, 2007).

Figure 10 - Seasonal Variations in Dissolved-Oxygen Concentrations, Big Thompson River at Loveland, CO (Source: J.D. Stednick, Colorado State University, written communication, July 30, 2010)



3.11 Cache la Poudre River Watershed

The NRCS (2009) completed a “rapid assessment” of this watershed, focusing upon irrigated agriculture. Conservation system improvements included issues of nutrient and pest management. Impaired water quality stream segments were identified for *E. coli* and selenium, as well as low dissolved oxygen concentrations in Horsetooth Reservoir

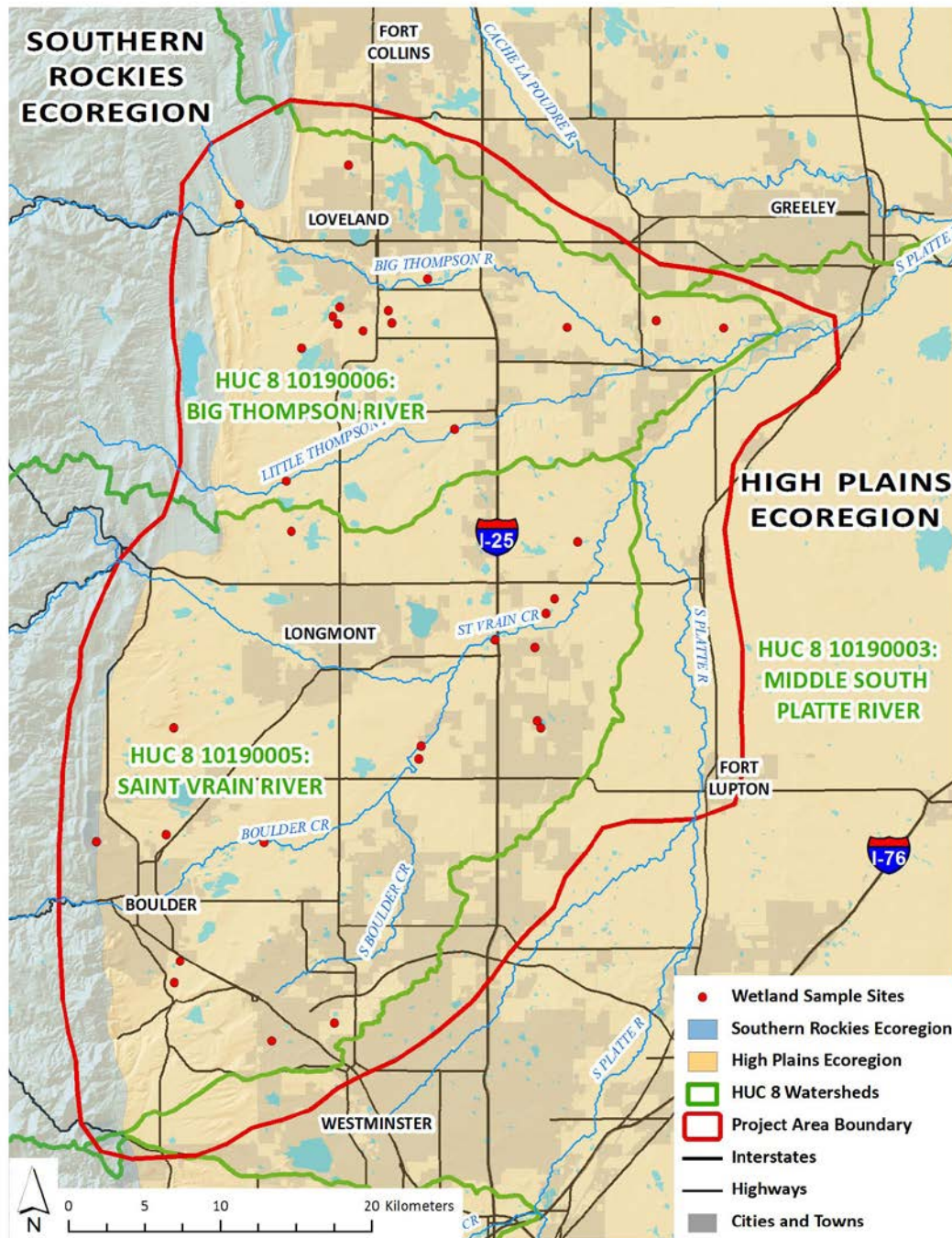
(NRCS, 2009, p. 12). Additional water quality descriptions are included in CDPHE (2012) and WQCD (2013).

This watershed plays a major role in the Colorado-Big Thompson trans-basin diversion project and the more recent proposed Windy Gap Firming project (USBOR, 2011). Another proposed project currently undergoing review is the Northern Integrated Supply Project (NIPS) (USEPA, undated). All of these water development projects have water quality and watershed health implications. A baseline water quality monitoring program started in 1991 under the auspices of the Northern Colorado Water Conservancy District. The program component, as an example, for “flowing sites” (streams, rivers, and canals) is described in a summary fact sheet by NCWCD (2010). Basic data and numerous water quality data analysis reports are available from NCWCD. With the domestic/municipal water use of NCWCD’s system, emerging contaminants also are being analyzed (NCWCD, 2013). A “rapid assessment” was made by the NRCS (2009). The Cache la Poudre watershed has also been doing water quality mitigation after the fire.

A couple of CSU studies are relevant to this watershed relative to nutrient characterization:

- Goodwin (2011) – phosphorus transport/eutrophication in the Cache la Poudre watershed
- Son (2013) – nutrient load inputs to the Cache la Poudre watershed

Figure 11 – Big Thompson – St. Vrain Watersheds Showing Wetland Sample Sites
(Source: CDPHE-WQCD, 2012, p. 122)



3.12 Northern Plains Basin Tributaries (Lone Tree Creek & Crow Creek)

Wylie and others (1993) studied nitrate conditions in the alluvial aquifer of Lone Tree Creek. Lone Tree Creek is susceptible to flooding. This subarea is part of the Pawnee

National Grasslands (USDA, 2014; ARNF, 2009), protected as part of the Arapaho-Roosevelt National Forest. No other water quality data sources or related issues were found in this cursory assessment effort.

3.13 Southern Plains Basin Tributaries (Box Elder Creek, Kiowa Creek, and Bijou Creek)

The Boxelder Stormwater Authority was created in August 2008. Although its 2006 Master Plan dealt primarily with flooding issues, it included components addressing water pollution control and watershed protection (PBSJ, 2006). Recent concerns of hydraulic fracking in Box Elder Creek (Jaffe, 2014) are indicative of the increasing public awareness of this energy development alternative in many parts of the South Platte Basin.

3.14 Lower South Platte River Basin

The Lower South Platte Water Conservancy District (LSPWC) was founded in 1964 and deals primarily with water resources management of the Basin's interactive surface water/groundwater system within the State of Colorado. A number of CSU-based studies have been conducted for evaluating ambient quantity/quality characteristics as well as model-predicted changes for improved water resources management.

Figure 12 - Irrigation-Diversion Ditch, Lower South Platte River (Source: LSPWCD website)



3.15 Republican River Basin

The part of the Republican River Basin in Colorado is bordered on the east by the State of Kansas. The Republican River Water Conservation District was created in 2004 to promote compliance with the tri-state Republican River Compact, principally involving farmers and ranchers in the Basin. Water use in Colorado involves surface waters of the

Republican River system as well as the west-central part of the critical Ogallala Aquifer (American Ground Water Trust, 2002). No surface water investigations were found through the internet web research. However, the Ogallala Aquifer was studied intensively by the U.S. Geological Survey. Water quality baseline studies were conducted in earlier USGS reports. A recent New York Times article (Bair, 2011) summarized several water quality issues impacting the Ogallala Aquifer:

- 14 percent of all Ogallala irrigation wells tested contained one or more pesticides
- The most common detected herbicide was Atrazine
- Five percent of tested Ogallala irrigation wells indicated nitrate concentrations equal to or in excess of the safe drinking water standard ($<10 \text{ mg/L NO}_3\text{-N}$) set by the USEPA.

4 Impaired and Threatened Waters

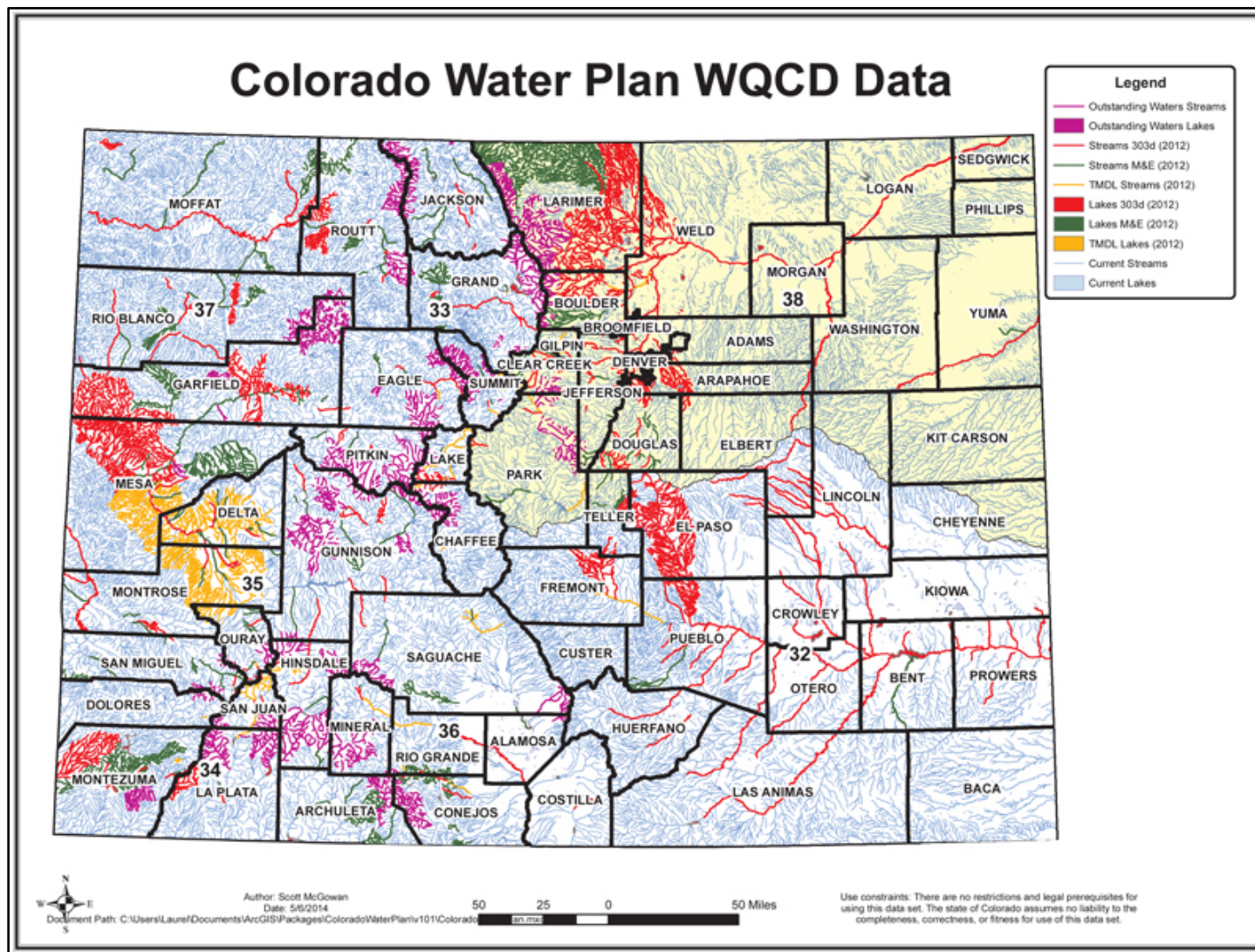
The term "303(d)" indicates those waters on the list of impaired and threatened waters (stream/river segments, lakes) that the Clean Water Act requires all states to submit for EPA approval. States are required to assess the condition of surface waters and submit lists of those that are too polluted to meet water quality standards (called impaired waters). The Act requires that states establish priorities to address these impaired waters by developing water restoration plans (also known as Total Maximum Daily Loads or TMDLs). TMDLs identify pollutant load limits necessary to clean up the water to meet water quality standards and then quantify a pollutant "budget" for different sources of pollutants. The water restoration plans are then implemented via permit requirements and through a variety of other local, state or federal water protection programs.

The Colorado Department of Health and Environment maintains an ongoing monitoring plan to assess the water quality of the State's streams and lakes. The objective of the monitoring plan is to gather, assess and report data regarding the chemical, physical and biological integrity and quality of state surface waters for the Federal Clean Water Act (CWA) 303d list of impaired waters and the 305b report of status of water quality in Colorado as the EPA Integrated Report.¹

The 303d listed lakes and streams found throughout the Basin are shown in Figure 13, highlighting waterways where water quality may be of concern in the South Platte Basin.

¹ Sources: Colorado Department of Health and Environment (CDPHE), Environmental Protection Agency (EPA)

Figure 13 - South Platte 303d Listed Waterways



Source: CDPHE

5 Summary and Conclusions

A tabulation of various watershed based water quality management entities (a few water conservancy districts are included) was judged to be useful for the users of this document, where only selective references can be given to indicate the diversity and magnitude of useful investigations and reports available for addressing water quality and watershed health:

Table 2 - Summary of Watershed/Regional/Subbasin Organizations, South Platte River Basin

<i>SP Organization</i>	<i>Website</i>	<i>Contact</i>	<i>Description/Notes</i>
Coalition for the Upper South Platte (CUSP)	www.uppersouthplatte.org	Beth Nielsen, Program Assistant	Water quality, forest health, wildlife mitigation, and education; South Park (oil & gas development)
Chatfield (Reservoir) Watershed Authority	www.chatfieldwatershedauthority.org	Larry Moore & Kevin Urie, Co-Chairs	Water quality protection for drinking-water supplies, recreation, fisheries, and other beneficial uses, small WWTPs
South Platte Coalition for Urban River Evaluation (SPCURE)	www.spcure.org	Sarah Reeves, Coordinator	Water quality monitoring, USGS data/model studies, TMDLs, sediment impacts; WWTP discharges
Bear Creek Watershed Authority (BCWA)	www.bearcreekwatershedauthority.org	Russ Clayschulte, Executive Director	Established 1981, monitoring program, includes Turkey Creek, GW-WQ studies, TMDLs, small WWTPs
(Lower) Bear Creek Watershed Planning and Assessment	groundworkscolorado.org	Rachael Hansen, Program Manager	319 Grant (awarded in 2011); website information; watershed plan in process
Cherry Creek Basin Water Quality Authority (CCBWQA)	www.cherrycreekbasin.org	Chuck Reid, Manager	Watershed plan (2012); long term water quality monitoring (annual reports); reservoir controls (TP/chlorophyll-a); WWTPs
Upper Clear Creek Watershed Association (UCCWA); Clear Creek Watershed Foundation (CCWF)	www.clearcreekwatershed.com	Katie Fendel, UCCWA Chair; J. David Holm, CCWF Executive Director	Water quality monitoring, USGS data/model studies, TMDLs, I-70 sediment-control impacts; WWTP discharges; watershed plan update (2013); management agreement (Standley Lake Cities)
St. Vrain River	www.svlhwcd.org	Sean Cronin,	Organized in 1971; levy

<i>SP Organization</i>	<i>Website</i>	<i>Contact</i>	<i>Description/Notes</i>
Watershed Stakeholders		Executive Director	taxes; providing augmentation water to members; water education
Big Thompson Watershed Forum (BTWF); also NCWCD, see below	www.btwatershed.org	Zach Shelley, Program Director	WQ monitoring and assessments; watershed management plan (2007); watershed protection volunteers; CO-BT Project
Big Thompson River Restoration Coalition			Restore river corridor, fisheries and natural areas, and make watershed resilient to future flooding.
Cache la Poudre River Basin - Northern Colorado Water Conservancy District (NCWCD)	www.northernwater.org (also see STP below)	Eric Wilkinson, General Manager	Providing water to northeastern CO via the trans-basin CO-BT P and the Windy Gap projects (above) and the proposed NIPS/Glade Project
Lone Tree Creek/Crow Creek tributaries (Pawnee Natl. Grasslands)	www.fs.fed.us/r2/arnf/	T.J. Williams, USFS	Arapaho-Roosevelt National Forest/Pawnee National Grasslands
Box Elder Creek/Kiowa Creek/Bijou Creek	www.hoaonlineresource.com/boxelder/news.php?category=4		Boxelder Stormwater Authority; stormwater master plan (2006)
Lower South Platte Conservancy District	www.lspwcd.org	Jo Frank, General Manager	Created in 1964; 406,000 acres of agricultural lands; water management and technical services
South Platte River Urban Waters Partnership	www.urbanwaters.gov	Devon Buckels, AICP, Coordinator	Non-regulatory partnership of over 40 organizations focusing on water quality, water protection, and water awareness in the South Platte River watershed.
South Platte Forum	www.southplatteforum.org	Jennifer Brown	Annual conferences since 1989
Republican River Water Conservation District (RRWCD)	www.rrwcd.org	Deb Daniel, General Manager	Created in 2004, self-governed, promotes local involvement in Republican River Compact; Ogallala Aquifer conservation
Colorado Department of Parks and Wildlife (CDPW) - RiverWatch	www.coloradowater.org	Michaela Taylor, Program Manager	Started in 1989; primarily volunteers with training; lab in Ft. Collins (CDPW)
Save the Poudre (STP)–Poudre Waterkeeper	www.savethepoudre.org	Gina Janett	Advocacy group, against proposed NIPS/Glade Project
Centennial Water & Sanitation District	www.centennialwater.org	John Hendrick, General	Water/wastewater provides in Highlands Ranch

<i>SP Organization</i>	<i>Website</i>	<i>Contact</i>	<i>Description/Notes</i>
		Manager	
Evergreen Metro District	www.evergreenmetrodistrict.com	David Lighthart, General Manager	Supplies water and wastewater treatment for the Evergreen community area
Aurora Water	aurorawater.org		Supplies water to its service area
Golden Utilities	www.cityofgolden.net/departments-divisions/water/		Water & wastewater treatment for the Golden service area
Littleton Water & Light	www.littletonwaterandlight.org		
Lakewood Utilities	www.lakewood.org/Utilities/		
Englewood Utilities	www.engagewoodgov.org		
Denver Water Department	www.denverwater.org		Supplies water to its service area
Standley Lake Cities	Cities of Westminster, Northglenn, Thornton, and Arvada		Stakeholders in the upper Clear Creek watershed
Greeley	www.greeleygov.com/water		
Longmont	www.ci.longmont.co.us/pwwwu/water/		
Fort Collins	www.fcgov.com/utilities/		
Fort Collins-Loveland Water District	www.fclwd.com/		
Boulder	https://boulder.colorado.gov/water		
United Water and Sanitation District	www.unitedwaterdistrict.com	Bob Lembke, President	Client districts: ACWWA and ECCV (SE Denver metro area)
Northern Colorado Water and Sanitation District	www.northernwater.org/		

Municipal water supply utilities and providers require development and submittal of annual water quality reports to be available to the public. Examples are those by Centennial (2013), Aurora Water (2012) and the Denver Water Department (2013).

Long term human-health epidemiological studies are recommended to assess the potential long term adverse impacts of the presence of minute concentrations of chemicals introduced into water supplies – namely, herbicides and insecticides, and pharmaceuticals and personal care products (PPCPs, or emerging contaminants) (Battaglin and others, 2013; Daughton and Ternes, 1999; Sprague and Battaglin, 2005; NCWCD, 2013; Stephenson, 2013). These substances currently are unregulated by the USEPA and CDPHE; however, low detection analytical methods have been developed, and this regulatory situation may change in the near future.

Finally, review of water management strategies proposed in the past (Nichols and others, 1972; CCRI South Platte Team, 1980) might be beneficial with regard to future planning in the South Platte River Basin as well as Statewide planning from the standpoints of

water quality and watershed health. The benefits of dealing with these issues on a watershed/subarea scale are demonstrated by the bibliographic overview provided by this document. Also, we may learn from *post audit* analysis of water development projects that were not authorized (USEPA, 1996). The review of reasons why these past efforts did not move forward can assist in future planning, particularly as similar projects will likely be needed in the future.

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Appendix F – South Metro Water Supply Authority Concept for Discussion

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin
Roundtable

April 17, 2015



Below is a collaborative conjunctive use multi-purpose project concept based on a potential Flaming Gorge Pipeline project and conjunctive use with the Denver Basin Aquifer System. This is an example that provides something for others to react to, and should be evaluated and built upon through the Basin Roundtables and planning process. Although this "straw-man" is conceptualized around a Flaming Gorge Pipeline project, many of the concepts could extend to other new water supply projects. Section 1 describes the concept and Section 2 provides additional summary information on the Denver Basin Aquifer and the opportunity to use it as a drought reserve.

Section 1: Conjunctive Use Multi-Purpose Project Concept

This description outlines potential elements of a conjunctive use multi-purpose new supply project.¹ This conceptual "straw-man" project is prepared to test and demonstrate the ability of a project to meet stakeholders' concerns including environmental, recreational, and water users concerns. It could be centered around a number of potential projects such as the Green Mountain/Blue River Pumpback, Yampa Pumpback, Blue Mesa Pumpback, or Flaming Gorge Pipeline with conjunctive use of the Denver Basin Aquifer and interruptible supply agreements in the South Platte Basin.

This description is intended to focus discussions related to new supply development and provide a framework for analysis and feedback. It is anticipated that the substance of a specific concept will change and additional details will be developed over time. This description can help inform recent IBCC and roundtable discussions and ultimately be included as part of a roundtable-to-roundtable engagement within Section 4.8 Interbasin Projects and Methods of the South Platte and Metro's Basin Implementation Plan (BIP).

As a starting point, the following elements of a multi-purpose project are described:

- Project Description
 - o Water Source
 - o Risk Management and Variability
 - o Headwater Enhancement
- Overall Benefits of the Project
- Challenges/Issues/Costs of the Project
- Potential Area of Origin Compensation
- Statewide Policy Objectives
- Financing and Governance

¹ Several sources were used to compile this memo including: Prior "Basin of Origin" bills (between 1988 and 2000 the Colorado General Assembly looked at 16 out of basin transfer proposals of which some were compensation/mitigation approaches, some focused on additional requirements before diversion, and two required voter authorization); Reports from the Colorado Water Resources Research Institute on area-of-origin compensation; The South Metro Water Supply Study (February, 2004); SWSI Phase II Section 5 (Addressing the Water Supply Gap); Discussions between the Yampa/White Roundtable and South Platte Roundtable on the proposed Yampa Pumpback Project; SWSI 2010 and the December 15, 2010 IBCC Report; and Basin Roundtable Project Exploration Committee (a.k.a Flaming Gorge Task Force) Phase 1 Report.

These elements are outlined in general terms below. Additional details such as yield (average, firm, and dry), water rights, infrastructure, cost estimates, mitigation, funding, etc. will need to be further developed with additional stakeholder input. In addition, a section at the end further describes the Denver Basin Aquifers as an opportunity for a risk and drought reserve. Including the Denver Basin aquifers as an asset to provide supplies when no project yield is available can be an important element in risk management of Colorado's Compact Entitlement.

The specific elements of projects, mutual commitments, and milestones of progress would be the subject of an exploratory investigation and ultimately negotiation among multiple parties. It is anticipated that should a package of projects emerge as feasible and desirable, commitments would be made in tandem. As potential end users made certain commitments, potential opposers would also make commitments helping to ensure that a new west slope supply project will, in fact, be a fundamental part of "filling the gap" package. This approach needs to provide confidence that Colorado River water supply development will be available for the east slope, thereby providing an alternative to agricultural to urban water transfers.

Elements of a Conjunctive Use Multi-Purpose Project

Project Description:

For discussion purposes, this concept is centered around the Flaming Gorge Pipeline Project. It has been initially screened through a sub-committee, and also been investigated by a variety of agencies over several decades. Much information is already available, reducing the need to gather new data. A group has also begun to coordinate with the US Bureau of Reclamation to review hydrologic analyses and model projections of potential yields and operations. This Conjunctive Use Flaming Gorge Pipeline Multi-Purpose Project contains several major components. The components include:

1. **Flaming Gorge Pipeline:** The source of water for the project would be a contract with the Bureau of Reclamation (BOR) for an annual average yield from Flaming Gorge Reservoir of 150,000 + acre feet. The water would be diverted from the Green River through a pumpstation at Flaming Gorge Reservoir. A 400-mile 7-8 foot diameter pipeline would convey this water to the Front Range. The most likely pipeline route would travel along Interstate 80 through Wyoming to Laramie, and then south along the Colorado Front-Range. The pipeline would convey supplies to municipalities in Wyoming and on the Colorado Front-Range in the South Platte and Arkansas Basin.

The overall capacity of the pipeline should include consideration of several opportunities beyond that required to convey 150,000 acre feet for several reasons:

- a) Cost/benefit review of moving additional water under certain hydrologic conditions;
- b) Potential as a water management tool, capable of bringing water to the Front Range as an alternative diversion method to depletion in the

headwaters of the Colorado River. That might position the project as a riparian restoration project as well as a new supply project, and;

- c) In a fashion similar to the transaction between the Southern Nevada Water Authority and the Arizona Water Banking Authority², Colorado could perhaps develop underground storage of other Upper Basin state's compact entitlement as a component of risk management and oversize the conveyance system for that type of possibility.

2. **Risk Management and Project Variability Strategies:** In 2010, the IBCC agreed that the development of new water supplies from the Colorado River "should be accompanied by a risk management program that ... is integrated with 'triggers' and utilizes other dry cycle sources to fill the gaps when the new supply water is unavailable." Because populations and economies would be dependent upon this new water supply from Flaming Gorge, mechanisms would need to be in place to deal with periodic supply shortages. The IBCC recommended a two-pronged approach: 1) "to put in place an 'early warning' system that shuts down, curtails, or offsets [the new supply project] in advance of a Compact curtailment. The early warning system would be based on hydrologic triggers;" and 2) "the water supply triggers would be coupled with an emergency water bank or other operational scenario that would meet the critical needs of all of Colorado's post-1922 users if a curtailment cannot be avoided."

a) Triggers and Dry-Period Sources

- i. **Triggers:** Hydrologic triggers could include Lake Powell levels, overall storage in the CRSP system, the 10-year rolling average of upper basin deliveries, or some combination. The IBCC notes, "additional work is needed to define which triggers would be used ... and how they would work."
- ii. **Sources to meet shortages:** Regardless of the triggers, the end users of the project would need supplies that can be used conjunctively with the Flaming Gorge supplies. This is not a new concept for many front-range utilities. For example, the South Metro region recently secured a permanent, but variable, renewable water supply through the WISE Project. In years when no delivery occurs, they will continue to rely on Denver Basin well pumping. Similar strategies could be used to deal with the variability of a Flaming Gorge project and associated triggers.
 - 1) **Denver Basin Aquifer Conjunctive Use and ASR:** Diversion of water from Flaming Gorge could be tied to levels in Lake Powell or other triggers to avoid compact curtailment. This strategy involves diverting a larger amount of water in wet years for front range groundwater users to store water in Denver Basin aquifers through an ASR (aquifer storage and recovery) program to assure sustained productivity. In dry periods when supplies are not available from

²http://www.snwa.com/ws/future_banking_arizona.html

Flaming Gorge, municipalities with access to the Denver Basin Aquifer would meet their water needs from local groundwater supplies.

Through ASR and changing the use of the Denver Basin Aquifer from a base supply to a drought supply, the aquifers can be managed to assure long-term reliability. Additional information on this concept is included in the section below "Denver Basin Aquifers - Our Best Opportunity for a Risk and Drought Reserve."

- 2) **East Slope Temporary Ag. Transfers:** Interruptible supply agreements with east slope agricultural water rights could also provide a back up water supply during dry-cycles. An alternative agricultural transfer project could build on the FLEX Market concept and include the temporary transfer of agricultural water rights similar to substitute water supply plans (CRS 37-92-308) and interruptible supply contracts (CRS 37-92-309). It could also include supporting the development of additional storage and infrastructure in the Arkansas and South Platte river basins to facilitate the temporary transfer of agricultural water rights to Front Range municipalities.
- b) **Emergency West Slope Water Bank for pre-1922 Water Rights:** The triggers and dry-sources above would be coupled with an emergency west slope water bank to help ensure the critical needs of all of Colorado's post-1922 users would be met if a curtailment cannot be avoided. As described by the IBCC, "this water bank would utilize the consumptive uses of Colorado's pre-1922 water rights on a willing buyer/lessee—willing seller/lessor basis. The bank could be combined with or include the use of the capacity of existing reservoirs such as Blue Mesa. The concept of such a bank is the effort of a current study by West Slope and Front Range water users."
3. **Headwater Enhancements:** This multi-purpose project could include non-consumptive environmental and recreational benefits to the headwaters of the Colorado River system. This could involve exchanges with current transbasin diverters for additional flows in Colorado headwaters and could utilize specifics from the Grand County Streamflow Management Plan and the Colorado Roundtable's Nonconsumptive Needs Assessment. This concept would need to be explored with current transbasin diverters.

Potential Area of Origin Compensation

Through the IBCC and Basin Roundtable process, west slope representatives have said that they would need several commitments before being supportive of this type of multi-purpose project. These included:

- Continued viability of the west slope's regional economy
- Certainty – ensure an increment of water is available for development in each west slope basin
- Front-Range commitment to conservation and reuse
- Environmental mitigation and enhancement

These elements could be met through a combination of water related benefits for the west slope sub-basins and/or socio-economic compensation.

Water related benefits for west slope sub-basins

Even though the diversion may not occur directly in each basin, different elements could be included to distribute statewide benefits, ensure continued viability of the west slope's economy, and provide certainty.

- Yampa/White
 - o Infrastructure for irrigation of additional acres in Moffat County (20,000-30,000 acres of land could be irrigated)
 - o Water for future municipal development particularly in Steamboat and Craig. Upper basin interests have previously secured 60,000 a.f. subordinations to protect future uses and they have indicated they would want a similar subordination or component of the project.
- Colorado
 - o Exchanges with current transbasin diverters for additional flows in Colorado headwaters (Grand County Streamflow Management Plan; Blue River Flow enhancement)
 - o Maintain Dillon Reservoir Levels
 - o Wolcott Reservoir for future west slope water demands and additional yield to the Grand Valley
- Gunnison
 - o Agricultural firming projects in the upper basin (Tomichi Creek, etc.) to help with current agricultural shortages
 - o Water quality improvements in the Uncompahgre River and Lower Gunnison (selenium)
- Southwest
 - o Financial assistance and support developing their identified projects and processes

Socio-Economic Compensation (Development Fund)

Generally, the most useful form of compensation would be unrestricted monetary compensation to be used by the west slope to compensate unprotected parties and for whatever other purposes its citizenry prefers. Rather than committing to specific projects, a development fund could be established. The money from this fund would be available to provide assistance for future water needs (see above) or other economic development on the west slope.

The fund could be financed in a number of ways as further described below. These financing mechanisms could also be accompanied by a charge placed on users of the multi-purpose project water (perhaps indexed to the current price of water in the South Platte Basin). The fund could be held by the state (CWCB) or potentially by west slope

conservation districts or counties. Expenditures would be made against the fund for projects proposed by municipalities, conservancy districts, and other public entities on the west slope. Appropriate expenditures could be solely water related³, or appropriate expenditures could include other economic development projects.

An alternative, predicated on the pipeline becoming a riparian restoration management tool, would be application of funds in two ways: First, for compensatory projects in the Colorado River basin, and; Secondly, to fund the increased cost associated with alternative diversions of transbasin sources. The first compensation is an early milestone in the process, bringing environmental benefits to the headwaters on the way to project permitting. The second form of compensation, where water providers with low cost, gravity delivery systems accept alternative deliveries, may also be necessary to have the required support for the project.

The major Front Range water providers have invested enormous capital in transbasin diversion structures. That investment yields lower cost water supply for their customers. The offset to the increased cost of alternative delivery might take the form of cash or delivery of more water than could have been historically diverted. The combination of a hold harmless economic approach, coupled with compensatory water stored underground, might be sufficient to garner enthusiastic support for the project.

Financing

In addition to the configuration of the project, the other major outstanding questions relate to how the project would be financed, managed and implemented. Four models could be further explored:

1. Federal/State partnership similar to the Central Arizona Project
2. State water project such as the California State Water Project
3. State/Local partnership where the state facilitates the project, but end users finance and manage it
4. Local/Local partnership similar to WISE and Chatfield as water examples and E-470 as a transportation example
5. Public/Private partnership similar to transportation projects (Hwy 36)⁴

Under any funding model it is most appropriate for use rates and tap fees to be the primary base of funding. This connects the customers with what they are paying for. However, the conceptual package of projects described above will likely also include broader public benefits that are more dispersed than those that accrue to the specific end users of the transmountain diversion project. Therefore broader public funding

³New storage projects, repair and rehabilitation of existing water storage and delivery facilities, municipal water systems, improvement of irrigation systems, on-farm improvements resulting in greater efficiency, water based recreation facilities, securing in-stream flows, and other water-related projects.

⁴Western Resource Advocates published a report, "Economic and Financial Impacts of the Proposed Flaming Gorge Pipeline" by Honey Creek Resources, Inc. September 6, 2011. The report compares public and private finance approaches. The report does not consider a public-private partnership.

mechanisms should also be explored. Two funding mechanisms, a "water" mill levy and a Container Fee, are briefly described as examples of how some of the broader public components of this multi-purpose concept could be funded. These funding mechanisms are described in order to demonstrate that broader funding mechanisms could be available if a package of projects is generally agreed to. SMWSA is not advocating for nor necessarily supportive of either method; rather, they are described as possibilities in order to spark further discussion.

Finance - "Water" Mill Levy

A two (2) mill property tax on the nine largest front-range counties will generate about \$107 million/year. (Adams \$9m; Arapahoe \$15.2m; Boulder \$11m; Denver \$20.2m; Douglas \$8.6; El Paso \$11.6; Jefferson \$14.4; Larimer \$7.6m; Weld \$9m). As a point of comparison most fire districts collect an 8+ mill. An additional two mills might incentivize linking land-use planning and water supply planning in the "Big 9."

One (1) mill, or about \$54 million/year could help provide water and economic development for the west slope. This could be done through a "Development Fund" as described above or it could be divided between the west slope counties.

The other (1) mill or about \$54 million/year could help fund construction and operation and maintenance of the multi-purpose project, including headwaters exchanges.

As a point of comparison, the 2009 General Fund Revenue for the following counties - Gunnison \$10.388M; Montrose \$10.1M; Logan \$4.5M; Garfield \$28M; Otero \$1M (estimate) - approximate what this fund could generate.

Finance – The Container Fee Ballot Initiative of 2010

In 2010, two citizens filed a Ballot Initiative seeking a fee on beverage containers sold in Colorado. Unofficially captioned "Container Fee to Fund Water Preservation and Protection" by legislative staff for tracking purposes, the initiative was heard by the Ballot Title Setting Board at its hearing April 21, 2010. The minutes of that hearing document that the legislative staff determined such a fee would generate approximately \$100 Million per year in revenue.

The Title Board's opinion setting the initiative title for the ballot was appealed to the Colorado Supreme Court. The basis of the appeal was that by naming the Basin Roundtables specifically (the funds were to be allocated in part based on roundtable approval of grants), the initiative was not a single subject. The Supreme Court granted the appeal. Given the timeline of the Colorado Water Plan, consideration could be given to a similar ballot initiative in November, 2015. The funds generated could go immediately to riparian restoration projects with future use for compensatory offsets. In the long run, the funding stream would support project development, permitting and eventually debt service.

Overall Benefits of the Project

- Front-range municipalities get an increment of high quality reusable water.

- New water supply development minimizes loss of irrigate acres in South Platte and Arkansas Basins. Transfers of east slope agricultural would no longer be the dominant strategy for meeting front-range water needs. East slope agriculture could participate in the project and receive additional yields (either directly or through “second use” of fully consumable return flows).
- Acceptable water quality that does not require advanced water treatment and may be used to blend with lower quality South Platte supplies.
- Allows development of new water supplies and utilization of Colorado’s compact entitlements while protecting recreation, environmental flows, and future economic development on the west slope.
- Depending upon the location of the diversion it could diversify the state’s M&I water supplies. The CRWAS indicates that climate change impacts are less severe in northern basins such as the Green River. Adding a more northerly water supply, and a basin other than the Colorado mainstem, would diversify the state’s M&I water supply and could mitigate potential risks from climate change.

Challenge/Issues/Costs of the Project

- Potential endangered fish and depletion issues downstream of the diversion would need to be analyzed.
- May require enlargement or construction of additional storage in the South Platte or Arkansas basins. This storage could be surface water storage or underground storage.
- Additional cost analysis of the various component of the package of projects will be needed. This will include, but not be limited to, the cost of equipping existing wells for ASR, implementing a regional ASR program, and comparing the costs of ASR with above ground storage.
- Complexities of water right administration in the event of a compact call.
- Although the Colorado Compact recognizes the right of one state to move water through another state, there will likely be a need for an agreement with Wyoming, perhaps Utah and perhaps between all four Upper Basin States.

Statewide Policy Objectives

- Safe reliable drinking water supply for all Colorado citizens
- Conservation – the project can include elements to require or encourage different conservation measures
- Reuse – the project can be configured for maximum utilization of fully consumable water either through M&I reuse or “second use” by east slope agriculture
- Maximum utilization of the state’s Colorado River Compact entitlements
- Environmental and recreational preservation and enhancements

Section 2: Denver Basin Aquifers - Our best opportunity for a risk and drought reserve

Existing Groundwater Conditions

Denver Basin Aquifers (Laramie-Fox-Hills, Arapahoe, Denver, and Dawson) comprise a huge groundwater storage reserve immediately beneath much of the central Front Range. The aquifers extend from roughly Greeley on the north to Colorado Springs on the south, the Foothills on the west, and the eastern boundaries of Adams, Arapahoe and Douglas counties on the east, comprising around 6700 square miles. The combined aquifers hold over 450 million acre-feet of water, and over 250 million of that may be economically pumped. Wells have been drilled and can produce up to as much as 1000 gallons per minute (gpm).

Historically, the South Metro area has relied almost exclusively on this non-tributary, nonrenewable groundwater supply. Estimates are that approximately 38MAF of recoverable water exists under the South Metro area. However, recent work reinforces previous observation regarding steady rates of aquifer declines. The 2013 Douglas County Rural Water Supply System Feasibility Study included a comparison of USGS groundwater modeling, measurements in active wells, and CDWR investigation of Denver Basin aquifer levels. The USGS modeling predicts a -1 to -5 feet per year average annual groundwater level decline and the CDWR investigation predicts a -5 to -13 feet per year decline. South Metro water providers continue to experience declines in aquifer levels and the cascading reduction in well yields.

Given the historic, current, and predicted declines in aquifer levels, the volume of Denver Basin Aquifer production will have a future economic limit which is likely to fall short of urban demands. Numerous studies between 2004 and 2013 all suggest that costs associated with continued reliance on non-tributary, nonrenewable groundwater are expected to be comparable or higher than costs for developing a regional renewable water supply system, thereby providing appropriate incentive to import renewable supplies that can be used conjunctively with the Denver Basin Aquifer.

Future Scenarios for Denver Basin Aquifer Groundwater Use

There are two likely scenarios for South Metro entities involving future use of Denver Basin groundwater: the first scenario is the status quo use of non-renewable groundwater supplies at increasing cost due to declining well production capacities. For the reasons discussed above, this scenario is generally unacceptable as it is an expensive and non-sustainable model.

A second – preferable - scenario is a large-scale conjunctive use plan involving development of renewable supplies and implementation of a robust wet-year aquifer recharge program in which reliance on Denver Basin Aquifer groundwater is primarily as a drought supply. While efforts to increase renewable supplies are currently underway, formalization of a significant conjunctive use plan involving a new transbasin diversion is urgently needed.

Such a conjunctive use plan can operate largely through existing and planned infrastructure. Water providers in the southern metro region rely on multiple wells for their water supply, and have constructed infrastructure connecting them with community water distribution systems. There are around 150 municipal supply wells in Douglas County alone. Recently, the WISE project included plans to link these service areas over the majority of the region. This will provide a water link both internally and to sources of renewable water from outside the region. The opportunity to recharge the Denver Basin Aquifers and a large-scale conjunctive use project is here.

Current annual well production in the area exceeds 40,000 afy (acre feet per year), which corresponds to an average rate of 35 mgd. Assuming the majority of wellfields are sized to meet summer demands and typically triple the average rate, there may be over 100 mgd of peaking capacity available in off-peak periods. With proper equipping and treatment capacity, a significant volume of renewable water could be supplied to the Denver Basin in wet periods for use during droughts.

A rough approximation of rates of flow into the aquifers can begin with the assumption that typical provider demands in the summer are sized for triple that year round rate, or 105 mgd in the aggregate. This leaves an average of up to 70 mgd in off-peak months. If off-peak demands are met with imported water making wells available for recharge, this rate could be returned to the aquifers for a total ranging between 25,000 and 45,000 af per year. Specific rates and durations of flows would be examined in detail during the feasibility review process. Generally, the initial projections affirm the potential viability of this concept.

The potential of a conjunctive use approach to integrating local non-tributary groundwater supplies and storage with interruptible surface water supplies from the South Platte and West Slope drainage basins was outlined in the State of Colorado's Metro Water Supply Investigation, Final Report (Colorado Water Conservation Board, 1998). Subsequently, the South Metro Water Supply Study (prepared for the South Metro Water Supply Study Board in February, 2004) carried the concept further through a joint effort between the Douglas County Water Resources Authority, Denver Water, and the Colorado River Conservation District.

Conjunctive Use is characterized as "The coordinated use of surface and groundwater resources and facilities to produce a larger, more reliable and cost effective combined water supply that could be generated from either source alone." (SMWSSB, page 1-12)

Centennial Water and Sanitation District in Douglas County has operated a conjunctive use plan since the early 1980's and an aquifer storage and recovery project with Denver Basin deep wells since 1992. The technology and recharge operation have met no significant impediments after over 20 years of and over 14,000 acre-feet of treated potable water back into the aquifers. South Metro WISE participants are currently evaluating the feasibility of expanding this operation with future WISE deliveries.

To date, many water suppliers along the Front Range who rely on deep bedrock aquifers have not been able to capture wet year supplies. With the addition of WISE Project infrastructure and Parker's Rueter-Hess Reservoir, the South Metro Area will soon have necessary infrastructure for a large-scale conjunctive use program. A large-scale conjunctive use plan could bring renewable surface water into the South Metro Region by utilizing:

- Interruptible raw water deliveries from existing transbasin diversion systems, Flaming Gorge, or another new transbasin project.
- Deliveries only in wet periods of low-risk hydrologic and administrative conditions.
- Distribution to existing deep aquifer wells equipped for recharge.
- Dry period use of reliable, drought-proof deep aquifer production to provide water when surface yields are not available.
- No increase of risk to yields controlled by partner entities.
- Protecting the integrity of the Colorado River Compact under a working cooperative operation.

This concept has been investigated and described for over 15 years (if not longer) by key parties who would potentially be involved and is now worthy of serious consideration by the IBCC and the CWCB through Colorado's Water Plan. This concept is recommended for further investigation and a role as a practical and viable means to manage Colorado's statewide water resources. It should be vigorously pursued in subsequent stages of the Colorado Water Plan.



Appendix G – South Platte Basin Surface Water Availability Analysis

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin
Roundtable

April 17, 2015



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Appendix H - Summary of Public Comments

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin Roundtable

April 17, 2015



1 Phase I

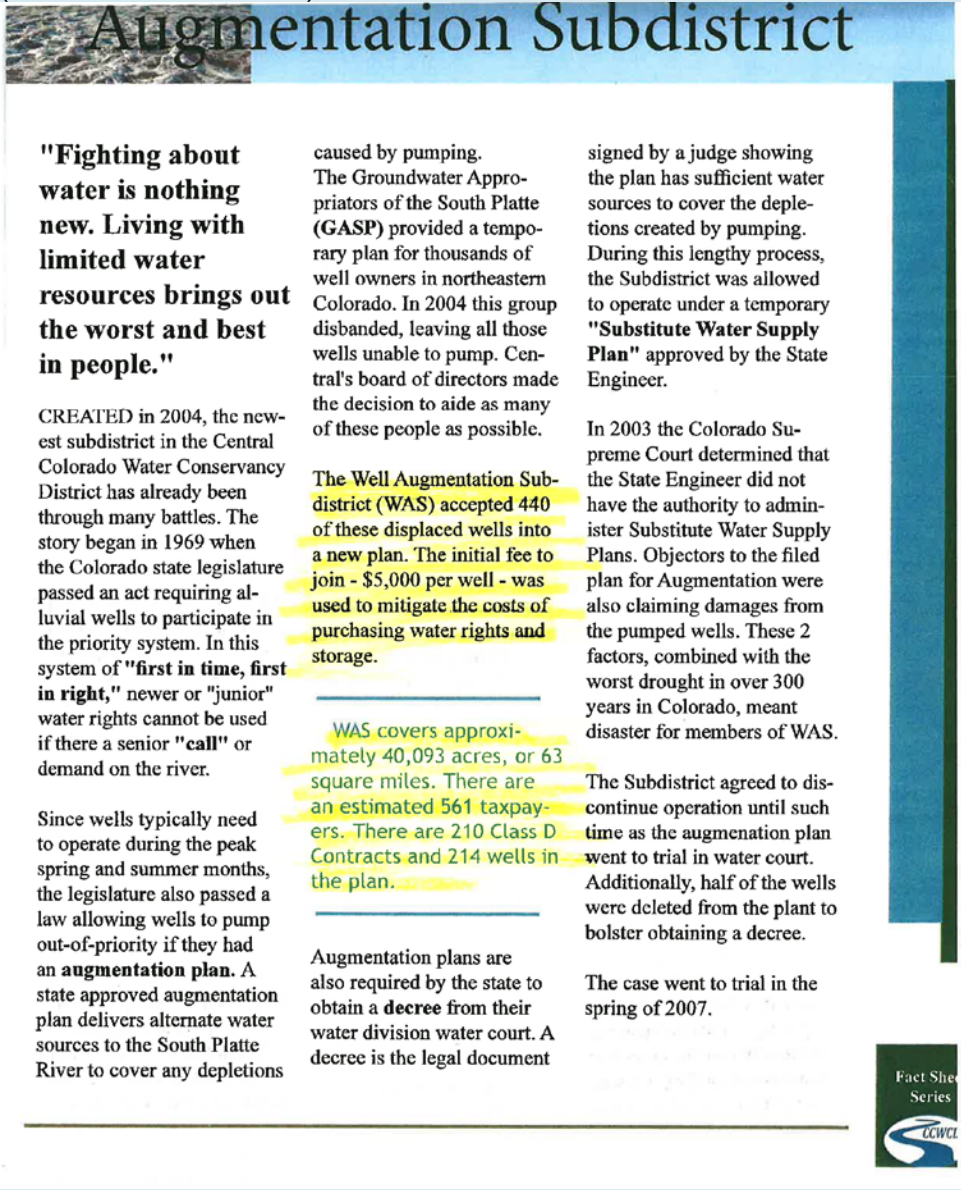
1.1 Public Outreach Meeting Comments

The below table summarizes comments from a series of public meetings held in 2014. The meeting dates were February 26, March 3, March 5, March 19, and April 10.

No.	Date Received	Comment	Type (Email, Letter, or Comment Form)
1	2/26/14	Hard to see how 73% of irrigated acres [Decrease of 27% = 831,000 acres yr 2014 to 607,000 acres yr 2050] By 2050 will increase or stabilize or solidity our food supply. If another chance to present this info in Fort Morgan arises we would be able to get more attendance/input. See need for more storage reservoirs Against buy & dry	Comment Form
	Response	<i>The South Platte BRT will hold a roving BRT meeting in Sterling during the second phase. The South Platte BIP supports the IBCC water planning strategy “Four Legs of the Stool” which includes using Conservation, Reuse, IPPs and New Colorado Supply to meet the future gap. All these elements would not be able to be achieved without additional storage.</i>	
2	3/5/14	REAL TIME MONITORING & MODELING Solves high ground water problems – when you use interceptor wells when levels rise above optimal levels Lost Creek Basin – 500,000 acre feet & capacity Need some work to formalize agreements to satisfy concerns of farmers – municipal – MUCH less than \$20million I BET! AVAILABLE NOW – BEEN TALKED about for decades! HOW MUCH MORE WATER FLOWS OUT-OF-STATE BEFORE WE START TO UTILIZE IT? WHAT BOB LONGENBAUGH SAID	Comment Form
	Response	<i>The CDWR has implemented a monitoring system under a WSRA grant. The SP BIP recommends that a sustainable funding source for this program be found so that it can continue in the future. Additionally, the SP BRT Groundwater subcommittee is reviewing recommendations from HB 1278 report. The BIP supports the implementation of more storage to further utilize South Platte native flows.</i>	
3	3/3/14	Non consumptive: Q. Existing Watershed Management Plans identifying critical watershed needs and management actions: Upper Clear Creek Watershed Plan – to be released March 2014 Includes management action & suggested project identification areas. Counties included – Jefferson, Adams, Gilpin, Clear Creek For information and electronic share of plan and maps contact either UCCWA – Upper Clear Creek Watershed Association or Dave Holm, Executive Director Clear Creek Watershed Foundation (3) 567-2699 * I understand various member of UCCWA have attended meetings related to this process over the years. I do not believe the most current information, which includes needs and management actions has been suggested that a formal presentation must be requested to the round tables to request inclusion in plans. I have included contact person/organization above to trigger that action.	Comment Form
	Response	<i>Various watershed plans were briefly reviewed during the reference review for the SP BIP. The summary of the review is included in Appendix D. Specific projects were included in the SP BIP as agreed upon by the environmental and recreational subcommittee.</i>	

4	3/3/14	How are microplastics in estuary systems being prevented? Microplastics are plastics deteriorating over time into smaller pieces, small plastics from makeup, litter and industrial spillage as well as other sources. Primary scientific studies are finding this phenomena become prevalent in the Great Lakes as well as estuaries and island beaches. Methods of remediation, including adequate storm water cleansing have been difficult to pass on a global level. I believe this should be examined in Colorado's long term awareness and planning to protect our ecosystems – see 5gyres.org Are public access water fountains being included in recreational planning? This can help minimize pollution while building awareness. Recycling should be available. Can you cut out single use plastic water bottles at your meetings? How is fracking water being recycled?	Comment Form
	<i>Response</i>	<i>Thank you for you comments. Public access water fountains are a decision for individual water providers. Additional discussion was included regarding fracking water use.</i>	
5	3/5/2014	P.A.U.L. E.D. Water Protect - Public interest in water Access – Public Bridge Access to streams Use (non-consumptive) Label – Label water value on food, etc like nutritional values in grocery stores E Educate – increase integration of water uses in K-12 curriculum Water	Comment Form
	<i>Response</i>	<i>Thank you for your comments. We will consider these when developing the Draft BIP.</i>	
6	3/3/14	The City of Black Hawk has 3 new reservoirs planed for a total of 1660AF plus an expansion of an existing reservoir by 600AF I want to make sure the following reservoirs are listed as an identified projects list Quartz Valley Reservoir – 600AF Missouri Creek Reservoir – 600AF Pickle Gulch Reservoir – 460AF Expand Chase Gulch Reservoir – 600AF	Comment Form
	<i>Response</i>	<i>Thank you for your input. Additional information (i.e. project sponsor(s), estimated firm yield, construction timeline, anticipated cost) would be needed by CWCB staff to include as a new IPP.</i>	

7	3/5/14	According to “The Evolution of The South Platte River” by Bart Woodward The “Natural Flows” of the river were overappropriated about 1880. Ditch diversions constructed after that date created The South Platte River as we know it today. In the early years Nebraska encouraged development of diversions along the river, because every diversion created more return flows, that didn't exist before. Thus creating a live river for a longer time during the summer. Irrigation wells started being drilled from 1920-1950 & 1960's. These wells were drilled to supply water when ditch diversions were inadequate during periods of drought. This once again to additional stream flows extending the live river. In 1965 the river was again overappropriated. This overappropriation is what led to the 1969 Water Act. You can see from the attached “South Platte River Facts” That there are from 13 to 15 million acre feet of Ground Water storage available. Since the drought of 2002 more than 500 augmentation plans have been implemented and another 200 are in planning stages. High water tables have been recorded & recognized by results of HB-1278. Utilization of existing irrigation wells Brighton to Kersey would maximize “beneficial use” of ground water reservoir without spending a dime. High water tables would disappear. It is ludicrous to be sitting on a reservoir of 13 to 15 million AF and not use a portion of it. (see list below) South Platte River Facts <table><tr><td>Surface Reservoir Storage</td><td>1,000,000 AF</td></tr><tr><td>Groundwater Storage</td><td><u>10,500,000 AF</u> *</td></tr><tr><td>Potential More G.W. Storage</td><td>3,500,000 AF</td></tr><tr><td>Annual Diversions from River</td><td>4,000,000 AF</td></tr><tr><td>Number large capacity wells</td><td>9,000</td></tr><tr><td>Annual volume pumped</td><td>1,000,000 AF</td></tr><tr><td>Annual Flow from mountains</td><td>1,200,000 AF</td></tr><tr><td>2002 flow from mountains</td><td>300,000 AF</td></tr><tr><td>Transmountain Diversions</td><td>600,000 AF</td></tr><tr><td>Phreatophyte C.U. (consumptive Use)</td><td>429,000 AF</td></tr></table>	Surface Reservoir Storage	1,000,000 AF	Groundwater Storage	<u>10,500,000 AF</u> *	Potential More G.W. Storage	3,500,000 AF	Annual Diversions from River	4,000,000 AF	Number large capacity wells	9,000	Annual volume pumped	1,000,000 AF	Annual Flow from mountains	1,200,000 AF	2002 flow from mountains	300,000 AF	Transmountain Diversions	600,000 AF	Phreatophyte C.U. (consumptive Use)	429,000 AF	Comment Form
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	Response	Thank you for your comments. Consideration of increased groundwater use will be incorporated into the Draft SP BIP.																					
8	03/17/14	The water table is too high-our vegetable crops die because of too much water. Corn is stunted. The high water table is pushing salts up and killing the soil. Our septic tank system is straining to keep up. And to this, the wells on our farm have been shut off and people out East are allowed to drill new wells, install pivots and water previously dry land! This problem has been “studied” to death. How many years? How many millions? (SPDSS) Now more studies. Do something – They did 10 years ago without all these studies. Two lawyers using black magic and sky hooks got hundreds of wells shut off and caused all this. No proof, no science. We attended the annual CCWCD meeting held at Greeley, CO March 11, 2014. In the presentation, the water engineers, and Central Water District acknowledges that we have <u>Over Compensated</u> augmentation, resulting in these huge problems for many of us. The remedy is to allow more pumping (Presently) both irrigation wells have been shut off that once irrigated our fields, resulting in no water to irrigate the crops we grow to make a living. The very little surface water (5 shares) does not even reach the farm down the ditch, it seeps away before it can be used. We used the wells to supplement the irrigation.	Comment Form, US Mail																				
	Response	The SP BRT Groundwater subcommittee is currently reviewing recommendations from HB 1278 report.																					

9	3/18/14	Farmers care about the environment as much as anyone. The environment is our Life and livelihood. However, the trees and plants in the South Platte River are out of control. The phreatophytes use approximately 350,000 to 400,000 Acre FT. of water per year. Agriculture uses about 80,000 Acre FT. a year, as presented at the annual CCWCD meeting on March 11, 2014. The 2 wells on our farm were totally shut down, which was the irrigation water. We tried to use the 5 shares of surface water ("ditch water"), to supplement the wells. The surface water is so little that it did not reach our farm from the headgate as it seeps away in the ditch before it arrives here. We joined Central in a water substitute plan (WAS). To join was \$5,000.00 and annual assessments were \$3,000.00 and rising to \$5,000.00. Because of very little income from the farm, and the financial hardship imposed upon us, we could not remain in the WAS plan of CCWCD, and dropped out. We are in a special taxing District for WAS. We are located 1 ½ miles east of the So. Platte River in District 2 in the Platteville/Gilcrest area. Our post pumping depletions were paid back (replaced) while we were still members of WAS as confirmed by engineering. Now, we are getting a "second hit" and more damages. We are not able to use the ground water conjunctively causing our agriculture land to be unproductive, and by being burdened with high water levels, with water rising in the fields and in our septic systems. WE NEED RELIEF. It is not fair, but is wrong and immoral to take our hundreds of <u>new</u> wells for irrigating land that have not been previously irrigated, this is because of over water augmentation resulting in a high water table. At the CCWCD meeting, CCWCD and Colo. State speakers said the wells have been overaugmented causing the high water table. PS. Please see enclosed information regarding the well augmentation subdistrict (WAS). (Scanned and entered below)  "Fighting about water is nothing new. Living with limited water resources brings out the worst and best in people." CREATED in 2004, the newest subdistrict in the Central Colorado Water Conservancy District has already been through many battles. The story began in 1969 when the Colorado state legislature passed an act requiring alluvial wells to participate in the priority system. In this system of "first in time, first in right," newer or "junior" water rights cannot be used if there a senior "call" or demand on the river. Since wells typically need to operate during the peak spring and summer months, the legislature also passed a law allowing wells to pump out-of-priority if they had an augmentation plan. A state approved augmentation plan delivers alternate water sources to the South Platte River to cover any depletions caused by pumping. The Groundwater Appropriators of the South Platte (GASP) provided a temporary plan for thousands of well owners in northeastern Colorado. In 2004 this group disbanded, leaving all those wells unable to pump. Central's board of directors made the decision to aide as many of these people as possible. The Well Augmentation Subdistrict (WAS) accepted 440 of these displaced wells into a new plan. The initial fee to join - \$5,000 per well - was used to mitigate the costs of purchasing water rights and storage. WAS covers approximately 40,093 acres, or 63 square miles. There are an estimated 561 taxpaying wells. There are 210 Class D Contracts and 214 wells in the plan. Augmentation plans are also required by the state to obtain a decree from their water division water court. A decree is the legal document signed by a judge showing the plan has sufficient water sources to cover the depletions created by pumping. During this lengthy process, the Subdistrict was allowed to operate under a temporary "Substitute Water Supply Plan" approved by the State Engineer. In 2003 the Colorado Supreme Court determined that the State Engineer did not have the authority to administer Substitute Water Supply Plans. Objectors to the filed plan for Augmentation were also claiming damages from the pumped wells. These 2 factors, combined with the worst drought in over 300 years in Colorado, meant disaster for members of WAS. The Subdistrict agreed to discontinue operation until such time as the augmenation plan went to trial in water court. Additionally, half of the wells were deleted from the plant to bolster obtaining a decree. The case went to trial in the spring of 2007. Fact Sheet Series CCWCD	Comment Form by mail
	Response	Thank you for your comment	

10	4/01/14	At the March 19 SPBIP meeting in Fairplay a Park County Commissioner stated that there was no new supply of water available to the South Platte River Basin. I am writing this letter to disagree and to suggest new water supply sources. I heard three possible sources of new supply mentioned at the March 19 meeting. They were conservation, re-use, and the capture of excess water in new or expanded reservoirs or the pumping of excess water into underground aquifers. These are all good ideas and I would like to support them. I would like to offer five more suggestions for new supplies of water. Cutting trees in the mountain forests to create gaps in the canopy. The gaps could collect snow during the winter and allow it to melt into streams in the spring. Leaving the canopy intact would allow the snow to either not be deposited or to evaporate into the air. Cutting Gaps in the trees would require coordination with the Forest Service and possibly the EPA. Cutting trees along rivers to reduce the amount of water transpired to the atmosphere by the trees. This was suggested by a water engineer (retired?) at the March 3 SPBIP meeting at the Tivoli center. Cutting a significant number of trees along the South Platte would require co-ordination with recreational groups that would want their riverside paths shaded. Recover the water produced by our power plants that burn natural gas. Conceptually this could be accomplished by running the power plant exhaust through a condenser to collect the water produced by burning methane, $[CH_4 + 2O_2 = CO_2 + 2H_2O]$. Condensing water from flue gas is already being done in the Middle East and North Africa. My calculations suggest that for every Mcf of Natural Gas burned .02 acre feet of water can be recovered. In 2010, Colorado burned 150000 Mcf of natural gas for electrical power. That could mean 3000 acre feet of new supply. Recover water produced from oil and natural gas wells when they hit horizons of brine in the drilling process. The brine would have to be desalinated and there might be only enough produced to offset the water required for fracking. Still, buried seawater is a potential source of new supply and should be investigated. Desalination of ocean water is a source of new supply. Colorado could help build a desalination plant in California or Texas, supply natural gas to run the plant and arrange for the water produced to be exchanged for water that Colorado would no longer be required to let flow out of the state. New laws would have to be created to allow exchanges between states, but creating new laws to facilitate problem solving is what governments should do. Whether any of the above ideas would be considered outlandish or not depends on the cost of every acre-foot produced. A good decision point for landish or outlandish might be \$2000 per acre-foot, the price San Diego has decided to pay for desalinated water in California. I would consider water transfers from Hudson Bay, the Missouri river or even the Western Slope outlandish because the transfers do not create water they merely move existing water someplace else, possibly creating shortages for the source areas.	Comment form/by mail
	Response	Thank you for your comment. These suggestions will be considered in the development of the Draft SP BIP.	
11	4-10-14	One of Largest Water Storage Facilities in World. Hardly any Evaporation Ogallala Aquifer Pick a location or multiple locations Red lion Road, to State Line. Develop a way to inject extra water that flows in high water flow times w/low use Never let 1 extra gallon flow into Nebraska than what is required. Store the water there (in Aquifer) until needed allowing republican River basin to remove half of it and save half of it for later for urban use. Would have to change basin rules to allow export of water but if importing could export it as long as below amount injected. Say 50% Challenges: Management, \$\$, underground loss to Nebraska. Compact,	Comment Form
	Response	Thank you for your comment. Both groundwater and surface water resources are important components within the South Platte Basin. These suggestions will be considered in the development of the Draft BIP.	

1.2 Online Survey Responses

The questions below were part of the Phase II online survey available at www.southplattebasin.com. The Phase I survey was available online from 02/2014 – 12/2014.

Questions		What ideas do you have for meeting existing and future water needs?	Response	Do you have additional input for the South Platte Basin Implementation Plan? If so, please provide:	Response
Responses	09/23/2014	More water storage for wet years.	<i>The South Platte BIP supports the IBCC water planning strategy "Four Legs of the Stool" which includes uses Conservation, Reuse, IPPs and New Colorado River Basin Supply to meet the future M&I gap. Additional storage is integral to all of these components.</i>		
	06/25/2014	Stop the unfettered urban sprawl, for which we don't have the resources. Our population had grown dramatically since the last water agreement with surrounding states, but we still only get the Orion of water for a small population. Perhaps revisiting that agreement to gain more water based on our percentage of population over our historical levels would be a better place to start. Why do other staff have green yards, but we want to raid and pave over our farms and further delete or natural resources. We're only cannibalizing our own state.	<i>An overarching theme of the SP BIP is to identify solutions that are pragmatic, balanced and consistent with Colorado Law and property rights.</i>	Moving water from the W. Slope and San Luis Valley to meet Metro needs eliminated the source of exasperation that eventually falls here. If we dry that up to water our yards, we will create an ever greater drought and dust bowl situation than we've seen over the past twelve years. The more we cover the natural ground with more asphalt and homes, the more heat this area released, endorsing and drugging up even the small amount of water we have available here.	<i>Additional supplies from the Colorado River Basin may be needed to meet future M&I demands in the South Platte Basin. The Roundtables support a balance program to plan and preserve options to develop Colorado River Basin Water in the future.</i>
	05/13/2014			We reviewed the "WQCD_20140418_CWP Revised Water Quality Section.pdf" document and have the following comments: 1) Page 2, Section 5.4.1.1. This bullet is very confusing with the way it is structured, needs to be rewritten. The ideas switch back and forth from one topic to another with no transition. Doesn't explain how recreational fishing is related to stratification and release from dams. 2) Page 4, Section 5.4.1.2. Third paragraph. Needs to be rewritten for clarity. Starts out with discussion of 401 then jumps to 404 without any transition. Definitions are unclear. Run-on sentences.	<i>This comment refers to the Draft CWP.</i>
	05/07/2014	Lots of conservation in the cities, particularly landscaping. Follow some farms in drought and willing seller sales of agricultural water rights. Don't ruin the mountain streams with crazy ideas about diverting them, we've done enough of that. Protect the environment of Colorado. We're in the west man, there will never be enough water, you'll be talking about the next need the next drought.	<i>South Platte and Metro Basins are one of the leaders in conservation practices. Alternative Transfer Methods (ATMs) may provide a means for agricultural producers to "share" their water with M&I users. The SP BIP strives to proactively identify and implement methods to protect and enhance environmental and recreational water uses.</i>		
	04/21/2014				
	4/21/2014				
	04/15/2014				
	04/15/2014	I believe we need more reservoirs for the larger populated areas and for recreation. I also believe landowners should have more flexibility in retaining water on their property for both fire prevention and personal use.	<i>The South Platte BIP supports the IBCC water planning strategy "Four Legs of the Stool" which includes uses Conservation, Reuse, IPPs and New Colorado Supply to meet the future gap. Additional storage is integral to all of these components.</i>		
	04/15/2014	Allow food growers to have a high priority, allow the use of water for energy production.	<i>One of the ten "Plan Elements" in Section 5.5.4 of the SP BIP is to "minimize traditional agricultural buy-and-dry and maximize ATMs to where Practical and Reliable". The South Platte Basin is the leading agricultural producer in the State and the Plan supports maintaining the agricultural economy within the South Platte Basin.</i>		

	04/08/2014	Since ag is the primary use of water, I would encourage more conservation initiatives for ag, with possible subsidies.	<i>ATMs may provide a means for agricultural producers to “share” their water with M&I users and potentially reduce the negative socioeconomic effects to agricultural communities.</i>		
	03/27/2014	Urban and suburban water conservation should be the top priority in our basin. Smart growth and careful land use management is critical!	<i>The South Platte Basin and Metro basin have already achieve great reductions in their gallon per capita use and are pursuing even more aggressive conservation goals for the future.</i>		
	03/19/2014	water sharing between ag and utilities - longer term contracts (ATMs) for drought firming, recovery and unforeseen events (fire, floods, construction etc.). This includes helping utilities use the ag water they own w/o a change case (3 in 10) and or leasing of water owned by producers for these purposes.	<i>The South Platte is further exploring making ATMs a feasible options for agricultural and M&I users.</i>	The Poudre Basin Water Sharing Working Group funded by CWCB is working on prototype contracts for several water sharing mechanisms. They will improve the basin-wide data base, survey irrigators and utilities and ditch companies about their perceptions of each of 4 possible water sharing mechanisms: decree swaps, 2 kinds of interruptible supply and short-term leases. Contact is Mary Lou Smith at the Colorado Water Institute. We hope to look at potential for shared storage, dredging and water banking after the current work is completed	<i>Thank you for your comment. Your suggestions will be considered in the development of the Draft SP BIP</i>
	03/19/2014				
	03/14/2014	Improve open channel delivery systems through new technology	<i>Thank you for the recommendation. This type of improvement may be considered by individual water users or diverters throughout the basin as a mechanism for improving delivery efficiency.</i>	Improving the operation of canal systems could make 50% water more available to its intended use. This was proven in Australia	<i>Thank you for this recommendation. Implementation of canal system improvements may be too expensive for individual systems to implement. Cost sharing mechanisms will need to be explored to make efficiency improvements economical.</i>

2 Phase II

2.1 Online Survey

The questions below were part of the Phase II online survey available at www.southplattebasin.com. The survey was available online from 01/2015 - present.

Question 1	What water needs are most important to you? Select all that apply.					
Survey Date	Agricultural	Environmental	Industrial	Municipal / Residential	Recreational	Other
02/25/2015						Other
02/10/2015	Agricultural	Environmental	Industrial	Municipal / Residential	Recreational	
02/04/2015	Agricultural					
01/25/2015	Agricultural			Municipal / Residential		
01/18/2015	Agricultural	Environmental	Industrial	Municipal / Residential		
01/14/2015						
Totals	4	2	2	3	1	1

Question 2	Comment	Response
The solutions to our water supply challenges as proposed in the South Platte Basin Implementation Plan are comprehensive.	Strongly agree	
	Agree	What of the once-considered idea of transferring water from the Missouri River in eastern Nebraska/Kansas via pipeline? The Colorado River Basin cannot be the solution for the front range issues, IMO.
	Strongly disagree	Nothing new in this document
	Agree	Need to get the Bur. of Reclamation involved. For Olympus Dam and Lake Estes: use for flood control as well as agriculture goals. During flood water conditions, need to have capacity and rules that allow such water to be diverted to the Flat Iron/Carter Lake complex (note: Carter Lake was at low water levels during the 2013 Flood).
	Strongly agree	One major source of water waste is dirt irrigation ditches that leak badly. There are many miles of ditches in that condition in the South Platte basin. The issue must be addressed.
		<i>Thank you for your comment. Importing water from other basin outside of Colorado may be considered in the future.</i>
		<i>Noted.</i>
		<i>Thank you for your comment. Expansion of existing infrastructure, such as reservoirs, may be a more economical solution than development of new reservoirs. This type of option will be incorporated into the Final SP BIP.</i>
		<i>Thank you for your comment. Development of irrigation ditches in Colorado began in the 1850s. Lining of ditches throughout to SP Basin would be cost prohibitive, however, localized solutions may be explored to improve delivery efficiency.</i>

	Strongly agree	Much water can be saved if we look at lawn watering usage. I know my water consumption goes up, (I live in town), 300-400% in the summer months. Restrictions on the sizes of grass lawns, in ratio to house size, could be implemented, over time. These lawns are mostly just something pretty to look at and could be replaced by fake grass or xeriscaping, retaining aesthetic value, and saving a lot of water.	<i>Thank you for your comment. Higher levels of conservation will require broad statewide support and political will beyond the purview of water utilities within the South Platte Basin alone. Greater savings in outdoor water use would require major changes in landscaping that moves beyond just efficiency measures; this would involve lifestyle considerations about our urban environments. These decisions must be made and implemented at the broader community level, as well as at the water planner level.</i>

Question 3		Comment	Response
Finding solutions to the water supply challenges faced by the South Platte Basin is critical to the future quality of life and economic prosperity of the region.	Strongly agree		
	Strongly agree	See above	<i>Noted.</i>
	Strongly agree		
	Strongly agree	Regarding my list in question 1, I could have checked all of them. I only checked two of them so as to rank them higher in priority.	<i>Noted.</i>
	Strongly agree		
	Strongly agree	The criminalizing of catching rain water off my roof, to water my vegetable garden, I find oppressive and criminal in itself. If you figure out the roof areas, compared to open ground in Colorado, I think you'd find it very minimal, therefore effecting the recharging of aquifers very little. And if you take into account that people using this rainwater, would not have to pump it out of there wells, or tap city supplies, nobody is gaining anything. The only thing this law really does, is oppress the people, with another useless law.	<i>Thank you for your comment. The solutions identified in the SP BIP must be consistent with existing Colorado Water Law and property rights. Future legislative changes may provide an opportunity for rainwater harvesting on a statewide basis. The State of Colorado has authorized a pilot study for rain water harvesting.</i>

Question 4		Comment	Response
Do you agree that the Basin Roundtables are working to create balanced plans that consider all water needs?	Agree		
	Neutral		
	Strongly disagree	The Ag representatives don't say much...	<i>Noted.</i>
	Neutral	Saw a notice, but could not attend. So I don't know. Hope they weren't all one-sided, like "Save-the-Poudre.	<i>Noted.</i>
	Neutral		

Question 5		Comment
How would you rank your understanding of overall water resource issues in the South Platte Basin?	Strong	
	Intermediate	
	Strong	
	Intermediate	My training was (am now retired) in geology and earth sciences.
	Fair	
	Intermediate	

Question 6		Comment
Before visiting this site, rank your understanding of the BIP's purpose and content.	Intermediate	
	Poor	
	Intermediate	
	Intermediate	
	Fair	
	Fair	

Question 8	How did you hear about this survey?					
	Internet	Newspaper	Email	Referral	Word of mouth	Other (please specify)
02/25/2015	Internet					
02/10/2015				Referral		
02/04/2015			Email			
01/25/2015		Newspaper				
01/18/2015		Newspaper				
01/14/2015		Newspaper				
Totals	1	3	1	1	0	0

Question 9	In the future, I would like to learn more about the BIPs via:					
	Website	Public meeting	Emails	Webinars	Written articles	Presentations
02/25/2015			Emails			
02/10/2015	Website				Written articles	
02/04/2015		Public meeting				
01/25/2015			Emails			
01/18/2015	Website	Public meeting				
01/14/2015						
Totals	2	2	2	0	1	0

2.2 Phase II - Roving Basin Roundtable Meeting Surveys

Please answer the following:										
Questions		The scope and goals of the Basin Implementation Plans were adequately explained in this meeting.	The solutions to our water supply challenges provided at tonight's meeting are comprehensive.	Finding solutions to the water supply challenges faced by the South Platte Basin is critical to the future quality of life and economic prosperity.	Based on the information presented tonight, do you agree that the Basin Roundtables are working to create balanced plans that consider all water needs?	How would you rank your understanding of overall water resource issues in the South Platte Basin?	Before tonight's meeting, rank your understanding of the BIP's purpose and content.	Before tonight's meeting, were you aware of the Basin Implementation Plans and Colorado's Water Plan?	How did you hear about this survey?	In the future, I would like to learn more about the BIPs via:
Responses	1/13/2015	Agree	Agree	Strongly Agree	Strongly Agree	Strong	Strong	Strong		
	1/13/2015	Agree	Disagree	Strongly Agree	Neutral	Strong	Strong	Strong		
	1/13/2015	Agree	Agree	Strongly Agree	Agree	Intermediate	Intermediate	Strong	Email	Email/ Website
	1/13/2015	Neutral	Neutral	Strongly Agree	Neutral	Strong	Intermediate	Strong		
	1/13/2015	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strong	Intermediate	Strong	Word of Mouth	
	2/10/2015	Agree	Neutral	Agree	Agree	Strong	Intermediate	Strong	Email	
	2/10/2015	Agree	Neutral	Agree	Agree	Strong	Intermediate	Strong	Email / Referral	Email/Public Meeting

