2012 UPPER COLORADO RIVER WATER QUALITY MANAGEMENT PLAN

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1.0 WATERSHED OVERVIEW

1.1 Geography and Hydrology

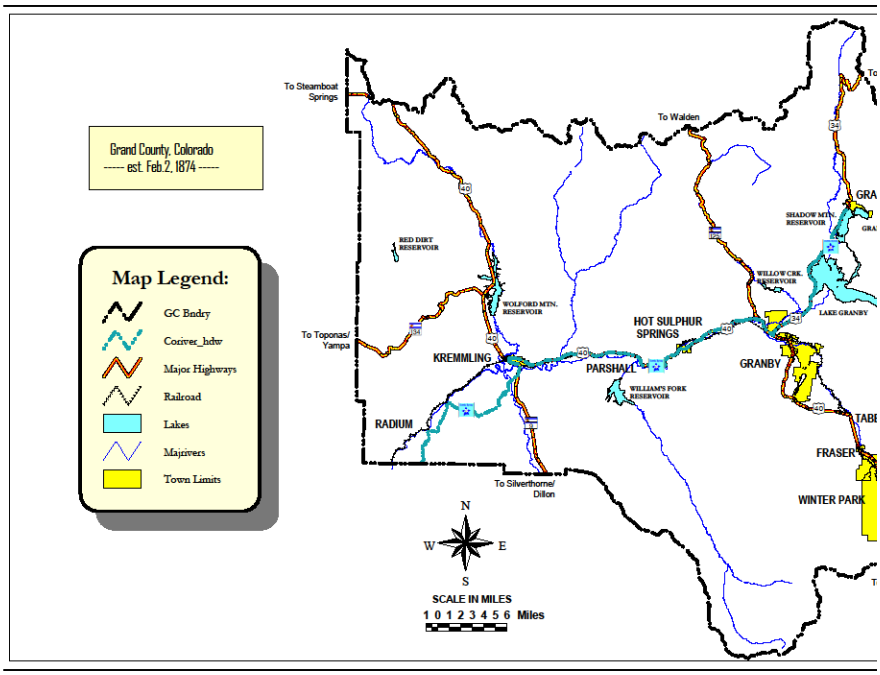
The Colorado River headwaters watershed in this plan is defined as the Continental Divide on the east and north, the Williams Fork Mountains ridge to the south and west, and the Gore Range ridge to the northwest (Figure C-1). This area is generally defined by Grand County, which encompasses an area of 1,869 square miles (1,196,000 acres) with altitudes ranging from 13,400 feet along the Continental Divide to 6,800 feet near Radium. The Blue River, which flows into the Colorado River outside of Kremmling, is described in the Blue River Watershed Management Plan.

The major sub-basins in the headwaters of the Colorado River include: the Colorado River, which originates in Rocky Mountain National Park and is often referred to as the Three Lakes (Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir) sub-basin; the Fraser River; Willow Creek; Williams Fork; Troublesome Creek; and Muddy Creek. While the Blue River is of course tributary to this system, the Blue River watershed is discussed in a separate section. Major tributaries flow from the Continental Divide through wilderness and National Park lands and include the North and East Inlets, Arapaho Creek, and the Roaring Fork Creek. The Fraser River originates at Berthoud Pass and flows northwest to its confluence with the Colorado River near Granby. Principal tributaries to the Fraser River include St. Louis Creek, flowing east, and Ranch Creek, flowing westward and joining the Fraser River near Fraser. Other principal tributaries to the Colorado River are: Williams Fork, flowing north and joining the Colorado River near Parshall; Troublesome Creek, flowing south and joining the Colorado River at Troublesome; Muddy Creek, flowing south from Rabbit Ears Pass and joining the Colorado River at Kremmling, and the Blue River, flowing north through Summit County to its mouth below Kremmling.

The lower portion of the Upper Colorado watershed includes parts of Routt (Rock Creek drainage), Eagle, and Garfield Counties, and ends at the confluence of the Roaring Fork and Colorado Rivers in Glenwood Springs. Below the confluence of the Blue River, the Colorado River flows through a remote and rural area until it joins with the Eagle River at Dotsero and then parallels the major east-west interstate Highway 70 corridor to Glenwood Springs. Tributaries to this portion of the Colorado River include: the Piney River which flows northwest to the confluence at State Bridge; Rock Creek which flows southwest to the confluence at McCoy; and Sweetwater Creek which flows southeast to the confluence about five miles upstream of Dotsero. Between the confluences of the Eagle and Roaring Fork Rivers, the Colorado River has no major tributaries.

The Colorado River and its tributaries experience widely varying seasonal fluctuations in flows. In addition, trans-basin and irrigation diversions cause fluctuations in flow on affected streams. Most stream flow results from snowmelt [US Geological Survey, Hydrology of Area 58, Northern Great Plains and Rocky Mountain Coal Provinces, Colorado and Utah, 1987].

Figure C-1. Upper Colorado River Watershed and Grand County Map.



The spring runoff period, May through mid-July provides approximately 75% of the total annual flow. During this time there is usually a surplus of available water, however, during the late summer and fall when stream flow is low, demand continues or increases and often exceeds supply [US Forest Service, Rock Creek/Muddy Creek Draft Environmental Impact Statement, 1987]. The annual average annual runoff of the Colorado River at various locations is listed in Table C-1 below.

Table C-1. Upper Colorado Drainages and Average Annual Runoff*

Drainage	Area (square miles)	Water Years (Oct.- Sept.)	Annual Runoff (acre-feet)
Colorado @ Hot Sulphur Springs	825	1982-2000	207,800
Blue near Kremmling	645	2000	298,700
Colorado nr Kremmling	2,382	1962-2000	755,000
Eagle blw Gypsum	945	1947-2000	419,100
Colorado blw Dotsero	4,394	1941-2000	1,543,000
Roaring Fork @ Glenwood Spr	1,451	1972-2000	905,400
Colorado blw Glenwood Sprs	6,013	1967-2000	2,522,000

*Data comes from Water Resources Data Colorado Water Year 2000, US Geological Survey, 2001

The major storage facilities in the Upper Colorado watershed are: Shadow Mountain Reservoir (17,384 acre feet, active capacity n/a), Lake Granby, Windy Gap Reservoir (445 acre feet, active capacity n/a), Willow Creek Reservoir (10,553 acre feet, active capacity 3,329 acre feet), Williams Fork Reservoir (97,000 acre feet), Meadow Creek

Reservoir, and Wolford Mountain Reservoir (66,000 acre feet). In addition, a number of tunnels and diversions transport approximately 300,000 acre-feet per year to the eastern side of the Continental Divide. These diversions include the Gumlick and Vasquez Tunnels owned by the Denver Water Department, the Moffat Tunnel, currently owned by the Colorado Department of Local Affairs, the Grand Ditch, owned by the Water Supply and Storage Company, and the Adams Tunnel, owned by the US Bureau of Reclamation and operated by the Northern Colorado Water Conservancy District.

1.2 Land Uses and Population Characteristics

The predominant land uses are woodland or rangeland and are managed by the US Forest Service (USFS) and Bureau of Land Management (BLM). The USFS manages approximately 892 square miles (Arapaho and Routt National Forests) [Statistical Abstract of Colorado, University of Colorado, Boulder, Business Research Division, 1987] and the BLM manages approximately 175 square miles, together accounting for 60% of the headwaters watershed.

The economies of the Fraser River sub-basin and the Three Lakes region are based primarily on recreation *(*including significant motorized recreation) while the economy of the remaining parts of the watershed is based mostly on agriculture. The Fraser River sub-basin, located in southeastern Grand County, contains major ski areas (Winter Park, Sol Vista, Devil's Thumb**,** Young Life Camp and Snow Mountain Ranch). Extensive development of condominiums and vacation homes, at a particularly rapid pace during the 1990's, has occurred along the Fraser River between Winter Park and Granby in the vicinity of the ski areas and recreational facilities. The Three Lakes region, an important recreational area in the northeast part of the county, includes Lake Granby, Shadow Mountain Lake, and Grand Lake. The headwaters watershed provides numerous opportunities for lake and river-based recreation, camping, hiking, biking, horseback riding, hunting, snowmobiling, wildlife viewing, skiing, and golfing. Ranching, timber production, and gravel mining, are the major activities from Granby to Glenwood Springs. Recreational boating and fishing are also economic drivers in the lower area of the basin from "Pumphouse" to Glenwood Springs. The Upper Colorado River accounted for over 25% of all commercial user days statewide in 2010. The Upper Colorado has significant underutilized commercial permitting "capacity" on the river particularly between State Bridge and Glenwood Canyon according to an industry user group of commercial guides (CROA, 2010).

The major population centers in the headwaters portion of the watershed are Winter Park, Fraser, Tabernash, Granby, Grand Lake, Hot Sulphur Springs, and Kremmling. The seasonal population increases significantly at the ski areas in and near Winter Park in the winter, and in the Three Lakes region in the summer. For Grand County, the permanent population between 1980 and 1990 grew 6.6%, and between 1990 and 2000 grew 56.2%, and between 2000 and 2010 grew 6.8%.

The lower portion of the Upper Colorado River is remote and land uses generally consist of ranching, timbering**,** recreational boating and fishing, and mineral extraction. Population centers in the lower portion of the Upper Colorado River include: Radium, State Bridge, Bond, McCoy, Burns, Dotsero, and Glenwood Springs. Below the confluence of the Eagle River, the River receives little in the way of substantial inflows and point source discharges until the confluence with the Roaring Fork River, but is impacted by its proximity to the highway, towns, and the Shoshone Hydroelectric Power

Plant.

In the Upper Colorado River watershed there are 155 community, transient non-community, and non-transient non-community drinking water systems, serving a combined total population of 93,833 persons [Colorado Department of Public Health and Environment, Water Quality Control Division, 2011]. This information does not include systems serving less than 25 people.

1.3 Watershed Water Quality Management

Organizations in the Upper Colorado River watershed that are addressing water resource issues include:

East Grand Water Quality Board

The mission of the East Grand Water Quality Board is to protect, restore and monitor the headwaters of the Colorado River in the Fraser River watershed. The East Grand Water Quality Board is organized exclusively for charitable, scientific and educational purposes. Developing a non-point source pollution control plan and administering an erosion and sediment control program are some of the objectives intended to achieve this purpose. The Board contracts each year with the USGS to sample 9 sites along the main stem of the Fraser and its major tributaries.

Grand County Water Information Network;
http://www.gcwin.org/

The Grand County Water Information Network (GCWIN) was established in 2004 as a collaborative effort to enable better decision-making through science-based water quality monitoring, information-sharing and educational programming. After its initial successes of building a strong membership base and developing its monitoring programs, GCWIN now has expanded its water quality monitoring to five programs: Stream Temperature and Healthy Headwaters monitoring along the Fraser and Colorado Rivers, Cyanotoxin Monitoring of Lakes and Reservoirs, Secchi Monitoring of Grand Lake, Columbine Lake, and Shadow Mountain Reservoir, and Three Lakes flowing sites Temperature and Specific Conductivity. With the Healthy Headwaters monitoring program, GCWIN has established partnerships with Region 8 EPA and the CDPHE (Colorado Department of Public Health and Environment) to monitor monthly from April to October for nutrients, anions, heavy metals and e Coli as well as annual monitoring for Benthic Macro Invertebrates. In addition, GCWIN is responsible for an NADP (National Atmospheric Deposition Program) monitoring site in the Rocky Mountain National Park.

To better access to the information collected, GCWIN has established a publicly accessible water quality database (http://www.wilbur.gcwin.org) that holds all water quality data for the county. GCWIN also has developed annual field-based educational programming that taught over 450 students in 2010 and again in 2011about environmental stewardship and watershed science..

Three Lakes Watershed Association;
http://www.threelakeswater.org/

Formerly the Upper Colorado Lakes Protection Association; the Upper Colorado River Alliance, and the Shadow Mountain Home Owner's Association), these organizations combined efforts in 1998, This group's focus is on protecting and improving the quality of life in the area of Granby Reservoir, Shadow Mountain Reservoir, and Grand Lake. Activities in recent years have been predominately centered on improving the clarity of the water in both Shadow Mountain Reservoir and Grand Lake. Specifically, we maintain contact with Grand County, US Department of Interior, US Bureau of Reclamation, Northern Colorado Water Conservancy District, Colorado River District, and our Colorado Congressional Delegation.

Greater Grand Lake Shoreline Association;
http://www.gglsa.org/

The purpose of the Greater Grand Lake Shoreline Association (GGLSA) is to preserve and protect the Lake of Grand Lake and its surroundings, and to enhance the water quality, fishery, boating safety, and aesthetic values of Grand Lake, as a public recreational facility for today and for future generations.

River Watch
http://wildlife.state.co.us/LandWater/Riverwatch/Pages/Riverwatch.aspx

River Watch is a program of the Colorado Watershed Assembly. Water quality data is collected by volunteers in the Fraser (Fraser@CR83) and Colorado Rivers (Granby, Windy Gap, Pioneer Park), Blue (Knorr, Trough) and on Muddy Creek (Pinto, Colburn) Frequency of monitoring is monthly and includes dissolved oxygen, pH, temperature, alkalinity, hardness, and metals (Al, As, Ca, Cd, Cu, Fe, Mg, Mn, Pb, Se, and Zn). Nutrients are measured twice a year, at high and low flows.

Trout Unlimited;
http://headwaterstu.org/, http://www.coloradotu.org/, http://www.tu.org/
Trout Unlimited is very much engaged in Grand County water issues. Our mission is to "Protect, Reconnect, Restore and Sustain coldwater trout fisheries". To that end we have chosen to involve ourselves in numerous and varied efforts to provide the best possible trout habitat – assuring future generations the opportunity to enjoy and appreciate the environment that trout thrive in - cool, clear, clean waterways that provide the habitat for trout as well as innumerable other species that also benefit directly or indirectly from such an environment. Localized TU efforts have included joining in the fight for proper mitigation for water diversion efforts, projects to efficiently and effectively utilize water to allow more effective flows to remain in channel for trout, restoration and reconstruction efforts to recreate degraded trout habitat and protection of water quality by monitoring for temperature, clarity and purity of water resources within the county.

2.0 WATERSHED WATER QUALITY ASSESSMENT

2.1 Upper Colorado River Headwaters (Stream Segments 1, 2,3, 4, 6a & 9)

Stream Segment 1 of the Upper Colorado River includes the mainstem of the Colorado River, including the tributaries, lakes, reservoirs and wetlands within Rocky Mountain National Park, or which flow into Rocky Mountain National Park. This stream segment

has been designated "Outstanding Waters", and according to regulation "shall be maintained and protected at [its] existing quality".

The USGS, as part of its National Water Quality Assessment program for the Upper Colorado River basin study unit, selected a fixed site in Rocky Mountain National Park on the Colorado River below Baker Gulch [Water Quality at Basic Fixed Sites in the Upper Colorado River Basin National Water-Quality Assessment Study Unit, October 1995-1998, Water Resources Investigation Report 99-4223]. The stream reach in which this is located (segment 1) is composed mostly of forest, tundra, and meadows; a few cabins are located within the basin. Dissolved iron concentrations reflect geologic sources of iron and the reducing environment of large wetland areas in the basin. Suspended-sediment concentrations were low (median of 2 mg/L). Concentrations of ions were fairly dilute, sediment and nutrient concentrations were low, as shown in Table C-2.

Table C-2. Summary of selected parameters at Colorado River below Baker Gulch Site, 1995-1998 USGS data.

Constituent	Minimum	Median	Maximum
	Mg/L		
Suspended organic carbon	<0.1	0.2	0.9
Dissolved ammonia	<0.2	<0.2	0.06
Dissolved nitrite	<0.01	<0.01	0.02
Dissolved phosphorus	<0.01	<0.01	0.03
Dissolved orthophosphate	<0.01	<0.01	0.02
Dissolved oxygen	7.5	9.3	11.0

The Three Lakes area surrounds Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir. These lakes receive a high degree of recreational usage. The Three Lakes Sanitation District provides wastewater treatment for this area, and about 85% of the service area has been connected to the wastewater treatment plant. Water quality data is collected by the US Geological Survey (USGS) and Grand County Water Information Network, for the Northern Colorado Water Conservancy District, the US Bureau of Reclamation, Grand County, the Colorado River Water Conservation District, Town of Grand Lake, and Three Lakes Watershed Association . In ____(year) water quality data collected from the Three Lakes was compiled into a water quality database by the Northwest Colorado Council of Governments. This database has been incorporated into the Three Lakes Clean Lakes Assessment Grant, an EPA Section 319 Grant funded project discussed in Chapter 4.1. In addition, water quality data is made available by the US Geological Survey at http://wdr.water.usgs.gov/nwisgmap/ , Northern Colorado Water Conservancy District at http://www.northernwater.org/DynData/WQDataMain.aspx , and Grand County Water Information Network at http://wilbur.gcwin.org/.

Since about 2005 there has been a much more organized approach to monitoring for clarity and assessing trophic status indicators and evaluating the Three Lakes as a whole, see below.

Of the Three Lakes, dissolved oxygen concentrations pose the greatest concern in Shadow Mountain Reservoir, where values below 4.0 mg/L (affecting fish) are found at depths below 22 feet in summer and fall, it is on the 2012 303(d) list for D.O. impacts. In Granby Reservoir, dissolved oxygen concentrations below 4.0 mg/L are found at 40 feet

and deeper. Data for Grand Lake do not indicate a dissolved oxygen concentration problem in this lake.

Willow Creek Reservoir is on the 2012 303(d) list for manganese.

Granby Reservoir is on the 2012 303(d) list for mercury in fish tissue. In Shadow Mountain Reservoir manganese occasionally exceeds drinking water standards in the deeper water. There is very little data for metals concentrations in Grand Lake, however the data, which does exist, indicates no metal concerns.

Excessive phosphorus concentrations, bacteriological contamination, and accelerated eutrophication were the primary water quality problems evaluated in a 1970 study by EPA. Previous studies by the Colorado Department of Public Health and Environment (1960) had attributed water quality concerns in the lakes with poorly functioning or failing septic systems producing "nuisance" algae conditions. A subsequent EPA study conducted in 1974 indicated that no chemical or bacteriological standards were exceeded in any of the samples collected from the lakes or from streams flowing into the lakes. However, nonpoint source runoff from land disturbance increased nutrient and sediment yields to the lakes. During this study, no adverse chemical or biological effects were measured in the lakes as a result of septic systems. The conclusion of this study was that the cause of "nuisance" algae conditions was primarily from nonpoint source runoff, rather than from septic systems in the Three Lakes region. Since 1995 septic system installations have been well documented and tracked by the County.

This old EPA study indentified land use practices and manmade activities have contributed to the majority of nutrient and sediment problems in the lakes. For example, Shadow Mountain Reservoir was built upon highly productive hay meadows. The lakes are characterized by EPA as being oligotrophic to mesotrophic (small to medium production of biota) with nitrogen the limiting factor in Grand Lake, and phosphorus and nitrogen the limiting factors in Shadow Mountain Lake and Lake Granby. Because other studies have reported excessive blue-green algae production and small dissolved oxygen concentrations in the Three Lakes, and the oligotrophic status probably should not be considered a stable condition. More recent studies have updated information on these matters, see below.

An aquatic plant mechanical harvester was purchased by the US Forest Service for use on Shadow Mountain Reservoir in order to maintain boating access to the reservoir in shallow areas where excessive plant growth was encroaching on boating channels.

In 2000 Grand County was awarded an EPA 319 “Clean Lakes” Grant to assess and develop a protection strategy for water quality in the Three Lakes. [See Project section – Chapter 4]. According to the draft Phase I Report dated April 19, 2002, using data collected since 1989, Grand Lake exhibits mesotrophy with respect to chlorophyll *a* (summer mean of 5.7 ug/L), total phosphorus (12 ug/L), and secchi disk depth (2.9 meters). No apparent trends over time were associated with these parameters. With respect to Shadow Mountain Reservoir, the water body exhibits mesotrophy with respect to 12 years of chlorophyll *a* (4.0 ug/L), total phosphorus (13.2 ug/L), and secchi disk depth (2.7 meters) data. Granby Reservoir should also be considered mesotrophic based on the data collected since 1989. Chlorophyll *a* (3.1 ug/L, actually suggests oligotrophic conditions), total phosphorus (13ug/L), and secchi disk depth (2.9 meters) values did not show any apparent trends over time.

Recent modeling by Hydros, Inc, (2012) points to internal loading as a more significant nutrient loading issue than landuse practices as was concluded by the EPA in the 1970's.

In 1999 the Shadow Mountain Homeowners Association was awarded an EPA 319 grant to assess and provide direction regarding sediment deposition at the mouth of the Colorado River as it enters Shadow Mountain Reservoir. See Project section – Chapter 4.

In 2007, Grand County and Northwest Colorado Council of Governments requested that the Colorado Water Quality Control Commission adopt a water clarity standard for Grand Lake. The Commission adopted a 4-meter Secchi depth numerical clarity standard to be effective by 2015 if a more appropriate standard has not been determined. The narrative standard was set to "the highest level of clarity attainable, consistent with the exercise of established water rights and the protection of aquatic life". Reclamation, Grand County, and Northern Water are cooperatively working together on a Grand Lake clarity study that will: 1) identify and evaluate factors that diminish Grand Lake clarity, 2) coordinate water quality monitoring that supports an appropriate clarity standard for Grand Lake as well as exploring options for meeting the clarity standard and, 3) identify and evaluate structural and nonstructural alternatives that could be implemented without adversely impacting C-BT Project yield. In addition, Reclamation, Grand County and Northern Water are also involved in an on-going, multi-year nutrient study to determine sources and quantities of nutrients contributing to water-quality changes in the Three Lakes System and in east slope C-BT facilities.

Table C-3 below shows recent minimum and maximum secchi depth measurements (meters) for Grand Lake and Shadow Mountain Reservoir

	Grand Lake		Shadow Mountain Reservoir	
	Minimum	Maximum	Minimum	Maximum
2007	1.4	4.9	1.2	3.1
2008	1.5	4.6	1.3	3.3
2009	2.0	4.9	1.5	4.6

Much of the water quality analysis associated with this cooperative effort is summarized in a 2010 report "Operational and Water Quality Summary Report for Grand Lake and Shadow Mountain Reservoir" compiled by Hydros Consulting, Inc. The report also outlines the somewhat mixed success of two years of experiments where pumping of water from Shadow Mountain Reservoir was stopped during August of 2008 and 2009 to evaluate the effect on clarity in both Grand Lake and Shadow Mountain Reservoir. Although the stop pump resulted in measureable effects.,. Stop-pump periods to improve Grand Lake clarity may have mixed results for water quality in Shadow Mountain Reservoir.

In November of 2008, US Bureau of Reclamation scientist Davine Lieberman published an extensive study entitled *Physical, Chemical, and Biological Attributes of Western and Eastern Slope Reservoir, Lake, and Flowing Water Sites on the C-BT Project, 2005 - 2007: Lake Granby, Grand Lake, Shadow Mountain Reservoir, Horsetooth Reservoir,*

Carter Lake for Northern Colorado Water Conservancy District as a part of their ongoing multi-agency Nutrient Project. This report documents measured values for temperature, pH, dissolved oxygen (DO), specific conductance, nitrogen, phosphorus, total suspended solids, total organic carbon, iron, manganese, chlorophyll a, Secchi disk transparency, and phytoplankton in Granby and Shadow Mountain Reservoir, and Grand Lake. The report indicated that greater productivity on the western slope was most likely from a combination of factors including exchange of water between the three water bodies as a result of C-BT pumping operations; that the west slope water bodies are nitrogen limited or co-limited (nitrogen and phosphorus); that internal loading is occurring in the Three Lakes; and that Granby Reservoir ranges from mesotrophic to meso-eutrophic, while Shadow Mountain Reservoir and Grand Lake range from mesotrophic to hypereutrophic.

A 2010 report suggested that transport of non-algal organic particles through Shadow Mountain Reservoir during pumping and may be the most significant limiting factor for clarity in Grand Lake as a result of CBT pumping. Algae and DOC were also found to be contributing but less significant factors to reduced clarity. (Factors Controlling Transparency in Grand Lake, Colorado", James H. McCutchan, Jr. 2010)

2.2 Fraser River (Stream Segments 9, 10a,10b & 10c)

Stream segment 9 of the Upper Colorado River includes all tributaries to the Colorado and Fraser rivers, including all wetlands, within the Never Summer, Indian Peaks, Byers, Vasquez, Eagles Nest and Flat Tops Wilderness Area. Stream segment 10a incudes the mainstem of the Fraser River from the source to a point immediately below the Rendezvous Bridge, and all tributaries to the Fraser River, including wetlands, from the source to the confluence with the Colorado River. Steam segment 10b includes the mainstem of the Fraser River from a point immediately below the Rendezvous Bridge to a point immediately below the Hammond Ditch. Stream segment 10c includes the mainstem of the Fraser River from a point immediately below the Hammond Ditch to the confluence with the Colorado River.

A USGS 1976 -1977 study [USGS, Reconnaissance Evaluation of Surface-Water Quality in Eagle, Grand, Jackson, Pitkin, Routt, and Summit Counties, Colorado, Open File Report 79-420, 1979] found that the Fraser River near its headwaters is relatively unproductive, with a diversity index of only 1.50 for aquatic organisms. There were no apparent differences among downstream sites. Downstream sites had the most organisms collected with a total of 55, but the diversities among the sites were similar at about 2.80.

A four-year monitoring effort by the USGS and funded by the East Grand Water Quality Board was completed in 1994. Use of the Colorado Ammonia Model using the monitoring data has indicated that all three domestic wastewater treatment plants discharging to the upper Fraser River (Winter Park, Grand County Number 1, and Fraser) will have to significantly upgrade their facilities (provide nitrification treatment) in order to comply with instream ammonia standards established to protect the Fraser River fishery. In addition to nitrogen and flow data, conductivity, pH and temperature data has also been collected. This data helped facilitate the construction of a consolidated WWTP at Fraser, additional discussion on this issue is provided in the Point Source Issues Section (Section 3.1). USGS monitoring at multiple stations is ongoing.

Denver Water Department water quality data have been collected at two sites on the mainstem of the Fraser River: downstream of Vasquez Creek and at Tabernash. Data collected between 1993 and 1994 at the site below Vasquez Creek shows the impact of sediment, with Total Suspended Solids (TSS) values of 2 -13 mg/L (compared with Williams Fork sites which have values of less than 1 to 3 mg/L). Total phosphorus values ranged from 0.03 to 0.26, with an average of 0.088 mg/L. In Tabernash, un-ionized ammonia values exceeding the stream standard of 0.02 mg/L occurred twice in five samples. Dissolved oxygen was 4.6 mg/L (standard is 6.0) on one of five sampling dates. Total phosphorus at the site ranged from 0.04 to 0.4 and averaged 0.144. Total suspended solids at this site ranged from 2 - 7 mg/L.

Sedimentation on the Fraser River has been identified by the Colorado Nonpoint Source Assessment Report as an issue, and this segment has been designated "Partially Supporting" designated uses in the State's 1994 305(b) Report. Division of Wildlife data from September 1979 and July 1993 indicates that the coldwater fishery is impacted as a result of stream sedimentation. A similar, but un-impacted stream (Saint Louis Creek) has approximately five to ten times the number of trout, 280-700 per acre, versus seventy per acre below the Denver Water diversion structure on the Fraser. High sediment loads in this drainage are associated with erosion from cut and fill slopes along US Highway 40 on the north side of Berthoud Pass, as well as road sanding practices. A number of entities, including the East Grand Water Quality Board, the Winter Park Recreation Association, the Denver Water Department, the Colorado Department of Transportation, the US Forest Service, and the Water Quality Control Division were able to install a sediment basin to address this issue, see section 4.

As part of this effort, the Forest Service has provided leadership in monitoring the Fraser River, and a “reference site” location in Saint Louis Creek. Fish collection data in October of 2000 found an estimate of 1,570 and 1,051 brook trout per acre in each of these streams, respectively. Fish condition, represented by weigh at a given length, tended to be higher in the Fraser River. Fish biomass was estimated to be 63 and 43 pounds per acre for the Fraser River and Saint Louis Creek. Fine sediment (less than 8 mm) in the Fraser River makes up a significantly higher proportion of the substrate than in Saint Louis Creek, however, residual pool depths are similar (averages of 1.41 and 1.36, respectively). Macroinvertebrates were sampled in August 2000 at both sites.

A 1986 study of the assimilative capacity of the Fraser River concluded that levels of un-ionized ammonia would exceed toxic levels by 1995 without advanced wastewater treatment at the Grand County #1 wastewater treatment plant discharge. The increasing levels of ammonia are projected due to anticipated growth within the service area. A similar modeling study in 1987 evaluated the instream flow necessary to dilute sewage effluent to meet state water quality standards. Based on a peak population of approximately 40% of the potential capacity in the upper Fraser Valley, the study concluded that enhanced waste water treatment at all upper Fraser Valley facilities, or greater diluting flows in the Fraser River, will be necessary to prevent exceedance of the standard for un-ionized ammonia. Additional release flows of 1.4 cfs in Vasquez Creek and 4.2 cfs in Saint Louis Creek would be required during winter months.

Water quality monitoring data in the Fraser River basin includes that measured by the Colorado Department of Public Health and Environment's Water Quality Control Division at Granby. A review of the data from this station for the period from 1977 to 1987

indicates elevated phosphorus, mercury, cadmium, copper, silver and lead concentrations as well as pH as high as 8.5. In the most recent three years of this period only the average concentrations for lead and mercury exceed state standards. Total phosphorus is above the EPA recommended concentration.

A 1973 assessment of waste loads for the Fraser River indicated that the Fraser River receives less waste than its assimilative capacity, but point source discharges in some instances did not meet effluent standards. Waste loads of approximately twice those of the 1973 loads would cause concentrations of un-ionized ammonia to exceed the toxicity criteria for aquatic life. The 1986 and 1987 annual reports of the Water Quality Control Division list the Fraser River as threatened for un-ionized ammonia indicating that it is currently meeting the designated uses but there is a downward trend.

The USGS 1976-1977 [USGS, 1979] selected sites on the Fraser River between Berthoud Pass and Granby to determine effects from recreation and point source discharges at Winter Park and Fraser. The Fraser River upstream from the Mary Jane Ski Resort was established as a control site to determine the effects of recreational and urban activities in downstream reaches. Water at this site had a maximum dissolved solids concentration of only 68 mg/L. As a result of natural occurrence, concentrations of total cadmium, iron, and zinc exceeded standards for aquatic life downstream of the resort area.

The Fraser River near Granby was assessed for possible effects on water quality from upstream agricultural activities and from septic system use at Tabernash as a part of the USGS study [USGS, 1979]. Nutrient concentrations increased in this reach. The report stated that this increase could be due to seepage of septic systems in Tabernash and cattle grazing.

Because the Fraser River valley contains an underlying clay, sand, and gravel aquifer, the river is partly sustained during low flows by ground water. The water table is generally within a few feet of the bottom of the stream channel.

The 1979 USGS study reported that the nutrient increase in the water downstream from Tabernash (site GC-7) is probably a result of a hydraulic connection between the stream and ground water containing septic system seepage. The dissolved solids concentrations were less than 100 mg/L. Total cadmium and lead concentrations exceeded standards for aquatic life at that time. Water quality data collected by the Water Quality Control Division between 1988 and 1992 indicates continued detection of cadmium, but at levels well below those that would impact aquatic life. Dissolved lead was not detected in any samples during this time.

The USGS Study [USGS, 1979] found phytoplankton [algae] concentrations consistently increased downstream. The largest increase corresponds with the nutrient increases previously cited. The most productive site was the Fraser River at its confluence with the Colorado River, where 30 types of algae were collected, including seven types of green algae and two types of blue-green algae. Anabaena and Chroococcus were the blue-green algae collected. Both types are considered to be polluted water algae because of objectionable taste and odor and filter clogging characteristics, but their presence alone does not indicate pollution. The phytoplankton diversities were 3.55 at site GC-6 and 3.49 at site GC-9.

The 1989 Colorado Nonpoint Assessment states that water diversions in the Fraser River headwaters, Saint Louis, and Vasquez Creek greatly reduce stream flows effecting the quality and beneficial uses of the river. Low instream flows coupled with point and nonpoint loads reduces the potential of the stream as a trout fishery.

The 1976 USGS study [USGS, 1979] selected sites on the Colorado River and tributaries to the Fraser River to examine possible water quality effects from agricultural and natural runoff. The Colorado River upstream from the Fraser River was assessed for possible water quality effects from agricultural activities upstream. The water was suitable for all uses as concentrations of all constituents were low. Downstream from the Hot Sulphur Springs sewage lagoons, nutrient and bacterial concentrations increased as compared to upstream, probably because of effluent discharges from the sewage lagoons. Total cadmium and lead concentrations exceeded standards for aquatic life.

A Water Quality Control Division (WQCD) monitoring site on the Fraser River near Granby was active between 1979 and 1992. This station showed no exceedances of water quality standards between 1988 and 1992 with the exception of occasional exceedance of the chronic dissolved iron standard (0.3 mg/L) for drinking water supplies: 17 samples collected had a mean value of 0.21 mg/L and a range of 0.10- 0.45 mg/L. There were no detections of lead between 1988 and 1992 (17 samples); no detection of mercury (16 samples); 15 of 17 samples were non-detect for copper (other 2 were at and just above the detection limit). Fecal coliform samples collected between 1979 and 1992 had a maximum of 430 MPN per 100 ml, and average of 47 (the standard is 2,000). For the period 1988 through 1992, the maximum fecal coliform number was 230, with an average of 49 MPN / 100 ml. Total phosphorus between 1979 and 1992 averaged 0.078 mg/L, and between 1988 and 1992 was 0.077 mg/L, which is close to the median value (0.0775 mg/L) for all WQCD stations within the NWCCOG region.

The USGS produced a report titled “Fraser River Watershed, Colorado – Assessment of Available Water-Quantity and Water-Quality Data Through Water Year 1997” [Water Resources Investigation Report 98-4255]. Analysis of limited water quality data in the watershed indicates that changes in the land use/land cover affect the shallow alluvial ground-water quality. Iron and manganese concentrations in eight shallow alluvial wells exceeded EPA secondary drinking water standards and radon concentrations from these wells exceeded proposed maximum contaminant levels (300 pCi/L). Surface water quality data are sparse, but two samples from two surface water sites exceeded the un-ionized ammonia chronic criteria. Spatial distribution of nutrient species (ammonia, nitrate, nitrite, and total phosphorus) shows that elevated concentrations occur primarily downstream from urban areas. Sites with five or more years of data were analyzed of temporal trends in nutrient data. Downward trends were identified for ammonia and nitrite at three sites. For nitrate one site showed a downward trend and two sites showed no trend. Total phosphorus showed no trend. Total phosphorus concentrations that exceeded 0.1 mg/L were detected in 23% of the phosphorus samples (95 analyses), with the median concentrations being similar for range and urban land uses. The surface water metals data reviewed did not indicate heavy metals concerns.

In 1996-1997 the Water Quality Control Division monitored four sites in the Fraser River basin. These sites were: Fraser River at Granby; Fraser River above Winter Park, Pole Creek near Tabernash, and Saint Louis Creek near Fraser. Nutrients, metals, and inorganic parameters were collected.

GCWIN and others have implemented an extensive temperature monitoring network and as a result CDPHE has found portions of the Fraser River, Ranch Creek, Muddy Creek and the mainstem of the Colorado River are impaired for temperature exceedances (for temperature data see http://wilbur.gcwin.org/).

A review of water quality data in the 2010 Grand County Stream Management Plan indicates that exceptions to normal pH values occurred between 1995 and 2004 at gages near Tabernash on the Fraser, where pH values routinely exceeded 9.0. In addition, the pH of the Colorado River at Windy gap has exceeded 9.0 several times since 2000.

In 2011, the State placed the Fraser River from the Town of Fraser to the confluence with the Colorado River on the monitoring and evaluation list based on recent data analysis that indicated elevated levels of copper.

Grand County is concerned that untreated seepage from the Moffat Railroad tunnel is responsible for metals and fine particulates in the Fraser. CDPHE has issued a compliance order to Union Pacific Railroad for the construction of waste treatment facilities for this discharge (permit number CO0047554).

2.3 Willow Creek (Stream Segments 6a, 6b, & 6c)

Former Upper Colorado segment 6 has been re-segmented into segments 6a, 6b and 6c due to differing water quality conditions in the three new segments. Stream segment 6a of the Upper Colorado River includes all tributaries to the Colorado River including wetlands from the source to a point immediately above the confluence with the Blue River and Muddy Creek. Segment 6b includes the mainstem of un-named tributary from the headwaters to Willow Creek Reservoir Road. Segment 6c includes the mainstem of unnamed tributary to Willow Creek from the Willow Creek Reservoir Road to the confluence of Willow Creek.

Willow Creek, a tributary of the Colorado River, which enters just north of Granby, has sediment loads (primarily due to road construction associated with logging activities) which severely impact aquatic life, according to the 1989 Colorado NPS Assessment. Willow Creek is also impacted by intensive recreation land uses in the both the upper area (motorized and mechanized) and lower area (numerous guest ranches).

A TMDL for segment 6c was completed by the Water Quality Control Division in July 2000 and approved by EPA. The TMDL goal is the attainment of chronic and acute un-ionized ammonia standards at the top of segment 6c.

A temporary modification for ammonia, set at ambient to reflect existing conditions of discharge and agricultural activities, has been established on segment 6c. This will allow the Three Lakes Sanitation District sufficient time to conduct monitoring of the segment to determine sources and continue sampling and data collection. Three Lakes

is a rural public entity with limited tax and revenue base to finance capital improvements needed to address un-ionized ammonia, estimated at roughly $4 million in treatment plant expenditures. The Commission determined that the underlying ammonia standards adopted in 2011 were adequate to protect public health and the limited aquatic environment of the unnamed tributary and aquatic life in Willow Creek, however this temporary modification will be revisited after a five year period and subsequent monitoring.

2.4 Upper Colorado River (Stream Segments 3 & 4)

Stream segment 3 of the Upper Colorado River includes the mainstem of the Colorado River from the outlet of Lake Granby to the confluence of the Colorado River. Segment 4 includes all tributaries to the Colorado River, including all wetlands, from the outlet of Lake Granby to the confluence with the Roaring Fork River which are on National Forest lands, except specific tributaries included in segments 1 and 2 and specific listings in segments 8, 9 and 10a.

The USGS 1976 Reconnaissance Study [USGS, 1979] assessed the downstream reaches of the Colorado River for possible water quality effects from agricultural activities. Dissolved solids and nutrient concentrations generally increased at these sites.

The USGS study also found an area of iron rich sediment which is probably eroded during spring runoff between Hot Sulphur Springs and Troublesome, as the total iron increased from 850 to 11,000 ug/L in this reach of the stream. Some of the rocks along this reach of the stream are iron bearing olivine basalt, which is easily weathered.

A review of the Water Quality Control Division water quality monitoring data for the period from 1977 to 1987 indicated average concentrations for cadmium, copper, and zinc above state standards near Hot Sulphur Springs. Occasional exceedances of silver concentrations were also noted. Fecal coliform and total phosphorus levels were found to be high. However, in the most recent three years of this period concentrations of all the above water quality parameters are reduced. Data collected by the Division between 1988 and 1992 indicated no exceedances of copper, zinc, or fecal coliform bacteria. Dissolved cadmium continues to be detected, but at low levels.

A 1975 Colorado Department of Health study of the Colorado River near Hot Sulphur Springs found that concentrations of several constituents exceeded water supply standards. For example, dissolved iron concentrations exceeded water supply standards, with a maximum of 1,500 ug/L. Water Quality Control Division data from 1988 to 1992 (18 samples) showed a maximum concentration of dissolved iron of 260 ug/L and an average of 176 ug/L (the standard is 300 ug/L).

In 2012 portions of segments 3 and 4 were added to the 303(d) list for temperature.

GCWIN and others have implemented an extensive temperature monitoring network and as a result have found portions of the Fraser River, Ranch Creek, Muddy Creek and the mainstem of the Colorado River are impaired for temperature exceedances (for temperature data see http://wilbur.gcwin.org/).

A 2011 study by Colorado Parks and Wildlife investigations documents the relative distribution and abundance of the mottled sculpin *Cottus bairdi* and the aquatic invertebrate fauna of the Colorado River in Middle Park, Colorado in 2010 and compare the results with historical data and records compiled over the past 25-40 years, prior to the construction and operation of Windy Gap Dam in 1983.. Findings for the study include the loss or significant reduction of certain macroinvertebrates, and extirpation of the native mottled sculpin as a result of transmountain diversions from the Upper Colorado River. The study provides recommendations to improve this situation. http://wildlife.state.co.us/SiteCollectionDocuments/DOW/Research/Aquatic/pdf/F-273Nehring2011.pdf

2.5 Williams Fork Sub-basin (Stream Segment 8)

Stream segment 8 of the Upper Colorado River includes the mainstem of the Williams Fork River, including all tributaries and wetlands from the source to the confluence with the Colorado River, except for those tributaries listed in segment 9.

Water quality data in the Williams Fork area have been collected by the Denver Water Department at seven sites beginning in 1974 (one above the Williams Fork Reservoir, and six above the Henderson Mine and mill property). Collected data from 1993 through 1994 indicates water in the Williams Fork is of suitable quality for all uses. At all sites the concentrations of dissolved solids were less than 100 mg/L, and trace element concentrations and bacteria counts also were correspondingly small. Trace element concentrations at sites near the Urad- Henderson Mine did not exceed any water quality standards.
with very low nutrients, low metal concentrations, high dissolved oxygen, and low suspended sediments. This data indicates that any previously documented problems with respect to heavy metals have been resolved.

The 1976 USGS study [USGS, 1979] on the Williams Fork near the Urad-Henderson Mine (Amax Corp.) found that the Williams Fork downstream from the west portal of the mine was not polluted by heavy metals. Also, there was no increase in heavy metals concentrations because of mining activities.

A 1974 study showed effects from the excavation of a tunnel for the Urad-Henderson Mine on the Williams Fork drainage. The Williams Fork upstream from Keyser Creek showed an increase in the concentrations of most trace elements. Concentrations of dissolved copper and lead exceeded drinking water standards and concentrations of pH, total copper, iron, and zinc exceeded aquatic life standards. The 1974 study was done at the time the tunnel was under construction.

The 1989 Colorado Nonpoint Assessment reports cadmium, copper, and silver concentrations above basic standards for aquatic life on the Williams Fork from the source to the confluence with the South Fork of Williams Fork, which carries only cadmium above standards. From the confluence to Williams Fork Reservoir it exceeded the recommended limits for cadmium, copper, and zinc, however, good trout fisheries are reported in the Williams Fork.

These two previous statements indicate that any heavy metals concerns at that time were probably not due to existing mining operations, as metals exceedances were

observed above the Henderson Tunnel, where there were no current mining operations.

In the 1999 Upper Colorado River Basin Standards hearing, the point of compliance for the Henderson Mill discharge permit was determined to be a downstream well. Monitoring of the well showed that the stream standard is being attained. Additionally, the Water Quality Control Division in the 2000 Basic Standards hearing changed the aquatic life standards for manganese to a hardness-based equation, which effectively increased the numeric standard to a level that the Williams Fork River is meeting. The "Water Quality Limited" designation on this segment was removed and reflected in the State's 2000 305(b) report.

The Henderson Mill is, generally speaking, a non-discharging facility. Management of the facility attempts to estimate the annual water need and capture that amount during the spring runoff. Only under high spring flows does the facility discharge, and then the amount discharged is that amount in exceedance of the process needs.

2.6 Troublesome and Muddy Creeks (Stream Segments 4, 6a, 6b, 6c & 7a)

Stream segment 4 of the Upper Colorado River includes all tributaries including all wetlands from the outlet of Lake Granby to the confluence with the Roaring Fork River, which are National Forest lands, except for those tributaries included in segments 1 and 2 and specific listings in segments 8, 9 and 10a. Segment 6a includes all tributaries and wetlands from the source to a point immediately above the confluence with the Blue River and Muddy Creek, which are not on National Forest lands, except for specific listings in segments 1, 2, 4, 5, 6b, 6c, 8, 9 and 10a-c. Segment 6b includes the mainstem of un-named tributary from the headwaters to Willow Creek Reservoir road. Segment 6c includes the mainstem of un-named tributary to Willow Creek from the Willow Creek Reservoir road to the confluence with Willow Creek. Segment 7a includes all tributaries to the Colorado River including all wetlands from a point immediately above the confluence with the Blue River and Muddy Creek to a point immediately below the confluence with the Roaring Fork River, which are not on National Forest lands, except for specific listings in segment 7b, 7c and in the Blue River, Eagle River and the Roaring Fork River basins.

Through the Kremmling area the Colorado River water becomes more mineralized, as evidenced by the larger specific conductance values and sulfate concentrations. This area is underlain by Pierre Shale, parts of which are easily weathered. Red Dirt Creek, which flows into Muddy Creek from the west, also flows through Pierre Shale, but the water was suitable for all uses, although a larger total organic carbon concentration was determined as compared to sites along the Colorado River. This area contains much carbonaceous debris rich in organic material.

The Rock Creek/Muddy Creek Draft Environmental Impact Statement [USFS, 1987] found that in the Muddy Creek drainage "[w]ater quality standard violations (when water quality concentrations exceed state water quality standards) have not been attributed to any specific land use activity. It appears that the geologic input dominates surface water chemistry. Parent materials are predominantly Pierre and Mancos shales . . .." Additionally, occasional water samples were analyzed for heavy metals, with no problems identified. Nitrogen and phosphorus levels were identified as being in higher than expected concentrations (potentially due to natural background sources and poor riparian vegetation along the main channel of Muddy Creek). This, in conjunction with

relatively warm water temperatures, has the potential to create water quality problems in Wolford Mountain Reservoir. Muddy Creek suspended sediments upon occasion exceeded 3,000 mg/L, and the waters of Wolford Mountain Reservoir have potential to be turbid, as many of the shoreline soils will be subject to erosion from wind generated wave action.

The USGS has two sites at which they collect water quality data on Muddy Creek - one above Antelope Creek, and one at Kremmling. The water quality data from these two stations from 1992-1994 indicates high specific conductance, turbidity, hardness, dissolved solids, sulfate, iron, and suspended sediment. Nutrients are generally at low to moderate concentrations.

The 1989 Addendum to the Colorado Nonpoint Source Assessment Report states that "[e]rosion has been reported by local soil conservation districts along this portion of the Colorado River. In particular, Eightmile Creek, Little Muddy Creek, Big Muddy Creek, Troublesome Creek, and Cottonwood Creek are erosion areas; however, the reach of the river that these creeks are tributary to, just above State Bridge, does not show the effects of sediment loads. Effects within these watersheds require further documentation." Further information on nonpoint source issues on the Colorado River are available at the Nonpoint Source Colorado website: http://npscolorado.com/ .

Water quality data is collected at several stations (including Muddy Creek by West Grand High School as part of the Division of Wildlife's River Watch Program at Colburn and Pinto).

2.7 Colorado River below Blue River (Upper Colorado River Segments 3, 5, 7a, 7b and 7c)

Segment 3 includes the Colorado River from the outlet of Lake Granby to Roaring Fork River, segment 5 includes all lakes and reservoirs tributary to the Colorado River from Rocky Mountain National park and Arapahoe National Recreation Area to the confluence of the Roaring Fork river not on National Forest., Segment 7a are all the tributaries to the Colorado River from the Blue River to the Roaring Fork (excluding the Blue and Eagle River watersheds) not on National Forest lands. Segment 7b is the mainstem of Muddy Creek from the outlet of Wolford Mountain Reservoir to the confluence with the Colorado River, and the mainstems of Rock Creek, Deep Creek, Sheephorn Creek, Sweetwater Creek and the Piney River including all tributaries and wetlands, from their sources to their confluences with the Colorado River which are not on National Forest lands. Segment 7c includes the mainstem of Muddy Creek from the source to a point below the confluence with Eastern Gulch as well as all tributaries to and wetlands of Muddy Creek from the source to the outlet of Wolford Mountain Reservoir, except for listings in segment 4. The mainstems of Derby, Blacktail, Cabin and Red Dirt Creeks from their sources to confluence with the Colorado River are all included except for listings in segment 4 (which are on National Forest lands)

The 1989 Addendum to the Colorado Nonpoint Source Assessment Report states that "the Colorado River mainstem begins to show impacts from sediment in the segment downstream from State Bridge. The Eagle County Conservation District has designated a stream bank erosion area. This may explain the elevated sediment levels in this reach."

Rock Creek near Toponas within the Routt National Forest was assessed for possible water quality effects from upstream timber production activities. This site had water suitable for all uses, evidenced by low dissolved solids (less than 100 mg/L) and nutrient concentrations [USGS, 1979].

Although Rock Creek has a temporary modification for the mercury standard which is due to expire in 1996, the Rock Creek/Muddy Creek Reservoir Draft Environmental Impact Statement [US Forest Service Rocky Mountain Region, 1987] states "[w]ater quality analyses for Rock Creek occasionally included heavy metals analyses and, in all cases, metal concentrations were well below water quality standards". USGS monitoring on Rock Creek at McCoy and Crater between 1987 and 1993 did not detect mercury.

2.8 Instream Flows

The most recent tabulation of minimum instream flows approved by the CWCB are available at http://cwcb.state.co.us/technical-resources/instream-flow-water-rights-database/Pages/main.aspx which lists the Colorado Water Conservation Board's (CWCB) instream flow filings in the Upper Colorado River watershed. Colorado statute (CRS § 37-92-102(3) recognizes that preserving the natural environment to a reasonable degree, through the protection of instream flows and maintenance of natural lake levels in natural lakes, is a beneficial use of water. Under the same statute, the Colorado Water Conservation Board is declared the exclusive agent authorized to appropriate water rights for the purpose of preserving the natural environment. The acquisition of the water rights to protect minimum instream flows has to be made within the context of existing water rights appropriation regulations. Minimum instream flows are therefore subject to appropriation dates, and the CWCB can only call out water rights junior to their own for maintenance of those flows. Most of the appropriation dates in the Upper Colorado River watershed are between 1977 and 1990, although the mainstem of the Colorado River had its first instream flow right appropriated in 2011.

CWCB appropriation flows, determined in consultation with the Division of Wildlife and the Division of Parks and Outdoor Recreation, are the flows necessary "to preserve the natural environment to a reasonable degree" (CRS 37-92-102(3)). The fact that the CWCB has filings for these instream flows does not ensure that stream flows will always exceed the minimum necessary to protect the natural environment, as the water rights associated with these flows have relatively junior appropriation dates. Exercise of water rights that are senior in date to the CWCB instream flow appropriation dates can result in stream flows lower than the CWCB appropriation amount.

A minimum stream flow agreement exists between the US Department of the Interior and the Municipal Subdistrict of the Northern Colorado Water Conservation District [Colorado-Big Thompson Windy Gap Projects Colorado Final Environmental Impact Statement, Water and Power Resources Service, US Department of Interior, 1981]. The agreement requires minimum stream flows as follows: from Windy Gap diversion to Williams Fork 90 cfs; from Williams Fork to Troublesome Creek 135 cfs; Troublesome Creek to Blue River 150 cfs. Once every three years, if equivalent flows do not otherwise occur, a flushing flow of 450 cfs for 50 hours, sometime within the months of April, May, and June. Windy Gap water delivered to the Eastern Slope have averaged about 11000 acre feet per year. This delivery will be relatively uniform year to year [DOI, 1981].

NCWCD is authorized to take up to 310,000 acre-feet annually, and has averaged 241,660 acre-feet on a 10 year average. The Alva B. Adams tunnel passed 244,865 acre-feet in water year 2009 [Division 5 Water Resources Annual Report].

3.0 WATER QUALITY ISSUES

The major water quality issues in the Upper Colorado River watershed are the result of water diversions, and include elevated temperature in streams, excessive sedimentation in streams, loss of clarity in Grand Lake from CBT pumping, low dissolved oxygen, and dissolved solids loads from nonpoint sources. In addition, some stream segments require load allocations for point source dischargers in order to meet ammonia standards.

3.1 Point Source Issues

3.1.1 Municipal Discharges

Point source problems were extensively evaluated by the Colorado Department of Health in 1974 as part of the Colorado River Basin 303(e) Plan. Point source treatment needs, consolidation of wastewater treatment facilities, waste load allocations, treatment alternatives and other related matters were addressed in the basin plan. The principal problems addressed included the future need for ammonia removal capability at domestic facilities to protect the Fraser River from ammonia toxicity. Since the adoption of the basin plan in 1974 and the 1978 version of the 208 plan (which incorporated its recommendations), the development of wastewater treatment facilities has generally proceeded in accordance with its recommendations. Facility plans under Section 201 of the Clean Water Act have defined the precise treatment mechanisms and locations for wastewater treatment and have implemented the recommendations of both the 208 and basin plans.

The major point source discharges in the Upper Colorado River watershed include municipal or domestic wastewater treatment plants. The larger municipal and domestic wastewater treatment plants (greater than 0.02 Million Gallons per Day, MGD, discharge) are listed in Table C- 4, along with their Colorado Discharge Permit System number and their hydraulic capacity.

Table C-4. Municipal and Domestic Wastewater Permits Over 0.02 MGD

CDPS Permit Number	Facility Name	Responsible Party	Hydraulic capacity, MGD
CO-0037681	Three Lakes WWTF	Three Lakes W&SD	1.3/approved for 2.0
CO-0026051	Winter Park WWTF	Winter Park W&SD	0.45
CO-0040142	Fraser WWTF	Fraser SD	2.0

CO-0046566	Devil's Thumb Ranch	Colorado Mountain Resort Investors, LLC	0.034
CO-0045501	Tabernash WWTF	Tabernash Meadows W&SD	0.2
CO-0045411	Young Life WWTF	Young Life Camp	0.034
CO-0023442	Snow Mountain Ranch	YMCA of the Rockies	0.22
CO-0020699	Granby WWTF	Granby SD	2.0
CO-0024350	Hot Sulphur Springs WWTF	Town of Hot Sulphur Springs	0.09
CO-00588084	Kremmling WWTF	Kremmling SD	0.17

Three Lakes Wastewater Treatment Facility

The Three Lakes Water and Sanitation District wastewater treatment facility is a 2.0 MGD aerated lagoon facility that discharges to an unnamed tributary to Willow Creek, Segment 6b of the Upper Colorado River. This stream segment is designated use protected, and the one-day in three year and 30 day in three-year low flow events are both 0.0 cfs (without discharge from the plant, this is an ephemeral stream). The facility consists of influent magnetic flow recorder, sequencing batch reactor system, UV disinfections, aerobic digesters and effluent parshall flume ultrasonic recorder The organic capacity of the facility is rated at 5,004 pounds of BOD per day. The district's discharge permit expires April 30, 2013.

Point source problems associated with providing wastewater treatment facilities for the Three Lakes Area were originally addressed in a 1976 study by EPA. This study addressed alternative means and service areas to provide collection and treatment for domestic waste. A facility plan based upon the conclusions of this study provided the basis for point source treatment in the area. More recently, Three Lakes has taken on influent that used to go to the Sun Valley treatment facility.

Winter Park Water and Sanitation District Wastewater Treatment Facility

The Winter Park Water and Sanitation District wastewater treatment plant is a 0.45 MGD aerated lagoon/mechanical hybrid plant that discharges to the upper Colorado River Stream Segment 10a (Fraser River). The district serves the Winter Park Ski area and residential and commercial buildings in the old town area of Winter Park surrounding the ski area.

In 1999 the state approved a site application for a hydraulic capacity of 0.45 MGD and an organic capacity of 1,690 pounds of BOD per day. Permit limits for ammonia discharge range from 1.8 to 8.0 mg/L. 30E3 low flow for the facility was determined to be 3.5 cfs. The facility consists of bar screen, influent 3-inch Parshall flume, 5.5 million gallon aerated lagoon, a burner basin to raise lagoon effluent temperature, two aeration basins, 2 final clarifiers, gas chlorine for disinfection, chlorine contact chamber and sulphur diaoxide feed. The current permit expires December 31 2016.

Grand County #1 Water and Sanitation District Wastewater Treatment Facility

Grand County Water and Sanitation District No. 1 (GCSD #1) wastewater treatment plant was a 0.995 MGD aerated lagoon discharging to the Fraser River which was abandoned in 2004 and effluent was piped to the consolidated Fraser WWTF.

Fraser, Grand County #1 and Winter Park Ranch Consolidated Wastewater Treatment Facility

The original Fraser treatment plant was rebuilt during consolidation and went online in 2004. The Joint Fraser wastewater treatment plant is a 2.0 MGD facility. The facility consists of a 12-inch influent parshall flume, an 18-inch effluent magnetic flow meter, a mechanical screen, grit removal, 2 aeration basins, 2 clariflocculators, a UV disinfection unit and a standby chlorine contact chamber. The organic capacity of the facility has been rated at 4,170 BOD/day. Sludge disposal is accomplished by removal to the sanitary landfill at Granby. The current permit has an expiration date of November 30, 2010.

The Fraser facility has a discharge permit with ammonia limits ranging from 1.4 to 8.6 mg/l. 30E3 low flow for the plant is 14.0 cfs.

Devil's Thumb Ranch

The Devils Thumb Ranch is a 0.034 MGD mechanical plant with a maximum of 39.22 lbs. BOD5 per day of organic loading (30-day average). The permit was modified in 2012 to remove monitoring requirements for copper.

Young Life Crooked Creek Camp

Young Life's Crooked Creek Ranch camp has discharge permit for a 0.033 MGD Rotating Biological Contactor (RBC) facility, with a primary clarifier, two aeration/ equalization basins, a secondary clarifier, and ultraviolet disinfection with chlorine disinfection back-up. The organic capacity of the plant has been rated at 200 pounds of BOD per day. In Grand County's 1041 permit hearing on the approval of this facility, the permittee agreed that the facility would meet an ammonia discharge level of no more than 15 mg/L total ammonia during the months of June, July and August. 30E3 low flow for Crooked Creek is 0.4 cfs. The current permit expires September 30, 2016

Tabernash Meadows

Tabernash Meadows Water and Sanitation District and the community of Tabernash received site approval for a 0.2 MGD new wastewater treatment facility. Currently the facility is operating at 0.1 MGD capacity. The organic capacity of the facility has been rated at 418 pounds of BOD per day. The facility is a Sequencing Batch Reactor (SBR), with mechanical bar screens, two SBR basins, one equalization basin, operating with ammonia removal and ultraviolet disinfection. Biosolids are treated in and aerobic digester and hauled offsite. Ammonia limits vary from 7.0 to 53 mg/L total ammonia . Biosolids are treated in an aerobic digester and hauled offsite. Monitoring for copper due to inclusion in the Monitoring & Evaluation list, monitoring for temperature due to a 303(d) listing, and monitoring for total inorganic nitrogen are required. The TMDL for temperature in the receiving stream has not been finalized; however the permit may be

reopened to include limitations based on a finalized TMDL. The permittee has been given until 2012 to install temperature-monitoring equipment. No inflow or infiltration problems have been documented in the service area. There were numerous non-numeric violations such as late submittal of discharge monitoring reports noted by the State in 2011 factsheet (Sept. 6, 2011) for the facility.

Snow Mountain Ranch Wastewater Treatment Facility

Snow Mountain Ranch, owned by the YMCA of the Rockies, has a permitted average daily flow capacity of 0.22 MGD and 0.05 MGD annual average non-discharging land application wastewater treatment facility approximately five miles west of Tabernash. The organic capacity of the facility is rated at 500 pounds of BOD per day. The facility consists two aerated ponds, a settling pond, and a polishing pond. There are also two lined storage ponds, chlorination and a spray irrigation system. Sludge disposal is intermittent, due to the lagoon treatment. Land application by sprinkler occurs over an area of 24 acres with 205 sprinkler heads is capable of receiving 300,000 gallons per day. The permit expires on November 30, 2009.

Granby Sanitation District Wastewater Treatment Facility

The Granby wastewater treatment plant was recently upgraded to a 2.0 MGD discharging to the Fraser River (Upper Colorado River Segment 10c), about one mile above the confluence with the Colorado River. The organic capacity of the facility is rated at 4,700 pounds of BOD per day. The plant consists of influent and effluent magnetic flow meters, two mechanical bar screens, rotary grit removal, two circular 50 ft diameter secondary clarifiers, 4 aeration basins and 4 anoxic tanks, and two UV disinfections banks. Biosolids are treated in an aerobic digester and mixed with bulking agent and loaded into vessels for composting. Monitoring for both copper and temperature is required. The 30E3 low flow for the receiving Fraser River is 33cfs. Granby Sanitation District's discharge permit expires February 28, 2017.

Town of Hot Sulphur Springs Wastewater Treatment Facility

Hot Sulphur Springs' wastewater treatment facility is a 0.14 MGD multicell advanced facultative lagoon that discharges to Segment 3 of the Upper Colorado River (Colorado mainstem). The organic capacity of the facility is rated at 300 pounds of BOD per day. An ammonia wasteload allocation study was done to determine if a wasteload allocation was necessary for the Hot Sulphur Springs plant. The resulting calculated limits for ammonia were found to be much higher than expected effluent concentrations, thus no ammonia limits were required. Since this is an aerated lagoon, sludge removal takes place on a limited basis and is not a concern. Numerous violations for BOD and flow have been recorded. The facility's discharge permit expires May 31, 2010

Kremmling Sanitation District Wastewater Treatment Facility

Kremmling Sanitation District's wastewater treatment facility is a 0.30 MGD lagoon system discharging to Muddy Creek, segment 7b of the Upper Colorado River. The organic capacity of the facility is rated at 600 pounds of BOD per day. The facility consists of three lined aerated lagoons, one lined un-aerated lagoon, and two unlined exfiltration lagoons with a chlorine contact tank that would be used if the facility were to

discharge. The new permit effective January 1, 2011 changed the facility from groundwater to surface discharge. The facility uses evaporation and exfiltration of the effluent from the unlined lagoons. Inflow or Infiltration does not appear to be a problem. A reuse water system has been installed but is not currently in operation. Recent permit conditions included the installation of an influent flow measuring device and the collection of various effluent parameters including ammonia, temperature and pH data. The most recent discharge permit has an expiration date of December 31, 2015.

Sanitation facilities below Kremmling
A number of ISDS systems are permitted through Eagle County, including Rancho Del Rio, State Bridge, and Burns. Little information exists on these systems. Dotsero Mobile Home Park is permitted through the Water Quality Control Division. This facility is a Rotating Biological Contactor plant which discharges to ground water.

Two Rivers Village

This project in Eagle County Dotsero area, just below the confluence with the Eagle River, has been granted site approval for a 0.15 MDG facility (1,500 population equivalents). The Colorado Water Quality Control Division has extended the site application permit for this facility to October 9, 2002. The proposed facility includes two lift stations, and an extended aeration activated sludge process ("Aeromod" System) followed by sand filtration and ultraviolet disinfection. [This facility is also mentioned in the Eagle River Water Quality Management Plan]

Below Glenwood Canyon, there is a sanitation district that currently has no collection or treatment facilities.

3.1.2 Population Statistics and Projections

Population statistics and projections for Grand County are listed in Table C-5, below. For Grand County, the permanent population between 1980 and 1990 grew 6.6%, and between 1990 and 2000 grew 56.2%, and between 2000 and 2010 grew 6.8%.
For the other areas in the watershed, (small parts of Routt, Eagle, and Garfield Counties), the population is extremely dispersed, and accounts for probably less than 5% of the total population in the watershed.

Table C-5. Grand County Population Statistics and Projections.

	Permanent Population[1]			
ENTITY	1980	1990	2000	2010
Grand County	7,475	7,966	12,442	14,843
Fraser	470	573	910	1,224
Granby	963	966	1,525	1,864
Grand Lake	382	259	447	471
Hot Sulphur Springs	405	347	521	663

Kremmling	1,296	1,166	1,578	1,444
Winter Park	480	528	662	999

[1]: US Census data, provided by Denver Post, Census 2000 Special Report, March 20, 2001
[2]: 1996 NWCCOG 208 Plan projections, based on the Department of Local Affairs, State Demographers Office, 1994 projections.
[3]: 2010 populations based on Colorado State Demography Office data accessed August 15, 2011 (http://dola.colorado.gov/dlg/demog/2010censusdata.html)

Peak Population

Permanent population estimates in the NWCCOG region only partially show the extent of development and growth in the region. Two additional variables also need to be considered regarding development and growth (and infrastructure needs) in the region. One variable is the "transient" visitor to the region who relies on infrastructure (e.g. hotels, motels, etc.), which is not part of the population estimate. The other variable is the second homeowner, who maintains a secondary residence in the region, but does not add to the population estimate. In 2001, second homes were estimated to represent 85% of the housing stock in Winter Park, and 70% in Grand Lake. A 2011 report entitled "Water and its Relationship to the Economies of the Headwater Counties" indicates that 72% of all homes in Grand County are owned by out-of-county residents. These two variables are extremely important considerations in growth and development in the region, and again, are not reflected in the population estimates and census data, and peak population data is inadequate.

3.1.3 Industrial Discharges

Industrial discharges in the Upper Colorado River watershed are generally related to mining activities. Discharge permit holders include Climax Molybedenum (Henderson Mine and Mill, permit CO 0000248)), and numerous gravel and aggregate mining operations. In general, water quality impacts from these dischargers are infrequent and have not been documented to be of significance. Earlier 208 documents (1988 and previous plans) cited water quality impacts from the Henderson Mine (1974 study and 1987 Colorado Nonpoint Source Assessment Report). As previously discussed, recent Denver Water Department water quality data collected in the Williams Fork, indicates excellent water quality. The data does not indicate water quality impacts from the Henderson site.

3.1.4 Point Source Issues - Summary

In summary, the current point source water quality issue(s) in the Upper Colorado River watershed are:

Clarity in Grand Lake, addressing sources of materials pumped into Grand Lake via CBT in order to attain the 4 meter secchi depth standard.

UPRR Moffat Tunnel Discharge (permit CO 0047554), notice of permit issues needs to be given in both counties where there is a discharge, Gilpin and Grand. Metals of concern

in Grand County are silver, Cu, Fe, Pb, U. There are violations for TSS. Grand County is concerned about very small <3 microns particulates, damage to fish with metals and particulates, damage to fish habitat with particulates.

3.2 Point Source Recommendations

NWCCOG recommends that the Union Pacific Railroad Moffat tunnel discharge is treated for metals and TSS removal as soon as possible.

NWCCOG recommends implementation of any feasible alternatives identified in the Bureau of Reclamation's *Colorado Big-Thompson Project West Slope Collection System Technical Review – Alternatives Analysis and Plan of Study* in order to help address clarity in Grand Lake.

3.3 Nonpoint Source Issues

Nonpoint source water quality issues in the Upper Colorado River watershed include: the loss of stream flows due to trans-basin diversions which reduces the amount of high quality water in the basin (see section 3.3.1.1); impacts related to urban land uses (including roads and construction activities); water quality impacts associated with recreational activities including snow making, nutrient loads from golf course irrigation, increased visitor impacts, and agricultural activities; sediment loads due to road traction sand, logging, gravel mining operations, and urban runoff. Additional information on nonpoint source issues in the Upper Colorado River is available at the Nonpoint Source Colorado website: http://npscolorado.com/ .

3.3.1 Hydrologic Modification Activities

3.3.1.1 Trans-basin Diversion

In 1993, approximately 274,427 acre-feet of water were diverted from the Upper Colorado River watershed to the eastern plains (Denver Water letter to NWCCOG, March 13, 2002 from Chris Schuyler-Rossie). The major water diverters from this watershed are the Denver Water Department and the Northern Colorado Water Conservancy District. The ten-year average or these diversions is 313,854 acre-feet [State Engineer's Office, District V Engineer's Office, 1994]. The Denver Water records for the 1993 ten-year average for this same area indicate 313,185 acre-feet were diverted. The annual flow at the USGS gage above Gore Canyon for the 1993 water year (subtracting the Blue River flow) was 532,200 acre feet. This suggests that approximately one-third of the annual stream flow in the Upper Colorado River watershed near Kremmling is diverted out of the drainage. This water use is 100% consumptive, i.e. none of it is returned to the stream system from which it came. The withdrawal of this amount of water from the streams in the watershed has impacts on water quality including: decreased dilution flows; decreased spring runoff "flushing flows" which move accumulated sediments and impact fish spawning habitat (particularly in the Fraser River); decreased aquatic life habitat; increased stream temperature and other water quality concerns associated with changes to channel morphology, and loss of high quality "headwaters" with low pollutant concentrations.

In water year 2009 (November – October), trans-basin diversions from the Upper Colorado River watershed were 309,730 acre-feet. This included 18,990 acre-feet from the Grand Ditch, 244,865 from the Alva Adams Tunnel, and 45,875 acre-feet from the Moffat Tunnel. The 10-year average of diversions from the watershed for 2009 is 317,764.4 acre-feet [2009 Annual Report, Division 5 Water Resources, State Engineers Office].

Some of the reservoirs and structures in the Upper Colorado River watershed, which are used to enable, and sometimes mitigate the consequences of trans-basin diversions (Wolford Mountain), include the following.

Granby Reservoir is the major Colorado-Big Thompson storage reservoir (owned by the Bureau of Reclamation and operated by the Northern Colorado Water Conservancy District). The reservoir inundates about 7,300 acres and has 539,760 acre-feet of storage capacity. The active capacity is 465,600 acre-feet.

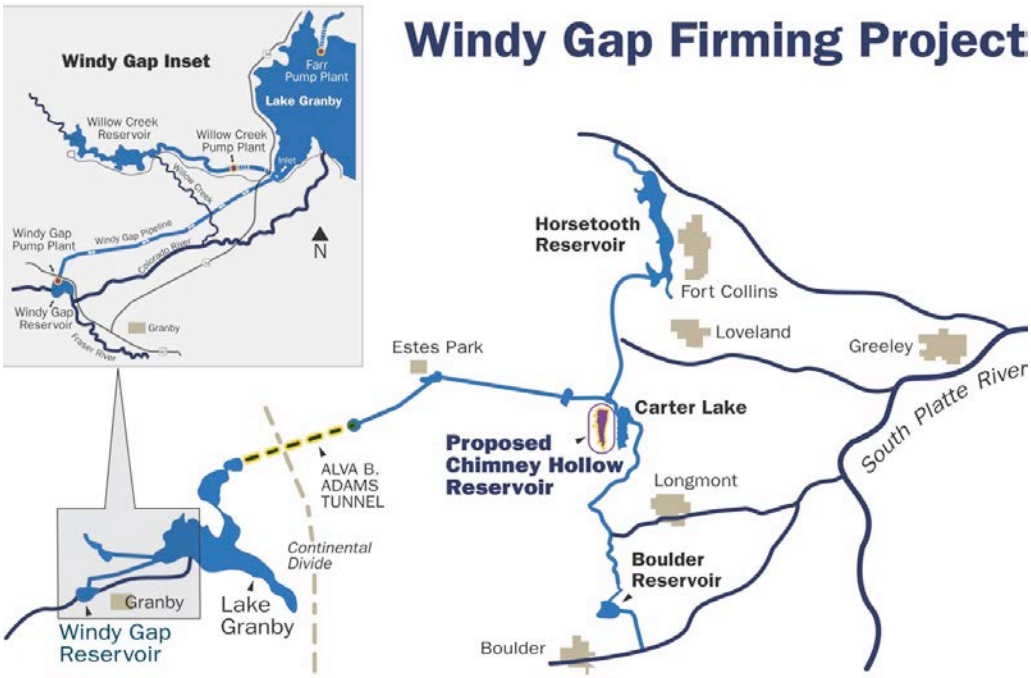
Shadow Mountain Reservoir is contiguous with Grand Lake at normal operating elevation. The two water bodies have about 1,852 surface acres and 18,400 acre-feet of storage. Grand Lake's surface elevation fluctuation is limited to one foot by legislation. This limitation provides 1,839 acre-feet of regulation in both lakes [US Department of the Interior Water and Power Resource Service, Colorado-Big Thompson Windy Gap Projects Colorado Final Environmental Impact Statement, 1981]. Grand Lake has a surface area of 507 acres and a maximum depth of 265 feet. Grand Lake, which is Colorado's Largest natural lake, is used as a conduit as part of the Colorado-Big Thompson Project.

Willow Creek Reservoir has a total storage capacity of 10,550 acre-feet, and an active capacity of 9,067 acre-feet (300 surface acres).

Though Willow Creek Reservoir is part of the C-BT system, Windy Gap and Willow Creek transfer systems are operated by Northern Colorado Water Conservancy District and divert approximately 11,000 acre feet of water annually to Lake Granby [Surface-Water Quality Evaluation Windy Gap Project 1994 Monitoring Program, Harlan & Associates, Inc. June 1995].

In 2003, thirteen water interests initiated a federal permitting process for a firming project to improve the reliability of the Windy Gap project operated and maintained by Northern Colorado Water Conservancy District. In addition, Middle Park Water Conservancy District owns 3,000 acre-feet of Windy Gap water. The firming project's key feature is a new 90,000 AF east slope reservoir called Chimney Hollow, which would provide 30,000 acre feet of firm water yield for the project participants.

In February 2012 letters to Army Corps of Engineers and the Bureau of Reclamation the Environmental Protection Agency (EPA) raised concerns regarding both the findings of the EIS and the proposed mitigation. EPA comments included issues with the methodology for evaluating water quality impacts, including temperature, errors in the hydrologic analysis, and concern about continued negative impacts to the aquatic ecosystem including macroinvertebrate species. Information on the project can be found on Northern's website at http://www.northernwater.org/WaterProjects.



In the Fraser River drainage, Denver Water Department operates a diversion above Winter Park. This diversion structure takes water from 35 streams tributary to the Williams Fork, Vasquez and Saint Louis Creek drainages as well as the Fraser River and sends it to the eastern slope (Gross Reservoir) via the Moffat Tunnel. The annual average diversion (1999-2009) through the Moffat tunnel is 59,402 acre-feet. The City of Thornton owns the Berthod Pass Ditch high on the Fraser River, which diverts an annual average of 614 acre-feet.

Williams Fork Reservoir is owned and operated by the Denver Water Department, and is used to meet downstream calls which could call out Denver's use of Blue River water.

Wolford Mountain Reservoir was constructed in 1994 and 1995 by the Colorado River Water Conservancy District on Muddy Creek. This Reservoir was constructed to hold 60,000 acre-feet and has a surface area of 1,447 acres. Of the 60,000 acre-feet, Denver Water Department owns 24,000 acre-feet (40%), and the remainder is available for lease by the Colorado River Water Conservancy District.

In 2010, Denver Water submitted a Draft Environmental Impact Statement (DEIS) to the Army Corps of Engineers for a project that would triple the size of Gross Reservoir, enabling Denver Water to significantly increase its current diversions out the Fraser and the Williams Fork River basins for use on the Front Range. The existing Moffat Tunnel diversion already removes a large portion of the native flows of streams within the Fraser and Williams Fork River basins. The planned diversions will have impacts on the Blue, Fraser and Colorado Rivers.,

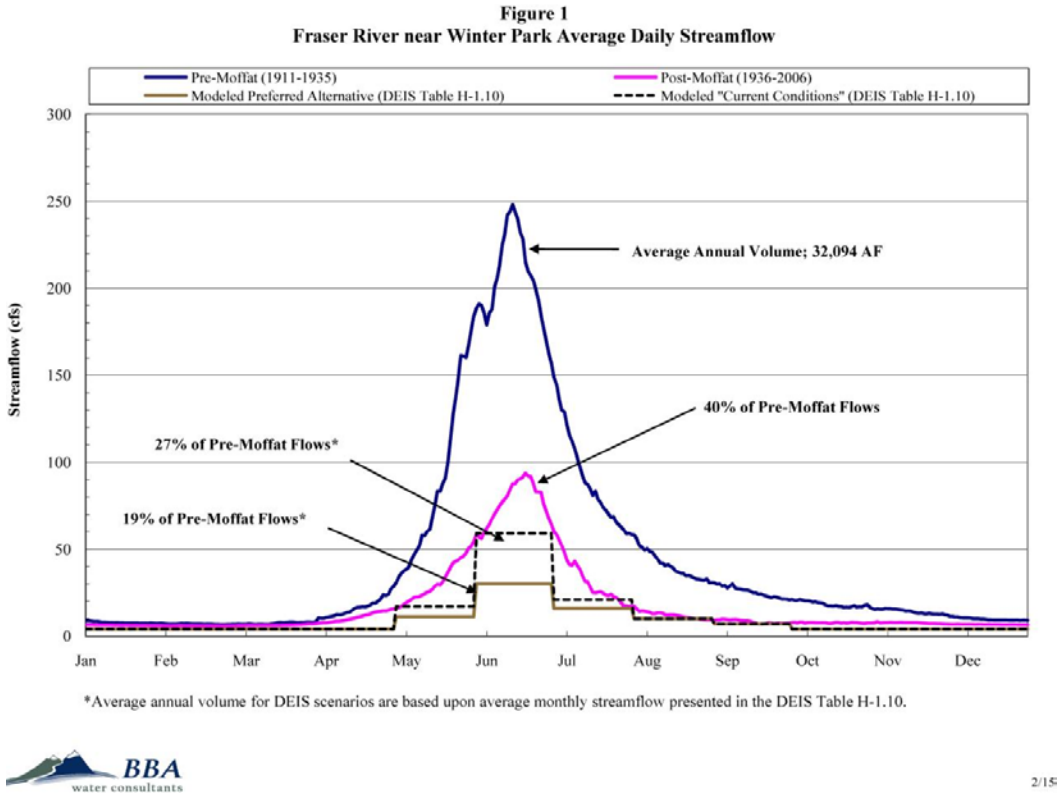


Figure C-2. Denver Water's preferred expansion plans would reduce average flows on the Fraser River near Winter Park to less than twenty percent of its historic average. Excerpt from Moffat Collection System Project DEIS joint rebuttal report submitted by Grand County, Summit County, NWCCOG, Middle Park Water Conservancy District, Trout Unlimited, Colorado River Water Conservation District and Western Resource Advocates March 17, 2010.

3.3.2 Urban and Construction Activities

The areas of most concentrated urban activities in the watershed occur in the upper Fraser River and in the Three Lakes area. Some of the urban and construction activities which can impact water quality include: increased road sanding and salting; increased nutrient loads from lawn irrigation; increased organic and metals loads due to increased traffic; pesticide and herbicide applications; increased sediment from construction sites and new roads; etc.

3.3.3 Recreational Activities

Recreational activities potentially impacting water quality include water diversions for snow making and golf course irrigation which can increase pollutants in runoff and increase consumptive water use. Riparian area disturbance due to fishing, boating, etc., can lead to increased sediment and nutrient loads to streams in the watershed.

3.3.4 Agricultural Activities

Most of the watershed is rural in nature with agricultural activities, mainly grazing and logging, as the predominant land use. Although this land use has not been documented

to have impacts upon water quality in this watershed, due to the percentage of land use in this category, and due to the lower stream flows due to trans-basin diversions, it is appropriate to recommend Best Management Practices (BMPs) to minimize the nutrient and sediment loads to the streams in the watershed.

3.3.5 Nonpoint Source Issues - Summary

The major nonpoint source water quality problems of streams and lakes in the Upper Colorado River watershed include:

Non-algal organic particulates, nutrients, and dissolved organic carbon decrease clarity in Grand Lake, support algae blooms, and aquatic plants in Grand Lake and Shadow Mountain Reservoir.
Increases in sediment in the Fraser River as a result of erosion and traction sanding along State Highway 40 (Berthoud Pass), as well as other land use practices which increase sediment movement in to water bodies above natural conditions.

Increased nutrient inputs from land development activities in the Fraser River basin.
Elevated water temperatures in the Fraser and Colorado Rivers and Ranch Creek. These are exacerbated due to trans-basin diversion of high quality water in the headwaters of the watershed. Loss of high quality “dilution flows” results in increased in-stream nutrient concentrations lower in the Fraser River.

Excessive concentrations of total iron and suspended sediment in the Colorado River downstream from Troublesome Creek as a result of natural runoff from iron rich and easily eroded geologic formations.

Increased water development activities associated with the trans-basin diversion of water. These projects significantly modify the hydrology of the Fraser and Williams Fork Rivers. Modification of the hydrology downstream of point source discharges on the Fraser and Upper Colorado Rivers increase the average concentration of pollutants, including concentrations of ammonia and chlorine downstream of municipal sources.

3.4 Nonpoint Source Recommendations

Implementation of Policies 1, 2, 3, 4, 5, and 6 of this Plan (see table of contents for Volume I for titles of policies).

4.0 WATERSHED IMPROVEMENT PROJECTS

4.1 Existing Projects

4.1.1 Clinton Reservoir Agreement

An agreement between the Denver Water Department and numerous "West Slope Parties" enables additional flows in the Fraser River using Clinton Reservoir, in the Tenmile drainage of the Blue River watershed. A maximum of 920 acre feet of "bypass" water has been made available by the Denver Water Department to Grand County users, available September 15 through May 15.

4.1.2 Berthoud Pass Sediment Control Projects

The Colorado Department of Transportation (CDOT) is working on a slope stabilization project adjacent to Zero Creek on the north side of Berthoud Pass. In addition, the Forest Service and CDOT cooperated in a project at the base of the pass, which prevents snow storage immediately adjacent to the Fraser River, and provided vegetative stabilization of the stream bank in the vicinity of the bottom switchback.

NWCCOG was the recipient of a 1997 EPA 319 Grant to coordinate and implement a project which is designed to reduce the sediment load in the upper Fraser River. The project intends to capture a portion of the sediment load during the post-runoff period of late summer and early fall when river flows are not sufficient to carry the sediment load through the system, by utilizing the detention area next to the Denver Water Board diversion structure for the Moffat tunnel. After several years of delays the project was completed in 2011.

4.1.3 Three Lakes Water Quality Monitoring Database

In 1993, a water quality database for the Three Lakes (Grand, Shadow Mountain and Granby) was developed by NWCCOG. The database includes data collected by the USGS, the Colorado Water Quality Control Division (including samples collected by the Upper Colorado Lakes Protection Association), and the Northern Colorado Water Conservancy District. The database is updated annually, and will be used by NWCCOG to produce annual summaries of water quality in the Three Lakes. This database was used to assist in the following project, and has been incorporated into the following effort.

4.1.4 Three Lakes Clean Lakes Watershed Assessment Grant

In 2000 Grand County was awarded an EPA 319 grant for $135,000 to perform a “Clean Lakes Assessment” of Grand Lake, Shadow Mountain and Granby Reservoirs. The project is designed to document trophic status, and define needed programs to restore or protect beneficial uses of the Three Lakes.

4.1.5 Sheephorn Creek Riparian Improvement Project

The goal of this 2001 project was to reduce stream bank cutting on a ¼ mile section of Sheephorn Creek and increase sub-surface water in a meadow area on Piney Peak Ranch in Grand County about 18 miles southwest of Kremmling. The project was funded by a $10,000 matching grant from the State Soil Conservation Board, and developed $30,000 worth of stream and stream bank improvements. Structures included several instream V-shaped rock weirs, “J- hooks”, and embedded logs. The lower one-third of the project area was fenced to provide a buffer zone for comparison of grazing vs. non-grazing in a riparian habitat. Project coordinators were Mark Volt of the Natural Resources Conservation Service Middle Park Soil Conservation district conservationist, and Darcee Biekert.

4.1.6 Shadow Mountain Reservoir Delta Formation

In 1999 the Shadow Mountain Homeowners Association was awarded an EPA 319 grant

to assess and provide direction regarding sediment deposition at the mouth of the Colorado River as it enters Shadow Mountain Reservoir. [Project section – Chapter 4]

4.1.7 Grand County Stream Management Plan

In August of 2010, with support from Denver Water and Northern Colorado Water Conservancy District, Grand County prepared a Stream Management Plan. The purpose of this Stream Management Plan is to provide the frame work for maintaining a healthy stream system in Grand County, Colorado through the protection and enhancement of aquatic habitat while at the same time protecting local water uses, and retaining flexibility for future water operations. The ultimate measure of success will be the presence of a self-sustaining aquatic ecosystem and fishery resource while meeting water user's needs (http://co.grand.co.us/WRM/Draft_Report/draft.html).

4.1.8 Grand County Water Quality Specialist

As part of their commitment to water quality Grand County hired a water quality specialist to perform complex administrative and technical work as required by the County Manager. The new job scope includes review of existing data and data in process of being generated dealing with water and related issues; advises the County Manager on such projects as the Windy Gap Firming Project, the Moffat Firming Project, the Colorado-Big Thompson Nutrient Study, the State Health Department Water Quality Study, the state Clarity study for Grand Lake, and the Stream Management Plan; helps to assure compliance by other agencies of regulations and agreements as they impact upon the county's interests; and researches and responds to questions or problems raised by the County Manager or Board of County Commissioners, outside agencies, and the public.

4.1.9 Grand Ditch

Restoration of this failed ditch which resulted in significant sedimentation of the Upper Colorado River was initiated through an EIS process with the Forest Service.

4.1.10 Bureau of Reclamation Alternatives Study

Reclamation's process to evaluate what feasible options exist to address the water quality impact in Grand Lake associated with Colorado Big Thompson pumping water to the Adams tunnel.

4.2 Future Project Needs

4.2.1 Instream Flow Improvement Projects

Projects designed to minimize or mitigate the impact of hydrologic modifications in the Upper Colorado River watershed are needed.

4.2.2 Agricultural Best Management Practice Projects

Voluntary projects that minimize impacts or demonstrate new and innovative approaches to protecting water quality impacts from agricultural practices (including logging activities) are needed, especially in areas of high soil erodability.

4.2.3 Urban Runoff Water Quality Improvement Projects

Projects designed to improve water quality, especially sediment and nutrient reduction, from existing and future land development areas are encouraged in the Fraser Valley and Three Lakes area.

5.0 LAND USE REGULATIONS APPLICABLE TO WATER QUALITY PROTECTION AND IMPROVEMENT

Grand County's Planning Commission has adopted the 208 Plan as a guidance document and requests NWCCOG's comments on development proposals with respect to how the proposals comply with the 208 Plan. Grand County requires a 30 foot building setback from streams, intermittent streams, and lakes if the building is on central sewer. A 150 foot setback from waterbodies is required for septic systems.

Grand County has adopted "1041" regulations for permitting of new and expanded water and wastewater projects.

Beginning in 1996 Grand County and the towns within Grand County undertook a Growth Strategy project, which identified water quality protection as a key concern. The NWCCOG has provided Grand County with the model Water Quality Protection Standards (Appendix 6) as an example for a watershed wide water quality protection regulation.

In 2011, Grand County adopted a new master plan which includes policies intended to guide development and growth. Protection of long-term viability of water resources and water quality is a stated priority, including support for efforts of the Grand County Water Information Network and the East Grand Water Quality Board (http://co.grand.co.us/planning.html).

6.0 WASTELOAD ALLOCATIONS

The Three Lakes Sanitation District has been conducted Use Attainability study to determine appropriate water quality standards for the unnamed tributary of Willow Creek in which they discharge (Upper Colorado River segment 6b), and the segment downstream of Willow Reservoir Road to the confluence with Willow Creek (Segment 6c). The Use Attainability Analysis was completed and a TMDL has been established for Segment 6c. The TMDL goal is the attainment of chronic and acute ammonia standards at the top of segment 6c. The ammonia wasteload allocation for the Three Lakes wastewater treatment facility is:

Three Lakes Sanitation District @ 2.0 MGD (mg/L chronic limits):

January	6.4
February	6.4
March	6.7
April	6.6
May	7.1
June	7.1
July	7.4
August	5.3

Sept.	5.9
Oct.	6.1
Nov.	6.4
December	6.4

Wasteload allocations have been established for point source discharges in the Fraser River drainage. The East Grand Water Quality Board contracted with Regulatory Management, Inc. (RMI) to model the upper Fraser River drainage and estimate ammonia effluent limits for the wastewater treatment plant discharges to the upper Fraser River. RMI reported estimated ammonia effluent limits for effluent limits based on the Colorado Ammonia Model (CAM) adjusted with a wasteload allocation procedure that considered the relative impact of the CAM results on each discharger. A wasteload allocation agreement has been proposed between Winter Park W&SD, Grand County W&SD No. 1, and Fraser SD which will limit Winter Park W&SD ammonia discharge to levels that will meet winter time concentrations at the downstream discharger's outfall(s) of 0.5, 0.5, 0.4, and 0.3 mg/L (January - April).

The CAM modeling and wasteload allocation analysis was performed for a number of alternative wastewater discharge flow rates for each wastewater plant and alternative locations for the dischargers. The final determination of the ammonia limits for each discharger will be based on wasteload allocation negotiations between the dischargers and the Water Quality Control Division.

Point Sources:Allowable Ammonia Discharge (mg/L as N)

Winter Park Water and Sanitation District (based on a downstream consolidated facility at Fraser):

	@0.45 MGD
January	5.0
February	8.0
March	5.7
April	2.4
May	3.3
June	6.1
July	4.1
August	2.8
September	2.3
October	1.8
November	2.3
December	6.7

The Fraser Consolidated has the following ammonia effluent limits.

	@ 2.0 MGD
January	4.9
February	8.6
March	6.6
April	2.1
May	2.1
June	2.2
July	1.4

August	1.6
September	1.8
October	1.5
November	3.0
December	3.0

Young Life Camp @ 0.034 MDG

January	30
February	63
March	41
April	43
May	94
June	41
July	21
August	17
Sept.	20
Oct.	40
Nov.	32
December	30

Note: Young Life has agreed with Grand County in its 1041 permit to limits its ammonia discharge to 15 mg/L from June through August.

Tabernash Meadows Water and Sanitation District @ 0.1 MGD

January	7t
February	12
March	12
April	19
May	16
June	21
July	42
August	53
Sept.	24
Oct.	13
Nov.	9
December	12

Granby Sanitation District @ 2.0 MGD:

January	10
February	13
March	12
April	10
May	13
June	17
July	17
August	16
Sept.	17
Oct.	9.3
Nov.	9.1
December	9.8

7.0 WATER QUALITY MONITORING

7.1 Existing Monitoring Efforts

Existing ambient water quality monitoring efforts in the Upper Colorado River watershed include:

USGS sampling of three sites in the Three Lakes area (paid for by Northern Colorado Water Conservancy District) and other sites - Hot Sulphur Springs, Muddy Creek, and below the Blue River confluence;

USGS sampling in Rocky Mountain National Park as part of National Water Quality Assessment Program;

Three Lakes Technical Committee Water Quality Evaluation largely funded by Northern Colorado Water Conservancy District.

Colorado River Water Conservation District's Wolford Mountain Reservoir monitoring program;

East Grand Water Quality Board's sponsored USGS monitoring of the Fraser River;

Denver Water Board monitoring of the Williams Fork and Fraser drainages;

Division of Wildlife's River Watch program (West Grand High School monitors two stations on Muddy Creek (and two on the lower Blue River);

Colorado Dept. of Public Health and Environment Water Quality Control Division - volunteer monitoring program on Grand Lake (Upper Colorado Lakes Protection Association).

7.2 Water Quality Monitoring Needs

There is a need for continued monitoring of nutrient concentrations and associated phytoplankton counts in Grand Lake, Shadow Mountain Lake and Lake Granby. Although much of this work was conducted through the Three Lakes Technical Committee, continued monitoring would aid in establishing a long-term picture of the lakes' trophic status and cause and effect relationships.

Evaluation of the Fraser River downstream of Winter Park to establish water quality conditions important to the maintenance of the fishery would be helpful to establish quality criteria necessary for protection of this resource. In particular, there is a concern with regard to the effect of diminished stream flows over the stability of the stream channel and the ability of the stream to flush out accumulated sediment with a diminished frequency of bank full conditions. Field evaluation of channel cross sections would assist in a determination of criteria important to the maintenance of channel stability.

Locating sources of and monitoring concentrations of total iron and suspended sediment entering the Colorado River, principally from Troublesome Creek and downstream of State Bridge, would aid in determining if remedial measures to control runoff from iron

rich and easily eroded geologic formations can be achieved. Analyses of iron in bed and suspended sediment samples need to be made to determine how much iron is transported with the sediment.

8.0 WATER QUALITY STANDARDS

8.1 Existing Classification and Standards

Streams in the Fraser River Basin are classified for protection of cold water aquatic life (Class I), primary and secondary contact recreation, water supply and agricultural uses. Current stream classifications and standards can be reviewed at: http://www.cdphe.state.co.us/regulations/wqccregs/33_2012(01)tables.pdf. The Williams Fork River and tributaries are classified for primary contact recreation, cold water aquatic life (Class I), water supply and agriculture. Streams in Rocky Mountain National Park are designated as "Outstanding Waters" and receive special protection under Colorado Water Quality standards (no degradation is allowed). Streams in the Indian Peaks Wilderness Area currently have higher quality water than the numeric criteria necessary to protect the designated uses included in state standards are reviewable under the state's antidegradation rule.

Grand Lake, Shadow Mountain Reservoir and Granby Reservoir have previously been classified as threatened segments because of concern for a downward trend in water quality measured by an increased concentration of phosphorus and other nutrients increases in chlorophyll a concentrations, and a decreasing level of water clarity. However, the provision of a regional wastewater treatment system serving the area has eliminated this trend and the segment is no longer classified as threatened.

Streams in the lower portion of the watershed are classified for the protection of aquatic life, primary and secondary contact recreation, water supply, and agriculture uses. All waters in this area are reviewable under antidegradation regulations except for the un-named tributary to Willow Creek (Segments 6b and 6c of the Upper Colorado River).

8.1.1 Designated Use Impairment Stream Segments

The state's 2012 list of impaired streams can be found at: http://www.cdphe.state.co.us/regulations/wqccregs/93_2012(03).pdf .

8.1.2 303(d) List

The Clean Water Act requires the state to list those stream segments or waterbodies that require Total Maximum Daily Load (TMDL) allocations in order for the segment to attain or maintain water quality standards. The state's 2012 (Table C-6). Previously the Upper Colorado River watershed had one stream segment is identified, Segment 6c, tributary to Willow Creek. A TMDL has been completed for this section, and once the Three Lakes Water and Sanitation District facility is operational, it is expected that this segment will be in compliance with standards and will be deleted from the State's 303(d) list. Note in Table C-6 below those segments without a M&Epriority are on the State's Monitoring and Evaluation list

Table C-6. 303(d) and M&E Listed Segments in the Upper Colorado River Basin

Segment	Description	Portion	Impairment	Priority
COUCUC02	Mainstem of Colorado River, including all tributaries and wetlands within or flowing into Arapahoe National Recreation Area.	Willow Creek Reservoir	Mn	L
COUCUC03	Mainstem of the Colorado River from Lake Granby to the Roaring Fork River	578 Road Bridge to confluence with Blue River	Temperature	H
COUCUC03	Mainstem of the Colorado River from Lake Granby to the Roaring Fork River	From the outlet of Windy Gap Reservoir to 578 Road Bridge	Aquatic Life	M&E
COUCUC06b	Mainstem of unnamed tributary from the headwaters of Willow Creek Reservoir Road	All	D.O.	M&E
COUCUC05	Lakes and Reservoirs tributary to Colorado	Wolford Mountain Reservoir	Temperature	H
COUCUC07a	All tributaries to the Colorado River abv confluence with Blue River to blw confluence with Roaring Fork	Alkali Slough	Fe(Trec), Se	L
COUCUC07a	All tribs to the Colorado River, including wetlands from a point abv the confluence with the Blue River to blw confluence with the Roaring Fork, which are not on National Forest Lands except specific listings in segment 7b	Muddy Creek and tribs	Temperature	M&E
COUCUC07b	Muddy Creek from Wolford Reservoir. Rock Creek, Deep Creek, Sheephorn Creek, Sweetwater Creek, Piney River	Muddy Creek from Wolford Mountain Reservoir to Cow Gulch	Temperature	M&E
COUCUC07b	Muddy Creek from Wolford Reservoir. Rock Creek, Deep Creek, Sheephorn Creek, Sweetwater Creek, Piney River	Muddy Creek from Cow Gulch to the Colorado River	Temperature	H
COUCUC10a	Mainstem of the Fraser River from the source to a point immediately below the Rendezvous Bridge. All tributaries to the Fraser River, from the source to the Colorado River	Fraser River, Vasquez Creek	Aquatic Life (provisional)	L
COUCUC10a	Mainstem of the Fraser River from the source to a point immediately below the Rendezvous Bridge. All tributaries to the Fraser River, from the source to the Colorado River	Ranch Creek	Temperature	L
COUCUC10c	Mainstem of the Fraser River, from Hammond Ditch to the Colorado River	All	Temperature	L
COUCUC10c	Mainstem of the Fraser River, from Hammond Ditch to the confluence with the Colorado River	From the Town of Fraser to the confluence with the Colorado River	Cu	M&E
COUCUC10c	Mainstem of the Fraser River, from Hammond Ditch to the confluence with the Colorado River	From the Town of Tabernash to the Town of Granby	Pb	M&E

COUCUC12	Lakes and Reservoirs within Arapahoe National Recreation Area inc. Grand Lake, Shadow Mountain Lake and Lake Granby	Shadow Mountain Lake	D.O.	H
COUCUC12	Lakes and Reservoirs within Arapahoe National Recreation Area inc. Grand Lake, Shadow Mountain Lake and Lake Granby	Lake Granby	Aquatic Life Use (Hg fish tissue)	H

A TMDL is the estimated assimilative capacity of a waterbody, which estimates how much of a pollutant may enter a water body without affecting its designated uses. The TMDL represents the sum of the point sources, the nonpoint sources, and a margin of safety (which can include anticipated future pollutant loadings).

8.2 Recommendations on Standards

8.2.1 Support of Existing Classifications and Standards

Water quality standards (including use designations and criteria) for the Upper Colorado River watershed are generally adequate to protect the existing uses under current conditions.

NWCCOG is supportive of the State's antidegradation provision and protection of high quality waters.

The existing narrative clarity standard in Grand Lake, "The highest level of clarity attainable, consistent with the exercise of established water rights and the protection of aquatic life" needs to be evaluated prior to the 2015 effective date of numeric standard of July through September Grand Lake Clarity = 4 meter secchi disk depth.

8.2.2 Outstanding Water Designation

Designation of the following stream segments as "Outstanding Waters" under the system established by the Water Quality Control Commission:

NWCCOG does not currently recommend any additional waterbodies to the list of "Outstanding Waters" designation. If Congress approves new wilderness areas within the watershed, NWCCOG recommends investigations of waterbodies within those areas for appropriateness of "outstanding waters" designation.