DRAFT REPORT
STREAM MANAGEMENT PLAN
PHASE 3

GRAND COUNTY, COLORADO

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LIST OF ACRONYMS

Acronym or abbreviation	Full Phrase
BLM	United States Department of Interior, Bureau of Land Management
CDSS	Colorado's Decision Support System
CDPHE	Colorado Department of Public Health and the Environment
CDOW	Colorado Department of Natural Resources, Division of Wildlife
CNHP	Colorado Natural Heritage Program
CWCB	Colorado Water Conservation Board
CWWTP	Consolidated Wastewater Treatment Plant
DW	Denver Water
Forest Service	United States Department of Agriculture, National Forest Service
GCWIN	Grand County Water Information Network
HRC	Hydrosphere Resource Consultants
IHA	Indicators of Hydrologic Alteration
ISF	Instream Flow
NCWCD	Northern Colorado Water Conservancy District
ORV	Outstanding Remarkable Value
PACSM	Platte and Colorado Simulation Model
PHABSIM	Physical Habitat Simulation
RVA	Range of Variability Analysis
SG Plan	Upper Colorado River Wild and Scenic Stakeholder Group Management Plan
TAM	Triactinomyxon (trout-infecting spore)
TU	Trout Unlimited
UPCO	Upper Colorado River Basin Study
UPRR	Union Pacific Railroad
USDOI	U.S. Department of the Interior
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WPWSD	Winter Park Water and Sanitation District
WQCC	Water Quality Control Commission
WUA	Weighted Usable Area

EXECUTIVE SUMMARY

ES1. Introduction

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. This report presents the analyses and recommendations of target flows, restoration opportunities and monitoring recommendations. It is recognized that not all recommended target flows can be achieved at all times. Fluctuations of flows are expected and in some cases these will be outside of the recommended flow ranges. Of particular concern is when flows are less than the recommendations, thereby potentially threatening the health of the aquatic habitat and impeding water users. Thus restoration opportunities, including flow enhancements and physical restoration, are developed and presented in this Stream Management Plan with the goal of minimizing the impacts from low flow conditions. A ranking system is also proposed to help prioritize restoration and implementation efforts by reach.

ES1.1. Background

The study area generally covers 80 miles of river in the Upper Colorado River basin, spanning the length of Grand County from Winter Park to the Grand-Eagle County Line. See the **Site Location Map, Figure ES-1**. This study focuses on the Colorado and Fraser Rivers, and ten tributaries. These tributaries include Williams Fork, Blue River, Muddy Creek, Reeder Creek, Troublesome Creek and Willow Creek along the Colorado River and Jim Creek, Vasquez, Saint Louis and Ranch Creeks along the Fraser River. The study area is divided into 30 reaches as depicted on the **Vicinity Map** appended in the plan pocket.

Several phases of work were required to develop this Stream Management Plan (SMP). Phase 1 of the SMP was completed in spring 2007 and included inventory and review of existing pertinent data and information for streams within the County. Phase 2 was completed in April 2008 and included scientifically-based recommendations of environmental streamflow and flushing flows for 11 study sites as well as a description of flows to support non-consumptive water uses including recreational, municipal, industrial, and agricultural. This Phase 3 report includes the addition of 8 more study sites for the development of environmental target flows (one upper Fraser River, four on the Blue River, two on Ranch Creek and one on the Colorado River below Windy Gap), and 2 single transect sites (Troublesome and Reeder Creeks). These additional reaches now have environmental target flow and flushing flow recommendations. The Phase 3 report also includes stream assessments, spawning surveys, restoration concepts, a suggested priority list for implementation, and general monitoring guidelines. Phase 3 is a cooperative effort lead by Grand County with support from Denver Water, Northern Colorado Water Conservancy District and the Colorado Water Conservation District.

ES1.2. About This Report

This report is compiled into three main sections as described below.

Executive Summary: The Executive Summary provides an overview of study efforts, methodology of analyses, key findings, restoration opportunities (both physical and flow enhancements) and monitoring recommendations.

Reach Summaries: Each of the 30 reaches is presented in detail including reach descriptions, study methodology and results, recommendations of environmental target flows, review of existing temperature and water quality data, restoration opportunities, monitoring guidelines, unique features and/or issues and support data.

Appendices: The six appendices presents details on methodology, background data collection and review, water users information, survey information, and restoration and monitoring.

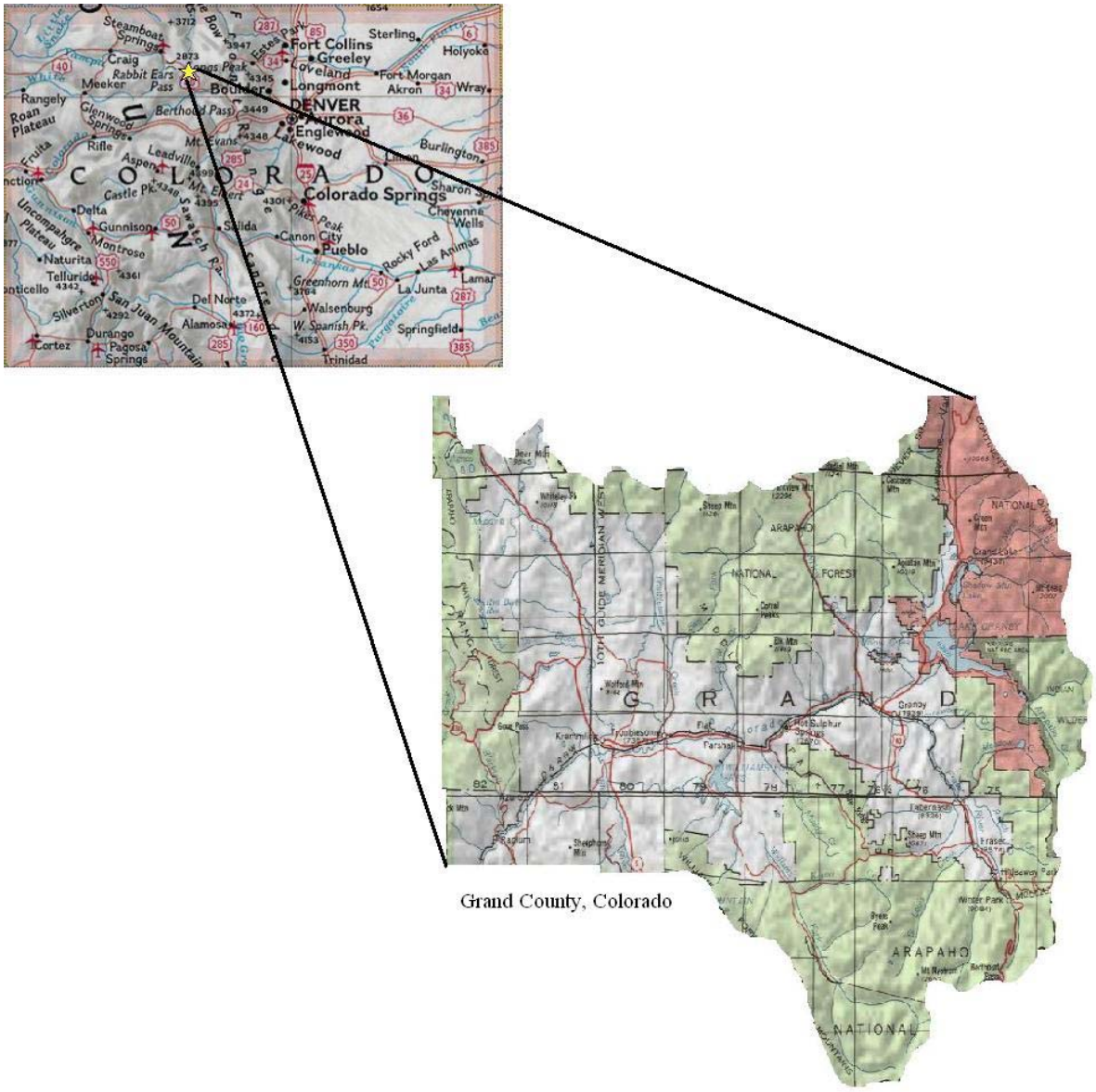

Figure ES-1. Site Location Map

ES2. Summary of Objectives and Methods

ES2.1. Objectives

For environmental target flows, the primary objectives have been to 1) acquire, analyze, and evaluate hydrologic data describing streamflow regimes of the study reaches; 2) acquire, analyze, and evaluate channel morphology, hydraulic geometry, and aquatic habitat information for the project reaches to describe habitat-flow relations for target fish species and life stages; and 3) based upon our findings under Objectives 1 and 2, recommend target flows for the project study area that will likely protect environmental values. Recommendations for environmental flows also include review of existing temperature and water quality data relative to current standards and biological limitations for the fish species of concern. In addition to determining environmental flows, flow conditions for other water users are considered and, in some cases, may exceed those values recommended for environmental flows. Water users include irrigators, municipalities and industries, and recreational users.

ES2.2. Environmental Target Flows

Within the context of this study, the term environmental target flow range refers to those flows that were determined to best maintain the ecological needs of the stream in relation to its fisheries. The relationships between available trout habitat and streamflow were investigated using PHABSIM (Bovee 1997; USGS 2001) during the 2007, 2008 and 2009 field seasons in 21 of the 30 Grand County stream reaches. These reaches were selected for study based upon several guidelines, including streamflow magnitude, history of hydrologic alteration, location within the County's river drainage network, relative importance for recreational and other water uses, and in many cases, the lack of previous detailed instream flow studies. Seven PHABSIM sites were located on the Fraser River and its tributaries, five on the mainstem Colorado River, five on the Blue River, and one site each on the Williams Fork and Muddy Creek. A single transect approach similar to the CWCB method of instream flow determination was used on two Colorado River tributaries, Troublesome Creek and Reeder Creek. Detailed methods are provided in Appendix A, Environmental Flows, Methods for Determination.

The flow-habitat relations developed for each study site, target species (primarily brown trout and rainbow trout), and life stage (adult, juvenile, spawning, incubation, winter survival) were inspected to determine the recommended environmental target flow ranges for two seasons of the year. Summer (April 1 to September 30) flow ranges are based primarily on the availability of adult habitat, while winter (October 1 to March 31) flows are based primarily on spawning/incubation habitat availability. The portions of the trout life cycle considered in the recommendation of target flows are depicted in Figure ES-2. The recommended environmental target flow ranges were typically bounded on the upper end by the flow which provided the maximum habitat for the target species and life stage and on the lower end by the flow below which habitat is lost at the greatest rate.

Figure ES-2. Stages in Trout Life Cycle
Starting at the lower left and proceeding clockwise: spawning, incubation, emergence, juvenile and adult.
Photos used with permission from photographer Richard Grost: copyrighted

PHABSIM, or similar, instream flow studies had previously been conducted by other investigators in six of the 30 reaches. These studies were reviewed and, where appropriate, the results used to develop environmental target flow ranges. CWCB instream flows have been established within 24 of the 30 reaches, while other instream flow requirements have been set or recommended within 11 of the stream reaches by the Forest Service or other agencies.

Flushing flow recommendations were developed for 19 of the 30 stream reaches. The magnitude of each flushing flow was based upon bedload transport modeling to identify the threshold flow at which spawning gravel mobilization is initiated. Flushing frequency and duration are based primarily upon a hydrologic events approach (Reiser et al 1990). Methods are described in Appendix A.

Analysis of Grand County streamflow records was primarily accomplished using the Indicators of Hydrologic Alteration (IHA) approach as described in Appendix A. IHA analysis was conducted for USGS and NCWCD gage records on 16 of the 30 stream reaches investigated. Of these8 reaches have gages with sufficient period-of-record to allow at least limited temporal comparisons (i.e. historic vs. recent) of flow alteration to be made, while at the remaining stations, IHA was used solely to describe the hydrologic regime. Unfortunately, many of these stations were not useful for quantitatively describing the hydrologic alteration which have occurred in Grand County since the first half of the 20th century. Reasons for this include 1) discontinuous years of gage operation, 2) conversion to seasonal-only operation, 3) missing data within years, and 4) inadequate period of operation either prior to or after major water development activities occurred. Only one station (USGS Gage 09024000, Fraser River at Winter Park, CO) had sufficient period-of-record to allow valid (i.e. at least 20 years of complete record for each time period considered) comparisons of streamflow before and after transbasin diversions for the pre- and post-1936 periods. For this station, the IHA's Range of Variability (RVA) analysis was also conducted to better describe the magnitude of hydrologic alteration which has occurred. This level of

analysis was also possible for USGS Gage 09058000 (Colorado River at Kremmling, CO) to compare more recent pre- and post-transbasin conditions (1962 - 1984 and 1985 - 2007), as well as the Green Mountain Reservoir operations change in the mid-1980's. Other hydrologic analyses included the development of daily streamflow exceedence plots and flood frequency analysis, as described in Appendix A and presented in the Reach Summaries.

Additional channel and habitat assessments and surveys were conducted in many of the 30 reaches during late summer and fall of 2008 in support of the target flow and restoration recommendations. The assessments included the Stream Reach Inventory and Channel Stability Evaluation (SRI/CSE), the EPA Rapid Habitat Assessment protocol, and the Riffle Stability Index procedure. A brown trout spawning survey was also conducted. Detailed methods are provided in Appendix A, while reach-specific findings are reported in the Reach Summaries.

ES2.3. Surface Water Temperature

Temperature standards set by the Colorado Department of Public Health and Environment, Water Quality Control Commission (WQCC), have been established by the State to protect the aquatic community from the harmful effects of elevated surface water temperatures. Segment specific numeric standards for both chronic and acute conditions were adopted by the WQCC in the Upper Colorado River Basin in 2008. The chronic standard is measured as the Maximum Weekly Average Temperature (MWAT), which is the largest mathematical mean of multiple, equally spaced daily temperatures over a seven-day consecutive period with a minimum of three data points spaced equally throughout the day. The acute standard is measured as the Daily Max (DM) which is the highest two-hour average water temperature recorded during a given 24 hour period.

Tiers are used to define segment-specific temperature standards and are generally based on fish species with similar thermal requirements present in river segments. Study reaches for the Stream Management Plan fall into one of two tiers: Cold Stream Tier I and Cold Stream Tier II which are further defined by specific reaches in Appendix B, Temperature Data Review. Continuous temperature data for 2006-2009 is available at 22 locations throughout the 30 reaches of the study area. Other data available for review include instantaneous readings taken at a variety of locations. Detailed data sources and information are presented in Appendix B, while water temperature data are provided in the Reach Summaries.

ES2.4. Water Quality

For the purpose of this study, 14 constituents were identified as being important indicators of the health of stream habitat. These constituents include sediment, nutrients, metals, and inorganic and organic parameters. In addition, algae conditions are briefly reviewed and included were appropriate.

Nonpoint source water quality issues in the study area include increased sediment and nutrient loads from urban land uses, agriculture, winter road maintenance and recreational activities. The major point source discharges in the study area include municipal or domestic wastewater treatment plants. Point source problems were extensively evaluated by the Colorado Department of Health in 1974 as part of the Colorado River Basin 303(e) Plan. This basin plan was developed and adopted to address point source problems. Since the adoption of the basin plan, the development of wastewater treatment facilities has generally proceeded in accordance with its recommendations. Most of the wastewater treatment and improvements to point source discharges occurred in the mid 1990s (NWCCG 2002). Thus, review of water quality data focuses on data collected over the last 10 to 15 years so as to best represent current conditions. A summary of the constituents, guidelines for review, and a synopsis of the results for each parameter are presented in the following Reach Summaries section of this report as well as Appendix C, Water Quality and Algae Data Review.

ES2.5. Water Users

Irrigators and Municipalities and Industry: Streamflow management for water users focuses on two issues. The first is physical limitations associated with stream flow that may impact the ability of a water user to retrieve or utilize water. The second issue is the water user's impact on flows in the stream relative to maintaining recommended flows.

Within the study reach there are hundreds of diversions. These diversions are identified so that in the future, as flow recommendations are implemented, there is a basis for accounting for flow reductions from diversions. A summary table and line diagram of major water diversions within Grand County is included in Appendix D, Water Users and Recreation.

Recreational Flows: In order to gain an understanding of recreational use within the study area, rafting, kayaking, and angling commercial outfitters were contacted for their opinions on preferred flow conditions. In addition, American Whitewater provided preferred floatboating flows for the private boating community. The information from this research was combined with the results of the UPCO report and is summarized in the Reach Summaries and presented in detail in Appendix D.

ES2.6. Water Supply

Current and future water demands, specifically municipal and domestic water supplies, are reported in the Upper Colorado River Basin Study (UPCO) (HRC 2003a).

ES3. Key Findings

ES3.1. Environmental Flows and Related Assessments

Environmental Target Flows: In general, recommended environmental target flow ranges are commonly present within many reaches during the April to July period, but less available under current river operations for the remainder of the year. Review of future flow conditions as depicted by Denver Water's PACSM model indicate that in many reaches the late summer flows, flushing flows and winter base flows, without flow enhancements or restoration, will be typically lower than recommended target flow ranges. The recommended environmental target flow ranges are presented in the Reach Summaries and are summarized in Table ES-1.

The recommended targets show a logical progression within the Upper Colorado River drainage with generally increasing flows in a downstream direction as contributing area and channel size increase. For the Fraser River, the target range for summer flows increases from 4 - 10 cfs in Reach F3, to 80 - 120 cfs at the mouth in Reaches F9 and F10. Above the Fraser River confluence, the target summer range for the Colorado River in Reach CR3 is 90 - 160 cfs, while below the confluence in Reach CR4 the range increases to 200 - 400 cfs. As major tributaries (Williams Fork, 40 - 140 cfs; Muddy Creek, 60 - 90 cfs; Blue River, 200 - 300 cfs) enter the Colorado, the summer target range increases to 600 - 1000 cfs in CR7, the most downstream reach in Grand County. A similar trend is exhibited by the winter target flow ranges. Such a natural progression for environmental flows from the headwaters of the county to the downstream terminus adds a measure of assurance regarding the consistency and reliability of the PHABSIM results.

The summer flow target ranges are based consistently on the availability of adult trout habitat throughout the Grand County river system. For all sites and flows considered, adult habitat weighted usable area was less than that available for juvenile trout. Therefore, adult habitat is considered potentially more limiting for the fishery and target flows are recommended to reflect this limitation. In general, adult brown trout habitat tended to be more abundant than that for adult rainbow trout and the summer flow targets tended to agree well with the preferred angling flows.

The winter target flow ranges are based primarily upon the availability of trout spawning and incubation habitat. Successful natural reproduction is an indication of a healthy stream environment, reflecting not only supportive flow regimes but also high quality channel boundary and inter-gravel conditions. Brown trout spawn in the fall to early winter period and the eggs incubate in the stream gravels over the winter before hatching in the spring. Rainbow trout may begin spawning in the late winter and continue well into the spring. Thus, it is important the recommended target flow ranges are protective of this critical life function and stage from the time the eggs are deposited in the gravels to the time the fry emerge. Within Grand County, natural reproduction and recruitment are necessary to maintain healthy brown trout populations and to help rebuild rainbow trout stocks decimated by whirling disease.

Flushing Flows: The flushing flows recommended in Table ES-1 range from a low of 40 cfs in Ranch Creek, a tributary of the Fraser River, to 2500 cfs for the Colorado River in Reach CR7. As with the summer and winter target flow ranges, the flushing flows progressively increase in a downstream direction with increasing drainage area and channel size. As the recommended flushing flows are based on the output of hydraulic and sediment transport models, they are not yet supported by empirical evidence of gravel mobilization and spawning success. The stream assessments and spawning survey results reported below provide some insight into the bedload transport processes and the condition of the intergravel environment at the time of trout redd construction. However, further field investigation into the need for and effectiveness of these initial flushing flow recommendations is likely warranted in future phases of this work. In the short term, under "learning by doing", pre- and post-flush comparisons of fine sediment concentrations within core samples collected from spawning beds within different channel types

could greatly enhance our understanding of the benefits of these higher magnitude, shorter duration flow events. In the longer term evidence of natural recruitment by brown trout and rainbow trout through periodic fish population monitoring could also help to answer questions regarding our flushing flow recommendations.

Ramping Rates: Field observations of stranded, desiccated trout redds, coupled with records of rapid stream flow changes have been identified by Tetra Tech as a possible issue below several major water storage facilities in Grand County. Stream reaches potentially affected include the Blue River below Green Mountain Reservoir, the William's Fork below William's Fork Reservoir, Muddy Creek below Wolford Mountain Reservoir, and the Colorado River below Granby Reservoir. Such flow fluctuations can adversely influence aquatic life, including fish, and also pose a human safety risk for recreationists and others along the river corridor. Rapidly rising stream flows could potentially re-locate fish and other aquatic life downstream into less favorable habitats, while rapidly declining flows can strand fish and other aquatic life in temporary habitats ultimately leading to desiccation and death (Reiser et al 2008). Also, flow reductions during important life cycle events such as spawning and incubation can lead to drying of developing embryos in redds and immobile fry attempting to emerge from the inter-gravel environment. While the magnitude of this problem in Grand County is not fully determined, desiccated trout redds have been observed on the Blue River through the Blue Valley Ranch and also downstream below the Trough Road. It is possible that this may be occurring in other tailwaters.

Streamflow Alterations: Streamflow regimes within Grand County are dramatically altered by water development. IHA results comparing 1911 - 1935 (pre-transbasin) with 1936 - 2007 (post-transbasin) for the Fraser River at Winter Park indicate that of the 33 hydrologic parameters evaluated, 18 were highly altered, 11 were moderately altered, and only 4 had low alteration (see Reach F3 Summary for results). Median monthly streamflows from May through November have been highly altered, with the range of monthly values reduced from 14 - 195 cfs prior to 1936 to 5.1 - 37 cfs in the post-development period. Likewise, the 1-, 3-, 7-, 30- and 90- day minimum and maximum flows have been dramatically reduced. For example, the median 3-day minimum has declined from 6 to 3.5 cfs, while the median 3-day maximum has been reduced from 273 to 145 cfs. Since 1971, streamflow has improved modestly on the Fraser when compared to the 1936 - 1970 period, although the regime is still substantially altered from the pre-development period. Sufficient streamflow records for the Colorado River were sufficient to compare pre- and post-Windy Gap flow conditions, but not sufficient to include impacts from the Moffat tunnel.

Previous Recommendations: The recommended environmental target flow ranges presented in the Reach Summaries and summarized in Table ES-1 have been slightly revised compared with the original 2008 Draft Flow Recommendations as noted below:

1. Critical and optimal flows have been combined into one recommendation representing a range of flows and defined as an environmental target flow range. The recommended environmental flow ranges are bounded on the upper end by the flow which provides the maximum habitat for the target species and life stage and on the lower end by the flow below which habitat is lost at the greatest rate.

2. Recreational flows have been combined into one range of recommended flows.

3. Recommended environmental target flows have been added for Fraser River (F3), Ranch Creek (F-RC1 and F-RC2), Troublesome Creek (TR) and Reeder Creek (RE).

4. The low end of the winter recommended environmental target flows have been slight adjusted, for several reaches on the Fraser River (F8, F9, F10), the Colorado River (CR3, CR4) and Blue

River based on water availability in the winter months as reflected in long term stream gage records. This resulted in slight increases to the low end of winter flow recommendations for CR4 and BR and slight decreases to the low end of winter flow recommendations for F8, F9 and F10.

5. In the 2008 Draft Report flushing flow recommendations were presented as a range of values with a minimum flow, based on sediment transport, and a maximum flow, based on bankfull capacity. This has been modified to eliminate the bankfull value so as to not imply there should be an upper limit on peak flows for the purposes of producing a flushing flow.

6. The minimum flushing flow recommendations have been further analyzed based on bedload transport for the particle size distribution of spawning gravels measured during the October 2008 trout spawning survey (see Appendix A). This resulted in increases for minimum flushing flows at F9, F10, F-StL, CR5, CR6, WR and CR7 and decreases for minimum flushing flows at F3, F6, F-VC, CR4, MC2 and WC.

Table ES-1. Summary of Recommended Target Flows

Reach Description [1]			Recommened Environmental Target Flows [2]				CWCB ISF Q, cfs		Other flows Q, cfs			Recommended Recreational Flows [2]		
			Target Flows Q,cfs		Flushing, cfs									
Reach ID	River	Section description	winter [3]	summer [3]	Recommended Minimum (3 days, 1 in 2 yrs)	Source	winter [3]	summer [3]	winter [3]	summer [3]	source	Kayaking Target Flows Q, cfs	Rafting Target FlowsQ, cfs	Angling Target FlowsQ, cfs
F1	Fraser River	US 40 to DW Diversion					2.5	6						
F2	Fraser River	DW Diversion to WPWSD intake							4	10	Forest service by-pass			
F3	Fraser River	WPWSD intake to Town of WP	4-10	4-10	80	Tt 2008	3.5	8	4	10	Forest service by-pass			
F4	Fraser River	Town of WP to Town of Fraser	10-30	20-30		Chadwick 1985	5	11	4.6	4.6	Brown and Caldwell 2003			60-200
F5	Fraser River	Town of Fraser to Fraser CWWTP					11	17						60-200
F6	Fraser River	Fraser CWWTP to Ranch Creek	40-50	40-60	200	Tt 2007	11	17						60-200
F7	Fraser River	Ranch Creek to mouth of Canyon					19	30				250-700		60-200
F8	Fraser River	Canyon	40-100	75-100		Chadwick 1985	19	30				350-900	500-1300	60-200
F9	Fraser River	Canyon to Granby	40-100	80-120	400	Tt 2007	19	30				350-900	500-1300	60-200
F10	Fraser River	Granby to Colorado River at Windy Gap	40-100	80-120	400		19	30				350-900	500-1300	60-200
F-JC	Fraser River Trib	Jim Creek					1.5/1	4	1.5/1	4	CWCB flows abv DW div			
F-VC	Fraser River Trib	Vasquez Creek between diversions	5-8	5-8	50	t 2007, Chadwick 198	3	6	3	8	Forest service by-pass			
F-RC1	Fraser River Trib	Ranch Creek (upper)	6-10	6-10	40	Tt2008	1.5	4	2	4	Forest service by-pass			
F-RC2	Fraser River Trib	Ranch Creek (lower)	20-30	30-50	150	Tt2008	5	8	2	4	Forest service by-pass			
F-StL	Fraser River Trib	St. Louis Creek	5-10	5-10	70	Tt 2007	3.5	6	3	10	Forest service by-pass			
F-TC	Fraser River Trib	Tenmile Creek					2	4						
CR-1	Colorado River	North Fork to Shadow Mountain												
CR2	Colorado River	Shadow Mountain to Granby Reservoirs					25	50						
CR3	Colorado River	Granby Reservoir to Windy Gap	40-100	90-160	200	Tt 2007	20	40	35-85 ab WC 42-100 bl WC 20	50-100 ab WC 65-130 bl WC 40-75	USFWS1951 USFWS1951 U.S.Dept of Interior 1961			
CR4	Colorado River	Windy Gap to Williams Fork	125-250	200-400	600	CDOW	90	90 w/450 flush				300-1600	700-2500	60-300
CR 5	Colorado River	Williams Fork to KB Ditch	150-250	250-500	800	Tt 2007; Miller 2007	135	135						60-300
CR 6	Colorado River	KB Ditch to Blue River Confluence	150-250	250-500	850	Tt 2007	150	150						60-300
CR 7	Colorado River	Blue River Confluence to County Line	400-600	600-1000	2500	Tt 2007			400-800 Oct-Nov 400-600 Dec-Mar	800-1000 Apr-Jun 600-1000 Jul-	SG Plan	See Reach summary for CR7 for detailed information.		450-1000
WR	Williams Fork	Below reservoir to Colorado River	40-100	40-140	200	Tt 2007			75-150 (10/1-11/30) 50-150 (12/1-3/31)	50-150 (4/1-6/30) 50-250 (7/1-9/30)	Chadwick 1997			50
MC1	Muddy Creek	Inflow to Wolford												
MC2	Muddy Creek	Wolford to Colorado River	30-60	60-90	350	Tt 2007	20 (7/15-4/30)	70 (5/1-5/14) 105 (5/15-6/30) 70 (7/1-7/14)						20
BR	Blue River	Green Mountain to Colorado River	200-300	200-300	1150	2009, Tt 2008, Tt 200	60 (7/16-4/30)	85 (5/1-7/15)				400-1000	550-1400	100-1200
RE	Reeder Creek	BLM fishing site to Colorado River	1.2	2.1	12	Tt 2008	2.5	2.5						
TR	Troublesome Creek	Hwy 40 to Colorado River	10	13	130	Tt 2008	5.9	9.3						
WC	Willow Creek	Reservoir to Colorado River	7-10	7-10	50	Miller 1996			7 or inflow		U.S. Dept of Interior 1961			

NOTES

(1) See reach summaries for details

(2) Recommended flows may or may not be present, depending on flow operations and natural hydrology of the watershed. these flows are achievable will be evaulated in Phase 3.

(3) Specific dates defining the beginning and end of summer versus winter flows vary depending on the reach location and the source of data and anlaysis. See the Reach Summaries for specific dates.

ES3.2 Spawning Survey

The brown trout spawning survey was conducted in October 2008 to 1) document spawning activity at and in the vicinity of our PHABSIM sites, 2) identify important spawning bars within Grand County that could be monitored under future water and land development conditions, 3) collect physical habitat data to verify the habitat suitability curves used for PHABSIM modeling, and 4) measure stream bed particle diameters from trout redds to develop a field-based particle size distribution plot for use with bedload transport modeling for flushing flow determinations. Methods are described in Appendix A. In total, 78 brown trout redds were identified and measured, with numerous other likely redds observed but not measured due to limited field time. Popular spawning habitats were identified in the middle and lower Fraser River (F5, F6, and F9; 16 redds measured), lower Ranch Creek (F-RC2; 10 redds measured), Colorado River just above Windy Gap (lower CR3; 8 redds measured), the Colorado below Windy Gap (CR 4, 5, and 6; 27 redds measured), lower Williams Fork (6 redds measured), lower Muddy Creek (MC2; 11 redds measured), and the lower Blue River below Trough Road (numerous redds observed but not measured due to rapidly changing streamflow). Habitat suitability curves developed from the water depth, velocity and substrate data collected at these redds were similar to, and verified the use of, the spawning curves used for the PHABSIM analysis (Figure ES-3). The substrate particle sizes selected by trout for spawning fell primarily within the gravel range, with a median particle size of 34 mm (Figure ES-4). Field observations indicated that substrate quality at spawning sites was commonly diminished by high fine sediment levels, especially in lower Ranch Creek, the lower Blue River, Muddy Creek (MC2), and upper CR4 (Figure ES-5).

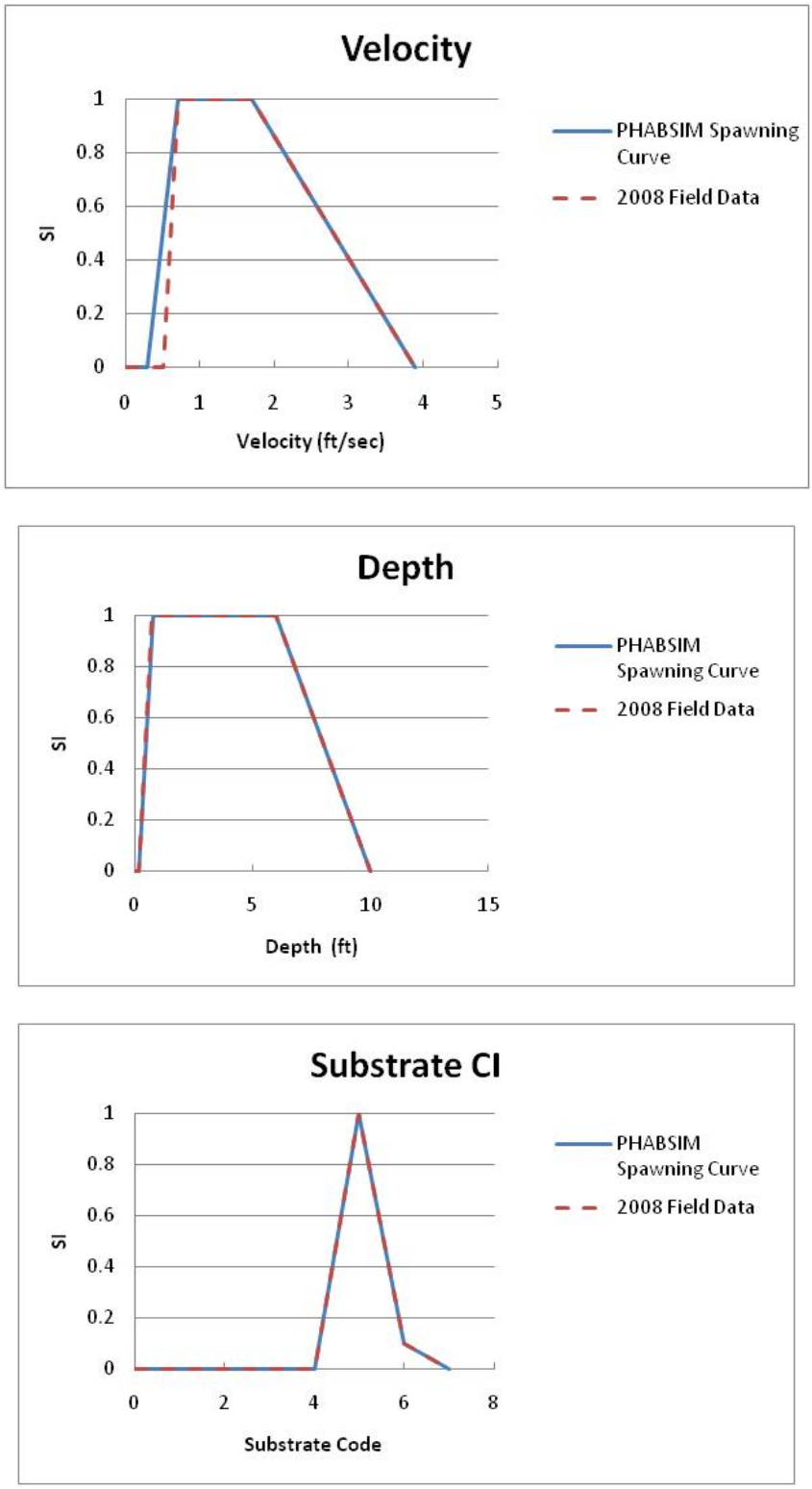

Figure ES-3. Spawning Suitability Curves
The velocity, depth and substrate channel index (CI) spawning suitability curves used for the PHABSIM studies as compared to trout redd data collected in Fall 2008.

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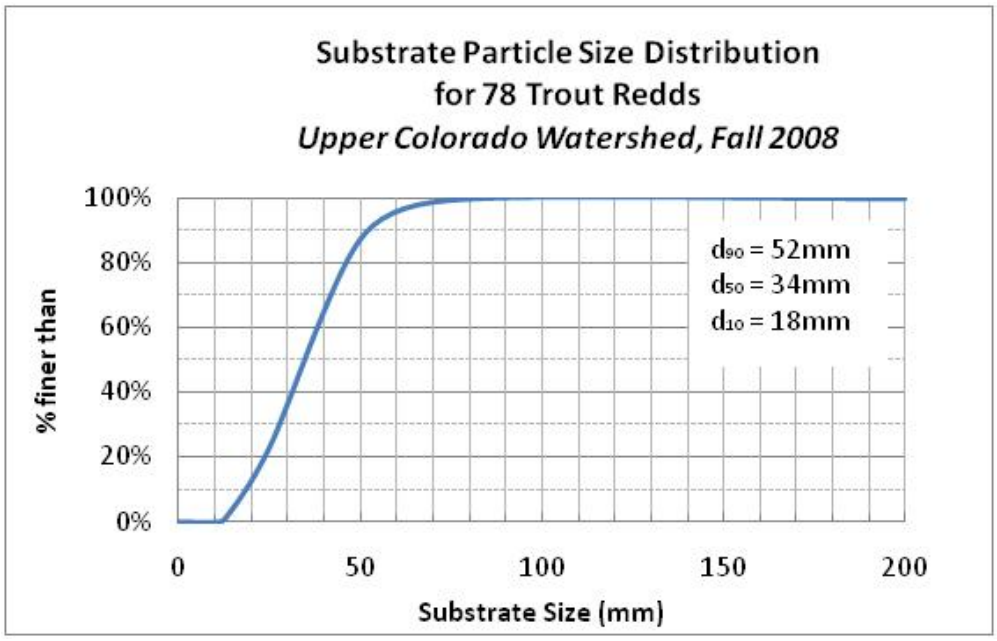

Figure ES-4. Substrate Particle Size Distribution Plot
Substrate particle size distribution plot of 78 trout redds collected in the Upper Colorado River basin, Fall 2008.

Figure ES-5 Embedded Spawning Bars

Upper left: Brown trout redds in a relatively "clean" spawning bar in Colorado River, CR5, below Parshall.
Upper Right: Brown trout redd in a moderately embedded spawning bar in F-RC2, lower Ranch Creek.
Lower Left: Brown trout redd in a highly embedded spawning bar in MC2, lower Muddy Creek.
Lower Right: Brown trout redd in a highly embedded spawning bar in upper Colorado River, CR4.

ES3.3 Stream Assessments

In 2008 and 2009 three evaluations were conducted at 29 locations within 22 of the project reaches. These reaches are identified in Table ES-2 and described in the Reach Summaries. The following is a brief description of these assessments and the subsequent results. Further detail can be found in Appendix A.

Stream Reach Inventory and Channel Stability Evaluations (SRI/CSE): SRI/CSE were conducted on stream sections county-wide from the headwaters of the Fraser River downstream to the Colorado River below Gore Canyon, including most tributaries (Table ES – 2). The SRI/CSE procedure was developed by the USDA Forest Service to provide a systematic measurement and evaluation of the resistive capacity of stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from potential changes in flow and/or increases in sediment production. Overall, 14 sections (45%) were found to be in "good" condition and 17 sections (55%) were rated "fair". No sections fell into the "excellent" or "poor" categories. Channels found to be in the best condition were typically the steeper streams with coarser substrates such as upper Ranch Creek (F-RC1), Vasquez Creek (F-VC) and the Fraser River canyon (F8), although reaches such as the middle Fraser River (F5 and F4) and the uppermost site on the Blue Valley Ranch (BVR-U) also were found to be quite stable. Channels found to be in the poorest condition were generally those having lower gradients, a more downstream location, and more intense land use (e.g. Willow Creek (WC), lower Muddy Creek (MC2), Troublesome Creek (TR), lower Fraser River (F9), lower Blue River below Trough Road (BR-L), Colorado River CR6, and lower Ranch Creek F-RC2). Typically these channels had more extensive stream bank erosion and fine sediment deposition than those channels in better condition. The upper Fraser River (F2) was also found to be in relatively poor condition due primarily to extensive sediment deposition resulting from highway sanding and under-sized culverts. The ratings for individual stream sections are presented and discussed in the Reach Summaries.

EPA Rapid Assessment Protocol: The EPA Rapid Assessment was conducted on the same 31 stream sections as the SRI/CSE. (Table ES – 2). This assessment is based on the protocol designed and approved by EPA for use nationwide, and provides procedures for a simplified visual-based field procedure to measure habitat characteristics relevant to a broad range of stream-dependent life forms. Overall, 27 sections (87%) were found to be in "suboptimal" condition while 4 sections (13%) were "marginal". These marginal sections included upper Colorado River Reach 3, Colorado River Reach 6, lower Muddy Creek (MC2), and Willow Creek (WC). No sections fell into the "optimal" or the "poor" condition categories. Individual attributes which commonly scored marginal or worse throughout Grand County included sinuosity (29 sections), aquatic structure and cover (12 sections), fish passage barriers (10 sections), bank stability (7 sections), riparian zone width (7 sections), water velocity and depth regime (6 sections), riparian vegetation cover (5 sections) and channel flow status on day of survey (5 sections). Regarding sinuosity, it should be noted the EPA protocol is heavily weighted in favor of highly meandering streams, a fairly rare characteristic of the Grand County landscape. The ratings for individual stream sections are presented and discussed in the Reach Summaries.

Riffle Stability Index (RSI): The RSI evaluates stream bed stability and particle mobility in riffle habitats of cobble/gravel bed rivers. The RSI protocol was employed in late summer 2008 to provide an assessment of bedload transport capability at 15 riffles within or near established PHABSIM sites. See Table ES-2 and Appendix A for locations of these riffles. A 16th site (CR3) was field measured but the results are not reported here as the 2008 antecedent high flow of just 92 cfs in this highly regulated reach was likely not of sufficient magnitude and stage to deposit large sediment particles on the adjacent point bar. As shown on Table ES – 2, 2008 spring runoff flows were exceptionally high in comparison to our recommended flushing flows, with peaks reaching as high as 6120 cfs in CR7. The average size of the largest particles mobilized and then deposited by the 2008 high flows ranged from 86 mm (small cobble) at the lower Blue River site (below Trough Road) up to 190 mm (large cobble) at F4, while the median particle sizes comprising the wetted bed of the riffles ranged from 34 mm (coarse gravel) at F-RC2 up to 100 mm (small cobble) at Vasquez Creek. These results suggest a high proportion of the riffle substrate at our sites was susceptible to mobilization and transport

during the 2008 spring runoff, as indicated by RSI scores ranging up to 98 (i.e. 98 % of the riffle bed particles susceptible to transport). The low proportion of fine sediment (% less than 2 mm) found in these relatively steep riffles (Table ES-2) suggest they were well flushed by the 2008 spring runoff. In comparison, the spawning bars identified at several sites (i.e. lower BR, CR4, F-RC2) in fall 2008 as part of the spawning survey, were quite heavily embedded with fine sediment which had deposited between the end of spring runoff and October. Several factors likely contributed to this observation, including 1) the spawning bars, commonly located just upstream of hydraulic controls and the downstream riffles have a lower gradient than the riffles; 2) the filamentous green algae which commonly develops over the summer months acts to filter out and deposit finer sediments being transported as suspended load; and 3) intensive and extensive land uses within Grand County are contributing to this sedimentation problem. Now that known spawning bars have been identified, future efforts to refine our initial flushing flow recommendations should focus on such areas. Also, efforts to reduce algae blooms and fine sediment loading to the river system will likely be instrumental in helping to maintain high quality spawning and incubation habitat.

Table ES-2. Summary of Stream Assessments

SITE	SRI/CSE	EPA	RSI	RIFFLE D_{50} (mm)	%<2mm	Average Diameter of Largest Particles Transported (mm)	2008 Peak Daily Average Q (cfs)	Recommended Minimum Flushing Q (cfs)
F2	90	112	-	-	-	-		
F3	83	139	90	76	2.5	170	100	80
F4	64	155	84	97	0.0	190		
F5	60	153	-	-	-	-		
F6	69	137	76	80	1.0	117	815	200
F7	81	146	-	-	-	-		
F8	63	149	-	-	-	-		
F9	96	125	93	70	0.0	121	1235	400
F10	70	142	-	-	-	-		400
F-JC	51	111	-	-	-	-		
F-VC	57	149	64	100	0.0	130		50
F-RC1	51	129	96	66	0.5	148		40
F-RC2	90	125	98	34	0.5	120		150
F-StL	71	128	73	82	0.0	113		70
CR3-UPPER	70	98	-	-	-	-		
CR3-L (PHABSIM)	83	136	-	-	-	-	83	200
CR4-U (PHABSIM)	79	129	93	92	0.0	180	1950	600
CR4-(BYERS CANYON)	69	127	-	-	-	-		600
CR4-L	88	138	-	-	-	-		600
CR5	69	150	97	82	2.0	161	3590	800
CR6	94	105	86	67	0.0	108	3460	850
CR7-Radium	78	155	92	50	0.5	100	6120	2500
WC	112	84	-	-	-	-		50
WR	79	145	80	91	0.0	148	1200	200
RE	65	141	-	-	-	-		12
TR	106	117	-	-	-	-		130
MC	110	96	87	59	1.0	106	915	350
BVR-U	63	158	-	-	-	-		1150
BVR-M	82	159	-	-	-	-		1150
BVR-L	77	139	-	-	-	-		1150
BR-L (PHABSIM)	93	132	98	40	0.0	86	1780	1150

ES3.4 Surface Water Temperature

Review of continuous temperature data from 2007-2009 revealed some exceedences in surface water temperatures in the Fraser River, Colorado River and several tributaries. The Colorado Department of Public Health and Environment has identified several reaches as having temperature impairment as defined by the Clean Water Act Section 303(d) (WCQQ). These are noted below and in the individual reach summaries.

Table ES-3. State of Colorado Section 303(d) list for Grand County Rivers

River Segment Description	Stream Reaches	Priority
Fraser River from Hammond Ditch downstream to confluence with Colorado River	F5, F6, F7, F8, F9, F10	Low
Colorado River from County Road 578 to confluence with Blue River	CR4, CR5, CR6	High
Ranch Creek	FRC1, FRC2	High
Muddy Creek from Woldford to Cow Creek	MC2	Monitor & Evaluate
Muddy Creek from Cow Creek to the Colorado River	MC2	High

Temperature data indicate that temperature exceedences typically occur in July and August. Of particular concern are exceedences of the MWAT on the Colorado River between Windy Gap and Williams Fork confluence, and exceedences of the DM on Ranch Creek. As water temperatures begin to exceed the optimum ranges for trout, fish activity levels decline, stress levels increase, growth is curtailed, and mortality rates may increase dramatically, especially along popular fishing areas where fish can be repeatedly stressed by angler capture and handling. Other trends observed from the three years of continuous data are summarized below.

- The warmest temperature readings were typically July to mid-August.
- The Colorado River between Windy Gap and Williams Fork consistently had the highest MWAT.
- Ranch Creek consistently had the highest DM readings.
- Releases from Granby and Willow Creek Reservoirs may be keeping CR3 water temperatures relatively low.
- Temperatures measured in CR7 were comparatively cool relative to the temperatures upstream most likely due to confluences of both the Blue River and Muddy Creek.
- Temperatures in Williams Fork, upper Fraser, Vasquez and St Louis are all below State Standards.

ES3.5 Water Quality

Review of water quality data indicates that most constituents are within guideline levels established for this study. Several specific issues are discussed briefly.

- pH: Review of the available pH data indicates that most readings fall within the acceptable guidelines. Exceptions occur between 1995 and 2004 at gages near Tabernash on the Fraser River, 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.

- Review of the available DO data indicates that most readings fall within the acceptable guidelines. One exception occurred at Williams Fork, where several readings fell below 6.0 mg/L.

- Phosphorous, although it is within acceptable levels, may, in combination with low flows and high water temperatures, be contributing to or exacerbating algae blooms.

- Filamentous algae were observed in most stream reaches within Grand County, as well as in Granby Reservoir, Shadow Mountain Reservoir and Grand Lake, referred to as the 'Three Lakes'. Algae can be a "nuisance", due to aesthetics, and clogging of pump intakes. Algae can also contribute to fish mortality as warm, still, or slow-moving water with high nutrient content (N and P) contribute to low dissolved oxygen content. As water temperature increases, the Petri dish effect magnifies the influence of N and P accelerating algae growth and continued decline in dissolved oxygen. Didymosphenia geminata (didymo) was also observed in several reaches over the past three years including Muddy Creek and the Colorado River below Windy Gap. Didymo can form large mats covering the bottom of the rivers. Although it is not considered a significant human health risk, it can affect stream habitats and sources of food for fish and make recreational activities unpleasant. Both filamentous algae and didymo could potentially contribute to, or accelerate sedimentation or aggradation by filtering fine sediments from the water column as flows move past the roughened surface.

- Copper: As of April 2010 several reaches on the Fraser River have been placed by the State of Colorado on the 303(d) list for monitoring and evaluation for copper. This includes F6, F7, F8, F9 and F10, extending from Hammond Ditch to the confluence with the Colorado River.

- Whirling disease: The Colorado River below Windy has been highly affected by whirling disease and elevated water temperatures, both of which may be exacerbated by the warm, nutrient rich environment of Windy Gap located immediately upstream. Studies of the spore triactinomyxon (TAM) production and introduction of whirling disease- resistant rainbow trout are two efforts concurrently ongoing to increase the rainbow trout populations. Nutrient loading at Windy Gap may warrant further study, in particular nutrient loading from water fowl that forage in the vicinity of the reservoir and defecate in the water.

- Moffat Tunnel Discharge: UPRR operates the Moffat Tunnel, which includes the discharge of groundwater seepage from the tunnel to both the east and west sides of the portal, as permitted by the Colorado Department of Public Health and Environment. Monthly monitoring data received from the state on UPRR's Moffat discharge indicate that some of the parameters are of concern, in terms of aquatic and stream health, including total suspended solids (TSS), iron, mercury, copper and lead. The magnitude of the problem for TSS and metals will most likely worsen as river flows are predicted to decrease with increases in diversions.

ES3.6 Water Users

Flow recommendations for water users tend to be highly variable, depending on use and user. Recreational flows, which tend to be the highest of the flow recommendations, are subjective and typically based on user opinion. In extreme cases flows could be sufficiently low that the recreational use is not physically possible such as boating in extremely shallow conditions. However, generally flow recommendations represent a range of values from tolerable to optimum experience. Key findings are presented below.

General: Current and future water demands, specifically municipal and domestic water supplies, are reported in the Upper Colorado River Basin Study (UPCO) (HRC 2003a). The UPCO report concludes

that many of the stream reaches within the study area are experiencing occasional water shortages under current conditions but will experience water shortages on an increasingly frequent basis, based on the assumed future conditions. The UPCO report defines current conditions as those present in the year 2000, and future conditions as those assumed in the year 2030 for Denver Water with full build-out for Grand County.

Irrigators/diverters: In general, most users are experiencing some difficulty in retrieving or using water, especially during the recent drought years. Many irrigators, especially along CR4 and CR5 are constructing make-shift cobble dams to divert flows into and through their headgates. In CR6 where diversions are made by pumping, flows are limited by the available supply as well as by nuisance clogging from algae growth. Some pump intakes must be cleaned daily to remove algae, and in some cases up to three times a day, for the pumps to operate properly (Thompson 2007).

Municipalities and Industrial Users: The UPCO report indicates that under future conditions most providers above and below the Town of Fraser and below the Fraser-Colorado confluence will experience shortages. Shortages will be the most severe for the Grand County Water & Sanitation District, occurring primarily in the fall and winter months (HRC 2003). Current conditions are defined in the UPCO report as conditions in the year 2000. Future conditions are based on full build-out for Grand County and anticipated development and water use in the year 2030 for Denver Water. Wastewater treatment plants discharge permits are based on certain minimum instream flows for determining water quality and quantity of the wastewater that can be discharged to the stream (HRC 2003a). In general the minimum flows identified for both current and future conditions for wastewater discharging are less than those recommended for environmental target flows. The UPCO report indicates that sufficient flows exist for proper dilution in the Colorado River under both current and future flow conditions (HRC 2003a). However, for the Fraser River, the UPCO report states that existing conditions are occasionally below minimum flow levels but under future conditions flows are predicted to be 'often' below the minimum flow levels. Here again current conditions are defined in the UPCO report as conditions in the year 2000, and future conditions are based on full build-out for Grand County and anticipated development and water use in the year 2030 for Denver Water. Site specific water user-related issues are presented in the Reach Summaries section of this report.

Recreational Flows: Reaches identified as important and/or popular for floatboating and angling are identified and associated with target flow ranges. These flows are presented in Table ES-1 and discussed in the Reach Summaries. An overview of recreational use for the Colorado and Fraser Rivers is presented below.

> Fraser River: In terms of floatboating, the Fraser River is a relatively small river, with adequate flows limited to the spring snowmelt runoff. Below Winter Park the Fraser traverses many private properties. Anglers will fish all along the Fraser River, particularly on public lands as well the privately developed Granby Ranch.
>
> Colorado River: The Upper Colorado, from Kremmling to the Grand-Eagle county line, has some of the most spectacular, high-quality floatboating in the west. Immediately below Kremmling, the Big Gore Canyon offers an extremely challenging class V boating experience. Downstream of the Big Gore are the Pumphouse and Radium runs with popular class III rapids that support a thriving commercial rafting industry. Byers Canyon, near Hot Sulphur Springs, is also a popular kayaking run; however the flows are often too low, and the run very short, for a high quality boating experience.
>
> The Colorado River from the confluence of the Fraser to Troublesome Creek is a designated Gold Medal fishery by the Colorado Wildlife Commission and is known as an outstanding section for

wading-anglers with excellent accessibility via public access points along U.S. Highway 40. Downstream of Pumphouse the Colorado River is managed as a "Wild Trout" area, and is also a very popular reach to fish with many anglers fishing from river dories and rafts, especially with commercial guides. Here again access is excellent due to abundance of public property.

ES3.7 Other Considerations

Climate Change: The Colorado Water Conservation Board (CWCB) recently published a report on climate change with particular emphasis on Colorado. Highlight that are relevant to Grand County are noted as follows:

1. Colorado air temperatures have warmed on the average 2^{o}F over the past 30 years. Model projects indicate an addition average warming trend of 2.5^{o}F by the year 2025 (CWCB). Because air temperature is the primary factor in surface water temperature, it can be expected that surface water temperatures will continue to be elevated, particularly without restoration.
2. In terms of precipitation, no consistent long-term trends have been detected although there is an overall shift in precipitation moving toward more rainfall and less snow. Spring runoff has shifted by two weeks, occurring earlier in the year and snowpack below 8200 feet in elevation is projected to drop 'precipitously'. Overall, runoff in the Colorado River watershed is projected to decline by an estimated 5% to 20% in the 21st century as compared to the 20th century (CWCB). The reduction in water availability from snowpack runoff, when combined with increased demand from the front range as a result of growth plus a reduction in low elevation snowpack, could result in increased pressures on Grand County Rivers. Thus establishment of the target flow ranges and implementation of the restoration opportunities are critical to protect the aquatic resource.

Within Grand County there are several other State and Federal programs currently in progress that are relevant to this SMP. This includes Wild and Scenic Suitability analysis and CDOW Colorado Cutthroat conservation strategy program. The impacts of these programs on the Stream Management Plan are yet unknown; however, it may be that future study efforts, management strategies and/or prioritizations of reaches will consider these program recommendations. These programs are discussed below.

Wild and Scenic Rivers: In March 2007 the U.S. Department of Interior, Bureau of Land Management (BLM) completed the Final Wild and Scenic River Eligibility Report for the Kremmling and Glenwood Springs Field Offices, as part of the resource management plan revision process. As of August 2010 the Colorado River from the upstream limits of Gore Canyon to Glenwood Springs is being considered for suitability, which includes CR7 in this SMP. Alternatives are being formulated including a locally preferred alternative being developed by a stakeholders group comprised of east and west slope agencies, water providers and municipalities. This SMP proposes to endorse, support and incorporate recommendations from the Wild and Scenic Alternative and as such may require some modification as both the Wild and Scenic Plans and this SMP evolve. See the reach summary for CR7 for details.

Colorado River Cutthroat Recovery: The Colorado River cutthroat trout (CRCT) now inhabits only a few upper reaches of the Colorado River system. Native cutthroat trout require clear and cold water, naturally-fluctuating streamflows, low levels of sediment, well-distributed pools, stable streambanks, and abundant stream cover. Widespread introductions of non-native salmonids over the last century have served to limit current distributions of CRCT to isolated headwater streams and lakes. The CRCT is down to about 6% of its historic habitat within the upper Colorado River drainage. CDOW has developed a CRCT conservation strategy to assure the long-term viability of CRCT throughout their historic range (CRCT 2006). In short, aquatic habitats that currently support populations of CRCT will be maintained and additional suitable

habitat areas will be managed to increase CRCT populations. In addition, new populations will be established where ecologically and economically feasible. Several tributaries within the study area are included in the CDOW conservation strategy and are noted in the Reach Summaries. This SMP proposed to endorse, support and incorporate recommendations from CDOW for protection of existing or establishment of new CRCT populations, and as such may require some modifications as CDOW develops their strategy plan.

ES4. Restoration Opportunities

This section presents the initial framework for developing a restoration plan for the reaches studied in this SMP. This is the initial framework and additional design will be required as well as extensive stakeholder coordination for implementation. The primary objective here is to enhance and maintain the aquatic habitat within the study area. To begin the process, the key issues within each reach are identified as well as corresponding restoration opportunities to address these issues. Key issues identified throughout this SMP include adequate flows and flow regimes for support of stream health and aquatic habitat; adequate flows for local water users including diverters and recreational uses; water temperatures that are supportive of cold water fisheries; water quality; excessive sediment deposition; and the presence of algae.
In 2009Denver Water and NCWCD committed to a Mitigation/Enhancement Proposal consisting of four categories of measures: Stream Flow/Water Supply, Water Quality, Aquatic Habitat and Cooperative Measures. This proposal is shown in **Appendix F, Restoration Opportunities**. Negotiations on the details of this proposal are on-going.

With regard to the 2009 Denver Water and NCWCD proposal, restoration opportunities addressed in this SMP generally fall into the categories of Stream Flow/Water Supply (referred to here as flow enhancements) and Aquatic Habitat (referred to here as physical restoration). Cooperative measures are also going to be applicable as part of the implementation process and as part of the 'Learning by Doing' process. Thus restoration opportunities presented herein generally fall into one of two categories, flow enhancements and physical restoration. Included with flow enhancements are flushing flows and ramping guidelines as discussed below.

> ***Flow Enhancements***: The 'Stream Flow/Water Supply' measures (flow enhancements), include five potential sources of water, totaling 11,200 ac-ft which would be delivered through several different systems for the purpose of enhancing or augmenting low flows. There are a variety of potential applications, some of which were evaluated and are presented in Appendix F.
>
> *Ramping Guidelines*: Although ramping guidelines below large reservoirs were not included in the original flow enhancement proposal, they are being presented for consideration as part of the overall restoration effort of this SMP. Rapid changes in streamflow (ramping) have been identified as a possible issue below several major water storage facilities in Grand County. Three regional approaches that may be applicable have been identified and are outlined in Appendix F.
>
> *Flushing Flows:* Field observations indicated that substrate quality at spawning sites was commonly diminished by high fine sediment levels, especially in lower Ranch Creek, the lower Blue River, Muddy Creek (MC2), and upper CR4 (Figure ES-5). Thus these reaches are good candidates for use of enhancement flows to augment flushing flows. However, use of flow enhancement water for augmenting flushing flows on either the Colorado or Fraser Rivers, or their tributaries, will require further evaluation and detailed consideration to ensure that it is used effectively (specifically not all used up in a single flush if late summer flows are also needed) and in a manner that does not interfere with existing water rights and water operations throughout the Upper Colorado River basin. In addition, the application of enhanced flushing flows must also consider the capacity of the downstream river reaches, most importantly hydraulic structures such as bridges and culverts, to ensure adequate conveyance of enhanced flows.
>
> ***Physical Restoration:*** Physical restoration is proposed in many reaches to improve in-stream habitat in flow-limited reaches by increasing channel flow depths; providing in-stream habitat features (cover) and channel diversity; restoring and protecting riparian habitats; enhancing fish passage to increase connectivity within or between reaches; and reducing elevated water

temperatures. A range of different restoration elements are identified to achieve these objectives, including instream habitat features such as large woody debris structures, channel bar enhancements, and boulder structures; channel bank revegetation; channel restoration; enhanced fish passage; irrigation diversion and pump intake improvements; overbank BMPs and the construction of a sediment basin.

These restoration opportunities are applied to the reaches as appropriate, integrating the environmental flow recommendations, stream assessments, water temperature and water quality reviews, and considerations for local water users. This forms a matrix of elements, or a restoration framework, on a reach by reach basis. Included in this analysis is a ranking system (see Appendix F), developed to prioritize reaches and implementation. Table ES-4 presents a summary of restoration recommendations, organized in order of ranking from the highest priority (lowest ranking number) to lowest priority. Note that each study reach may also include specific issues and restoration opportunities that are unique to the reach and/or particular uses within the reach. The restoration elements common to most reaches are described briefly below and presented in detail in Appendix F. Specific issues and restoration opportunities are noted in Table ES-4 and discussed in detail in the individual Reach Summaries.

- ✓ Apply enhancement flows to increase low flows, typically in August and September and/or to increase or augment flushing flows during spring runoff. Alternate application of enhancement and flushing flows as needed.

- ✓ Increase aquatic structure and cover with 'cover and pool' structures and construct channel bar enhancements to narrow the low flow channel.

- ✓ Inspect headgates at irrigation diversions and replace as needed where stream bed manipulation is currently required to maintain adequate headwater.

- ✓ Assess benefits of fish passage enhancement around existing dams and diversion structures.

- ✓ Practice and enforce effective Best Management Practices (BMPs) associated with local construction and land uses for the control of sediment runoff.

- ✓ Consider site-specific bank and trail restoration to stabilize the areas impacted from public use. This might include formalizing footpaths and soil stabilization of fishing access points.

- ✓ Explore river restoration and public access improvement opportunities.

- ✓ Implement ramping guidelines.

Table ES-4. Summary of Restoration Opportunities

Reach Description			RANKING	Restoration Opportunities										
Reach ID	River	Section description		Apply enhancement flows to low flows	Apply enhancements to flushing flows	In-stream habitat features	Channel bank revegetation	Channel restoration	Enhance fish passage	Irrigation diversion and pump intakes	Overbank BMPs	Sediment Basin	Ramping Guidelines	Notes
CR4	Colorado River	Windy Gap to Williams Fork	-6	√	√	√		√	√	√				Highly impacted reach; recommendations include both enhancements and physical restoration
F2	Fraser River	DW Diversion to WPWSD intake	-3	√	√						√	√		Flow enhancements, sediment basin, passage of spawning gravels and Moffat tunnel discharge treatment are recommended
CR3	Colorado River	Granby Reservoir to Windy Gap	-3	√	√	√				√	√		√	Previous and ongoing restoration is extensive. Additional study is recommended. Flow enhancements for CR4 will improve CR3
F-RC2	Fraser River Trib	Ranch Creek ds of gage to confluence	-2	√	√	√	√	√						F-RC2 benefits from flow enhancements recommended for F-RC1
F-RC1	Fraser River Trib	Ranch Creek to ds of gage	-2	√	√									Investigate culvert capacities downstream to accommodate increased flushing flows
F3	Fraser River	WPWSD intake to Town of WP	-2								√			Recommendations in F2 will provide benefits in F3
MC2	Muddy Creek	Wolford to Colorado River	-2	√	√			√	√		√		√	Allow stream to stabilize before developing restoration recommendations
F4	Fraser River	Town of WP to Town of Fraser	-2			√					√			Recommendations in F2 will provide benefits in F4
CR1	Colorado River	North Fork to Shadow Mountain	-1											Additional study required in conjunction with Red Top diversion changes
CR 6	Colorado River	KB Ditch to Blue River Confluence	0			√				√				Recommend additional study to address grade control structures
CR 5	Colorado River	Williams Fork to KB Ditch	0			√				√				CR5 benefits from flow enhancements in CR4
F6	Fraser River	Fraser CWWTP to Ranch Creek	0				√	√			√			Partner on existing projects
F7	Fraser River	Ranch Creek to mouth of Canyon	0			√	√							Consider public access and trail enhancements
F8	Fraser River	Canyon	0											Consider public access
F9	Fraser River	Canyon to Granby	1					√						Partner on existing projects
BR	Blue River	Green Mountain to Colorado River	1				√						√	Develop ramping and flow management strategies to support spawning
CR 7	Colorado River	Blue River to County line	1											Maintain target flows and support recommendations from Wild and Scenic alternative
F5	Fraser River	Town of Fraser to Fraser CWWTP	2								√			
F10	Fraser River	Granby to Colorado River at Windy Gap	2						√					
F-StL	Fraser River Trib	St. Louis Creek	4					√						Support efforts to restore native cut throat populations
F1	Fraser River	US 40 to DW Diversion	5								√			
WR	Williams Fork	Below reservoir to Colorado River	7										√	Monitor for and address low DO levels
F-VC	Fraser River Trib	Vasquez Creek	*						√					
F-JC	Fraser River	Jim Creek	*											No recommendations made at this time
WC	Willow Creek	Reservoir to Colorado River	*											No recommendations made at this time
MC1	Muddy Creek	Inflow to Wolford	*											No recommendations made at this time
F-TC	Fraser River	Tenmile Creek	*											No recommendations made at this time
CR2	Colorado River	Shadow Mountain to Granby Reservoi	*											No recommendations made at this time
TR	Colorado Trib	Hwy 40 to confluence	*											No recommendations made at this time
RE	Colorado Trib	Cty Rd 33 to confluence	*											No recommendations made at this time

ES5. Learning by Doing (Aka Adaptive Management)

The goal of this SMP is to highlight the need for 'Learning by Doing' which is one element in the overall Plan Implementation structure. In the context of the SMP, 'learning by doing' includes the monitoring, evaluation and adjustment of restoration opportunities, including flow enhancements, for the purpose of meeting pre-established goals. This is not an exhaustive discussion nor will it include detailed specifications. It will, however, present the frame work for moving forward with the development of a 'learning by doing' strategy in concert with restoration planning. Note that there is a relatively extensive effort currently already in-place for some of the recommended parameters including surface water temperatures and water quality. Thus the implementation of some of these recommendations will require a relatively minimal effort to complete a logical basin-wide program to monitor future flow alternations and support restoration efforts.

ES5.1. Monitoring Plan

Integral to the 'learning by doing' process and the restoration efforts outlined in this SMP is the development of a monitoring plan. Monitoring results will allow the Stakeholder Group to evaluate the effectiveness of restoration, including the application of flow enhancements, and to help guide the decision processes for future improvements, operations and management decisions. Recommendations presented here are conceptual in nature and intended to provide a frame work for implementation. Further, monitoring recommendations for a given reach will depend on 1) the key issues being addressed by the restoration effort, and 2) the specific techniques being used to protect, restore and/or enhance environmental flow conditions.

The type and degree of monitoring could also vary from reach to reach depending upon the type and level of management actions being taken. For example in some reaches it may only be necessary to monitor fish populations while in others, monitoring of cross sections, temperature and/or flow may be recommended. A list of potential monitoring parameters is presented in Appendix F, including its purpose and several general recommendations for implementation.

Table ES-5 provides a summary of preliminary monitoring recommendations on a reach by reach basis, presented in order of priority established for restoration implementation. Additional details are presented in the individual reach summaries. Note that some of the recommendations presented here and in the reach summaries may be accomplished by consolidating efforts to a few pre-selected, representative reaches. For example, monitoring of surface water temperatures is recommended for most of the reaches. However, it may be possible to accomplish this by monitoring temperatures in half of the reaches and interpolating in between. This would also be true of air temperatures.

If implemented, a monitoring program such as that described in Table ES-5 should provide the basic information needed to track the long term health of Grand County streams and the response of the aquatic ecosystem to changes in flow regime, channel morphology, habitat quality, water temperature, water quality, and connectivity resulting from the various enhancement measures implemented.

ES5.2. Stakeholder Group

Ultimately, implementation of the SMP will require oversight by an involved and committed Stakeholders Group. This will require establishing open lines of communication and procedures on decision making, budgeting, and scheduling for implementing restoration and enhancement measures and for developing, conducting and evaluating a detailed monitoring program. Through this role, the Stakeholder Group will oversee the 'Learning by Doing' process.

Table ES-5. Preliminary List of Potential Monitoring Recommendations

Reach Description			RANKING	Potential Monitoring Parameters									
Reach ID	River	Section description		Surface water temperatures	Air temperatures	Stream flows	Intergravel fine sediment concentrations	Fish population and diversity	Benthic macro invertebrates	Channel cross sections and assessments	Water quality and algae	Recreational Use	Special Notes
CR4	Colorado River	Windy Gap to Williams Fork	-6	√	√	√	√	√	√	√	√		Monitor for whirling disease. Replace stream gage at Hot Sulphur. Assess ramping rates. Continue to evaluate stonefly extrication.
F2	Fraser River	DW Diversion to WPWSD intake	-3			√	√			√			Install new gage at DW diversion. Monitor traction sand.
CR3	Colorado River	Granby Reservoir to Windy Gap	-3	√	√	√				√			assess ramping rates.
F-RC2	Fraser River Trib	Ranch Creek ds of gage to confluence	-2	√	√	√	√	√		√	√	√	Install new gage
F-RC1	Fraser River Trib	Ranch Creek to ds of gage	-2	√		√							
F3	Fraser River	WPWSD intake to Town of WP	-2			√	√			√			
MC2	Muddy Creek	Wolford to Colorado River	-2	√	√	√	√	√		√	√		ramping rates.
F4	Fraser River	Town of WP to Town of Fraser	-2					√	√	√			Monitor Fraser River Enhancment restoration
CR-1	Colorado River	North Fork to Shadow Mountain	-1			√							New study site required for implementation of 10825
CR 6	Colorado River	KB Ditch to Blue River Confluence	0	√	√	√					√		Add stream gage at Highway 9
CR 5	Colorado River	Williams Fork to KB Ditch	0	√	√	√	√	√	√	√	√	√	
F6	Fraser River	Fraser CWWTP to Ranch Creek	0	√	√						√		Identify high pH source
F7	Fraser River	Ranch Creek to mouth of Canyon	0	√	√						√		Identify high pH source
F8	Fraser River	Canyon	0	√	√						√	√	
F9	Fraser River	Canyon to Granby	1	√	√		√	√			√		
BR	Blue River	Green Mountain to Colorado River	1			√	√						Collect streamflow data to more thoroughly assess ramping rates.
CR 7	Colorado River	Blue River to County line	1	√	√	√		√			√	√	Perform spawning surveys. Additional monitoring may be required in Wild and Scenic Alt
F5	Fraser River	Town of Fraser to Fraser CWWTP	2										No recommendations made at this time
F10	Fraser River	Granby to Colorado River at Windy Gap	2	√	√			√			√		
F-StL	Fraser River Trib	St. Louis Creek	4			√							
WR	Williams Fork	Below reservoir to Colorado River	7			√					√		Collect streamflow data to more thoroughly assess ramping rates.
F1	Fraser River	US 40 to DW Diversion	5										Track maintenance requirements for the sediment basins
F-VC	Fraser River Trib	Vasquez Creek	*			√							
F-JC	Fraser River Trib	Jim Creek	*										No recommendations made at this time
WC	Willow Creek	Reservoir to Colorado River	*										No recommendations made at this time
MC1	Muddy Creek	Inflow to Wolford	*										No recommendations made at this time
F-TC	Fraser River Trib	Tenmile Creek	*										No recommendations made at this time
CR2	Colorado River	Shadow Mountain to Granby Reservoirs	*										No recommendations made at this time
TR	Trib	Hwy 40 to confluence	*										No recommendations made at this time
RE	Trib	Cty Rd 33 to confluence	*										No recommendations made at this time

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