Dolores River – Nonpoint Source Pollution Watershed Plan

A project of the Dolores River Dialogue (DRD)

Healthy Watershed, Healthy River, Healthy Economy and Healthy Communities

Protecting and maintaining watershed health while ensuring the persistence of native fish in the Dolores River, honoring water rights and protecting local agriculture.

June 2013

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http://ocs.fortlewis.edu/drd/

The Dolores River Dialogue Steering Committee would like to thank everyone who contributed to the development of this plan and especially consultants and writers Ann Oliver and Jeff Kane. Additional writing contributions were made by Gail Binkly, professional writer, Matt Clark, Trout Unlimited, Ken Curtis and Don Schwindt, Dolores Water Conservancy District (DWCD), Marsha Porter-Norton, facilitator for the Dolores River Dialogue, and Chester Anderson with B.U.G.S. Consulting. Please find a description of the Dolores River Dialogue as well an organizational chart in Appendix 1.

The Dolores River Dialogue (DRD) is a coalition of diverse interests, whose purpose is to explore management opportunities, build support for and take action to improve the ecological conditions downstream of McPhee Reservoir while honoring water rights, protecting agricultural and municipal water supplies, and the continued enjoyment of rafting and fishing. You can find scientific reports and studies, meeting minutes, handouts, maps and much more at the DRD Web site: http://ocs.fortlewis.edu/drd/

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1. Introduction and Background

This Nonpoint Source Pollution Watershed Management Plan (hereafter, the Plan) is part of a coordinated stakeholder effort, led by a coalition called the Dolores River Dialogue, or DRD. The DRD's purpose statement is as follows:

> . . . [T]o explore management opportunities, build support for and take action to improve the ecological conditions in the Dolores River downstream of McPhee Reservoir while honoring water rights, protecting agricultural and municipal water supplies, and the continued enjoyment of boating and fishing.

This watershed plan describes some of the results of a collaborative watershed planning effort to identify nonpoint sources of pollution that may be impacting aquatic life in the Lower Dolores River, additional information needed about such nonpoint source pollution, and potential management opportunities and other actions to reduce any such impacts.

The particular focus of this effort is the conservation of native fish. In recent years, there has been a growing consensus among the DRD participants and the communities affected by and dependent on this watershed that working on ensuring the persistence of native fish in the river is a goal. Also, the Tres Rios Office of the Bureau of Land Management has concluded that one specific native fish, the roundtail chub, is an Outstandingly Remarkable Value for purposes of the federal Wild and Scenic Rivers Act. There are stakeholders who care about native fish for their intrinsic ecological value and there are stakeholders who desire to prevent these fish from being threatened with extinction in the Lower Dolores River and from being classified as threatened or endangered under the Endangered Species Act. These shared interests have brought together conservation groups, county and state and federal governments, water managers and organizations, fishing groups, and recreationists to learn, plan, monitor and develop actions to promote the continued viability of the native fish. Accordingly, the objective of this Plan is to identify potential opportunities to improve and maintain watershed health through identifying and managing nonpoint source pollution downstream of McPhee Reservoir that may be detrimental to aquatic life in general and to native fish communities in particular.

For the purposes of this document, the Lower Dolores River refers to the reach from McPhee Dam to the confluence with the San Miguel River (Figure 1). This reach is the focus of the Plan because it is expected that actions carried out by the DRD and/or other partners in this reach will most directly affect the native fishery. Below the confluence with the San Miguel River, native fish populations are influenced significantly by the substantial flows of the San Miguel River, and their densities and size structure improve.

This Plan was prepared under the direction of the Steering Committee of the DRD. The Steering Committee reports to the full DRD and is comprised of a number of DRD member organizations intended to represent the array of interests of DRD members while keeping the Committee at a workable size for overseeing DRD activities.[1] While the Steering Committee does not have final decision-making authority on behalf of the DRD, it is empowered to as the clearing house for DRD activities. A group called the Lower Dolores Plan Working Group (LDPWG) helped provide stakeholder coordination and outreach for this Plan as well. The LDPWG convened in 2008 to develop and submit a report to the Dolores Public Lands Office (USFS/BLM) that makes recommendations regarding an update to the current management plan for the Lower Dolores River. The group was also asked to determine if they could find an alternative to the Lower Dolores River continuing as being "suitable" for the Wild and Scenic River designation Please refer to Appendix 1 for additional background on the DRD, Steering Committee, LDPWG, a DRD organizational chart.

The Plan's preparation was funded by a Colorado Nonpoint Source Program grant awarded by the Colorado Department of Public Health and Environment's Water Quality Control Division. In addition, "core DRD" funds provided a match. Those funds were contributed by the Colorado Water Conservation Board, Southwestern Water Conservation District, Dolores Water Conservancy District, The Nature Conservancy, San Juan Citizens Alliance, Montezuma Valley Irrigation Company, and Dolores County.

[1] The Steering Committee includes representatives from Bureau of Reclamation, Colorado Parks and Wildlife, Dolores Water Conservancy District, Montezuma Valley Irrigation Company, The Nature Conservancy, San Juan Citizens Alliance, American Whitewater, San Juan Basin Farm Bureau, Southwestern Colorado Livestock Association, and Trout Unlimited.

Figure 1: General Location Map of the Dolores River Basin

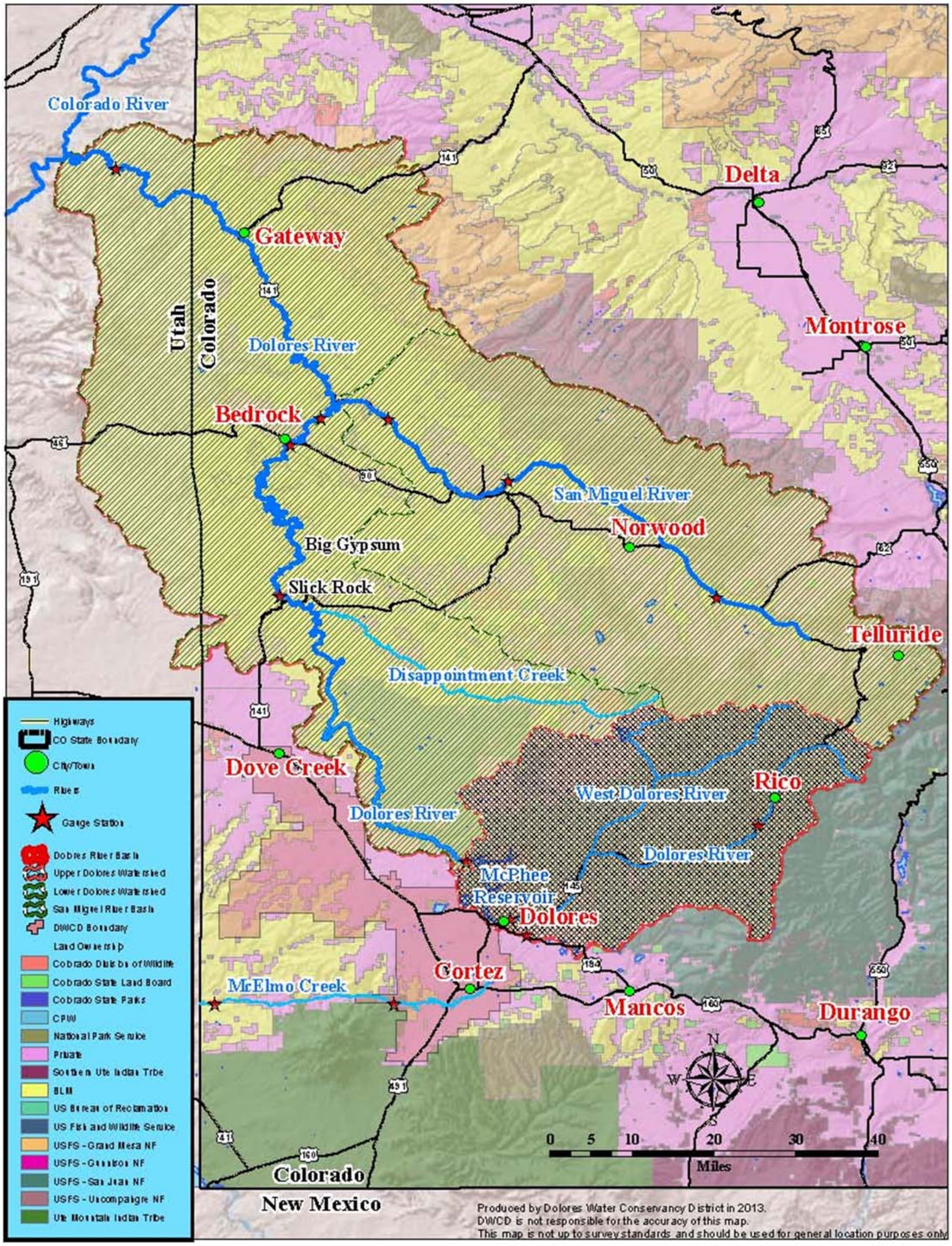


Figure 2: DRD Map of the Identified Reaches

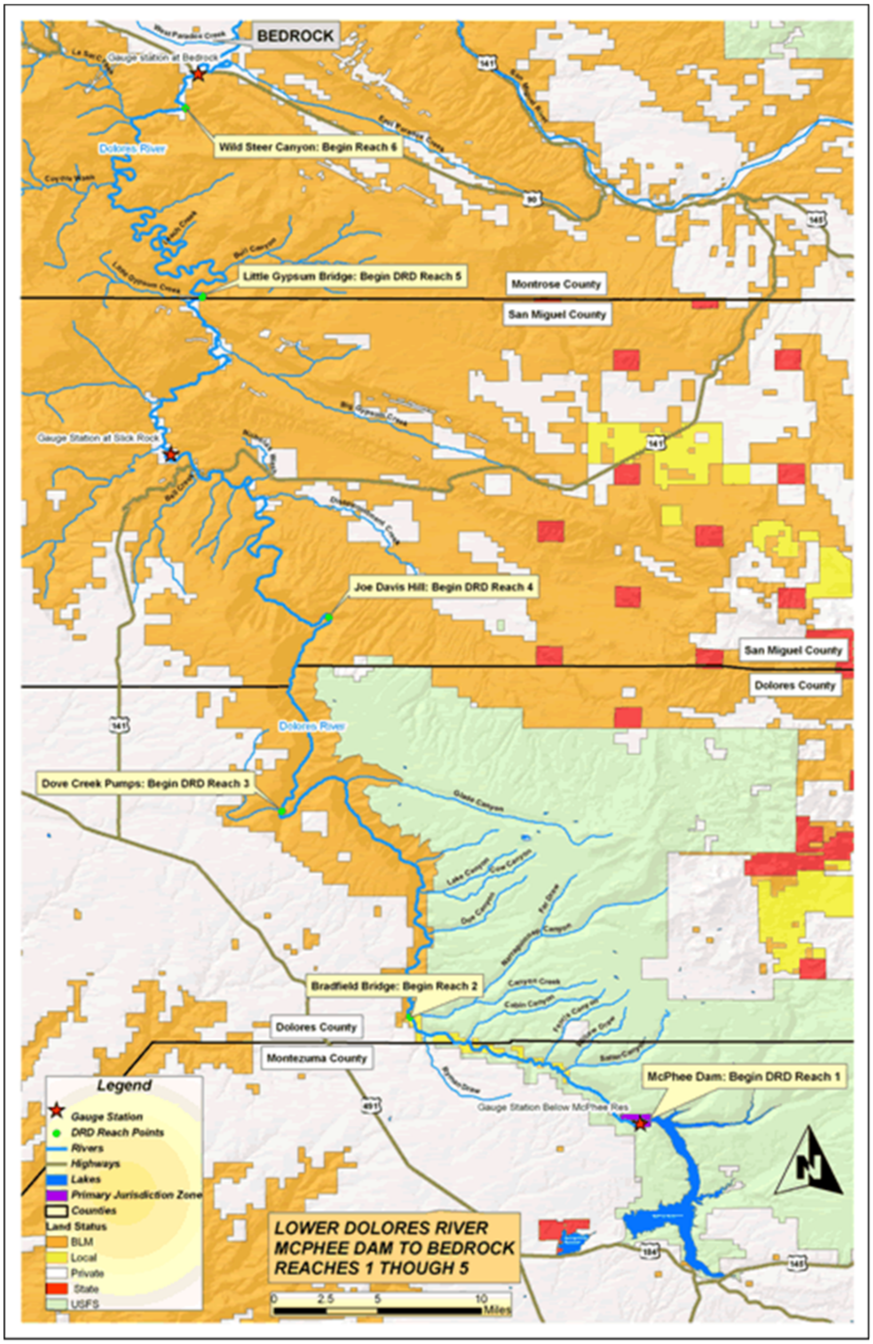
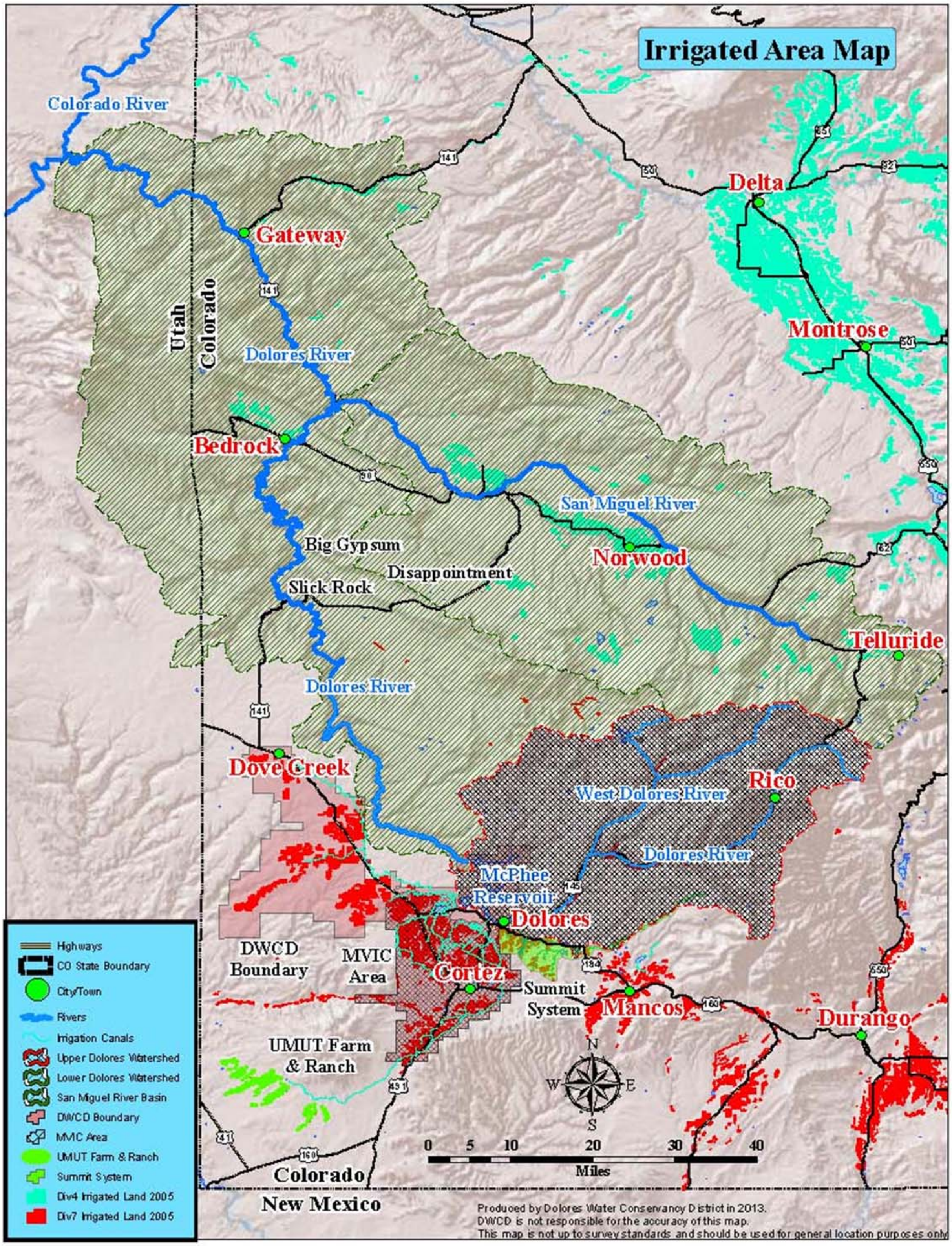


Figure 3: Irrigated Area Map



The DRD's mission statement was formulated in recognition that actions could be taken to improve the ecological condition of the Lower Dolores River while honoring water rights, protecting agricultural and municipal water supplies, and the continued enjoyment of rafting and fishing. Water rights perfected under state law and agreements required to develop significant storage of Dolores River flows in McPhee Reservoir as part of a federal reclamation project enhanced the availability and certainty of water supplies, enabling these Southwestern Colorado rural communities in Montezuma and Dolores counties to develop (see Figure 3 above). Subsequent developments in water law as well as federal environmental legislation have affirmed the environment as an integral part of the Dolores Project's obligations, thus creating the impetus for the DRD. Accordingly, identifying potential actions to achieve the DRD's mission requires a detailed understanding of the geography, environment, social history, and history of settlement and water use in the region. Appendix 2 was created to facilitate that understanding.

The DRD's history and the results of the stakeholder coordination completed to develop this Plan demonstrate that the success of this watershed planning effort requires that the Plan identify opportunities for improving aquatic habitat conditions that are compatible with supplying water to local farms, ranches, towns and cities, supporting economic development, and promoting the enjoyment of recreational boating and fishing. As discussed by local farmers and others in Appendix 3, the Dolores River is the lifeblood of the communities that have developed not only in the Dolores River Basin but also in the McElmo Creek drainage, which is tributary to the San Juan River, through trans-basin diversions from the Dolores River. Without the Dolores River water that was primarily diverted by Montezuma Valley Irrigation Company and its predecessors, the Town of Cortez and the entire agricultural community around it would never have been established. Through the development and operation of the Dolores Project, significant strides have been made in supporting the development of the Montezuma Valley, Dolores County, and McElmo Creek basin economies while also seeking to minimize the effects of operating McPhee Dam on the aquatic community and boating opportunities downstream of the Dam. But there are a wide diversity of opinions among stakeholders related to conditions downstream of the Dam in terms of the fisheries (both native warm-water fish and cold-water trout), riparian health and boating, and there are many ideas for improvement or change in each of these areas while balancing water supplies and Dolores Project commitments.[2] Because the purpose of a nonpoint source pollution watershed plan is to identify non-regulatory opportunities for voluntary actions that can be taken through collaborative approaches to address nonpoint source pollution, the DRD chose this planning process to explore and identify any opportunities related to water quality that might further the goals of improving conditions for the native fishery.

a. What is a Nonpoint Source Pollution Watershed Plan?

> The **Clean Water Act (CWA)** establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating the quality of surface waters. Under the CWA, EPA, states, and Indian tribes implement pollution control programs such as setting wastewater standards for industry and water quality standards for contaminants in surface waters. The CWA also makes it unlawful to discharge any pollutant from a point source into navigable surface waters without a permit under EPA's National Pollutant Discharge Elimination System (NPDES). Nonpoint sources of pollutants are not regulated by permits, but instead through voluntary measures, such as best management practice (BMP) implementation and pollutant trading with point sources.

Nonpoint source (NPS) pollution, as opposed to point source pollution from individual point-source discharges (e.g., wastewater treatment plants) is pollution originating from diffuse land-use activities that is carried into water bodies by runoff. The 1987 amendments to the Clean Water Act established the Section 319 Nonpoint Source Management Program. Section 319 addresses the need for greater federal leadership to help focus state and local nonpoint source efforts. Under Section 319, states, territories and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects. It is important to note that a

[2] Stakeholders have also been considering implementation of other conservation strategies that are compatible with existing water rights and Project allocations, such as predator control and eradicating non-native fish from warm-water native fish habitat, but that do not directly involve improving or protecting water quality.

nonpoint source pollution watershed planning effort is a non-regulatory program designed to promote local, voluntary planning efforts to deal with nonpoint source pollution

The Environmental Protection Agency has identified nine key components to be included in nonpoint source pollution watershed plans to improve water quality in waters affected by nonpoint source pollution. The elements are as follows:

(1) An identification of the causes and sources or groups of similar sources of NPS pollution that will need to be controlled to achieve the necessary load reductions estimated in the watershed-based plan.
(2) An estimate of the load reductions expected for the management measures described in the watershed plan.
(3) A description of the nonpoint management measures that will need to be implemented to achieve the expected load reductions.
(4) An estimate of the amounts of technical and financial assistance needed, associated costs, and the sources and authorities that will be relied upon to implement your watershed plan.
(5) A reasonably expeditious schedule for implementing the management program.
(6) An information and education component that will be used to enhance public understanding of the program and encourage the public's early and continued participation in selecting, designing, and implementing the management program.
(7) A description of interim measurable milestones for determining whether the management program or measures or other control actions are being implemented.
(8) A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards, beneficial uses or other appropriate end targets.
(9) A monitoring component to evaluate the effectiveness of the implementation efforts over time and measured against the criteria established to document load reductions.

b. What is Unique About this Watershed Plan

The DRD undertook this planning effort to provide a foundation to protect water quality and promote native fish conservation in the Lower Dolores River. The Plan integrates the results of stakeholder outreach and coordination in the Lower Dolores River, compiles information on the history and development of the Lower Dolores River watershed, assembles available water quality data and information for the Lower Dolores River, and identifies nonpoint pollutants of concern for native fish, potential sources of nonpoint source pollution, data gaps, and potential management actions to mitigate the sources of nonpoint source pollution. With the Plan in place, the DRD, other partner individuals and groups, and other interested stakeholders, expect to be able to identify, prioritize, and seek funding for additional studies, monitoring, community outreach and/or management actions to address nonpoint source pollution that have widespread buy-in from stakeholders.

As detailed below, the nonpoint source pollution issues on the Lower Dolores River are different than those that typically warrant a nonpoint source pollution watershed planning process. The NPS pollutants of concern for the two segments of the Lower Dolores River listed as having impaired water quality on Colorado's Section 303(d) list (i.e., iron in the Dolores River from Little Gypsum Valley to the Colorado/Utah State line and copper and iron in Roc Creek) have not been identified by stakeholders as being of particular concern for conserving native fish populations in the Lower Dolores River. Instead, water quality parameters including temperature, sediment, uranium, salinity, and nutrients, most of which are generally at levels that comply with water quality standards established by the Colorado Water Quality Control Commission, are the focus of this Plan. These parameters are thought to have potential to be stressors on native fish reproduction and survival in the Lower Dolores River. Therefore, the Plan is intended to identify opportunities to mitigate such stressors through improved voluntary watershed management and protection efforts, even for parameters that do not exceed regulatory thresholds.

This approach to watershed planning is the result of years of collaborative efforts among a swath of stakeholders interested in the environment of the Lower Dolores River. Accordingly, it is vital that the Plan identify issues and actions of common interest that will be supported by stakeholders and landowners. It is also essential that the information and tradeoffs in the Plan be articulated in a straightforward and accurate manner.

c. Dolores River Basin Geography

The Dolores River Basin watershed encompasses approximately 4,620 square miles in southwestern Colorado and southeastern Utah. Its headwaters in the San Juan Mountains include peaks exceeding 14,000 feet in elevation, while its confluence with the Colorado River in Utah is 4,400 feet in elevation. The Basin is located in the northern part of the Colorado Plateau, within the salt anticline region of the Paradox Evaporite Basin. The Lower Dolores River generally flows from south to north in a deep canyon that is interrupted only where the river crosses the Gypsum and Paradox Valleys. A series of anticlinal and synclinal valleys result from a sequence of northwest-trending folds within the area. The river courses through a range of plant communities, from alpine grasslands to montane forest areas to semiarid shrub lands.

The study area for this Plan includes the Dolores River from McPhee Dam downstream to the Utah state line, a length of approximately 200 river miles. <u>However, the primary focus of the planning effort is the portion of the Dolores River from McPhee Dam to the confluence with the San Miguel River, where DRD efforts are expected to provide the greatest benefit for conserving native fish</u>. Below the confluence with the San Miguel River, native fish populations are influenced significantly by the substantial flows of the San Miguel River, and their densities and size structure improve considerably (Colo. Dept. of Nat. Resources 2010).

The San Miguel River, which joins the Dolores River at an elevation of about 4,910 feet, is the only significant tributary to the Dolores River downstream of McPhee Dam. Most of the tributaries in the Lower Dolores River have only intermittent or ephemeral flow. The watershed area above the confluence with the San Miguel River is approximately 2,145 square miles. About 80% of the flow in this reach is derived from lands upstream of the Town of Dolores and McPhee Reservoir, an area that represents only 23% of the total Lower Dolores River watershed (K. W. Curtis III, Chief of Engineering and Construction, DWCD, pers. comm. to J. Kane).

The Lower Dolores River basin is largely semi-arid. It is characterized by low precipitation and humidity, abundant sunshine, a fairly large daily temperature range, and moderate westerly winds. As a result of topographic changes, the local climate exhibits large variations within short distances, with increases in precipitation and decreases in temperature generally found from southwest to northeast. Average annual precipitation, in the area of focus (below McPhee dam to the San Miguel), varies from roughly 10 to 20 inches.

Flows in the Dolores River, both naturally and as regulated by McPhee Dam, vary considerably within and between years. The basin upstream of the San Miguel River yields an annual average volume of 370,000 acre-feet, 80% of which comes down during the spring snow melt runoff over four months (K. W. Curtis III, Chief of Engineering and Construction, DWCD, pers. comm. to J. Kane). But the yield at McPhee Reservoir has varied from 80,000 acre-feet to over 600,000 acre-feet annually over the past 50 years. Peak flows result from spring snowmelt in the headwaters of the San Juan Mountains, usually occurring in May and averaging 2,000 cfs, but reaching 5,000 cfs in some years at Dolores (see Figure 4). The volume of spring runoff is similarly variable, ranging from about 50,000 to over 500,000 acre-feet per year in the past 50 years. Even with McPhee Dam capturing and regulating spring flows, spring spills are still highly variable, estimated to average 187,010 AF with a standard deviation of 123,441 AF (66%) and having minimum and maximum spills of 5,685 and 464,005 AF, respectively (Graf, 2006). High intensity thunderstorms also cause localized peak flows intermittently during July, August, September and October. Tributaries, except those draining mountainous areas, are ephemeral or intermittent (BLM 1990). This variability makes it difficult to assess and generalize about ecological conditions in the Lower Dolores River in any one year, with the implication that monitoring river environment and implementing management actions requires a long-term approach and commitment by stakeholders.

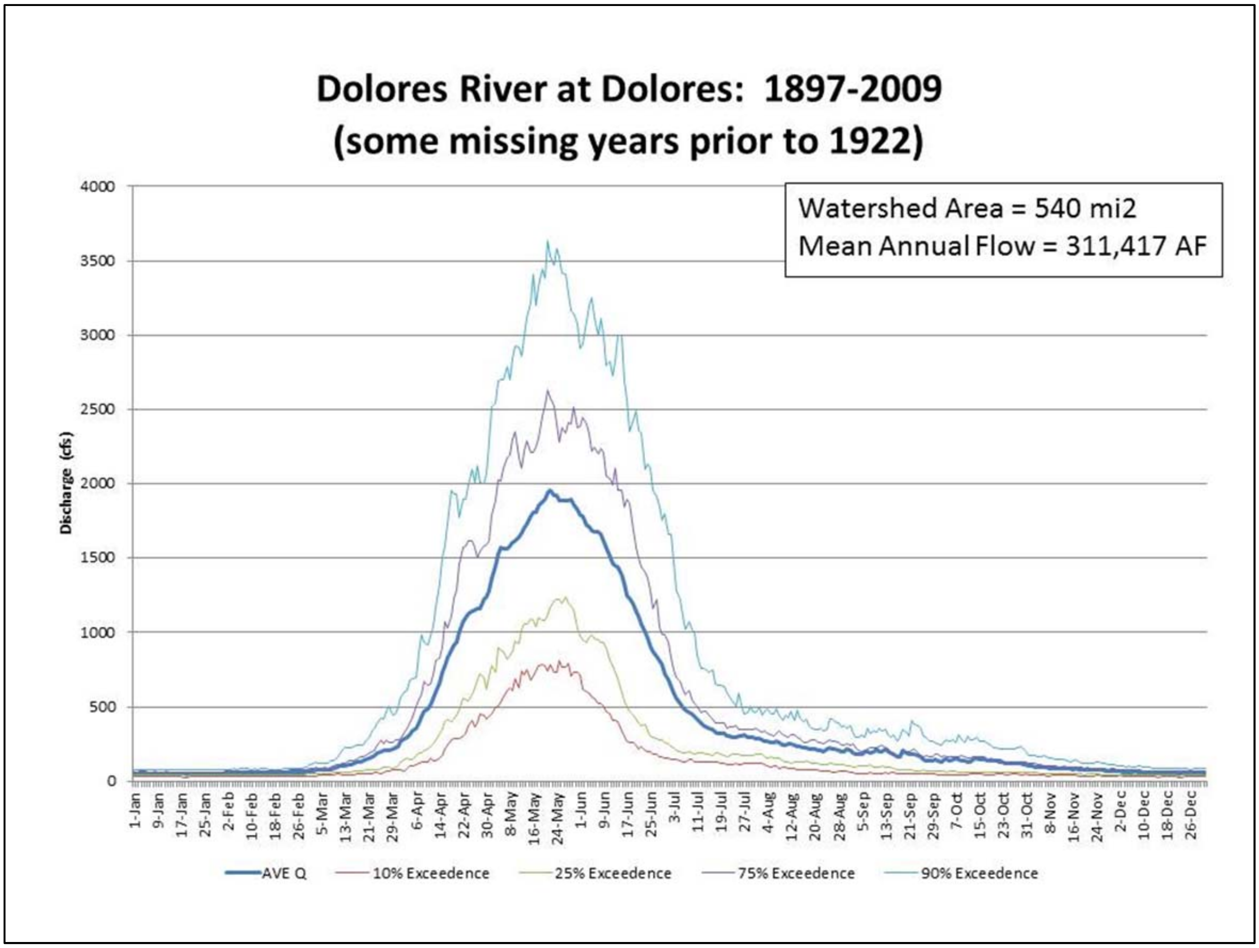


Figure 4: Hydrograph of the Dolores River at the Town of Dolores, just upstream of McPhee Reservoir, for the available period of record. Exceedance curves indicate the flow that was not exceeded in the given percentage of years on record (e.g., the flow of the 10% exceedence curve was not exceeded in 10% of the years on record). (Source: D. Graf, Regional Water Specialist, Colorado Parks and Wildlife, pers. comm. to J. Kane)

Most of the lands within the watershed are owned by the U.S. Bureau of Land Management (BLM) or the U.S. Forest Service (USFS). The Dolores River has historically been recognized by BLM and the general public as a nationally significant, unique resource capable of providing highly sought after, widely-valued recreation opportunities (BLM 1990). In 1976, an analysis by the Departments of Interior and Agriculture that evaluated the Lower Dolores River's qualities, taking into account the anticipated construction and operation of the Dolores Project, recommended "Wild and Scenic River" status for roughly 94 miles of the river downstream from the Bradfield Bridge (U.S. DOI and USFS 1976). The deep meandering canyon between Little Gypsum Valley and Bedrock was also recommended for inclusion in the nation's Wilderness

Preservation System by BLM and is classified as a "Wilderness Study Area" (WSA). The WSA is now being managed by BLM to maintain its w Wilderness characteristics until such time that Congress decides upon final Wilderness designation or non-designation.

Private lands within the Lower Dolores River corridor are limited to sites of gentler relief where settlers to Slick Rock, Disappointment Valley, and Paradox Valley could gain access to the river. Most patents were issued as Homestead Entries at about the turn of the 20th century. Private land uses within the Lower Dolores River corridor are limited to ranching and small commercial developments. Restricted by the narrow valley, ranching in the Lower Dolores River valley "…was destined to remain small scale and family operated" (Dishman 1981).

The hydrology of the Lower Dolores River also requires considering the environment and land use in the adjoining Montezuma Valley and the McElmo Creek Basin. In the 1880s, early European settlers excavated a "Great Cut" and a 5,400 foot-long tunnel to divert the flows of the Dolores River to the Montezuma Valley, where there was abundant land for settlement and agriculture, relative to the thin strip of bottom land in the Dolores Valley (Gerhold 1981). Those structures diverted up to 707 cfs from the river, leaving flows of less than 10 cfs in the river at the present site of McPhee Dam throughout most of the late irrigation season. Thus, below Bradfield Bridge, the combination of seepage past the MVIC diversions and occasional tributary inflow from ephemeral drainages at best may have maintained some year-round flow, or at a minimum maintained standing water in the deeper pools of the river (Graf, 2006). This means there was little or no baseflow in the Lower Dolores River during much of the summer and fall due to MVIC diversions, likely leaving only standing water in deeper pools barely connected by any flow for several miles downstream. However, MVIC's diversions had a more limited impact on the duration, size, and stream power of peak runoff flows given that at most about 700 cfs could be diverted from peak flows that ramped up and down from an average of about 3,000 cfs.

Construction of the key components of the Bureau of Reclamation's Dolores Project on the Dolores River, including McPhee Dam and Reservoir, Great Cut Dyke and Dolores Tunnel, was completed in 1986, although it took until 1997 for all Dolores Project facilities to be completed and Project water deliveries have just recently reached full supply.[3] McPhee Reservoir captures much of the spring runoff in an average year and provides for the regulation and release of stored water both downstream of the dam and to the McElmo Creek basin. This has provided municipalities, industry, and farmers north and south of the Town of Cortez, in Dolores County and on Ute Mountain Ute Indian Reservation with a more plentiful and reliable supply of water.

But water development and construction and full operation of the Project also impacted the hydrology of the Lower Dolores River by regulating baseflows and by capturing and regulating the release of spring run-off. Figure 5. With regard to baseflow impacts, the Definite Plan Report (DPR) and Environmental Impact Statement (EIS) for the Project evaluated the impacts of Project operations on the Lower Dolores River hydrology, fishery, and boating opportunities. It was estimated that the Project would result in an average annual net increase in depletions of water from the Lower Dolores River of 80,900 AF, in addition to the pre-Project MVIC average annual depletion of 136,100 AF (U.S. BOR 1977a).[4] For the fishery, those documents planned, and the initial Project contracts required, that downstream baseflow releases would be made to provide a "fish flow," with the rate set at 20, 50, or 78 cfs depending on predicted runoff conditions on March 1st each year (i.e., dry, average, or wet), which would

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[3] *See* Appendix 2 for a detailed account of the history of the Project and the environmental and recreational issues summarized here.

[4] To provide additional context, subsequent modeling by Graf and J. Porter (2006) using the 78-year period of record for Dolores River stream gages up to 2005 and integrating trans-basin depletions from the Project found that Post-Dam spills are expected to average 187,010 AF with a standard deviation of 123,441 AF (66%) and maximum and minimum spills of 464,005 AF and 5,685 AF, respectively. No spill is expected to occur in 45% of years, a less than average spill in 29% of years, and greater than average spill in 26% of years. *See* Graf (2006), Table 1, http://ocs.fortlewis.edu/drd/pdf/DRD%20Big%20Gypsum%20Monitoring%20Site%20Grant%20Report%20Edition%20II%20Appendix%20B.pdf.

result in average annual downstream releases for fishery purposes of 25,400 AF (U.S. BOR 1977a). Those flows were intended to provide a cold-water trout fishery downstream of McPhee Reservoir, to provide continuous post-spill baseflow to the Lower Dolores River, and to improve downstream habitat conditions in general. The DPR and 1976 Wild and Scenic River evaluation for the Dolores River also anticipated that the aesthetic improvement resulting from the continuous stream flows to be provided by the Project would contribute to the River's appeal as a potential Wild and Scenic River (USBOR 1977a; USDOI and USFS 1976).

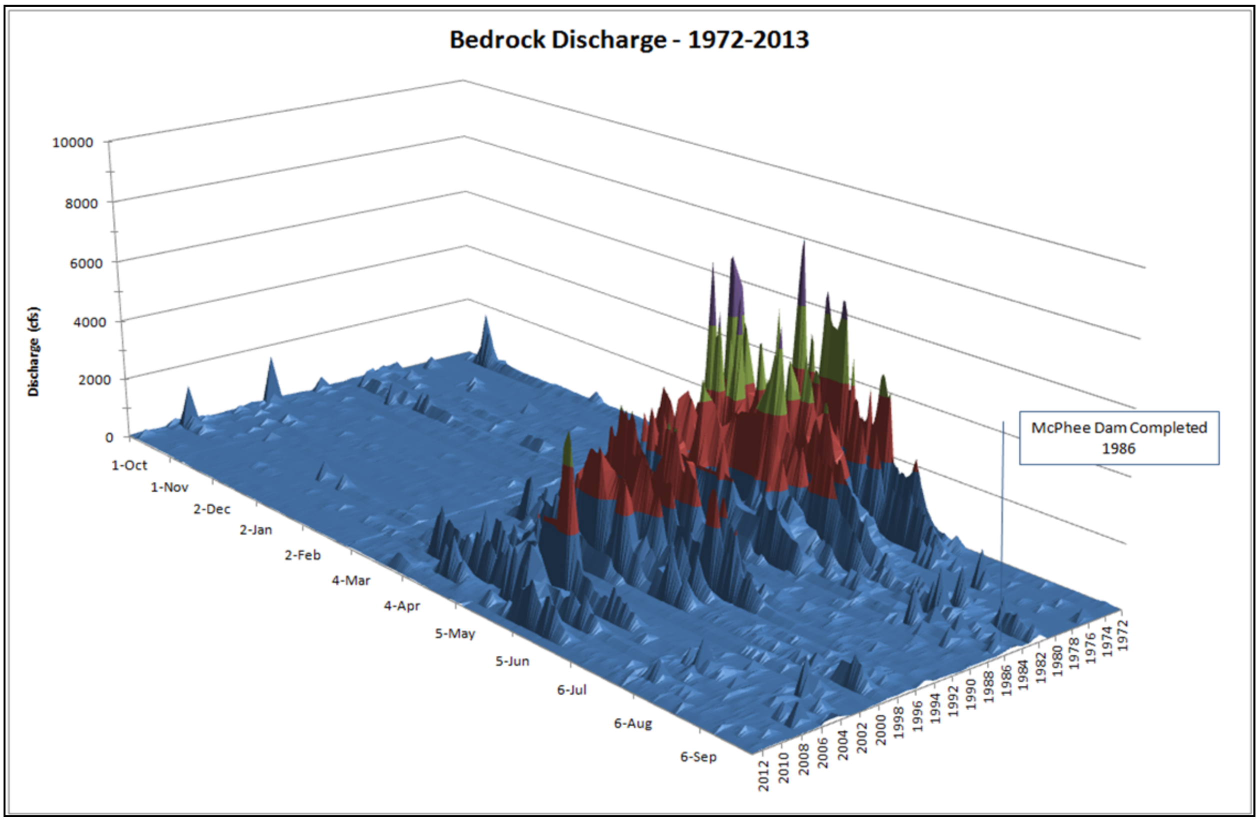

Figure 5: Three-dimensional hydrograph of Dolores River discharge at Bedrock from 1972 to 2013 illustrating the decreased duration, magnitude, and frequency of peak discharge following construction of McPhee Dam and full operation of the Dolores Project. (Source: D. Graf, Regional Water Specialist, Colorado Parks and Wildlife, pers. comm. to J. Kane)

The "fish flow" approach guided Project operations until 1990, the first year in which a drought resulted in a "dry" year with downstream releases to be limited to 20 cfs. Recognizing that 20 cfs releases could have caused detrimental impacts to the downstream trout fishery, Reclamation began seeking alternatives to the regime prescribed in the DPR and EIS. The result was to drastically change Project operations from the "fish flow" approach to allocating a "fish pool." A 1996 environmental planning process established a storage volume for the fish pool based on the volume of water that would have been released in an "average" fish flow year, releases from which would be guided by the recommendations of a Biology Committee (USBOR 1996). Releases during managed spill periods also would not be charged against the fish pool allocation. The resulting Project allocation for the fish pool provided more flexibility to manage the timing, magnitude, and duration of downstream baseflow releases based on promoting the health of the downstream cold-water and warm-water (i.e., native) fisheries. It also made more water available for downstream release in "dry" years than was originally intended for the Project, thereby reducing the available supply of water for all Project irrigators in such years as well as the amount of Project carry-over storage to offset a subsequent low runoff year.

With regard to spring runoff, Project documents planned for it to be captured and released using a "fill then spill" approach. Because of high natural variability and limitations in the ability to forecast runoff volumes in each year, this would insure that a full Project water supply could be stored before risking the release of appreciable volumes of water downstream. It was understood that both the storage of water itself and this operational approach would have an unavoidable impact on recreational boating opportunities downstream. The Project EIS estimated that Project operations would reduce average annual launching days from 54.6 to 23.9 (USBOR, 1977b). To mitigate this expected loss of more than half of boating days on average, the EIS recommended managing McPhee releases such that the availability of boating water would be more predictable and opportunities for boating on the lower Dolores would continue to the extent compatible with Project purposes. McPhee releases, in anticipation of spring inflows, would be made on a scheduled basis with advance public notice of intended releases so that white-water boaters could plan their use of the river. Project operators have been engaged in efforts to refine that approach through improved snowpack measurement and runoff forecast modeling, as well as improved communication of planned reservoir spills. While recreational boating opportunities have been significantly reduced in the post-McPhee era, the Project objective has been to maximize boating opportunities within the constraints of minimizing the risk of not achieving a fill in any given year. Project managers now coordinate with all affected interests to include optimizing recreational opportunities as well as promoting ecological benefits as criteria for releases made in anticipation of a spill.

The impacts on spring runoff hydrology from construction of the Project are still being evaluated, but it appears that the alteration in frequency, timing, and magnitude of spring runoff events has diminished the deep pools that have historically been an important part of the river's habitat, especially for native warm-water fish. There is also evidence that these changes in hydrology along with associated changes in water temperature have impacted the timing of spawning, egg development, rearing success, and general fitness of native warm-water fish populations in the Lower Dolores River.[5] Thus, there is consensus among DRD stakeholders to pursue the collection of data, the creation of flow models, temperature models and sediment models, and the development of potential management actions to support the optimal management of the spill and of the fish pool such that any impacts to native fish habitat conditions from the Project can be minimized. There is also consensus that identifying and managing sources of nonpoint pollution could mitigate the effects of related stressors on native fish habitat conditions. Accordingly, as detailed in Sections 4 through 11 of this Plan, the DRD has identified a number of collaborative opportunities related to Dolores Project management and water quality that may improve conditions for native fish in the Lower Dolores River.

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[5] Because of limited native fish population surveys and limitations in survey methods prior to Project construction, historical population dynamics and the impacts of pre-Project MVIC diversions are not certain. In addition, it is not yet clear whether and the extent to which other stressors on native fish, such as the management of a trout fishery downstream from McPhee Dam, the presence of trout and other non-native fish in the Lower Dolores River, predators, or water quality may be affecting population dynamics today.

2. Water Quality of the Lower Dolores River

Typically, nonpoint source watershed plans are prepared in response to water quality problems identified through the failure of a water body to meet numeric or narrative water quality standards for one or more pollutants or parameters over a sufficient assessment period. Such exceedances are expected to be associated with the non-attainment, or impairment, of one or more designated uses (e.g., aquatic life, recreation public water supply, agriculture). While some pollutants and parameters (e.g., temperature) have been measured in the Lower Dolores River at levels that exceed applicable numeric criteria on a short-term basis, few have met the Colorado Water Quality Control Commission assessment methodology requirements to warrant impairment listings. Given the conservation objectives of the DRD to promote the health and habitat of native fish, the water quality issues of interest are not those currently subject to regulatory identification and management. Accordingly, the motivation and objectives of this Nonpoint Source Watershed Plan are geared toward watershed protection and are somewhat unique.

The water quality of the Lower Dolores River generally meets established standards and designated uses are generally fully supported (s*ee* WQCD (2012a) (Appendix A). As discussed in Section 4, there are two segments listed on the CWA Section 303(d) list as impaired: the Dolores River from Little Gypsum Valley downstream to the Colorado/Utah State line for Aquatic Life use standard for iron and Roc Creek, a tributary to the Dolores River, for the aquatic life use standards for copper and iron. But those listings are seen as a low priority relative to others in the State of Colorado and the Colorado Water Quality Control Division has not scheduled the preparation of Total Maximum Daily Loads for these segments. Further, the DRD stakeholders have not identified levels of iron or copper in the Lower Dolores River as being of particular concern for the conservation of aquatic life.

Yet, there are water quality conditions in the Lower Dolores River resulting from nonpoint sources of pollution that stakeholders have concluded may be acting as stressors to aquatic life, in particular for species of native fish that are driving conservation efforts on the Lower Dolores River. These include temperature, sediment, uranium, salinity, and nutrients. While some of these parameters or pollutants have been observed to exceed water quality standards on a short-term basis (e.g., temperature at Bradfield Bridge), none have been concluded to be impairing a designated use based on available data and Colorado's water quality assessment procedures. However, alone or in combination these parameters and pollutants may be acting as stressors that affect the fitness or reproductive success of one or more aquatic species.

Another motivation of the DRD in initiating this process was to study the environmental conditions of the river's aquatic habitat and water itself. Most efforts of the DRD to date have focused on the river's hydrology and physical riparian environment rather than specific conditions in the aquatic environment, such as the presence of salinity and uranium. Therefore, this planning effort has aimed to give attention to conditions in the water column that may affect native fish conservation in the Lower Dolores River.

3. Collaboration is the Only Way to Succeed

A primary objective of this planning effort was to compile stakeholder perspectives that reflect the history and values associated with the Lower Dolores River watershed and provide essential context in support of viable and broadly accepted strategies for addressing water quality issues in the river. The construction of McPhee Dam and the Dolores Project set in motion changes that involved the transition from the pre-European settlement era, early Montezuma Valley diversion era beginning in the late 19th century, MVIC era beginning in the early part of the 20th century, to the Dolores Project construction era from 1980 to 2000 and the post-construction era from 2000 forward. These changes have expanded irrigated acreage, extended the irrigation season, and provided a reliable water supply for domestic use and economic development – all of which have benefited the communities in Dolores and Montezuma Counties and the Ute Mountain Ute Indian Tribe. Managed releases from McPhee Dam have also affected boating opportunities and fish and riparian plant and wildlife populations below the dam. Because the changes brought about by the Dolores Project have profoundly reshaped all of the interests described above, it is important to consider the rich history and culture of the Dolores River and the communities that have benefited from the trans-basin diversion in the pre-McPhee

MVIC era, as well as the adjustments set in motion during the construction era which continue into the post-construction period. All of these changes involve interrelated social, economic and ecological dimensions that provide the foundation for collaborative watershed planning going forward. Further, this planning effort provided an opportunity to elucidate what the three pillars of the DRD purpose statement seeks to address: (1) improving ecological conditions in the Lower Dolores River, (2) honoring water rights and protecting agricultural and municipal water supplies, and (3) promoting the continued enjoyment of boating and fishing. This section provides an overview of the results of that effort, which are detailed in the Appendices 1, 2, and 3 of this plan.

Appendix 1: Formation and Evolution of the DRD and Other Collaborative Stakeholder Efforts to Promote Conservation of the Lower Dolores River

The DRD was not the first collaborative stakeholder group formed to improve management of the Lower Dolores River, but it has had the most staying power and success. As described in Appendix 1, the DRD first formed in 2002 at the initiative of the San Juan Citizens Alliance and the Dolores River Water Conservancy District. Invitations were sent to many other government and private stakeholders, resulting in the early years in completing the foundational work needed to build trust, a sense of willingness, and appropriate institutional processes to find solutions to downstream issues on the river. Early on it was agreed that science would be used as a guiding center point of the DRD's work. Over time and with this in mind, the DRD's mission statement has been refined, additional committees have been formed to respond to specific needs, and procedures have been refined so that scientific studies and management strategies could be completed within a collaborative and transparent framework.

Any successful coalition working on natural resources such as water, changes and evolves as community buy-in, support and needs change. The DRD crossed a 10-year milestone in 2012. Over the years, through continued convening, establishing information and working across institutions in the best interest of everyone, the DRD has accomplished a lot. It has prepared this Plan using stakeholder input and involvement. The DRD Steering Committee has reviewed it and supports the process described for considering and implementing potential management actions it identifies. These activities, while sometimes cumbersome and lengthy, lead to important actions that can be taken for the good of the communities **and** the good of the Lower Dolores River.

Appendix 2: History of Dolores River Water Use, the Dolores Project, the Rise of Environmental Consciousness Nationally and Locally, and Stakeholder Collaboration to Promote Conservation of Lower Dolores River Natural Resources

The Dolores Project is a boon to local economic development and stability in the Montezuma Valley and surrounding areas while also including the key infrastructure impacting environmental of the Lower Dolores River. Central to understanding the importance of the Dolores Project is the history of settlement and water use along the Dolores River in the Montezuma Valley prior to the construction of the Project; the commitments made by the U.S. Congress, Federal agencies, and local entities – Montezuma Valley Irrigation Company (MVIC) and Dolores Water Conservancy District (DWCD) and the Ute Mountain Ute Indian Tribe – necessary to make the Project a reality, and the responsiveness of stakeholders to evolving issues and concerns in the community and nationally.

Appendix 2 narrates that history and explains how Colorado water law, particularly the prior appropriation doctrine, trans-basin diversion issues and MVIC's senior water rights, and Dolores Project contracts and other Bureau of Reclamation (BOR) responsibilities, impact Dolores Project water use and the Dolores River. This appendix also discusses the evolution in conservation ethos and environmental awareness that coincided with Project development. Appendix 2 is organized by this timeline of historical events:

- archaeological evidence of settlement and irrigated agriculture by Ancestral Puebloans and Ute Indians;
- discovery and settlement of the Dolores River and southwestern Colorado by non-Indians;
- trans-basin diversion of up to 707 cfs of Dolores River flows to Montezuma Valley beginning in the 1880s, facilitating agricultural development in the Montezuma Valley and McElmo Creek drainage and the construction of the City of Cortez;
- the rise and fall of various private companies prior to the formation of MVIC to hold and operate the earliest water rights on the River;

- early calls to develop a significant reservoir to store spring flows for a more vibrant and reliable agricultural economy and the formation of DWCD to organize local resources and operate such a project;
- study of the Dolores Project by the Bureau of Reclamation and authorization by the U.S. Congress;
- passage of landmark federal environmental legislation, including the Endangered Species Act, Clean Water Act, and Wild and Scenic Rivers Act, as well as the incorporation of environmental needs into Colorado water law;
- recommendations to designate portions of the Lower Dolores River as a Wild and Scenic River;
- contractual commitments to MVIC by DWCD and the Bureau of Reclamation to make development and operation of the Project feasible notwithstanding MVIC's senior water rights;
- the incorporation of commitments to environmental conservation objectives and the Ute Mountain Ute Tribe as a central feature of a reclamation project;
- construction and infrastructure development that resumed despite a Presidential "hitlist" and that took over two decades to complete;
- the growth, stability, and direct and indirect economic development reaped by the local community;
- adoption of a range-wide conservation agreement and strategy among six states and two Indian tribes to study and conserve three species of native, warm-water fish found in the Colorado and San Juan river basins, including the Lower Dolores River; and
- evolving conservation objectives, recognition of impacts to recreational boating opportunities, and the accomplishments of diverse stakeholders and interests in facilitating the adjustment of Project operations within existing constraints and commitments to improve conditions.

That history sets the stage for the efforts embodied by this Plan to protect water quality and conserve native fish. Appendix 2 also includes a brief summary of status of native conservation species, why we need to seriously consider their status, and what is currently being done about it.

Appendix 3: A Beginning Compilation of Stakeholder Perspectives on the History of Dolores River Diversions, Agriculture, and Recreational Uses of the Dolores River

To bring the Dolores River's history to life and document the perspectives of local citizens, farmers, officials, anglers, and boaters, Appendix 3 provides a collection of perspectives and quotes compiled as part of the stakeholder outreach process for this Plan. The interviewees' comments in Appendix 3 reflect some of the history and values associated with the watershed and the changes described above. They provide essential context in support of viable and broadly accepted strategies for addressing water-quality issues in the Lower Dolores River.

The original impetus for collecting these perspectives was to illustrate the views of the people who own and rely upon the water rights that the DRD's mission statement pledges to honor. In that same spirit, the effort was broadened to include the perspectives of recreational boaters. Those perspectives were not designed to suggest solutions to management issues on the river, but to provide a snapshot of the views of those who use, benefit from, and value the resources of the Lower Dolores River. The DRD-Steering Committee also recognizes that this appendix could grow to include the voices of others such as landowners in the river corridor, interests involved with salinity, mining and grazing, and other stakeholders. Therefore, this appendix is not meant to be the final story of all stakeholders' views; it is a start and it recognizes that many diverse voices and interests care about this watershed.

4. Nonpoint Source Pollution Regulation and Stakeholder-Identified NPS Issues in the Lower Dolores River

a. Nonpoint Source Pollution

Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is driven by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters and ground waters. In contrast to point source discharges of pollutants, nonpoint source pollution is not regulated through the issuance of discharge permits that require technology controls and limit the concentrations of each pollutant that may be discharged. Instead, nonpoint source pollution is managed by identifying sources and implementing best management practices (BMPs) through cooperative and voluntary efforts of concerned citizens, government agencies, and land owners.

> **Best Management Practices (BMPs)** are methods, measures, or practices that can be applied to reduce or eliminate the transport of nonpoint source pollution, such as sediment, nutrients, and pesticides, into receiving waters. Examples include fencing riparian areas, providing sources of livestock water away from riparian areas, planting riparian vegetation, altering grazing practices, and improving range vegetation. Many of these practices for private lands are promoted and facilitated by the USDA's Natural Resource Conservation Service (NRCS).

Examples of NPS pollution include the following:

- excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;
- oil, grease, and toxic chemicals from urban runoff and energy production;
- sediment from construction activity, ground disturbance, crop and forest lands, and eroding stream-banks;
- salt from irrigation practices and acid drainage from abandoned mines;
- bacteria and nutrients from livestock, pet wastes, and faulty septic systems; and
- atmospheric deposition.

In addition to proactive watershed planning and protection efforts, NPS pollution and management practices may be assessed as part of preparing a Total Maximum Daily Load (TMDL). TMDLs are prepared for specific water bodies and pollutants when monitoring data demonstrates that the water quality standard for a pollutant or pollutants is being exceeded, resulting in the listing of the water body as "impaired" under Section 303(d) of the Clean Water Act. The TMDL process results in a calculation of the maximum amount of a pollutant that a water-body can receive and still safely meet water quality standards. The TMDL and subsequent watershed plans also formulate the steps necessary to bring a water body into attainment of its water quality standards through new permit restrictions for point sources and management strategies for nonpoint sources. The advantage of preparing a Nonpoint Source Watershed Plan before a TMDL is warranted is that it can result in identifying pollutants of concern and voluntary implementation of watershed protection actions before conditions degrade so much that water quality standards are not attained. Therefore, preparing a Nonpoint Source Watershed

Plan focused on watershed protection is well-suited to watersheds, like the Lower Dolores River, where there are few impairment designations and no TMDLs are scheduled to be prepared. *See* Section 4.c.

b. The Colorado Water Quality Regulation Framework

i. Colorado Water Quality Control Act

The regulation of water quality in Colorado is primarily governed by the Colorado Water Quality Control Act, C.R.S. §§ 25-8-101 *et seq*, although the State also implements the Clean Water Act through a delegation of authority by U.S. EPA. The major elements of the federal Clean Water Act and the Colorado Water Quality Control Act are very similar, although the scope of regulatory authority over waters and activities under State law is somewhat greater than that permitted by the federal law. Each is based on a discharge permit program for point source discharges of pollutants, requiring that discharges meet both federally-established technology-based effluent limitations and state-adopted water quality standards. The Colorado Act provides that the state "shall maintain a program which does not conflict with the provisions of the federal act," and many of the activities required by the Colorado Act are intended to meet and implement requirements in the Clean Water Act. Areas in which the Colorado Act differs from the federal Act include the following:

- The federal Act regulates only surface water quality, while in Colorado "waters of the state" is defined to include ground water;
- The Colorado Act includes a number of special provisions (particularly in section 25-8-104) to assure that water quality control efforts in Colorado do not interfere with Colorado's established water rights system;
- The Colorado Act includes a requirement for "site approval" of new or expanded domestic wastewater treatment plants, which does not appear in the federal Act;
- Under the Colorado Act, the state may adopt "control regulations" for a fairly broad set of water quality protection purposes, subject to specific limitations on adopting control regulations for agricultural nonpoint sources;

- The Colorado Act includes a program addressing potential ground water quality impacts from agricultural chemicals, administered largely by the Commissioner of Agriculture, which has no parallel in the federal Act; and
- The Colorado Act provides for asserting Section 401 certification review so that the State may certify, certify with conditions, or object to the issuance of any federal permit for an activity that may affect water quality in the State.

The Colorado Water Quality Control Act, like the Clean Water Act, does not address drinking water quality management issues that are addressed by the federal Safe Drinking Water Act.

ii. Colorado Water Quality Control Commission

The Colorado Water Quality Control Commission (Commission) is the Colorado agency responsible for developing specific state water quality policies in a manner that implements the broader policies set forth in the Colorado Water Quality Control Act and the federal Clean Water Act. It is made up of nine citizen commissioners appointed by the Governor. Using a public hearing process, the Commission adopts water quality classifications and standards for surface and ground waters of the state, as well as various regulations aimed at achieving compliance with those classifications and standards. The Commission makes 303(d) list impairment decisions based on input from the staff of the Water Quality Control Division (Division) and also adopts TMDLs prepared by the Division.

> The **Colorado Water Quality Control Commission** is the administrative agency responsible for developing specific state water quality policies, in a manner that implements the broader policies set forth by the Legislature in the Colorado Water Quality Control Act. The Commission adopts water quality classifications and standards for surface and ground waters of the state, as well as various regulations aimed at achieving compliance with those classifications and standards.
>
> The **Water Quality Control Division** is a state agency that acts as staff to the **Commission** and is responsible for enforcing water quality control regulations and proposing new regulations and policies for adoption by the Commission.

iii. Water Quality Control Division

The Water Quality Control Division is the technical staff that implements and recommends decisions and policies made by the Commission. Its Clean Water Program activities include monitoring and assessing Colorado's water quality, evaluating and recommending protective water quality standards for adoption by the Commission, providing discharge permits that are protective of the established water quality standards, providing compliance oversight, technical and financial assistance for facilities. The protection, maintenance, and restoration of Colorado's water resources is managed by the Clean Water Program within the Division. Colorado's water quality is assessed periodically in conjunction with the triennial review of water quality standards, the development of discharge permits, 303(d) Lists and Total Maximum Daily Loads (TMDLs), and the completion of special studies.

vi. How Water Quality Standards, Impairment Listings, and TMDLs are Prepared and Adopted

The Commission adopts water quality standards, makes impairment listing decision, adopts TMDLs, and creates other water quality related regulations and policies at formal public hearings. Water Quality Standards for each river basin in Colorado are made at a "Triennial Review Hearing." The Triennial Review Hearing generally involves proposing new or revised water quality standards, which include designated uses, numeric and narrative criteria for pollutants and parameters, anti-degradation classifications, and implementation policies. Colorado has a list of default narrative and numeric criteria for pollutants, or "table values," which are promulgated in Regulation No. 31. The table values are generally adopted for all surface waters in the State unless site-specific information indicates that a more appropriate criterion should be adopted.

Colorado's 303(d) List of impaired waters and its Monitoring and Evaluation List (M&E List) are included in Regulation No. 93. This list fulfills section 303(d) of the federal Clean Water Act which requires that states submit to the U.S. Environmental Protection Agency a list of those waters for which technology-based effluent limitations and other required controls are not stringent enough to implement water quality standards and for which TMDLs are required. The M&E List includes segments where there is reason to suspect water quality problems, but there is also uncertainty because of data limitations. The list assists the Water Quality Control Division allocate monitoring resources, but an M&E listing does not require any particular regulatory action.

c. Water Quality Standards for the Lower Dolores River Basin

A Triennial Review Hearing for all water bodies in the Dolores River Basin was completed in November, 2012. The standards for the upper Dolores River, which is defined to extend to the Bradfield Bridge, are included in Regulation No. 34. The standards for all segments downstream of the Bradfield Bridge are included in Regulation No. 35. The 2012 hearing included a re-segmentation of the lower Dolores River and adoption of revised aquatic life use designations and temperature criteria for those segments based on available temperature and fish survey data. Specifically, the Commission (1) adopted a revised Aquatic Life Cold table value temperature standard from below McPhee Reservoir to Bradfield Bridge; (2) adopted ambient temperature standards for the segment from the Bradfield Bridge to Big Canyon Creek (a/k/a Dove Cr Pumps) (Segment 1a); (3) adopted a second set of ambient temperature standards from Big Canyon Creek to the Highway 141 crossing near Slick Rock (Segment 1b); and (4) designate an Aquatic Life Warm table value temperature standard from the Highway 141 crossing to the State line (Segment 2). The ambient temperature standards were calculated using temperature data considered representative of current temperature conditions in each segment, so the ambient temperature standards were intended to protect existing aquatic life communities and conditions.

Colorado last completed a 303(d) list hearing in 2012. The State lists those water body segments for which sufficient monitoring data demonstrates that one or more water quality standards are not being attained. These waters are considered “impaired” and a TMDL must be prepared. Colorado also designates segments for listing on the Monitoring and Evaluation (M&E) List. The M&E listing is used to identify segments where there is reason to suspect water quality problems, but there is also uncertainty because of data limitations.

All current segments, designated uses, antidegradation designations, and monitoring and Evaluation and 303(d) listings are summarized in Table 1. Specific temperature criteria adopted at the 2012 Triennial Review Hearing are summarized, within the temperature section, in Table 3. All other narrative and numeric criteria for each segment can be found by cross-referencing the tables in Regulation Nos. 34 and 35 and the table values in Regulation No. 31.

Table 1: Summary of water body segments, designated uses, antidegradation designations, and water quality monitoring and impairment listings for the main stem of the Lower Dolores River.

<table>
<tr><th>Segment</th><th>Designated Uses</th><th>Antidegradation Designation</th><th>M&E List Parameter</th><th>303(d) List Parameter</th></tr>
<tr><td>Upper Portion (Regulation 34)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4a. Main stem of the Dolores River from a point immediately above the confluence with Bear Creek to the bridge at Bradfield Ranch (Forest Route 505, near Montezuma/Dolores County Line).</td><td>Aq Life Cold 1
Recreation E
Water Supply
Agriculture</td><td>Reviewable</td><td></td><td></td></tr>
<tr><td>Lower Portion (Regulation 35)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1a. Main stem of the Dolores River from the bridge at Bradfield Ranch (Forest Route 505, near Montezuma/Dolores County Line) to a point immediately above the confluence with Big Canyon Creek near Dove Creek.</td><td rowspan="2">Aq Life Cold 1
Recreation E
Water Supply
Agriculture</td><td rowspan="3">Reviewable</td><td></td><td></td></tr>
<tr><td>1b. Main stem of the Dolores River from a point immediately above the confluence with Big Canyon Creek near Dove Creek to a point immediately above the Highway 141 road crossing near Slick Rock.</td><td></td><td></td></tr>
<tr><td>2. Main stem of the Dolores River from the Highway 141 road crossing near Slick Rock to the Colorado/Utah border.</td><td>Aq Life Warm 1
Recreation E
Water Supply
Agriculture</td><td>E. coli</td><td>Fe(Trec)</td></tr>
</table>

Table Legend:

<u>Designated Uses</u> (WQCC Regulation 31.13):

Recreation Class E - Existing Primary Contact Use: These surface waters are used for primary contact recreation or have been used for such activities since November 28, 1975.

Agriculture: These surface waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.

Aquatic Life: These surface waters presently support aquatic life uses, or such uses may reasonably be expected in the future due to the suitability of present conditions, or the waters are intended to become suitable for such uses. Class I waters (1) are currently capable of sustaining a wide variety of cold/warm water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions.

Domestic Water Supply: These surface waters are suitable or intended to become suitable for potable water supplies. After receiving standard treatment (defined as coagulation, flocculation, sedimentation, filtration, and disinfection with chlorine or its equivalent) these waters will meet Colorado drinking water regulations and any revisions, amendments, or supplements thereto.

Antidegradation Designations (WQCC Regulation 31.8):

Outstanding Waters – no degradation of existing water quality by regulated activities is allowed
Reviewable Waters – waters evaluated before any new or increased water quality impacts are allowed Use Protected Waters – where degradation is allowed up to the water quality standard

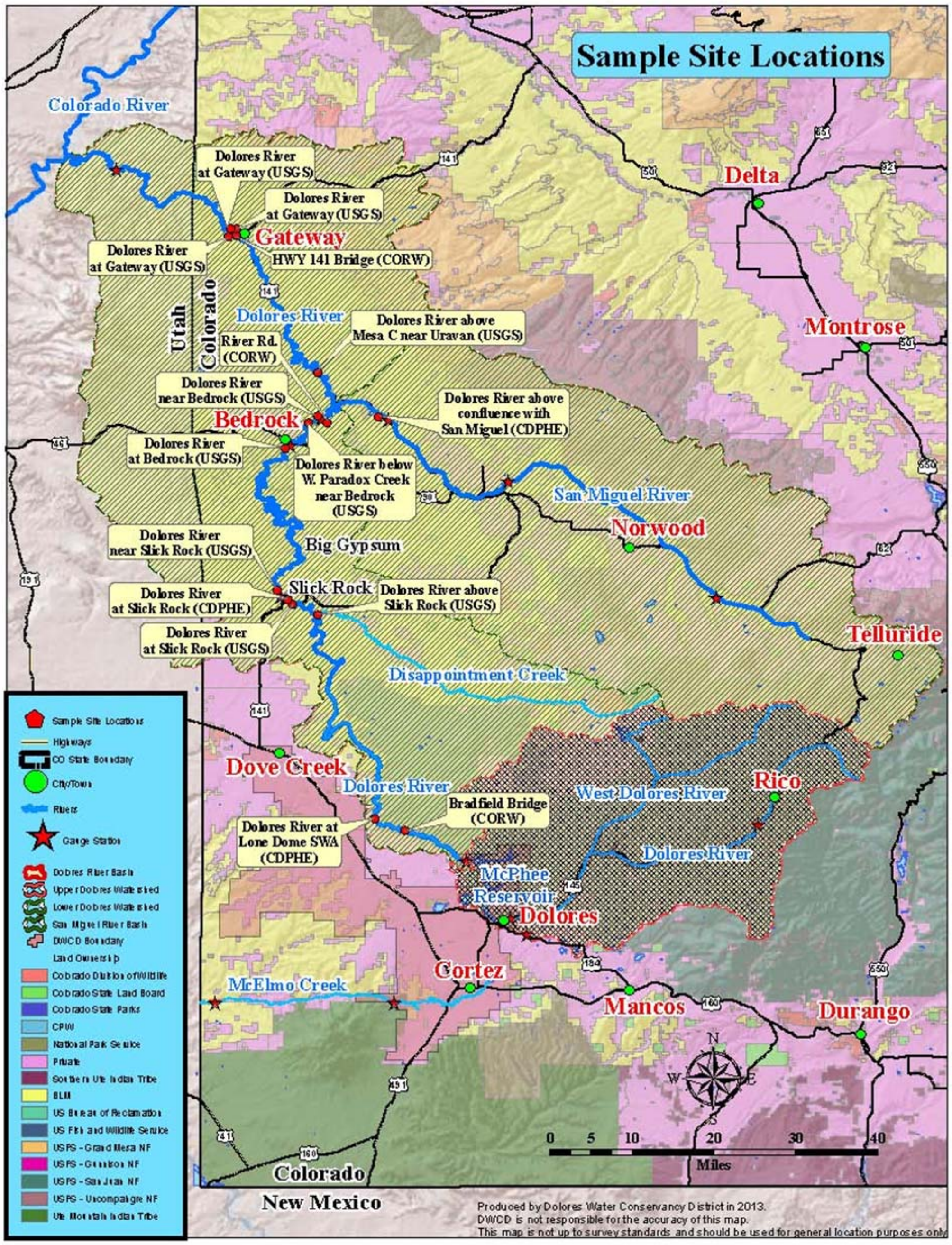
Within the lower Dolores River study area, two segments are listed as impaired on the 303(d) list and five are listed on the M&E List. The impairment listings are for iron in the Dolores River from Little Gypsum Valley downstream to the Colorado/Utah State line (this listing predated re-segmentation in 2012) and for copper and iron in Roc Creek, a tributary to the Dolores River that enters approximately 15 to 20 miles downstream of the confluence with the San Miguel River. The M&E listings are for Lost Canyon Creek (*E. coli*), Dolores River from Little Gypsum Valley downstream to the Colorado/Utah State line (*E. coli*), Disappointment Creek (Selenium, *E. coli*), West Paradox Creek (*E. coli*, iron), and Roc Creek (*E. coli*).

Each of the TMDL listings is prioritized as "high," however the Division's TMDL unit has not initiated work on the any of them, and it projects that it will be several more years before it does. Pers. comm., Phil Hegeman, TMDL Program Lead, Colorado Water Quality Control Division to J. Kane (2013). This is because at present they do not represent high priority projects given the location and Division resources. The Division's TMDL program work plan is devised based upon a number of considerations. Among those considerations are the potential to affect subsequent remediation which will bring the water bodies into attainment, and the resources necessary to develop sufficient information to support TMDL development. As the 303(d) List has grown to some 400-plus listings, the Division has focused resources where it can collect samples to support the development of multiple TMDLs, and support other Division activities, in the most cost effective manner. Preparing TMDLs for the Dolores River listings is a low priority relative to other "high" priority ones because the TMDL Program considers there to be a lack of such opportunity to combine objectives and resources for multiple projects, an anticipated difficulty remediating the pollutant sources, and the severity of the non-attainment (in terms of the degree of non-attainment, the uses which are not supported, and the parameters in non-attainment).

d. Available Water Quality Data from State, EPA, or Other Sources

Primary data on a range of water quality parameters in the Lower Dolores River fall into three categories: 1) water quality sampling data stored in STORET (http://www.epa.gov/storet/dw_home.html) and/or the Colorado Data Sharing Network (CDSN) (http://www.coloradowaterdata.org/), 2) water quality sampling data contained within published scientific reports and/or peer reviewed literature, 3) water quality sampling data taken by various entities but not published or publicly available. Figure 6 shows the locations and sampling entities of the 18 data collection points for which data are available (as of January 2013) through the CDSN and STORET on the Dolores River between McPhee Reservoir and the Utah/Colorado Stateline (see Figure 6 on the next page).

Figure 6: Locations and Sampling Entities, Lower Dolores River



e. Water Quality and the Native Fishery

Through the various public stakeholder processes that have occurred regarding Dolores River land and water management (*see* Appendix 1), water temperature, sediment, uranium and salinity have been identified as potential water quality problems for the recovery of native fish. Because none of these parameters are currently included on the 303(d) list of impaired waters for the Dolores main stem below McPhee Reservoir, and no TMDL has been developed, this planning process aims to identify thresholds for these parameters – thresholds that are relevant to the Dolores River and the goals of the DRD.

The pollutant currently included on the 303(d) list for the Dolores main stem is iron for the segment from Little Gypsum Valley Bridge to the Colorado/Utah state line. To date, iron has not been identified by stakeholders as a concern for native fish, nor is a TMDL scheduled for preparation. Therefore, these pollutants are not specifically addressed in this plan.

NPS Pollutants of Concern for Native Fish Conservation in the Lower Dolores River

5. Temperature

a. Colorado's Water Quality Criteria for Temperature

As indicated above, in the most recent Triennial Review Hearing for the Lower Dolores River Basin, the Colorado Water Quality Control Commission decided to re-segment the Lower Dolores River and to adopt revised temperature standards for each segment. This included adopting (1) an updated Aquatic Life-Cold temperature standard from below McPhee Reservoir to Bradfield Bridge, (2) an ambient temperature standard for the segment from Bradfield Bridge to Dove Creek Pumps, (3) a second set of ambient temperatures standards from Dove Creek Pumps to the Highway 141 crossing near Slick Rock, and (4) an updated Aquatic Life-Warm temperature standard from Highway 141 to the State Line. The temperature standards were developed for these segments based upon updated table value standards for Cold and Warm aquatic life segments, the fish species expected to be present as indicated in fish survey data provided by Colorado Parks and Wildlife, temperature measurement data for each segment, and other available evidence. Ambient temperature standards were calculated using temperature data considered representative of current temperature conditions in each segment. The Commission also determined that the Dolores River from the Highway 141 road crossing to the Little Gypsum Valley Bridge had been misclassified as a cold-water river. Reg. 35 SBP at 17-18.

Table 2. Numeric Criteria for temperature adopted by the Commission for lower Dolores River segments.

Segment	*Aquatic Life Designated Use*	*Numeric Criteria for Temperature (chronic/acute)[1] (^oC)*	*Basis*
Upper Portion (Regulation 34)			
4a. Main stem of the Dolores River from a point immediately above the confluence with Bear Creek to the bridge at Bradfield Ranch (Forest Route 505, near Montezuma/Dolores County Line).	Cold 1	18.3/23.9 (Apr-Oct) 9.0/13.0 (Nov-Mar)	Table Value for Tier II Cold Stream (CS-II)[2]
Lower Portion (Regulation 35)			
1a. Main stem of the Dolores River from the bridge at Bradfield Ranch to a point immediately above the confluence with Big Canyon Creek near Dove Creek.	Cold 1	23.8/26.6 (Mar 23 - Oct 31) 9.0/13.0 (Nov 1- Mar 22)	Ambient (data from Dove Creek Pumps site)
1b. Main stem of the Dolores River from a point immediately above the confluence with Big Canyon Creek near Dove Creek to a point immediately above the Highway 141 road crossing near Slick Rock.	Cold 1	24.7/27.6 (Mar 23 - Oct 31) 9.1/13.0 (Nov 1 - Mar 22)	Ambient (data from above Disappointment Creek site)
2. Main stem of the Dolores River from the Highway 141 road crossing near Slick Rock to the Colorado/Utah border.	Warm 1	28.5/27.5 (Mar - Nov) 14.3/13.8 (Dec - Feb)	Table Values for Tier II Warm Stream (WS-II)[3]

[1] The "chronic" standard is assessed using the "maximum weekly average temperature" (MWAT), which is calculated as the largest mathematical mean of multiple, equally spaced temperatures over a seven-day consecutive period, with a minimum of three data points spaced equally through the day. The "acute" standards is assessed using the "daily maximum temperature" (DM), which is the highest two-hour average water temperature recorded during a 24-hour period. WQCC Reg. No. 31.

[2] Cold Stream Tier II is defined as streams where cold-water aquatic species, excluding cutthroat trout or brook trout, are expected to occur. WQCC Reg. No. 31.

[3] Warm Stream Tier II is defined as streams where brook stickleback, central stoneroller, creek chub, finescale dace, longnose dace, Northern redbelly dace, razorback sucker, or white sucker are expected occur, and none of the more thermally sensitive species in Tier I (i.e., common shiner, Johnny darter, or orangethroat darter) are expected to occur. WQCC Reg. No. 31.

The classifications and segmentation boundaries for segments 1 and 2 had not been changed since November 1981, when Reg. No. 35 was first adopted and before McPhee Reservoir was completed. In 2007, the Commission adopted revised table values for temperature. The Commission indicated its intent that in the subsequent round of triennial reviews, numerical temperature standards generally would be adopted for segments throughout the state. It also acknowledged that the adoption of segment specific temperature standards might require re-segmentation and other adjustments of the current standards framework to appropriately match numerical standards with changes in species compositions.

The revised temperature table values were developed to protect the aquatic community from the harmful effects of temperature and based on the thermal requirements of the fish species found in Colorado. The chronic standard is intended to protect fish from sub-lethal temperature effects on behavior, metabolism, growth, and reproduction. The acute standard is intended to protect fish from lethal temperature effects. Fish species with similar thermal requirements are grouped in tiers. All segments are also subject to the following narrative criterion for temperature:

> Temperature shall maintain a normal pattern of diel and seasonal fluctuations and spatial diversity with no abrupt changes and shall have no increase in temperature of a magnitude, rate, and duration deleterious to the resident aquatic life.

At the 2012 Triennial Review Hearing, the Commission concluded that temperature and fish survey data for the most upstream and most downstream segments of the lower Dolores River were consistent with the original Cold I and Warm I aquatic life use designations, so the Commission adopted the table value standards for temperature based on the fish communities present (WQCD 2012b). The aquatic community temperature characteristics of the middle segments (i.e., 1a and 1b of Reg. No. 35) were consistent with a cold-water classification. However, temperature and fish data confirm that these segments were capable of supporting cold water fishes at warmer temperatures than those required by Cold Stream tier II standards. Therefore, ambient based temperature standards were concluded to be protective of the aquatic life use for those stream reaches.

b. Regulatory Hearing Related to Temperature

At the 2004 hearing to identify impaired waters for listing on the State's 303(d) list, the Commission was asked by Trout Unlimited to list the Dolores River below McPhee Reservoir as having impaired aquatic life. Trout Unlimited asserted that releases from McPhee Reservoir were insufficient for aquatic life because River temperatures below the Reservoir were too high. After reviewing the evidence before it, the Commission declined to list the River as impaired and concluded as follows:

> Despite a recent decline in the fish population in the Dolores River below McPhee Reservoir the Commission found that there was not adequate readily available evidence to conclude that there exists an impairment of the aquatic life use due to other than extraordinary events associated with the long-term drought that has existed in southwest Colorado for several years. In view of evolving operations of McPhee Reservoir and varying (and generally declining) hydrologic conditions, the Commission is not able at this time to identify an "expected condition" upon which to base a decision of impairment. Further, even if an impairment caused by other than the extraordinary events associated with the drought were found to exist, the Commission could not conclude based on this record that the decline was due to a "pollutant" as compared to "pollution." Nevertheless, the Commission encourages cooperation by all interested parties in the implementation of habitat improvement measures that may serve to enhance the quality of the fishery in the reach. The Commission is prepared to revisit the concept of "expected condition" as it applies to this reach should that be warranted by changes in habitat condition. Certainly the achievement of goals set under the 1996 Operating Agreement for McPhee Reservoir may influence the nature of the expected condition. Finally, any evidence of impairment due to pollutants can be brought forth at the next listing hearing.

(WQCC Reg. No. 93) Since 2004 hearing no parties have requested that the Commission list any segments of the lower Dolores River as having impaired aquatic life use.

c. Implementation Team Work on Temperature Below McPhee Reservoir

The "A Way Forward" scientists identified thermal regime modification through spill management as an opportunity to mitigate the negative effects of thermal shock to incubating eggs and hatched fry (Bestgen et al. 2011). During spring runoff, the temperature of the water at downstream sites is inversely correlated with the volume of water being released from McPhee. Therefore, the AWF scientists suggested early release of some quantity of forecasted spill water during the spring (April-May) in order to more closely mimic natural runoff patterns and to depress water temperatures enough to delay spawning until after peak runoff (Bestgen et al 2011; Bureau of Reclamation 2012).

In 2009, the DRD contracted a study of the relationship between downstream algal biomass, dissolved oxygen and temperature and the potential for use of the McPhee Dam selective level outlet (Anderson 2011). Water temperature data collected by various agencies from the Dolores River below McPhee Dam was compiled and a model (SSTEMP) developed to help gauge the effect of various discharges from McPhee (Anderson 2011). This coarse water temperature model suggested the hypothesis that streamflow of 125 cfs in late April, and 200 cfs on May 15 may keep temperatures below 15°C between the Dove Creek pumps, and just above Disappointment Creek during this period. (Anderson 2011). Based on this working hypothesis, some of the DRD stakeholders are working diligently to better understand water temperature and its relationship to discharge from McPhee Dam.

In 2008, the Dolores Water Conservancy District, with contributions from the DRD partners, reactivated the USGS stream flow gage at Slickrock. In 2012, through the "A Way Forward Implementation" grant from the Colorado Water Conservation Board, the Colorado Department of Parks and Wildlife installed a real-time satellite-linked temperature gage that provides relative humidity, stream and air temperature measurements just above the Disappointment Creek confluence (www.DataGarrison.com).

The agreement and intent of stakeholders working on this issue is to both fill McPhee Reservoir and to use the real-time temperature data and the Slickrock gage data, together with the bi-weekly Upper Colorado River Basin Forecast Center runoff forecasts and the 5-and 10 day National Weather Service forecasts, to fine-tune release recommendations intended to meet thermal objectives in a given year. There is agreement from boaters and water suppliers that slowly ramping flows at 5-10 cfs increments and using real-time satellite fed stream temperature information may be the most efficient way to manage releases from McPhee Reservoir to meet thermal objectives. The Bureau of Reclamation has prepared a Categorical Exclusion (2012) to allow for the managed release of water earlier than required under existing Dolores Project operating procedures to assist in temperature regulation for the benefit downstream native fish until 2015 (Bureau of Reclamation 2012). All stakeholders retain power and institutional oversight over their management and action The Dolores Water Conservancy District and the Bureau of Reclamation are ultimately responsible for managing releases from McPhee Reservoir, so implementation of any flow recommendations is strictly voluntary. Nevertheless, the identification and implementation of reservoir release guidelines to benefit native fish are noteworthy management opportunities that were identified through collaborative work among the stakeholders and serve to show that management adjustments to protect both water rights and the environment are possible. This watershed plan identifies steps that can support efforts to manage the thermal regime and to monitor and evaluate the success of these efforts.

d. Water Temperature and the Native Fishery

Water temperature directly governs the metabolism of fish and influences their behavior. Water temperature can have a dramatic influence on the diversity and health of the aquatic community. Fish and aquatic macro invertebrates are cold blooded organisms that have evolved within specific thermal conditions, and changes from the natural patterns and ranges of these thermal conditions can affect reproduction and survival of individuals and therefore the distribution and composition of fish communities.

Water temperature depends on various factors including solar radiation, ambient air temperature, stream shade, channel morphology, stream flows, ground water inflows, and various land and water management activities. However, these thresholds have not been specifically assessed on the Dolores River. There is a need for investigation of these factors specific to the Dolores River.

i. Spawning

Under natural hydrologic conditions adult native fish move to suitable spawning habitat in late spring or early summer. Sucker species make this movement as flow levels are rising or peaking, while roundtails move when flow levels are declining. The timing of spawning during or just after peak flows means that the gravel cobble spawning beds are clean and ready for the native fish eggs to adhere to the rocks and develop between the rocks. The flannelmouth sucker is the first to spawn, at water temperatures of 10-18°C; the bluehead sucker is next, at water temperatures of 14-20°C; and the Roundtail Chub initiates spawning the latest, at temperatures of 16-22°C (Bestgen et al 2011). However, these thresholds have not been specifically assessed for these species in the Dolores River.

ii. Growth and Survival

Following spawn, native fish embryos and larvae develop when flows are declining or stable and water temperature is increasing. The rate of development and growth depends on water temperature. Sucker eggs can take three weeks to hatch at 10°C; they may not emerge from the spaces between the spawning cobbles for an additional 7-14 days. Roundtail chub eggs will hatch in as little as 5-7 days at 18°C, and emerge within approximately 7 days (Bestgen et al 2011). Again, these thresholds have not been specifically assessed for these species in the Dolores River.

e. Source of Water Temperature Problem

The operational practice of filling McPhee reservoir prior to releasing water downstream in years when low to moderate spring runoff is predicted, also known as the "fill and spill" strategy, can result in an inappropriately timed native fish spawn. Data from sites downstream of McPhee Dam show that during spring baseflow releases prior to the beginning of a managed spill from the reservoir, water temperatures sometimes elevate to the point that native suckers may initiate spawning (especially the flannelmouth sucker, which spawns between 10-18°C(50-64°F) (Bestgen et al 2012, Bureau of Reclamation 2012). Pre-spill water temperatures above 10°C (50°F) have been observed on multiple occasions since 2006 (Bureau of Reclamation 2012). The release of a large, cold, managed spill from McPhee likely produces thermal shock reducing the survival of any incubating eggs or hatched fry that may have resulted from early spawning induced by elevated water temperatures (Bureau of Reclamation 2012).

f. Potential Solutions/Actions and Additional Information Needs

Specific actions that could be implemented to address the water temperature issue include:

a. Manage water temperature while minimizing risk to Dolores Project water users.

Use of a staged decision-making framework informed by the best available runoff forecast information (e.g. Upper Colorado River Basin Forecast Center) and the new real-time temperature gage just above Disappointment Creek, and accounting as spelled out in the BOR's Categorical Exclusion (2012) can help to minimize risk to Project water supplies and optimize dam operations of managed releases for temperature regulation. Planning for multiple planned decision points during the runoff season to incorporate the latest coordinated runoff forecasts can minimize risk by allowing ever improving forecasts to inform the possibility of pre-spill releases to suppress water temperature. In a given year, real-time temperature readings might show that temperatures at April 30 and/or May 15 actually remain below 15°C, reducing the need for pre-spill releases.

b. Manage water temperature through spill management from McPhee Reservoir.

Implement a staged decision-making framework informed by the best available runoff forecast information (e.g. Upper Colorado River Basin Forecast Center) and the new real-time temperature gage just above Disappointment Creek to achieve and maintain water temperatures below 15 degrees C in April and May, when managed spills are projected.

c. Continue to refine the temperature model in order to fine-tune thermal management hypotheses.

Investigate and evaluate best available options for modeling downstream water temperature against existing downstream temperature model. Select model and continue to incorporate new data from the Slickrock gage and the newly installed real-time satellite-linked temperature gage just above Disappointment Creek, as well as spawn monitoring data. Continued incorporation of new information can allow for improvements in the level of certainty around the most effective timing and volume of releases aimed at maintaining water temperature below 15 degrees Celsius prior to a managed release, and refinement of the thermal regulation hypotheses. In addition, refinements to model water temperature by reach and by time period might provide useful insights and refinements to management hypotheses.

Consider incorporating a variable that reflects the effect of runoff from tributaries entering the Dolores downstream of McPhee Dam on water temperature. One approach might be to develop a flow rating curve for Disappointment Creek (Implementation Team 2012).

d. Monitor and assess the effectiveness of April and May releases at suppressing native fish spawn.

When spring releases are implemented in order to suppress water temperature, conduct monitoring within spawning habitat to assess whether native fish spawned prior to the spill or afterwards, and to assess the success of the spawn. Use this information to inform future efforts to manage thermal regime.

g. Potential Effects of Potential Solutions/Actions

i. Native Fish Species

Suppression of water temperatures sufficiently to delay native fish spawning until after a managed spill would benefit native fish populations by increasing the number of years (on average) where reproduction and survival of eggs and fry can occur successfully. It will take on-the-ground monitoring of spawn success and fish population sampling to determine whether flow management actions are having the desired effect.

If forecasted surplus water does not materialize in actual runoff, any volume of water released for temperature suppression prior to a managed spill might contribute to the reservoir not filling in that year. In the event that the reservoir does not fill, the shortage is shared *pro rata* among all project uses except municipal and industrial (Bureau of Reclamation 1996). Shortage in the fishery pool volume of water would result in diminished baseflows in the summer, fall and/or winter, reducing the amount of fish habitat in the river in that year.

ii. Agriculture

The intention and agreement of the Implementation Team is first to ensure that McPhee Reservoir fills and second to address the possibility of thermal regime modification. The reason for this is that release of “managed spill” water prior to filling the reservoir can increase the risk that the reservoir may not fill. If forecasted surplus water does not materialize in actual flows into the reservoir, then an April/May temperature suppression release might contribute to a shortage of water stored and available for agricultural uses in that year as well as carry-over storage that might otherwise be available and needed for the following year.

iii. Recreational Boating

Historically, water released above the base pool allocation, that is water in excess of the reservoir's storage capacity, has been managed for the benefit of the recreational boating community (Bureau of Reclamation 2012). Traditionally, water released prior to a managed spill is not considered "boatable water." Therefore, release of water in April and May, assuming it is not part of a managed spill, would reduce the total volume of surplus water available to be managed for recreational boating downstream during the managed spill, likely reducing the number of "boatable" days.

iv. Cold-Water fishery

If forecasted surplus water does not materialize as actual runoff, there is a risk that the volume of water released for temperature suppression prior to a managed spill might contribute to the reservoir not filling in that year. When the reservoir does not fill, the shortage is shared *pro rata* among all project uses except municipal and industrial uses (Bureau of Reclamation 1996. Shortage in the fishery pool volume of water would result in diminished baseflows in the summer, fall and/or winter, reducing the amount of habitat available to all fish in the river in that year. Reduction in the amount of habitat during the summer, fall and winter can reduce growth and survival.

h. Estimates of Effects of Potential Solutions/Actions on Water Quality

If small and modest-sized managed spills can be accurately forecasted and temperature suppressing flows can be achieved to maintain water temperatures below 15 degrees C prior to those managed spills, then the current best predictions of future hydrologic expectations (based on the record of inflows to the reservoir since 1928) (Graf 2006) suggest that the survival of eggs and fry could be enhanced in the approximately 12% of years when spills are less than 64K. The assumption is that in years with spill volumes greater than 100K, there is a high probability that the managed spill will begin by April 20 and no temperature suppression is necessary (Bureau of Reclamation 2012). Also, in the 45% of years with no spill, temperature suppression is not necessary, as there is no spill to cause thermal shock to the native spawn (Graf 2006). It is important to note that it is possible that the future hydrology of the upper Dolores River may be different than the hydrology since 1928. If so, the percent frequencies presented here would change. For instance, if in the future the upper basin yields less water, then the frequency of spills less than 64K would likely increase, and with it the need to suppress water temperature downstream to support successful spawn.

6. Sediment

Sediment transport is a natural function of streams. Sediment enters streams through erosion of the stream channel and upland surfaces. Excessive deposition of sediment onto the bottom of streams and rivers can result in impairment or loss of habitat for fish, aquatic invertebrates, and algae (Waters 1995). Potential impacts to fish from excessive sediment include smothering of fish spawning gravels and cobble surfaces resulting in decreased inter-gravel oxygen and a reduction in survival and growth rates; loss of fish food sources; and loss of pool and other habitat types through changes in stream channel morphology. Potential impacts to aquatic invertebrates include smothering and infilling of interstitial spaces in gravel and cobble substrates. Chapman and Mcleod (1987) found that bed material size is related to habitat suitability for fish and macroinvertebrates and that excess sediment decreased both density and diversity of aquatic insects. Specific aspects of sediment-invertebrate relationships may be generally described as follows: (1) invertebrate abundance is often correlated with substrate particle size; (2) fine sediment can reduce the abundance of original populations by reducing interstitial habitat normally available in large-particle substrate (gravel, cobbles); and (3) species type, species richness, and diversity may change as substrate particle size changes from large (gravel, cobble) to small (sand, silt, clay) (Waters 1995). However, the relationship between sediment loads and aquatic life is highly complex and the impact of human activities is generally difficult to discern because sediment is a natural component of the stream environment and stream biota have evolved to withstand regular, natural sediment transport events. Therefore, extensive and well-designed study of channel morphology, stream hydrology, and sediment sources are needed to characterize sediment dynamics and habitat effects in a river.

a. Colorado's Regulatory Criteria for Sediment

Colorado addresses potential sedimentation impacts using the following narrative standard:

> . . . state surface waters shall be free from substances attributable to human-caused point source or nonpoint source discharge in amounts, concentrations or combinations which . . . can settle to form bottom deposits detrimental to the beneficial uses. Depositions are stream bottom buildup of materials which include but are not limited to anaerobic sludges, mine slurry or tailings, silt, or mud . . .

In 2005, the Commission issued a guidance document to provide a consistent approach for the Division, other agencies, and stakeholders, to gather data to document the effects of sedimentation on aquatic life uses (WQCC 2005). This guidance is intended to apply to the assessment of impacts to aquatic life uses in higher gradient, cobble-bed, course-grained, mountainous stream and wade-able river environments. The guidance also provides a procedure to assess the impacts of bottom deposits on the attainment of the aquatic life uses and to determine whether a particular stream segment is attaining the narrative standard. The approach of the procedure is to compare actual sediment conditions of a study stream with the "expected condition" for the same stream. A wide variety of factors including, aquatic life use classification, geology, elevation, climate, hydrology, and land use will influence the selection of appropriate expected conditions. The guidance is intended for identifying impairment due to sediment, but is not intended to address the development of TMDL's for sediment, and therefore does not address how to solve sediment problems or how to identify sediment sources or allocate loads.

b. Findings on Sedimentation below McPhee Reservoir

The "A Way Forward" scientists identified two sediment related opportunities for potentially improving habitat conditions for native fish populations: sediment flushing flows and habitat maintenance flows. Habitat maintenance flows are large enough to move large channel bed material and occasionally rework channel geometry (Bestgen et al 2011). Sediment flushing flows can help mitigate the negative effects of the accumulation of fine sediments (i.e. nonpoint source sedimentation) on native fish spawning and foraging substrates, and in winter holding pools. Stakeholders have acknowledged that sediment flushing is important whenever a spill is possible because spawning success is vital to native fish persistence below the dam (Bureau of Reclamation 2012).

Two flow hypotheses, with specific habitat objectives, have been identified for meeting the sediment flushing goal:

1. 400-800 cfs for at least one day in the fall or spring almost every year is expected to "mobilize fine tributary sediments (<2mm) accumulated in both pools and riffles from monsoon runoff" with the goal of "maintaining bed porosity and preparing cobbles for spawning."

2. 800-2000 cfs for at least 7 days every 1-2 years is expected to mobilize the median particle size (D50), scour pools, "refresh spawning cobbles, enhance instream productivity; and maintain pattern and profile".

(Bestgen et al. 2011) This watershed plan identifies steps that can support efforts to manage fine sediment deposition and to monitor and refine these working hypotheses.

c. Sediment Deposition and the Native Fishery

i. Reproduction

The successful reproduction of flannelmouth suckers, bluehead suckers and roundtail chub is linked to the quality of the substrate where they spawn. These fish deposit their eggs over gravel-cobble beds located in riffle and run habitats (Bestgen et al 2011, Richard and Wilcox 2005). The eggs float down into the spaces between the individual rocks and adhere to the rocks. As water moves freely through these open spaces it delivers oxygen to the developing embryos (Bestgen et al 2011). In streams where hydrology is unaltered, the fish deposit their eggs on these spawning beds at or shortly after the peak flows. This timing means that the flows have flushed any accumulated fine particles (silt or sand) out of the gravel/cobble substrate, leaving the interstitial spaces clean and flowing with water.

To date, there has been no direct study to determine whether sedimentation is negatively affecting native fish reproduction in the Dolores. There are, however, informed observations that together suggest that sedimentation may be a problem, given the reproductive needs of these fish. Anderson (2005) and Stewart sampled the fish community in the Big Gypsum Valley, about 15 miles downstream of Disappointment Creek in 2000, 2001, 2004 and 2005. They noted that "the fish community was dramatically altered at Big Gypsum between 2000 and 2004 and the most likely cause was reduced flows. In 2004 there had not been a flushing flow since 1999, allowing sediment from Disappointment Creek to accumulate for five years" (Anderson and Stewart 2006).

ii. Growth and Survival

The growth and survival of native fish is also related to the degree of sedimentation occurring in a stream. Clean and hard surfaces support the highest food abundance in the habitats that each species uses as juveniles and adults (Bestgen et al 2011). Roundtail chubs generally occupy pool and backwater habitat, while flannelmouth suckers occupy pools and runs, and bluehead suckers occupy fast runs and riffles (Bestgen et al 2011). Each species has different dietary preferences, but all forage to a large extent on food (invertebrates, algae, etc.) that is adhered to the channel substrate, or living in the spaces between the rocks. In addition to productive habitats that support growth and survival, adult fish need deep pools where they can overwinter beneath surface ice (Bestgen et al 2011).

In sampling the native fish community at Big Gypsum between 2000 and 2005, Anderson and Stewart (2006) found reduced biomass of flannelmouth, bluehead and roundtail chub in 2004. They noted that reduced biomass is an expected response to reduced forage potential, and observed that riffles appeared "more silted" after the 2002 drought year (Anderson and Stewart 2006). They noted that the accumulation of sediment in riffles and pools over four consecutive years without flushing flows resulted in a reduction in habitat quality (Anderson and Stewart 2007). Richard and Wilcox (2005) also noted the predominance of silt in the channel bed substrate through the Big Gypsum Valley and suggested that these fine sediments may have accumulated in the reach "due to reduced flows and increased fine sediment supplies."

CPW staff measured a cross section of the Dolores River through a pool located below the BLM recreational site in the Big Gypsum Valley in 2005 before and after the large spill. The measurements show that the high spill flows scoured over 6 vertical feet of silt, clay and organic "muck" from the pool. They estimated pool volume increased by ~300 % due to the 2005 runoff (Graf, personal communication).

d. Source of Sediment Problem

On the Lower Dolores River, the construction of the Dolores Project has caused changes to the stream flow regime. A hydrologic analysis completed by Richard and Wilcox (2005) found that the dam reduced the magnitude of the two-year flood by 27% and that of the mean annual flood by 50%. The reduction in the magnitude and duration of peak flows (Bestgen et al 2011, Budy and Salant 2011, Anderson and Stewart 2007, Wilcox and Merritt 2005) has decreased the average capacity of the stream to move sediment compared to pre-dam conditions, particularly in low gradient reaches of the river not closely confined by canyon walls (i.e. Big Gypsum Valley, Little Gypsum Valley, Paradox Valley, etc.) (Richard and Wilcox 2005, Bestgen et al 2011). The reduction of the River's average capacity to move sediment could be exacerbated by an increase in the river's sediment supply due to increased erosion and sediment loading related to land uses. Roads, trails, recreation activities, cultivation, and livestock grazing can increase sediment loading to adjacent streams (Allan 2004, Bestgen et al 2011).

Along the length of the Dolores River, sediment load per acre of drainage area tends to increase as one moves downstream. Looking at historic gage data, Richard and Wilcox (2005) found that Total Suspended Sediment (TSS) per acre of drainage area was more than twice as high at the USGS Dolores River at Cisco gage than above McPhee Dam. Below McPhee, a large proportion of the watershed has a more arid climate, fine grained erodible soils (i.e. shales, sandstones, etc.), and sparse, semi-desert vegetation. There are very few perennial tributaries between McPhee Dam and the mouth of the San Miguel River. The San Miguel is a large perennial tributary with relatively unaltered spring flows. The San Miguel's spring and fall "flushing" flows likely combine with the Dolores River flows to help limit the accumulation of fine sediments in habitats downstream of the confluence (Richard and Wilcox 2005). Therefore the current assumption is that sedimentation presents a greater challenge to native fish recovery between McPhee Dam and the San Miguel River, than it does below the San Miguel confluence (Richard and Wilcox 2005). Within this stretch of the river the reaches most likely to be affected by accumulation of fines are downstream of high sediment loading tributaries (Richard and Wilcox 2005).

The USDA (1972) characterized sediment yields in the Disappointment Valley, Big Gypsum Valley and Paradox Valley as between 1 and 3 ac-ft/mi^2/year (Richard and Wilcox 2005). Disappointment Creek is the largest perennial tributary to the Dolores River above the San Miguel confluence, with a drainage area of 350 mi^2. Given its perennial flow, large drainage area and the predominance of easily erodible Mancos Shale in the valley (Figure X), Disappointment Creek is likely the largest contributor of sediment in the reach between McPhee Dam and the San Miguel confluence (Richard and Wilcox 2005, USDI BLM, 1990, USDA 1972).

A recent field assessment of public lands condition in portions of Disappointment Creek and Big and Little Gypsum Valley drainages identified upland range condition as a partial source of sediment loading to Disappointment Creek and Big Gypsum Creek. The Dolores Public Lands Office drafted an "Environmental Assessment (EA) of Livestock Grazing Use on Three BLM Allotments in the Vicinity of Lower Disappointment Valley" (2010) to analyze the impacts of livestock grazing and other public land activities on public land resources in these allotments. The EA proposes alternative grazing options pursuant to lease renewals (BLM 2010).

Proper Functioning Condition is a qualitative survey used to assess the hydrology, vegetation and erosional/depositional processes of riparian areas (both lentic and lotic). Riparian areas are rated Proper- Functioning-Condition (PFC), Functional-At-Risk (FAR) or Non-Functional (NF). Functional-At-Risk ratings include an assessment of trend (Pritchard et al. 1993).

The allotments analyzed are located in the Disappointment Creek, Big and Little Gypsum Creek vicinity, and include the following streams: Disappointment Creek, Big Gypsum Creek, Coyote Wash, Nicholas Wash, Dawson Draw, Travellers Draw, Spring Creek, and East Branch Pine Arroyo. The riparian areas in these allotments were rated by BLM Managers using the Proper Functioning Condition protocol. The assessment classified most of the riparian areas as in Proper-Functioning-Condition or Functional-At-Risk with an upward trend. However, for many riparian areas in the analysis area the assessment noted that the surrounding upland watershed was contributing to riparian-wetland degradation as evidenced by either excessive erosion or excessive deposition (BLM 2010). The state of upland areas can affect the condition of a riparian-wetland area by influencing the magnitude, timing, or duration of overland flow events, and this finding suggests that these tributaries may be high sediment loading sources to the Dolores River.

As part of the EA, BLM managers also conducted land health assessments in each allotment. These assessments involve evaluation of a list of 17 indicators in relation to expected conditions described in ecological site descriptions (USDA NRCS 1997), associated soil survey descriptions (USDA NRCS 2001), and/or a local reference (benchmark) site (Pyke et al 2003). According to the EA, each allotment departed moderately or greater from the BLM's standards for "soil and site stability" and for "hydrologic function," noting the following indicators:

- Water flow patterns were more numerous and extensive than expected;
- Pedestals were active,
- Bare ground was higher than expected for the site; bare areas were of moderate or larger size and connected,
- Gullies were moderate or greater in number with indications of active erosion; vegetation was intermittent or infrequent on slopes and/or bed; headcuts were present.
- Soil surface resistance to erosion was significantly reduced in at least half of the plant canopy interspaces and may be reduced beneath plant canopies.
- Soil surface loss or degradation was moderate to severe in plant interspaces with some degree of degradation beneath plant canopies; soil structure was degraded and soil organic matter was significantly reduced.

Soil and site stability is the capacity of an area to limit redistribution and loss of soil resources (including nutrients and organic matter) by wind and water.

Hydrologic function is the capacity of an area to capture, store, and safely release water from rainfall, run-on, and snowmelt (where relevant), to resist a reduction in this capacity, and to recover this capacity when a reduction does occur.

- Biological crust cover was greatly reduced with a limited suite of life-forms and species, occurring only in protected areas or not at all.
- Litter movement was moderate to extreme for small class sizes and greater.
- Infiltration was moderately to greatly reduce due to adverse changes in the plant community composition and/or distribution.
- Amount of litter present was moderately to greatly more or less than expected for the site relative to potential and weather.

In the Big Gypsum Valley reach of the Dolores, the EA noted that Big Gypsum Creek, an ephemeral wash, has incised several feet and continues to erode laterally in its upper reach. The EA suggests that Big Gypsum Creek's condition is partly the result of upland watershed conditions, where the analysis found that in the majority of sites assessed the upland soils were not meeting the upland soil standard for rangeland health.

Between Dove Creek Pumps and the mouth of Disappointment Creek, the Dolores River passes through a confined reach. There is evidence that some native fish spawning activity may occur in this reach, and young of the year roundtail chubs have been documented there (Graf, personal communication). The presence of a 4WD road along the river in this reach was considered by the Lower Dolores Plan Working Group (LDPWG) because of its potential to contribute sediment to the river (LDPWG 2010). The route runs along and sometimes crosses the river from 2.4 miles north of the San Miguel/Dolores County line to an exit to Highway 141 near Disappointment Creek. In considering the management of this route, the group acknowledged that there is some erosion associated with its use and condition that might impact native fish habitat. The group recommended that the route continue to be available for use, without increased maintenance or improvement, but that the BLM should "adopt specific criteria as a guide for when active management of 'problem spots' along the road should be initiated (e.g. eroding river banks, spur routes/trails forming, impacts to riparian vegetation, etc.)," and that the agency "document the level, type and timing of use of this route so that such baseline information can inform them about whether management thresholds/criteria are being met" (LDPWG 2010).

Another periodic source of sediment loading to this upper reach of the Dolores River is wildfire. As noted by Rees et al (2005b), "input of large quantities of sediment into streams frequently occurs during storm events at recently burned areas. Once in the watershed, the increased sediment load can diminish suitable spawning habitat, reduce fitness through reduction of the prey base, and cause direct mortality through suffocation." Chester Anderson (personal communication) witnessed just such an event on the Dolores River following the Narraguinnep Fire in 2010. Mr. Anderson was sampling water quality in the vicinity of Bradfield Bridge on July 27 and 28th and noted smallmouth bass, roundtail chubs, trout and lots of small fish in distress (i.e., "belly-up") at the surface.

e. Potential Solutions/Actions and Additional Information Needs

Specific tasks that the DRD or its partners could complete to address sediment as a nonpoint source pollutant include:

a. Conduct monitoring to determine whether flow hypotheses achieved the intended habitat objectives using specific measureable benchmarks and monitoring protocols. If monitoring shows that habitat objectives are not being met, reassess and refine the sediment flushing hypotheses, and consider changes to flow regime.
b. Develop and calibrate a sediment transport model for priority reaches in the Dolores River;
c. Quantify loading of sediment to Dolores River from Disappointment Creek and Big Gypsum Creek;
d. Open dialogue with private landowners and public land permittees on sediment concerns for native fish, land management challenges and potential strategies.
e. Work with interested landowners to identify, fund and implement BMPs to reduce sediment loading.

f. Potential Effects of Potential Solutions/Actions

i. 3 native fish species

Achievement of habitat objectives for flushing flows should improve the production of food for native fish (macroinvertebrates, especially in riffles), improve habitat and improve opportunities for successful spawn. Overtime these improvements could result in greater survival and reproduction of native fish (Bestgen et al. 2011).

An additional benefit of achieving flushing flow targets of 400-800 cfs is that these flows overlap with the optimal flows for monitoring native fish in the remote reaches of Pyramid to Disappointment (~500 cfs) and Slickrock Canyon (~800cfs) (Implementation Team 2012). Frequent monitoring of native fish will inform and potentially accelerate refinements in management hypotheses.

ii. Agriculture

Proposed release hypotheses related to sediment can only occur when water is available and will not affect agricultural supplies. Therefore, there should be no consequence of sediment management proposals on agricultural water supplies in the Dolores Project.

Sediment loading related to agricultural practices would be considered nonpoint source pollution, and therefore is regulated only through voluntary implementation of best management practices. Therefore, there is no direct regulatory consequence for agricultural producers.

On public land allotments, managers will continue to be required to assess and adjust management toward attainment of agency land health standards. This requirement is not affected by the goals and steps identified in this plan.

iii. Boating

Managing for flushing flows may require the managed release of water from storage, but these flows may not meet minimal whitewater boating flow targets (minimal flows are ~700-900 cfs), so "boatable flow days" might be reduced (Bureau of Reclamation 2012). However, flushing flow targets of 400-800 cfs do meet some non-whitewater boating goals.

iv. Cold-water fishery

Achievement of habitat objectives for flushing flows should improve the production of food for native fish (macroinvertebrates, especially in riffles) and improve the quality of spawning habitat for trout. Over time, these improvements could result in greater survival and production of trout species (Bestgen et al. 2011).

There is no current proposal to change the operation of managed releases, so there should be no consequence of sediment management proposals on the water available for downstream releases. However, if a managed release is operated to increase the magnitude of flows or increase the duration of a certain flow (e.g. 800 cfs) in order to meet flushing flow targets and if any of the water used for the spill came from the Project fishery pool, the base pool budget might be affected that summer, fall and/or winter.

g. Estimates of Effects of Potential Solutions/Actions on Water Quality

There is not enough information available to assess the current actual effects of accumulated fine sediments for native fish nor the quantity of sediment loaded to the Dolores River from various sources.

In general, based on the best available information, if efforts to reduce sediment loading from Disappointment Creek and Big Gypsum Creek, and other sediment sources between McPhee Dam and the confluence San Miguel River can be implemented and successful, and/or the natural hydrology allows dam operators to release surplus water at flows of 400 cfs or greater annually, the accumulation of fine sediments on spawning and foraging substrates should be minimized.

7. Uranium

Uranium is a radioactive element found naturally in small amounts in the environment in rocks, soil, air and water. Mining and milling processes add uranium to the environment. The lower Dolores Rivers flows through the "Uravan mineral belt," one of the most productive uranium mining areas in the United States during the first half of the 20th Century (Fishcer and Hilpert 1952). Water quality impacts from uranium tailings have been cited as a cause of poor composition and abundance of native fish populations in the Dolores River downstream of the San Miguel confluence (Valdez et al. 1982).

a. Colorado's Regulatory Criteria for Uranium

The Water Quality Control Commission has adopted separate numeric criteria for uranium to protect drinking water and aquatic life designated uses (WQCC Reg. No. 31, Table III). The table value for drinking water is provided as a range of 16.8 to 30 µg/l (30-day). The first value, 16.8 µg/l, is a strictly health-based value, based on the Commission's established methodology for human health-based standards. The second value, 30 µg/l, is a maximum contaminant level (MCL), established under the Safe Drinking Water Act that has been determined to be an acceptable level of this chemical in public water supplies, taking treatability and laboratory detection limits into account. Water bodies are considered in attainment of these criteria, and not included on the Section 303(d) List, so long as the existing ambient quality does not exceed the latter value.

For aquatic life use, like for many other regulated metals, acute and chronic numeric criteria are given as an equation that is a function of the hardness of the water. For a range of hardness from 25 to 400 mg/l $CaCO_3$, the acute criterion ranges from 521 to 11,070 µg/l and the chronic criterion ranges from 326 to 6,915 µg/l (WQCC Reg. No. 31, Table IV). Accordingly, the numeric criteria to protect drinking water use are far more stringent than those to protect aquatic life use. The Commission also has adopted a policy to consider the need to maintain radioactive materials at the lowest practical level when applying the table value standards for uranium to individual segments (WQCC Reg. No. 31, footnote 17).

b. Historical Overview of Uranium Mining in Dolores Basin

The Uravan mineral belt is a zone of uranium-vanadium deposits in San Miguel, Montrose, and Mesa counties, Colorado, and Grand County, Utah. Mines in this area produced the most uranium in the United States in the early 20th century. The mineral belt includes the Slick Rock, Gypsum Valley, Uravan, and Gateway mining districts (Fischer and Hilpert 1952). There are numerous vanadium and uranium mine sites and permits within the Dolores River basin below McPhee Reservoir (http://drmsmaps.state.co.us). Uranium mill tailings contain the radioactive element radium, which decays to produce radon, a radioactive gas. The radium in these tailings will not decay entirely for thousands of years. The mill tailings pose a potential hazard to public health and safety.

In the 1980s, the price of uranium fell and as a result U.S. uranium mines and mills were shut down or scaled back. To provide for the management of these mill tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public, Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) (http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/mill-tailings.html). In the mid-2000s, the price of uranium rose rapidly, sparking renewed interest in uranium mining and processing (http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/mill-tailings.html).

The Uranium Mill Tailings Remedial Action (UMTRA) Project was created by the United States Department of Energy (DOE) to monitor the cleanup of uranium mill tailings. In 1978 the US Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) which tasked the DOE with the responsibility of stabilizing, disposing, and controlling uranium mill tailings and other contaminated material at uranium mill processing sites spread across 10 states and at approximately 5,200 associated properties. Under UMTRCA, the DOE created UMTRA to decommission uranium mills and dispose of their residual mill tailings.

The Slick Rock, Colorado, Processing Sites consist of two former uranium-ore processing facilities: the Slick Rock East and the Slick Rock West sites. The sites, managed by the U.S. Department of Energy (DOE) as Uranium Mill Tailings Remedial Actions (UMTRA) sites, are located along the Dolores River and cover over 70 acres. Surface remediation of the two sites was completed in 1996.

c. Current Status of Uranium Loads in the Lower Dolores River

For the reach from McPhee Dam downstream to the Colorado State Line, data available from STORET and the CDSN as of January 2013 includes 3 measurements of Uranium-238. All of these were collected at the CDPHE sampling site at Slickrock, CO (located approximately 2 miles upstream of the remediated former uranium-ore processing facilities). Two of these measurements, taken on 10/19/2004 registered below the Method Detection Level of 1 µg/l. The remaining measurement taken on 1/10/2005 was 2 µg/l.

d. Uranium and the Native Fishery

Uranium in water appears to suppress some fishes' physiological defenses against oxidative stress. Oxidative stress can be caused by environmental or nutritional stressors, disease, etc. Buet et al. 2005 studied the effects of a range of concentrations of uranium in water (20, 100 and 500 µg U l-1) on juvenile rainbow trout (*Oncorhynchus mykiss*) exposed for 10 days. They found that uranium exposure reduced the activity of two liver enzymes that play a role in the antioxidant defense system of fish, and that the reduction in activity increased with both length of exposure and dose. They concluded that exposure to uranium may cause increased sensitivity to oxidative damages in the tissues of rainbow trout (Buet et al 2005). In another study, a similar decrease of antioxidant enzyme activities was also documented in zebra fish (*Brachydanio rerio)* exposed to Uranium. Zebra fish are tropical freshwater fish belonging to the minnow family (Cyprinidae) *(Ercal et al 2001)*.

Nolting (1959) documented a dramatic decline in the number of fish captured in the San Miguel and Dolores Rivers downstream of operating uranium mills in Naturita and Uravan between 1953 and 1956. In 1956 no aquatic life was observed as far as 7.5 miles downstream of Uravan, and large reductions in numbers of fish captured were documented as far as 35 miles downstream, below Gateway, CO (Nolting 1959).

In 1982, Valdez et al noted that native fish composition and abundance were found to be poor downstream of the San Miguel confluence, a river reach heavily impacted by poor water quality due to uranium tailings (Valdez et al. 1982). Sampling by Valdez et al in 1990 showed "[n]o major changes in fish composition and numbers … compared to the USFWS survey in 1981." These findings suggest that, even after their operations ceased in the 1960's, contamination or legacy effects from the uranium mill sites at Naturita and Uravan on the San Miguel River continued to have a negative effect on native fish populations in the Dolores River downstream of the San Miguel. In 2003 and 2008 remediation to address threats to surface and groundwater at the Naturita and Uravan mill sites was complete (http://www.wise-uranium.org). DOE conducts annual groundwater monitoring at the Naturita sites.

It is possible that the uranium mills at Slick Rock had a similar effect on fish populations in the Dolores River. These sites were remediated in 1996. The DOE (2012) Monitoring

Verification Report finds very little evidence for persistent contamination from these mill sites, except during storm events.

e. Sources of Uranium

Active uranium mines and mills can both be sources of water pollution. However, contamination from mining is not as common as pollution from active mills (Abell 1994). Mill wastewaters are radioactive and can also contain high Total Dissolved Solids (i.e. salinity) concentrations. Active uranium mills generate radioactive solid wastes. Uranium mill tailings piles are easily eroded and can yield effluent with radium-226. Radium-226 is the major radiological pollutant resulting from uranium mining and milling. Colorado standards for both uranium and radium-226 are based on chemical toxicity rather than radiological hazards (Abell 1994).

Remediation on two mill sites once located at Slickrock was completed in 1996. In 2012, the DOE completed a Verification Report (2012) to evaluate groundwater and surface water monitoring data collected since 2000, and to assess the status of the compliance strategy for groundwater cleanup at these remediation sites. The proposed compliance strategy for cleanup of the Slick Rock sites is natural flushing combined with institutional controls and compliance monitoring (DOE 2012). The strategy for the Slick Rock West site also includes an alternate concentration limit for selenium. An alternate concentration limit may be adopted within specified areas when an established maximum concentration limit is unattainable or when no drinking water standard exists. However, the alternate concentration limit must not pose a present or potential future hazard to human health or the environment.

Surface water sampling results from the Dolores River for the 2011 monitoring period completed by the DOE found "essentially no impact to the Dolores River from site activities at either the Slick Rock East and [or] the Slick Rock West sites" based on sampling sites upstream and downstream and at the predicted entry point of contaminated groundwater. No CDPHE water quality benchmarks were exceeded with the exception of a single measurement of uranium in 2006 (550 μg/L) that occurred during a period of heavy rain. This measurement exceeds the MCL drinking water standard of 30 μg/L and, depending on the coincident hardness, is close to the lowest value in the ranges of acute and chronic criteria for aquatic life. The report concluded that the “anomalous measurement was likely influenced by storm water runoff.” (DOE 2012). The report went on to say that “high-intensity thunderstorms occur in the general area and in the past have resulted in erosion of the tailings piles at both processing sites” (DOE 2012). Such stormwater runoff is classified as NPS pollution but little is known about the frequency and effects of such events on the Dolores River and the native fisheries.

Recent increases in the price of uranium have prompted renewed interest in uranium mining. In July 2008 the DOE approved a plan that allowed uranium leasing on 42 square miles in Colorado and Utah, expanding the area that could be leased and mined in the Dolores watershed. Thirty one leases and 43 mines were approved under the plan. However, in 2012 the plan was halted, pending NEPA analysis of the impacts of this plan on federally listed endangered fish species. A “Draft Uranium Leasing Program Environmental Impact Statement” was completed by the DOE in March 2013 (http://energy.gov/sites/prod/files/EIS-0472-DEIS_Vol1-2013.pdf). The preferred alternative evaluated in the draft EIS is to make all 31 lease tracts evaluated available for potential exploration and mining of uranium ores.

The preferred alternative identified in this draft EIS includes all 31 lease tracts as available for potential exploration and mining of uranium, with leases continued for another 10 years, or other reasonable period. The draft EIS found that under this preferred alternative impacts on aquatic life could occur during mine development and operation from (1) direct disturbance within a mine site, (2) sedimentation by soil erosion from mine areas, and (3) changes to water quality due to releases of contaminants. According to the draft EIS “impacts on aquatic biota and habitats from the accidental release of contaminants into intermittent or ephemeral drainages would be localized and small, especially if response time was rapid” and that “the accidental spill of uranium or vanadium ore into an intermittent or ephemeral stream, or more notably a permanent stream or river such as the Dolores River or San Miguel River, could pose a localized short-term impact on the aquatic resources,” noting that the risk of such a spill is “extremely low” (DOE 2013).

However, the draft EIS does note that “water withdrawals from the Upper Colorado River Basin to support mining activities may result in potentially unavoidable impacts on aquatic biota (particularly the Colorado River endangered fish species).” Approximately 3,200,000 gal or 9.7

ac-ft of water (and possibly more) would be needed "to support mining activities during the peak year of operations" (DOE 2013). The draft EIS assumes that this water would come from the Upper Colorado River Basin, and given that all of the lease tracts assessed by the EIS lie within the Lower Dolores River watershed, it is possible that that water would come from the Dolores River. Potential depletion of Dolores River flows related to future uranium mining could affect the native fish populations in the Dolores River.

f. Potential Solutions/Actions and Additional Information Needs

Specific tasks that the DRD and partners could complete to address the uranium nonpoint source pollutant include:

a. Compare measured levels of uranium and uranium mining related pollutants to the levels identified as of concern for native fish species and life stages.
b. Identify top source areas loading uranium and other pollutants related to uranium mining.
c. Identify and implement BMPs to address the top sources.
d. Work with UMTRA personnel to investigate ways of addressing runoff of uranium, etc. in storm water from the remediated Slickrock mill sites.
e. Work with CDPHE, CO RiverWatch and USGS to enhance water quality monitoring for parameters that might be related to increasing uranium mining activity.
f. Identify and monitor nonpoint source concerns from potential future mining development.

g. Potential Effects of Potential Solutions/Actions

i. 3 native fish species

At this time there is not enough known about the effects of the uranium pollutant on the native fishery. There is some evidence that even exposure to uranium levels below the maximum contaminant level (MCL) of 30 µg/l might reduce the fishes' ability to cope with other environmental stressors (Buet et al 2005). If this is true, then reductions in uranium loading from top sources could increase the physiological resilience of the native fish population. If implementation of the proposed steps/solutions ultimately resulted in greater resilience to environmental stressors for native fish in the Dolores River, this might contribute to a reduction in the long term risk of further declines in the fish and of an ESA listing of one or more of the native fish species.

ii. Agriculture

Implementation of the proposed steps/solutions should have no significant consequence for agriculture aside from promoting a general interest in native fish conservation.

iii. Boating

Implementation of the proposed steps/solutions should have no significant consequence for recreational boaters.

iv. Cold-water fishery

The reaches draining historic uranium mining and milling facilities lie downstream of the cold-water fishery. Based on Buet et al's (2005) study of the effects of uranium on rainbow trout, there is some evidence that even exposure to uranium levels below the maximum contaminant level (MCL) of 30 µg/l might reduce the trout's ability to cope with other environmental stressors (Buet et al 2005). If this is true, then reductions in uranium loading from top sources could increase the physiological resilience of any brown trout present in reaches below such sources.

h. Estimates of Effects of Potential Solutions/Actions on Water Quality

Neither uranium nor other uranium mining related pollutants are currently identified as exceeding water quality standards in the Dolores River for drinking water or aquatic life uses, so implementation of the identified steps will not improve attainment of standards.

However, very little is known about the effects of these pollutants on the native fishery. There is some evidence that even exposure to uranium levels below the maximum contaminant level (MCL) of 30 µg/l might reduce the fishes' ability to cope with other environmental stressors (Buet et al 2005). If this is true, then reductions in uranium loading from top sources could increase the physiological resilience of the native fish population.

8. Salinity

Salinity is also referred to as Total Dissolved Solids (TDS). The principal inorganic components include carbonates, chlorides, sulfates, and nitrates; principal cations include sodium, potassium, calcium, and magnesium. The USGS defines freshwater as having a TDS concentration of 0-1,000 mg/l; 1,000-3,000 as slightly saline; 3,000-10,000 as moderately saline; 10,000-35,000 as very saline; and greater than 35,000 is as briny (Abell 1994).

Salinity carried in the Colorado River and its tributaries has long been a national concern. By the early 1970s, salinity concentrations in the lower Colorado River increased to levels impacting the ability to use the water for irrigation, especially by the time it reached the Republic of Mexico. In response, Congress enacted the Colorado River Basin Salinity Control Act and the seven Colorado River basin states formed the Colorado River Basin Salinity Control Forum to monitor salinity and implement salinity control projects throughout the Basin. These actions have reduced salinity concentrations in the lower Colorado River over the past 30 years even as additional water use and projects have been developed in the upper Basin (Forum 2011).

In 1971, EPA published a study that estimated the proportion of salinity in the Colorado River originating from naturally-occurring and human-caused sources (EPA 1971). EPA concluded that about half (47 percent) of the salinity concentration measured in water arriving at Hoover Dam is from natural causes, including salt contributions from saline springs, groundwater discharge into the river system (excluding irrigation return flows), erosion and dissolution of sediments, and the concentrating effects of evaporation and transpiration. The natural causes category also included salt contributions from nonpoint sources, excluding irrigated agriculture. The greatest portion of the naturally occurring salt load originated on the vast federally owned and administered lands in the Basin. Human activities can influence the rate of natural salt movement from rock formations and soils to the river system and include livestock grazing, wildlife management, logging, mining, oil exploration, road building, recreation and urbanization.

One of the most significant of the salinity control projects, accounting for approximately 10 percent of the 1.2 million tons of salt that these projects are estimated to prevent from entering the Colorado River each year (Forum 2011), is the Paradox Valley Unit, located on the Dolores River near Bedrock. Paradox Valley was formed by the collapse of a salt dome. Groundwater in the Valley contacts the top of the salt formation and becomes nearly saturated with sodium chloride, with salinities measured in excess of 250,000 mg/L. It is considered by far the most concentrated source of salt in the Colorado River Basin. Prior to the project, the river was estimated to pick up more than 122,700 tons of salt annually as it passed through the Paradox Valley.

The Paradox Valley Unit project, operated by the Bureau of Reclamation, was completed in 1996. A series of wells were constructed adjacent to the Dolores River to intercept the brine before it reaches the river. The brine is filtered and injected into a 16,000-foot-deep disposal well. The project has prevented approximately 90 percent of the salinity naturally contributed to the lower Dolores River as it flows through Paradox Valley from entering the River (Chafin 2003).

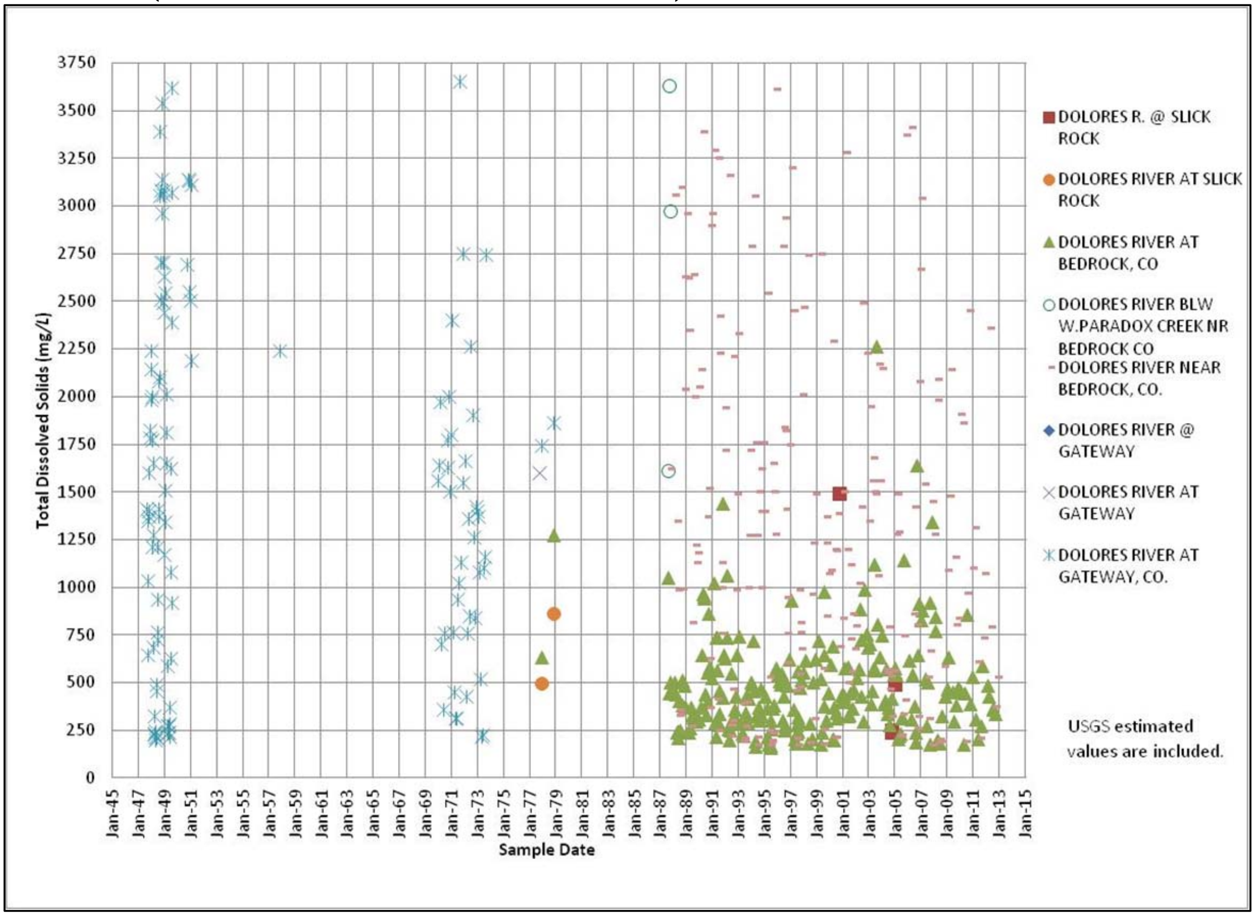
a. Colorado's Regulatory Criteria for Salinity

While the Colorado Water Quality Control Commission recognizes that excessive salinity and suspended solids levels can be detrimental to water quality, it has not established table value numeric criteria for salinity. WQCC Reg. No. 31.22. Instead, its policy is generally to rely on watershed plans and other processes to mitigate salinity issues where they are identified. But the Commission has adopted salinity standards for the Colorado River Basin. WQCC Reg. No. 39. Those standards are for three downstream, out-of-state locations and are reviewed and monitored by the Colorado River Basin Salinity Control Forum: Below Hoover Dam, 723 mg/l; Below Parker Dam, 747 mg/l; and At Imperial Dam 879 mg/l.

b. Status of Salinity in the Lower Dolores River

There is an extensive record of Dissolved Solids measurements available for the Dolores River below McPhee Dam to the Colorado State Line, from 1947 to the present day. Figure 2 displays the data by sample date and by sample location.

Figure 7. Total Dissolved Solids measured between McPhee Dam and the CO State Line since 1947 (Sources: STORET and CDSN, 1/2013).



Although this data set includes 662 measurements taken over a span of 65 years, very few of them were collected upstream of the present day site of the Paradox Valley Unit at Bedrock. There are a total of 6 measurements collected at Slickrock sampling locations, and no measurements from locations on the Dolores main stem between Slickrock and McPhee Dam. At Slickrock, the values were collected between 1978 and 2005 and range from 240 mg/l to 1,490 mg/l, measured in October of 2004 and 2000, respectively. All of the remaining measurements were collected in the vicinity of Bedrock or downstream at Gateway. In the Paradox Valley, values were collected between 1978 and 2012, and range from 162 mg/l (May 1994) to 3,630 mg/l (October 1987). At Gateway, values were collected between 1947 and 1978, and range from 197 mg/l (June 1948) to 3,650 mg/l (September 1971).

c. Sources of Salinity

Prior to 1996, the Dolores River picked up an estimated 122,700 tons of salt annually as it crossed the Paradox Valley, primarily from the surfacing of natural brine groundwater (V. Harrel, Civil Engineering Technician with the Western Area Office of the Bureau of Reclamation, Comm. to J Kane.) From near the middle of the Valley to near the river`s exit from the Valley, brine entered the river through seeps and springs and nearly tripled its flow-weighted average salinity. The Paradox Valley Unit, completed in 1996, operated by the Bureau of Reclamation and located near Bedrock, Colorado, was designed to prevent this natural source of salt from entering the Dolores River and degrading water quality.

Differences in the dissolved-solids load of the Dolores River between two gaging stations, one upstream and one downstream from the Paradox Valley Unit, indicated that by September 2001, the dissolved-solids load contributed by brine had declined to an average of about 29 tons per day— a decrease of about 90 percent. A decrease, however, that might have been facilitated by a decrease in precipitation and stream-flow into the Paradox Valley (Chafin 2003).

The deep well that the Paradox Valley Unit maintains to dispose of brine is nearing capacity. The Bureau of Reclamation has initiated a NEPA process to explore new alternatives for brine disposal. The "Scoping Report - Paradox Valley Unit EIS" was released in January 2013 (http://www.usbr.gov/uc/wcao/progact/paradox/ScopingReport.pdf).

Mancos Shale is a naturally occurring sedimentary formation, prevalent in the reaches and tributaries of the Dolores downstream of Dove Creek Pumps Mancos Shale is known to contribute salt to surface waters via surface runoff and groundwater discharge (Abell 1994). Ephemeral streams can exhibit high TDS concentrations following storms, especially early in the monsoon season (Abell 1994). The Disappointment Creek watershed is the largest of these Mancos shale dominated tributaries between Dove Creek Pumps and the confluence with the San Miguel River, suggesting that it might be a significant contributor of TDS to the Dolores main stem.

The presence of the non-native riparian shrub tamarisk generally increases as one moves downstream on the Dolores River. Until recent control efforts conducted by the Dolores River Restoration Partnership coupled with the arrival of the tamarisk beetle, dense stands of tamarisk have existed between the confluences of Disappointment Creek and the San Miguel River, as well as downstream of the San Miguel, and within the Disappointment Creek drainage. Tamarisk species have been found to excrete salt from their leaves, increasing salinity in soils (Ladenberger et al., 2006; Smith et al., 1998). Tamarisk control within the Lower Dolores River basin may help address soil salinity and TDS in water, although the effect of such control efforts on water quality has not been well documented.

There are very few measurements of salinity recorded upstream of Bedrock, and none upstream of Disappointment Creek. This report is limited in scope to looking at data on the main stem of the Dolores River. In order to identify the most significant source areas for TDS loading to the Dolores River it would be necessary to sample individual sources (e.g. Disappointment Creek, Big Gypsum Creek, Little Gypsum Creek, Coyote Wash, etc.) Also, there is some data available from sampling locations on some tributaries.

d. Salinity and the Native Fishery

The U.S. Environmental Protection Agency (1986) reported that water with TDS concentrations exceeding 15,000 mg/l is unsuitable for most freshwater fish. TDS concentrations within the Dolores River are generally below this level. However, reproduction and growth may be affected during unusually high salinity periods due to additional stress on fish (Melancon et al. 1979, Abell 1995)). Any stress due to salinity would tend to be exacerbated by prolonged low flow conditions which concentrate dissolved solids (Abell 1994, Lucas and Baras 2001).

One study has identified some salinity ranges preferred and tolerated by endangered Colorado River natives (Abell 1994). Pimentel and Bulkley (1983) conducted experiments with juvenile pikeminnow, humpback chub (*Gila cypha*) and bonytail (*Gila elegans*) to identify the TDS concentrations the fish preferred or avoided. Table 4 summarizes their findings. At this writing we are not aware of any studies quantifying salinity tolerance ranges for the native fish species in in the Lower Dolores River with regards to salt concentrations.

Table 3. TDS concentrations preferred and avoided by three native Colorado River fishes (taken from Pimentel and Bulkley 1983, Abell 1994).

Species	TDS preferred * (mg/l)	TDS avoided ** (mg/l)	Temp. of gradient (C)
Colorado squawfish	560-1,150	4,400	14-16
Humpback chub	1,000-2,500	5,100	12
Bonytail	4,100-4,700	560; 6,600	16-18

Concentrations of TDS measured as conductivity after 24 hours and converted to mg/liter TDS by the equation mg/liter = (μmhos conductivity - 618)/0.68. Preferred TDS concentration given as the range of concentrations over the three replicates for the pooled modal compartment.

* Mode of the pooled-treatment distribution
** Concentration avoided by 95% of the fish

In scoping for this plan, one question/hypothesis/concern posed by Dolores River stakeholders was that high salinity levels in the Dolores River might be acting, or may have acted in the past, as a barrier to native fish movements up and down the main stem, particularly through the Paradox Valley. While there is evidence from other systems that chemical pollution can act as a barrier to fish movements (Lucas and Baras 2001), there is only limited evidence relative to this question for the Lower Dolores River. For the period of record reflected in Figure 2 levels of Dissolved Solids sampled downstream of McPhee and upstream of the confluence with the San Miguel range from 162 mg/l (May 22, 1994 at Bedrock) to 3,630mg/l (October 5, 1987 below West Paradox Creek near Bedrock). The highest value recorded in the data set is 3,650 mg/l, measured at Gateway on September 30, 1971. By simple comparison, and without considering other interactive factors like water temperature, this maximum value is well below the avoidance thresholds identified by Pimentel and Bulkley (1983) for the Colorado River Pikeminnow, Humpback Chub and Bonytail, and also occurred prior to the completion of the Paradox Valley Unit. However, it is important to recognize that the TDS avoidance thresholds for Flannelmouth Suckers, Bluehead Suckers and Roundtail Chubs are likely different than those of the three ESA-listed native species. An experimental assessment of the TDS tolerances of these three species, together with a well-designed study of the movements of these fish in the Dolores River and especially through the Paradox Valley, would be necessary in order to obtain a satisfactory answer to this concern regarding migration. CPW has begun tagging native fish with Passive Integrated Transponders (PIT) and, in 2013, installed an array to read these transponders just upstream of the mouth of Disappointment Creek (Graf, personal communication 2013).

e. Potential Solutions/Actions and Additional Information Needs

Specific tasks that the DRD and partners could complete to address the salinity nonpoint source pollutant concerns for native fish include:

a. Determine the TDS tolerances/preferences of the roundtail chubs, flannelmouth suckers and bluehead suckers
b. Determine whether native fish occupy and/or move through the Paradox Valley reach of the Dolores River by installing at least one additional PIT tag array downstream of the Paradox Valley.
c. Evaluate the level of concern that salinity levels represent for native fish in the Dolores River.
d. Conduct synoptic sampling to identify top TDS loading source areas along the Dolores River main stem.
e. If salinity levels constitute a priority concern for native fish, work with private landowners (on a voluntary basis) and public land managers to fund and implement BMP's to minimize TDS loading from runoff from Mancos shale soils in priority areas.

f. Potential Effects of Potential Solutions/Actions

i. 3 Native Fish Species

If recent salinity levels are determined to be problematic for one or more of the three native fish species, then identifying top sources of salinity loading and working with willing private landowners and public land managers to reduce loading at those top sources should benefit populations of these fish species, by improving productivity and growth, and/or by increasing habitat availability.

ii. Agriculture

Voluntary efforts to reduce salinity loading to the lower Dolores River can benefit willing landowners by potentially increasing the availability of technical expertise and of funding for projects aimed at reducing runoff and erosion from their lands.

iii. Boating

Implementation of the proposed steps/solutions should have no significant consequence for recreational boaters.

iv. Cold-water fishery

The reaches most influenced by Mancos Shale runoff and/or Paradox Valley brine lie primarily downstream of the cold-water fishery.

g. Estimates of Effects of Potential Solutions/Actions on Water Quality

While the Colorado Water Quality Control Commission recognizes that excessive salinity and suspended solids levels can be detrimental to water quality, it has not established table value numeric criteria for salinity (WQCC Reg. No. 31.22). Instead, its policy is generally to rely on watershed plans and other processes to mitigate salinity issues where they are identified. Implementation of the proposed actions would be consistent with and supportive of this policy.

There is not enough information at this time to assess whether reduction in salinity loading to the Dolores River will benefit native fish populations. The proposed actions can increase knowledge of the relationship of salinity to the native fishery, and contribute to the Colorado River basin-wide effort to reduce salt loads in the Colorado River.

9. Nutrients

In the water quality context "nutrients" refers to nitrogen and phosphorus. As the building blocks for algal growth and food webs, nutrients are a naturally occurring, necessary, and generally beneficial component of aquatic ecosystems. But elevated levels of nutrients can impair designated uses when a number of physical, chemical, and biological processes combine to increase algal growth and cause the symptoms of eutrophication (e.g., altered DO concentrations and pH, elevated chlorophyll *a* concentrations, excessive algal growth, impacts to taste and odor, altered biotic community composition). Nutrient concentrations and impacts can vary widely within the same water body both with location (i.e., spatially) and over time (i.e., temporally). Thus, characterizing nutrient dynamics in any particular water body requires site-specific quantification of a number of parameters besides nutrient concentrations themselves (e.g., DO concentration, pH, algal biomass, and aquatic community composition metrics), and requires doing so over a sufficient spatial and temporal scale to adequately represent the complex interactions operating in a water body.

The primary human-related sources of nutrients to water bodies include wastewater treatment plants, a point source regulated by NPDES discharge permits, and nonpoint sources associated with agriculture (e.g. fertilizers and manure), leaking septic systems, and landscape-disturbing development (e.g., timber harvest, road-building, building construction). Reservoir releases often have elevated nutrient concentrations due to the cycling of nutrients in a reservoir between organic matter in the reservoir bed and the water column and because releases are generally from the nutrient-rich lower levels of reservoirs. This commonly results in highly productive tailwater trout fisheries immediately downstream.

a. Colorado's Regulatory Criteria for Nutrients

In 2012, the Colorado Water Quality Control Commission adopted "interim" table values for nitrogen, phosphorus, and chlorophyll *a* in both lakes and streams (Table 5). The table values are "interim" because they generally will not be adopted as numeric criteria for particular streams and lakes until after 2017. They represent default numeric criteria designed to be protective of waters state-wide. They include a chlorophyll *a* criterion for streams. Rather than a water column concentration, this criterion is a measure of the amount of attached algae present on cobble in the stream bed.

Table 4: Table values for total phosphorus and total nitrogen that may be adopted as numeric criteria in the future. WQCC Reg. No. 31.17.

Receiving Water Type	Use Classification	TP (µg/L)	TN (µg/L)	Chlorophyll a (µg/l or mg/m^2)[2]
Lakes and Reservoirs[1]	Cold Water	25	426	8
	Warm Water	83	910	20
Rivers and Streams	Cold Water	110	1,250	150
	Warm Water	170	2,010	150

1. Lake criteria apply only to lakes and reservoirs greater than 25 acres in surface area and are given as summer average concentrations in the mixed layer (median of multiple depths), with an allowable once-in-five-year exceedance frequency. Stream criteria are given as the five-year median value.

2. For lakes, chlorophyll *a* criteria are in water column concentration units of µg/l. For streams, the units are mg of attached algae per surface area of stream bottom.

The Commission also adopted a nutrients management control regulation that establishes numerical effluent limitations for nitrogen and phosphorus discharged from wastewater treatment plants above a certain size. The control regulation also establishes nitrogen and phosphorus monitoring requirements for most wastewater treatment plants, requiring monthly or bi-monthly sampling of effluent and the receiving stream upstream and downstream of each discharge. Thus, the Commission's strategy is to make progress reducing nutrient loads in Colorado through implementing effluent limits that require many treatment plants to upgrade to new, more effective nutrient-removal technologies. In the meantime, a great deal of nutrient monitoring data will be collected to inform the adoption of numeric nutrient criteria throughout the state.

b. Status of Nutrients in the Lower Dolores River

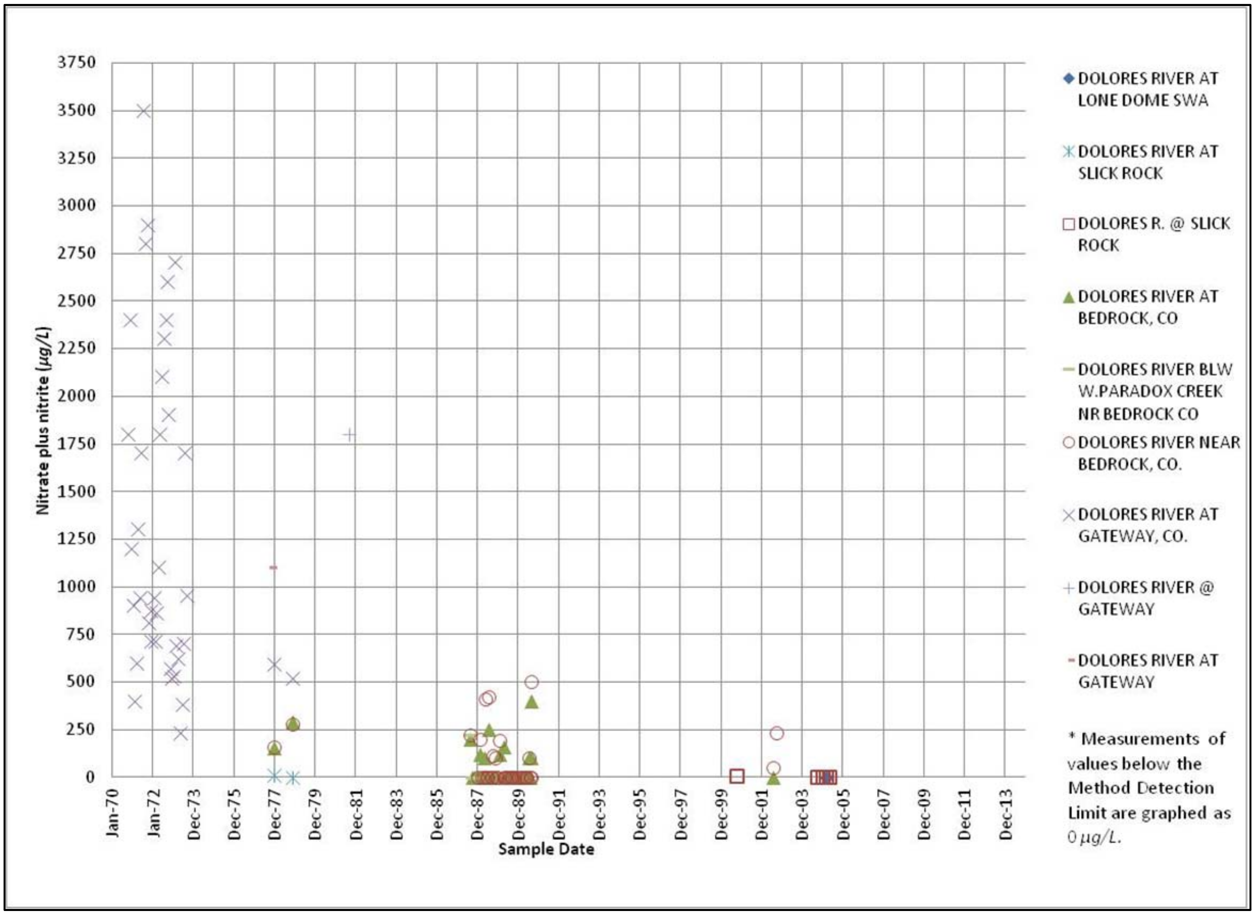
Some data pertaining to nutrients has been collected in the reach of the Dolores River between McPhee Dam and the Colorado/Utah State Line. However, there is little consistency in what parameters have been measured, where and for how long. In CDSN (2013) and STORET (2013), the record of nutrient data collected at locations in this reach begins with some measurements collected in 1947 and continues to 2012. However, the data was collected at a variety of locations, with no one location recording data over that whole period of time. Further, a variety of different parameters have been measured, varying with the sample site and sample date.

The parameters which have been measured include: Total nitrogen, Organic nitrogen, Ammonia, Nitrite (filtered), Nitrate (filtered), Nitrate (unfiltered), Ammonia plus organic nitrogen), Nitrate plus nitrite, Orthophosphate, Phosphorus (unfiltered), Phosphorus, Ammonia (milligrams per liter as NH_4), Dissolved oxygen, Phosphate-phosphorus, Ammonia-nitrogen, Inorganic nitrogen (nitrate and nitrite), Kjeldahl nitrogen (CDSN 2013, STORET 2013).

Colorado's interim numeric table value criteria are for Total Nitrogen, Total Phosphorus and Chlorophyll-a. Total Nitrogen (TN) is the sum of nitrate-nitrogen (NO_3-N), nitrite-nitrogen (NO_2-N), ammonia-nitrogen (NH_3-N) and organically bonded nitrogen. Total Kjeldahl Nitrogen (TKN) is the sum of ammonia-nitrogen plus organically bound nitrogen. TKN does not include nitrate-nitrogen or nitrite-nitrogen (http://www.asaanalytics.com/total-nitrogen.php)

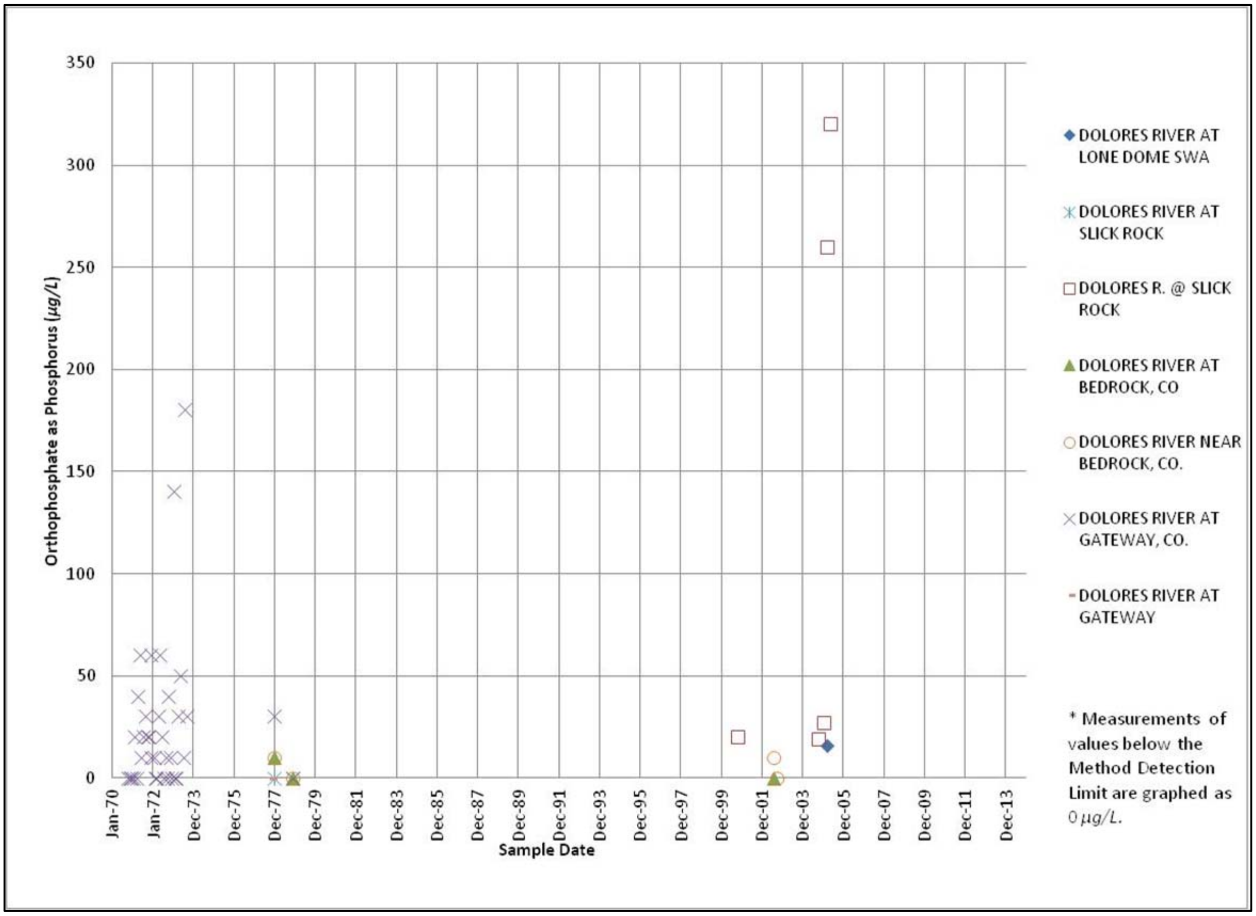
The available data includes only six instances where either Total Nitrogen is reported or all of the components for the calculation of TN are present concurrently at a given site. However, there are many measurements of "Nitrate plus nitrite." Total Nitrogen is the sum of Nitrate plus nitrite, Ammonia (NH_3-N) and Organic Nitrogen. Figure 3 displays the measurements of nitrate plus nitrite for this reach available from CDSN and STORET as of January 2013.

Figure 8. Nitrate plus Nitrite measurements taken between McPhee Dam and the CO Stateline since 1970 (Sources: CDSN and STORET, 1/2013).



Total phosphorus is the sum of all the forms of phosphorus in a sample (orthophosphate, condensed phosphate (also called polyphosphate), and organic phosphate). Total Phosphorus measures both dissolved and suspended phosphorus (http://water.epa.gov/type/rsl/monitoring/vms56.cfm). Total Phosphorus was not specifically reported for any sampling date or location for which data was available in CDSN and STORET as of 1/2013. However, one of the three components which summed make up Total Phosphorus, Orthophosphate as Phosphorus, was measured at several locations on numerous sampling dates. Figure 4 displays the measurements of Orthophosphate as Phosphorus taken between McPhee Dam and the Colorado/Utah State Line and available from CDSN and STORET as of January 2013. Two out of the nine measurements of orthophosphate as phosphorus taken since 2000 are above the newly adopted interim warm-water table values for Total Phosphorus. Both were measured at Slickrock, and both occurred in spring 2005: 260 µg/L on March 8 and 320 µg/L on May 2005.

Figure 9. Orthophosphate as Phosphorus measurements taken between McPhee Dam and the CO Stateline (Sources: CDSN and STORET, 1/2013).



High levels of Nitrogen and/or Phosphorus can result in decreased levels of Dissolved Oxygen. Dissolved Oxygen was measured at many locations on many occasions in the reach between McPhee Dam and the Colorado State Line (CDSN 2013, STORET 2013) (Figure 5). Figure 5 shows eight instances where DO levels were measured below the Colorado State dissolved oxygen standard for cold water fisheries of 6mg/l. These measurements were all taken at USGS gages at or near Bedrock, Colorado in July or August of 1973, 2006 and 2012 (Table 6). One of these measurements, 4.1 mg/l taken on August 14, 2012, falls below the Colorado State dissolved oxygen standard for warm water fisheries of 5mg/l.

Figure 10. Dissolved Oxygen measurements between McPhee Dam and the CO Stateline since 1972 (Sources: CDSN and STORET, 1/2013)

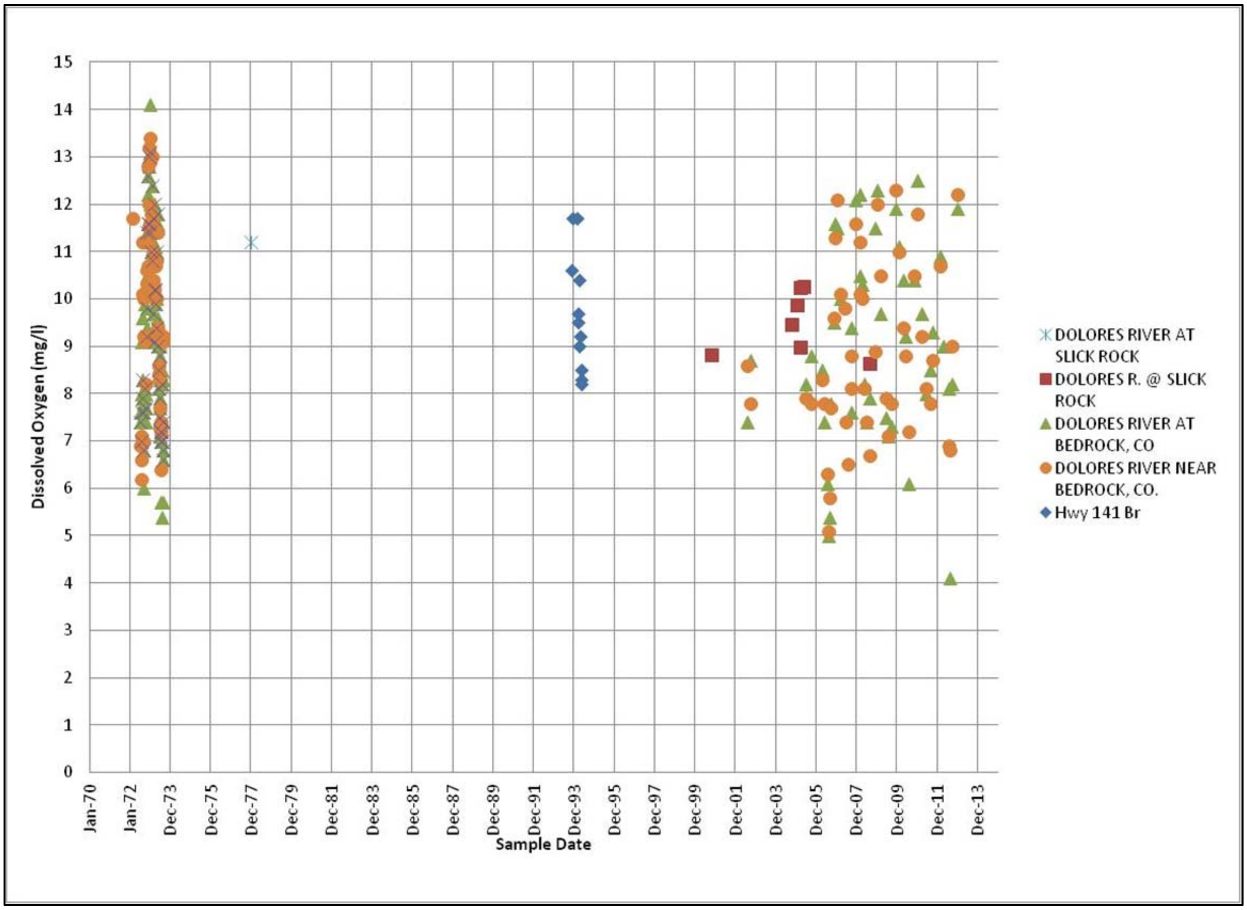


Table 5. Measurements of Dissolved Oxygen below 6.0mg/l on the Dolores River between McPhee Dam and the Colorado/Utah state line, from 1972-2012 (CDSN and STORET, 1/ 2013).

Name of Sampling Location	*Sampling Entity*	*Date*	*Dissolved Oxygen (mg/l)*
Dolores River at Bedrock, CO	USGS	7/20/1973	5.7
Dolores River at Bedrock, CO	USGS	8/3/1973	5.4
Dolores River at Bedrock, CO	USGS	8/30/1973	5.7
Dolores River at Bedrock, CO	USGS	8/17/2006	5.0
Dolores River near Bedrock, CO	USGS	8/17/2006	5.1
Dolores River at Bedrock, CO	USGS	8/24/2006	5.4
Dolores River near Bedrock, CO	USGS	8/24/2006	5.8
Dolores River at Bedrock, CO	USGS	8/14/2012	4.1

c. Nutrients and the Native Fishery

The enrichment of a river through the addition of nitrogen and phosphorous can stimulate the growth of algae and aquatic plants. When these plants and algae die, the chemical processes involved in their decay can deplete the amount of oxygen dissolved in the water. Sometimes, this depletion can cause dissolved oxygen levels to become lethal to some fish (USFWS 2009) Also see (http://water.epa.gov/polwaste/upload/nutrient_pollution_factsheet.pdf)

As of 2005 there were no Dissolved Oxygen thresholds identified for the roundtail chub (Rees et al 2005), the bluehead sucker (Ptacek et al 2005), nor for the flannelmouth sucker (Rees et al 2005b). In their "Aquatic Life Habitat Assessment", the North Carolina State University Water Quality Group lists DO levels for the white sucker, a species that is not native to the Colorado River basin but that readily hybridizes with the flannelmouth sucker, as greater than 5-6mg/l for normal activity, and greater than 7 mg/l for spawning (http://www.water.ncsu.edu/watershedss/info/aqlife.html).

An additional potential stressor sometimes associated with nutrients and nutrient loading is un-ionized ammonia, one of the common by-products of the decomposition of both plant and animal products (King et al 2009). An instance where native fish, including a native minnow species, the Gila topminnow, were directly impacted by excessive nutrient loading to a stream is documented on the Santa Cruz River in Arizona (King et al 2009). A 1997 study (USEPA 1998), as well as concurrent laboratory tests, found that the discharge from the Nogales International Wastewater Treatment Plant (NIWWTP) was likely contributing toxic concentrations of un-ionized ammonia downstream (US EPA 1998).

d. Sources of Nutrients

There has been very little study of nutrient loading and sources to the Dolores River, probably partly due to the fact that until 2012 the State of Colorado did not have any numerical standards in place. To date, the most in-depth look at nutrients and nutrient loading on the lower Dolores has been a study of algal growth and nutrient contributions associated with releases out of McPhee Dam.

Anderson (2010) documented high concentrations of algae in reaches downstream of McPhee Reservoir, which he attributed to the waters being released from the bottom of the reservoir through the bypass gate. During the summer/fall stratification of reservoirs, reactive forms of nitrogen and phosphorus develop within the deep anaerobic reservoir layers (Abell 1994, Correl 1998). Anderson hypothesized that the combination of nutrient rich water promoting high rates of growth of algae, algae consuming oxygen in respiration, dead algae decomposing, and limited photosynthesis (which produces oxygen) may occur at night, during cloudy periods, when turbidity is high and/or in winter. During such periods dissolved oxygen concentrations in the reaches below the dam may fall below critical thresholds for trout and possibly for native fish, although there is currently little information on the DO thresholds for flannelmouths, blueheads and roundtail chubs.

On September 17-19, 2008, temperature and dissolved oxygen were measured with a YSI Sonde at three sample stations: below McPhee Dam, Ferris Creek Campground and Bradfield Bridge (Anderson 2010). The dissolved oxygen concentrations (5.99mg/l @ Bradfield Bridge and 6.06mg/l @ Ferris Creek Campground and 6.55mg/l @ the Dam) measured in the early morning were close to the Colorado State dissolved oxygen standard for cold water trout fisheries (i.e., 6mg/l generally;7mg/l during spawning). Discharge from McPhee was 40 cfs and the chronic temperature threshold for trout (64.9 ^{o}F) was not exceeded during the sample period (Anderson 2010).

In their 2011 analysis, the Standards Attainment Assessment Summary prepared by WQCC (2011) found that the two assessed reaches of the Dolores from McPhee Dam to the Colorado/Utah state line were in attainment of the dissolved oxygen and temperature standards.

e. Potential Solutions/Actions and Additional Information Needs

Specific tasks that the DRD and/or partners could complete to address nutrients as nonpoint source pollutant concerns for native fish include:

a. Conduct experimental studies to identify DO threshold levels for flannelmouth sucker, bluehead suckers and roundtail chub.

b. Complete additional monitoring of nutrient concentrations and related parameters (e.g., DO, pH, algal cover) to evaluate whether and where nutrient concentrations are of concern in the Lower Dolores River.
c. Conduct escapement study to inform the potential for use of Selective Level Outlet Works in McPhee Dam without increasing escapement of non-native fish from the reservoir.
d. Conduct synoptic sampling to quantify and prioritize nutrient loads contributed by key tributaries.

f. Potential Effects of Potential Solutions/Actions

i. 3 native fish species

Learning more about the thresholds of native fish sensitivity to low dissolved oxygen levels, and the top sources of nutrient loading to the Dolores main stem would improve our understanding of nutrients as a potential stressor to the native fish community in the Dolores. If partners have concern about nutrient loading as a stressor, then identifying and addressing top sources could help reduce this stress, and potentially improve native fish reproduction and/or survival.

One suspected source of nutrient loading to the Dolores is the water released from the bottom levels of the reservoir through the lowest Selective Level Outlet Works and the bypass gates. One way to address the nutrient levels present in the water released through the dam might be to release water from higher strata in the reservoir, through use of higher level Selective Outlet works (Anderson 2010). However, currently there is no support for use of these higher outlets due to concern for increasing the risk of release of non-native predator fish from the Reservoir into the downstream environment. Carefully sampling the level of escapement of fish through a well-controlled study of these higher level outlets might reveal no increase in risk of escapement and thus allow for careful use of these outlets to control nutrient loading. However, if such studies revealed any increase in risk of live escapement of non-natives, then this tool for reducing nutrient loading would likely remain without support.

ii. Agriculture

Participation in voluntary efforts to reduce nutrient loading to the lower Dolores River along the main stem below the dam and from tributaries can benefit willing landowners by potentially increasing the availability of technical expertise and of funding for projects aimed at reducing runoff and erosion from their lands and/or improving riparian habitats for livestock and wildlife.

iii. Boating

Implementation of the proposed steps/solutions should have no significant effect for recreational boaters.

iv. Cold-water fishery

Reduction in nutrient loading from waters released from low levels of the reservoir could benefit the cold-water fishery if it resulted in fewer instances of low levels of dissolved oxygen. However, if reducing the nutrient loading out of the dam involved release of warmer water, this might be detrimental to the cold-water fishery.

g. Estimates of Effects of Potential Solutions/Actions on Water Quality

As discussed above, recent data (2005) at Slickrock, CO show instances of phosphorus levels above newly adopted interim table values for Total Phosphorus in warm water reaches. Recent data (2006 and 2012) at or near Bedrock, CO shows instances of dissolved oxygen levels at or below the warm water standard of 5.0 mg/l. To the extent that elevated nutrient concentrations are stimulating the growth of algae, reducing nutrient loading to the main stem of the Dolores River from top sources could help maintain DO levels above the warm water standard.

10. Next Steps (Process, Potential Actions, Costs, Schedule, Milestones)

This section summarizes the actions that could be taken to address the five nonpoint source pollutants discussed in this plan. Over the course of the next several months, or longer if necessary, the DRD Steering Committee (DRD-SC) will evaluate and prioritize these ideas using the process described below to determine the extent of stakeholder support for the proposed actions and identify those actions that the group could pursue on in the short term. Below are very rough cost ranges for the potential actions; costs will be better defined as the DRD-SC further evaluates each action.

a. Background

As part of discussing our approach to identifying next steps, the DRD-SC feels it is valuable to review the process used to develop this Nonpoint Source Watershed Plan. That process occurred in four steps. First, the DRD-SC decided that the drafting of a watershed plan could be valuable in fulfilling the DRD goals as described in its mission statement. Next, the DRD-SC appointed a subcommittee and requested their facilitator to team up with the subcommittee and the contractor (author) to help shape and develop the appropriate substance to include in the Plan. Accordingly, that team developed a fairly specific outline that was thoroughly vetted with the DRD-SC, and available for vetting with the organizations that are represented on the DRD-SC. Finally, through an evolution of membership of the drafting team, and with a similar vetting process being used through several Plan iterations, the Plan was completed.

Thus, the DRD-SC developed this unique Nonpoint Source Pollution Watershed Plan as a plan that:

- Should prove to be a foundational document for identifying next steps to implement work on the ground and see where more data is needed on water quality;
- Is “non-regulatory” and “non-binding;” and

- Will provide an opportunity to look at data and identify what might be the top concerns regarding water quality on the Lower Dolores River, especially with regard to the conservation of native fish.

b. Process for Identifying, Prioritizing, and Supporting Projects

Once accepted by the State, a Nonpoint Source Pollution Watershed Plan helps provide guidance to stakeholders and facilitates applying for grants available to implement voluntary nonpoint source water quality projects. While there are nonpoint source pollutants, associated background information, and potential actions identified within the plan, it stops short of making detailed recommendations on projects and their associated budgets and schedules. Because of the specific circumstances surrounding the development of this Plan, the DRD-SC has determined that identifying the DRD process for helping to analyze, and where appropriate, support or approve potential nonpoint source projects would be useful to explain here.

We expect that projects will be proposed in various ways and from a number of possible entities. Many of these entities are independent and can pursue grants or other funding opportunities on their own, although working with the DRD could be helpful in providing additional community education and support. If a project is brought to the DRD or initiated by the DRD, the decision tree below will be helpful to the DRD-SC in assessing how to proceed with the proposed project. The framework process the DRD has already developed (find it at: http://ocs.fortlewis.edu/drd/framework.htm) may also be utilized.

The decision tree outlined below provides a framework for quickly assessing whether a project falls under the purview of the DRD, and if so, provides a subjective framework for the DRD-SC, and then the full DRD if appropriate, to rank and lend support or approval to potential projects.

c. Decision Tree

1. Outside of Direct DRD Oversight – recommended to talk to the DRD, but not required.

   - Such projects might be initiated by institutional partners with authority, such as BOR, CPW, etc. These projects might also be initiated by other organizations or NGO's who may be DRD partners (e.g. Trout Unlimited, The Nature Conservancy, etc.), or by ad hoc groups with ties to DRD, but that are considered separate collaborative efforts (e.g. Implementation Team, Lower Dolores Plan Working Group, Legislative Sub-Committee, etc.).

2. Has Direct DRD oversight – needs to have DRD consensus to move forward.

- Such projects would be initiated by DRD-based groups. The DRD-SC will continue to guide the process, work to find consensus, and make recommendations to the DRD. The DRD-SC will evaluate all projects on a case-by-case basis to assess potential controversy.
- As a means of identifying the degree of controversy and the potential for consensus associated with a proposal, the DRD offers the following "project do-ability categories":
  - *Non-controversial or "exempt"* – DRD-SC gives a go ahead with funding application
  - *Not Likely Controversial* - Should be fine but review by DRD-SC would be prudent (DRD-SC blessing specifically, question of authority?)
  - *Somewhat Controversial* – Likely will need full DRD review and support process to try and bring either the necessary changes or understanding to make the project non-controversial
  - *Very Controversial* – DRD-SC can try to assess ways to address the controversy. Full DRD review and support process might be useful for the project to move forward

d. Summary of Identified Potential Actions, Estimated Costs, Milestones and Criteria, by NPS Pollutant

i. Temperature

Criteria: Maintain water temperature below 15°C between Dove Creek Pumps and just above Disappointment Creek in April and May in years when there is a managed spill.

Potential Actions, with Estimated Costs, Milestones, Schedule

a. Minimize risk to McPhee Project water users through use of staged decision-making informed by the best available runoff forecast and real-time temperature information.
    - Estimated New Cost: $0
    - Milestones: Annually, BOR holds monthly meetings from February thru May to review the most up-to-date forecast and temperature readings, and solicit input on spill management.
    - Schedule: Annually (since 2012): February thru May.
b. Manage water temperature through managed releases from McPhee Reservoir.
    - Estimated New Cost: $0
    - Milestones: Track continuous readings of water temperature at Dove Creek Pumps and just above Disappointment Creek in April and May in years when there is a managed spill.
    - Schedule: Assess need annually, based on real-time temperature information and best available runoff forecast.
c. Evaluate and agree on temperature model to use going forward. Continue to refine the temperature model with new data in order to fine-tune thermal management hypotheses.
    - Estimated Cost: $2,000 to $5,000 every 2 years
    - Milestones: An appropriate and robust model is agreed upon (this may be the existing model); the model is accessible and functional; all data is in the appropriate format; the validation method is established; the model is validated; model run, results interpreted, discussed and incorporated into management hypotheses.
        - Schedule: Agree on temperature model by January 2015. Update and run model every two years.
d. Consider incorporating a variable that reflects the effect of "low runoff," i.e. runoff from tributaries entering the Dolores downstream of McPhee Dam, on water temperature.
    - Estimated Cost: $5000-$10,000.
    - Milestones: Develop a flow rating curve for Disappointment Creek; analyze hydrologic, snowpack, climate etc. data to identify suitable predictor(s) of

"low runoff" probability and yield; incorporate variable(s) into temperature model; validate model.

- Schedule: Within next five years.

e. Monitor and assess the effectiveness of April and May releases at suppressing native fish spawn and at supporting successful spawn.
   - Estimated Cost: $0 for monitoring and data analysis is completed by CDOW. $0-5000 for Implementation Team workshop to review data and agree on adjustments to management hypotheses.
   - Milestones: Conduct early life history surveys in reaches between Dove Creek Pumps and Bedrock; conduct larval fish sampling; monitor native fish population structures through repeat surveys at long-term sampling sites, especially Dove Creek and Big Gypsum; relate actual flow data and water temperature measurements during pre-peak period to field-based assessments of spawning success; adjust management hypotheses according to findings.
   - Schedule: Annually and as conditions allow.

ii. Sediment

Criteria:

1. Almost every year mobilize fine tributary sediments (<2mm) accumulated in pools and riffles from monsoon runoff in order to maintain bed porosity and clean cobbles for spawning.

2. Every 1-2 years mobilize the median particle size (D50) in order to scour pools, refresh spawning cobbles, enhance instream productivity; and maintain channel pattern and profile.

Potential actions:

a. Conduct monitoring to determine whether flow hypotheses achieved the intended habitat objectives using specific measureable benchmarks and monitoring protocols.

If monitoring shows that habitat objectives are not being met, reassess and refine the sediment flushing hypotheses, and consider changes to flow regime.

- Estimated Cost: 0$ -$20,000/year, depending on whether monitoring is conducted by an agency partner or by a contracted hydrologist. $0-5000 for Implementation Team workshop to review data and agree on adjustments to management hypotheses.
- Milestones: Conduct flushing flow monitoring; assess whether managed hydrology is maintaining desired conditions; adjust management hypotheses according to findings.
- Schedule: Annually.

b. Develop and calibrate a sediment transport model for priority reaches in the Dolores River;
   - Estimated Cost: $30,000-$60,000
   - Milestones: identify priority reaches; for each, collect appropriate water discharge and corresponding bedload and suspended sediment loads; survey channel geometry; identify bed pavement and sub-pavement material composition; develop and calibrate hydraulic model such as HEC-RAS; identify management hypotheses/recommendations.
   - Schedule: Within next 5 years.

c. Quantify loading of sediment to Dolores River from Disappointment Creek and Big Gypsum Creek;
   - Estimated New Cost: $10,000-20,000.
   - Milestones: Contract hydrologist; collect and analyze data; report findings.
   - Schedule: By 2020.

d. Open dialogue with private landowners and public land permittees on sediment concerns for native fish, land management challenges and potential strategies.
   - Estimated Cost: $2000-5000 for DRD facilitator time.
   - Milestones: Identify and contact landowners; meet with landowners to share water quality and native fish information and to hear landowner concerns and interests.
   - Schedule: By 2017.

e. Work with interested landowners to identify, fund and implement BMPs to reduce sediment loading.
    - Estimated Cost: $50,000-100,000 per individual BMP project.
    - Milestones: Contact landowners; identify areas of erosion concern for runoff to Disappointment Creek; develop erosion control project concepts with individual landowners; identify and obtain project funding through grants, cost-share, in-kind, etc.; implement projects; monitor results. (Consider combining with TDS BMP implementation efforts).
    - Schedule: By 2018.

iii. Uranium

Criteria: Maintain levels of uranium and metals associated with Uranium mining and processing under the Colorado water quality acute and chronic standards for aquatic life use,

Potential Actions:

a. Compare measured levels of uranium and uranium mining related pollutants to the levels identified as of concern for native fish species and live stages.
    - Estimated Cost: $2000-8000.
    - Milestones: Review literature to identify levels of radium, vanadium and other mining-related pollutants that pose a concern for native fish species and life stages; compile existing data on measurements of these pollutants in the Dolores River main stem; compare measured levels to levels of concern to native fish; identify hotspots and recommended actions.
    - Schedule: By 2018.

b. Identify top source areas loading uranium and other pollutants related to uranium mining.
    - Estimated Cost: $20,000-50,000, contracted.
    - Milestones: Identify funding, select contractor, conduct synoptic load sampling between the Pyramid and the San Miguel River of all perennial and ephemeral inflows during spring runoff, as well as monsoon runoff. Also

sample on main stem at drainages of known uranium mining and processing locations. Identify top loading inflows, and recommended next steps. (Consider combining with synoptic sampling for other NPS pollutants of concern.)

- Schedule: By 2018.

c. Work with Division of Reclamation Mining and Safety and BLM to identify and if possible implement BMPs to address the top sources.

- Estimated Cost: $0 to unknown.
- Milestones: Contact DRMS and BLM to review data and sites; identify appropriate BMPs and plan for implementation.
- Schedule: By 2020.

d. Work with UMTRA personnel to investigate ways of addressing runoff of uranium, etc. in storm water from the remediated Slickrock mill sites.

- Estimated Cost: $0.
- Milestones: Meet with UMTRA personnel to discuss concerns and identify potential for taking action.
- Schedule: By 2015.

e. Work with CDPHE, CO RiverWatch and USGS to enhance water quality monitoring for parameters related to increasing uranium mining activity.

- Estimated Cost: $0
- Milestones: Contact CDPHE, CO RiverWatch and USGS to discuss concerns and identify potential and costs of enhancing current monitoring.
- Schedule: By 2015.

iv. Salinity

Criteria: There is not enough information at this time to assess whether reduction in salinity loading to the Dolores River will benefit native fish populations. The proposed actions can increase knowledge of the relationship of salinity to the native fishery, and contribute to the Colorado River basin-wide effort to reduce salt loads in the Colorado River.

Potential Actions:

a. Determine the TDS tolerances/preferences of the roundtail chubs, flannelmouth suckers and bluehead suckers.
   - Estimated Cost: $10,000-50,000
   - Milestones: Contact CPW and CSU Department of Fisheries and Wildlife to propose this controlled study; potentially assist in raising funds to support research; review results and assess TDS data against results. (Consider combining with DO threshold/preference study).
   - Schedule: By 2018.

b. Determine whether native fish occupy and/or move through the Paradox Valley reach of the Dolores River by installing at least one additional PIT tag array downstream of the Paradox Valley.
   - Estimated Cost: $0 (assumes array is funded and maintained by CPW).
   - Milestones: Review data and findings with CPW.
   - Schedule: By 2015.

c. Evaluate the level of concern that salinity levels represent for native fish in the Dolores River.
   - Estimated Cost: 0$
   - Milestones: DRD and IT review existing salinity data; discuss and agree on current level of concern; identify next steps.
   - Schedule: By 2015.

d. Conduct synoptic sampling to identify top TDS loading source areas along the Dolores River main stem.
   - $20,000-50,000, contracted.
   - Milestones: Identify funding, select contractor, conduct synoptic load sampling between the Pyramid and the San Miguel River of all perennial and ephemeral inflows during spring runoff, as well as monsoon runoff. Identify top loading inflows, and recommended next steps. (Consider combining with synoptic sampling for other NPS pollutants of concern.)
   - Schedule: By 2018.

e. If salinity levels constitute a priority concern for native fish, work with private landowners (on a voluntary basis) and public land managers to fund and implement BMP's to minimize TDS loading from runoff from Mancos shale soils in priority areas.
    - Estimated Cost: $50,000-100,000 per individual BMP project.
    - Milestones: Contact landowners; identify areas of salinity loading/erosion concern; develop salinity loading control project concepts with individual landowners; identify and obtain project funding through grants, cost-share, in-kind, etc.; implement projects; monitor results. (Consider combining with sedimentation BMP implementation efforts).
    - Schedule: By 2020.

v. Nutrients

Criteria: Maintain levels of total nitrogen, total phosphorus and chlorophyll-a below Colorado's interim table values identified for warm-water rivers. Maintain dissolved oxygen levels above Colorado's standard for warm water reaches.

Potential Actions:

a. Conduct experimental studies to identify DO threshold levels for flannelmouth sucker, bluehead suckers and roundtail chub.
    - Estimated Cost: $10,000-50,000
    - Milestones: Contact CPW and CSU Department of Fisheries and Wildlife to propose this controlled study; potentially assist in raising funds to support research; review results and assess DO data against results. (Consider combining with TDS threshold/preference study).
    - Schedule: By 2018.
b. Complete additional monitoring of nutrient concentrations and related parameters (e.g., DO, pH, algal cover) to evaluate whether and where nutrient concentrations are of concern in the Lower Dolores River.
    - $20,000-50,000, contracted.

- Milestones: Identify funding, select contractor, conduct synoptic and other sampling between the McPhee Dam and the San Miguel River of all perennial and ephemeral inflows during spring runoff, as well as monsoon runoff. Identify top loading inflows, and recommended next steps. (Consider combining with synoptic sampling for other NPS pollutants of concern.)
- Schedule: By 2018.

c. Conduct escapement study to inform the potential for use of Selective Level Outlet Works in McPhee Dam without increasing escapement of non-native fish from the reservoir.
    - Estimated Cost: $0-50,000, depending on level of agency funding available.
    - Milestones: Discuss potential for such a study with CPW, BOR, IT and Biology Committee; identify avenues to support agencies in conducting study; review findings and management implications; identify next steps.
    - Schedule: By 2020.
d. Conduct synoptic sampling to quantify and prioritize nutrient loads contributed by key tributaries.
    - $20,000-50,000, contracted.
    - Milestones: Identify funding, select contractor, conduct synoptic and other sampling between the McPhee Dam and the San Miguel River of all perennial and ephemeral inflows during spring runoff, as well as monsoon runoff. Identify top loading inflows, and recommended next steps. (Consider combining with synoptic sampling for other NPS pollutants of concern.)
    - Schedule: By 2018.

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Appendices ***(Included in separate files)***

APPENDIX 1: "Formation and Evolution of the DRD and Other Collaborative Stakeholder Efforts to Promote Conservation of the Lower Dolores River," Marsha Porter-Norton, DRD Facilitator

- ✓ Introduction
- ✓ Intent and Purpose
- ✓ Foundational Work
- ✓ DRD Evolution, Milestones and Accomplishments
- ✓ Staffing and Resources
- ✓ Efforts to Establish a National Conservation Area and Better Manage Native Fish in the Context of Available Water Supplies
- ✓ The DRD Today

APPENDIX 2: "History of Dolores River Water Use, the Dolores Project, the Rise of Environmental Consciousness Nationally and Locally, and Stakeholder Collaboration to Promote Conservation of Lower Dolores River Natural Resources," Ken Curtis, Dolores Water Conservancy District; Jeff Kane, Watershed Plan Consultant; and Matt Clark, Trout Unlimited.

- ✓ A Brief Historical Overview of Pre-European Settlement
- ✓ Broader Colorado History and the Settlement of Montezuma and Dolores Counties
- ✓ Bureau of Reclamation (BOR) and Western Reclamation Projects
- ✓ Western Reclamation and the Environment: Evolution in the Conservation Ethos
- ✓ Colorado Water Law
- ✓ Interstate Water Issues and The Colorado River Compact
- ✓ Federal Reserved Water Rights for Indian Reservation
- ✓ The Local Reclamation Era: Constructing the Dolores Project
- ✓ Trans-Basin Diversions and Montezuma Valley
- ✓ Mutual Ditch Companies and MVIC
- ✓ Dolores Project as Cooperative Venture with MVIC
- ✓ Irrigation of the McElmo Creek Basin
- ✓ Water Conservancy District Law in Colorado

- ✓ A Brief Timeline of the Dolores Project
- ✓ Dolores Project Accomplishments
- ✓ Downstream Impacts
- ✓ Dolores Project Enabling Legislation, Water Rights Decrees, Contracts, and other Project Commitments

APPENDIX 3: "A Beginning Compilation of Stakeholder Perspectives on the History of Dolores River Diversions, Agriculture, and Recreational Uses of the Dolores River," Gail Binkly, professional writer and journalist

- ✓ Preamble
- ✓ Early Years in the Montezuma Valley
- ✓ McElmo Canyon
- ✓ Montezuma Valley Irrigation Company
- ✓ The Dolores Project
- ✓ The Future
- ✓ Boating on the Lower Dolores River