MEMORANDUM

To: Upper Colorado River Wild & Scenic Stakeholder Group

From: Hydrology Study Group

Subject: Development Timeline of Upper Colorado Wild & Scenic Hydrology and Resource Guides

Date: January 23, 2017

The purpose of this memorandum is to summarize the development of the hydrology and the recreational fishing and floatboating Provisional Resource Guides that are currently in the Stakeholder Group ("SG") Management Plan ("the Plan"). In addition, the memorandum highlights particular stumbling blocks and issues that arose during the negotiations and how they were resolved.

Various committees and work groups (Recreational Float-boating Sub-Committee, MIGs, Rule Curve Committee, Hydrology Work Group, Segment 7 Technical Work Group, Monitoring Committee) were convened beginning in 2008 to address particular technical questions and issues raised by the SG. We have attempted to track those efforts here based upon the Hydrology Study Group members' various files and notes. While it is not discussed here, it should be noted that there were also significant discussions amongst the SG regarding what would happen if any of the indicators and guides are not satisfied (elevation procedures).

We note that because the focus of this study group is hydrology, the ORV Indicators are not discussed here as they are not evaluated against measured streamflow. The implementation of the selected hydrology and ORV indicators will be discussed by the Hydrology Study Group at the next SG meeting on January 30, 2017.

1. Development of Hydrology

Throughout the development of the Plan, several committees and work groups were convened to discuss the technical aspects of how and what hydrology data should be used within the Plan with the goal being to accurately characterize the range of flows that are protective of the ORVs (and are achievable under the SG Plan). The primary issues that the SG dealt with and negotiated during the development of the Plan are summarized below.

a. *Study Period*: The SG recognized that the hydrology in the Upper Colorado River has changed dramatically over the last 100 years due to the development of water rights. However, it was determined that the post-Windy Gap operating environment (after 1983) was a reasonable study period to use given that it is unlikely that the high flows experienced prior to that time will be replicated under current water rights administration. Note that Denver Water's Platte and Colorado Simulation Model ("PACSM") future modeled hydrology was ultimately used in the Plan (see Section 3c) and had a study period of 1947-1991.

b. *Gage selection*: One of the first decision points for the hydrology sub-committees was to determine which stream gages should be used to define the hydrology for each segment of the Wild & Scenic ("W&S") reach. USGS's Kremmling and Dotsero gages have sufficiently long periods of records and are located at the upstream and downstream ends

of the W&S reach, respectively. For purposes of developing resource guides, it was assumed that Segment 4-6 metrics would be compared to the Kremmling gage and Segment 7 compared to the Dotsero gage. To address the lack of representative flows upstream of the Eagle River (particularly Segment 6), a new USGS stream gage (ID09060799) was installed in 2016. While this gage is likely to assist the SG in cooperative measures and monitoring efforts, it is not currently included in the Plan.

c. *Historical vs. Future Flows*: Considerable time was spent discussing what streamflow data should be used as the basis for the protection of the flow-based ORVs. In general, the West Slope entities advocated for the preservation of recent historical hydrology (1983-2006) arguing that the ORVs were created as a result of that hydrology and any diminishment of the flows would compromise the ORVs. The East Slope entities argued that the Moffat and Windy Gap firming projects, as well as the Eagle River MOU depletions should be included in any hydrology used. Many comparisons of the two hydrologic regimes were evaluated to understand the potential effects to the ORVs if the future hydrology were to be used. The "achievability" of meeting various target flows under different hydrologic regimes was also reviewed. In addition, the SG and workgroups had extensive discussions regarding the extent to which the SG would be able to effect streamflow, particularly on the high end of the target ranges.

   It was negotiated that Denver Water's PACSM Scenario 3 hydrology (which takes into account Windy Gap and Moffat Firming project depletions) would be used to model future hydrology which in turn would be used to develop the year types and Floatboating Resource Guides (Boatable Days) in the Plan. However, the SG also agreed to include a hydrograph of average historical streamflow to illustrate the extreme reduction in flow that has occurred since the early part of the 20th century (see Figure 3 on page 64 of the Plan).

   Since the development of the Plan, Denver Water's PACSM study period has been extended from 1947-1991 and now includes the period from 1947 to 2007. It should be noted that no 10825 water releases for the Colorado River Recovery Program were modeled under the PACSM Scenario 3 (i.e. interim releases from Wolford Mountain Reservoir or Williams Fork Reservoir) and that 5412.5 acre-feet are now being released by the east-slope water providers from Granby Reservoir. In addition, Green Mountain Reservoir is no longer operating according to the Interim Policy but under the recently defined Green Mountain Protocol. The Hydrology Study Group is currently considering whether to recommend any changes to the Plan year types based on the extended record being used for PACSM.

d. *Segment 7/Eagle River MOU Issues*: Around the time that the SG decided to use PACSM future hydrology as a baseline, the Eagle River MOU Partners argued that the Segment 7 hydrology should also be adjusted for the depletions associated with their Eagle River MOU (up to 30,000 ac-ft). Those depletions were subtracted from the PACSM Scenario 3 hydrology (described above) to develop the baseline hydrology used in the Plan.

e. *Mean vs median*: The SG recognized that a single descriptive statistic was needed to characterize a range of daily flows as a daily value to shoot for. As such, there was considerable technical discussion regarding whether mean or median streamflows and usable days should be used in the Plan. Multiple analyses and hydrographs were completed to compare the results of each metric and an educational statistics presentation was given to the SG. Although the differences between mean and median flow are very

small, the SG ultimately decided to use median usable days to avoid the effects that very high or low values might have when using the average.

f. *Year Type Break Down*: After evaluating various year type breakdowns, the hydrology work groups determined that the baseline hydrology used for the plan should be broken into quartiles (wet years, wet-typical years, dry-typical years, and dry years) based upon total annual volumes (W&S year). Future year types will be determined based upon how the total annual volume compared to the quartiles determined from the SG baseline hydrology. The Colorado River Basin Forecast Center (CRBFC) forecasted streamflow volume will also be used to determine the expected year type (and therefore flow targets) by the SG (or an ad-hoc committee designated by the SG) around April 1st of each year (the beginning of the Wild and Scenic year, as described below). Note that during this discussion the East Slope water providers were seeking a drought provision which could potentially relax the ORV protections during a drought. Such a concept was not included in the final Plan. However, the Plan does include acknowledgement by the SG that "based on an analysis of both historical and simulated future flow data, that flow conditions can be expected to continue to be highly variable and that flow levels will at times lie outside the ranges of these guides[1]."

g. *Wild and Scenic Year*: The W&S water year is defined April 1 through March 31. This time period corresponds with the last CRBFC (presumably most accurate) forecast of snowpack as well as the start of the SG defined recreational floatboating season. In addition, April 1 was chosen as the beginning of the Wild and Scenic year because it is typically close to the date of peak snowpack as well as the time of year that water managers begin planning the upcoming year's operations that affect flows in the Colorado River near Kremmling.

h. *Floatboating Season*: Recreational floatboating occurs on the Colorado River throughout the year. However, the SG negotiated a floatboating season of April 1 through September 30 which represents the period of time during which the majority of *user* days are observed. It was recognized by the SG that the shoulder months included in the floatboating season provide a unique opportunity in the region (particularly in the late summer).

2. Defining the Recreational Fishing Resource Guides

The Recreational Fishing Resource guides apply to Segments 4, 5, and 6, and are composed of three parts in the Plan, as described below.

a. *Seasonal Flows*: The first part of the Recreational Fishing Resource Guide is defined by minimum seasonal flows that were determined through various field studies and consultation with Colorado Parks and Wildlife ("CPW") to be necessary to support the Upper Colorado River fishery. The seasonal flows are defined as a range of flows, with the mid-point value being the reference flow used to determine whether the guide is satisfied on a 5-year rolling average basis. During the development of the Plan, the seasonal flow guides were compared to actual historical flows as well as modeled future flows (using PACSM) to determine the likelihood of achievability. Some SG members

[1] SG Plan at page 19.

requested acknowledgement in the plan that, as was the case historically, future flows are expected to be highly variable and that they may "lie above or below the range of the seasonal flow guides."

b. *Flushing Flows:* During the development of the Plan, several SG members expressed the need to maintain flows of adequate magnitude, duration and frequency to maintain streambed conditions for fish habitat and spawning. As stated in the Plan, "the SG has not achieved consensus on a definition or amount of a flushing flow in Segments 4, 5, and 6 but will continue to work toward consensus during the provisional period." For purposes of the provisional period a periodic high flow based on field data, analysis, and defined in the Grand County Stream Management Plan was included. A study group known as the "Channel Maintenance Work Group" was convened after the Plan was developed (around 2013/2014) to further define and evaluate flushing flows and make recommendations for substrate monitoring required in the Plan.

c. *Channel Maintenance Flows:* In addition to flushing flows, some SG members argue that flows higher than flushing flows, known in the Plan as "Channel Maintenance Flows", are necessary to maintain adequate habitat and channel form and were part of the historical hydrologic regime that established the ORVs. Other SG members argue that there is either not enough data indicating that such flows are needed in the W&S segments or that such flows are high enough that the SG could not use any cooperative measures to meet the flows (in other words, these high flows are out of the SG's control). As stated in Section III.C.1.c, "During the provisional period, the SG agrees to study the extent to which channel maintenance flow guides will be incorporated in the Plan." Channel maintenance flows were also discussed by the Channel Maintenance Work Group, along with two educational presentations on this topic that were provided to the SG in September 2013 and June 2015.

3. Defining the Recreational Floatboating Resource Guides

The SG and various work groups initially struggled with how to define the boating ORV and what should be measured, tracked, monitored, and/or preserved. A few major themes/questions arose:

a. *Streamflow Based Guide*: The SG began by trying to determine to what extent *streamflow* defines the ORV that the SG is aiming to protect. There were extensive discussions regarding whether and the extent to which non-streamflow related factors make floatboating on the Upper Colorado River outstanding (for example, access to restrooms, parking, and boat ramps).

b. *User vs. Usable Days*: There was significant discussion regarding whether the floatboating ORV should be defined and tracked based upon *user* days (the number of individuals that utilize the resource within a set time period, for any reason) or *usable or Boatable* Days (the number of days in which flows are adequate to satisfy defined flow preferences). Several studies in other rivers that use usable days and user day metrics were reviewed.

c. *Resolution*: The SG decided that several factors are important in maintaining the experience, but that because the Plan is focused on the primary *streamflow-influenced* ORVs (including recreational floatboating), a streamflow-based metric should be tracked

as a resource guide. Therefore, usable or Boatable Days was chosen as the metric because it is more objective, easily measured/calculated and is solely based upon streamflow. In addition, it was recognized that user days data was, at least at that time, somewhat difficult to obtain and analyze and was generally limited to commercial data, therefore not fully representative of the use of the resource.

d. Note that factors other than useable or Boatable days continue to be monitored by the SG by deploying user intercept surveys during the boating season. Beginning in 2013, these surveys are conducted and analyzed by Chris Cares (RRC Associates). How this data will be used in the context of the Plan Indicators and Guides remains to be seen.