COMMENT

GROSS RESERVOIR HYDROELECTRIC PROJECT

(MOFFAT COLLECTION SYSTEM PROJECT)

PROJECT NO: 2035-099

DENVER WATER, LICENSEE

The Environmental Group,
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Submitted via eFiling by Michael Thomason, President
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INTRODUCTION

In our document of April, 2010, "Comments on the Draft License Amendment Application by Denver Water," we discussed in some detail aspects of the proposed Moffat Collection System Project (Moffat Project) that are of great concern to us. We critiqued the underlying assumptions and purposes of the project, finding them faulty. We included our response to the Draft Environmental Impact Statement prepared by the U.S. Army Corps of Engineers in its entirety as Appendix A. We concluded our introduction as follows: "We ask that the license amendment application for the Proposed Project by Denver Water be denied on failure to demonstrate sufficient purpose and need for the project and because impacts to the natural environment are contrary to the goals of land management established by the Federal Energy Regulatory Commission."

Since then we have continued to rigorously investigate water conservation and efficiency measures that are rapidly evolving. We find that in spite of population growth, many western cities, including Denver, use less water today than when Denver Water and the U.S. Army Corps of Engineers first envisioned the proposed project. The final Environmental Impact Statement **falsely** shows increasing demand. We also find water supply data to be highly questionable. These miscalculations are important because the projection of a 18,000 AF/yr shortfall—originally by 2030, now by 2032—provides a primary rationale for the project. These projections appear to be suspiciously arbitrary. Denver Water uses these projections in the FERC application.

It was no surprise that the shortfall in supply did not begin in 2016 as originally projected by Denver Water—no one expected it. It is surprising that the same data are used in the final EIS, but the shortfall is now projected to begin in 2022. Errors like these raise serious questions about the integrity of the environmental impact statement and the validity of the rationale for the Moffat Project. This equally applies to the FERC application.

We also continue our analyses of the other purposes of the Moffat Project—the "imbalance" between Denver Water's north and south systems and the need for increased "flexibility" in the event of a complete failure of the south system. Denver Water describes these issues in the FERC application. We are certain that these needs are overstated and can be addressed in more creative and sustainable ways than the "build a bigger reservoir" approach—a reservoir filled with a distant, unreliable and already depleted resource. As in the case of supply and demand projections, only those alternatives that could address these secondary purposes were selected for analysis.

There is strong evidence that the preferred alternative, the Moffat Collection System Project, is not the least environmentally damaging practicable alternative as required by the Clean Water Act. It is also clear that the alternatives analysis required by NEPA was faulty. More importantly, new data show that the project is **likely to fail and cannot meet the reservoir filling requirement set forth in the alternative screening criteria** (see Section VI of this document). We believe that this is critical to the FERC analysis. A large and partially filled reservoir basin is an environmental and recreational hazard that cannot be mitigated.

In preparing our response to the final Environmental Impact Statement, we also analyzed the alternatives for the project that were rejected, finding that several less damaging alternatives should have been included, and the important "no action" alternative is highly flawed and does not meet requirements. This is reflected in Denver Water's response to item 7 of the FERC application, "A statement and evaluation of the consequences of denial of the license application . . ." (Vol. I, page D-4). The alternatives selection is critical; FERC must now evaluate the validity and impacts of preferred alternative. For this reason, we include our appraisal of the selection process. We conclude, and believe you will concur, that requirements set forth by NEPA, CWA and the U.S. Army Corps of Engineers for project design and analysis have not been met.

We appreciate the role of the Federal Energy Regulatory Commission in its regulatory function and oversight of hydroelectric projects that are potentially damaging to the environment but also generate electricity. The proposed Moffat Collection System Project is unique. Denver Water makes it clear that although there will be a small increase in power generation due to the increased hydraulic head, this is not the purpose. The purpose is to raise Gross dam and enlarge the reservoir for storage of water from the Western Slope for a rare drought or shortfall—based on unlikely "what if" scenarios. A small increase in firm yield is the stated goal, not an increase in hydroelectric power.

We assume therefore that the FERC review of the project focuses entirely on its mandate, "protection of recreational opportunities, and preservation of other aspects of environmental quality." This is our goal as well. Environmental protection and recreational opportunities, on both sides of the Continental Divide will best be served by asking Denver Water to pursue its goals through other less destructive and more sustainable means.

The position taken by Western Slope entities in Grand and Summit counties, the U.S. Forest Service and Fish and Wildlife Service is understandable. They have much to gain from their agreements with Denver Water. This however, does not change the fundamental questions: is the Moffat Project viable, is it essential, and is it the least environmentally damaging practical alternative? These are the questions before you. We hope that this document provides the "back-story" and data to answer in the negative. If that is the case, Denver Water and its customers will be inspired to enhance the many water conservation programs now in place—when the need arises. Denver Water prides itself on innovation—the future for best practices water management—and can do so while protecting the environment and water supply for decades to come.

We begin at the beginning—the proposed purpose and need for the Moffat Collection System Project based on water supply and demand projections. We conclude with an analysis of possible additional diversion flows, from the Western Slope, and provide **strong evidence that the Moffat Project cannot meet the criteria for reservoir filling and should have been rejected as an alternative**.

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REGULATORY OVERVIEW

> "In accordance with the National Environmental Policy Act, highly-trained FERC technical staff, including biologists, archaeologists, geologists, other environmental scientists, and engineers thoroughly analyze the environmental effects of proposed natural gas pipeline, gas storage, LNG, and hydropower facilities." "In addition, FERC coordinates with other agencies to consider environmental statutes as appropriate, including the Endangered Species Act, National Historic Preservation Act, Coastal Zone Management Act, and Clean Water Act. These actions help the Commission make well-reasoned and timely decisions on natural gas and hydroelectric infrastructure, fostering economic and environmental benefits." *Federal Energy Regulatory Commission Strategic Plan, March 2014*, page 17.

Numerous state and federal agencies are involved in evaluation, analysis and approval of projects involving U.S. waters and the environment in general. In the unique case of the Moffat Collection System Project, Denver Water is applying to FERC for a license amendment, not because its hydroelectric generation will be changed, but because the project has major effects on the environment around Gross Reservoir and on the Western Slope water drainages. FERC oversees reservoir boundaries that include environmental and recreational project effects and is therefore involved.

This massive project also necessitates a 404 Clean Water Act permit issued by the U.S. Army Corps of Engineers. The Corps makes a determination that the project meets both NEPA and the CWA requirements: (1) the purpose and need for the project are valid and substantiated. (2) the need and purpose of the project are not so narrowly defined as to exclude reasonable alternatives, (3) a broad spectrum of alternatives are evaluated, including a No Action alternative, (4) the preferred alternative is the least environmentally damaging practicable alternative (the LEDPA) and furthermore, (5) a project that is not water dependent such as the Moffat Project, must in addition disprove the presumption that there are practicable alternatives that do not involve special aquatic sites and have less adverse impact on the aquatic ecosystem, (6) that the data and analysis are accurate and scientific, (7) the first priority is to avoid impacts. Our comments address these requirements. We understand that FERC pays close attention to the NEPA and CWA regulations in reviewing applications.

Denver Water claims that FERC is not concerned with project effects on the Western Slope because such effects are outside its jurisdiction, and refers to previous relicensing to document this: "The scope of analysis for the Proposed Project is limited to the FERC's jurisdiction under the Federal Power Act. For the information provided in this application, Denver Water refers to the scope of the current license and the analysis conducted during the relicensing of Gross Reservoir" Vol. III, page 26. and quotes from FERC re the 2001 re-licensing, " . . . the features of Denver's municipal water supply system upstream of Gross Reservoir are not part of the project's unit of development and therefore will not be placed under the license" (Order Issuing New License, 94 FERC ¶61,313, March 16, 2001.

The current application is entirely different. This is the first time that FERC is considering a relicensing amendment application from Denver Water for increasing the height of the dam and expanding Gross Reservoir—fundamentally changing the landscape, within and beyond FERC boundaries. These changes are entirely dependent upon diverting water from the Western Slope. Western Slope drainages are therefore intrinsic to the project. Interestingly, having provided this "disclaimer" on FERC's behalf, Denver Water nonetheless discusses at length the proposed mitigation plans for West Slope drainages including installing fish ladders. In this document we also address Western Slope drainages in the context of water supply and reservoir filling. Gross Reservoir fills primarily with this water and what happens to the water effects the reservoir, which is in FERC's jurisdiction. If the reservoir does not fill as proposed by Denver Water both the environment and recreational opportunities, that FERC protects, will be effected.

We do not however, critique mitigation plans *per se*, or describe extensive damage to wetlands on the Western Slope, as we did in our response to the final EIS produced by the Corps. In brief, we find that Western Slope wetlands impacts are underestimated significantly. Denver Water's agreement with Western Slope entities—

the Colorado River Cooperative Agreement—includes a joint mitigation approach called Learning By Doing. Basically, this is a "wait and see" approach to mitigation. As a mitigation strategy, Learning By Doing is a euphemism for "trial and error" and error is hard to mitigate.

The Moffat Collection System Project, as described in the Corps' EIS and in the FERC application has numerous regulatory and other "fatal flaws" that should take the project back to the drawing board, or cancel it altogether.

SECTION I

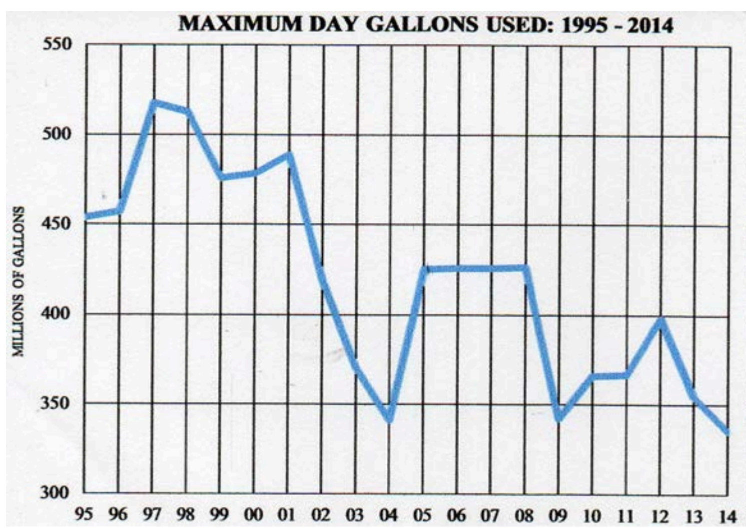
Critique of Supply and Demand Projections

The following comments are based on the final Environmental Impact Statement released by the Corps in April, 2014. They apply equally to the FERC application for license amendment. These projections are fundamental to the rationale for the Moffat Project and therefore must be studied carefully; we have done this.

Projection: demand will equal supply in 2022.

Total supply will equal demand in 2022. "Beginning in 2022 Denver Water predicts its average annual water demand will exceed available supplies . . . " (FEIS, ES-6). No numeric data are given to support this calculation. It appears that the year 2022 is based on a graph (Figure ES-3) showing a linear projection of demand 2010-2050 in which the upward slanting demand line crosses the unvarying horizontal supply line of 345,000 AF in the year 2022. "Total system supply" is held constant at 345,000 AF, 2010-2050. The validity of this approach to determining supply and demand convergence depends on the accuracy of the demand line and the supply line. Both are invalid for current conditions as discussed below.

Curiously, **the identical graph in the DEIS (Figure 1-5) shows the supply line gradually increasing until it meets the demand line in 2016, and is horizontal at 345,000 AF from 2016 on (not from 2010 as in the FEIS**). **These graphs cannot both be correct.** Furthermore, water consumption has dropped substantially from pre-drought levels since the 2002-2004 drought (the initial drop was over 47,000 AF due mainly to reduced landscape irrigation), and after a brief "bounce back" is continuing to drop. A graph showing steadily increasing demand is **blatantly false** and should have been eliminated from the environmental impact statement. The following graph tells the story (Denver Water 2015 Comprehensive Annual Financial Report, p. III-75.) Note the rapid drop in treated water use during the drought of 2002-2004 due to a minor reduction in landscape watering. The drop in 2009 was due to a wet summer. Landscape still consumes about 50 percent of total treated water use (retrieved from www.denverwater.org/SupplyPlanning/WaterUse).



As pointed out in the Introduction, demand did not exceed supply in 2016 as originally predicted. **Using the same data,** the convergence was moved to 2022. The 2016 prediction was always in doubt; this casts more doubt on the validity of the 2022 prediction. Furthermore, these manipulations of figures cast doubt on the entire discussion and alert us to other apparent falsehoods.

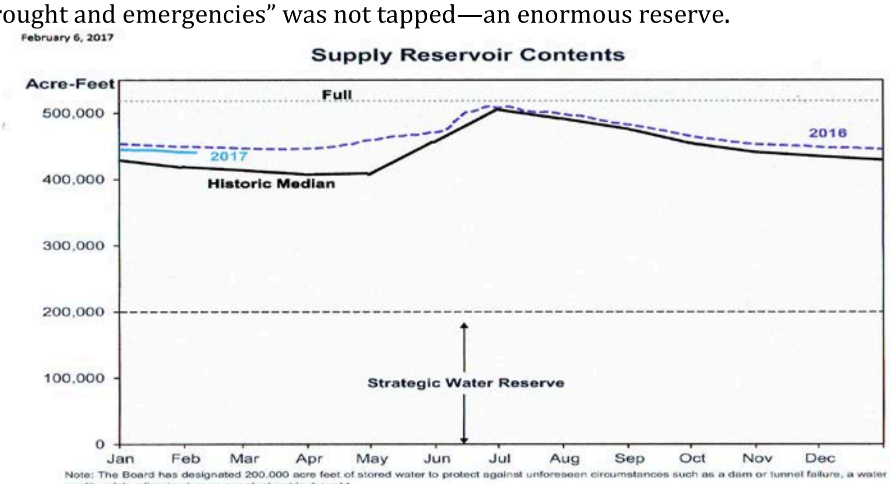
While the supply/demand convergence is moved forward six years, the 18,000 AF/yr shortfall is extended only two years, 2030 to 2032, although as noted, the supply and demand numbers do not change. DEIS Table 1-1 and FEIS Table 1-1 have identical numbers for total system supply and total system demand for calculating the shortfall of 18,000 AF. From this perspective, the date of the 18,000 AF/yr shortfall appears to be arbitrary and merely a function of changing the date in the FEIS.

A. Supply. *"Denver Water's collection system is designed to dependably meet the needs of customers during hydrologic conditions similar to those of the past 380 years (1634–2013). Denver Water's supply is the estimated amount of water available from its collection system to meet customer demand."*[1]

1. Denver Water reservoir storage system has a current usable capacity of 518,271 AF,[2] with a total capacity of 692,846 AF in the entire system. Inexplicably, "supply" appears to be unrelated to reservoir capacity for purposes of calculating supply versus demand. In fact, in the FEIS, baseline "system supply" is **315,000 AF, 2002-2050**.

"Total system supply" of 345,000 AF is achieved by adding supply sources that are not related to reservoir capacity—non-potable reuse for example. And yet, every month in the Water Watch Report, Denver Water posts "usable capacity" more than 200,000 AF higher than "system supply" used in the FEIS. Clearly, Denver Water has much more "usable" water than is used for supply/demand calculations in the FEIS for the Moffat Project.

2. **Strategic Water Reserve.** *"Denver Water maintains a Strategic Water Reserve of 30,000 AF/yr of firm yield to account for uncertainties in planning and forecasting and in operation of water supply infrastructure. This 30,000 AF* ***is not included*** **(emphasis added)** *in the total system supply because it is not considered available for meeting the total system demand under normal operating conditions; rather it is intended to be reserved for uncertainties and/or unforeseen events . . .* "[3] Recently the Denver Water Board of Commissioners increased the reserve to 200,000 AF (50,000 AF firm yield)."[4] Like the previous reserve of 30,000 AF, this enormous reserve is not included in supply calculation. **Increasing the "reserve" makes past droughts look more severe.** Nonetheless, on a model-derived graph of reservoir content, 1634-2013, reservoir content would have fallen to 200,000 AF on only two occasions.[5] Such episodes are rare, and 200,000 AF usable storage for "drought and emergencies" was not tapped—an enormous reserve.



Denver Water Water Watch, February, 2017.

In determining supply and demand ratios, 345,000 AF is called "total system supply" beginning in 2010. Actual system supply beginning in 2010 is **more than 545,000 AF based on reservoir capacity**. Increasing the

[1] Denver Water Drought Response Plan 2014, page 2.
[2] Denver Water Water Watch Report, August 10, 2015.
[3] FEIS, Chapter 1, page 1-19.
[4]Denver Water's monthly Water Watch Reports includes this note: "The Board has designated 200,000 acre feet of stored water to protect against unforeseen circumstances such as a dam or tunnel failure, a water quality crisis, climate change or catastrophic drought."
[5] Denver Water Drought Response Plan 2014, page 3.

strategic reserve to 200,000 AF does not eliminate 200,000 AF from the reservoirs. Water demand will not exceed supply in 2022, or in 2032.

3. In calculating supply, Denver Water uses "additional conservation" savings of 16,000 AF remaining constant, 2010, 2032 and 2050 (FEIS, Table 1-1.) No rationale is given for this unchanging estimation. Conservation savings are cumulative and every year Denver Water conservation programs are enhanced. Denver Water estimates that by reducing current single-family residence landscape watering from three times a week to twice a week, approximately 37,000 AF of treated water would be saved;[6] watering a few minutes less each time in a typical summer would save 6,138 AF.[7]

Using the identical number across time for variables that may change non-linearly over time and are extremely important in calculating supply and demand, is **unscientific and misleading**.

4. Supply is not static. As conservation increases, supply increases. To calculate total system supply, the line item "system refinements/cooperative actions" is added to "system supply." This addition to supply is held constant at 12,500 AF, 2010-2050. This is false. Every year Denver Water adds supply by repairing leaks and upgrading infrastructure. **Every increase in supply extends the supply and demand convergence.** The Water Infrastructure and Supply Efficiency (WISE) program has been planned for many years. In 2016 Aurora and Denver Water began selling "new supply" to South Metro distributers. The additional supply appears to be included in supply calculations. In addition to increased supply, Dave Little, director of planning for Denver Water says, "We're thrilled to be moving forward in the WISE Program. This agreement will create more system flexibility and increase the reliability of our water supply system, leading to a more secure water future for communities throughout the region."[8]

B. Demand.

1. **Faulty demand model**. Denver Water uses a demand forecasting model with ten variables. The demographic and economic variables have a margin of error that the model does not incorporate, and confidence bands are not shown on demand tables. Three other variables are of note: marginal price of water for single-family households, marginal price of water for institutional users, and 3-year average annual conservation expenditures. In general, water rates are indirectly proportional to water use; water rates are increasing and can be used as a conservation tool. Conservation spending is directly proportional to water saving. Both rates and conservation spending **are not updated**. The FEIS uses 2010 data to project demand in 2010, 2032 and 2050. Rates have increased and Denver Water's 3-year average conservation budget is erroneously reported as $1,149,949, unchanging from 2000 to 2050.[9] In fact, the annual conservation budget is three million dollars higher; the 2015 budget was $4.3 million.[10] These three variables skew the demand projections. The model produced a total system demand of 247,888 AF in 2010.[11] Actual use was 238,528 AF[12] Demand is overestimated by 9,360 AF. Curiously, FEIS Table 1-1 shows "total system demand" of 289,200 AF in 2010. Can any of these numbers be trusted?

These figures demonstrate the unreliability of demand data. This is important because the Moffat Project is environmentally damaging on both sides of the Continental Divide and accurate data are essential in determining the validity of the needs and purpose statement, and the impacts of the project.

As noted above, treated water consumption is **decreasing** as population is increasing.[13] How long this trend will continue is unknown. Investment in conservation, including the development of graywater systems for home

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[6] *Ibid*, page 13.
[7] www.denverwater.org:Conservation.
[8] Retrieved at denverwater.org/AboutUs/PressRoom/
[9] FEIS, Appendix A-4, Attachment 1, projected demand model summary.
[10] Denver Water, "Conservation Year in Review: 2014, page 10.
[11] Ibid, Attachment 3.
[12] Comprehensive Annual Fiscal Report 2010, III-67.
[13] 2014 Denver Water Comprehensive Annual Financial Report, April, 2015, page III-76.

landscape irrigation that Denver Water is considering, and efficiency practices, have untapped potential for keeping supply ahead of demand for years to come. These variables are not included in Denver Water's demand model, casting further doubt on the validity of the prediction that in 2022 demand will exceed supply—even if system supply were as low as reported.

Projection: 18,000 AF shortfall in 2032.

"*Beginning in 2022 Denver Water predicts its average annual water demand will exceed available supplies and will grow to 34,000 AF/yr by 2032. Of this near-term 34,000 AF/yr shortfall, Denver Water will rely on 16,000 AF/yr forthcoming from the implementation of additional conservation efforts. New firm yield must be identified to meet the remaining shortfall. Denver Water proposes to meet the remaining shortfall with 18,000 AF/yr of newly developed supplies*."[14] **The model-driven shortfall of 34,000 AF is false**. Denver Water's actual supply was not used in the projection, and water that is conserved, 16,000 AF/yr, is not demanded. Therefore, in this model-driven scenario, the true projected shortfall should be 18,000 AF/yr. This illustrates again the inaccuracy of the demand model; the model cannot account for actual conservation.

This "shortfall" figure, 18,000 AF/yr, is critical to the rationale for the Moffat Project as stated above. The expansion of Gross Reservoir by 72,000 AF is based on this figure alone. **It is critical to get it right**. **NOTE**: embedded in the demand figures and thus in the 18,000 AF shortfall is 3,000 AF/yr contracted to the City of Arvada, contingent upon completion of the project. In 2015 the city budgeted $93 million for the project with the line item "construction costs" at $54,344,667 (City of Arvada Capital Improvements Plan, 2015-2024, page 135). Denver Water is contracted to deliver 3,000 AF/yr to Arvada if the project succeeds—if not the projected shortfall in 2032 would be 15,000 AF.

A. Derived. The projected shortfall of 18,000 AF/yr cannot be verified because it is a derived figure based on estimated supply and demand variables, plus 3,000 AF contracted by the City of Arvada contingent upon completion of the project. The category "unrestricted demand" of 432,7000 AF in 2032 appears to be invalid. Using the demand model and 2010 demographic data, Denver Water calculated demand in 2030 at 336,666 AF.[15] The FEIS figure for 2032, "total system demand" of 379,000 AF is subtracted from the derived total system supply of 345,000 AF, resulting in the "shortfall" of 34,000 AF in 2032. The estimated conservation saving of 16,000 AF is then subtracted, yielding the projected shortfall of 18,000 AF/yr. When several derived figures containing errors are used to determine another figure, the errors are compounded. This is the case in the supply and demand calculations in the FEIS for the Moffat Project.

It is worth noting that in the draft environmental impact statement of October 2009, the same figures are used: total system demand 379,000 AF (2030); total system supply 345,000 AF (2030); shortfall in 2030, 18,000 AF. The numbers used in the DEIS to calculate these figures are different but the outcome is the same as in the FEIS, yielding the 18,000 AF/yr shortfall in 2032.

B. Contrived. The figures used to derive the shortfall of 18,000 AF/yr in the FEIS were not critically analyzed by either Denver Water or the Corps, as evidenced by numerous problems—the least of which is the fact that water consumption is decreasing, not increasing as portrayed. It is not beyond a reasonable person's thinking to consider these facts:

1. When asked about the increased size of Gross Reservoir, Denver Water's director of planning Dave Little said, "We sized the project based upon what the site would produce"[16] Little did not say, "We sized the project to meet the 18,000 AF/yr shortfall in 2032." Little's comment suggests that the maximum expansion of Gross Reservoir is limited by the physical terrain. This is the case. "*The existing dam was completed in 1954 as a concrete gravity-arch dam rising 340 above streambed. The alignment of the existing* dam ***in a narrow gorge*** **(emphasis added)** *was sited to facilitate a raised dam to a height of 465 feet. Under the proposed action Denver Water will increase the*

[14] FEIS, Appendix A-4. Summary of 2002 Demand Model Update, Attachment 3.

[15] Ibid, Attachment 3.

[16] KGNU Community Radio. Roundtable panel discussion, "Moffat Collection System Expansion," April, 2014.

dam's elevation by 131 feet, for a total dam height of 471. . " [17] This explains Little's remark. And this being the case, an additional 72,000 AF plus 5,000 AF for the environmental pool is the maximum additional water that can be stored in Gross Reservoir due to maximum dam height limit. Because Denver Water and the Corps use a 1:4 firm yield to storage ratio, a shortfall of 18,000 AF firm yield is needed to validate a 72,000 AF increase in Gross Reservoir.

2. Denver Water has storage and refill rights to 113,078 AF in Gross Reservoir.[18] It is notable that the proposed increase in the reservoir, 72,000 AF (based on the projected shortfall of 18,000 AF and the 4:1 ratio), is approximately current storage in Gross Reservoir of 41, 811 AF plus 72,000 AF. This fact, and the questionable figures from which the shortfall is derived, raise the possibility that the shortfall was "designed" to necessitate the additional 72,000 AF so that Denver Water could use its full right to Western Slope water. That the projected shortfall is exactly 18,000 AF/yr, and that the additional required storage to achieve 18,000 AF firm yield is 72,000 AF—all that Denver Water has rights to—is too great a "coincidence" to ignore.

3. A projected shortfall of 18,000 AF per year does not necessitate additional storage capacity of 18,000 AF **firm yield**; the shortfall and firm yield figures are confounded. From this perspective, it appears that Denver Water is not trying to meet an annual shortfall, rather, it is trying to justify the total amount of additional water that it has rights to from the Western Slope, 72,000 AF. Given the 4.1 ratio, Denver Water must claim that 18,000 AF firm yield is needed (72,000 AF storage) to meet the 18,000 AF annual shortfall. This may also be why Denver Water claims that the 18,000 AF cannot come from conservation or other means, and all alternatives that could do so were eliminated (see Section III).

Because a shortfall beginning in 2022 and rising to 18,000 AF/yr by 2032 is not substantiated by data, other explanations for the "shortfall" rationale must be considered. The Moffat Project is destructive—therefore all details must be scrutinized. **These explanations support the conclusion that preparing for the "projected shortfall" of 18,000 AF/yr is not a valid purpose of the Moffat Project.**

Conclusion. The purpose and need of the Moffat Project based on projections of water supply and demand cannot be validated, or are in fact, invalid. The figures used in the projections are derived from questionable data and may actually be contrived to "fit" Denver Water's unstated plan to acquire from the West Slope all the water that it has rights to and that can be contained in the restricted space of the Gross Reservoir terrain. The shortfall rationale is suspect. We must wonder why Denver Water didn't simply say," We have right to the water, we want it, and this is how we are going to get it." Obviously, that would not have worked; regulatory agencies would not have approved.

[17] FEIS, Chapter 2, page 2-39.
[18] Colorado River Cooperative Agreement, Appendix S, page 1

SECTION II

The "Imbalance" Issue

The secondary needs and purposes of the Moffat Project are increased system flexibility and reliability, and reduced vulnerability. Denver Water claims that the imbalance makes the large south system vulnerable and the increase in supply in Gross Reservoir would change the balance, thus increasing flexibility and reducing vulnerability in the case of a south system failure. Denver Water claims that these secondary needs cannot be met by reducing system-wide demand through conservation and efficiency practices or by increasing supply through recycling or other technologies because they don't increase supply in the north system—the only solution is changing the balance by enlarging Gross Reservoir. This is why the stated purpose of the project is to "... develop 18,000 acre-feet per year of new, firm yield to the Moffat Treatment Plant and raw water customers upstream of the Moffat Treatment Plant." The only water available is from Gross Reservoir.

The 80/20 supply ratio. These concerns are based primarily on an imbalance between the south collection system and the north collection system as noted above. We conclude that the "imbalance" is not as threatening as stated in the Moffat Project FEIS, and will not be solved by expanding Gross Reservoir. The fundamental issue is:

> Denver Water's entire collection system is currently vulnerable to natural and manmade disasters and system failures. Approximately 90% of overall available reservoir storage and 80% of available water supplies rely on the unimpeded operation of Denver's South System, particularly Strontia Springs Reservoir. Loss of operation of any portion of the South system could require more water from the Moffat Collection System to meet customer's water demands. This would exacerbate the water supply reliability problem . . . "[19]

The crux of the problem appears to be that the Moffat system provides only 20 percent of total available supply while the south collection system provides 80 percent. The assumption is that this imbalance threatens the operation of the entire system because "*loss of operation of any portion of the South system would require more water from the Moffat Collection System . .* " On the other hand, the following is true:

> The Northern Collection System delivers water from the Williams Fork and Fraser rivers and provides approximately **31%** of Denver Water's supply.[20]

In practice, the north system provides considerably more than 20 percent of supply. Supply from the Moffat Collection System varies year to year because raw water is distributed across the three components of the total collection system—South Platte, Robert's Tunnel and Moffat. In 2013 the north system provided 36 percent of total supply; during the drought in 2003 it provided 21 percent.[21] In 2014 the Moffat system provided 24 percent of total supply.

Percent of total supply, 31 December (Comprehensive Annual Financial Reports)

Supply system	2013	2012	2011	2010	2009	2004	2003	2002 drought	2001
South Platte	36	44	33	50	50	47	37	40	43
Moffat	36	28	26	25	29	23	21	22	26
Roberts	28	28	41	25	21	30	42	38	34

[19] FEIS, Chapter 1, "Purpose and Need" page 1-27.

[20] Denver Water 2014 Cost-of-Service Rate Report, page 5.

[21] Data are from Denver Water Comprehensive Annual Financial Reports, "supply facts."

Flexibility and reliability. It is also the case that water delivery is not impeded when an entire south system treatment plant is shut down, and in winter a south plant and the Moffat treatment plant can be shut down with no interruption of service.

> Unlike the raw water collection systems, the treated water system **is connected**. During periods of low demand, it is possible **for any** of the three treatment plants to serve most areas within the CSA. The Marston and Moffat WTPs are primarily peaking plants, with greatest use generally during high demand. The system is designed for dual feed to any area to **minimize service interruption** (emphases added) and to maintain fire protection capability."[22]

In 2013 the Foothills plant was shut down for several months and in 2014 the Marston plant was shut down over the year while the reservoir outlet to the plant was being upgraded. The Moffat plant is shut down October-April every year. It is not the case that "loss of operation of any portion of the South system would require more water from the Moffat Collection System." The "imbalance" between the systems has no impact on operations even when a south treatment plant is shut down. **Flexibility and reliability are built into the system**.

Worst-case scenario. In the event that both south plants were shut down simultaneously, in summer, with total delivery dependent on the Moffat treatment plant alone, it is unlikely that the additional supply from a totally filled Gross Reservoir would be able to meet demand for treated water across the system, and raw water deliveries from Gross/Ralston Reservoirs. **No data are provided to show that it could**. Furthermore, the FEIS provides **no quantitative analysis** of the likelihood of this happening and **no quantitative analysis** of the effects on actual water supply and delivery. If this "what if" scenario happened, Denver Water would treat the situation as it does drought conditions by limiting landscape watering and taking other measures to reduce demand. As an immediate back-up, the treated clear water storage system holding 1,055.7 AF (344 million gallons) could add supply for emergencies.

The actual imbalance in usable supply. Analysis of supply data reveals that an additional 72,000 AF in Gross Reservoir would not bring total supply in the north system above 20 percent. Reservoir supply and "usable" supply are shown below.[23] Usable supply in the north system, with the additional 72,000 AF in Gross Reservoir, is below 20 percent of total.

Reservoir Full, additional 72,000 AF

	Total System, AF	**South**	**North**
Reservoir Capacity (supply)	638,720	514,144	124,576
% of total supply		80.5%	19.5%
Usable Supply*	590,271	481,184	109,087
% of total usable supply		81.5%	18.5%

*Usable supply is available supply, not reservoir capacity. For example, Gross Reservoir holds 41,811 AF but **usable supply** is 29,811 AF because a draw-down below 29,811 AF endangers the outlet mechanisms. Ralston Reservoir holds 10,776 AF but usable supply is 7,276 AF.

These data indicate that the Moffat Project will not overcome the "imbalance" between the supply capacity of the south and the north systems. The explanation is simple: currently the imbalance between total **usable supply** of these systems is **92.8/7.1** percent. Current total usable supply is **518,271 AF**; the north system usable supply is **37,087 AF** (Gross Reservoir and Ralston Reservoir combined). The conclusion must be that this long-standing

[22] FEIS, Chapter 1 "Purpose and Need" page 1-12.

[23] Data are from Denver Water's bimonthly Water Watch Report.

imbalance has not contributed to system vulnerability during normal operations and during plant shut-downs. This is because the entire supply system, north and south combined, is immense, and has **built-in flexibility and is reliable**. During the drought of 2002-2004 the strategic water reserve was maintained and raw water was delivered to Ralston Reservoir from the south system for north system raw water customers when Gross Reservoir was down to minimum pool level.

The further conclusion must be that even with the ratio of south to north system supply of 80/20 with the Moffat Project at full capacity, according to Denver Water, the system-wide vulnerability threat would not be reduced. Therefore, the rationale for the expansion of Gross Reservoir, which would yield a 80/20 imbalance, is moot.

The Moffat Treatment Plant. The capacity of the Moffat plant is another factor concerning the practicability of the Moffat Project. The use of additional supply in Gross Reservoir to solve the imbalance/vulnerability problem during a complete south system failure is constrained by the capacity of the treatment plant. Daily demand for treated water varies primarily with weather and irrigation needs. In summer with high demand, if both south treatment plants shut down or some other catastrophe occurred, **the Moffat treatment plant would not be capable of handling demand.**

The year 2009 represents "the best case scenario" regarding lowest use of treated water due to a wet summer with 15 inches of rain, and water use was similar to the 2002-2004 drought. In 2009, maximum daily treated water consumption was 341,800,000 gallons; average over the year was 170,600,000 gallons per day.[24] The Moffat treatment plant can process 185,000,000 gallons a day. In summer, the Moffat plant would be unable to keep up with demand, with a "deficit" of over 150,000,000 gallons a day. The capacity of Gross Reservoir has no bearing on this problem.

It is noteworthy that treated water use in 2009 was essentially the same as in 2004[25] at the end of the 2002-2004 drought when landscape watering was restricted to twice a week (daily maximum was 340.9 million gallons and average daily was 165.6 million gallons). This indicates that even during a severe drought, with reduced water use, the Moffat plant would be unable to keep up with demand in summer particularly. Therefore, the Moffat Project will not solve the "worst case" vulnerability and flexibility needs during drought or during normal periods of high demand because an expanded reservoir does not change the capacity of the Moffat treatment plant.

Conclusion. The supply "imbalance" between the south and north collection systems is not as threatening as described in the Moffat Project FEIS and the FERC application. Today the usable supply south/north system imbalance is 93/7 percent. It is curious that Denver Water did not use the more accurate usable supply to determine the imbalance. Reservoir capacity does not tell the entire story. The usable supply imbalance is remarkable, but obviously it has little impact on service. Perhaps this is why Denver Water did not reveal it.

Treated water delivery is distributed across the entire system; the Moffat plant provides at least 31% of supply. The distribution system is designed for flexibility and reliability; a south system treatment plant shut-down does not put greater demand on the Moffat treatment plant than currently exists. In the event of the catastrophic scenario described in the Moffat Project FEIS, in which the entire south system is disabled, additional storage in Gross Reservoir would not solve the problem. Therefore, **the "balance" purpose of the Moffat Project cannot be substantiated as a legitimate rationale for the project.**

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[24] 2009 Comprehensive Annual Financial Report, page III-75.

[25] *Ibid*, page III-75.

SECTION III

Is the Moffat Collection System Project the Least Environmentally Damaging Practicable Alternative?

Comments to the draft and final EIS have a common theme—that by including "firm yield to the Moffat Treatment Plant" the purpose of the project is too narrow. A specific purpose, such as 18,000 AF firm yield, at a particular location automatically eliminates analysis of viable alternatives and could eliminate the LEDPA, the primary requirement for a 404 permit. We state again (discussed in the demand projection section) that "firm yield" places a narrow constraint on alternatives and was used to eliminate many.

The Corps' consistent response to this objection is to point to the 303 water supply sources, infrastructure and storage components that were screened, the creation of criteria, the process of eliminating components and the eventual construction of "a variety of alternatives" as evidence that the stated purpose is not too narrow. In fact, this extensive process is evidence of nothing other than that the Corps followed NEPA requirements by creating "a broad spectrum" of components and alternatives and **developing criteria based on the project purpose for eliminating them.** The fact that the final five alternatives are essentially the same—all include diversions from the Western Slope—is evidence of the narrowness of the purpose, preventing "a clear **basis for choice** among the options. These five are described in the FERC application.

Developing the alternatives. Following the development of the purpose and need statement, the next step in the NEPA/CWA process is the delineation of possible alternatives to the proposed project. This process began by generating the list of 303 water supply and infrastructure components, most of which were irrelevant to the purpose of the project. The development of viable alternatives is mandatory, but as noted, one gets the impression that this initial process and elimination was merely to fulfill the requirement for a "wide spectrum" of choices.

When the purpose of a project is narrow, the criteria for elimination of alternatives to that project are automatically narrow since the criteria are developed from the purpose. In this case, the primary screen element is PN2—must supply water to Moffat Collection System. The second limiting criterion is that the project must deliver 18,000 AF new firm yield (including 3,000 AF for the City of Arvada if the 404 permit for the project is granted). Questions concerning the validity of this criterion based on actual supply and demand were raised earlier, supported by the comment of Denver Water's director of planning Dave Little, "We sized the project based upon what the site would produce."

Eliminating alternatives based on faulty cost estimates. After the elimination of 255 of the 303 elements, the cost screen was applied to the remaining 34 alternatives. Project cost is a key factor in determining practicability, and a critical criterion that eliminated otherwise practicable alternatives. Project cost is heavily weighted in alternative selection, and in the balance, cost can out-weigh environmental destruction, as in this case. The cost screen was based on relative costs. First, project costs were estimated, then a broader measure, the relative development cost was derived by adding 50 percent to account for additional variables. The **relative cost screen was based on the least cost alternative**, which was given a value of 1; **the preferred action had the lowest cost**. The 34 alternatives were given a value relative to the cost of the Moffat Project. For example, an alternative twice the cost of the Moffat Project was scored a 2. With a cutoff of 5, 19 alternatives were immediately eliminated. **Further analysis will show that by cost alone the LEDPA might have been eliminated.**

Of the five alternatives that survived the main screens, the preferred action—the maximum expansion of Gross Reservoir—appeared to be the least costly, thus making it more "practicable" then the others and a reason for selecting it in spite of environmental impacts.

There is however, an apparent inconsistency that raises doubt about the actual cost of the project and the reporting of cost to the Corps. Table 2-25 in the draft EIS, listing basic construction costs for the five alternatives being analyzed is **identical to** Table 2-21 in the final EIS. These tables have the same calculations of cost for each alternative. Costs have not been updated to reflect current values. The draft EIS table was simply "lifted" into the final EIS; figures are indexed to January, 2006. The inconsistency however, is more serious. We were not aware of this until we reviewed

Denver Water's draft application for the FERC license amendment after submitting our comments on the draft EIS to the Corps. Evidence for the under-estimation of the preferred alternative cost is the following:

A. Cost estimates for the Moffat Project are underestimated. In the draft EIS and final EIS "total capital construction cost" for the Moffat Project is **$139.9 million.** In the Moffat Collection System Project Draft FERC Hydropower License Amendment Application (October, 2009, Table D-1, p. D-4), "total estimated construction cost" is **$364,144,000**. While the "construction costs" might not be identical in configuration, the discrepancy between the Corps estimates and the FERC estimates is significant.

B. The higher figure in the draft FERC application is corroborated by the fact that the City of Arvada has budgeted $93,000,000 for the project. And as noted above, the line item "construction costs" is $54,344,667.[26] $54,344,667 is 16.67 percent of $324,252,190. (Arvada agreed to pay 16.67 percent of project costs.) This figure approximates the construction cost in the FERC application. This estimation is not new. Notes for the Denver Board of Water Commissioners meeting of **April 14, 2010** state, "Based on the most recent project cost and system development charge estimates, the City of Arvada will pay Denver Water approximately $93 million.[27] Based on this figure, in 2010, project costs would have been estimated at $5,578,884. NOTE: In the FERC application estimate of project costs, under "project inflows" the City of Arvada participations is $101 million (Vol. I, D-3).

It is clear that in the alternatives analysis for the Corps the costs of the Moffat Project are significantly under-stated. The Moffat Project appeared to be by far the least costly of the alternatives, giving it a "practicability edge," skewing the cost analysis significantly. Because project cost was a criterion for eliminating alternatives in the selection process, project cost under-estimation of this magnitude is a serious flaw that biased the alternatives analysis in favor of the preferred alternative.

Estimating the actual construction cost of the Moffat Project at $400 million for example, reduces the relative cost index of all the alternatives assessed in the cost screen; several drop below the cut-off value of 5. The "cost practicability" of the Moffat Project is less and the practicability of the rejected alternatives is greater. Furthermore, using cost alone to eliminate alternatives without analysis violates Section 404 guidelines and NEPA guidelines because it cannot be determined that a rejected alternative does not have less adverse effects on the aquatic ecosystem than alternatives that meet the cost criterion (40 CFR § 230.10(a); 230.12 (a)(3)(i)). This bears significantly on the question, Is the preferred alternative the LEDPA?

In addition, the high cost of alternatives that include agricultural water or reusable water to augment Gross Reservoir supply is due to the inclusion of an **advanced water treatment plant** in these alternatives. Two alternatives were eliminated partly because of this high cost. The plant was needed to process this water before transfer to the Moffat Treatment Plant, because when the alternatives were configured, the Moffat plant could not treat this grade of water, "Since the existing Moffat WTP would be incapable of treating the resulting blended supply to meet drinking water standards, a new 13.6-mgd AWTP would be required to treat the South Platte River return flows prior to their introduction to the Moffat Collection System" (FEIS, Chapter 2, p. 2-84). **This is no longer the case.** Recent upgrades to the Moffat plant enable it to handle agricultural and reusable water (Joe Sloan, public relations for the Moffat Project, personal communication). Therefore, **the cost and environmental impacts associated with the building and use of the advanced treatment plant in these alternatives are void.** This changes the evaluation of these alternatives and opens the door for a new look at retrieving agriculture and reusable water for delivery to the Moffat Treatment Plant.

Several alternatives to the Moffat Project were eliminated because they could not meet the criterion, "Must produce a solution within the necessary near-term timeframe." "Necessary" near-term timeframe is undefined. Figure 1-5 (FEIS, Chapter 1 p. 1-16) shows near term as a period between 2002 and 2032. If "near-term" refers to the period between 2014 and the projected supply/demand convergence, 2022, six years from now, then time seems to be less of a constraint and all alternatives eliminated by this criterion should be evaluated. Like a narrow definition of purpose and need, a too-narrow criterion for eliminating viable alternatives could eliminate the LEDPA and the project would not be in compliance with Section 404 regulations.

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[26] City of Arvada Capital Improvements Plan, 2015-2024, page 135.
[27] City of Arvada, 2015-2024 Capital Improvement Plan, page 135.

The most important alternatives that were eliminated by the time constraint, and meet the CWA 404 guidelines as potential least environmentally damaging practicable alternatives—certainly they are less environmentally damaging than the Moffat Project and they are practicable—are:

- Renegotiate 1940 Consolidated Ditch Agreement to allow **reuse** of Fraser Basin water

- Treated water load shifts: conduits, pumping and treated water storage to **transmit treated water from Foothills or Marston to the Moffat system**

- Buy back contract commitments: buy back all portions of the raw water contract to Arvada, North Table Mountain and Westminster

- Convert Northwest raw water contracts to treated water contracts:

- Additional treatment capacity at Foothills or Marston, conduits, pumping, and treated water storage to **transmit treated water to Arvada, Westminster and North Table Mountain. (**Emphases added.)

We note in particular, alternatives that deliver water to the Moffat Treatment Plant; they solve the north/south balance issue that so narrowly defined the purpose of the project, and meet the criterion that eliminated the majority of alternatives: must supply water to the Moffat Collection System.

These alternatives are listed in the environmental impact statements as institutional/water management approaches (FEIS, Appendix B, p. 10-11). Potential storage capacity is not given. However, the raw water contracts with Arvada, Westminster and North Table Mountain total 30,000 AF per year. These alternatives would reduce the load on the Moffat Treatment Plant and Gross Reservoir by that much per year. These alternatives should be reassessed given a revised timeframe.

Denver Water CEO/Manager Jim Lochhead said recently, "***There is enough water; we can live within our means. But the systems we have in place simply do not have enough flexibility to move water to the places where it is most needed."*** (Retrieved from denverwater.org/supplyPlanning/WaterterSupplyProjects/Otherprojects). Lochhead states the case exactly. The least environmentally damaging, and practicable approach is to connect the two systems. This was done temporarily during the 2002-2004 drought and it can be done permanently. **The problem is not lack of water—the problem is lack of a conveyance system.** Appendix A is an outline of a north/south system connection that was submitted to the Corps in 2015, "Citizen's Alternative for the Moffat Project."

The alternative "Direct Potable Reuse: Water from Metro Reclamation Facility would be sent to an advanced water treatment plant, then blended into the existing distribution system" was rejected. This alternative was rejected by criterion ET1: must use proven technology and management practices. **ET1 does not apply**. Proven technology and management practices are established and used around the world and have been for many years. The potential supply from either indirect or direct reuse is substantial and this alternative should not have been eliminated. Furthermore, this approach to water supply is sustainable and can be considered as the LEDPA when lack of environmental damage is balanced with cost.

Not proposed—the elephant in the room. The view of many reviewers of the Moffat Project is that the most commonsense and obvious LEDPA was not proposed—water conservation, in its many forms. [See also the discussion of the No Action Alternative]. The response to these comments by the Corps is that conservation cannot deliver new supply to the Moffat Treatment Plant or solve the "balance" problem, and therefore cannot be a viable alternative. It must be assumed however that if conservation practices were in place permanently, in all sectors including agriculture, then the expansion of Gross Reservoir would be superfluous.

As noted in the discussion of supply and demand, Denver Water has enormous supply. The strategic water reserve is 200,000 AF. Most of this water is in the south system. The solution is getting water to the Moffat system **when needed,** not by compensating with a bigger reservoir in the north, but by building conveyance systems that bring raw water directly to the Moffat Treatment Plant, or upstream of the plant to provide raw water to customers.

Time and technology have not stood still while the draft EIS and the final EIS were in production. Wastewater treatment is becoming more efficient and less costly, and the development of satellite wastewater treatment systems and gray-water systems is moving ahead. Denver Water should propose an alternative that fits with the times and is forward-looking. Because there is time, the Corps and Denver Water should go back to the drawing board and find creative and non-destructive ways to meet future supply and demand needs.

Faulty No Action Alternative Analysis. The National Environmental Policy Act alternatives regulation require the project proponent to include a No Action alternative—the consequences of taking no action compared to the preferred alternative.

> 32 CFR Part 651 requires the alternative of *no action* be included in the analysis for all Army EAs and EISs. Inclusion of the No Action alternative "provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives. It is also an example of a reasonable alternative—outside the jurisdiction of the agency—which must be analyzed" (CEQ *Forty Most Asked Questions*, Number 3). Here, rather than simply not implementing the proposed action, an analysis of the environmental impacts of not meeting the need identified in the Purpose and Need section should be performed.[28]

For large and environmentally destructive projects, as is the Moffat Project, the No Action alternative demands careful consideration, and is **the preferred alternative when the project purpose and need cannot be unsubstantiated.**

In the final EIS for the Corps, "no action" for the Moffat Project refers to continuing with conservation measures, nonpotable recycling and system refinements. Denver Water concludes however, that the No Action alternative would not prevent the convergence of supply and demand in 2022. Further, the No Action alternative would require . . . "imposing more frequent and mandatory restrictions during drought periods." And, " . . . Gross Reservoir would be frequently drawn down to the minimum operating pool."[29] The assertion seems to be that "no action" will actually cause more droughts. In fact, droughts and emergencies are rare—the PACSM model predicts a possible draw-down of Gross Reservoir 4 times in 45 years; **in most years the system would operate as usual.**

> It is important to note that if demand overtakes supply in 2022 as projected, **the shortfall is exceedingly gradual.** Theoretically it would increase 1,800 AF per year, reaching the projected 18,000 AF in ten years. This is minor—Denver Water would prevent this. In the supply/demand calculation in the Corps' EIS, holding conservation savings constant, 2010-2050 is fallacious. A single innovation—use of residential and multi-unit gray water systems, added potable or non-potable recycling, agricultural water transfers, water banking, incentivizing EPA installation of WaterSense fixtures—would cancel the shortfall; these are ignored in the rationale for the Moffat Project. This is ironic and misleading. Denver Water is already focusing on these solutions, and water demand is dropping. Furthermore, Denver Water is developing additional south system storage facilities of 30,000 AF in accordance with the Colorado River Cooperative Agreement. "No action" is an oxymoron. Denver Water would be the first to say so.

Obviously, the No Action alternative does not increase environmental harm to Western Slope watersheds. The dire consequences of "no action" are portrayed most vividly as consequences to Denver Water and to customers

[28] Guide to Development of the Description of Proposed Action and Alternatives: A supplement to the US Army NEPA Manual Series. US Army Environmental Center, February, 2004, page 3-7.
[29] FEIS, Chapter 5, page 5-590.

during drought. The consequences of not increasing supply to the Moffat Treatment Plant are speculative; no quantitative analyses are provided. The highly speculative nature of the consequences of the No Action alternative is illustrated in this analysis:

> "Long-term and permanent socioeconomic impacts would result from the No Action Alternative. Increased chances of a major system failure through the treated water or raw water systems may result in a loss of trust in Denver Water . . . This could result in a change in Denver Water's management structure and responsibilities. Severe and more frequent mandatory watering restrictions, including surcharges, may result in a reduced quality of life and place financial burdens on customers. Though still infrequent, mandatory restriction would reduce production, employment, and other business activity in the Denver Metropolitan area." (FEIS, Executive Summary, ES-70.)

The Moffat Project solution to these drastic "no action" scenarios is based on several assumptions: (1) that Gross Reservoir will fill; (2) that 72,000 AF would be available during a major system failure; (3) that the additional 72,000 AF would somehow prevent a major system failure; (4) that Denver Water and its customers would be incapable of handling a major system failure, or even a drought. These assumptions are questionable. And, as discussed in Section II, the Moffat treatment plant would be unable to deliver the needed supply in any case.

The most glaring problem with the No Action alternative analysis in the final EIS is more serious. All calculations of demand (and thus of available supply) are based on **unrestricted use** of water during a drought. **This alone invalidates the No Action analysis.** The rationale is that calculating demand during periods of drought is too complicated **" . . .** this approach uses the simplifying assumption that customer demands would not be restricted during a drought and sets aside a Strategic Water Reserve as a way to compensate for issues not specifically accounted for in the approach."[30] This simplified demand model approach is **perilously unscientific and leads to false calculations and false conclusions,** such as the need to use the Strategic Water Reserve when the need does not exist.

The entire No Action alternative analysis as described in the Corps' is unscientific and misleading. Furthermore, data are available from Denver Water for calculating demand during a drought. The use of this spurious model invalidates the No Action analysis in the EIS, an important component in the NEPA requirement. The No Action alternative discussion fails CEO Guidance, 46 Fed. Reg. 18026, 18027 (March 23, 1981): **"Where a choice of 'no action' by the agency would result in predictable actions by others, this consequence of the 'no action' alternative should be included in the analysis."** Denver Water restricts water use during drought, mainly landscape watering, with remarkable water savings, and would rely on other conservation practices as needed. This discussion also fails the requirement for high quality information and accurate scientific analysis.

In response to (7) page D-4, Volume I of the FERC application, "A statement and evaluation of the consequences of denial of the license application . . . " Denver Water writes:

> Since enlargement of Gross Reservoir required both Corps and FERC approval, denial of the FERC License Amendment Application would have the same consequences as denial of the 404 Permit application, which is described in the Corps EIS for the Moffat Collection System Project as the No Action Alternative. The consequences to Denver Water's future water supply would be severe because the proposed changes, which are designed to increase the storage capacity of Gross Reservoir, are necessary to increase Denver Water's water supply to meet demand and system reliability needs.

Having said that, Denver Water then changes the No action alternative discussion in the FERC application, referring to a "combination strategy (Executive Summary, Vol. I, page 80.) [The text states that a complete description is at 8.2.1; not there; 8.2.6 states that a more detailed discussion is at 7.1.1 and 7.1.2, not there.] This strategy combines use of the strategic water reserve (erroneously stated as 30,000 AF), and "imposing restrictions" during drought conditions. Again, there is no evidence that the reserve of 200,000 AF would be

[30] Ibid, page 5-569.

tapped because landscape watering restrictions alone are powerful. The "restrictions" approach is commonplace during drought—and the grass survives.

Conclusion. The alternatives analysis required by NEPA and Section 404(b)(1) of the Clean Water Act is highly flawed. Agencies and the public are given no clear choice when the non-preferred alternatives and the preferred alternative are essentially identical and none are the least environmentally damaging practicable alternative available. No proof is given that the preferred alternative is the LEDPA, or that there are no other alternatives with fewer adverse effects on aquatic systems, as is required for non water-dependent projects. Because the purpose and need for the project are narrowly defined, many viable alternatives were eliminated without comment. The discussion of the No Action alternative is without merit.

Based on the questionable supply/demand projections and the fact that the Moffat Project will not solve the putative "imbalance" problem, and given the fact that powerful conservation and supply technologies are on Denver Water's horizon, it can be concluded that denial of the license amendment will have no severe consequences. The No Action alternative is the LEDPA and poses no risk to Denver Water customers. Compared to the destruction proposed in the Moffat Project, at Gross Reservoir and on the Western Slope, **the No Action alternative should be the preferred alternative.** But because Denver Water wants its water, this alternative is misrepresented.

In fact, denial of the license could be considered a boon to Denver Water, its customers and certainly to the citizens in the Gross Reservoir area as a sustainable system-wide, multi-component approach to water security is developed. More importantly, unlike the built-a-bigger-dam approach, Denver Water would engage the largest shareholder group, the customers, in that security.

SECTION IV

Haul Studies, Traffic Safety, The Roads

Denver Water must understand the challenges and hazards of a 4-year construction project during which haul trucks, logging trucks and worker vehicles must use the only road into Coal Creek Canyon, Hwy 72, with access to miles of dirt roads to the reservoir and those to be constructed for logging. Yet, as with all impacts, impacts to residential traffic are minimized as temporary, moderate and indirect (License Amendment Application, E-245). This is like saying that a four-year migraine headache is temporary. The main canyon road, Hwy 72 is used by tourists, cyclists and bikers, but is primarily a residential road for over 4,000 residents—and children on the way to school. The prospect of commuting up and down the canyon during construction is daunting. We are therefore, paying close attention to how Denver Water handles this issue, and describes it in the FERC license amendment application for your assessment.

Several documents in the application have outdated haul truck figures, even as recently as April 28, 2016. The URS Corporation memorandum to the Corps reports estimated average and peak one-way truck trips as 22 and 37, failing to update information to the Corps. In the September 13, 2016 "Final Quarry Location Report (Vol. III, Attachment E-4) haul truck numbers are reduced to 6 (and 21) because "preliminary engineering evaluations have verified the ability to produce all sand and gravel aggregate on-site." This would reduce haul truck impact substantially.

Haul studies. Original analysis of traffic impacts was based upon haul studies performed by Harvey Economics (Denver Water, 2012b), "HDR 2012," for Denver Water, using 15 cu. yd. trucks for the 4.1 year, 260 days/yr construction period. Estimated average and peak one-way daily truck trips are shown in Table 2-19 as 22 and 37 respectively and daily worker commuter trips are shown similarly as 60 and 101.

Fly ash and cement would be hauled to Gross Reservoir and trucks associated with these materials and must be accounted for. It is possible to arrive at a more accurate count of daily truck trips—subtracting 16 trips—by using information in the 2012 study:

Material	Truck Loads		One-way Miles from source
Sand	360,000 cu.yd./15 cu. yd.=	24,000	52.4
Cement	62,000 cu. yd./ 15 cu. yd.=	4,133	144.9
Fly ash	55,000 cu. yd./ 15 cu..yd.=	3,667	346.9
Total truck loads:		31,800	

260 days/yr x 4.1 yrs = 1066 days of hauling overall. 31,800/1066 = 29.83 or **30 one-way trips per day, not 22**. Using the same peak/average ratio, we have 37/22 = x/30 and then x = 50 maximum trips per day. Based on these calculations, taking into account reduction of trips by 16 (20 minus 6), the more accurate number of one way trips is **14** not 6, more than twice the estimate.

Denver Water is still vague about hauls of logs and slash, but HDR 2012, Table B-8, estimates 6 loads/day in the first construction year. For a 10-hour day, peak load is 50 + 6 = 56/10 = **5.6 trucks/hour** in the initial year and average loads are 3.6 trucks/hour. This **does not include** the steel pipe that will be part of the dam structure nor miscellaneous supplies.

In HDR 2009, pp. 1-3, an analysis of the need for climbing lanes on Hwy 72, was made utilizing the American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets* (AASHTO, 2004). Traffic data were obtained from the Colorado Department of Transportation (CDOT) and showed average daily traffic (AADT) of 4900 vehicles of which 3% were heavy trucks. Using the industry standard of 10% AADT to calculate peak upgrade traffic, they showed 490/2 = 245 vehicles with 3% or 7.4 heavy trucks/hour baseline. This analysis was further refined in HDR 2012 to include 3% medium trucks, an additional 7.4 peak vehicles/hour likely to operate at lower speeds than autos. However, **no account** was taken of recreational vehicles (RVs), which are described in AASHTO 2004, p. 233, as "self-contained motor homes, pickup campers, and towed trailers of numerous sizes."

Three criteria have to be satisfied to justify climbing lanes (AASHTO, 2004: p. 244):

1. Upgrade traffic flow > 200 vehicles/hour
2. Upgrade truck flow > 20 " "
3. One of the following conditions exists:
 - 10 mph or greater speed reduction for a typical heavy truck
 - Level-of-service E or F exists on the grade
 - A reduction of 2 or more levels of service is experienced when moving from the approach segment to the grade

HDR 2009 noted that criterion 1 was met with 245 vehicles/hour. The reduction of sand and aggregate haul trucks reduces vehicle/hour calculations and it could be less than 200. The report conceded that >/= 10 mph speed reduction was likely, meeting criterion 3. Criterion 2 was not satisfied and might not be even with the inclusion of medium trucks. However, AASHTO includes provisions for recreational vehicles, and these data are missing. AASHTO, 2004: p. 233 states, "...where a low percentage of trucks may not warrant a truck climbing lane, sufficient recreational vehicle traffic may indicate a need for an additional lane." Moreover, immediately following the criteria statement above, AASHTO, 2004: p. 245 states: **"In addition, safety considerations may justify the addition of a climbing lane regardless of grade or traffic volumes."**

Concern for public safety is a FERC mandate. This is clearly a case for a license amendment condition requiring Denver Water to mitigate traffic hazards either by constructing climbing lanes on Hwy 72 or by doing whatever it takes to use the railroad to delivery materials where the tracks cross Gross Dam Road—an option that has been rejected so far. To date, Denver Water will not construct a bike lane, or pay for climbing lanes; the only traffic mitigation being considered is widening pull-outs. It is unlikely however, that truckers would use pull-outs going up the canyon because regaining speed takes time and distance.

A proper evaluation of traffic hazards requires a complete picture of the roads and terrain. Appendix B is a thorough look at Hwy 72 as it winds through Coal Creek Canyon and over the top to Pinecliffe, a section that logging trucks must use. Gross Dam Road and several dirt roads that will carry logging truck traffic are included. Photos of these roads provide a visual story of the problems. NOTE: the photographs in the borrow haul study do not tell the story—including the rigged Photo 8 "Existing pull off being used during site visit" in which the truck is still on the pavement and cars passing are out of the lane. (Vol. III, Attachment E-8). Appendix C is the frightening testimony of a local truck driver before the Boulder County Commissioners public hearing on the project.

There are also deeply flawed assumptions that make the planned construction schedule impossible to meet and exacerbate the negative impacts outlined above. For example, HDR 2012 assumes an average 40 mph haul truck speed on Hwy 72. There is an 8.5-mile segment from Hwy 93 to Gross Dam Rd., of which 6.8 miles are curving mountainous grades with posted speed limits of 25 and 35 mph in some areas. As described in Appendix A, this mountainous segment has numerous blind driveways, blind curves, school bus stops, commercial establishments, a total of 92 warning signs and an elevation gain of 1510 feet. The altitude gain from the beginning of the canyon to Wondervu pass is 2,151 feet in 9.9 miles. With convoys of trucks followed by long lines of cars in both directions, there will be many occasions when trucks will have to stop or slow to a crawl. It will then take time and distance to regain speed (see data in AASHTO, 2004: p. 235 for information on heavy truck acceleration on upgrades and downgrades).

Another flawed assumption is that haul trucks will arrive in the canyon at uniform intervals. With the disparate source locations and mileages to Hwy 72, it is likely that truck spacing will be minimal at times, resulting in even longer traffic backups. The extreme likelihood of truck speed reduction of > 10 mph gives rise to increasing safety concerns. AASHTO, 2004: p. 239 notes that "...the crash involvement rate increases significantly when the truck speed reduction exceeds 15 km/h (10 mph) with the involvement rate being 2.4 times greater for a 25km/h (15 mph) reduction than a 15 km/h (10 mph) reduction."

Another perspective on cost is the value of human life. The truck driver said in his testimony—**there will be fatalities**. Also, the impact of stress cannot be denied. Canyon residents have witnessed both hazardous slow driving and hazardous risky fast driving. These opposite hazards will escalate and stress levels will increase. Road rage is likely. Climbing lanes would solve these problems.

Denver Water's truck test was inappropriately conducted and failed to prove viability of the truck hauling option. On August 8, 2013 Denver Water conducted a test-run of loaded semi-trucks carrying aggregate along Highway 72 and Gross Dam Road to Gross Reservoir. The test was intended to illustrate the viability of the truck hauling option. The test run was filmed by Denver Water via helicopter and GoPro cameras mounted to some of the truck cabs. Additionally, private citizens recorded video of the test via GoPro cameras mounted to a private vehicle.

Some highlights of the truck test include:

- One of the eight trucks broke down on the way up the canyon and was abandoned on a pull-out. The truck remained on the pull-out for several hours.
- The "loaded" trucks at about 1/3 capacity.
- The drivers were being paid $100/hr (3 to 4 times their regular rate).
- The trucks dominated the road on nearly every corner, crossing over to the far-side shoulder on many turns and were forced to do excruciatingly slow multi-point back-and-forth turns to shimmy around the intersection of highway 72 and Gross Dam Road.
- The trucks averaged 15-20 mph to the reservoir (a 40 mph average was erroneously, and somewhat humorously, used for calculations in the haul study referenced above).

These highlighted issues, as well as several other observable conditions illustrate the fact that semi-truck runs to and from the staging site cannot be performed without putting the public's safety at a significant and unacceptable level of risk.

Conclusion. Perhaps from Denver Water's perspective, dealing with the potential hazards of constructing a dam and stripping steep terrain of trees in a remote area—with access via a residential highway—is a concern, as it is to residents. It is however, not enough for Denver Water to adopt alternatives to the Moffat Project or alternatives to transportation of equipment and materials to the construction and logging sites. Residents are distressed; some are thinking about selling their home before construction begins. We invite FERC staff to travel these roads and imagine what it would be like, 260 days a year, rain or snow, navigating the canyon with haul trucks—and then ponder whether or not the impact of the Moffat Project is temporary, moderate and indirect.

SECTION V

Will the Expanded Portion of Gross Reservoir Fill?

The Moffat Project is designed to store an additional 77,000 AF of water in Gross Reservoir, bringing 72,000 AF of "new" water into the reservoir from the Western Slope. This goal was used to screen numerous alternatives and from further consideration in the Corps' EIS process The question arises: is there enough additional divertible water to meet this goal and the filling criterion established by Denver Water?

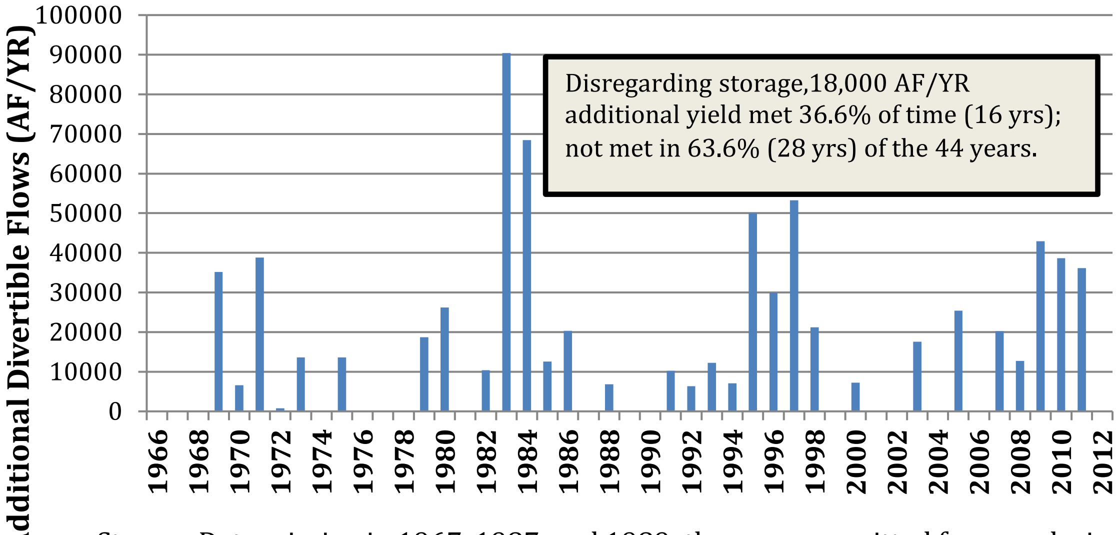
Extensive analysis of historical streamflow provided in an independent firm yield analysis, shows that there is not (Buchanan, 2015, Appendix C in this document). Over the years, residents living near Gross Reservoir will be impacted by views of a much expanded reservoir that is not full. The relocated quarry at Osprey Point will not be inundated as the "optimistic" layout shows, and with the expanded portion of the reservoir half full, the exposed highwall could be at least 100 feet above the water line (Vol. III, Attachment E-4, p 7).

More importantly, for the future of the Moffat Project, the answer is "no." The technical evidence shows that additional divertible flows at existing diversion structures in the upper Fraser and Williams Fort basins are not sufficient to yield an additional water supply of 18,000 AF per year to Denver Water's northern system.

Additional divertible water from the West Slope basins is not adequate. The extensive firm yield analyses by Buchanan provides technical evidence that additional divertible flows at existing diversion structures in the upper Fraser and Williams Fork basins are not sufficient to yield an additional water supply of 18,000 acre-feet per year to Denver Water's northern system. [See Appendix D, *"Evaluation of Feasibility of Attaining 18,000 AFY of Firm Yield from Excess Flows Remaining in the Fraser and Williams Fort Basins Combined with 72,000 AF Additional Storage in the Expanded Gross Reservoir*, Buchanan, 2014 revised 2015.]

The first step in the firm yield analysis was to estimate how much water remained in the Fraser and Williams Fork basins that could be diverted above historical diversions during a 44-year test period (Figure 1). In only 16 years of that period additional diversions from these basins was available for the desired 18,000 AF yield. In 28 years, less than 18,000 AF streamflow was available for additional diversions, including 14 years of below average streamflow, when no additional water can be diverted. As seen in Figure 1, unpredictable variability is a liability for the Moffat Project—and is not adequately addressed in the FERC application.

Figure 1: Additional Divertible Flows From Diversion Structures in Fraser and Williams Fork Basins: Firm Yield Analysis



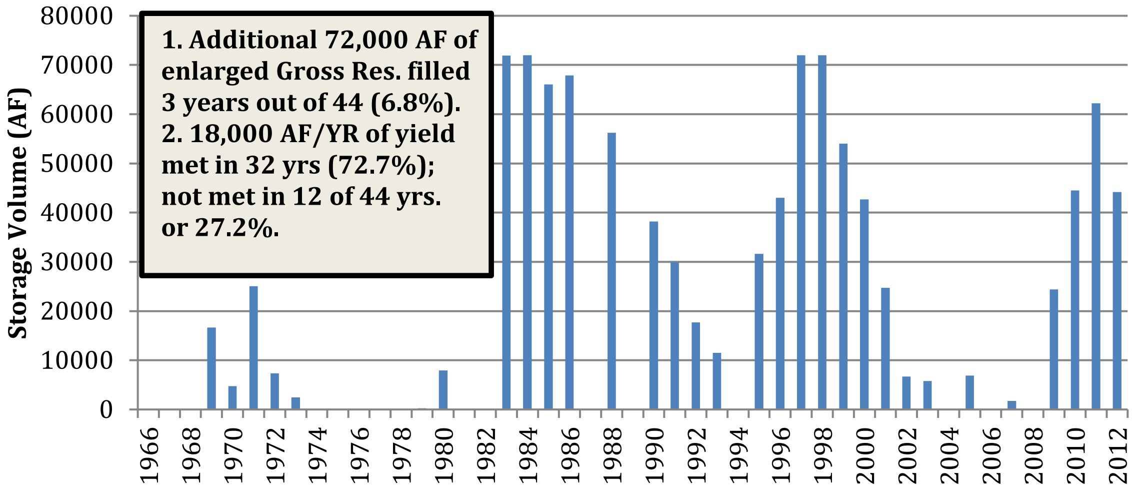
Storage Data missing in 1967, 1987, and 1989; these years omitted from analysis.

The success of any water supply project in meeting a firm yield goal depends on the yearly variability of streamflow and reservoir storage volume. Since the Corps' environmental impact statement primarily reports averages, one of the goals of the firm yield analysis was to provide yearly estimates of additional divertible streamflow. These yearly flows are shown in Figure 1, with an average of 15,557 Af/yr, somewhat higher than the FEIS estimate of 12,998 Af/YR.

In the next step of the firm yield analysis, additional divertible flows were "routed" through the expanded portion of Gross Reservoir (72,000 AF). The annual water balance for the expanded reservoir is yearly incoming flows, storage from previous years, and depletions up to 18,000 AF of additional deliveries to water customers. When additional divertible inflows are less than 18,000 AF, water must be taken out of the reservoir to meet demand and water level drops.

If Denver Water uses up to 18,000 additional acre-feet in years when additional water is available, then based on estimates of additional divertible flows determined in the firm yield analysis, **the expanded portion of the reservoir would fill in only 3 years, would be almost full in 1 year, would be less than half full in 30 years and would be at or near empty in 16 of the 44-year test period** (Figure 2). Streamflow in the late 1980s and early 1990s depleted the expanded storage to zero by 1994. The enlarged reservoir storage was also depleted for several years in the 1970s and 2000s.

Figure 2: Storage (AF) in Additional 72,000 AF Volume of Expanded Gross Reservoir: Using Additional Divertible Water from Upper Basins



1. Gross Reservoir Storage Data missing in 1967, 1987, and 1989; these years omitted from the analysis. 2. Ending Storage for each irrigation season of each year calculated as ending storage in previous year + additional divertible water in current year irrigation season minus up to 18.000 AF required yield.

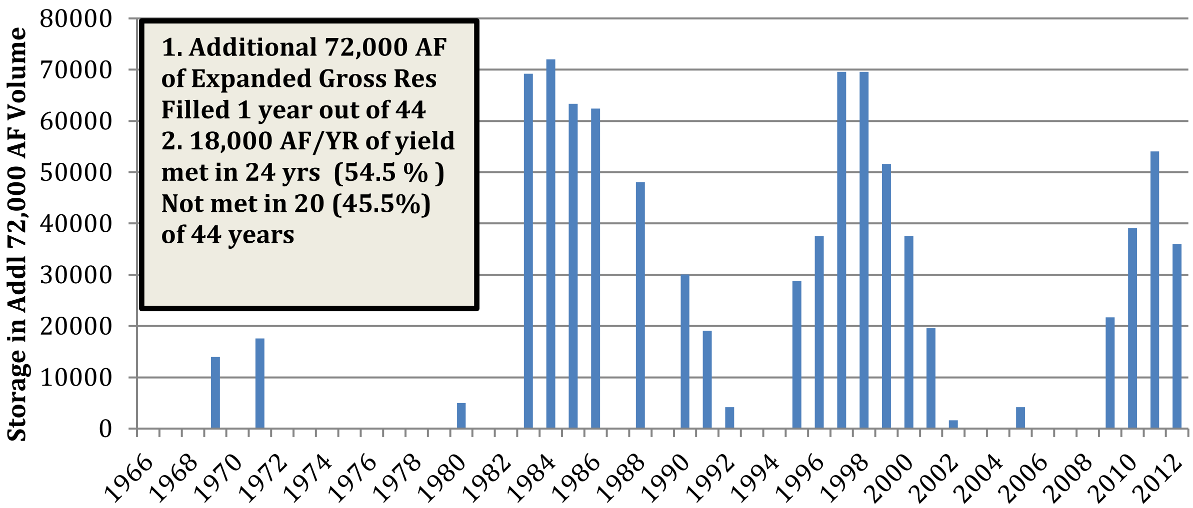
As presented in the FEIS, the Moffat Project would divert only 10,280 AF/YR more on average through the Moffat Tunnel, using the Full Use project baseline. The analysis shows that this is insufficient to fulfill the project purpose. The FEIS states that without the project, an additional 2,713 AF/YR could be diverted from the upper Fraser and Williams Fork basins if Eastern Slope demands increase as predicted and Gross Reservoir is operated in a flow-through mode. To simulate this scenario, 2,713 AF/YR were subtracted from the estimated additional divertible flows and routed through the expanded portion of Gross Reservoir. Note that average additional divertible flows averaged 12,844/YR (15,557 minus 2,217). Thus, the firm yield analysis is a best-case simulation of the feasibility of the Moffat Project under the FEIS full-use baseline.

If Denver Water uses up to 18,000 additional acre-feet in years when additional water is available, based on a full-use (meaning the supply is fully used, predicted for 2022) project baseline, the expanded portion of the reservoir would fill in only 1 year (2.3%), be less than half full in 31 years (70 %), and at or near empty in 24 years (54%) of the 44-year test period (Figure 3).

It is clearly stated in the FEIS and FERC application that one goal of the project is to achieve additional firm yield to provide for an impending shortfall beginning in 2022; this is incorporated in the purpose and need statement. Nonetheless, scattered throughout these documents we find a contradiction—the expanded reservoir will be used for **drought contingency**. These are very different goals. The contract with the City of Arvada for an additional 3,000 AF/yr from Gross Reservoir increases the likelihood that all or a portion of the 18,000 AF yield each year, will be used. Also, the IGA for the 5,000 AF environmental pool for the cities of Boulder and Lafayette states, "The Environmental Pool shall begin operation concurrently with the Board commencing storage of water in the Enlarged Gross Reservoir." This changes the drought contingency aspect of the project. The data on reservoir filling show that both the firm yield and the drought contingency goals are in jeopardy, and perhaps the environmental pool as well.

In summary, if 18,000 AF is drawn from Gross Reservoir to meet a shortfall, then residents living in the area will see a lot of barren shoreline when the expanded portion of the reservoir is less than half full, half the time, and both environmental and recreational hazards will increase. Additionally, we are concerned that several mitigation plans and recreation plans will be completed **only after** the reservoir is filled. This could be a long wait.

Figure 3: Storage in Additional 72,000 AF Volume of Expanded Gross Reservoir: Full Use or Project Baseline



1. Gross Reservoir Storage Data missing in 1967, 1987, and 1989; these years omitted from the analysis .
2. Additional divertible flows from Firm Yield Analysis reduced by 2,713 AF/Y equal to the EIS average annual increase in Moffat Tunnel diversions between Current Condition and Full Use (Project) Baselines

Another consideration relates to a flow restriction at the Pinecliffe gage of 1,2000 cfs. "During high runoff, Denver Water must limit Moffat Tunnel deliveries in order to meet this constraint" (Vol. II, E-38). Calculations for the critical period of drought, 1953-1957, for current conditions and proposed action, (Figure 3.3.1-4 Vol. II, E-44) show an impressive reservoir refill in June, 1957 for the proposed action. The proposed action graph begins slightly above 100,000 AF in October 1953, drops significantly with seasonal increases and decreases, and in a single month rises from near minimum pool level to full capacity, 113,000 AF, in June 1957. The historical data show that on July 1, 1957 reservoir storage was 41,555 AF from a low of 6,294 AF in May (retrieved from Colorado Decision Support System). However, the restriction of 1,200 cfs at Pinecliffe might prevent a flow rate that would add 100,000 AF in one month. We do not have sufficient data to analyze this outcome.

Impacts to Western Slope Rivers. Our document of October 2015, *"Re-Evaluation of Western Slope Hydrologic Impacts of the Moffat Collection/Gross Reservoir Expansion System*," was submitted to the Army Corps and the Colorado Department of Health and Environment (CDPHE) regarding both the 404 and 401 permits (Appendix E). The report concludes that project impacts to the upper Western Slope Fraser and Williams Fork Rivers were substantially understated in the Final Environmental Impact Statement as follows:

- Existing reduction of upper basin streamflow, caused by historical diversions to the existing 42,000 AF Gross Reservoir, is understated.

- Inappropriate use of the modeled "current conditions" baseline (from which impacts are evaluated in the FEIS) does not represent existing conditions in the upper basins and substantially understates impacts to these basins.
- Impacts of additional diversions from the upper Williams Fork tributaries and Darling Creek drainages, needed to fully utilize the expanded Gross Reservoir, were not discussed in the FEIS.

Estimation of existing streamflow depletion caused by past and present trans-basin diversions is critical, not only to evaluate the existing health of the source river aquatic systems, but also to determine how much additional water can be diverted for water supply and how additional diversions will impact these source basins. In particular, the expansion of Gross Reservoir will **increase the existing storage volume by a factor of three while streamflow in the source basins is already heavily depleted**. Existing streamflow depletion of the upper Fraser and Colorado Rivers was understated in the FEIS.

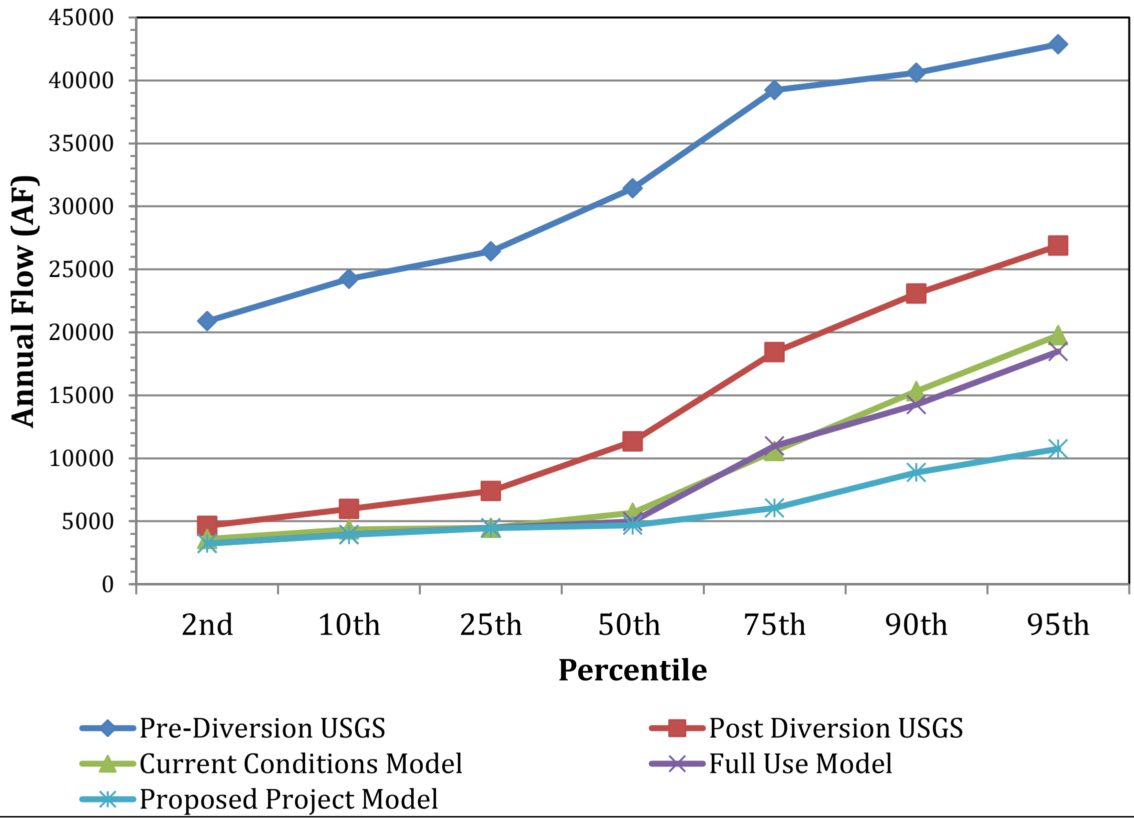
In our 2015 report, pre-diversion streamflow data, collected prior to completion of the Moffat Tunnel in 1936 at two USGS gaging stations, were used to evaluate cumulative impacts to upper basin streamflow caused by past and present diversions. Comparison of historical pre-diversion and post-diversion data, after 1936 at the Winter Park gage and after 1985 at the Hot Sulphur Springs gage, show that **annual native flows** on the Fraser and the upper Colorado Rivers have already been depleted by **64%** and **77%** respectively. The FEIS estimates only **50%** and **57%** depletion of annual native flows at these locations (FEIS Section 3.1.5.1). In the irrigation season of May, June, and July, streamflow is already depleted by **70 to 80%** at the Winter Park gage and **78 to 89%** at the Hot Sulphur Springs gage, due to past and present diversions. According to the FEIS, additional water for the expanded Gross Reservoir will be diverted from the Western Slope basins during the high flow irrigation season. Under-stating the existing streamflow depletion **overestimates** how much additional streamflow is available for diversion and **understates** the impact of those additional diversions on upper basin source streams.

Four baselines were considered in the October 2015 report: measured pre-diversion (prior to 1936), measured post-diversion or existing (1936 to 2013 in the Fraser Valley), current condition (modeled using Denver Water's Platte and Colorado Simulation Model, PACSM), and full use or project (modeled) baselines. In the FEIS, the modeled current conditions and full use project (modeled) baselines were used to define cumulative and project impacts to the upper basins. The report provides technical evidence that these baselines are inappropriate and **vastly understated impacts of the project.** The pre- and post-diversion baselines should be used to determine cumulative and project impacts. Annual streamflow percentiles for each of the above baselines and the proposed project (Figure 4), illustrate how use of the arbitrary current conditions baseline **substantially understates** the impact the Moffat Project has on upper basin streamflow.

A percentile is defined as the percent of annual flows that are less than or equal to a specific flow value. For instance, at Winter Park, 95% of annual flows during the **pre-diversion** (blue line) time period were below 42,869 AF/YR while 95% of annual flows in the **post-diversion** time period were below 26,875 AF/YR, a difference of almost 16,000 AF/YR caused primarily by past and present trans-basin diversions to the eastern slope. Ninety-fifth percentiles of annual streamflow under the FEIS modeled **current conditions** and **full use project** baselines are 19,766 AF/YR (green line) and 18,500 AF/YR, respectively; 7,100 AF/YR and 8,400 AF/YR less than the 95th percentile of **post-diversion or existing** baseline flows that have been measured at the Winter Park Gage on the Fraser River since 1936.

To further illustrate this point, when using the FEIS current conditions baseline to define cumulative impacts, the 95th percentile of annual streamflow would be reduced by 9,050 AF/YR whereas, based on the full use project baseline, the 95th percentile would be reduced by 7,730 AF/YR, due only to implementation of the Moffat Project. Using the more appropriate pre- and post-diversion baselines, the 95th percentile would be reduced cumulatively by 32,100 AF/YR and, due to the Moffat Project alone, by 16,100 AF/YR—**between 2 and 4 times greater than cumulative and project related impacts reported in the FEIS. Use of the current conditions baseline obfuscates the true impact of past, present, and projected trans-basin diversions from the upper Fraser River basin.**

Figure 4: Annual Flow Percentiles at Winter Park USGS Gage on Fraser River



Lastly, the FEIS claims that project related impacts are insignificant or minimal compared to impacts caused by additional diversions between the current conditions and full use baselines. Figure 4 refutes this claim. As is clearly evident in Figure 4, percentiles continue to decrease substantially after additional streamflow is diverted by the proposed project (light blue line). High annual streamflow (95th percentile) would be reduced to below the 50th percentile of existing measured flows at the Winter Park Gage if the Moffat Project were implemented, dramatically reducing high flows in the basin.

Conclusion. The firm yield analysis provides technical evidence that additional diversions through the Moffat Tunnel for the Moffat Project expansion of Gross Reservoir were not nearly sufficient to attain the stated goal of 18,000 AF/YR of additional yield for Denver Water's water supply system. Over the 44-year test period, diversions could only maintain the expanded Gross reservoir levels more than half full 70 percent of the time, was near empty 54 percent of the time, and filled in only 1 year or 2.3% of the time.

If Denver Water takes additional diversions from the Williams Fork basin to fulfill the goals of the Moffat Project, the impacts, above and beyond those noted in the FEIS, need to be fully evaluated and noted as impacts of the Moffat Project. A supplementary environmental impact statement would be needed. As it is currently designed, the Moffat Project will fail to meet the criteria that were used to select it as the preferred alternative. In short, it will fail.

SECTION VI
Other Considerations

<u>Climate change</u>. Denver Water is not a climate change denier. However, the discussion of climate change in the FEIS application focuses primarily what is not known, lack of science and lack of research *ergo* an inability to make predictions of stream flow based on air temperature changes. The discussion refers to "recent" publications of 2007 and 2008. However, Denver Water states, "Scientific studies have predicted that, because steam flows may peak earlier, evapotranspiration may be higher, and droughts may be longer and severe, it is also likely that water demands would increase in correlation with rising air temperatures." (Vol. II, E-32). On the contrary, during such conditions water demand may more likely **decrease**, as it has in the past during drought conditions.

<u>Seismicity</u>. The discussion of earthquake potential in the FERC application is the same as in the final EIS for the Corps, ending with "Potential issues related to seismicity will be addressed through geotechnical and seismic studies in the design and construction phases. (Vol. II, E-106.) If these issues can be studied then, they **can be studied now**—and should be. Agencies should then evaluate these studies before approval, not after.

Our response to the seismicity discussion remains the same:

> Gross Reservoir is in Seismic Zone 1 indicating that there is little chance for significant earthquakes. The seismic zones are determined by the International Conference of Building Officials, and uses active peak acceleration to determine the zones. However, to better understand the earthquake risk to Gross Dam, the magnitude of earthquakes and not the active peak acceleration is important. Like active peak acceleration, magnitude takes into account the movement of the earth at the surface, and is a measurement of the total energy the earthquake releases. Magnitude is a more widely and commonly used measurement of earthquakes (Swiss Seismological Service, 2013) and allows us to compare the earthquake risks at Gross Dam to other dams.
>
> Gross Reservoir is located on several faults. Denver is also in Zone 1 and is affected by several faults. Since 1960 Denver has experienced six quakes with a magnitude of 4.0 or greater and many of lesser magnitudes. In 1882 Denver experienced its largest earthquake recorded with an estimated magnitude of 6.6 (USGS, 2014). In 1967 an earthquake of this magnitude was enough to cause crack in the Konya Dam in Maharashtra, India (Chopra and Chakrabarti, "The Konya earthquake and the damage to the Konya Dam," Bulletin of the Seismology Society of America, 1973).
>
> Earthquakes can also be caused by increased water volume in reservoirs due to pressure on faults. While the FEIS states that the increased water in the expanded Gross Reservoir would not increase reservoir-induced earthquakes "at substantial levels" it also states any potential risks due to the increased volume will be studied during the construction phase. This study should be completed and considered before the expansion starts.
>
> Akin to Gross Dam, Konya Dam was considered to be in a stable and nearly nonseismic zone. Konya Reservoir caused its own earthquake due to increased water volume. In addition to damaging the dam, the earthquake killed 177 people and completely ruined 25 percent of nearby buildings.

When fully filled, Gross Reservoir will be 421 feet deep. In the FEIS and FERC discussion of seismicity, Denver Water states, "In general, reservoirs with depths greater than 300 feet may potentially induce seismicity. Increased seismic activity associated with water-lubricated faults is typically related to the load of a reservoir on an area that creates changes in stress at depths of at least a few miles. The water loads at Gross Reservoir would not change the water content in faults at depths of a few miles . . . " Is this speculation, or does Denver Water know this? We trust that FERC will verify this claim.

Recreation at Gross Reservoir. For residents of Boulder County, Coal Creek Canyon and beyond, the only benefit of a reservoir on South Boulder Creek is recreation—boating, kayaking, fishing, hiking and enjoying a picnic by the water. We gain neither drinking water nor electricity from Gross Reservoir. For many who oppose the Moffat Project, the disruption of recreation activities is a key factor, from loss of the beautiful Forsythe Falls area that will be inundated, to years of blasting, crushing, and other disruptive construction activity, beginning with months of offensive tree cutting and disposal. And all this during the months when the reservoir draws visitors from near and far—spring, summer and fall. No one would want to spend the day at Gross Reservoir during construction of the raised dam. Denver Water plans to keep some recreational areas open during construction—unlikely to be used. We must also consider the possibility that the expanded reservoir may not fill for several years, or ever, creating environmental and recreational hazards, as discussed in Section V. Mitigation cannot change this.

Minimizing impacts, whether environmental or "socioeconomic" is found throughout the FERC application. Two relate specifically to the reservoir area and might be categorized as "snarky." Regarding the loss of 200,000 trees, we learn that this is minimal compared to all the trees in Colorado; concerning the visual impact of the raised dam, we learn that soon visitors will have a new "cognitive map" and will grow accustomed to the visual change and finally not notice it. These comments illustrate a disregard for impacts that effect the visitor's experience and enjoyment of Gross Reservoir.

We find that in the FERC application, mitigation plans are vague concerning recreational activities and facilities at Gross Reservoir, confirmed in the letter of February 1, 2017 from FERC to Brian Gogas at Denver Water. For example, Denver Water would "relocate" the trail to Forsythe Falls in response to "Some stakeholders also expressed concern that Forsythe Falls would be inundated" but if the project goes forward, there will be no falls to hike to so this "mitigation" plan is curious, if not spurious. Because of the extent of the disruption of recreation at Gross Reservoir during destruction and construction, and the uncertainty of how and when Denver Water will establish new facilities, we request a public review of the final plan before the project is finalized and the FERC license amended.

Reopener Clause. There is currently no reopener clause included in the Denver Water proposal – it should be required. A reopener clause is a precautionary measure in this case. There is a significant likelihood that the Moffat Project will not meet its primary purpose to "develop 18,000 acre-feet per year of new, annual firm yield to the Moffat Treatment Plane and raw water customers upstream of the Moffat Treatment Plant pursuant to Denver Water's commitments to is customers." An extensive firm yield analysis (Section V of this document and Appendix D) demonstrates that the expanded portion of Gross Reservoir will not fill as expected; in many years it will remain less than half full or empty.

The environmental and recreational consequences of barren shoreline are uncertain. At some point it may be important to reassess mitigation strategies in the Gross Reservoir and South Boulder Creek areas. Changes to the operation of the Moffat Project, or to the articles of the license might also be necessary. Therefore a reopener clause is required.

SUMMARY

It didn't happen. 2016 came and went and water demand continued to drop—demand did not equal supply as Denver Water predicted. This is significant—Denver Water's projection models are wrong. Using questionable data however, a rationale for expanding Gross Reservoir was devised; supply and demand figures were not questioned. When the supporting data are faulty, the rationale is faulty and should never be the basis for a large and destructive project, as the Moffat Project is.

Nonetheless, the U.S. Army Corps of Engineers accepted this rationale. The Corps also accepted the "imbalance" rationale and the ancillary needs for flexibility and decreased vulnerability in Denver Water's delivery system. Based on these putative needs, the Corps accepted Denver Water's preferred alternative, the largest expansion of Gross Reservoir possible via water rights and terrain. If successful, the project would meet these needs, it is claimed. As of this writing the Corps is still deliberating the merits of the project.

Denver Water now submits an application for license amendment from FERC so that the project can go forward. The issues that we raise here are germane to the FERC review of this application: (1) the validity of the needs and purposes of the project, and (2) the viability of the project—will it succeed or fail in meeting the purposes and needs with an 18,000 AF/yr increase in Gross Reservoir? If it fails, land and recreational facilities within FERC boundaries at Gross Reservoir will be in jeopardy. Empirical evidence indicates that it will fail to to meet the criteria for success set forth in the project description.

Rather than being the least environmentally destructive, the Moffat Project is the most destructive of the alternatives. The process of alternative selection was faulty; the limiting description of purpose prevented a broad spectrum of alternatives for review; the No Action alternative description is without merit. If the Moffat Project goes forward, years of construction and destruction will follow. Destruction of the forest and land for the on-site quarry on Gross Reservoir cannot be mitigated. Staining the scarred cliffs to look like native rock will not do. Moving picnic tables and recreational facilities to higher ground will not compensate for the loss of 230 acres of Winiger Ridge and the falls, 465 acres in total of inundated land and many acres destroyed by the quarry. Acres of wetlands on the West Slope will suffer, streams will dry up and ultimately the Colorado River will be impacted.

Given these consequences, given the failure to demonstrate need, given the potential for failure and given the potential for increasing supply and reducing demand through sustainable, nondestructive innovation—the Moffat Project cannot be justified.

APPENDIX A

The South System/North System Connection Alternative

The primary purpose of the Moffat Project is to gain 18,000 AF/yr firm yield to meet a projected shortfall of 18,000 AF/yr by 2032 beginning in 2022. The purpose stipulates that the additional firm yield must be delivered to the Moffat Treatment Plant and must supply raw water to the upstream raw water users. The shortfall includes 3,000 AF/yr contracted with the City of Arvada contingent on completion of the project. Arvada will pay over $54 million of the construction costs. If the project is not permitted or completed, the projected shortfall would be 15,000 AF/yr. The raw water customers upstream of the plant are the City of Arvada (19,500 AF/y), City of Westminster (4,500 AF/y) and North Table Mountain and Sanitation District (6,000 AF/y), approximately 30,000 AF a year in total.

The alternative screening process for the Moffat Project was finalized in 2007. Ultimately the expansion of Gross Reservoir as the only component of the project was selected as the preferred alternative. In the alternative selection process all alternatives and storage and conveyance components that could deliver new firm yield to the Moffat Treatment Plant but were costly or impracticable for some other reason were rejected. Recent assessment of several determining variables warrant a fresh look at other alternatives that were not considered: the cost of the project, the likelihood that the expanded reservoir will not fill as required, (see Appendix B, page 29) the environmental destruction to Western Slope basins and Gross Reservoir terrain, and recalculation of "near-term" projections for supply/demand convergence (2016 to 2022) and the 18,000 AF/y shortfall (2030 to 2032).

Background. Table B-1 of the DEIS and the FEIS for the Moffat Project is the "long list" of 303 water supply sources and infrastructure components, of which 297 were eliminated. The items are listed by category beginning with Western Slope components. Under the category "Institutional/water Management Concepts," item #301, "raw water load shift" is described: "New raw water pipeline (and pumping facilities) would deliver raw water to the Moffat Delivery Point from a new diversion in Waterton Canyon or from Conduit 26 at Foothills Treatment Plant." Under the category "Demand Reduction Concepts, #501 "Convert Northwest Raw Water Contracts to Treated Water Contracts: "Additional treatment capacity at Foothills or Marston, conduits, pumping, and treated water storage to transmit treated water to Arvada, Westminster and North Table Mountain."[31] #501 was eliminated by screen PN3, "Must produce a solution within the necessary timeframe."

Screening criteria were categorized by "purpose and need," "existing technology," "logistics," "geographic location," "institutional issues," "practicality issues," and "environmental consequences." Sixteen criteria plus a cost screen were used to eliminate all but five alternatives; these five and a No Action alternative were analyzed by the Corps. Failure to meet a single criterion was a basis for elimination. The cost screen was decisive in determining the preferred alternative. Three purpose and need criteria were key: PN1: must provide new firm yield of 18,000 AF/yr. PN2: must supply water to Moffat Collection System. PN3: must produce a solution within the necessary near-term timeframe. "Near-term" is defined as "prior to 2032."[32]

The following alternative is grounded in these two alternatives that were rejected. Although rejected, this was not because they could not be done.

South system to North system conveyance alternative.

Denver Water presents an alternative to Moffat Project "purpose and needs" in describing its strategy during the 2002-2004 drought when Gross Reservoir was temporarily drawn down: *"Constructing infrastructure and pumping treated water from the South System into inefficient ditches for delivery and retreatment by raw water customers."*[33] Further, " [In] *these types of emergency, inefficient and expensive strategies do not provide an adequate permanent solution for the lack of water supply available to the Moffat WTP*." An adequate permanent

[31] FEIS, Appendix B, sheet 11.

[32] FEIS, Executive Summary, page ES-5.

[33] FEIS, Chapter 1 "Purpose and Need," page 1-26.

solution is exactly what is needed and can be achieved without the Moffat Project.

The following is an outline for delivering raw water to the City of Arvada while maintaining in the North Collection System, **as firm yield**, the water currently being drawn from Ralston Reservoir for the city. This alternative meets all of the screening criteria including "must provide new firm yield of 18,000 AF/yr," "must supply water to the Moffat Collection System," and "must produce a solution within the necessary near-term timeframe."

The City of Arvada is contracted with Denver Water for 19,500 AF/yr. Most of this supply flows from Ralston Reservoir through two pipes directly into the Ralston Treatment Plant in Arvada. A small amount flows from Ralston Reservoir into Arvada/Blunn Reservoir and to the Arvada Treatment Plant during periods of high demand. Ralston Reservoir receives water from Gross Reservoir via the South Boulder Creek diversion canal. This supply is delivered to Arvada over the year. The Ralston plant can treat 36 million gallons a day and the Arvada plant can treat 16 million gallons a day for a maximum capacity of 52 million gallons a day.

This alternative supplies raw water to Ralston Reservoir from Marston Reservoir for Arvada. During the drought Denver Water temporarily pumped treated water from the Marston and Foothills plants to Ralston Reservoir as needed. The specific design of a permanent system is beyond this Citizen's Alternative. As previously demonstrated, Denver Water can supply water to the north system, solving the "imbalance" problem without the costly and destructive Moffat Project. As Denver Water CEO/Manager Jim Lochhead says, "*There is enough water; we can live within our means. But the systems we have in place simply do not have enough flexibility to move water to the places where it is most needed*."[34] Lochhead states the case. A goal of the Moffat Project is increased flexibility by adding supply to the north supply system; connecting the south and north systems would do exactly that.

Appendix B shows that Denver Water's south supply system has enormous capacity compared to the north system. As Lochhead says, there is enough water.

Supply.

1. Chatfield Pump Station. Denver Water plans to pump lost "fish flows" into Marston Reservoir. This water is "lost" because Denver Water does not have sufficient storage in Chatfield Reservoir and must release the water into the South Platte River. A pump station and conveyance will deliver 3,000 AF of water to Marston Reservoir.

> Denver Water must maintain certain flow rates in the South Platte River between Strontia Springs Reservoir and Chatfield Reservoir for aquatic life. The "fish" flows are normally stored in Chatfield Reservoir, but because there is not enough space in Chatfield to store all the wintertime fish flows, they must be released from the reservoir and are lost from Denver Water's system. This project would recover those lost flows by pumping the water from Chatfield to Marston Lake so the water could be delivered to Denver Water's customers.[35]

A conveyance system between Marston treatment plant and Ralston Reservoir already exists, albeit "inefficient" according to Denver Water. Delivery of raw water to the north system avoids the "double" treatment, first in a south system plant, and then at the Arvada treatment plant. One concern is the quality of water that the plant can handle. Screening criterion EC2 stipulates "must use highest quality water available among similar components within a water sources category." Alternatives that included a South Platte River source, agricultural water or surface or underground stored water included treatment before delivery to the Moffat treatment plant, adding significantly to cost. Water from the Conduit 20 intake dam, three miles upstream of the mouth of Waterton Canyon, is one source for Marston Reservoir. This quality of raw water can be treated in Arvada's treatment plants that use the same treatment processes as the Foothills and Marston plants.

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[34] "The Risk of Cheap Water" by Eduardo Porter. New York Times, October 14, 2014.

[35] Retrieved from denverwater.org/SupplyPlanning/WaterSupplyProjects/OtherProjects

2. Denver Water has several possible uses for Marston water:

Water moved from Marston could be used in a few ways. At highest levels, the water will be treated and distributed from the treatment plant. Once the temporary pumps begin to move water through the Fort Logan lateral ditch, the raw water will be used for irrigation, exchanged for upstream water storage or stored in Denver Water's Downstream Reservoir Complex.[36]

Denver Water has several options for water stored in Marston Reservoir, and has the capability to construct effective and permanent infrastructure for transporting some of this water for distribution to the north system, as needed. The complexities of this alternative are dealt with daily throughout Denver Water's extensive system of reservoirs, ditches, conduits, pipes and pumps.

We cannot design a conveyance system between the south and north supply and delivery systems. Denver Water can, and in the selection process included two alternatives that focus on this solution, one for treated water supply and one for raw water supply. #301: "New raw water pipeline (and pumping facilities) would deliver raw water to the Moffat Delivery Point from a new diversion in Waterton Canyon or from Conduit 26 at Foothills Treatment Plant." Reducing the demand on Gross Reservoir, permanently, by conveying raw water from the south system to Ralston Reservoir or to the Moffat Delivery Point can be done.

[36] Denver Water, Marston Outlet Works, Construction Projects.

APPENDIX B
The Roads

Coal Creek Canyon, Hwy 72
Gross Dam Road
Magnolia/Lazy Z (CR 139 and 97E)

INTRODUCTION

The first issue raised by residents during the scoping process for what became the Moffat Collection System Project was traffic safety. It was obvious that using the narrow and winding canyon highway and dirt roads for hauling materials to the dam construction site and for tree removal, would be highly dangerous and would cause extreme difficulty for local residents. We did not, however, realize the extent of the problem nor did we know the amount of truck traffic that would be travelling up and down the canyon for at least four years. This appendix is a detailed description of the roads—but it is no substitute for actually driving up and down Coal Creek Canyon to understand our fears, Using Highway 72, the only road in the canyon, for hauling, is untenable; both it and Gross Dam Road are extremely unsafe for this use. The roads in the Magnolia/Lazy Z area are totally unsuited for logging trucks. Clearly the plan is unsupportable.

The purported needs and purposes of the Moffat Project are questionable, and cannot justify the potentially hazardous outcomes and threat to both the quality of life, and life itself, of citizens who live in the area and drive the roads.

The Roads

Highway 72, east side of Wondervu pass. The proposed plan to raise the height of Gross Dam by 131 feet involves extensive hauling of material to the remote site. Haul trucks would travel 6.8 miles on Hwy 72 from the beginning of Coal Creek Canyon to the turn onto Gross Dam Road; the **elevation gain is 1,510 feet** (Google Earth**;** Garmin GPS). There are 21 curves on this stretch of highway, several over 30 degrees; two are s-shaped; three are signed at 35 mph and three at 25 mph; two side roads join Hwy 72 in the middle of a C- curve. There are 44 homes and one church with driveways onto the highway; two warning signs read "Caution Blind Driveways Next 4 Miles." A gas station and shop are located on a sharp curve; a second gas station, a fire station and shops hug the highway. Driving the most severe curves in a passenger car is tricky and the driver must slow down in advance to stay in the lane; going down it is common to find a driver riding the brakes (Photo 1. *Note the deterioration of the double yellow lines; this is common on all sharp curves in the canyon and is a safety hazard that will be magnified with increased truck traffic.*) On this 6.8-mile section of Hwy 72, up and down canyon, there are a total of 92 warning signs, indicating continuous curves, sharp curves, right-angle turns, intersections, school bus stops, hidden driveways and pedestrians. A sign with the bicycle icon tells drivers to "share the road."

The total elevation gain on Hwy 72 on the east side, from the entrance of the canyon to Wondervu pass, is **2,151 ft. in 9.6 miles**. There are 61 homes, two fire stations, one hotel and several businesses along the highway. The turn from Hwy 72 onto Gross Dam Road is a hairpin of about 270 degrees, flanked by the offices and garage of United Power on one side and the parking lot of the community hall on the other (Photos 2 and 3). The community hall is the venue for several weekly events throughout the year.

The hairpin turn onto Gross Dam Road is at the end of a curve that blocks a good view of the downhill road. Truckers turning from Gross Dam Road back onto Hwy 72 will not be able to see upcoming traffic, and drivers coming up the canyon will not know that a truck is slowly maneuvering the turn, blocking both lanes. Due to the terrain and location between two properties, it will not be possible to make this turn safe for vehicles by reconstructing the road. A flagger will be needed at all times. It is our opinion that while the entire route on Hwy 72 would be extremely unsafe for all vehicles on it—trucks, cars, campers, bikes and motorcycles—**this turn eliminates the route for hauling**.

Although it is impossible to know with certainty how many trucks would be in use throughout the proposed project, Denver Water estimates that during peak concrete placement in the summer months, (also peak local and tourist vehicle traffic) there will be 208 haul truck trips in the canyon over a 14-hour period. [The original estimate was 240; this is reduced because aggregate will be produced on site.] Throughout the day a haul truck would pass a given point, going up or down—trucks could not avoid meeting at the most dangerous points. If a haul truck driver maintained an average of 22 mph (no use of pull-outs, no stopped school bus, no bottlenecks) on the 6.8-mile route from the base of Coal Creek Canyon to the turn-off to the reservoir on Gross Dam Road, there would be several trucks on the route at all times. **This estimation does not include logging trucks and all other vehicles associated with the project**.

However, numbers do not portray the real nature of the route and do not take into account the conditions that will cause delays—for example, snow. Denver Water defines "peak construction period" as **March 15-November 15.** Snowfall is usually heaviest in March and April and spring snow continues into May. Near record snowfall occurred in April, 2013. The winter snows begin in mid-October. It will be impossible to maintain the peak construction hauling schedule. But if Denver Water attempts to do so, canyon residents will be exposed to even greater danger.

In testimony before the Boulder County Board of Commissioners on January 7, 2013, a professional truck driver explained that in addition to being unsafe and impossible to navigate by 18-wheelers, Hwy 72 cannot accommodate this truck traffic regardless of the size of the truck (see Appendix B for the complete testimony). This witness said that staging trucks at seven minute intervals will create a "convoy" in the canyon and that the chance of a trucker using a pullout is "slim to none" because it would take half a mile to regain speed—meanwhile every vehicle on the road is backed up, including all the haul trucks. The backup at the hairpin turn onto Gross Dam Road described above would go down around the blind curve.

Highway 72, west of Wondervu pass. If the destruction of 20,000-30,000 trees is done through conventional logging, Hwy 72 will be the haul route out of the canyon going east. The section of highway between the most likely logging truck entrance onto Hwy 72 to the top of Wondervu pass is 4.7 miles, passing through Pinecliffe, with an elevation gain of 397 ft climbing out of town and a drop of 446 ft over the first pass, followed by a long switchback with an elevation gain of 200 ft. The final 1.8-mile section of Hwy 72 to Wondervu pass has many steep switchbacks, rated 10 mph, 15 mph and 20 mph (Photo 4). Two sharp switchbacks near the top have a combined elevation gain of 159 ft. There are many residential driveways entering Hwy 72 in this area. A popular restaurant sits at the top of the pass (elevation 8,690 ft.), with parallel parking a few feet off the highway (Photo 5). Two side roads join the highway in this area. The restaurant's web site says, "There is nothing like taking the beautiful drive up Highway 72 in the heat of summer to step out in the cool mountain air." If the proposed project is approved this will be false advertising. Crowded with trucks, the drive will be more frustrating than beautiful and the mountain air will be polluted with diesel smoke.

The eastern stretch of Hwy 72 is not feasible for logging trucks. Numerous steep and tight switchbacks make this impossible. Furthermore, at the junction of Hwy 72 and Gross Dam Road, loaded and slow-moving logging trucks would converge with empty haul trucks for the 6.8 mile, 1,510 ft. drop to the bottom of the canyon, adding to the danger and congestion on the east side. **Hwy 72 is a residential road**. Approximately 4,000 residents live in and near Coal Creek Canyon. School buses pick up and deliver children on this route. Children attend the grade school in the canyon and the high school in Nederland to the west and Arvada to the east. School buses, and in the summer a slow bus that delivers children to a nearby summer camp, will be in the canyon with haul trucks and logging trucks. This is dangerous and is another factor that should prohibit the use of Hwy 72 for the proposed project.

Gross Dam Road. This dirt road links Hwy 72 with Flagstaff Road on the north side of South Boulder Creek; the road to Gross Reservoir forks left at the lowest point. From Hwy 72, Gross Dam Road is the only access to Walker Ranch Open Space trail system, a popular biking and hiking loop. In summer the parking area off of Gross Dam Road is often filled (Photo 6). It is four miles from Hwy 72 to the turn off onto the reservoir road, with an **elevation drop of 1,114 ft**. The road spews dust that cannot be successfully mitigated with chemicals, it has washboard in places and sections of drop-off on one side, with no guardrail (Photo, 7). There are four steep and severe turns before the railroad tracks and three after. The speed limit is 20 mph but a trucker would be unable to take a curve at that speed. In his testimony, the truck driver explained that the jake brakes must be used because riding the wheel brakes causes them to crystallize, then smoke, then burn. In any case, he said, the jake brakes will warn homeowners that a truck is coming and to "be careful" because it could come through the house after a failed attempt to hit the embankment. This witness seemed to be as worried about the truckers as the residents, and rightly so. Gesturing to the people behind him in the Boulder County Commissioner's hearing, he ended his testimony saying, **"You are going to have a fatality on that road. It is going to happen. And it's a shame because one of these people is going to die."**

It was this testimony and that of a resident whose wife was in a severe accident on Hwy 72 that caused us to rethink our concerns about the haul route. A side note: we are now more acutely aware that home values will plummet during the years of construction due to the use of Hwy 72, Gross Dam Road and "logging roads." Anyone looking for a home in this foothills area must use these roads, generally during the summer months—peak construction period for several years. It is unlikely that anyone would buy a home in the area without a significant price-reduction incentive.

Roads in the Magnolia/Lazy Z area.

The web of dirt roads that would be used for conventional logging has not been determined, and as of this writing, Denver Water remains vague about how the removal of 200,000-300,000 trees will be accomplished. The roads are narrow, some traverse steep terrain and there are blind curves. This is a residential area and the roads are used for recreation and walking dogs. During spring melt these roads would be severely rutted by heavy truck traffic and would require continual grading. In summer dust would be a major problem. It is certain that logging and removal of trees in this area would be hazardous and would greatly reduce the quality of life of residents.

CR 68, Lazy Z and Magnolia Road west of CR 68. These dirt roads are the most likely routes for logging trucks. More than 250 homes are in this area and residents further east use these roads to get to Nederland. The roads are narrow in sections and washboard slows traffic. On all of these roads mail boxes are clustered and residents often cross the road to pick up mail from the vehicle (Photo 8).

Magnolia Road. Magnolia Road is a school bus route. During the school year bus stops are congested with cars and children in the morning and afternoon. A 2010 survey recorded 970 trips per day on Magnolia at Pine Glade Road. In the spring Magnolia Road is the route of a popular bike race, and it is used by running teams throughout the year including the Nederland High School track team. The three-mile section from CR 97 to Hwy 119 has 25 curves, including a sharp S curve giving access to a Boulder County Open Space trailhead with parking on the road. The Winiger elk herd is in the area from October through May. Residents stop and sometimes herd elk off the road; truckers must do the same. Ultimately the movement of elk and other animals will be disrupted by heavy truck traffic and it is likely that some will be killed.

Magnolia Road from CR 68 to CR 97. This section has twenty-four driveways entering it and four intersections with poor visibility in both directions. In a 1.7-mile section there are sixteen blind curves including a tight S curve on a slope with reverse banking that is **bracketed by a blind curve at each end** (Photo 9). The entrance to a heavily used USFS trailhead intersects Magnolia on a blind hill, just beyond a blind curve.

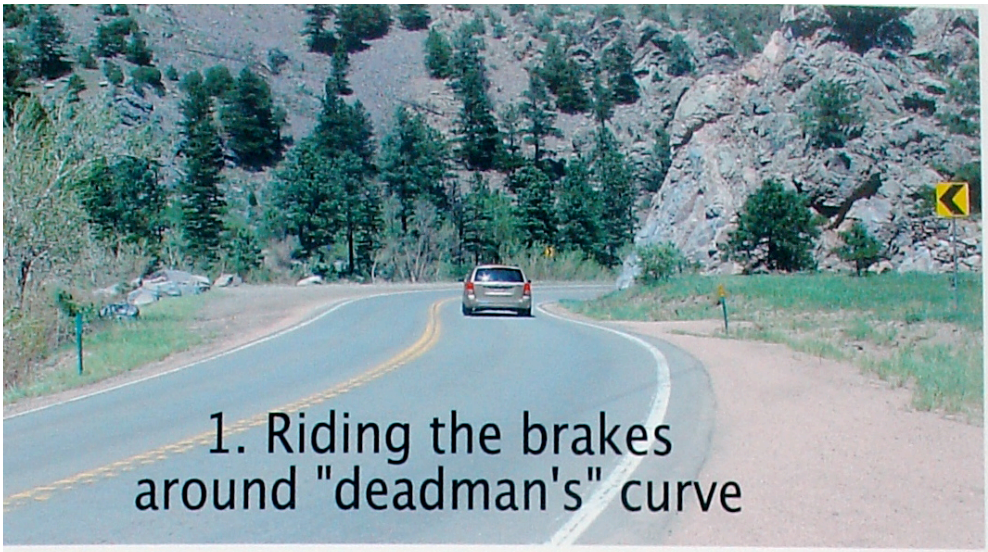
Lazy Z. As the name suggests, Lazy Z has many blind curves in sequence, one with four driveways entering the curve (Photo 10). In a 2.2-mile section there are 35 driveways and four intersections (Photo 11). There are six bus stops on Lazy Z. The lower three-mile section of Lazy Z (the Haul Road) blocked by a gate, is little more than a two-track jeep road with water ruts, rocks, hairpin turns, blind curves and three intersections with very steep USFS roads (Photo 12). This section is used by hikers, bikers and horseback riders and is considered by all to be unique and special.

CR 68. CR 68 begins as a steep, rocky and rutted "road" and is popular with runners, bikers, hikers and equestrians. Further up from this section a recently enlarged parking lot for the USFS 359 trailhead/jeep road invites greater use of the area. CR 68 is approximately two miles in length with 23 curves (five are blind, three are sharp 90+ degree turns) and three steep blind hills. Narrow sections, including a one-lane hill, add to the potential for accidents. CR 68 has a continuous uphill/downhill grade. Steep hills, open meadows and heavily wooded areas flank this route. It is intersected by four roads that service over 40 homes, and ten driveways enter it directly, one on a blind curve that borders a second "blind" driveway. One intersection is notoriously icy in winter. A stream with three ponds flows along the road. Some driveways and road intersections are obscured, particularly with summer foliage. The intersection of CR 68 and Magnolia Road is a bus stop and during the school year residents wait in parked cars to pick up their children twice a day.

CR 97. While this road is too dangerous to be a logging truck route, it will be a tempting shortcut to Hwy 72. It is narrow and steep and has twelve blind curves and eight driveways. There are large potholes and deep ruts caused by springs that percolate up through the dirt. A steep embankment on one side and a sheer drop-off on the other make this road especially hazardous.

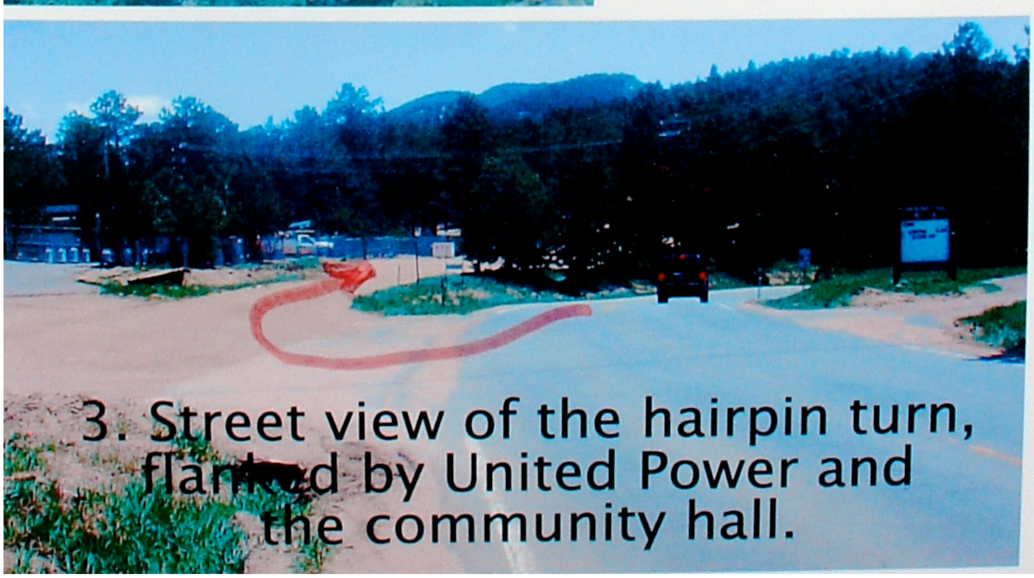
Magnolia Road East. This section of Magnolia Road will have increased traffic as residents try to avoid truck traffic on Hwy 72. This road down to Boulder Canyon is steep with numerous hairpin turns—hazardous on a good day.

In summary, these roads cannot be used for logging trucks, and yet this will happen if the project is permitted. A resident comments, "My general opinion is that the roads in our area are nothing but blind corners and blind hills with a few scattered visually open spots to differentiate it from a roller coaster." Another resident says, "The projected traffic in the area with the construction/logging is a major scare for me, as I know that these are the roads where my daughter will ride her bike, walk, and ride her horse. We are a homeschooling family, and the quiet and safety of the roads is a big issue for us. I hope that the well-being and safety of the children will be considered in the decision-making process."



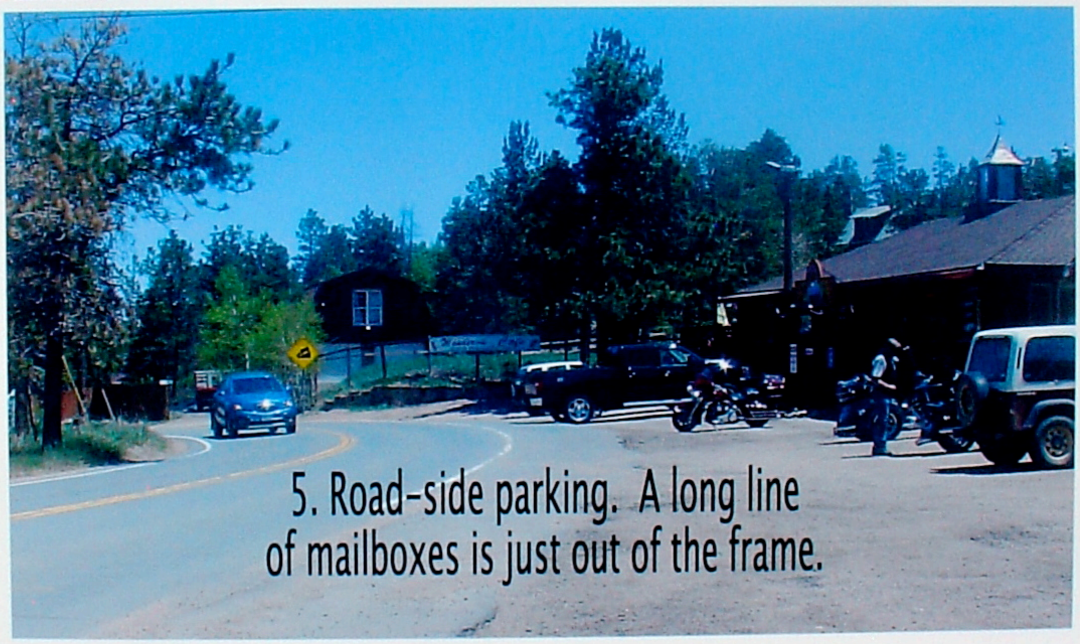
1. Riding the brakes around "deadman's" curve

2. Aerial view of the hairpin turn onto Gross Dam Road from Hwy 72



3. Street view of the hairpin turn, flanked by United Power and the community hall.

4. S curve on Hwy 72, west of Wonderview pass



5. Road-side parking. A long line of mailboxes is just out of the frame.

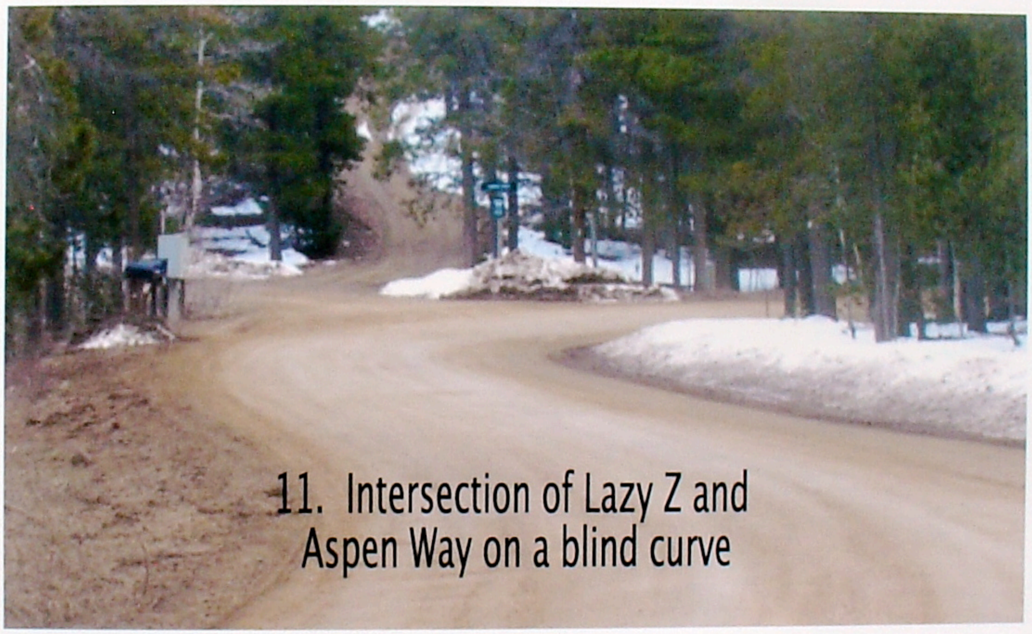
6. Crescent Meadow trailhead on Gross Dam Road

7. Sharp curve and drop-off on Gross Dam Road

8. Intersection of Magnolia and Lazy Z; large cluster of mailboxes on blind curve

9. Part of the double-S curve on Magnolia Road

10. Four driveways intersect on narrow blind curve on Lazy Z



11. Intersection of Lazy Z and Aspen Way on a blind curve

12. Best section of the haul road

APPENDIX C

Testimony before the Boulder County Board of Commissioners, January 7, 2012

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time code 3:10:47 – 3:15:44

I am a professional truck driver; I have been that since 1989. I don't really have any numbers or stats or anything like that for you, but I can say, for route 72, is a very dangerous road for trackers and trailers.

I service almost all the state of Colorado. I haul petroleum over Loveland Pass, Rabbit Ears, Boulder Canyon up here to get to Nederland. The turns that are set up inside of 72 are almost impossible to do, with that kind of truck traffic. I don't know where Denver Water comes up with the idea that they are going to have a truck come up every seven minutes because it is impossible. We run to Greeley in stages like that. We stage ourselves 45 minutes out and we all bottleneck into Greeley all the time. So you are going to have a convoy of trucks constantly going up there.

As far as the 40 mile an hour status that they are coming up with, that's baloney too. They have the idea that they are going to have truck pull-offs. Well there goes your 40 mile an hour right there. You are never going to get it back. I don't know if you know this or not, but route 72 is a secondary road. It is not 80,000 it is 85,000 they can haul up through there. Once you kill your speed, it is going to take you at least one half a mile to get it back. The chance of the trucks actually using it, is probably slim to none because it is going to kill all their speed. The 40 mile an hour on Gross Dam Road – the last time I looked the speed limit is 20 - so I don't know where the hell they are coming up with that either.

As far as the jake brakes - I hear a lot of people talk about how they are noisy, a glorified horn. They are not, but to save the brakes, because like I explain to some people, if you actually live on Gross Dam Road, you want to know where that truck is coming. Because when they are not allowed to use their jake brakes, that means they are riding their brakes the whole way down. And when you ride your brakes, it only takes about one eighth of a mile and they crystallize and that's where the smoke comes and the fire comes after that. And the problem is, with Gross Dam Road, you have four hard turns before the railroad tracks, and then you have three hard turns after that to get down to Gross Dam. If you make it past the railroad tracks, you might survive the rest of the way down.

The first thing you are going to hit is the trees. If you are lucky you are not going to catch on fire. And this is from experience, I have seen this stuff before. I have seen at least ten fatalities every year, driving for ten and a half years. I have seen two in the last week. It is not a nice sight. The houses that are along Gross Dam Road, there are probably five of them. I would actually tell these people to be very careful because a truck is going to come through the house. We used to see that back in Pennsylvania a lot. And the first thing is it hits the trees. The first thing you want to do is try to hit the embankment but that usually doesn't work, so you are taking out the trees and the next thing you know, you are taking out somebody's house.
As far as the weight-wise – on Gross Dam Road – they can't even grade it now. The washboard on that thing is horrendous. I have delivered down in Franktown, which is a flat road and it is heavily trucked area – you cannot even keep anything on your dash. I don't know how they think they are going to grade that thing. And as for spraying the chemicals on the road, it is only going to last about two days; it is going to be gone, it is going to be dust again. So I don't understand where they are going to come up with that.

As for expanding the road, like Boulder Canyon, is where you have the double lanes coming up through, Coal Creek does not have that kind of room for you to do that. And you don't have to take a ride in a tracker-trailer to simulate what it feels like to be in a truck and trailer. The next time you go up Coal Creek—because I did this to my wife and it only took three turns and she was like, "Holy crap we are going to die." All you have to do is, when you come around the turns, and when you are going up you are going to see a church sign on the right, that is your first big hairpin turn. Take your driver's seat and put it three-quarters into the other lane. That is what it takes to clear that turn with a 45-foot trailer. You have four turns of that and then you have eight of them up on top of Gross Dam Road. And they are saying that they don't want you to use Crescent Park Drive which is fine, but I don't know how you will ever make the turn at the top of the road to come back down on Gross Dam because you will have to take the whole rig, which is a 20-foot truck and 45-foot trailer, and you are going to have to put it in that complete other lane to come back 180 degrees to come back on Gross Dam Road, which is almost impossible. You are either going to have a flagman or you are going to have to reconstruct the whole road up there.

You are going to have a fatality on that road. It is going to happen. And it's a shame because one of these people is going to die. Thank you.

APPENDIX D
Firm Yield Analysis

Evaluation of Feasibility of Attaining 18,000 AFY of Firm Yield from Excess Flows Remaining in the Fraser and Williams Fort Basins Combined with 72,000 AF Additional Storage in the Expanded Gross Reservoir.

For: The Environmental Group (TEG)

5/15/2014 Revised 10/1/2015

By: Lisa Buchanan, M.S., Scientist/Engineer

Additional 10,280 AFY of water diversions from the Fraser and Williams Fork Basins through the Moffat Tunnel, in combination with the enlarged Gross Reservoir that affords 72,000 AF of additional storage volume, provide the needed 18,000 AFY additional firm yield in only 55% of years of the test period. If all of additional diversions between the historical post-diversion baseline and the proposed project, approximately twice that allocated for the proposed project, or 20,300 AFY, are included, the required firm yield will be met in only 77% of years of the test period. Therefore, the project does not meet the PN1 screen criteria and should have been screened from further consideration in the FEIS. To attain the firm yield in 100% of test period years, additional diversions from the planned expansion of the Williams Fork Collection system to Darling Creek would be required. Impacts analyses of thee required additional diversions need to be addressed in the FEIS.

Summary

Alternative 1A of the Moffat-Gross FEIS would increase storage in Gross Reservoir by 72,000 AF and Denver's firm yield water supply by 18,000 AF/YR. Water for this alternative would come from the Fraser and Williams Fork basins on the west slope through the Moffat Tunnel into Gross Reservoir on the east slope of the continental divide. Because stream flows in these basins are already depleted, up to 70 or 80 percent at the Fraser River at Winter Park USGS gage in the irrigation season, this analysis was undertaken to evaluate how much water remains in the basins, referred to as excess basin water, above and beyond what is currently diverted to the existing 41,800 AF Gross Reservoir.

Since measured flow data at Denver's diversion structures is not available, annual excess basin flows are estimated using USGS flow data and Gross Reservoir storage data over the 44-year period of 1966 to 2013, when data were available at all monitoring locations in all but three years. Estimated ground and surface water inflows that enter the stream between the diversion and USGS gage locations, sometimes over several miles, are subtracted from measured stream flows. Excess basin flows, equal to the yearly sum of the adjusted stream flows at the USGS gages, are applied each year toward storage in the expanded portion of Gross Reservoir and/or the 18,000 AF additional firm yield for Denver's water supply system. Firm yield, which accounts for both the water supply inflow and available reservoir storage from previous years, is assessed annually over this 44-year period.

The firm yield of expanded Gross Reservoir is tested against two flow situations. 1) Use of all calculated excess basin flows to test the firm yield of the combined reservoir/water supply system; this simulates the modeled "current condition" baseline in the EIS. 2) Use of all calculated excess basin flows <u>minus</u> the average annual diversion between the modeled "current" and "full use" EIS scenarios; this simulates the "full use" baseline in the EIS. Diversions up to and including the "full use" model scenario of the EIS when combined with 41,800 AF of storage in the existing Gross Reservoir meet Denver's projected water supply demands through 2022 according to the EIS. As stated in the EIS, after 2022, expansion of Gross Reservoir by 72,000 AF is required to provide the additional 18,000 AFY of firm yield required by 2032. The EIS only considers incremental basin impacts caused by diversions between the "full use" baseline and the proposed project to be project related.

Overall, results of this analysis indicate that the stated 18,000 AFY firm yield requirement for the proposed project, expansion of Gross Reservoir to almost three times its current volume, cannot be met under both of the flow situations above representing both the "current" and "full use" EIS baseline model scenarios. Results of this analysis are as follows.

- The average of all calculated annual excess basin flows closely match the FEIS average additional diversions between the "current" and "proposed" model scenarios of the PACSM water supply model. In fact, the average calculated excess basin flow is greater than average modeled diversions by approximately 2,600 AFY and so represents a "best case" estimate of the ability of the proposed project to meet the firm yield requirement of 18,000 AFY.
- Current conditions EIS baseline: Including storage in the expanded portion of Gross Reservoir and all estimated basin excess flows, the reservoir would fill in only 3 years out of 44; the 72000 AF of extra storage would be depleted or zero in 12 years; the required yield of 18,000 AF/YR would be met in 32 years (72.7%) and not met in 12 years (27.2%). The EIS PN1 screening criteria is not met.
- "Full Use" EIS Baseline: Under the "full use" baseline, a portion of the excess basin flows would be diverted through the Moffat Tunnel and the existing Gross Reservoir to the Moffat Water Treatment Plant without requiring expansion of the reservoir. The remaining 10,280 AFY are allocated for the proposed project. Under this baseline, that preferred in the EIS, the expanded reservoir would fill in only 1 year out of 44; the 72000 AF of extra storage would be depleted or zero in 20 years; the required yield of 18,000 AF/YR would be met in 24 years (54.5%) and not met in 20 years (45.5%) of this 44-year period of record. The percentage of years where the firm yield of 18,000 AF/YR was NOT met is substantially lower than 100%, the EIS alternative screening PN1 criteria; the project should have been screened from further consideration in the alternatives screening process.
- Incremental additional diversions from the Fraser and Williams Fork basins are included in the "current condition", "full use", and "proposed project" model scenarios. Of these, the impacts of only the last, the "proposed project" diversions, on basin stream flow are considered to be project impacts in the EIS. If all of the modeled additional diversions, equal to all additional diversions between the historical post-diversion and proposed project or approximately twice that of the "proposed project" diversions, are utilized the stated project firm yield of 18,000 AFY is met in 77 percent of the years; still below the acceptance criteria of 100 %.
- Basin impacts attributed to the "project" should reflect all additional diversions included in the "current", "full use", and "proposed project" model scenarios and are likely greater than twice that stated in the EIS.
- Guidance published by the New Jersey Department of Environmental Protection (NJDEP, 2011) define firm or "safe" yield as a continuous quantity of water that can be provided even through a historical critical drought period. Even with 4,000 AFY of additional excess basin flows, storage and firm yield in the expanded Gross Reservoir

were zero from 1976 through 1978 due to average or below average years leading up to these three years. This is in contrast to the selected 1950s critical drought years (1953 to 1957) of the PACSM modeling where the expanded Gross Reservoir filled in wet year 1952 just ahead of the drought period. The mid-1970s should also be included as a critical drought period against which to evaluate the feasibility of the project to achieve the additional firm yield of 18,000 AFY.

Analysis Description

Alternative 1A of the FEIS calls for a substantial increase in Gross Reservoir Storage; from 41,811 AF adding 72,000 AF for a total storage volume of 113,811 AF; an increase in storage volume of 172 percent. Alternative 1A is noted as the preferred alternative. Because stream flows in the Fraser River basin are already depleted under the current configuration of Gross Reservoir this evaluation was undertaken to estimate the additional firm yield of the Fraser and Williams Fork basins if storage in Gross Reservoir is increased.

The FEIS page 2-25 states that "*additional water is available for diversion under the existing Denver Water Rights from the Fraser River, Williams Fork River and South Boulder Creek.*" and (FEIS pg. 2-28) "*the existing diversion and conveyance facilities (i.e.* Moffat Diversion tunnel and South Boulder Creek Diversion Canal*) have adequate capacity to divert and carry additional flows."* However, it is unclear how much additional water remains at Denver Water's diversion structures for diversion to the expanded Gross Reservoir because 1) Denver Water does not measure surface water flow <u>at each of their</u> <u>diversion structures</u> in the Fraser and Williams Fork Rivers and 2) stream flow is monitored by the USGS gages that are located one half to several miles below Denver's diversion gates (See Figure 1). Measured flows not only reflect Denver diversion operations but also surface water and ground water inflows to the stream that enter between DW diversion points and the USGS gage locations. Therefore, it is not clear how much excess flow is available at the <u>point of diversion</u> for storage in an expanded Gross Reservoir. Flows measured at stream gages located a distance downstream of the diversion structures overestimate the amount of water physically available at the diversion structures.

Measured USGS stream flow data and storage data in Gross Reservoir are utilized in the following analysis to estimate excess flows from the Fraser and Williams Fork basins that would be used to fill the expanded reservoir and to satisfy Denver's increased firm yield of 18,000 AF/YR. Basin excess flows that exceed the firm yield of 18,000 AF/YR would be placed into storage in the expanded reservoir for use in years when basin yields are below the target demand rate.

Depletion of Stream Flows in the Fraser River Basin Observed at USGS gages

Stream flow data at the USGS gage (09024000) "Fraser River at Winter Park" located downstream of the west portal of the Moffat Tunnel were used to evaluate depletion of native flows in the Fraser River caused by current DW Moffat diversions. This USGS gage has recorded flows from 1911 to the present. Years 1911 to 1935 represent the time period prior to Moffat diversions. Pre-Moffat flows were compared to years 1936 to 2013 representing the time period when water was diverted out of the Fraser Valley through the Moffat Tunnel (Post-Moffat). Average and median monthly pre- and post- flows are shown in Figure 2. The percent reduction in monthly average and median pre- to post-time periods is presented in Figure 3.

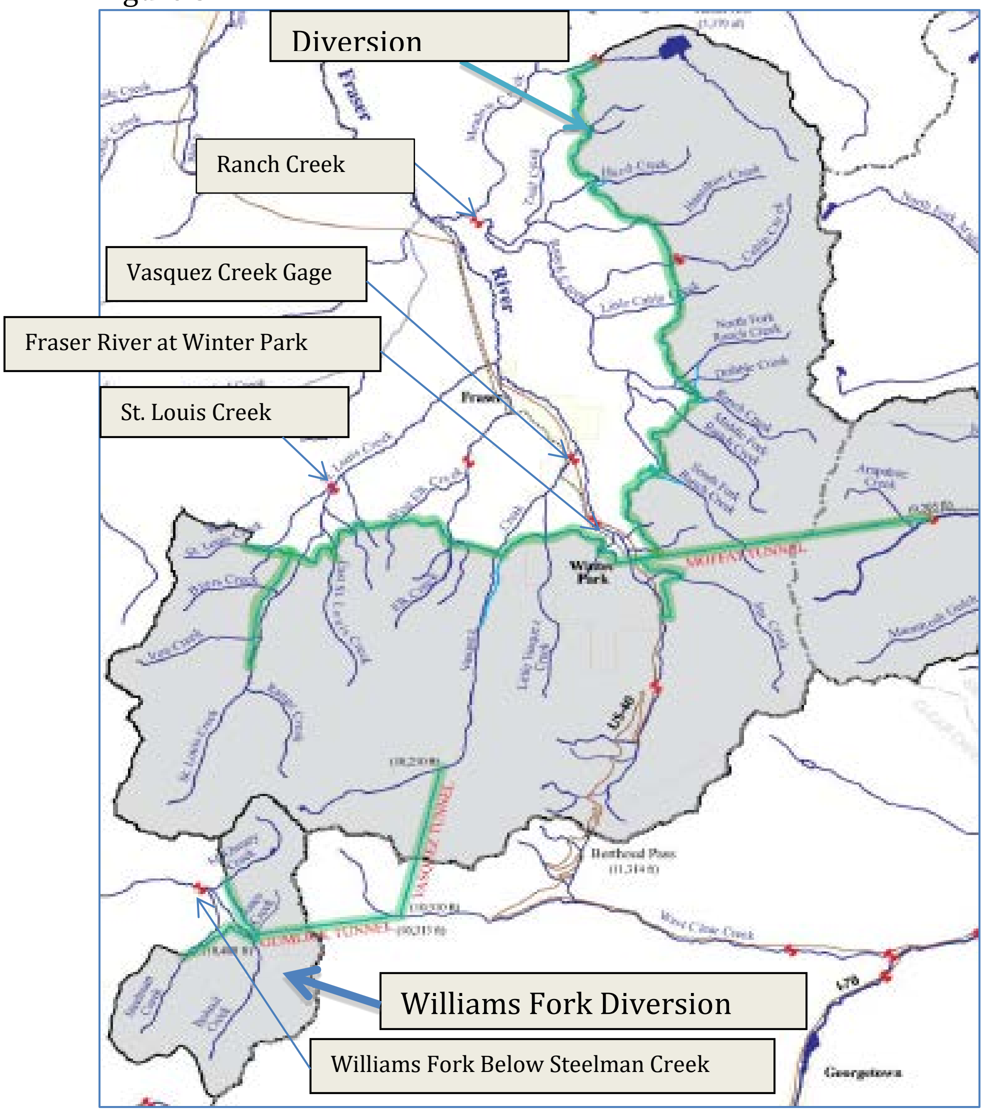


Figure 1 : Denver Water's Diversion System and USGS Gage Locations in the Fraser and Williams Fork River Basins
Source: Figure 1-1 FEIS

Figure 2: Average and Median Monthly Flows at USGS Gage 09024000; Fraser River at Winter Park; Comparison of Pre-and Post-Moffat Stream Flow

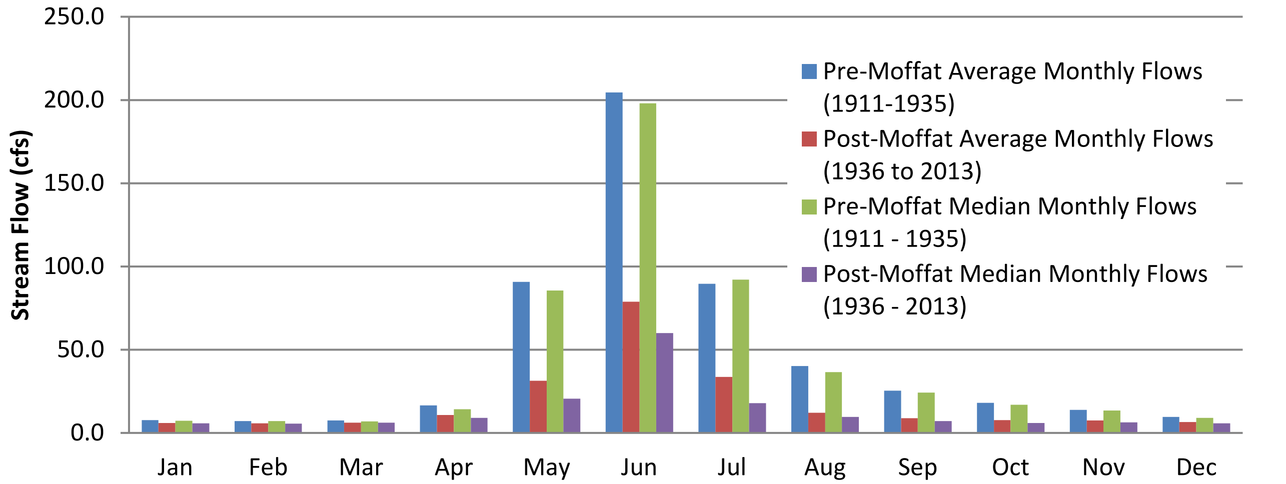
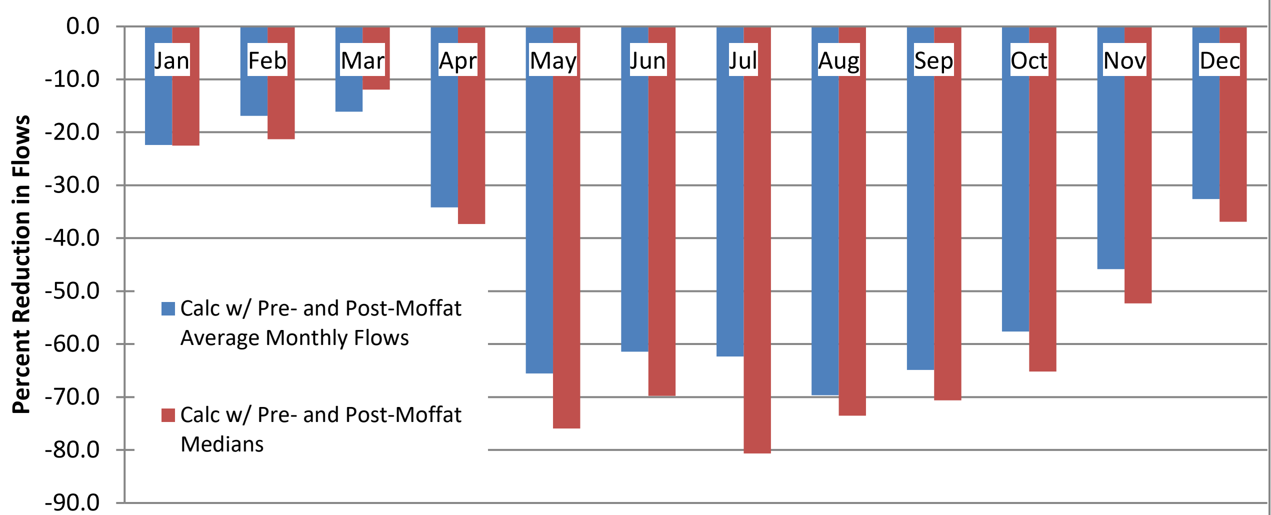


Figure 3: Percent Reduction of Pre- to Post-Moffat Flows at USGS Gage 09024000 "Fraser River at Winter Park"



Stream flow in the Fraser River at Winter Park is substantially depleted under current operating conditions and Gross Reservoir storage at 41,811 AF. Average stream flows have been reduced by between 60 and 70 percent in May through September. Median monthly stream flows, lower than average monthly flows, are reduced by 70 to 80 percent from pre- to post-Moffat diversion periods in May through September under the EXISTING Gross Reservoir configuration. This means that half the time flow depletion at the Fraser River at Winter Park gage could be greater than 70 to 80 percent in these months.

Given the substantial depletion of flow on the main stem of the Fraser River, it is unclear if there is sufficient water in the Fraser and Williams Fork basins to fill an additional 72,000 acre feet of an expanded Gross Reservoir or if there is an additional 18,000 AF of firm yield in the basin particularly since additional flows will be obtained primarily during the months of May, June, and July.

Estimate of Additional Firm Yield of Fraser and Williams Fork Basins

Additional Firm Yield from the Fraser and Williams Fork basins was estimated as follows:

1. Excess water at USGS gages in the irrigation seasons (May, June and July) of the 1966 to 2012 period was calculated by adjusting USGS stream flow data with estimated inflows between Denver Water diversion gates and gage locations. These months were selected for analysis because Denver's proposed additional diversions would occur in the high flow months (May through July) according to the FEIS.
2. Since storage capacity is utilized to meet firm yields in low water years; any supply that exceeded 18,000 AF each year was placed into storage in the 72,000 AF of additional storage volume of the expanded Gross Reservoir in this analysis. Water stored from earlier years was combined with water supply inflows in each year to achieve the 18,000 AFY firm yield in years when the yearly basin flow was less than 18,000 AF. In addition, it was assumed that the firm yield would be used in a flow through manner; thereby maximizing the amount of water available for storage in Gross Reservoir while allowing for use of 12,758 AF of storage in Ralston Reservoir.
3. Excess storage volume at the end of each irrigation season was added to the additional basin yield of the next irrigation season; this sum equal to the total amount of water in each historical year of record that would be available to meet the additional 18,000 AF of demand plus additional losses from evaporation (514 AF/YR). The incremental increase in conveyance losses was not included in this estimate though it would further decrease yields from the expanded Gross Reservoir.
4. The number of years when the 18,000 AF of firm yield could and could not be met was tallied; if the additional yield could not be met in some years the PN1 screening criteria of 100% of the years was not met.
5. Excess yield from this calculation corresponds to the difference noted between the modeled "current" to "proposed" scenarios of the FEIS. In the FEIS these excess flows are divided into the "Full Use" and the "proposed" scenarios where "Full Use" operates under the current configuration of Gross Reservoir at 41,800 AF of storage. Therefore, as stated in the FEIS, the incremental increase in diversions between the "Full Use" and the "proposed" scenarios would be used to fill the additional 72,000 AF of storage and provide the additional 18,000 AF of firm yield under the proposed alternative. The incremental increase of diversions noted in the FEIS from "current" to "full use" were thus subtracted from the excess basin flows and the firm yield evaluated as in number 4 above.

Yearly Excess Basin Flows

The amount of excess water available during the months of May, June, and July in the Fraser and Williams Fork Basins was estimated using USGS measured stream flow and reservoir storage data from 1966 to 2012. This period was chosen because:

- Stream flow data were available at all USGS gages in the Fraser and Williams Fork Basins that monitored stream flow below DW diversion structures (Downloaded from the Colorado Decision Support System (cdss) website).
- Gross reservoir storage data were available in all but three years of this period (1967, 1987, 1989) also available through the cdss website. These three years were omitted from the evaluation.
- This resulted in a 44-year period of record with sufficient measured data to estimate historical excess flows and evaluate if a firm yield of 18,000 AF/YR could be achieved with the enlarged Gross Reservoir.

This evaluation is based on two assumptions:

1. When the Current Gross Reservoir was NOT full (storage was below 41,000 AF), Denver Water diverted all available flow at their diversion structures drying up the stream just downstream of their gate; therefore, stream flow measured at the USGS gages when Gross Reservoir was NOT full reflects surface water and ground water inflow between the diversion points and the gages plus any flow obligations downstream of the collection system.
2. Excess flow would be available only in months of May, June, and July when Gross Reservoir was full; this is the when Denver's proposed additional diversions would occur according to the EIS.

Current Operations at Denver Water Diversion Structures

Currently Denver Water diverts water that is "*physically and legally available at each diversion point subject to minimum bypass flows and calls from downstream senior water rights*." "*Streams that do not have minimum bypass requirements (even those with downstream senior rights) are fully diverted at times during the year…*" "*This results in no stream flow for some distance below the diversions. This is how Denver Water has operated in the past and plans to operate in the future.*" (FEIS p. 3-35)

In dry years Denver Water diverts "*all available flows at each diversion point except for flows required*" to meet downstream obligations. In wet years Denver Water diverts "*100 percent of the water from streams that do not have minimum bypass flow requirements,*" therefore, these streams "*are fully diverted and dried up early in runoff season similar to dry years. Once Denver Water anticipates filling Gross and Ralston reservoirs and water demand is being met, Denver Water will begin to reduce diversions*" and allow water to flow past their diversion structures in the Fraser Valley until "*Gross Reservoir begins to be drawn down, typically in mid-summer,* when *Denver Water will again divert the maximum amount available to keep Gross Reservoir as full as possible." (FEIS p. 3-36).*

Historically then, except for downstream obligations, Denver Water often dries up flows downstream of their diversion points in the Fraser Valley, spilling water past diversion points only when Gross Reservoir is full. What volume of spilled water is available <u>at diversion points</u> in the Fraser Valley and Williams Fork watersheds and is this volume sufficient to provide the 18,000 AF of firm yield for an expanded Gross Reservoir?

Historical Storage Data for Gross Reservoir

Historical storage volumes in Gross Reservoir, read at the end or beginning of each month and sometimes mid-month, were evaluated to determine how often and when Gross Reservoir filled between 1966 and 2012. Months when storage in Gross Reservoir was greater than 41,000 AF are noted in Table 1. According to the FEIS, water used to fill the enlarged Gross Reservoir would be diverted primarily in the months of May, June, and July, therefore, these months were used in this evaluation. Note that the existing Gross Reservoir 941,800 AF) filled only once in May and did not fill in the irrigation season in 11 years of the 44 years of record.

Table 1: Months Gross Reservoir Filled; Storage Levels Above 41,000 AF

Water Year	May	June	July	Water Year	May	June	July
1966		Max 39,979 AF in Jul		1990		x	
1967		Missing storage data in irrigation season		1991		x	
1968		Max 39,419 AF in Aug		1992		x	
1969		x	x	1993			x
1970			x	1994		x	
1971		x		1995			x
1972			x	1996		x	
1973			x	1997		x	
1974		Max 40,800 AF in Jul		1998	x	x	
1975			x	1999		Filled in Sept and Oct	
1976		Max 27,096 AF in Jun		2000		x	
1977		Max 39,898 AF in Jun		2001		x	
1978		Max 40,062 AF in Jul		2002		Max 22,956 AF in Feb	
1979		x		2003		x	x
1980		x		2004		Max 40,381 AF in Oct	
1981		x		2005		x	
1982			x	2006		Max 40,859 AF Jun	
1983		x	x	2007		x	
1984		x	x	2008		x	
1985		x	x	2009		x	x
1986		x	x	2010		x	
1987		Missing storage data in irrigation season		2011		x	
1988		x		2012		Max Storage 38,350 in June	
1989		Missing storage data in irrigation season		2013		Storage Data not Entered	

Historical storage data from Gross Reservoir (Colorado Decision Support System - cdss)

Adjusted Stream Flows

Monthly stream flow measurements in May, June, and July in years 1966 to 2013 were used to estimate excess flows at the following USGS gages shown in Figure 1:

- Fraser River at Winter Park (09024000),
- Vasquez Creek near Winter Park (0902500),
- St. Louis Creek near Fraser (09026500),
- Ranch Creek near Fraser (09032000), and
- Williams Fork below Steelman Creek (09035500).

It is assumed that excess flows would only be available for additional storage at times when the existing Gross Reservoir was full. Therefore, when Gross Reservoir was NOT full there would be no additional water available in that month at that location.

The median of monthly flows for months when Gross Reservoir was NOT full during the time period 1966 to 2012 was assumed to represent the inflow between diversion structures and USGS gages; or "native downstream inflow" plus downstream water obligations. This median flow (shown in Table 2) was subtracted from monthly flows measured at the USGS gages in months when Gross Reservoir filled to estimate the adjusted excess stream flow. Adjusted flows that were negative, where total flows were less than the median adjustment factor, were changed to zero for this calculation.

Table 2
Median Monthly Flows (1966 to 2012) For Months When Gross Reservoir Did NOT Fill
Used to Adjust Monthly Stream Flows in Months When Goss DID Fill

USGS Gage	Elevation Feet	May AF/Mth (cfs)	June AF/Mth (cfs)	July AF/Mth (cfs)
Vasquez Creek near Winter Park (09025000)	8911	1051 (17.1)	878 (14.8)	760 (12.4)
St. Louis Creek near Fraser (09026500)	8773	1507 (24.5)	2705 (45.5)	1904 (31.0)
Fraser River @ Winter Park (09024000)	8985	1257 (20.5)	1928 (32.4)	1471 (23.9)
Ranch Creek near Fraser (09032000)	8665	1139 (18.5)	1236 (20.8)	382 (6.2)
Williams Fork Below Steelman (09035500)	9806	1181 (19.2)	5776 (97.1)	2362 (38.4)

Inflow between DWs diversion structures and the USGS gages originate from:

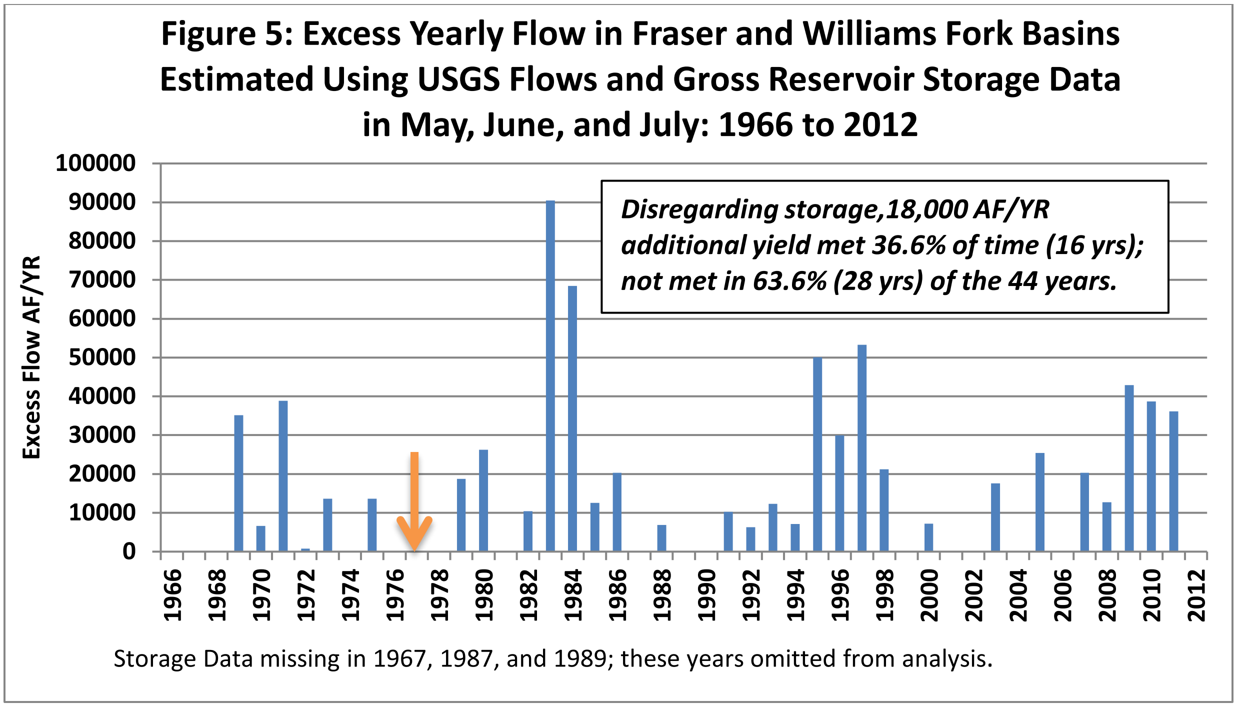
- Mary Jane Creek up to 11,000 feet elevation on the Fraser River;
- Lower elevation areas, up to 9,500 feet, on Vasquez Creek,
- Deadhorse and Spruce Creeks up to 11,584 feet at Bottle Peak on St. Louis Creek,
- Lower elevation areas, up to approximately 9,500 feet, on Ranch Creek, Hurd Creek, Hamilton Creek, Trail Creek, Cabin Creek, Little Cabin Creek, and Dribble Creek.

- Alpine areas up to 12,348 feet including St. Louis Peak (12246 feet) in the Williams Fork Basin. High inflows in June and July are consistent with drainage from high alpine areas, however, operations at the Williams Fork basin diversion structures that optimized filling Williams Fork Reservoir once Gross Reservoir was nearly full also added to flows recorded at the Williams Fork below Steelman Creek USGS gage during this time period (see Williams Fork section).

Minimum bypass requirements (FEIS Table 3.1-8) of 10 cfs on the Fraser River, 8 cfs on Vasquez Creek, 10 cfs for St. Louis Creek, and 4 cfs for Ranch Creek between May 15 and September 15 are reflected in excess flow values above. Bypass flows were incorporated into Right of Way agreements between Denver Water and the US Forest Service in 1970. As part of the Clinton Reservoir Agreement of 1992 Denver Water reserved the right to reduce bypass flows if mandatory restrictions to in-house domestic water use were imposed on its customers (FEIS 3-28). Table 3.1-9 of the FEIS notes that bypass flows were reduced in 1975, 1977, 1980 and consistently in September 2001 through July 2004, the end of the FEIS historical period of record (1975 to 2004). The median inflow value noted in Table 2 above (1966 to 2012 period of record) likely reflects times when bypass flows were both honored and reduced.
In addition, calls by higher priority water rights holders on the Fraser River likely increased flows past Denver Water diversions during the 1966 to 2013 period of record. Senior water rights holders include but are not limited to Beaver Dam Ditch, Deberard Ditch and Reservoir, Earl Ditch, Joy Ditch, Hammond Ditch, Ostrander Ditch, Peterson Ditch, Scybert Ditch, and Winter Park West Wells. For purposes of this evaluation, it was assumed that calls coming from the Fraser River were reflected in the historical flow records at the USGS gages and were not available for diversion by Denver Water.

Excess Basin Flows

Adjusted monthly stream flows in May, June, and July were summed to estimate the yearly total excess basin flow that would be available to fill the expanded Gross Reservoir storage of 72,000 AF. Estimated yearly excess flows are shown in Figure 5.



Average and median excess flows at each USGS gage location are shown in Table 3. Average estimated excess flows compare favorably to average tunnel diversion increases from "current" to "proposed" conditions modeled in the FEIS using the PACSM model (Table 4). In fact, the average of the estimated excess flows in both the Fraser and Williams Fork basins combined actually exceeds the modeled increase in Moffat flows by approximately 2,600 AF/YR on average and so represents a "best case" estimate of the ability of the proposed project to meet the firm yield requirement of 18,000 AFY. Average excess flows calculated for the Fraser Basin alone compare closely to the modeled increase in the Moffat Tunnel diversions.

It is valid to compare excess flow derived here with the modeled "current to proposed" scenario's diversion increases because full use system changes occur after 2006 (of the 1966 to 2012 period of calculation). The Full Use scenario included, among others, upgrades to the distribution system from the Foothills and Marston treatment plants, changes to Big Lake Ditch Denver water rights such that additional water could be stored in Williams Fork Reservoir (as of 2013), and an increase in demand of 60,000 AF/YR (as of 2006 per the EIS). It is not clear if water demand remained at the 2006 level through 2013. Full use did not include any additional storage in Denver's northern water system, including Gross Reservoir.

Table 3
Average and Median Excess Flows at USGS Gage Locations Available to Fill 72,000 AF of the Expanded Gross Reservoir and Provide Denver Water's 18,000 AF/YR Additional Yield

USGS Gage Location	Average of Estimated Excess Flows	Median of Estimated Excess Flows	Maximum of Estimated

	(AF/YR)	(AF/YR)	Excess Flows (AF/YR)
Williams Fork (WF) Below Steelman	2,682	2,150	11,314
Ranch Creek near Fraser	2,891	1,636	17,797
Fraser River @Winter Park	3,323	971	20,837
St. Louis Creek near Fraser	3,546	2,430	18,693
Vasquez Creek near Winter Park	3,115	1,183	21,942
Total Flow Fraser (excluding WF)	12,875	6,220	NA
Total Flow Fraser & Williams Fk. Basin	15,557	8370	NA

Period of Record = 1966 to 2012 not including 1967, 1987, and 1989. Maximum excess flows occurred in 1983 at all locations except the Williams Fork basin where maximum flows occurred in 1984.

Table 4
Average Modeled Increases of Tunnel Diversions noted in DEIS (Table H-7.1)

Gumlick Tunnel comparable to estimated excess flows in Williams Fork Basin	
"Current to Full Use"	887 AF/YR
"Full Use to Proposed"	1,904 AF/YR
"Current to Proposed"	2,795 AF/YR
Moffat Tunnel compares to sum of estimated excess flows in Fraser & Williams Fork Basins	
"Current to Full Use"	2,713 AF/YR
"Full Use to Proposed"	10,284 AF/YR
"Current to Proposed"	12,998 AF/YR

Williams Fork Diversions

Water rights belonging to Denver Water in the Williams Fork Basin, including those that are currently used for trans-mountain diversions on McQuery Creek, Jones Creek, Bobtail Creek and Steelman Creek (See Figure 1), are noted in Table 3.1-12 of the FEIS. Other rights in this basin include conditional flow rights from Middle Fork and South Fork of the Williams Fork River, Allen Creek, and Darling Creek that have not been developed as well as a storage right for the Williams Fork Reservoir for 96,637 AF. *"Denver Water's headwater diversions are protected by Williams Fork Reservoir such that when the Denver Water rights are out of priority with respect to senior diverters below Williams Fork Reservoir, the reservoir releases water to satisfy the senior diverters…. Williams Fork Reservoir is operated in part to exchange water to replace out of priority diversions at Denver Water's Moffat Collection System, Roberts Tunnel, and Dillon Reservoir" (FEIS pg.* 3-42).

As stated in the FEIS (pg. 3-42), *"Denver Water often diverts 90% to 100% of the average monthly native flow from McQueary, Jones, Bobtail, and Steelman creeks from October through April… During the summer from May through September, the average monthly percentage of* *native flow diverted by Denver Water varies more and ranges from 24% to 94% under Current Conditions. During those months, Denver Water diverts the greatest percentage of native flow in April, May, August and September when flows are typically lower. In June and July, Denver Water diverts a much lower percentage of the native flow at these locations (24% to 43% on average) because flows are typically much higher during runoff."*

According to the Upper Colorado River Basin Information report prepared as part of the Basin Round Table efforts for the Upper Colorado Basin (CWCB website 1/1/2007), the "*primary operational objective [for Williams fork diversions] is to fill Gross Reservoir. Once filled, the general practice is to cease diversions at the collection system in favor of storage in the Williams Fork Reservoir*." Denver now owns the water rights for the Big Lake Ditch which historically diverted just upstream of the Williams Fork Reservoir to Reeder Creek. As of 2013, this water, approximately 10,000 AF/YR, will be used for storage in Williams Fork Reservoir. In addition, under the 10,825 agreement, Denver no longer is required to release 5,412 AF to meet USFWS flow recommendations in the 15-Mile Reach in Grand Junction. Therefore, approximately 15,400 AF/YR of additional water is now available to Denver Water for storage in the Williams Fork Reservoir providing more flexibility for additional diversions through the Gumlick Tunnel from the upper Williams Fork basin. It is unclear how their operations have changed since 2013.

The assumption in this evaluation, that diversion head gates remain open when Gross Reservoir was not full, is not valid during June and July for the upper Williams Fork Basin. However, calculated excess basin flows for the Williams Fork diversion points (2,682 AF/YR average) very closely match the modeled increase between the "Current" and "proposed" PACSM model scenarios (2,795 AF/YR average). Therefore, calculated excess flows from the upper Williams Fork basin were retained in this firm yield analysis.

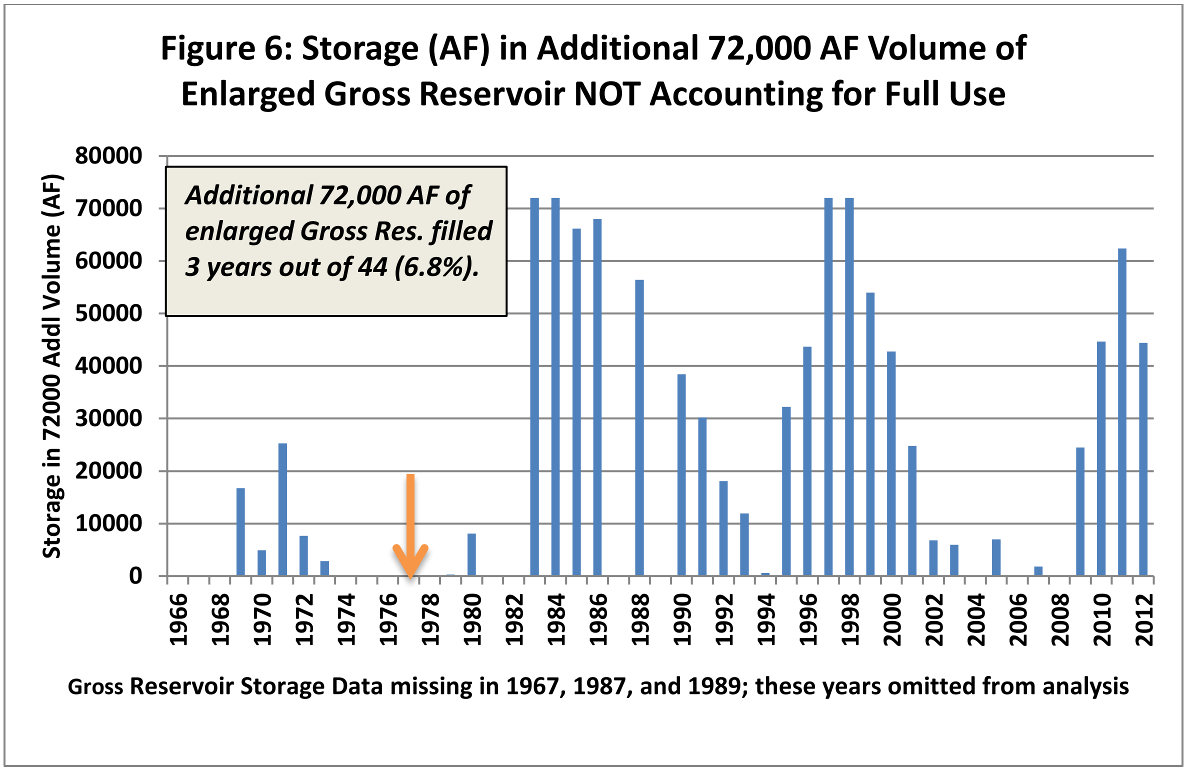
Average (Median) flows at the Williams Fork Below Steelman USGS gage in June and July over the 1966 to 2013 period of record are 6,862 (7926) and 3,448 (2875) AF/mth, respectively. Arbitrarily assuming that "native" inflows entering below the diversion structures but upstream of the USGS gage are 1000 AF (16.8 cfs) and 500 AF (8.4 cfs) in June and July, respectively; additional water available from the upper Williams Fork, on average, would be 5,862 and 2,375 AF/mth or 8,200 AF in these two months alone. This additional water from the Williams Fork Basin plus the 2,600 AF overestimate of calculated excess basin flows (compared with modeled numbers) is more than sufficient to supply the observed average 7,300 AF/Y discrepancy between measured and modeled Moffat Tunnel diversions under the "current" conditions scenario (See: Discrepancy Between Measured and Modeled Current Diversions section below).

Firm Yield of Excess Flows Diverted from Moffat and Williams Fork Basins NOT Accounting for Full Use Diversions: Current Use Baseline

In Alternative 1A Gross Reservoir needs to produce an additional firm yield of 18,000 AF/YR to meet Denver's future water demands. "Firm" yield takes into account storage of extra water (above the required yield of 18,000 AF/YR) that can be stored in the reservoir, in this case in the upper 72,000 AF of the expanded Gross Reservoir, and used in years when 18,000 AF of excess water is not available in the basin or 64 percent of the years between 1966 and 2012 (See Figure 5). "Firm yield" of excess basin water was calculated as follows:

- End storage for each irrigation season was calculated as end storage from the previous year's irrigation season plus additional excess basin water provided in the current irrigation season minus 18,000 AF, the required firm yield for the system. An additional 514 AF was subtracted from the yearly total to account for the incremental increase in evaporation in the expanded Gross Reservoir compared to the "Full Use" configuration (as discussed on page 5-15 of the FEIS). Incremental conveyance losses were not accounted for in this calculation.
- If storage for a given year was negative (i.e. there was not enough water to provide the 18,000 AF/YR yield) ending storage for that year was set at zero; assuming that water would not be taken from the current 41,811 AF in Gross Reservoir to meet the demand.
- If storage for a given year was over 72,000 AF it was set to 72,000 AF assuming that the current 41,811 AF or the existing reservoir would also be filled in these years.
- The previous year storage for the first year (1966), in the 72,000 AF portion of the total 113,800 AF expanded storage volume, was assumed to be zero as construction of Gross dam would have just been completed.

Estimated storage in the 72,000 AF of the expanded Gross Reservoir for 44 years between 1966 and 2012 (omitting 1967, 1987, and 1989) is shown in Figure 6. Storage levels and the ability to meet the firm yield requirement of 18,000 AF/YR in the expanded reservoir depend on hydrologic conditions in the first few years of filling, periods of drought (mid-1970s and mid 2000s), and periods of high flow (mid 1980s, late 1990s, and 2011). Based on this estimate of firm yield of the Fraser and Williams Fork Basins the expanded gross reservoir would fill in only 3 years and the 72000 AF of extra storage would be depleted or zero in 12 years (assuming all available yield under 18,000 AF would be used).



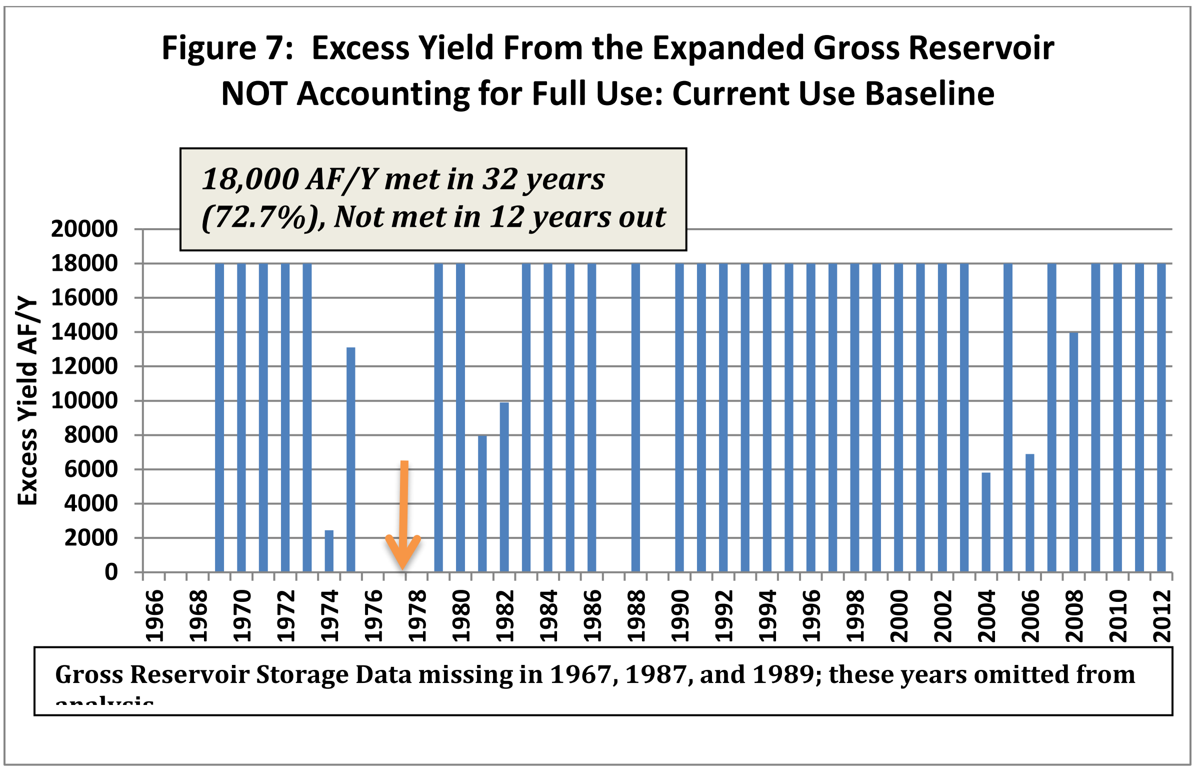
Year 1983 was notable. High snow pack and spring rains produced major flooding on the Colorado River. June and July issues of High Country News were awash in news of the flood: *"A record 120,000 cfs was flowing into Lake Powell from late spring snow and rain in the Rocky Mountains that no one had anticipated. On July 2, the lake - considered full at 3700' - was just 3.5 feet from its maximum capacity of 3711' and rising three inches a day."*

"The July 8 issue reported that the dam's spillway began breaking up when officials upped the release to 92,000 cfs. The high velocity water was carving out huge holes in one of the tunnels, a process known as cavitation that sent chunks of concrete and red silt from the eroding Navajo sandstone bedrock shooting into the clear river below the dam.

The expanded Gross Reservoir almost filled for the first time in 1983 in this calculation. Previous year (1982) excess storage was estimated at 0 AF with an additional 89,919 AF available from 1983 runoff: however, after filling an additional volume to 71,919 AF and subtracting 18,000 AF of firm yield, no additional water would have passed DWs diversion gates in 1983. Not only is this an indication of the substantial size of the new reservoir but also that filling it will depend on very high flow years, the frequency of which may decrease due to climate change. In this initial analysis, the expanded Gross Reservoir was estimated to fill in three years, 1984, 1997, and 1998. Extra water that could not be stored in the expanded reservoir amounted to 49,880, 5,812, and 2,723 AF in these years respectively. In all other years barring calls on the river and bypass flow requirements, diversion gates in the Fraser valley could remain open throughout the irrigation season, dewatering streams just downstream of the diversion gates, and there would be sufficient storage in the expanded reservoir to accommodate all of the flows.

Firm yield of 18,000 AF/Y was not met in 12 years out of the 44-year period of analysis or 27.3 percent of the time (Figure 7). In particular, an extended dry period occurred in the mid-1970s. Even though 18,000 AF/Y of excess yield could be achieved in 1969 through 1973, only in 1971 was storage sufficient to provide an additional yield of this amount. A prolonged period of dry years in the 1970s, perhaps a second critical period after the 1950s drought, resulted in low to no excess yield from 1974 to 1978. In drought years 2002 and 2012, there was sufficient storage in the expanded Gross Reservoir to achieve the desired excess yield of 18,000 AF/Y, however, following high flow years of the late 1990s, storage was depleted such that in two years of the mid-2000s excess yield was below 8,000 AF/Y.

Even with extra diversions; the calculated overestimate of 2,600 AF/Y and the additional average amount water of 2,713 AF/Y that was not allocated to the proposed project ("current" to "full use" model scenarios), the firm yield of 18,000 AF/Y was NOT met in 100% of the test period years and so did not meet the PN1 screening criteria.



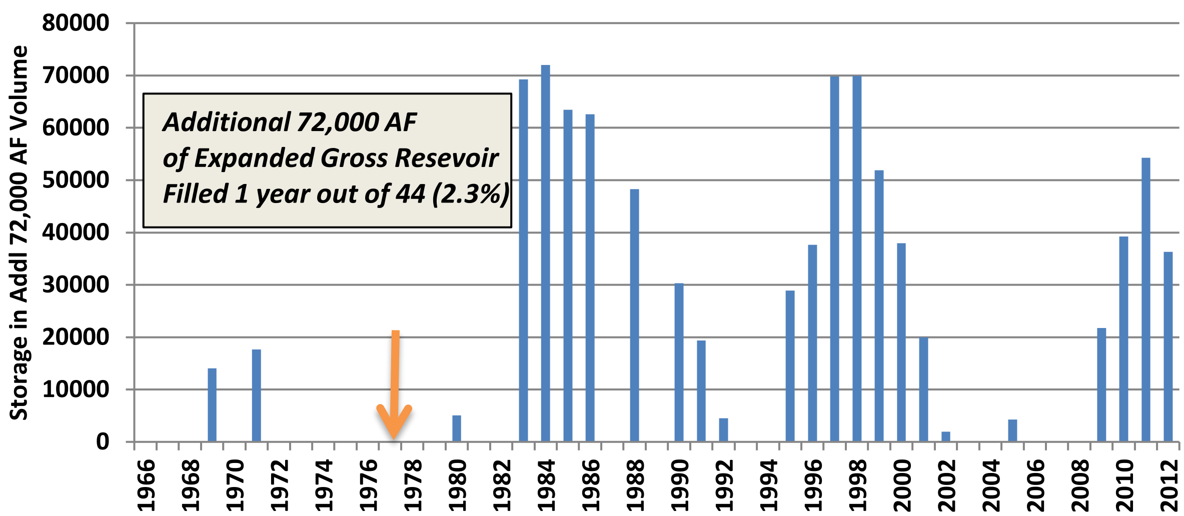
Firm Yield of Excess Flows Accounting for Full Use Diversions: Full Use Baseline

Because the FEIS states that any water diverted from the basin above and beyond that for the Full Use Scenario would be used to fill the expanded Gross Reservoir and contribute to the firm yield of 18,000 AF/YR, the average annual increase in Moffat Tunnel diversions from "current" to "Full Use" scenarios (FEIS Table H-7.1) of 2,713 AF/YR for an average year was subtracted from the adjusted flows and the calculation completed as described above. Storage in the additional 72,000 AF volume of the expanded Gross Reservoir is shown in Figure 8.

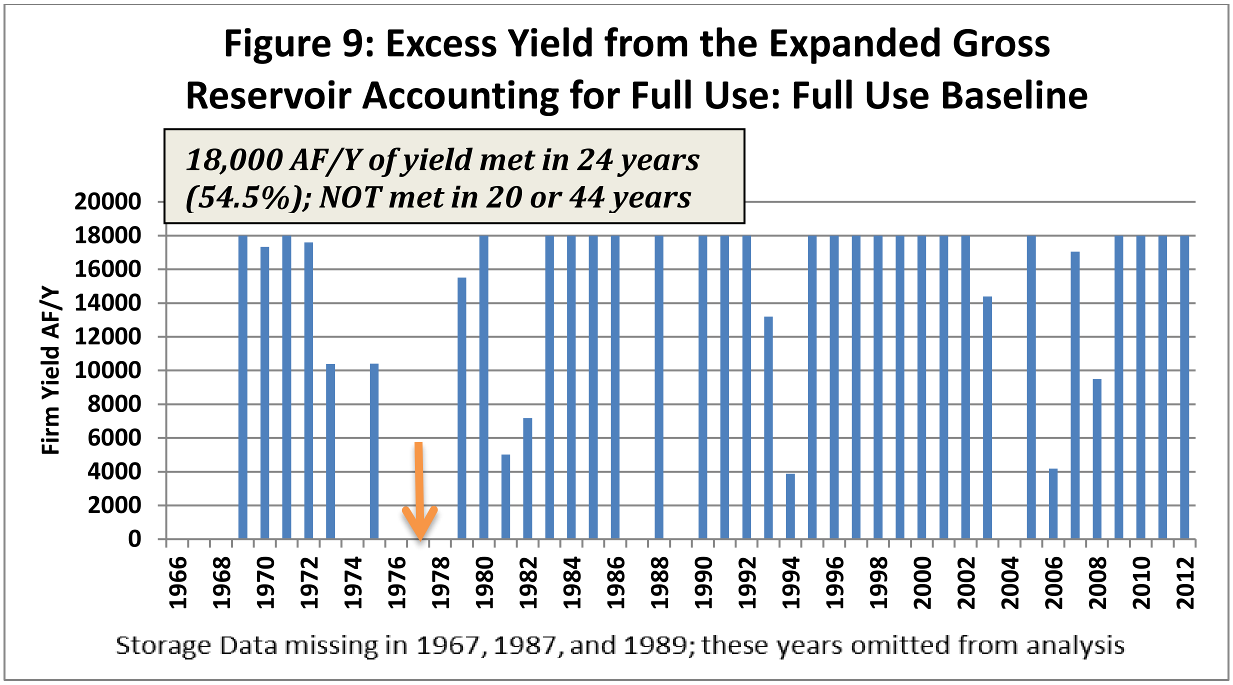
Based on this estimate of firm yield of the Fraser and Williams Fork Basins, accounting for Full Use diversions noted in the FEIS, the expanded gross reservoir would fill in only 1 year (1984) with 44,454 AF of extra water that could not be stored in the expanded reservoir. The 72000 AF of extra storage in the expanded reservoir would be depleted or zero in 20 years (assuming all available yield under 18,000 AF would be used).

In particular, from 1972 through the end of the 1970s, excess storage in the expanded Gross Reservoir was zero with excess yield also low to zero during this time period (Figure 9). As before, 18,000 AF of additional yield was achieved in 2002 because of high flow years in the late 1990s. However, excess storage in the expanded Gross Reservoir was depleted by 2002 and very low or zero from 2002 to 2008. Perhaps the 1970s and mid-2000s should be included as other critical time periods by which to judge the feasibility of the proposed project.

Figure 8: Storage (AF) in Additional 72,000 AF Volume of Expanded Gross Reservoir Accounting for Full Use Diversions: Full Use Baseline



1. Gross Reservoir Storage Data missing in 1967, 1987, and 1989; these years omitted from the analysis.
2. Average annual increase in Moffat diversions under Full Use of 2,713 AF subtracted from the adjusted excess basin flows in each year from 1966 to 2012.



Even with additional excess basin flows of 2,682 AF/Y overestimated in this calculation, the required yield of 18,000 AF/YR would be met in 24 years (54.5%) and not met in 20 years (45.5%) of this 44 year period of record. The percentage of years where the firm yield of 18,000 AF/YR was met was much less than 100% and so did not meet the PN1 FEIS screening criteria.

Climate Change Considerations

Climate change is predicted to decrease surface water supply in the south western United States by approximately 10 percent (Averyt, 2013). Water stress, estimated using the water supply stress index (WaSSI), the ratio of water demand to water supply, is predicted to increase due to climate change from between 0.4 and 4.0 percent (representing the range in stress index from different basins) to between 0.1 and 20 percent in western slope Colorado basins (Averyt, 2013). Note a WaSSI index of greater than one means water supply is less than water demand. Climate change is expected to substantially impact water supplies in western Colorado.

Truncated excess basin flows that account for "full use" model diversions were reduced by 10 percent in years when excess flows were available in the Fraser and Williams Fork basins (i.e. when the existing Gross Reservoir filled) and the firm yield of 18,000 AFY evaluated as before. Because flows in 1983 and 1984 were very high, the expanded Gross Reservoir filled in 1984 with 29,209 AF spilled below the diversion structures. The firm yield of 18,000 AFY was NOT met in one additional year (21 years) or 47.7 percent of the 44-year period of evaluation.

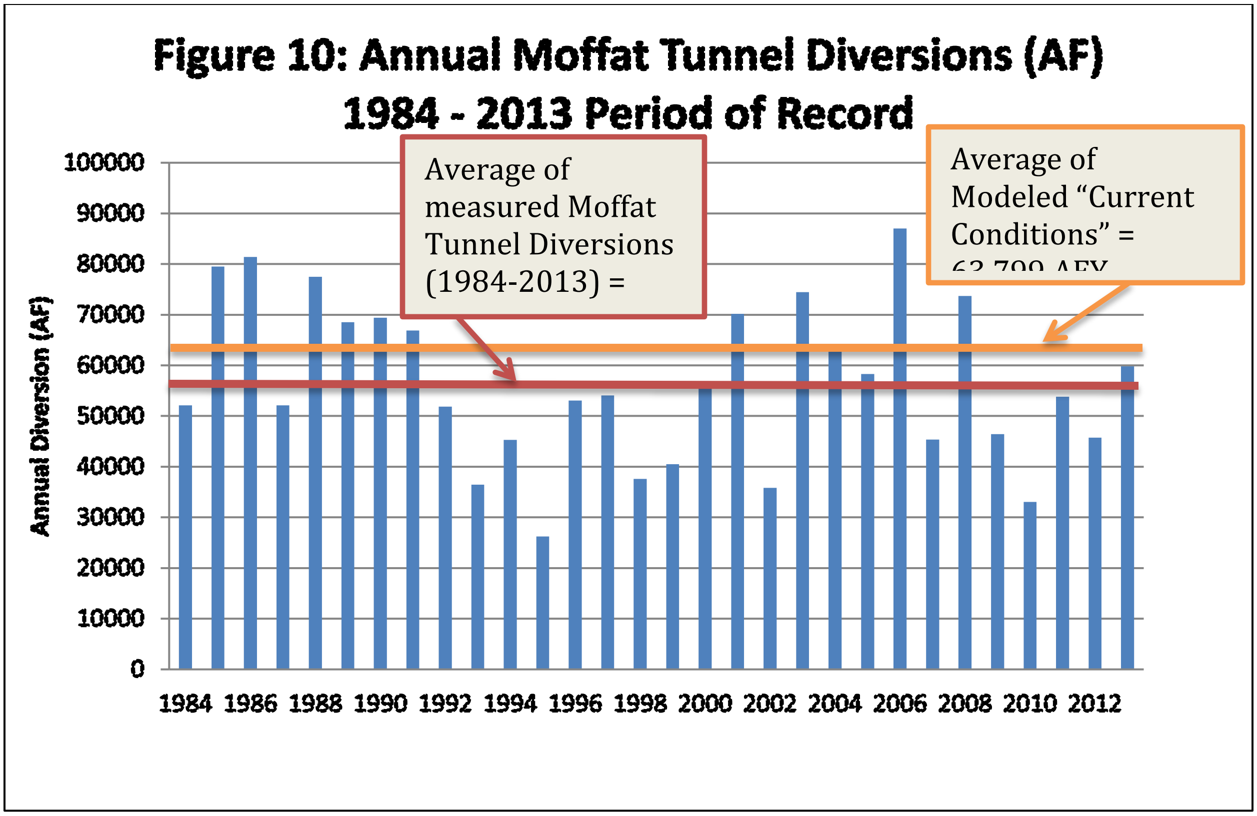
Firm yields are controlled by high flow years of 1983, 1984, 1997, and 1998. As before, no additional yield was available from 1976 through 1978. Of course, the past record cannot predict the timing, volume, and sequence of future water supply years though it is anticipated that, due to climate change, droughts may become more severe than the historical record.

<u>Basin Impacts are Hidden in Incremental Model Scenarios</u>

Additional diversions through the Moffat Tunnel are presented incrementally in the FEIS. First, 7,300 AFY above measured average diversions are diverted as part of the "current condition" modeling. Second, the "full use" model scenario utilizes an additional 2,713 AFY on average. Third, the proposed project utilizes an average of 10,280 AFY more water from the Fraser and Williams Fork basins. Only the third incremental increase is considered project water in the FEIS. Therefore, impacts to river flows are limited to only this last increase in diversions in the EIS analysis. "Current condition" model results are considered one of the baselines of the FEIS and so the first 7,300 AFY is not presented nor addressed in the FEIS document.

Discrepancy Between Measured and Modeled Current Diversions

Diversions through the Moffat and Gumlick (or Williams Fork Tunnel) Tunnels are monitored and data reported in the Colorado Decision Support System database. Average measured tunnel diversions from 1984 to 2013 are 56,532 AFY (Figure 10). Average modeled Moffat Tunnel diversions reported on Table H-7.1 are 63,799 AFY; 7,267 AFY more than the measured average. Measured Gumlick Tunnel diversions average 4,954 AFY from 1984 to 2012 and compare to modeled current conditions average diversions of 8,853 AFY. Modeled diversions from the Williams Fork Basin exceed measured averages by 3,900 AFY. Therefore, of the 7,300 AFY discrepancy noted for the Moffat Tunnel diversions, 3,400 AFY on average are supplied by water from the Fraser Valley in the PACSM model.



Tunnel Diversions in 2006, used to delineate “current conditions” in the PACSM modeling, exceeded every other year in the 1985 to 2013 period of record by at least 5,600 AFY. Year 2006 did not represent a new plateau in Denver Water’s water supply needs as diversions after 2006 were substantially lower, averaging 55,619 AFY and approximately 900 AF less than the 1984 to 2013 30-year average. Use of the 2006 baseline condition inflates withdrawals and reduces basin flows under the “current conditions” model scenario compared to actual measured stream and diversion flows in the Fraser and Williams Fork River Basins.

Discrepancies between modeled current flow and measured flows are seen at the Fraser River at Winter Park and the Williams Fork Below Steelman USGS gages (Table 5) but not at the Vasquez Creek and St. Louis USGS gages. It is unclear why the average annual flow discrepancies (8,961 AF) do not add up to that observed for the Moffat Tunnel diversions (7,300 AF) but may, in part, be due to conveyance losses in the Moffat collection system and Tunnel.

Table 5
Comparison of Average Post-Moffat Measured Flows with Modeled "Current Condition" Flows

Location	Average of USGS Post-Moffat Flows	Average Modeled "Current Condition" Flows[1]	Volume of Discrepancy Between Flows (AF)
Fraser River at Winter Park Gage (1936 – 2013)[2]			
Average Annual Flow (AF/YR)	13,020	8529	4,491
April Average Flow (cfs)	11	4	408
May Average Flow (cfs)	31	17	876
June Average Flow (cfs)	79	59	1,185
July Average Flow (cfs)	34	21	781
Total Summer months Fraser River at Winter Park			3,250[3]
Williams Fork Below Steelman Creek Gage (1966 – 2013)			
Average Annual Flow (AF/YR)	14,074	9,600	4,470
May Monthly Flow (cfs)	28	10	1,135
June Average Flow (cfs)	115	88	1,626
July Average Flow (cfs)	56	50	374
August Average Flow (cfs)	10	5	316
Total Summer Months Williams Fork Below Steelman			3,451[3]
Total Discrepancy at Fraser and Williams Fork Basin Gages: Measured vs Modeled			
Discrepancy Between Average Annual Flow (AF)			8,961
Summer Months Discrepancy (AF)			6,700

[1]Current Condition Flows from Tables H-7.1, H-1.33, and H-1.55.
[2]Averages for the post-Moffat period of record at each gage.
[3]Additional 1,209 AF discrepancy summed from August through April at Fraser River at Winter Park Gage and 971 AF summed from September through April at Williams Fork Below Steelman Gage.

Comparison of Calculated Excess Basin Flows with Modeled Diversions

The sum of the three incremental diversions from the FEIS, discussed above, matches calculated excess basin flows that are required to attain a firm yield of 18,000 AFY in the expanded Gross Reservoir at a frequency of 77% of the test period years (Table 6). These equal the sum of all additional diversions between the historical post-diversion baseline and the proposed project. To achieve the firm yield in 100 % of test period years will require even more additional diversions out of the Williams Fork basin from the planned expansion of the Williams Fork collection system to Darling Creek.

Table 6: Comparison of Calculated Excess Basin Flows with Modeled Diversions

Description of Calculated Excess Flow	Calculated Excess Flows (AFY)	Modeled Diversions (AFY)	Description of Modeled Incremental Diversions
Total Calculated Excess Basin Flows;	15,557	7,300	Average discrepancy between measured diversions and current conditions model
Additional Flow Required to Meet 18,000 AFY Firm Yield in Expanded Gross at a sufficient frequency.	4,000	2,713	Current to Full Use Model Scenarios
	---	10,284	Full Use to Proposed Model Scenarios
Totals	19,557	20,297	

Note: Calculated Excess flows do not include incremental conveyance losses within the Moffat Collection System.

Impacts to basin stream flow discussions in the FEIS should reflect all diversion increases that are required to operate the expanded Gross Reservoir at a firm yield of 18,000 AFY. Limiting responsibility of basin impacts to a small incremental increase in diversions in the FEIS significantly under-represents those impacts.

References

Averyt, K, J Meldrum, P Caldwell, G Sun, S McNulty, A Huber-Lee and N Madden (2013), **Sectoral contributions to surface water stress in the coterminous United States.** *Environ. Res. Lett. 8* (3), issn: 1748-9326, ids: 229FL, doi: 10.1088/1748-9326/8/3/035046, Published JUL-SEP 2013.

Colorado Decision Support Information (CDSS), 2007. Upper Colorado River Basin Information, January 2007. http://cwcbweblink.state.co.us/weblink/0/doc/125202/Page1.aspx?searchid=613f0ec8-2c8d-4d1f-a8c7-45025da55104

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APPENDIX E

Re-Evaluation of Western Slope Hydrologic Impacts of The Moffat Collection System/Gross Reservoir Expansion Project

October 23, 2015
Submitted via electronic mail

To: Rena Brand, Moffat EIS Project Manager
US Army Corps of Engineers, Omaha District
Denver Regulatory Office
9307 South Wadsworth Boulevard
Littleton, CO 80128
RE: Moffat Collection System/Gross Reservoir Expansion Project- Final Environmental Impact Statement

Dear Ms. Brand,

The following white paper, submitted on behalf of TEG (The Environmental Group), evaluates technical aspects of the FEIS that pertain to both the USACE's 404 permit and the State of Colorado's 401 certification for the Moffat Collection System/Gross Reservoir Expansion Project proposed by Denver Water. Comments on the direct, indirect, and cumulative impacts for the 404 permit are presented in Sections 3, 4, and 5 below, and comments on the State 401 certification application are provided in Section 6. The 404 comments also pertain directly to the 401 certification application. Section 7 evaluates proposed mitigation actions for both permit reviews. Specifically, this white paper discusses:

- An independent firm yield analysis which provides evidence that the stated project purpose, to attain 18,000 AFY of firm yield for Denver Water's northern water supply system, can be achieved in only 54% of the test period years using the additional diversions allocated for the proposed project; <u>the proposed project should have been eliminated from consideration under the screening criteria that were applied by USACE</u>. Further, use of all available stream flows above the historical post-diversion average, or twice the diversions allocated to the proposed project, would only achieve the firm yield in approximately 75% of the test period years. To attain the firm yield in <u>100</u> % of test period years would require additional diversions from the planned expansion of the Williams Fork collection system to Darling Creek. Impacts of these required additional diversions have not been included in the FEIS impact analysis.
- The determination of the inappropriateness of the Current Conditions baseline,

which was arbitrarily derived using the PACSM model and is inflated by higher than measured average water demand and Moffat Tunnel diversions resulting in lower modeled stream flows than those measured at USGS streamflow gages on the mainstem of the Fraser and Williams Fork Rivers. This inaccurate baseline is used to unreasonably constrain the cumulative impacts analysis in the FEIS. NEPA regulations indicate that existing conditions, the historical post-diversion baseline, should be used to evaluate basin impacts of the project.

- A re-evaluation of basin impacts using the historical baseline and medians of USGS measured streamflow reveals that the FEIS substantially understates cumulative and project related stream flow depletion, percent of dry years, reduction in streamflow percentiles, and reduction in average peak flows in the Fraser, Williams Fork, and Upper Colorado Rivers.
- Based on my analysis, data collected under existing hydrologic conditions do not represent the modeled Current Conditions baseline. This affects loading calculations and estimates of future water quality concentrations, stream temperatures and health of aquatic eco-systems presented in the State 401 application and the FEIS.
- A determination that the mitigation plans – which fail to follow EPA and CEQ guidance and NEPA regulations on mitigation - and enhancement plans primarily provide money to the impacted upper basins but do not provide details on how mitigation and enhancement will assure that the State use classifications, in the Fraser, Williams Fork, and the Upper Colorado River basins will be protected.

The USACE needs to take this analysis and these findings into consideration. Before making decisions on additional diversions and depletions, it needs to address and resolve the material issues raised in these and other comments. Project review must be contingent on accurate data, baselines, and projections to allow informed public comment and provide for an informed decision based on good science that complies with applicable legal standards. Current information in the FEIS does not provide sufficient justification for approval of the proposed Moffat Project.

Appendices attached to this report provide electronic copies of documents used in this analysis. Appendix F contains my resume to document my technical background. An additional e-mail provides data, spreadsheets, and calculations that have changed since the original TEG document was submitted in June 2014.
Sincerely,

Lisa Buchanan,
MS Civil Architectural and Environmental Engineering
BA Environmental Population Organismic Biology

Chris Garre,
The Environmental Group

Re-Evaluation of Western Slope Hydrologic Impacts of the Moffat Collection System/Gross Reservoir Expansion Project

Comments on the Final Environmental Impact Statement

October 23, 2015

Lisa R Buchanan; Scientist/Engineer

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Executive Summary

The primary purpose of the Gross Reservoir expansion project is to provide an additional 18,000 acre-feet (AF) of firm yield to the northern portion of the Denver Water's water supply system for both delivery of raw water to other northern entities with contracts and to Denver's Moffat Water treatment plant (MWTP). To achieve this additional firm yield Denver Water proposes to increase the existing capacity of Gross Reservoir of 41,800 AF by 72,000 AF for a total expanded storage volume of 113,800 AF. At this time, raw water cannot be conveyed efficiently between the south and north portions of Denver's water supply system; therefore, raw water deliveries to the contracting entities can only be supplied easily via Denver's northern system.

The north system diverts water from the Fraser and Williams Fork basins on the West Slope via an extensive diversion and conveyance system connecting to the Moffat Tunnel which then discharges into South Boulder Creek on the eastern slope. Diverted waters are either stored in the existing Gross Reservoir or are routed downstream to water customers (See FEIS Figures in Appendix A).

Four baselines (Section 3.1, Figure 3-1) have been utilized to evaluate direct, indirect, and cumulative impacts of the proposed project on the upper Colorado basins:

1) The pre-diversion period, prior to 1936.
2) The historical post-diversion period, derived from actual data collected throughout the upper basins after 1936 for the Fraser and after 1985 on the upper Colorado River to the present.
3) The FEIS-modeled Current Conditions baseline.
4) The FEIS-modeled Full Use baseline.
5)

Baselines 1 and 2 are used in this white paper to more accurately evaluate cumulative impacts due to past and present diversions (Baseline 1) and cumulative impacts of the proposed project with RFFAs (Baseline 2). Baselines 3 and 4 were used in the FEIS. The Army requires that existing conditions, in this case Baseline 2 above, —not a modeled projection—be used as the baseline by which to evaluate project impacts as required under NEPA.

The arbitrary FEIS Current Conditions baseline was derived by the PACSM model using demand and Moffat Tunnel diversion averages which are inflated compared to actual measured post-diversion averages for these parameters (Section 3.2). The use of these inflated diversion figures resulted in modeled average stream flows that were approximately 32 to 34 percent lower than measured average historical stream flows at the Winter Park and Below Steelman USGS gages on the Fraser and Williams Fork Rivers. Because the Current Conditions baseline was the starting point used for the FEIS cumulative impacts analysis, the 32 to 34 percent difference in stream flow, referred to as "hidden" impacts by this author, was not acknowledged nor incorporated into the impact analysis. Put simply, the FEIS reports "current" stream flows that are substantially lower than the actual observed flows and consequently obscures the extent of the impacts that can be ascribed to the proposed project. The FEIS Current Conditions baseline was used inappropriately in the FEIS.

An independent firm yield analysis (Appendix D and Section 4) was performed to attempt to verify that 18,000 AFY of firm yield could be achieved for the northern system as proposed in the FEIS. Firm yield, a water supply term, is the volume of water or yield that can be attained every year of an historical test period from reservoir storage and source basin stream flow diversions in a water supply system.

Firm yield is evaluated each year to include variability of annual water supply cycles. The results of the independent analysis show that additional average diversions of 10,280 AFY, allocated for the proposed project (FEIS Table H-7.1), would provide the additional firm yield in only 54% of years in the 44-year test period (1966 to 2013). The proposed project should have been screened from further consideration during the alternative screening process used by the USACE.

If all additional stream flows beyond the historical post-diversion baseline, approximately 20,300 AFY, are utilized, then the firm yield could be met in only 77% of the years and again, the project should have been screened. To attain the firm yield in 100% of test period years would require additional diversions such as those from the planned expansion of the Williams Fork collection system to Darling Creek described in Attachment Q of the Colorado River Cooperative Agreement (Appendix E).

The firm yield can be attained with expansion of Gross Reservoir but only with a substantially higher volume of additional diversions and substantially greater impacts to the Fraser, Williams Fork, and upper Colorado basins than described in the FEIS. The independent analysis also identified an extended period of below average flows as critical; sufficient additional diversions from the upper basins would not be available for operation of the expanded reservoir for three consecutive years. The need to convey raw water from the south to the north system —the elimination of which emergency measures is a goal of the proposed project—could potentially be repeated under these conditions.

Additionally, the FEIS used the average streamflow which is skewed high by infrequent high flow years and both overestimates the amount of water in the streams and under-estimates project impacts to the upper basins (Section 5.1).

In this white paper, cumulative impacts due both to past and present and to project plus RFFA additional stream diversions are re-evaluated using the historical baseline and median statistics of USGS gaged streamflow. Pre-diversion USGS streamflow data, available at some locations, were used to evaluate past and present cumulative impacts to the upper basins. Comparison of historical pre-diversion and post-diversion data (Section 5.2) show that the Fraser and the upper Colorado Rivers have, due to past and present streamflow diversions, been depleted by 64% and 77% on an annual basis and 70 to 80% and 78 to 89% in the irrigation season at the Winter Park and Hot Sulphur Springs gages, respectively.

The FEIS estimates only 50% and 57% depletion of annual native flows at these locations (FEIS Section 3.1.5.1). Adding predicted streamflow depletions caused by the proposed project and RFFAs (Section 5.3 and 5.4), overall streamflow depletion would reach 86% and 88% of annual flows at Winter Park and Hot Sulphur Springs and, between 95 to 100% at Winter Park and between 87 and 95% at Hot Sulphur Springs in the irrigation season months of May, June and July, much higher than depletions noted in the FEIS (Tables 5-3 and 5-4). If the expanded system is operated as presented in the FEIS, resultant streamflow, sometimes as low as zero, in several upper basin streams would not meet bypass flow requirements 50% or more of the time.

Stream functions, including hydraulic, biological, and water quality functions in the hierarchy aptly described in EPA guidance on mitigation of aquatic eco-systems, are all integrally linked to water quantity. Impact analysis using the historic post-diversion baseline shows that the FEIS also substantially understates project related impacts to other hydrologic parameters including increase in numbers of dry years, reduction in streamflow percentiles, and reduction in average peak flows (Section 5.4). The application for 401 state certification shows that project and RFFA-related reductions in stream flow will significantly impact water quality of reviewable waters in the Fraser, Williams Fork, and upper Colorado River segments (Section 6) and, for the same reasons stated above, use of the Current Conditions baseline in the 401 analysis, under-estimates impacts to water quality and aquatic wildlife in the state analysis.

Mitigation and enhancement agreements (Chapter 6) between Denver Water and several other entities on the western slope, that proffer substantial amounts of money, do not follow EPA and CEQ guidance and NEPA regulations on mitigation. The mitigation and enhancement agreements do not provide sufficient details to assure that state use classifications in the Fraser, Williams Fork, and upper Colorado rivers will be protected.

Denver Water needs to provide clear mitigation goals, detailed monitoring plans to gather additional baseline data and to evaluate efficacy of mitigation measures, accurate analysis of impacts by which to evaluate debits, detailed mitigation projects that specify expected credits of the measures, an enforcement plan that addresses when mitigation has failed and includes a contingency plan, and provision for agency and public involvement and oversight of the Learn By Doing committee and actions.

Not only are additional diversions above the historical post-diversion baseline not sufficient to meet the purpose and need of the project but impacts evaluated using this baseline are substantially greater than those evaluated under the Current Conditions baseline and disclosed in the FEIS. Mitigation measures proposed in the FEIS and various agreements do not come close to providing sufficient detail to evaluate the measures or to enforce mitigation requirements in the upper basins.

CEQ regulations state that the first goal of mitigation efforts is to avoid impacts. Under state law, if project impacts to a stream segment is significant, further analysis is required to determine whether reasonable alternatives are available that would result in less degradation. Under the Clean Water Act, the chosen alternative is obligated to be the least environmentally damaging practicable alternative. The FEIS has not provided sufficient evidence, particularly in light of the above evaluations, that the proposed project is the least environmentally damaging project that can fulfill the project purpose and need. Therefore, the FEIS is incomplete.

1.0 Description of North and South Water Systems

Denver Water's collection system spans seven river basins on the west and east slopes of the continental divide (FEIS Figure ES-4 provided here in Appendix A). Western slope collection systems divert waters to the eastern slope from the upper Colorado, Fraser, Williams Fork, and Blue River basins. The eastern slope collection system includes the South Platte, North Fork of the South Platte, and South Boulder Creek. This discussion centers on the North System descriptions below because impacts of the proposed Gross Reservoir expansion and subsequent increased diversions from the Fraser and Williams Fork Rivers will impact these basins and the upper Colorado River the most, but proposed diversions through the Roberts Tunnel will also generate considerable impacts in the Blue River Basin and downstream. The following excerpts from the FEIS briefly describe the Denver Water's North and South water supply systems.

1.1 North System Description

FEIS Section 1.3.1.1:

> The Moffat Tunnel Collection System captures water from the Williams Fork River, Fraser River, South Boulder Creek, and Ralston Creek, and subsequently delivers this water to the Moffat WTP and several raw water customers upstream of the plant. The major facilities in this system include the Williams Fork River Collection System, Gumlick Tunnel, Vasquez Tunnel, the Fraser River Collection System, the Cabin-Meadow Creek Collection System, Moffat Tunnel, Gross Reservoir, South Boulder Diversion Canal, and Ralston Reservoir. Figure 1-2 [provided here in Appendix A] displays these major facilities in the North System[...]
> The Williams Fork Collection System collects and conveys water from high elevation tributaries of the Williams Fork River to the Gumlick Tunnel. The Gumlick Tunnel is 2.9-miles long and carries water under the Continental Divide (Jones Pass) to the Vasquez Tunnel, which is a 3.4-mile tunnel that passes back through the Continental Divide and conveys water to Vasquez Creek. Water in Vasquez Creek, as well as water diverted from the Fraser River and tributaries, and the Cabin-Meadow Creek Diversion System, are collected and conveyed in 28 miles of pipes, tunnels, siphons, and canals [as part] of the Fraser River Diversion System to the West Portal of the Moffat Tunnel, located near the Fraser main stem above the Town of Winter Park.

FEIS Section 3.1.5.1:

> Denver Water's 32 primary diversion points in the Fraser River Basin, which contribute flows to the Moffat Tunnel, are shown in Table 3.1-6 and Figure 3.0-2 [provided here in Appendix A]. For the period from 1975 through 2004, the Moffat Tunnel conveyed an average of 55,900 AF per year under the Continental Divide (CDWR 2009) based on the State's Hydrobase records for station 09022500, Moffat Tunnel at East Portal. The capacity of the Moffat Tunnel is 1,360 cubic feet per second (cfs)[…]

> Denver Water's direct flow water rights in the Fraser Basin have been decreed as an aggregate amount divertible at the Moffat Tunnel, with multiple points of diversion at the numerous tributary diversion sites. Denver Water's Fraser River Basin water rights are tabulated in Table 3.1-7. Appropriated in 1921, these rights are junior relative to many of the irrigation rights in the basin. Denver Water's rights are also subject to bypass requirements, shown in Table 3.1-8 and Figure 3.0-5, pursuant to right-of-way (ROW) agreements with the U.S. Forest Service (USFS) under stipulations of the Amendatory Decision dated April 22, 1970.
>
> The first ROW stipulation with the USFS originated in 1970 and stipulated minimum bypass flows on the Fraser River, Vasquez Creek, St. Louis Creek, and Ranch Creek. In the Amendatory Decision, Denver Water has the ability to reduce the bypass flows under certain conditions. Under the 1992 Clinton Reservoir Agreement, Denver Water agreed that it would not reduce the bypass flows unless mandatory restrictions were imposed on its customers, provided the reduced bypass flows would not result in mandatory restrictions of indoor use to Grand County water users [...]
>
> The second ROW stipulation with the USFS originated in 1974 with the City of Englewood and stipulated minimum flows on North and South Trail Creeks, Hurd Creek, Hamilton Creek, Cabin Creek, Little Cabin Creek, and Meadow Creek. These bypass flows do not have provisions which allow for bypass reductions [...]

FEIS Section 3.1.5.2:

> Denver Water's Collection System in the Williams Fork River headwaters diverts from McQueary, Jones, Bobtail, and Steelman creeks, directing flow to the Gumlick Tunnel (Jones Pass Tunnel) for delivery into Vasquez Creek in the Fraser River Basin above the Moffat Collection System via the Vasquez Tunnel. The diversion locations are shown on Figure 3.0-2 [provided here in Appendix A].
>
> The Williams Fork Collection System intercepts a drainage area of approximately 14.2 square miles (Denver Water 2003c). The decreed capacity of the Gumlick Tunnel is 620 cfs and annual diversions averaged 5,100 AF from 1975 through 2005 (CDWR 2009). Denver Water has also adjudicated a number of conditional water rights for future extension and enlargement of the Williams Fork Collection System, including rights on Darling Creek, Webb Creek, and Middle and South Forks of the Williams Fork. Denver Water's rights associated with existing structures are listed in Table 3.1-12.
>
> The CWCB has minimum stream flow rights on the collection system tributaries[...] Denver Water has no bypass obligation other than for senior downstream irrigation rights; however, minimum bypasses would be imposed on both existing and future diversions if the collection system is extended, pursuant to a 1979 agreement with CWCB and the Colorado Parks and Wildlife (CPW) (Denver Water 2003c). The CWCB rights are listed in Table 3.1-13 and shown on Figure 3.0-6.

FEIS Section 1.3.1.1:

> [From the West Portal,] water is diverted into the 6.1-mile long Moffat Tunnel, which conveys water from the Fraser River Collection System and the Williams Fork River Collection System under the Continental Divide into South Boulder Creek, and eventually to Gross Reservoir. Gross Reservoir is located on South Boulder Creek with a gravity arch-concrete dam [currently] approximately 340 feet high and a storage capacity of 41,811 AF.
>
> Water from the reservoir is released into South Boulder Creek and is diverted through the South Boulder Diversion Structure to Ralston Reservoir. The South Boulder Diversion Structure is a gravity concrete dam 22 feet high and conduit approximately 10 miles in length. Ralston Reservoir is located on Ralston Creek with an earth-fill dam 180 feet high and a storage capacity of 10,749 AF. Water is delivered from this reservoir to the Moffat WTP via Conduits 16 and 22.

FEIS Section 1.3.1.3:

> The Williams Fork Reservoir is owned and operated by Denver Water as a replacement facility for Denver Water's trans-mountain diversion projects. It is located on the Williams Fork River near its confluence with the Colorado River in Parshall, Colorado. The reservoir has a storage capacity of 96,822 AF with a thin arch-concrete dam 217 feet high. The reservoir provides exchange water to meet downstream senior water rights requirements, replacing water diverted from the Fraser and Williams Fork collection systems and the Roberts Tunnel Collection System.
>
> This is an example of an exchange commonly performed within the collection system, whereby out-of-priority diversions can be made in exchange for water released from Williams Fork Reservoir. Releases from Williams Fork Reservoir can also be made in substitution for releases from Green Mountain Reservoir. (In a substitution, water is released from one location in exchange for release of water at another location.) This operation allows Denver Water to fill Dillon Reservoir, located upstream of Green Mountain Reservoir with water rights junior to Green Mountain, with water that Green Mountain was entitled to store. If Green Mountain Reservoir fails to fill, water supplies from the Williams Fork Reservoir are released (substituted) to downstream water demands in place of releases from Green Mountain Reservoir.

1.2 Typical Operations of Denver Water's Moffat Collection System in the Fraser River Basin

FEIS Section 3.1.5.1:

> The existing Moffat Collection System collects water from side slope "sheet flow" and numerous tributary diversion points, which are listed in Table 3.1-6 [shown here in Figure 3.0-2, Appendix A]. Typically, Denver Water diverts water that is physically and legally available at each diversion point subject to minimum bypass flows and calls from downstream senior water rights. Most of the water available for diversion occurs

during the May through July runoff season. Streams that do not have minimum bypass requirements (and even those with downstream senior rights) are fully diverted at times during the year and no water is bypassed from those diversion structures.

As a result, Denver Water, at times, diverts all the stream flow from tributaries in the Fraser River Basin that do not have minimum bypasses. This results in no stream flow for some distance below the diversions. This is how Denver Water has operated in the past and plans to operate in the future. Diversions from the Moffat Collection System must be replaced when the senior Shoshone or senior Grand Valley call is in effect. Denver Water uses Williams Fork Reservoir, and occasionally Dillon Reservoir, to replace these out-of-priority diversions.

As previously mentioned, operations vary depending on a wide variety of factors. In dry years Denver Water diverts the maximum amount of water it legally can from the existing Moffat Collection System. This means that Denver Water diverts all available flows at each diversion point except for flows required to meet senior water rights or minimum bypass flows (Table 3.1-8) [...] In wet and average years, early in the runoff season, Denver Water typically diverts the maximum amount of water physically and legally available at each diversion point. This water is used to fill Gross and Ralston reservoirs and to meet customer demand. Often, Denver Water diverts 100% of the water from streams that do not have minimum bypass flow requirements.

Therefore, streams that do not have minimum bypass requirements (even those with downstream senior rights) are fully diverted and dried-up early in runoff season similar to dry years. Once Denver Water anticipates filling Gross and Ralston reservoirs and water demand is being met, Denver Water will begin to reduce diversions and "spill" water from the Moffat Collection System that cannot be used or stored on the East Slope [....] As Gross Reservoir begins to be drawn down, typically in midsummer, Denver Water will again divert the maximum amount available to keep Gross Reservoir as full as possible.

According to the Upper Colorado River Basin Information report prepared as part of the Basin Round Table efforts for the Upper Colorado Basin (CWCB website 1/1/2007), the "primary operational objective [for Williams Fork diversions] is to fill Gross Reservoir. Once [Gross Reservoir is] filled, the general practice is to cease diversions at the collection system in favor of storage in the Williams Fork Reservoir" (Firm Yield Analysis, Appendix D).

Denver owns the water rights for the Big Lake Ditch which historically diverted just upstream of the Williams Fork Reservoir to Reeder Creek; as of 2013, this water, approximately 10,000 AFY, may be used for storage in Williams Fork Reservoir (FEIS Section 4.3.1). In addition, under the 10,825 agreement, Denver Water no longer is required to release 5,412 AF to meet USFWS flow recommendations in the 15-Mile Reach in Grand Junction (FEIS Section 4.4.1). The 10,280 AF is planned to be released from Granby, Reudi, and Wolford Reservoirs after 2013, (personal communication Heather Ramsey at DWR, April 20 2015). Therefore, approximately 15,400 AFY of additional water is now available to Denver Water for storage in the Williams Fork Reservoir potentially allowing additional transbasin diversions from the upper Williams Fork basin.

1.3 Colorado River

FEIS Section 3.1.5.3:

> The section of the Colorado River, from the confluence with the Fraser River downstream to the Kremmling gage, includes approximately 27 river miles beginning at the confluence with the Fraser River—the most upstream point at which Denver Water diversions have an impact on the Colorado River mainstem. It ends at Kremmling, where both the Blue River and Muddy Creek join the Colorado River….
>
> The river valley is sparsely populated, with Hot Sulphur Springs, the Grand County seat, being the only municipality other than Kremmling. Diversions in this reach of the river are primarily to flood-irrigate pasture grass grown in a relatively narrow corridor along the river…. These water rights are primarily located along the Colorado River mainstem downstream of the confluence with the Williams Fork River and upstream of Kremmling…. The other major diversion in this reach is the Windy Gap Project, which has a diversion dam just below the confluence with the Fraser River, and a pumping station with a capacity of 600 cfs.
>
> The Windy Gap Project is owned and operated by the Municipal Subdistrict of the Northern Colorado Water Conservancy District. The water diverted at Windy Gap is pumped to Granby Reservoir for eventual delivery to the East Slope via the Adams Tunnel. The historical average annual diversion at Windy Gap is approximately 10,600 AF (1985 through 2004).

1.4 South System Description

FEIS Section 1.3.1.2:

> The South System is comprised of two collection systems; the Roberts Tunnel and the South Platte collection systems (Figure ES-4, provided here in Appendix A) […]. The Roberts Tunnel Collection System includes Dillon Reservoir, which is located near the town of Dillon, Colorado at the confluence of the Blue and Snake rivers and Ten Mile Creek. The reservoir has a storage capacity of 254,036 AF with an earth-fill dam 231 feet high. The reservoir stores water from the Blue River and diverts into the Roberts Tunnel. The tunnel is 23.3 miles long and conveys water under the Continental Divide into the North Fork South Platte River, which is eventually captured by Denver Water's South Platte Collection System.
>
> The South Platte Collection System captures water from the mainstem of the South Platte River and Bear Creek. The major facilities in the system include three storage reservoirs along the South Platte River: Antero Reservoir (20,015 AF), Eleven Mile Canyon Reservoir (97,779 AF), and Cheesman Reservoir (79,064 AF), which supply

water to Strontia Springs Reservoir (7,863 AF). Water from Strontia Springs Reservoir can be delivered directly to Foothills WTP via Conduit 26, or released to the South Platte River where it can, if necessary, be diverted by Denver Water at Conduit 20, High Line Canal, or the Last Chance Ditch before reaching Chatfield Reservoir (27,428 AF). Conduit 20 is used to deliver water from the South Platte River to Marston Reservoir (19,796 AF), which serves as a storage reservoir for the Marston WTP. The High Line Canal is operated by Denver Water and delivers water to Platte Canyon Reservoir (905 AF), as well as several customers in the Denver Metropolitan area [**…]**

FEIS Section 1.3.2:

> [Denver Water's treated water facilities include] the Foothills, Marston and Moffat WTPs [with] a combined capacity of 715 mgd […] The Foothills and Marston WTPs treat water from the South Platte Collection System and Roberts Tunnel Collection System, while the Moffat WTP treats water from the Moffat Collection System.
>
> Unlike the raw water collection systems, the treated water system is connected. During periods of low demand, it is possible for any of the three treatment plants to serve most areas within the CSA. In general, the Foothills WTP is the primary treatment plant used to meet treated water demands, because of its lower cost of operation and ability to provide water to most of the areas Denver Water serves by gravity. The Marston and Moffat WTPs are primarily peaking plants, with greatest use generally during high demand […]

1.5 Proposed Project

Purpose and Need Statement

> The purpose of the Moffat Collection System Project is to develop 18,000 acre-feet per year of new, firm yield to the Moffat Treatment Plant and raw water customers upstream of the Moffat Treatment Plant pursuant to the Board of Water Commissioners' commitment to its customers.

Denver Water's need for the proposed Moffat Project is based on an alleged system imbalance with Denver Water claiming that as approximately 90% of the available reservoir storage and 80% of the available water supplies are supplied by the South System. Denver Water also claims an overall system water shortage beginning by 2022 and reaching 34,000 AFY by 2032.

To address these two issues, Denver Water is pursuing the proposed Moffat Project to provide 18,000 AFY of new firm yield to the north system to address both the overall near-term water supply shortage, and the imbalance in water storage and supply between the North and South systems.

Proposed Project Description

FEIS Section 2.3.1 (emphasis added):

> Using existing collection infrastructure, [additional] water from the Fraser and Williams Fork river basins, and South Boulder Creek, would be diverted during average and wet-years and delivered to an enlarged Gross Reservoir. In order to firm this water supply and provide 18,000 AF of new yield, the existing Gross Reservoir would be expanded from 41,811 to 113,811 AF to provide an additional 72,000 AF of storage capacity. In addition, Denver Water proposes to create an additional 5,000 AF of storage in the reservoir in order to store water that would be used in flow releases to enhance aquatic habitat in South Boulder Creek […]

FEIS Section 2.4.2.1:

> The existing dam was completed in 1954 as a concrete gravity-arch dam rising 340 feet above the streambed, […] Denver Water would increase the dam's elevation by 131 feet for a total dam height of 471 feet with a crest at elevation 7,406 feet mean sea level.

System operations in the Moffat Collection and WTP systems are predicted to change as described in FEIS Section 2.4.3. Changes include:

- Increased diversions from the Williams Fork and Fraser Rivers primarily during average and wet years.
- Increased diversions of native South Boulder Creek water either to storage in Gross Reservoir or at South Boulder Diversion Canal.
- Increased releases of Gross Reservoir water for delivery to the Moffat WTP particularly in winter months to maintain minimum flows of 30 mgd through the Moffat plant. As a result, the Foothills and Marston WTPs would operate at a lower level in winter. In summer, the load would be shifted to the southern system WTPs.
- Williams Fork Reservoir operations would change. Less water would be available for storage due to increased diversions from the upper Williams Fork River tributaries. As a result, Williams Fork Reservoir would generally achieve fills later in the year and spill less.

Note that, changes in operations in the Williams Fork basin are critical not only as they relate to protection of the native green back cutthroat trout present in the upper tributaries (Woodling, 2015) but also to determine if the required additional firm yield can feasibly be supplied by the proposed project (Section 4.0 below).

2.0 Pertinent Regulations

2.1 Water Quality Control Commission: Colorado Regulation 31, 33, and 93

Colorado has adopted anti-degradation provisions "to protect current water quality, especially where that quality is better than necessary to protect a water body's classified uses…" The state anti-degradation provisions are designed to protect water quality and use classifications of state waters. Colorado's beneficial use classifications that pertain to specific stream segments in the Fraser, Williams Fork, and upper Colorado River basins are described here.

Denver submitted an anti-degradation evaluation for the Gross Reservoir expansion project to the state as part of the application for 401 Certification. Comments on the certification application are included as Section 5 of this document.

WQCC Classifications and Pertinent Stream Segments

The FEIS at Section 3.2.0 states that WQCC classifies stream segments according to "actual beneficial uses of the water" including these classifications for stream segments relevant to the Upper Colorado River basin:

- "*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." Primary contact recreation means "activities where the ingestion of small quantities of water are likely to occur" such as swimming, kayaking, rafting, and water skiing (5CCR 1002-31).
- "*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."
- "*Class 1 – Cold Water Aquatic Life*. These are waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions." Tier I applies to stream segments where cutthroat and brook trout are expected to occur. Tier II has slightly higher temperature standards and applies to stream segments where cold water species, excluding Tier I species, are expected to occur, for instance brown trout (5 CCR 1002-33).
- "*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."

The following stream segments of the Upper Colorado River are classified for Aquatic Life Cold Water Class 1 Tier I (or Tier II as noted), Recreation E, Water Supply, Agriculture uses (FEIS Table 3.2-1 and 5CCR 1002-33 updated in 2015):

- Colorado River mainstem and tributaries, Segment 1, in or flowing into Rocky Mountain National Park (RMNP) and Segment 2, Arapahoe National Recreation Area (ANRA).

Waters in Segment 1 are classified as Outstanding.

- Colorado River mainstem from Lake Granby to confluence with Roaring Fork River, Segment 3; Tier II. Note this CDPHE classification is different than Class 2 noted in Table 3.2-1 of the FEIS.
- Williams Fork River mainstem and tributaries, Segment 8, from source to the confluence with the Colorado River except for Segment 9.
- All tributaries to the Colorado and Fraser Rivers (Segment 9) within the Never Summer, Indian Peaks, Byers, Vasquez, Eagles Nest and Flat Tops Wilderness Areas. Waters within Segment 9 are classified as Outstanding.
- Fraser River mainstem and tributaries, Segment 10a: mainstem from source to immediately below Rendezvous Bridge (downstream of Winter Park and Vasquez Creek) plus tributaries to the Fraser River from the source to the Colorado River.
- Fraser River mainstem, Segments 10b: from Rendezvous Bridge to Hammond Ditch (below the town of Fraser) and 10c: from the Hammond Ditch to confluence with the Colorado River are classified as Tier II.
- All lakes and reservoirs, Segment 11, within RNMP and Wilderness Areas noted under Segment 9 plus those in ANRA (Segment 12) including Grand Lake, Shadow Mountain Lake, and Lake Granby. Grand Lake also has a narrative clarity standard: "The highest level of clarity attainable, consistent with the exercise of established water rights, the protection of aquatic life, and protection of water quality throughout the Three Lakes system." As of January 1, 2017, the clarity standard from July through September for Grand Lake will be 4 meter secchi disk depth, 5CCR 1002-33 page 15.
- Mainstem of the Blue River, Segment 17, from the outlet of Dillon Reservoir to the confluence with the Colorado River.

Numeric water quality standards associated with each of the use classifications above are listed in 5CCR 1002-33.

Outstanding waters are defined as "Waters that have the highest level of water quality protection. These waters have water quality better or equal to that listed in the regulations. These waters also are an outstanding natural resource such as a national park and the waters require protection beyond that provided by a reviewable designation" (FEIS Section 3.2.0).

Stream sections impacted by the Moffat/Gross project fall into the Reviewable Waters designation: "Any water not designated as Outstanding or Use-Protected. This designation is intended to provide protection through a review of potential changes but also allows for changes when justified by economic or social need"(FEIS Section 3.2.0).

Stream Segments on Clean Water Act 303d and Colorado Monitoring and Evaluation Lists
Colorado's list of Water Quality Limited Segments that require evaluation of Total Maximum Daily Loads (TMDLs) per Section 303d of the Clean Water Act and Colorado's Monitoring and Evaluation List are included in Regulation 93 (5CCR 1002-93). Those segments of the Upper Colorado River Basin on the 303d list are:

- The mainstem of the Fraser River upstream of the Rendezvous Bridge and Vasquez Creek are provisionally listed for Aquatic Life Use, low priority. The Aquatic Life standard is measured using the Mulitmetric Index (MMI) score based on WQCC Policy 10-1, Aquatic Use Attainment. This and 30 other segments that have low MMI scores "are provisionally listed because there is no water quality data available to indicate impairment" (5CCR 1002-33).
- The mainstem of the Fraser River Segment 10c for temperature.
- Ranch Creek, a tributary to the Fraser River in Segment 10a, for temperature, low priority.
- Colorado River Segment 3 between 578 Road Bridge (immediately downstream of Windy Gap) to just above the confluence with the Blue River for temperature and manganese, high priority.
- Shadow Mountain Lake, Segment 12, for dissolved oxygen, high priority.
- Lake Granby, Segment 12, for Aquatic Life Use based on mercury in Fish Tissue, high priority. Note that previous mercury fish tissue data fall below the new standard and if additional data remain low this segment will be removed from the 303d list.

Segments of the Upper Colorado River Basin included on the Monitoring and Evaluation List (5CCR 1002-93) because of uncertainty in the data and/or the cause of impairment are:

- The mainstem of the Fraser River from the Town of Fraser to the confluence with the Colorado River, Segment 10c for copper, and from the Town of Tabernash to the Town of Granby in Segment 10c for lead.
- Colorado River Segment 3 from the outlet of Windy Gap Reservoir to 578 Road Bridge for Aquatic Life.

Once a river segment is included on the 303d list, TMDL requirements that will protect uses and bring the segment into compliance with water quality standards are evaluated and reviewed by the EPA. If approved, the segment and parameter are removed from the list but remain in Integrated Reporting Category 4A. Delisting can also happen if more recent data attain water quality standards.

2.2 National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA), 42 USC §§ 4321-4370h, was enacted by Congress, in part, to "promote efforts which will prevent or eliminate damage to the environment" (42 USC § 4321). This purpose is accomplished primarily through the preparation of an Environmental Impact Statement (FEIS) in which the agencies:

- "rigorously explore and objectively evaluate all reasonable alternatives" to the proposed action (40 CFR § 1502.14) that will achieve the proposed project's objective,
- "compare the environmental impacts of all available courses of action" (*New Mexico*, 565 F.3d at 703) including ecological, aesthetic, cultural, economic, and social impacts (40 CFR § 1508.8(b)); and,
- "insure the professional integrity, including scientific integrity of the discussions and

analyses in environmental impact statements (40 CFR 1502.24)."

Impact Analysis

For each type of impact, the agency must analyze the proposed project's direct, indirect, and cumulative effects (40 CFR § 1508.7-1508.8):

- Direct effects "are caused by the action and occur at the same time and place,"
- Indirect effects "are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable."
- "Cumulative impacts are "the impact[s] on the environment which [are caused by] the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions."

Selection of Baseline Conditions

The accuracy of an impact analysis depends heavily on the baseline used to describe the existing basin conditions against which both project related and cumulative impacts are evaluated. The baseline is used to determine if a project's environmental effects will be significant and is defined as:

> "the <u>existing</u> environmental conditions against which impacts of the proposed action and its alternatives can be compared" (Army NEPA Glossary, aec.army.mil/portals/3/nepa/glossary00.pdf, emphasis added).

Council on Environmental Quality (CEQ) Mitigation Regulation and Guidance

CEQ Regulations (40 CFR §1508.2) state that agencies can use mitigation to reduce environmental impacts in several ways including (emphasis added):

- <u>Avoiding</u> an impact by not taking a certain action or parts of an action;
- <u>Minimizing</u> an impact by limiting the degree or magnitude of the action and its implementation;
- <u>Rectifying</u> an impact by repairing, rehabilitating, or restoring the affected environment;
- <u>Reducing</u> or elimination an impact over time, through preservation and maintenance operations during the life of the action; and
- <u>Compensating</u> for an impact by replacing or providing substitute resources or environments.

The CEQ regulations (40 CFR § 1505.2(c)) also require that a Record of Decision "[s]tate whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not. A monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation."

CEQ published guidance for implementing mitigation in the NEPA process in 2011 ("Final Guidance for Federal Departments and Agencies on the Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact," 76 Fed. Reg. 3843 - 3853 (January 21, 2011)). Key elements include:

- "Federal agencies should take steps to ensure that mitigation commitments are actually implemented." 76 Fed. Reg. 3848 (January 21, 2011).
- "Agency NEPA implementing procedures <u>should require clear documentation of mitigation commitments</u> considered in EAs and EISs prepared during the NEPA process and adopted in their decision documents. Agencies should ensure that the expertise and professional judgment applied in determining the appropriate mitigation commitments are described in the EAs and EIS, and that the NEPA analysis considers when and how those mitigation commitments will be implemented." 76 Fed. Reg. 3848 (January 21, 2011), emphasis added.
- "Mitigation commitments should be carefully specified in terms of measurable performance standards or expected results, so as to establish clear performance expectations." 76 Fed. Reg. 3848 (January 21, 2011).
- "Agencies can, in their NEPA reviews, establish and analyze mitigation measures that are projected to result in the desired environmental outcomes, and can then identify those mitigation principles or measures that it would apply in the event the initial mitigation commitments are not implemented or effective." 76 Fed. Reg. 3849 (January 21, 2011).
- "A successful monitoring program will track the implementation of mitigation commitments to determine whether they are being performed as described in the NEPA documents and related decision documents." 76 Fed. Reg. 3850 (January 21, 2011).
- "Public involvement is a key procedural requirement of the NEPA review process, and should be fully provided for in the development of mitigation and monitoring procedures." 76 Fed. Reg. 3850 (January 21, 2011).

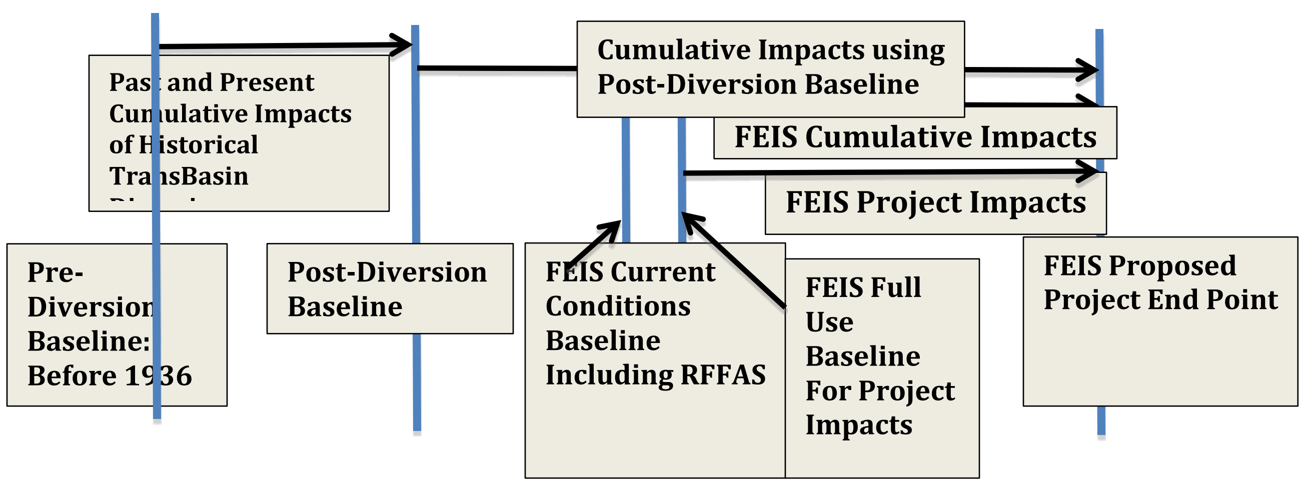
3.0 FEIS Current Conditions Baseline Inaccurate

The following briefly discusses four baselines considered in this white paper and evidence that the FEIS Current Conditions baseline, derived using the PACSM model and used to evaluate FEIS cumulative impacts of the proposed project with RFFAs, does not reflect existing conditions in the western slope source basins and is not an appropriate baseline per NEPA. The historical post-diversion baseline which reflects existing conditions in the western slope basins is more appropriate and should be used for impact analysis in the FEIS. These baselines are shown in Figure 3-1.

3.1 Description of Various Baselines

Pre-Diversion Baseline: This is the historically measured pre-diversion record. On the Fraser River and the Colorado River downstream of the confluence with the Fraser, this baseline represents conditions before diversions through the Moffat Tunnel commenced in 1936. This is the most appropriate baseline by which to evaluate cumulative impacts of past and present diversions.

Figure 3-1: Schematic of Four Baselines:
<u>Two Historical and Two FEIS Baselines</u>



Post-Diversion Baseline (Existing Conditions): This baseline represents the actual existing conditions of the rivers. On the Fraser River, this baseline represents conditions after diversions through the Moffat Tunnel commenced in 1936, sometimes referred to as post-Moffat. On the Colorado River downstream of the confluence with the Fraser, this post-diversion baseline represents conditions after 1985; after all upstream historical transbasin diversions including the Moffat, Colorado Big Thompson, and Windy Gap projects were implemented.

Measurements of stream flow, transbasin diversions, health of aquatic wildlife, and water quality among other data provide information from which impacts of historical transbasin diversions can be identified and quantified. The historic post-diversion baseline reflects the annual variability in hydrologic conditions and water supply operations that result in the existing measureable conditions in the basins of origin. This is the recommended and more appropriate historical post-diversion baseline to assess cumulative impacts of the proposed project with RFFAs.

Current Conditions Baseline: The Platte and Colorado Simulation Model (PACSM) model was used to evaluate what firm yield can be attained by various configurations of Denver's water supply system. System configurations were tested against hydrologic conditions in the 1947 to 1991 period of record; including the 1953 to 1957 critical drought.

The FEIS Current Conditions PACSM model utilized "demands [285,000 AF/Y], facilities, agreements, operations, and administration of the Colorado and South Platte River basins" as they existed in 2006 (FEIS Section 4.6.1). Further, "operations of all existing reservoirs and diversion facilities [and demand levels] are simulated for the entire study period, regardless of when they came on line" (FEIS Section 4.6.1).

The FEIS Current Conditions PACSM model results were used as the hydrologic baseline for evaluating cumulative impacts to western slope basins in the FEIS. Though important from a water supply planning perspective, PACSM modeled "Current Conditions," where a consistent water supply demand and configuration is imposed on the system throughout the test period, does not represent actual historical stressors to the basins and therefore does not represent existing "on the ground" hydrologic conditions.

The next section discusses how use of modeled demands that are greater than actual historical demands inflates the Current Conditions baseline so that is does not represent existing basin conditions and should not be used to evaluate impacts in the FEIS.

Full Use Baseline: Average annual demand in the Full Use of Existing PACSM model was increased to the projected 2022 Denver Water demand of 345,000 AFY. Other reasonable and foreseeable future actions (RFFAs), including, for the western slope, changes in Williams Fork Big Ditch and 10,280 water rights, the Windy Gap Firming Project (WGFP), and population growth in Grand and Summit counties, but not the Moffat project, were added to the system configuration (FEIS Section 4.6.1).

The Full Use PACSM model results were used as the hydrologic baseline for evaluating project impacts to western slope basins. The Full Use baseline was used primarily to model impacts of RFFAs alone and to isolate direct impacts of the project. The Full Use model also included additional diversions through the Moffat Tunnel and so the impact of RFFAs alone could not be discerned.

In the Proposed Action PACSM model, average annual demand was increased to 363,000 AFY, projected to occur by 2032, and the expanded Gross Reservoir is included in Denver Water's system configuration beyond what is included in the Full Use Model (FEIS page 5-2). Additional Moffat Collection System incremental diversions between the Full Use and the Proposed Action plus storage in the expanded Gross reservoir are to provide the project additional firm yield of 18,000 AFY to Denver's North water supply system.

3.2 Current Conditions Baseline Inflated

Cumulative impacts of the proposed project were evaluated in the FEIS as the incremental change in stream flows between the PACSM Current Conditions model and the PACSM proposed project model that included Full Use diversions and RFFAs. The Current Conditions baseline is evaluated here. As stated in FEIS Section 4.6.1:

> Current Conditions (2006) reflects the Denver Water-related current administration of the Colorado and South Platte river basins, demands, infrastructure, and operations. Under the Current Conditions (2006) scenario, Denver Water's existing average annual demand is 285,000 AF.

The diversions incorporated into the Current Conditions PACSM model are inflated due to:

1. Use of a higher average demand (285,000 AF/yr) than the actual historical average demand,
2. Modeled transbasin diversions that exceed measured historical diversions through the Roberts (Blue River), Gumlick (Williams Fork River), and Moffat (Fraser River) tunnels, and
3. Modeled average stream flows at both the "Fraser River at Winter Park" and "Williams Fork below Steelman" USGS gages that are lower than historical averages.

Annual water demand data, reported in Denver Water's Comprehensive Financial Reports, show that the average modeled demand used in the Current Conditions baseline model is higher than the actual average annual demand.

Treated and non-potable water delivered to both inside and outside Denver's Combined Service Area from 2000 to 2014 averaged 213,782 AFY and 37,117 AFY, respectively, equal to an average total demand of 250,900 AFY (Appendix C). Also in Appendix C is a link to the individual yearly financial reports that contain data on non-potable deliveries.

Though retained in the total demand figure, non-potable effluent and re-cycled water reduce the total demand for raw water supplies. For example, in 2014, 4,295 AF, or 17 percent, of non-potable water deliveries consisted of effluent and recycled water. Use of an average demand in the Current Conditions model that exceeds the measured average by approximately 34,000 AFY inflates the FEIS current conditions baseline. In the model, additional transbasin diversions through the Moffat and Gumlick Tunnels are increased to meet these inflated model demands resulting in higher modeled diversion rates in the current conditions baseline than measured historical diversion rates.

Because modeled diversions are high in the Current Conditions baseline, modeled streamflow in the western slope source streams are lower than averages of measured historical data. Therefore, water supply demand, transbasin diversions, and streamflow in the Current Conditions baseline do not reflect existing measured conditions and so, per NEPA requirements, should not be used as the starting point to assess impacts of the proposed project and RFFAs.

Historical average annual measured flows through the Moffat, Gumlick, and Roberts transbasin tunnels are shown in Table 3-1. Averages of the historical flows measured at the Moffat and Gumlick (between the upper Williams Fork basin and Vasquez Creek in the Fraser River basin) Tunnels for the most current 30 years, 1984 to 2013, are 56,532 AFY and 4,954 AFY, respectively. FEIS Section 3.1.5 (at page 3-27) states that diversions through the Moffat Tunnel from 1975 to 2004 averaged 55,900 AFY, approximately 600 AFY lower than the 1984 to 2013 average, but comparable.

The modeled current condition diversions used for the FEIS were 63,799 AFY and 69,676 AFY at the Moffat and Roberts Tunnels, respectively, exceeding actual historical averages by approximately 7,300 AFY and 13,500 AFY. As the FEIS cumulative impacts analysis was bounded by Current Conditions model results, FEIS cumulative impacts did not consider the 20,800 AFY diversions through both tunnels falsely incorporated into the model.

Table 3-1: Increases in Transbasin Diversions through the Moffat and Roberts Tunnels Resulting from the PACSM Model Scenarios in Comparison to Historical Diversion Data

Time Frame	Moffat Tunnel (AFY) (% of all additional diversions)			Roberts Tunnel (AFY)	Sum of Diversions
	Total	Fraser R.	Williams Fk	Total	
Historical Diversions	56,532[1]	51,578[2]	4,954[1]	56,227[3]	112,759
Current Conditions Baseline[4]	63,799	54,946	8,853	69,676	133,475
Current Minus Historical	7,267 (36%)	3,368	3,899	13,449 (30%)	20,716
Full Use Baseline[4]	66,512	56,772	9,740	96,939	163,451
Full Use Minus Current Cond.	2,713 (14%)	1,826	887	27,263 (60%)	29,976
Proposed Project [4]	76,797	65,149	11,648	101,775	178,572
Prop Project Minus Full Use	10,285 (50%)	8,377	1,908	4,836 (10 %)	15,121
Sum of ALL Incremental Additional Diversions	20,265	13,568	6,694	45,548	65,813
Sum Prop. Project - Current Cond. Incremental Diversions	12,997	10,202	2,795	32,099	45,097

1 Diversion data from cdss ; 1984 to 2013 average: Note, Gumlick Tunnel noted as Williams Fork Tunnel in cdss website
2 Fraser Basin Diversions equal the Total Moffat Tunnel Diversions minus Williams Fork Diversions

3 Source Grand County Rebuttal document: 1964 to 2008 average annual diversions
4 Average Annual Flows reported in Table H-7.1.

The impact of the additional diversions in the Fraser and Williams Fork basins is seen primarily at the "Fraser River at Winter Park" and the "Williams Fork Below Steelman" USGS gages. Average post-Moffat stream flows compared to the average modeled current condition flows at these gages are noted below. To summarize:

Fraser River at Winter Park USGS gage:

- Historical Post-Moffat (1936 to 2013) average annual flow equals 13,020 AFY (CDSS data).
- PACSM Modeled Current Condition average annual flow equals 8,529 AFY (FEIS Table H-7.1).
- Flow is depleted due to PACSM modeling assumptions by 4,491 AFY equal to 34.5 percent of the remaining historical post-Moffat average annual flow at this gage; the reduction is 45.2, 25.3, and 38.2 percent of the remaining average monthly flows in May, June, and July, respectively.

Williams Fork Below Steelman USGS gage:

- Historical Post-Moffat (1966 to 2013) average annual flow equals 14,074 AFY (CDSS data). Note that data collection at this gage started in 1966.
- PACSM Modeled Current Condition average annual flow equals 9,600 AFY (FEIS Table H-7.1).
- Flow is depleted due to PACSM modeling assumptions by 4,470 AFY equal to 31.8 percent of the remaining historical post-Moffat average annual flow at this gage; the reduction is 64.3, 23.5, 10.7 percent of the remaining monthly flows in May, June, and July, respectively.

By bounding cumulative impacts with the Current Conditions PACSM model results, the FEIS effectively "hides" significant depletions of stream flow that will result from the Moffat expansion and fails to consider the impacts of these depletions in the FEIS.

***Conclusion**:* The historical post-diversion baseline should be used to assess cumulative impacts of the proposed project with RFFAs. The modeled Current Conditions baseline does not reflect existing conditions in the Fraser, Williams Fork, and upper Colorado basins. Use of the Current Conditions baseline instead of the more appropriate historical post-diversion baseline, fails to account for significant depletions in basin streamflow caused by inflated demand and transbasin diversion inputs to the Current Condition PACSM model.

4.0 Independent Firm Yield Analysis Shows that FEIS Purpose and Need Is Not Met With Proposed Project

The FEIS did not verify that 18,000 AFY of firm yield could be achieved by the proposed project. Because western slope basin streamflow has been severely depleted by past and present transbasin diversions (see Section 5.0 below), an independent firm yield analysis was undertaken to evaluate if the purpose and need statement of the FEIS was met by the proposed project (Appendix D).

Denver Water's diversion structures are located between one-half mile and several miles upstream of USGS streamflow gages (See Figure 1-2 of FEIS, Appendix A). As direct measurements were not available, the first step in the firm yield analysis was to empirically estimate how much additional water could be diverted at Denver Water's diversion structures. Then, <u>water balances</u> were calculated <u>each year</u> of the test period that included water in storage in the expanded Gross Reservoir, additional water diverted from the western slope basins, and 18,000 AFY or less of deliveries. The number of years where the firm yield was met was then tallied.

4.1 Firm Yield Definition

The firm yield can be likened to a bank account. Each year, a variable amount of money is put into a savings account. Each year, a set amount of money needs to be paid out. It is unclear and there is no control over how much money will be available each year so extra money is retained in the savings account to cover future short falls. If in some years there is not enough money in savings or income to cover the outlay, the firm yield of your bank account is not met.

Because the goal of the proposed project is to achieve additional firm yield it is important to define this standard hydrologic term. FEIS Section 1.4-2 states:

> "The capability of Denver Water's supply system is expressed as the "firm yield" of water that the system can produce on an average annual basis. Firm yield is a measure of a system's ability to reliably supply water to meet demand during drought periods, and is dependent on many factors, including the amount and timing of supplies and demands, reservoir operations, and physical and legal constraints. Although firm yield is controlled by drought periods, it is expressed as the average annual supply available to meet demand during a representative hydrologic study period (which includes average, wet, and dry years)."

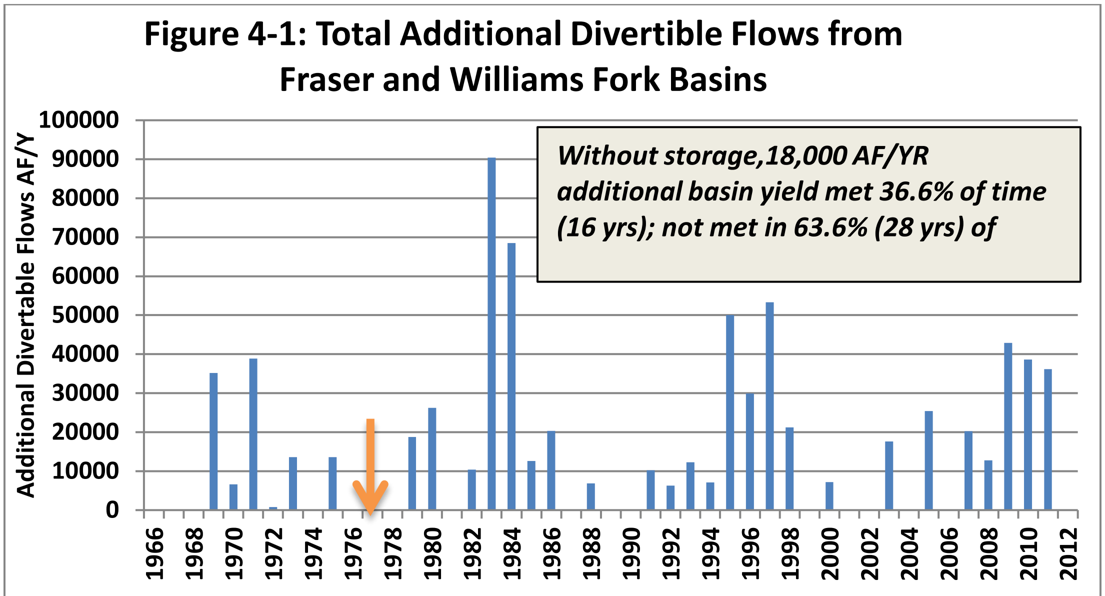
Firm yield should not be based solely on one critical drought period; rather it is the yield that can be produced over a longer term representative study period. The size of the expanded Gross Reservoir and the success of the project were determined using only the 1950s critical drought period where 18,000 AFY would be required over the 4 critical years of this drought. This methodology does not account for other critical periods, for instance, the mid-1970s, where below average streamflow persisted for several years and no additional diversions and storage were available (orange arrow in each of the figures below).

4.2 Excess Basin Flows or Additional Divertible Water

Additional divertible flows —that is, all of the remaining water in the streams at that could be diverted at Denver Water's existing diversion structures—were calculated using 1966 to 2012 historical data, including USGS stream flows and water levels at the existing Gross Reservoir.

The full method employed is described in detail in the Analysis (Appendix D). Figure 4-1 shows the full amount of additional water that could be diverted out of the Fraser and Williams Fork basins at Denver Water's diversion structures. The annual average of these additional divertible flows equals 15,557 AFY, approximately 2,600 AFY more than the FEIS average incremental increase of 12,988 AFY in Moffat Tunnel diversions between the current condition baseline and the proposed project (Table 3-1).

Of the total, estimated additional divertible flows out of the Williams Fork were 2,680 AFY compared to 2,800 AFY additional diversions noted in the FEIS. Fraser River calculated additional diversions were 12,875 AFY compared to the FEIS increase of 10,200 AFY. Because calculated average additional flows exceed FEIS diversions by 2,600 AFY, this independent firm yield analysis presents a more conservative approach and consequently provides a viable method by which to independently evaluate the firm yield of proposed project.



Storage Data missing in 1967, 1987, and 1989; these years omitted from analysis.
Source, Buchanan, 2014, Appendix D

Since this firm yield analysis was based only on additional diversions and storage and did not include variations in demand, the metric of success was if the firm yield of 18,000 AFY was achieved each year of the test period – the average of which would be 18,000 AFY if successful.

4.3 Independent Firm Yield Analysis Shows Project Purpose Not Achieved Under All Project Baselines

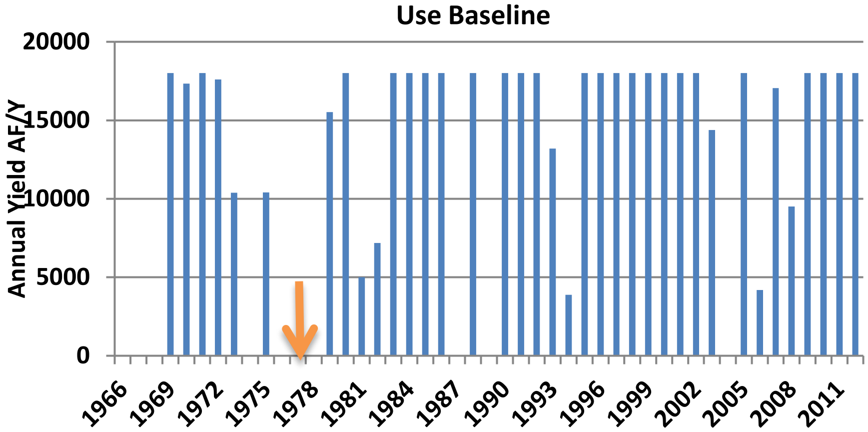
***Full Use Baseline**:* The FEIS incremental increase in transbasin diversions between "Full Use" and the Proposed Project is used to define and isolate impacts of the proposed project. According to the FEIS, to achieve an additional 18,000 AFY of new water for delivery to Denver Water's north water supply system, an average of 10,280 AFY will need to be collected from the Moffat Collection System in the western slope basins (8,377 AFY from the Fraser Basin and 1,908 AFY from the Williams Fork Basin).

The FEIS fails to explain how a firm yield of 18,000 AFY will be provided when only 10,280 AFY will be diverted—the presumption that Denver Water can provide more water to consumers than they divert from the streams is facially absurd. This discussion, however, will overlook this fatal flaw for the sake of full analysis.

Under this Full Use baseline, a portion of the total additional divertible flows (2,713 AF/yr) would be diverted through the Moffat Tunnel to meet increased demands without requiring expansion of Gross reservoir. This amount was subtracted from each year of the calculated flows. The remaining annual additional divertible flows (averaging 12,844 AFY), combined with storage in the expanded portion of Gross Reservoir (72,000 AF), were then used to evaluate the proposed project under the Full Use baseline. Years when the target yield was achieved are shown in Figure 4-2.

Based on this independent firm yield analysis, <u>the proposed project as presented in the FEIS does not meet the firm yield requirement stated in the purpose and need of the FEIS</u>. Screening criteria, PN1, reads, "Must provide new firm yield;" therefore, the proposed project — expansion of Gross Reservoir to 113,000 AF capacity plus 10,280 AFY average additional diversions — should have been screened from further consideration during the alternative screening process.

Figure 4-2: Annual Yields of Proposed Project Under Full Use Baseline



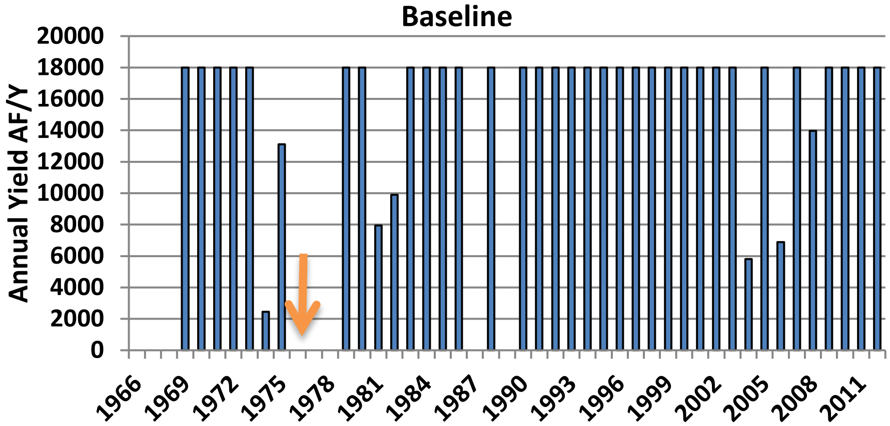
Storage Data missing in 1967, 1987, and 1989; these years omitted from analysis

18,000 AFY of yield met in 24 years (54.5%), NOT met in 20 years (45.5%) of 44 year period.

Expanded reservoir filled in only 1 year and the 72000 AF of extra storage was depleted or zero in 20 years.
Source: Buchanan, 2014; Appendix D

***Current Conditions Baseline**:* Under the Current Conditions baseline, that used to evaluate FEIS cumulative impacts, all calculated additional divertible flows (15,557 AFY, 2,600 AFY greater than FEIS additional diversions for cumulative impacts of 12,998 AFY) combined with storage in the expanded portion of Gross Reservoir (72,000 AF), were used in the independent firm yield analysis. Years when the target yield was achieved are shown in Figure 4-3. Even with all additional diversions between the Current Conditions baseline and the proposed project, the firm yield was not achieved. Again, the proposed project should have been screened from further consideration by the PN1 criteria.

Figure 4-3: Annual Yields Under Current Conditions Baseline



Storage Data missing in 1967, 1987, and 1989; these years omitted from analysis

18,000 AFY of yield met in 32 years (72.8%), NOT met in 12 years (27.2%) of 44 year period.

Expanded reservoir filled 3 years and 72000 AF of extra storage was depleted or zero in 12 years of 44. Source: Buchanan, 2014, Appendix D

If an additional 4,000 AF of divertible flows were available (approximately equal to the difference between the historical baseline and the Current Conditions baseline in the Williams Fork diversion system), the expanded Gross Reservoir would fill in only 4 years; the 72,000 AF of extra storage would be depleted or zero in 10 years; and the required yield of 18,000 AFY would be met in 34 years (77.2%) and not met in 10 years (22.8%) of the 44-year period of record.

Note that the 4,000 AFY of additional diversions could be attained from the existing diversion structures in the Williams Fork diversion system, particularly with changes to the Big Ditch and the 10,280 water rights in the Williams Fork Reservoir.

Conclusions: All incremental increases in diversions noted in Table 3-1 between the historical baseline and the proposed project sum to 20,265 AFY, approximately equal to additional diversions required to achieve the proposed firm yield of the Moffat project in 77% of the test period years. The proposed project would still fall short of the FEIS purpose and need, even with all additional diversions above the historical average, equal to almost twice that allocated for the proposed project in the FEIS. The proposed project should have been screened from further consideration.

The FEIS purpose and need, a firm yield of 18,000 AFY, could be attained if more water could be diverted from the Williams Fork basin. As part of the Colorado River Cooperative Agreement (CRCA), Denver Water would, contingent upon approval of expansion of Gross Reservoir, develop more capacity to divert water out of the upper Williams Fork drainage across the continental divide. Attachment Q of the CRCA describes Denver Water's plans for the "Darling Creek Enlargement and Extension of the Williams Fork Diversions Project", that would extend the collection system in the upper Williams Fork basin to include diversion structures on the West branch, North Fork, and South Fork of Darling Creek as well as on Eleventh Creek and any unnamed creeks in between (Appendix E).

In addition, Denver Water has developed plans included in the CRCA to expand the Moffat Collection System by adding storage dams for reservoirs on Meadow Creek Reservoir and Cabin Creek Reservoir in the Fraser Basin. It is unclear at this time how much water would need to be diverted from the Darling Creek drainage to make up the shortfall in diversions needed to achieve the firm yield of 18,000 AFY in each year of the test period.

Though additional diversions, particularly from the Williams Fork Basin, would provide more water to Denver's diversion system in the future and would likely provide enough water to attain the firm yield of 18,000 AFY every year in the test period, these additional diversions have not been included nor impacts addressed in the FEIS.

An alternative which does attain the firm yield of 18,000 AFY will require additional diversion from the Fraser and Williams Fork basins greater than twice those allocated for the proposed project. Impacts would then also likely be greater than twice that stated in the cumulative impacts section of the FEIS (Section 5). To continue with the current proposed project, the FEIS will need to be revised to: 1) use the historical baseline, 2) substantially increase the amount of additional diversions allocated to achieve the desired firm yield, and 3) substantiate that the firm yield is achieved by providing annual yields under the proposed project. Given that project impacts will be much greater than indicated in the FEIS, another path forward would be to evaluate other less impactful alternatives such as that presented in the Citizen's Alternative (TEG, 2015).

5.0 FEIS Understates Impacts to Upper Colorado Basins

The following discussion presents evidence that the FEIS:

- By using average instead of median streamflow statistics, the FEIS overestimates the amount of water that remains in the upper basins and under-estimates impacts of past and present transbasin diversions; Section 5.1.
- Understates and misrepresents past or historical impacts of transbasin diversions to the Upper Colorado River basins; Section 5.2.
- Impacts of proposed project with RFFAs re-evaluated using the historical post-diversion baseline; Section 5.3.
- Other hydrologic parameters; cumulative impacts of project with RFFAs; Section 5.4

5.1 Mean Versus Median Central Tendency Statistics

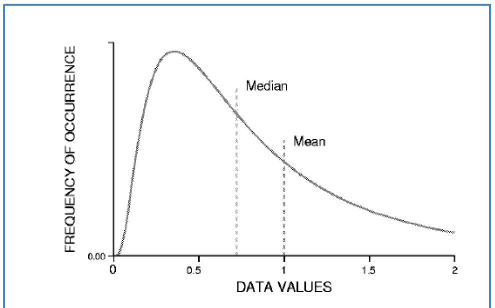
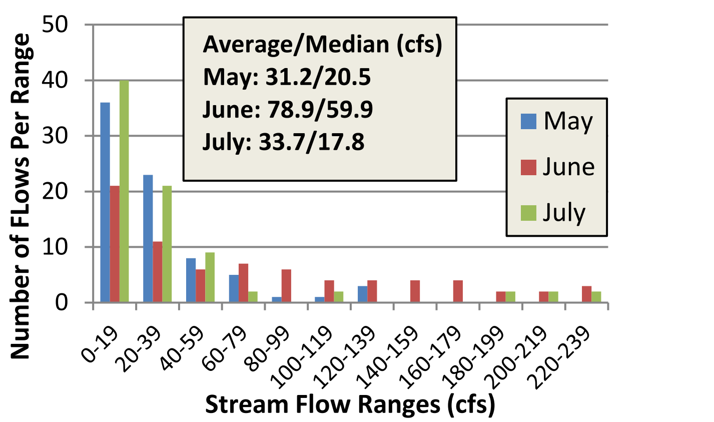


Figure 1.1 Density Function for a Lognormal Distribution

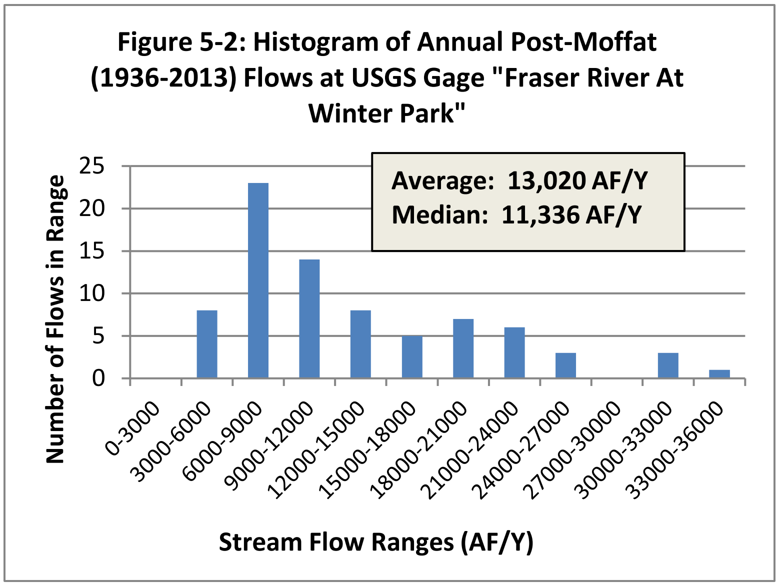
Means or averages have been used to describe the central tendency of hydrologic data. However, steam flow data are often positively skewed by infrequent high flows in the period of record, as shown in Figure 1.1 of the USGS report; Statistical Methods in Water Resources (Helsel and Hirsch, 2002), and the mean biased high. “If computing a mean appears of little value because of an outlier, the median has been shown to be a more appropriate measure of location for skewed data,” (page 11, Helsel and Hirsch, 2002). Use of the mean to define the central tendency of positively skewed stream flow data overestimates the amount of water that is available in the basin and inflates the baseline from which impacts of water diversions are evaluated.

Figure 5-1: Histogram of Post-Moffat (1936-2013) Monthly Stream Flows at USGS Gage "Fraser River at Winter Park"



The median or 50th percentile of the data more accurately represents the central tendency of skewed data. Frequency analyses of post-Moffat stream flows at all pertinent USGS gages in the Fraser, Williams Fork, and Colorado River basins show that stream flow data are, with one exception, positively skewed with the mean of historical stream flows higher than the median, often substantially higher. Frequency analyses of monthly and annual stream flows at the Winter Park USGS gage on the upper Fraser River are shown in Figures 5-1 and 5-2. Substantial positive skewness, apparent for both monthly and annual flows at this USGS station, is reflected in the disparity between the mean and the median of these data. Frequency analyses for monthly flow data obtained from

USGS gages on Vasquez, St. Louis, and Ranch Creek tributaries to the Fraser River, the Colorado River below Windy Gap and near Kremmling, and the Williams Fork River Below Steelman locations can be found in Figures 11 through 18 of the TEG Comments in Appendix B.



The degree that average streamflow data are skewed is evaluated by comparing the average streamflow to its corresponding percentile of the data; Table 5-1.

Average streamflow values over-predict the volume of water in the streams by between 5 and 25 percent over the median. Higher corresponding percentiles indicate a greater degree of positive skewness in the average.

Table 5-1: Comparison of Average Streamflow with Corresponding Percentile of Data

Streamflow	**Fraser River at Winter Park USGS Gage (1936-2013)**		**Vasquez Creek near Winter Park USGS Gage (1936-2013)**		**Colorado River Below Windy Gap USGS Gage (1985-2013)**		**Colorado River near Kremmling (1985-2013)**	
	Average	Percentile	Average	Percentile	Average	Percentile	Average	Percentile
Annual (AFY)	13,020	65th	10,572	61st	186,162	70th	717,187	57th
May (cfs)	31.2	75th	25.6	70th	531	75th	1643	63rd
June (cfs)	78.9	55th	67.6	60th	765	67th	2163	61st
July (cfs)	33.7	72nd	25.0	73rd	427	67th	1530	66th

SNOTEL data provide a relevant comparison. The National Resources Conservation Service reports normal snowpack as the 1981 to 2010 median of snow water equivalent at individual SNOTEL sites. Median snow pack values are utilized in water supply models that predict the timing and volume of water runoff on an annual basis (Pagano,2009). In both instances, the median of historical data provides a more accurate baseline to evaluate not only how much water is available in winter snow pack but also how much water is available in a basin for additional stream flow diversions.

Medians are used in several types of hydrologic evaluations. For instance, medians of hydrologic and reservoir storage data are output from climate models to assess future impacts of climate change on reservoir inflows, end of month reservoir storage, and surface water flow forecasting (USACE, 9/2011) as well as for flood control and hydropower generation (USACE, 5/2011) at dams on the Columbia and Snake River basins.

5.2 Impacts of Historical Transbasin Diversions Misrepresented in FEIS

Fraser River Basin: Stream flow gages maintained and monitored by the USGS are located throughout the Fraser and Williams Fork Basins (FEIS Section 3.1.5.1 and Figure 1-2 (Appendix A) and TEG Comments Figure 1 in Appendix B) and on the upper basins of the Colorado River. Of the gages in the Fraser River Basin, only the "Fraser River at Winter Park" USGS gage (09024000) located downstream of the west portal of the Moffat Tunnel was installed prior to 1936 when Denver Water began diverting water from the Fraser River through the Moffat Tunnel to the eastern slope.

FEIS Section 3.1.5.1:

> Average annual stream flow for the Fraser River at Winter Park gage prior to the existing Moffat Collection System was 32,080 acre-feet per year (AF/yr) for the period from 1911 through 1935. For the period from 1936 through 2004, after the existing Moffat Collection System began diverting from the Fraser Basin, stream flow averaged 12,890 AF/yr at the Winter Park gage. Differences in average annual flows for these two periods are caused primarily by the existing Moffat Collection System diversions, as well as variations in hydrologic conditions (snowpack, precipitation, temperature, and runoff.

Based on the <u>1936 to 2004 period</u> of record noted in the FEIS, Fraser River flows at Winter Park have historically been depleted on an average annual basis by <u>59.8 percent</u>. Utilizing average annual stream flows at the Winter Park USGS gage over the post-Moffat <u>1975 to 2004 period</u> of record (13,360 AFY) compared to the 1911 to 1935 pre-Moffat period, the historical average annual percent depletion is <u>58.3 percent</u>. These percentages were not included in discussion in the FEIS.

Stream flow depletions at the Fraser River at Winter Park gage were also evaluated using estimated native or unaltered flows, FEIS Table 3.1-11.

> FEIS Section 3.1.5.1.
>
> Native flows are defined as gaged flows or estimated flows at ungaged points plus adjustments for reservoir releases and filling, diversions, gaged inflows, transbasin imports, and irrigation or other returns to the river.

As noted in Table 3.1-11, "Denver Water maintains a gage that records diversions from Jim Creek and the Fraser River mainstem. Diversions from Cooper, Cub, and Buck creeks, which are also upstream of the Winter Park gage, were estimated since these diversions are not gaged individually."

In this case, native flows at the Winter Park gage were estimated by adding average annual streamflow depletions from the Fraser River, and Jim, Cooper, Cub and Buck Creeks (13,817 AFY) plus transbasin diversions through the Berthoud Canal (725 AFY) to measured stream flows at the USGS gage for the 1975 to 2004 period of record (13,360 AFY). Estimates of stream flow on ungaged streams typically utilize basin drainage area, elevation, slope aspect and other hydrologic parameters in flow calculations and may have a high degree of error. Based on these gaged and estimated stream flows, the FEIS states that,
FEIS Section 3.1.5.1 (emphasis added).

> On average, Denver Water diverted approximately 50% of the average annual native flow available at the Fraser River at Winter Park gage for the 30-year period from 1975 through 2004.

As such, this calculation has a high degree of error not only due to the method of native flow calculation but also because errors of summed numbers are additive. Adding several numbers and their respective errors produces greater uncertainty in the values than simply using two numbers from the USGS data set at the Winter Park gage. Also, 50 percent is not a cumulative impact as it describes only Denver Water's contribution to stream flow depletions in the Fraser River at Winter Park.

Use of average streamflow also skews the results. As discussed in Section 5.1 of this white paper, medians more accurately represent the central tendency of positively skewed stream flow data at USGS gages in the Fraser, Williams Fork, and the Upper Colorado River basins. Comparison of annual median pre- and post-Moffat flows at the Fraser River at Winter Park gage indicate that annual stream flow depletion due to historical diversions are likely as high as 64 percent, Table 5-2.

Table 5-2: Fraser and Colorado River Historical Streamflow Depletions

Fraser River at Winter Park USGS Gage (09024000)								
	Annual (AFY)		May Monthly Flow (cfs)		June Monthly Flow (cfs)		July Monthly Flows (cfs)	
Time Period	Average	Median	Average	Median	Average	Median	Average	Median
Pre-Moffat 1911 to 1935	32,079	31,423	90.7	85.5	205	198	90	92
Post-Moffat 1936 to 2013	13,020	11,336	31.2	20.5	78.9	59.9	33.7	17.8
(% Depletion)	(59.4%)	(**63.9**%)	(65.5%)	**(76.0%)**	(61.4%)	(**69.7%)**	(62.3%)	**(80.6%)**
Colorado River at Hot Sulphur Springs USGS Gage (09034500)								
Pre-Diversion 1905 to 1935	529,959	521,272	1866	1821	3419	3240	1362	1295
Post-Windy Gap 1985 to 1994	145,275	121,108	520	405	512	372	311	267
(% Depletion)	(73%)	(77%)	(72%)	**(78%)**	(85%)	**(89%)**	(77%)	(**79%)**
1981 Drought Yr. Measured flows	82,510		222		282		180	
Colorado River near Kremmling USGS Gage (09058000) d/s of Blue River and Muddy Creek								
Pre-Diversion 1905 to 1918	1,337,878	1,259,776	4220	4060	8029	7539	3485	3088
Post-Windy Gap 1985 to 2013	717,187	654,716	1643	1315	2163	1376	1530	1038
(% Depletion)	(46.4%)	(48.0%)	(61%)	(**68%**)	(73%)	(**82%**)	(56%)	(**66%**)

Per the FEIS, it is anticipated that additional stream flow will be diverted primarily in the months of May, June, and July, concentrating the impact of further diversions to the irrigation months. Streamflow depletions in these months, shown in Table 5-2, range from 61 to 66 percent depletion using average monthly flows and from 70 to 80 percent depletion using median monthly flows (Figures 2a and 2b, TEG Comments to FEIS, Appendix B).
Conclusion: By using average streamflow and calculated native flows, the FEIS under-estimates historical depletion of annual stream flows at the Fraser River at Winter Park USGS gage by as much as 14 percent and under-estimates historical monthly stream flow depletions in the irrigation season by up to 20 to 30 percent.

Upper Colorado River: Three USGS gaging stations, located below the confluence with the Fraser River, provide information on historic stream flow depletions on the Upper Colorado River mainstem from Windy Gap Reservoir to Kremmling:

- USGS (09034250) Colorado River Below Windy Gap; period of record from 1982 to present
- USGS (09034500) Colorado River at Hot Sulphur Springs; period of record from 1905 to 1994.
- USGS (09058000) Colorado River near Kremmling; period of record from 1905 to 1918 and 1962 to present.

Additionally,

> Native flow at Windy Gap was estimated to be the gaged-flow plus estimated depletions (Grand River Ditch, Adams Tunnel, Moffat Tunnel, and Windy Gap Diversion, C-BT evaporation, and Grand County depletions) upstream of the gage [for the 1985 to 2004 period of record]. This estimate does not include the effect of depletions associated with agricultural irrigation upstream of the Windy Gap gage.

Per FEIS Table 3.1-14, 33.6 percent of the native flows at the Windy Gap gage remain in the Colorado River; equal to 66 percent depletion of average annual native flows (noted as 62 percent in FEIS Section 3.1.5.3) at this location.

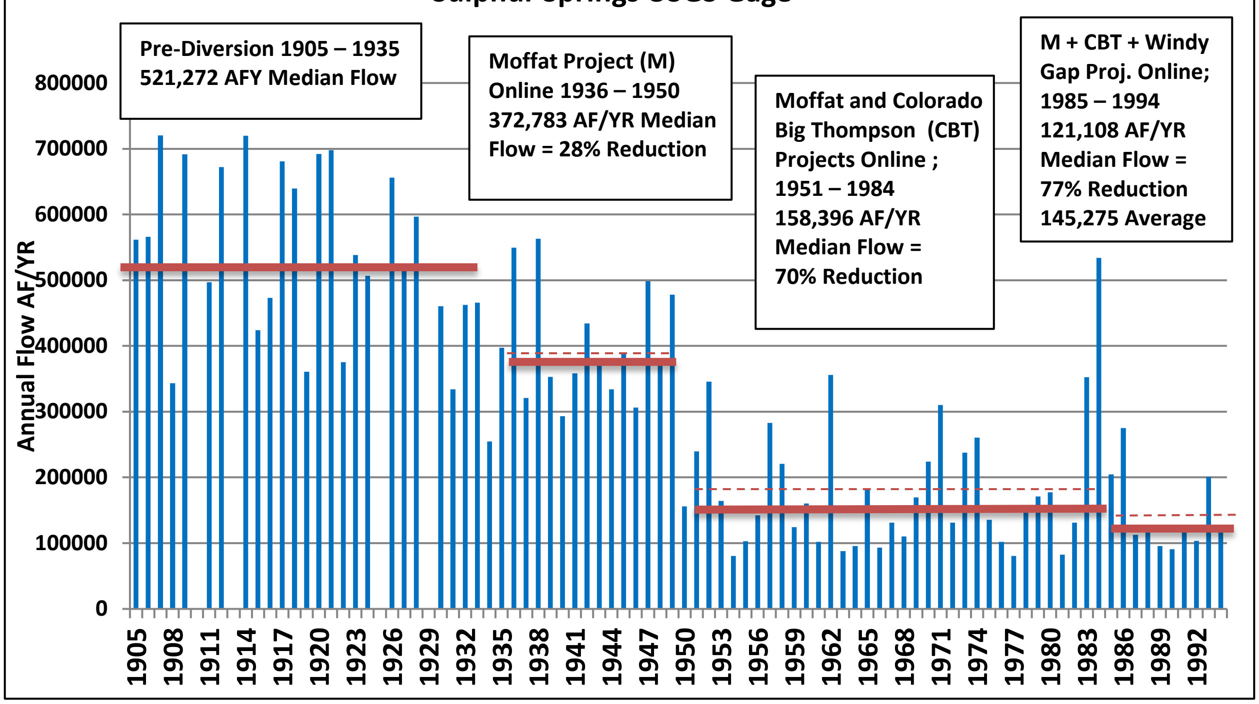
At Hot Sulphur Springs, the FEIS states an annual average depletion of 56.7 percent (FEIS Section 3.1.5.3, emphasis added):

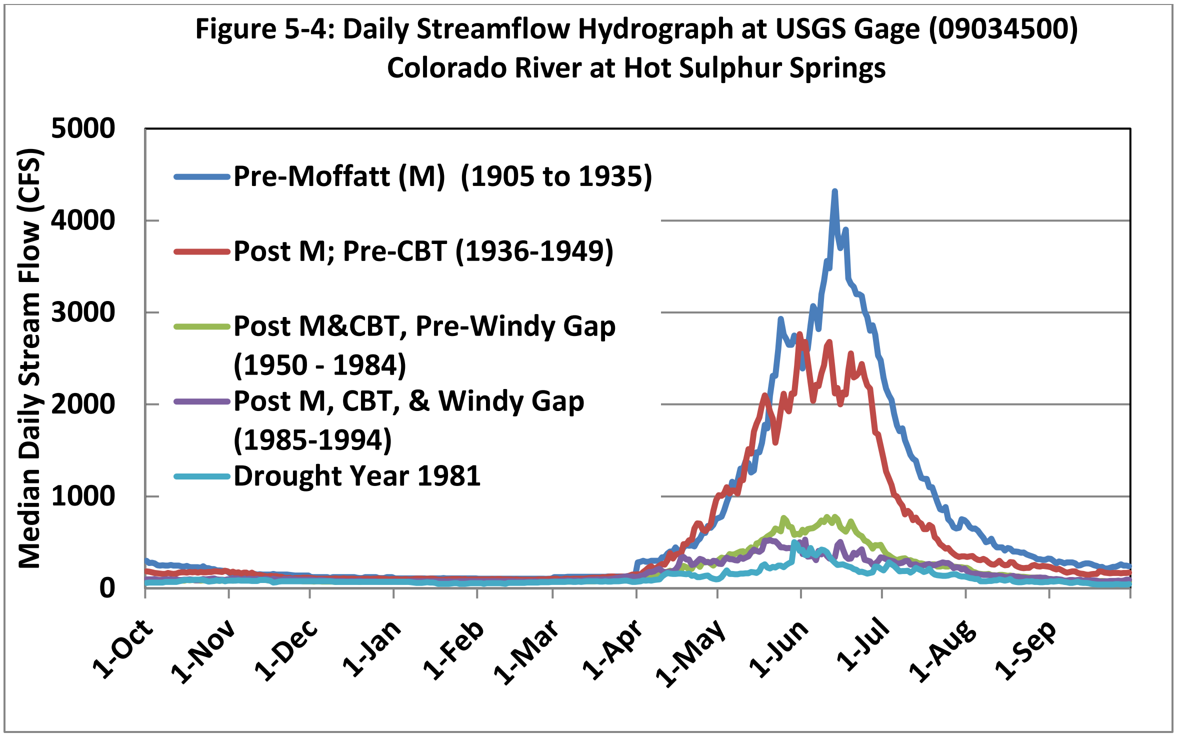
> Average annual flow [at] the "Colorado River at Hot Sulphur Springs" gage was 528,730 AF/yr prior to [Moffat tunnel diversions] (1905 through 1935) and 229,030 AF/yr for the post-Moffat time period from 1936 through 1994. Colorado Big Thompson and Windy Gap transbasin diversions started in 1950 and 1985, respectively."

Because diversion projects upstream of Hot Sulphur Springs came online at different times after 1936, it is more appropriate to utilize the period of record starting in 1985 to assess the cumulative impact of all historical diversions. Average annual flows at the Hot Sulphur Springs gage from 1985 to 1994 were 145,275 AF/yr (Table 5-2), resulting in a higher depletion of average annual historical flows of <u>73 percent</u>. Stream flow depletion is even higher <u>(77%)</u> when median annual flows are used and when monthly average and median stream flows in May (<u>72 and 78%), </u>June (<u>85 and 89%), </u>and July (<u>77 and 79%</u>) are considered (Table 5-2).

Use of average annual streamflows over the entire post-diversion period (1936 to 1994) at the Hot Sulphur Springs gage on the Colorado River substantially under-estimates the cumulative impact of upstream transbasin diversions. This concept is clearly depicted in Figures 5-3, which shows the stepwise increase in annual average and daily median stream flow depletions at the USGS Hot Sulphur Springs Gage, and 5-4, which shows median daily stream flows over the period of record and compares them to drought year 1981. Annual and monthly streams flows in 1981 are also included in Table 5-2 above.

Figure 5-3: Historical Annual Streamflow at the Colorado River at Hot Sulphur Springs USGS Gage





***Conclusion**:* The FEIS under-estimates historical streamflow depletion at the Hot Sulphur Springs gage by 20.3 percent (77.0 minus 56.7 percent). Historical diversions, without any additional projects, have already pushed the Colorado River at Hot Sulphur Springs toward perpetual drought conditions.

The Colorado River near Kremmling USGS gage is located on the Colorado River downstream of the confluence with the Blue River and Muddy Creek tributaries. As such, flows at this gage reflect a vast array of historical upstream diversions and reservoir operations.

Additional transbasin diversions from the Blue River through Roberts Tunnel, from the Upper Colorado Basin through the Alva B. Adams Tunnel at Grand Lake, and from the Fraser and Williams Fork Basins through the Moffat Tunnel will all further impact flows at this gage. Due to historical operations, annual flows have been reduced by between 46 and 48 percent or 605,060 to 620,691 AFY and monthly flows in May, June, and July have been depleted by between 56 and 82 percent (Table 5-2). Historical depletions are particularly high in June.

5.3 Re-evaluation of Cumulative Impacts of Past and Present and the Proposed Project plus RFFAs Streamflow Diversions

Per NEPA requirements and the results of the independent firm yield analysis (Section 4 above), the most appropriate baseline by which to evaluate cumulative impacts of the proposed project with RFFAs is the historical post-Moffat or post-diversion baseline. The cumulative impacts attributable to the proposed project with RFFAs include impacts caused by all additional diversions from the upper basins between the historical post-diversion baseline and the proposed project (including the increment between the historical and

Current Conditions baselines not acknowledged in the FEIS. Project impacts are re-evaluated here. Project related flow depletions, summarized in Table 5-3:

- Used the historical post-Moffat/ post-diversion baseline,
- Factored in diversion discrepancies noted in Section 3 above,
- Used both the average and median of measured post-Moffat or post-diversion flows to evaluate flow depletions caused by additional project diversions,
- Used flow changes between current condition and proposed project model results (noted in Appendix H of the FEIS).

Table 5-3 compiles extensive information. The left most column lists the USGS gage location and the post-diversion historical period of record used at each station. Both annual and monthly irrigation season data are presented. The second and third columns from the left provide averages and medians of historical post-diversion flows recorded at USGS gaging stations.

Current Condition modeled average flows reported in the FEIS are shown in Column 4. The difference between the historical and Current Condition averages is also shown in the 4th column, equal to the incremental changes in streamflow that are not acknowledged in the FEIS.

Total changes in flow from the historical post-diversion baseline, including FEIS modeled Current Conditions to proposed project flow changes, are noted in the 5th column. Changes were applied to both the historical post-diversion average (6th column) and median (8th column) to calculate projected post-project flows at each USGS gage location. Columns 7 and 9 show the percent depletion of both the average and median post-diversion historical streamflow. Percentages in Column 7 compare to FEIS percent depletions since both are based on averages.

Table 5-3: Re-Evaluation of Cumulative and Project Impacts in the Upper Colorado Basins

USGS Gage	**Post-Diversion Historical USGS Data[1]**		**Current Cond. Flows[2]**	**Change in Flows[3,4]**	**Adjusted Flows and Percent Depletion of Remaining Post-Diversion Historical Flows**			
	Average	**Median**	**Average**		**Average[5]**	**% (FEIS%)[6]**	**Median[5]**	**%[6]**
Fraser River at Winter Park USGS Gage (1936 -2013)[3]								
Annual (AF/yr)	13,020	11,336	8,529 (-4,491)	6,967	6053	53.5 (29)	4,369	61.5
May (cfs)	31	21	17 (-14)	20	11	64.5 (38)	1	95.2
June (cfs)	79	60	59 (-20)	49	30	62.0 (49)	11	81.7
July (cfs)	34	18	21 (-13)	18	16	52.9 (23)	0	100
Vasquez Creek near Winter Park USGS Gage (1936-2013)[4]								
Annual (AF/yr) (1936-2012)	10,572	7,826	10,458 (-114)	5,499	5073	52.0 (53)	2,327	70.3

May (cfs)	26	17	20 (-6)	11	15	42.3 (54)	6	64.7
June (cfs)	68	46	74 (+6)	33	35	48.5 (44)	13	71.7
July (cfs)	25	11	32 (+7)	15	10	60.0 (47)	-4	**136**
St. Louis Creek Near Fraser USGS Gage (1956-2013)[4]								
Annual (AF/yr)	15,490	14,065	15,648 (+150)	2,452	13,038	15.8 (16)	11,613	17.5
May (cfs)	28	23	27 (-1)	5	23	17.8 (20)	18	21.7
June (cfs)	98	84	101 (+3)	22	75	23.5 (22)	61	27.4
July (cfs)	54	37	54 (0)	10	44	18.5 (19)	27	27.0
Williams Fork Below Steelman Creek USGS Gage (1966-2013)[3]								
Annual (AF/yr)	14,074	14,358	9,600 (-4470)	7,269	6805	51.7 (29)	7,089	50.6
May (cfs)	28	19	10 (-18)	22	6	78.6 (40)	-3	**116**
June (cfs)	115	133	88 (-27)	46	69	40.0 (21)	87	34.6
July (cfs)	56	47	50 (-6)	26	30	46.4 (40)	21	55.3
Colorado River Below Windy Gap USGS Gage (1985-2013, post- Windy Gap)[3]								
Annual (AF/yr)	186,162	122,899	155,653 (-30,509)	59,395	126,767	31.9 (18)	63,504	48.3
May (cfs)	531	394	440 (-91)	246	285	46.3 (35)	148	62.4
June (cfs)	765	460	684 (-81)	210	555	27.5 (19)	250	45.7
July (cfs)	427	274	452 (+25)	97[4]	330	22.7 (22)	177	35.4
Colorado River at Hot Sulphur Springs (1985-1994 post-Windy Gap)[7]								
Annual (AF/yr)	145,275	121,108	na	59,395	85,880	40.9 (na)	61,713	49.0
May (cfs)	520	405	na	246	274	47.3 (na)	159	60.7
June (cfs)	512	372	na	210	302	41.0 (na)	162	56.5
July (cfs)	311	267	na	97[4]	214	31.2 (na)	170	36.4
Colorado River Near Kremmling Gage USGS Gage (1985-2013, post- Windy Gap)[3]								
Annual (AF/yr)	717,187	654,716	698,958 (-18,229)	80,838[3]	636,349	11.3 (9)	573,878	12.4
May (cfs)	1,643	1,315	1,333 (-310)	472[3]	1171	28.7 (12)	843	35.9
June (cfs)	2,163	1,376	2,295 (+132)	424[4]	1,739	19.6 (18)	952	30.0
July (cfs)	1,530	1,038	1,639 (+109)	209[4]	1,321	13.7 (13)	829	20.1

[1] USGS average and median flow utilizes data in years noted by gage name.

[2] "Current Cond. Flows" = PACSM Current Conditions Modeled Flows for FEIS evaluation of cumulative impacts; numbers in parentheses equal to modeled Current Conditions minus Post-Moffat historical average flows; negative number indicates the modeled numbers are lower than the historical Post-Moffat average (FEIS Tables H-7.1, H-1.33, H-1.37, H-1.42, H-1.55, H-1.58, H-1.60).

[3] Change in flow equals (Post-diversion measured minus the Current Conditions modeled average flows) + (modeled Current Conditions minus proposed project average flows from above FEIS Tables).

[4] change in flow equals (modeled current conditions - proposed project average flows from above FEIS Tables).

[5]Adjusted average equals average of historical measured flows minus change in flow. Adjusted median equals median of historical measured flows minus change in flow.

[6]Percent depletion of Post-diversion flows. Reduction in flow applied to either the average or median of Post-Moffat historical flow statistics. Number in parentheses equals the cumulative (current condition to proposed project) percent change in flows noted in FEIS Appendix H tables.

[7] modeled changes to flow at the Windy Gap location applied to previous Hot Sulphur Springs gage location; na = not analyzed in the FEIS.

Percentages noted in Table 5-3 refer to the percent depletion of remaining stream flows left in the basins after past and present diversions. Results from Table 5-3 are shown in Figures 5-5 and 5-6 below for the Winter Park and Vasquez Creek gages.

Figure 5-5: Comparison of Average & Median Post-Diversion Flows at USGS Gage (09024000) "Fraser River at Winter Park" with Reduced Median, Modeled Proposed and Dry Year Median Flows

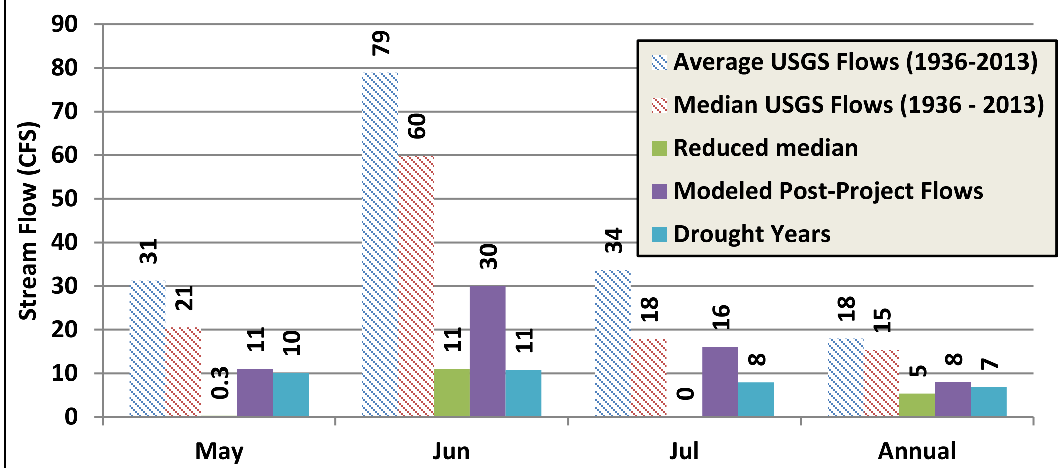
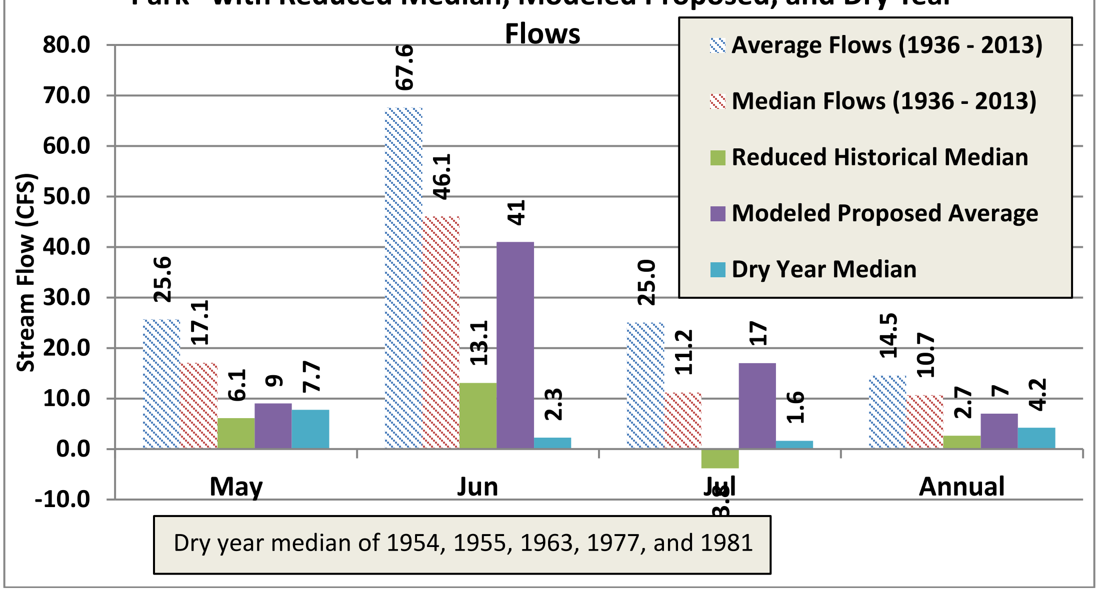


Figure 5-6: Comparison of Average & Median Post-Diversion Flows @ USGS Gage 09025000 "Vasquez Creek near Winter Park" with Reduced Median, Modeled Proposed, and Dry Year Flows



Comparative graphs for St. Louis Creek Near Fraser, Williams Fork Below Steelman Creek, Colorado River Below Windy Gap, and Colorado River Near Kremmling are found in Appendix B, TEG Comments, Figures 21 through 24.

Note that bypass flow requirements are 10 cfs on the Fraser River and 8 cfs on Vasquez Creek from May 15 to September 15. If Denver Water operates its system as presented in the FEIS future streamflow would not meet bypass flow levels in 50 percent or more of the years at these gages.

Average post-diversion stream flows at Vasquez and St. Louis Creek USGS gages are similar to modeled current condition flows. Therefore, FEIS percent depletion of average stream flows on these creeks is comparable to calculated depletions in Table 5-3. Current condition average flows on the Colorado River both under-predict and over-predict average post-diversion stream flows at Windy Gap and Kremmling. Modeled flows on the Colorado River depend on assumptions incorporated into both the PACSM and the Windy Gap Firming Project models which may increase modeling errors. Streamflow discrepancies at the Winter Park and Steelman gages have been discussed previously.

Medians of historical post–diversion flows were less than average historical flows at all locations except for the month of June at the Below Steelman gage on the Williams Fork. Therefore, when predicted changes in stream flows were applied to historical post-diversion data, use of the median resulted in higher percent reduction in stream flows, as opposed to the average. Averages that are skewed high by infrequent high flows likely over-predict the amount of stream flow that is available for additional diversions. Likewise, averages of positively skewed data under-estimate the impact that additional diversions have on basin stream flows and other ecological, aesthetic, cultural, economic, and social impacts that are inherently tied to water in streams.

Streamflow depletions noted in Table 5-3 are percentage depletions of the post-diversion streamflow that remains after past and present withdrawals. Pre-diversion flows, available at a few locations, were used to evaluate the total cumulative impact of historical and proposed future diversions on pre-diversion flows measured at USGS gages (Table 5-4).
Vasquez Creek: Per the FEIS on Vasquez Creek (FEIS pages 4-497 to 4-498_, at the USGS gage on Vasquez Creek near Fraser.

> The Proposed Action with RFFAs would result in lower flows in the runoff period compared to existing conditions. Annual flows would be 53% lower in average years, 67% lower in dry years, and 34% lower in wet years. Increased flow diversions would be greatest during spring runoff months, but flow depletions in individual months would be as much as 92% (refer to Appendix Table H-1.37). The frequency of dry years would also increase substantially (refer to Section 4.6.1).

Cumulative flow depletion on Vasquez Creek near Fraser is substantially under-estimated in the FEIS. Use of the median post-Moffat baseline flows at this gage provides a more accurate estimate of the true depletion that will occur with additional project diversions plus RFFAs (Table 5-3). True additional depletions range from 65 to over 100 percent in irrigation season months and annually are at 71 percent.

Table 5-4: Total Cumulative Impact of Past, Present and Proposed Diversions on Pre-Diversion Flows

	Pre-Diversion Median Stream Flow	Historical Diversions: Pre- to Post-Diversion Periods (% Depletion)[1]	Cumulative Proposed Project Diversions[2]	Total Diversions: Historical +Proposed	Percent Depletion of Median Pre-Diversion Stream Flow
Fraser River at Winter Park USGS Gage (09024000)					
Annual (AF/yr)	31,423	20,087 **(63.9)**	6,967	27,054	**86.1**
May (cfs)	85.5	65 (76.0)	20	85	**99.4**
June (cfs)	198	138 (69.7)	49	187	**94.5**
July (cfs)	92	74.2 (80.6)	18	92.2	**100**
St. Louis Creek near Fraser USGS Gage (09026500)[2]					
Annual (AF/yr)	25,654	11,589 (45.2)	2452	14,041	54.7
May (cfs)	54.8	31.6 (57.6)	5	36.6	**66.8**
June (cfs)	164	80 (48.9)	22	102	**62.3**
July (cfs)	82.6	45.6 (55.2)	10	55.6	**67.3**
Colorado River at Hot Sulphur Springs (09034500)[4,5]					
Annual (AF/yr)	521,272	121,108 (76.8)	59,395	459,559	**88.2**
May (cfs)	1,821	405 (77.8)	246	1,661	**91.3**
June (cfs)	3,240	372 (88.5)	210	3,078	**95.0**
July (cfs)	1,295	267 (79.4)	97[4]	1,125	**86.9**
Colorado River Near Kremmling USGS Gage (09058000)[4]					
Annual (AF/yr)	1,259,776	597,718 (47.5)	80,838	678,556	53.9
May (cfs)	4,060	2,745 (67.6)	472	3,217	**79.2**
June (cfs)	7,539	6,163 (81.7)	424	6,587	**87.4**
July (cfs)	3,088	2,050 (66.4)	209	2,259	**73.2**

[1]Historical diversions equal difference in Pre- and Post-Moffat (Diversion) median stream flow. Percent depletion due to historical diversions noted in parentheses, based on medians.
[2] Project diversions equal to change in flow column in Table 5-3.
[3] Two streams, Deadhorse and Spruce Creeks, enter St. Louis Creek between Denver Water's diversion points and the USGS gage. These streams, originating at Bottle Creek, elevation 11,584 feet, likely contribute significant flow to St. Louis Creek during snowmelt months of May and June.
[4] Post-Windy Gap 1985 to 1994 record at the HSS USGS gage,
[5] Project related changes in stream flow equal to model results at Windy Gap, see Table 5-3 footnote 7.

St. Louis Creek

Per the FEIS page 4-495:

> In St. Louis Creek downstream of the Denver Water diversion (PACSM Node 2170), on an average annual basis there would be 20% less water in average years, 8% less water in dry years, and 14% less in wet years (refer to Appendix H, Table H-1.40). The additional diversions would occur during spring runoff. Peak flow would decrease by 12.5 cfs (23%) in average years (refer to Appendix H, Table H-14.4).

These reductions are similar to percentages noted in Table 5-3 for St. Louis Creek, however, depletion of pre-diversion flows at this USGS gage location, not discussed in the FEIS but evaluated in Table 5-4, approach the annual 60 percent threshold noted in the FEIS pages 4-480 and 4-483.

FEIS Section 4.6.11.1:

> The diversions would occur from May through September; because flows are already nearly 100% diverted in the remaining months. The additional diversions would extend the period of no flow by approximately two weeks on average although there would be one year with up to 63 additional zero flow days. There is no bypass flow for these streams (tributaries to St. Louis Creek)."

***Hot Sulphur Springs**:* The Colorado River at Hot Sulphur Springs is located in a hole in the river. Transbasin diversions from both the upper Colorado and the Fraser River impact streamflow at this location as well as out-of-priority transbasin diversions which are replaced by releases from the Williams Fork Reservoir, downstream of Hot Sulphur Springs.

Since historical streamflow is already heavily depleted (77 percent annually) with substantial additional upstream transbasin diversions planned as part of both the WGFP and the Gross Reservoir projects, the potential for severe streamflow depletion is high at this location. As the PACSM model did not include a node at Hot Sulphur Springs, or it was not noted in the FEIS results table, to estimate the predicted impact on streamflow at Hot Sulphur Springs, modeled changes in flow at the Windy Gap gage location were subtracted from pre- and post-diversion flows at the Hot Sulphur Springs USGS gage location (Tables 5-3 and 5-4).

Annual streamflow at this location is heavily depleted, both before (77%) and after implementation of both the WGFP and the Moffat projects (88%). This stretch of river is classified for Aquatic Life Cold Water Class 1 Tier II, Recreation E, Water Supply, and Agricultural uses. The section of the Colorado River between Granby and Hot Sulphur Springs is a Gold Medal fishery. As such, preservation of aquatic wildlife in this stretch of river is important and deserves not only a node in the PACSM model but also special consideration in the 401 certification process.

***Williams Fork**:* Per the FEIS page 4-504, in the upper Williams Fork drainage,

> The hydrology data for the proposed action with RFFAs indicate average annual flow reductions of 13% in average and dry years and 6% in wet years. Peak flow in an average year would be reduced by 17 cfs (9%) (refer to Appendix H, Table H-14.4). Additional diversions would occur from May through August, and relative reductions would be largest in July of dry years.

By not accounting for the difference between historical and current conditions flows at the Williams Fork USGS gage below Steelman Creek, the FEIS substantially understates the impact of additional transbasin diversions on streamflow at this location.

Additional streamflow depletions at this gage would range from 34 to over 100 percent in irrigation season months and see an additional 50 percent annual depletion. Under-estimated stream flow depletion in the upper Williams Fork basin does not account for the inflated Current Condition baseline and casts doubt on the aquatic wildlife conclusions noted for the upper section of the Williams Fork; classified for Cold Water Aquatic Wildlife Class 1 use.

5.4 Re-Evaluation of Additional Hydrologic and Population Impacts

Impacts of additional transbasin diversions on other hydrologic parameters also depend heavily on which baseline is used. Technical analyses presented in previous sections provide evidence that the historical post-diversion baseline should be used to assess impacts to the Fraser, Williams Fork, and Colorado River basins. Impacts on annual and monthly flows are discussed above. Three other hydrologic parameters, the increase in the annual number of dry years, reduction in stream flow percentiles, and reduction of average peak flows (FEIS Section 4.6.1) are re-evaluated below. In contrast, the impact on water supplies in the Fraser and Blue River basins is over-stated in the Full Use model to minimize project related impacts associated population growth in the western slope basins. Impacts to water quality are evaluated in the state 401 certification project application as discussed in Section 6.0 below.

Change in Number of Dry Years

Dry years were identified in the FEIS as those having annual flow volume (acre-feet) less than the 25th percentile of the Current Condition annual flows; the lowest quartile of years in the 1947 to 1991 modeled period of record. Note that percentile is the percent of the distribution that is equal to or below this value or, in this case, annual flow volume. The FEIS analysis thus uses the Current Condition baseline.

Numbers of dry years were re-evaluated using the post-diversion historical baseline (Table 5-5) at locations where USGS data coincided with FEIS locations for this parameter. Twenty-fifth percentiles of the historical post- diversion data were calculated using the full and, for comparison to the FEIS, where possible, the 1947 to 1991 period of records. Twenty-fifth percentiles of the historical data were then compared to 25th percentiles of the current conditions baseline shown in FEIS Appendix H-15 Tables. For instance, in Table 5-5, the 25th percentile of historical annual post-diversion flows at the Winter Park gage was 7,394 AF and of Current Conditions modeled annual flows it was 4,465 AF.

The number of dry years under modeled Current Conditions, Full Use, and the proposed project was re-evaluated using the 25th percentile of historical data compared to annual model outputs provided in Appendix H-15 of the FEIS for 1947 to 1991. Modeled annual flows below the historical baseline 25th percentile were counted as dry years. At each location, the Current Conditions model row lists FEIS results from Appendix H-15. Other locations analyzed in the FEIS either were not co-located with USGS gages or the USGS data did not provide annual flows (Fraser River Below Crooked Creek).

Because Current Condition modeled flows at the "Winter Park" and "below Steelman" gages on the Fraser and Williams Fork rivers are much lower than historical post-diversion flows, the effect of using the historical baseline is most pronounced at these gages as well as at the downstream Colorado River gage at Windy Gap.

The percentage of dry years in the 1947 to 1991 period of record substantially increases when using the historical post-diversion baseline: for instance, 60, 58, and 53 percent of the modeled Current Condition years would be dry at these three locations compared to 27 percent of the years when using the Current Conditions baseline. This percentage jumps to 82, 73, and 67 percent of years that would be considered dry by today's standards if the proposed action were to be implemented. Even though results at Vasquez and St. Louis creeks more closely match the FEIS, it is anticipated that the percent of dry years on these tributaries will increase to 69 and 49 percent of the 45-year record, respectively. Using the inflated Current Conditions baseline dramatically understates the increase in dry flow years that will be experienced in the upper basins if Gross Reservoir is expanded to three times its current size and the WGFP moves forward.

The historic post-diversion baseline represents basin conditions that exist today. The lowest 25 percent of flows in the historic record are considered dry years that have been experienced by water providers in the past. Dropping the 25th percentile baseline to a modeled number that does not reflect existing average demands in Denver Water's supply system does not adequately prepare the basins for the increase in what are now considered dry years.

In other words, the lower 25th percentile of modeled current conditions ratchets down the definition of dry years: in fact, it represents much lower percentiles of flow experienced by water providers and planners in the historical post-diversion period; the 2nd, 10th, and 4th percentiles at Winter Park, below Steelman Creek, and at Windy Gap gages on the Fraser, Williams Fork, and Colorado Rivers, respectively.

For example, the 25th percentile of modeled current condition flows (4,465 AF) equals the 2nd percentile of historical stream flows at the Winter Park gage. Therefore, in the 88 years of post-diversion records at the Winter Park gage, the 2nd percentile would equal slightly more than the lowest flow recorded after 1936. Under the modeled current conditions baseline a quarter of the resultant flows are below this point.

Table 5-5: Number of Dry Years: Annual Flows Below 25th Percentile

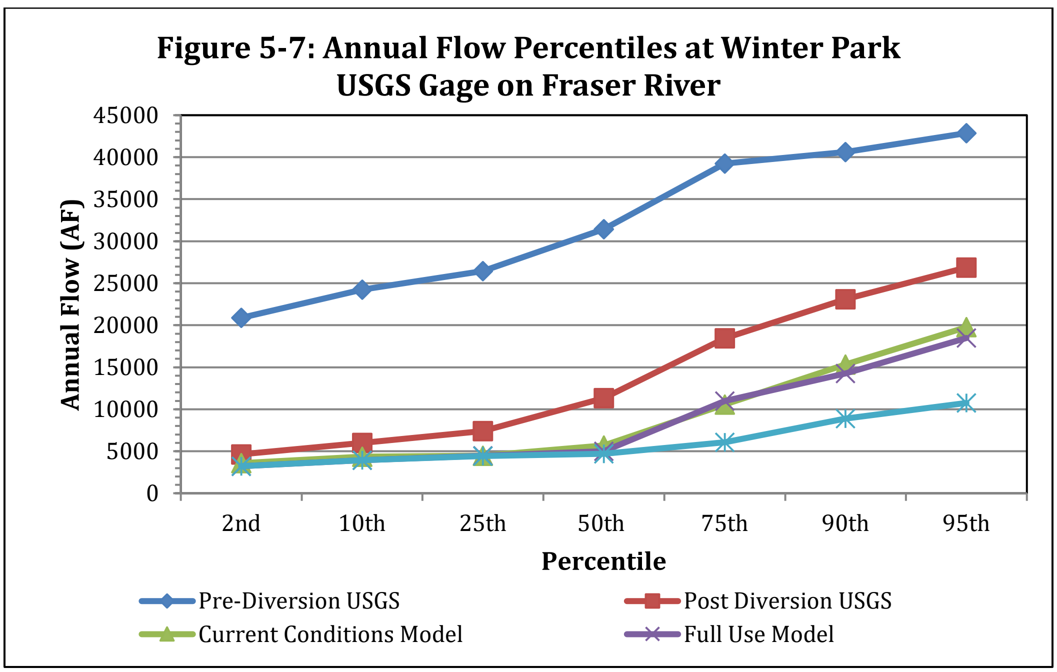
Station	25th percentile[1] (AF)	Current Conditions [2] (% dry years)[4]	Full Use[2] (% dry years)[4]	Proposed Project [2] (% dry years)[4]
Fraser River at Winter Park USGS gage (09024000)				
Post Moffat: 1936-2013	7,394	27 (60%)	30 (67%)	37 (82%)
Post Moffat: 1947-1991	7,124	26 (58%)	29 (64%)	37 (82%)
Current Conditions Model [3]	4,465	12 (27%)	12 (12%)	15 (33%)
Vasquez Creek Near Fraser USGS Gage (09025000)				
Post Moffat: 1936-2012	5,500	14 (31%)	24 (53%)	31 (69%)
Post Moffat: 1947-1991	5,056	13 (29%)	24 (53%)	30 (67%)
Current Conditions Model [3]	4,802	12 (27%)	23 (51%)	29 (64%)
St. Louis Creek Near Fraser USGS Gage (09026500)				
Post Moffat: 1936-2013	10,491	13 (29%)	16 (36%)	22 (49%)
Current Conditions Model [3]	9615	12 (27%)	13 (29%)	18 (40%)
Williams Fork Below Steelman USGS Gage (0903550)				
Post Moffat: 1966-2013	10,525	26 (58%)	28 (62%)	33 (73%)
Current Conditions Model [3]	3,405	12 (27%)	13 (29%)	17 (38%)
Colorado River at Windy Gap USGS Gage (09034250)				
Post-Diversion: 1985-2012	103,499	24 (53%)	30 (67%)	30 (67%)
Current Conditions Model [3]	81,582	12 (27%)	19 (42%)	22 (49%)

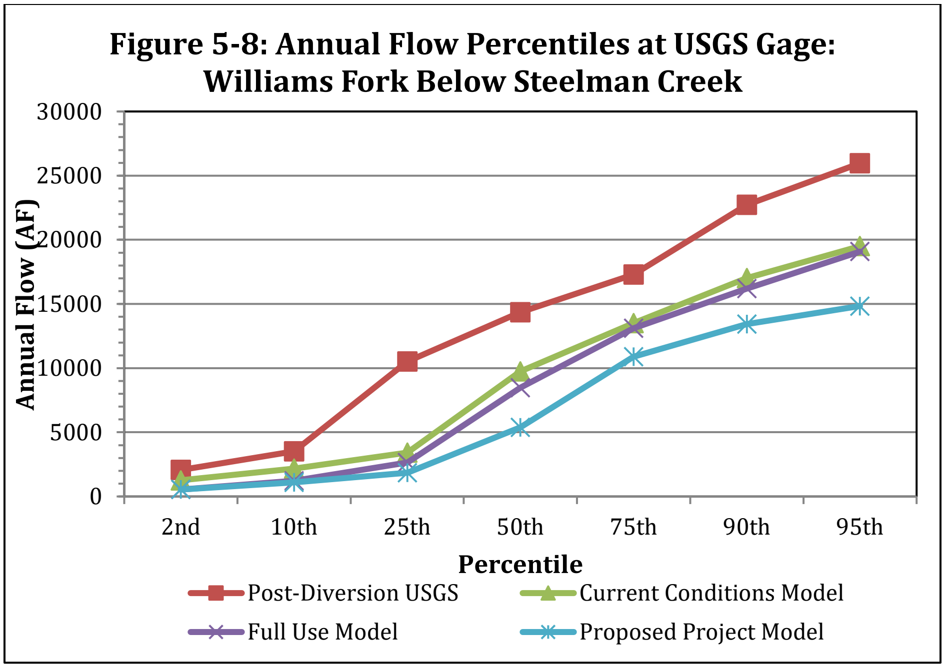
[1] 25th percentile of total annual flow volume recorded at USGS gages from the Post-Moffat period of record.
[2] Annual flows output from current condition, full use, No Action, and Proposed Project PACSM model scenarios for test period 1947 to 1991: Tables H-15.1, H-15.3, H-15.5, H-15.8, H-15.9.
[3] 25 percentiles and number of dry years reported in FEIS tables noted under footnote 2.
[4] percent of years of the 1947 to 1991 test period that are dry.

Percentiles of modeled annual flows (Appendix H-15) are compared to historical post-diversion USGS flow data at "Winter Park" and "Below Steelman" gages on the Fraser and Williams Fork Rivers in Figures 5-7 and 5-8, respectively. Also in Figure 5-7 are percentiles of pre-diversion annual flows in Winter Park.

Note that percentile is defined as the percent of a distribution that is equal to or below a value. For instance, at Winter Park, 95 percent of annual flows were below 42,869 AF and 26,875 AF under pre- and post-diversion conditions, respectively. Ninety-five percent of the annual flows modeled as part of the current conditions and proposed project scenarios would be below 19,766 AF and 10,747 AF, respectively. Note that 10,747 AF approximately equals the median (50th percentile) of post-diversion annual flow at Winter Park.

At both locations, percentiles are substantially reduced between the historical post-diversion record and the Current Conditions model; these reductions are not acknowledged in the FEIS. Percentiles continue to be reduced between the Full Use and proposed project models calling into question the FEIS statement that project related impacts are insignificant or minimal compared to Full Use impacts.





Peak Flow Reduction

Peak flow changes were evaluated in the FEIS using (FEIS page 4-94):

> The Nature Conservancy's Indicators of Hydrologic Alteration (IHA) to evaluate changes in the flow regime at 12 locations in the Fraser River Basin. The IHA is a statistically based program for comparing hydrologic regimes before versus after a river has been altered by human activities. The data series used for pre- and post-impact periods consisted of daily data from 1947 through 1991 for Current Conditions (2006) and the Proposed Action with RFFAs, respectively.

The IHA was used to calculate parameters for four different types of Environmental Flow Components: low flows, high flow pulses, small floods and large floods. IHA could not be re-evaluated using the post-diversion historical record. Changes reported in the FEIS very likely understate peak flow reductions caused by the proposed project because Current Conditions daily flow model outputs were used to represent the pre-impacted state of the Fraser River.

However, the average peak flows could be re-evaluated using historical post-diversion USGS data at select sites (Table 5-6). Many of the FEIS stream locations used for this hydrological parameter did not coincide with USGS gages. In particular, the FEIS analysis did not report results for the Winter Park, St. Louis, Vasquez, and below Steelman Creek USGS gages.

Four sites did coincide with USGS gage locations and so were used in this re-evaluation of the change in average peak flows. "Wet" years were not evaluated because post-diversion records at most of the USGS gages did not include all FEIS "wet" years. Average peak flows under the current condition baseline are consistently lower than historical average peak flows at these four locations; percent reductions in average peak flows between the current conditions baseline and the proposed project are correspondingly lower than the difference between historical average peak flows and the proposed project (compare columns 5 and 6 in Table 5-6) . For instance, peak flows are, on average, reduced by 45.5 to 62.7 percent on the Colorado River and by greater than 54 percent in the Fraser and Williams Fork Rivers: much higher than percentages reported in the FEIS (column 5 of Table 5-6). Change in average peak flows at Winter Park and below Steelman gages that could not be evaluated here, are of particular interest because of their effect on peak flows in the upper portions of both the Fraser and Williams Fork Rivers.

Table 5-6 Comparison of Average Peak Flows: Modeled versus Historical Post Diversion Peak Flows

Stream Gage	Historical Post Diversion USGS Average Peak (cfs)	Current Conditions Average Peak (cfs) (Table H-14.4)[1] (difference from hist. average peak)	Average Years Proposed Project: Average Peak (cfs) (Table H-14.4)[1]	Current Conditions – Proposed Project (cfs) (Table H-14.4)[1]	Historical Post Diversion-Proposed Project (cfs)
Fraser River Below Crooked Creek (09033300) 1999-2014	975	551 (-424)	436	-115 (21%)[2]	-539 (55.3%)[3]
Williams Fork Above Darling Creek (09035700) 1966-2014	411	204 (-207)	187	-17.3 (8.5%)[2]	-224 (54.5%)[3]
COR @ Windy Gap (09034250) 1985-2014	1,680	802 (-878)	626	-176 (22%)[2]	-1,054 (62.7%)[3]
COR near Kremmling (09058000) 1985-2014	3,802	2,641 (-1,161)	2,073	-568 (21.5%)[2]	-1,729 (45.5%)[3]

[1] Modeled flows 1947-1991 period of record. [2] Percent of current conditions average peak. [3] Percent of Historical post-Moffat average peak.

Additional Hydrologic Parameters

Use of the inflated Current Conditions baseline under-represents the impact of the proposed project on average peak flows and number of dry years that will occur if the proposed project is implemented. Other hydrologic parameters that would be influenced by this difference in baselines but have not been re-evaluated here are:

- IHA results for low flows, high flow pulses, small floods, and large floods discussed above,
- Reduction in 2-, 5-, and 10-year flows both in terms of magnitude and duration
- Effective discharges
- Groundwater fluxes into and out of the streams in the upper Colorado basin
- Floodplain extent: lower gage heights with reduced peak flows

These hydrologic parameters influence most all other impacts to the west slope basins in the upper Colorado River including:

- Stream Channel Morphology
- Sediment Transport
- Health and extent of wetlands and riparian vegetation

- Aquatic Biological Resources
- Protection of Special Status Species
- Recreation
- Water supply for Upper Basin communities
- Economics of Upper Basin communities

Water quality is also influenced greatly by water quantity. Water quality as it relates to protection of stream uses under state regulations was evaluated in Denver Water's 401 certification application. Section 6 summarizes key points and methodologies of the 401 certification application and, in light of the above discussions, provides comments on the application.

Full Use Baseline: Population Growth in Grand and Summit Counties Curtailed

An additional 2,700 AFY, on average, will be diverted through the Moffat Tunnel between the Current Conditions and Full Use Baselines. To assess the impacts of the proposed project alone, the FEIS utilizes the Full Use baseline stating that this amount of additional diversions could be withdrawn from the upper basins to serve 345,000 AFY of demand, expected to occur by 2022, without enlargement of Gross Reservoir.

Percent depletion of hydrologic parameters attributed to changes between Current Conditions and full use of the system is relatively small. For example, streamflow depletion at the Winter Park USGS gage between the <u>Full Use and proposed project</u> would be 1,900 AF/Y or 24 percent of average annual flows and 22.6 cfs or 43 percent in June, (FEIS page 5-20). Cumulative impact on streamflow depletion at this location (<u>between Current Conditions and proposed project</u>) is 29 percent of annual flows and 49 percent of monthly flows in June (Table 5-3). The differential of 5% and 6%, respectively is attributed to the change between the <u>current condition and full use baselines</u>.

Use of the Full Use baseline reduces basin impacts attributed to the proposed project, for many hydrologic parameters, by a small amount. Therefore, the bulk of the cumulative impacts noted in the FEIS between the Current Conditions baseline and the proposed project should be attributed to the proposed project. This concept is easily portrayed in Figures 5-5 and 5-6 above.

One exception is where in-basin diversions have increased to accommodate projected population growth and water use by Summit and Grand Counties. For example, Vasquez Creek Full Use flows at the Vasquez USGS gage are much lower than Current Conditions flows (by 30 % Table H-7.1) because build out water diversions for Grand County were included in the Full Use baseline as a RFFA.

The resultant incremental change in flow depletion under Full Use is also higher at locations downstream of Vasquez Creek, including Fraser River below Vasquez Creek, below St. Louis Creek, below Crooked Creek, and at Granby. Other exceptions are related to inclusion of other

RFFAs, such as the WGFP and water rights changes in the Williams Fork basin. In-basin growth is discussed here.

FEIS page 4-26:

> The population in Grand and Summit counties is expected to more than double over the next 25 years, from a year-round population of about 39,000 in 2005 to about 79,000 in 2030 (ERO 2007) [...] The largest growth in water demands in the Fraser River Basin is expected to occur in areas served by the Grand County Water and Sanitation District No. 1, the Town of Fraser, and Silver Creek Resort. The Grand County Water and Sanitation District No. 1, which serves areas along the Fraser River to the north of Winter Park, is the single largest water provider in Grand County. The largest growth in water demands in the Blue River Basin is expected to occur in areas below Dillon Reservoir including the towns of Silverthorne, Eagles Nest, and Mesa Cortina. Build-out municipal and industrial demands are estimated to be 16,168 AF for Grand County and 17,940 AF for Summit County as identified in the Upper Colorado River Basin Study (UPCO) (Hydrosphere 2003).
> FEIS page 4-27:
>
> Shortages would be most severe for the Grand County Water and Sanitation District and the Town of Fraser, averaging 358 AF/yr and 247 AF/yr, respectively. These shortages would occur primarily in the fall and winter months as a result of lack of physical supply and Denver Water's upstream diversions. Other water supply systems that would experience shortages to a lesser degree under build-out conditions include the towns of Hot Sulphur Springs and Kremmling, Winter Park West Water and Sanitation District, and Silver Creek Resort [now Granby Ranch Ski Area].

Modeled shortages for the upper basins are over-stated in the Full Use Baseline as follows. Column 3 of FEIS Table 4.1.3-3 presents current condition 2006 demands for upper basin entities. If the upper basin additional demands were increased yearly over the 24 years from 2006 to 2030, this would result in an annual increase in demand of 674 AF for Grand County and 748 AF for Summit County.

Over the 14 years between 2006 and 2020 at Full Use, demand would increase by 9,436 AFY and 10,465 AFY in Grand and Summit Counties, respectively. Beyond, 2020, demand would continue to increase each year but the shortage would be caused by implementation of the proposed project and so should be considered an impact of the project not factored out under the Full Use Baseline.

In essence, the effect of the proposed project is to limit growth and economic development in the western slope source basins to fuel growth and economic development on the Front Range. It is interesting to note that full build-out in the upper basins requires only 16,168 AF for Grand County and 17,940 AF for Summit County. The economic benefit of build-out in the western slope towns and ski resorts as well as streams with adequate flows for recreation might outweigh the benefits of supplying this much water to Front Range communities. It is also interesting to note that diversions for in-basin uses will return greater than 50 percent of the diverted amount to downstream flows reducing the impact within the basin as a whole. Water that is fully diverted from the source basins, or transbasin diversions, does not return any flows to the source basins so the impacts are 100 percent.

6.0 Application for State 401 Certification: Impacts on Water Quality Under-Estimated

Denver Water's application for State 401 Certification of the Moffat/Gross project can be accessed in the following link: **https://www.colorado.gov/pacific/cdphe/moffat-collection-system-project.** Though a full review of the application could not be conducted at this time, the following are comments on that document, several of which pertain to use of the Current Conditions baseline. Findings in the 401 application pertain to project related water quality impacts for the 404 permit.

State anti-degradation guidance focuses on evaluation of the low-flow baseline. As such, methods employed in the application (such as, water quality data to include in assessment of background water quality and the baseline available increment) were revised to address different stressors of increased water diversions compared to a new stationery point load. Site selection targeted the most impacted site in each basin, including the Fraser River below Vasquez Creek and the Williams Fork at Sugarloaf Campground on the Fraser and Williams Fork rivers as well as sites on South Boulder Creek and North Fork of the South Platte (page 3-9 of the 401 application). Also, change in temperature exceedances was evaluated on Ranch Creek.

Even though the site selection process was driven by water quality data availability and quality, several stretches of rivers in the upper basins already on the 303d and the Monitoring and Evaluation (M&E) lists should have been included in the evaluation. On the western slope, these include:

- Fraser River downstream of Fraser and Tabernash on M&E list for copper and lead; the selected site does not have the high metals concentrations of Sections 10b and 10c, therefore, this site is not representative of lower stream sections on the Fraser.
- Vasquez, St. Louis, and Ranch Creeks are all classified as Cold Water Aquatic Life Class 1; one or more of these tributaries to the Fraser River should be included in detailed analysis. In fact, copper concentrations on Vasquez Creek (3.82 ug/L at the diversion structure) exceed the water quality standard (3.4 ug/L) potentially due to impacts of diversions from the Williams Fork River into upper Vasquez Creek.
- The Colorado River below Windy Gap to Blue River on the 303d list for temperature and Manganese (high priority) and on the M&E list for aquatic life, important as a fishery and for tourism; though assessed for temperature and MMI, manganese was not evaluated.
- Shadow Mountain and Granby Lakes are on the 303d list for dissolved oxygen and Aquatic Life, respectively. Water quality in the Fraser River affects these lakes due to pumping from Windy Gap Reservoir to Lake Granby and subsequently to Shadow Mountain Reservoir and Grand Lake. Although these lakes have been monitored in the

past, however, future impacts due to additional diversions both through the Alva B Adams and the Moffat Tunnels may increase nutrient and other contaminant loading to these high quality lakes.

Because these stream segments are already under scrutiny, at a minimum, the 401 certification process should evaluate water quality impacts in these reaches.

Baseline Water Quality: Per the 401 application, it appears that sampling for water quality, temperature, flow, and aquatic wildlife parameters in the upper Colorado basins needs to be coordinated between all entities; including the USGS, Grand County (GCWIN), Summit County, Denver Water and River Watch sampling teams.

A sampling plan needs to be compiled to identify data gaps, sample locations, sample parameters, consistent methods of sampling and water quality analyses. This information would be used to provide a complete water quality baseline for the upper basins prior to acceptance of the 401 certification applications for both the WGFP and the Moffat/Gross projects.

The analysis presented in Denver Water's 401 certification application was limited due to lack of useable data. Without an adequate baseline determination, it is impossible to accurately predict impacts of future projects. Because water supply demand in Denver Water's system has been lower than anticipated after the 2002 drought, there should be ample time to collect additional data to characterize water quality and aquatic life baselines in the upper basins. As such, the analysis in the 401 application needs to be expanded.

Load Calculations: Recent historical measured water quality data (1998 to 2013) in the targeted basins were used to characterize the water quality associated with both Current Conditions and the projected flow changes. Future concentrations were derived using the following load calculations:

$Load_{future} = Load_{current} - \text{sum } Load_{divout} + \text{sum } Load_{divin}$ Eqn 3.1 of Application

Where:

$Load_{future}$ = total mass loading rate passing a specific stream location in the targeted basin estimated by Proposed Action.

$Load_{current} = Q_{current}C_{current}$ with

$C_{current}$ = representative [existing] stream concentration at the calculation point, and

$Q_{current}$ = Current Conditions PACSM (monthly) average steam flow model at the calculation point.

Sum $Load_{divout}$ = sum of all future upstream loads leaving the basin associated with future flow changes,

Sum $Load_{divin}$ = the sum of all future upstream loads entering the basin associated with future flow changes.

The future load as well as the future pollutant concentration, depends heavily on the calculated current load. Water quality data reflect existing flow conditions in and loading to the upper basins. Current loads calculated using flows from the PACSM Current Condition model, which at several locations in the upper basins are substantially lower than historical post-diversion flows (see discussion in Section 5), are low. Artificially low current loads lead to low future loads and concentrations of pollutants in the mainstem location below Vasquez Creek.

Likewise, modeled Current Condition transbasin diversions are higher than measured historical diversion flows by 7,300 AFY: modeled additional diversions of 3,368 AFY come from the Fraser basin and 3,899 AFY come from the Williams Fork. These additional diversions above existing historical diversions are included in the Current Condition modeled baseline.

Current Condition water quality in Vasquez Creek will be different from existing measured water quality because, as diversions from the Williams Fork to Vasquez Creek increase, the water quality in Vasquez Creek will be become proportionately more like that of the upper Williams Fork due to mixing of these waters high in Vasquez Creek. It is anticipated that water diverted out of the Williams Fork has higher concentrations of metals than the upper reaches of Vasquez Creek and that additional metals loading from Williams Fork will adversely impact water quality in Vasquez Creek.

This increment between existing and Current Conditions water quality not only in Vasquez Creek but also on the mainstem of the Fraser River is ignored in the FEIS and therefore in the 401 analysis.

Load removed from the basins equals the sum $Load_{divout}$. Benefits of load reduction from the Fraser basin are overestimated by taking the benefit twice; once from the Williams Fork and again from the Fraser basin. In fact, sum $Load_{divin}$ to Vasquez Creek from the Williams Fork diversions through the Gumlick Tunnel should equal the sum $Load_{divout}$ at the Vasquez Creek diversion structure for the Williams Fork diversions; essentially negating any impact on the Fraser River metals load below Vasquez Creek. Since the mainstem location below Vasquez Creek does not "see" the load coming from the Williams Fork, the benefit of load removal through the Moffat Tunnel should be adjusted by subtracting the Williams Fork load contribution.

The 85th and median of various water chemistry concentrations was used appropriately in the evaluation. Likewise, medians of historical stream flows should be used in lieu of averages to avoid any bias caused by infrequent high flows in the period of record. Average monthly flows in the irrigation season at all gages evaluated in the Fraser, Williams Fork, and Upper Colorado River basins are skewed high, with one exception in the Williams Fork River. The median more accurately represents the central tendency of flow data and should be used in loading calculations.

Water Quality Concentrations

"Future concentrations were calculated on a monthly basis using mean monthly flow projections provided by PACSM. Water quality concentrations were not varied monthly in these calculations due to a lack of supporting data. A full set of monthly calculations were performed for each of three hydrologic scenarios: average, wet, and dry conditions," (page 3-

13 of the 401 application). It is anticipated that water quality will vary on a seasonal basis and in wet versus dry conditions. Use of the same concentration for each month may be suitable for low flow months but cannot be applied to variable water concentrations during high flow times of the year.

Data gaps should be identified if seasonal variation in water quality cannot be assessed with existing data, and additional data obtained to facilitate load calculations and provide a reasonable estimate of future concentrations of contaminants.

Temperature and MMI Analyses

By not using the historical post-diversion baseline, data obtained under historical conditions and loadings do not represent the inflated Current Conditions baseline. Existing temperature and MMI data collected from the basins under the existing flow regime likely do not represent initial Current Conditions with a much lower flow regime, particularly on the Fraser and Williams Fork mainstems.

Conclusion*:* Because project related impacts are inappropriately based on the FEIS Current Conditions baseline, instead of the existing historical post-diversion baseline, water quality and aquatic wildlife impacts have been under-estimated in the state 401 certification application.

7.0 Mitigation and Enhancement Plans

According to EPA guidance (See Section 2.2 above) a mitigation plan needs to:

- Define goals of the mitigation; including which part of the functional hierarchy (for instance, water quality, wildlife, stream temperature, channel morphology, and/or sediment loads) will need to be mitigated.
- Define debits in stream function and how these debits will be offset by stream credits as well as how each will be measured,
- Define criteria upon which to base the success of the mitigation,
- Evaluate how ongoing mitigation activities will be measured in monitoring programs,
- Generate site specific standard operating procedures to assure that monitoring is conducted appropriately; for instance, specifying water quality detection limits that are lower than mitigation goals and use of accepted and consistent sampling methods so basin wide data can be incorporated into basin analyses in space and time.
- Provide enforcement and contingency plans in the event that mitigation is not successful.

Mitigation plans incorporated into the FEIS and enhancement plans negotiated with other entities fall far short of requirements for protection of state use classifications and NEPA regulations. Impacts of the proposed project or debits to stream function have been vastly understated in the FEIS; therefore, mitigation actions proposed in and required as part of the FEIS will not protect the environment as claimed. Proposed mitigation actions that are based on the insufficient FEIS impacts analyses are included as FEIS Appendix M, the Mitigation and Enhancement Coordination Plan (MECP), and Fish and Wildlife Mitigation Plan (FWMP).

Also in these documents and in other negotiated agreements including the CRCA, the Fish and Wildlife Enhancement Plan (FWEP), the Intergovernmental Agreement (IGA) with the Colorado Department of Transportation (CDOT) are enhancement plans not connected to the FEIS requirements. Section 5 of the 401 application for state certification describes these mitigation and enhancement measures in more detail.

In some cases, project related water quality, stream temperature, and aquatic habitat impacts, identified as significant in the 401 application would be addressed via enhancement measures rather than required NEPA mitigation actions. As the enhancement plans were not intended to address project impacts and are not legally binding through the USACE's permitting process, the enhancement actions must not be considered mitigation for the proposed project.

CEQ Guidance and NEPA regulations pertaining to mitigation are discussed in Section 2.2 of this document. FEIS mitigation and enhancement plans do not provide nearly enough details to fully evaluate mitigation actions and success or failure of the measures. There is no attempt in the FEIS to identify specific projects and their associated mitigation credits in relation to impacts or debits caused by the proposed project and so there is no assurance that classified uses of stream segments in the upper basins will be protected. The USACE must revise the mitigation plan to correct these shortcomings.

7.1 Mitigation and Enhancement Measures Incorporated into Various Agreements

Mitigation and enhancement measures have been incorporated into several agreements as summarized below and in Table 7-1:

- Moffat Collection System Project Mitigation Plan, Denver Water (2014); Appendix M of the FEIS.
- Moffat Collection System Project Fish and Wildlife Mitigation Plan (FWMP) Denver Water 2011, prepared for the Colorado Wildlife Commission (CWC).
- Moffat Collection System Project Fish and Wildlife Enhancement Plan, Denver Water and the CWC, 2011; fish and wildlife enhancements to the upper Colorado River between Windy Gap to the Kemp Breeze State Wildlife Area that will be implemented per the IGA to Implement Upper Colorado River Habitat Project (March 26, 2014).
- Colorado River Cooperative Agreement, (2013). The CRCA provides a framework for numerous actions to benefit water supply, water quality, recreation and the environment. Denver Water's commitments are contingent upon the issuance of permits necessary for the construction of the Moffat Project.
- Grand County MECP, prepared by Grand County, Trout Unlimited and Denver Water (2014) contains obligatory temperature monitoring at four locations in the Fraser

and upper Colorado Rivers and the voluntary Learning By Doing (LBD) cooperative effort that encompasses additional stream enhancement measures and monitoring, initiated in the CRCA. Parties included in the LBD decision making board are Denver Water, Grand County, the River District, Middle Park Water Conservancy District, Northern Colorado Water Conservancy District (Municipal Sub-district), Colorado Parks and Wildlife, and Trout Unlimited.

- IGA between CDOT, Grand County, Town of Winter Park, and Denver Water for the Fraser Sediment Pond (2011).

Mitigation plans will be presumably incorporated into the Record of Decision and are subject to NEPA and CWA regulations described in Section 2.2. Enhancements, though possibly negotiated in good faith with other entities, are not legally binding under NEPA and the CWA, and were developed to address impacts from earlier diversions, not the impacts of the proposed project.

Mitigation and enhancement measures may or may not have sufficient funding: The FEIS fails to provide adequate documentation to make a reasoned determination. Further, the various agreements and plans lack sufficient detail to determine if the mitigation and enhancement measures can maintain a healthy stream system when streamflow, the base of the functional hierarchy upon which all other basin functions depend (Harman, 2012), <u>is substantially depleted</u> under existing past and present transbasin diversions, and <u>would be even more depleted</u> by additional diversions serving the proposed additional 72,000 AF of storage capacity at Gross Reservoir.

Importantly, several enhancement actions are designed to be implemented prior to completion of the proposed project and it is not documented that these measures would still be effective after up to 100% of the remaining streamflow has been diverted due to the Moffat expansion.

The following are comments on the proposed mitigation and enhancement plans.

Table 7-1: Proposed Mitigation and Enhancement Measures

Mitigation Measures

Aquatic Habitat (404 Permit, MECP, FWMP):

- DW will provide $750,000 for stream habitat restoration projects in the Fraser and Upper Williams Fork Rivers. "CPW will ultimately be responsible for actual design of the stream habitat projects, and DW will be responsible for permitting, constructing, and maintaining the aquatic habitat improvements. DW's costs…are in addition to the $750,000." FEIS Appendix M.
- Habitat Project on the upper Colorado River described under Enhancement Plans; "If the Corps or the Bureau requires aquatic mitigation in the Segment, some or all of the committed resources [for enhancement] will be enforceable through conditions in the permits rather than within the Habitat Project," FWEP, page 9.

Cutthroat Trout Habitat Improvement (404 Permit, MECP, FWMP):

- "DW will provide funding ($72,000) to CPW to construct a barrier and restore cutthroat trout habitat in Grand County." FEIS Appendix M.

Temperature (404 Permit, MECP, FWMP):

- DW will monitor stream temperature at two USGS gage locations: Ranch Creek near Fraser and the Fraser River Below Crooked Creek. If temperature standards are exceeded between July 15 and August 31, DW will bypass up to 250 AF of water" from a location to be determined by the LBD committee or CDOW.

- If temperatures at Fraser basin locations still are above standards additional water will be released such that flow at the Ranch Creek USGS gage is 6 cfs and at the Winter Park USGS gage is 14 cfs until "temperature falls below the Action level or Project Water is no longer being diverted" (MECP)
- DW will monitor stream temperature at two locations on the upper Colorado River: at the Windy Gap USGS gage and upstream of the Williams Fork to be operated as noted above for the Fraser and Williams Fork Rivers.
- A temperature monitoring and action plan was included in these mitigation plans.
- Failure: If, after no more than 20 years of Project operation, the additional responses actions are determined by LBD and verified by the CDPHE to have *de minimus* effects, DW will contribute $1 million to LBD for the exclusive purpose of designing and constructing projects to address stream temperature issues on the Fraser River basin. (MECP, page 5).

Flushing Flows and Sediment Control: (404 Permit, MECP, IGA): The Grand County Stream Management Plan identified the need for flushing flows to improve channel stability and sediment transport capabilities.
- DW will make reasonable efforts to provide the following flows for a minimum of 72 consecutive hours…in 3 out of 10 years." DW will inform LBD when flows are available in excess of those needed for the Project or by its existing system…." (MECP, page 5). DW will provide flushing flows on the Fraser River and St. Louis, Vasquez, and Ranch Creeks in the Fraser basin, Steelman, McQueary, and Bobtail Creeks in the Williams Fork.
- DW will operate and maintain the Fraser River Sediment Pond to reduce sediment loads (IGA with CDOT, Grand County, and Winter Park; signed June 8, 2011).
- Failure: If response actions are ineffective, DW will contribute $1 million to LBD for project(s) to improve channel stability and sediment transport in the Fraser River basin.

Learn By Doing: "Since LBD is integral to the success of the MECP, DW will request that the Corps add a permit condition to the Section 404 Permit requiring DW to remain in good standing and actively participate in LBD…." (FEIS Appendix M).

Threatened and Endangered Species: Four endangered species; bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker reside in the upper Colorado river drainages. DW signed a Recovery Agreement with USFWS stating that, if new depletions are greater than 100 AFY, a one-time fee will be paid to support the Upper Colorado Endangered Fish Recovery Program.

Enhancement Measures

Upper Colorado River Habitat Project (IGA with CDOW): FWEP, page 3, "The goal of the Habitat Project is to design and implement a stream restoration program to improve the existing aquatic environment from the Windy Gap diversion to the lower terminus of the Kemp-Breeze state wildlife area (Segment)."
- DW and Northern Water Conservancy District (NWCD) will provide $1.5 million and 3.0 million to implement the Habitat Project.
- DW and NWCD will provide $0.5 million and $1.0 million for adaptive management and maintenance associated with the Habitat Project.
- FWEP, pages 5 and 6: "The Habitat Project will be implemented through an IGA between DW, NWCD, and CDOW…CDOW will design and implement the project…in collaboration with the Habitat Stream Team" consisting of entities that have contributed financial resources. Non-financial partners, such as Trout Unlimited and homeowners, can be included in the decision process as an Advisory Team.

Colorado River Cooperative Agreement: The LBD will coordinate the following items during the Project Period.
- $2 million for environmental enhancements
- Not reduce U.S. Forest Service (USFS) minimum bypass flows in the Fraser River, Vasquez Creek, St. Louis Creek, and Ranch Creek during droughts (2,000 to 3,000 AF) to maintain aquatic habitats, except when DW has banned residential lawn watering.
- 1,000 AFY of water for instream flows in the Fraser River basin and 1,000 AFY released from Williams Fork Reservoir, with up to 2,500 AF in reservoir storage to manage releases, for instream flow. "DW, Grand County, and CWCB have filed an application in Colorado water court to obtain the adjudication of a decree that will allow this use of water for instream purposes to improve aquatic habitat," (MECP).
- $1 million for pumping to circulate water from Windy Gap to Lake Granby to enhance flows in Colorado River between these reservoirs.
-

Learn By Doing (LBD): "The Grand County Stream management Plan (SMP) is the framework for the overall LBD Cooperative Effort. The SMP will be used as a living document that will be revised as additional monitoring data are gathered and as management goals for each stream reach are agreed upon. Though LBD is part of the CRCA, the LBD management team will coordinate the following items during the Interim Period – during design and construction phase of the project starting after issuance of necessary permits.
- $2 million for water quality projects in Grand County, including improvements to waste water treatment plants,

- $1.25 million for aquatic habitat improvements.
- Preparation of an Aquatic Resources Monitoring Plan to monitor existing conditions, define desired improvements and modifications, and measure effectiveness of future actions.
- Monitoring will include additional temperature, channel stability, sediment transport, benthic macroinvertebrate, and riparian and wetland habitat monitoring.
- Establishing a common database for the past and future data collected in the Fraser Watershed.

7.2 Mitigation Debits Vastly Understated by FEIS Impacts Analysis

The FEIS vastly understates project impacts; therefore, definitions of mitigation debits are not commensurate with the true impacts to the upper basins. Impacts noted in the FEIS are generally tied to the increment between current condition and full use baselines, while "project impacts," those between full use and proposed project, are often "minor", "negligible", or non-existent (throughout FEIS Section 5, also quoted in TEG FEIS comments, pages 84 to 86, Appendix B).

The FEIS claims that the majority of impacts will be caused by previous actions and RFFAs; therefore, the impacts of the proposed project are "minimal" and do not require mitigation. These conclusions are refuted by:

- The fact that the highest percentages of additional diversions occur in the full use to proposed project increment, Table 3-1;
- Evidence that substantially more additional diversions are required to achieve the project purpose, 18,000 AFY of firm yield, than noted in the FEIS (Section 4 here), impacts which are not evaluated in the FEIS;
- Impact analyses, presented in Section 5 of this document, that use the appropriate historical post-diversion baseline instead of the arbitrary FEIS Current Conditions baseline and demonstrate significant impacts directly attributable to the proposed project; and,
- Water quality analyses in the 401 application (Section 6) that provide evidence of significant project-related impacts to water quality.

By not acknowledging impacts of the proposed project, Denver Water attempts to avoid the legal mandates to implement mitigation.

<u>Since impact analyses throughout the FEIS repeatedly under-represent or understate impacts of the proposed project and RFFAs, mitigation debits will also be under-estimated leading to incomplete mitigation efforts.</u>

Before proceeding with a decision, the USACE must revise the FEIS to:

- Re-evaluate project impacts, including impacts in the 401 application, using the historical post-diversion baseline which represents existing measured conditions in the source basins and median stream flow and model output statistics instead of averages.
- Re-evaluate and confirm the amount of additional diversions that are required to achieve 18,000 AFY of firm yield for Denver Water's northern water supply system, the

purpose and need of the project, and incorporate all required additional diversions into the FEIS impacts analysis.

- Establish a monitoring plan to obtain data that adequately defines baseline conditions; data that should have been collected as part of the FEIS process and incorporated into the FEIS impacts analyses. Such data must include, but should not be limited to, data requirements as stated in the MECP for the proposed LBD Aquatic Monitoring Plan:

    - Monitoring to fully evaluate existing baseline conditions and critical stream reaches.
    - Expanding the current monitoring network of temperature gages to fully characterize stream temperature variations in the upper basins.
    - Monitoring to fully evaluate "channel stability and sediment transport, including the analysis used in the FEIS for the Project, and to develop valid prescriptions for specific stream reaches." These data would augment information included in the FEIS.
    - Benthic macroinvertebrate monitoring to "represent, at a minimum, the four stream segments in the Fraser River watershed defined in the WQCC's Standards and Classifications for the Upper Colorado River (5 CCR 1002-33). The purpose of the monitoring is to establish a baseline to identify priority stream reaches." These data gaps were identified in the 401 application.
    - "Design and implement a mapping program for riparian vegetation in the Fraser River watershed. Locations for monitoring efforts will be determined by LBD, and should include at a minimum a species inventory and photo documentation." This is information that should have been included in the FEIS as wetland impacts factor heavily into Section 404 determinations.

- Include additional data on water quality and aquatic wildlife data gaps identified in the 401 application and other locations omitted from the mitigation plan that would be heavily impacted by the proposed project, such as the Fraser River between Winter Park and Fraser, Vasquez Creek, and Williams Fork between Steelman and Darling Creeks. The monitoring plan must be part of the FEIS requirements and monitoring results incorporated into the impact analyses prior to issuance of the permit.

- After impacts of the proposed project are re-evaluated, it is likely that other alternatives screened during the FEIS process will be less impactful and costly than the current preferred alternative. These alternatives must be incorporated and seriously considered in the revised FEIS.

- If the proposed project is still the preferred alternative after impacts are re-evaluated, mitigation actions that are required and enforceable under NEPA and the Clean Water Act, follow EPA guidance, and provide evidence that state stream use classifications will be protected, must be incorporated into the FEIS mitigation plan.

7.3 Goals Not Clearly Defined in Mitigation Plan

The stated purpose of the package of mitigation and enhancement measures is to "maintain and, where reasonably possible, restore or enhance the condition of the aquatic environment in Grand County," (Section 5.1, 401 certification application). According to the state anti-degradation rules, the goal of the mitigation plan and enhancement actions should be to preserve the water quality and classified uses in the Fraser, Williams Fork, Blue, and Upper Colorado Rivers. Upfront clear mitigation goals and commitments are required against which the effectiveness of mitigation is measured and what enforcement measures (required under NEPA 40 CFR 1505.2, for mitigation actions) are necessary to assure protection of the upper basins.

The FEIS mitigation plan does not adequately address the outcome if mitigation fails; i.e. if stream function is not achieved by mitigation measures. For instance, if additional water releases fail to achieve temperature standards at the four temperature monitoring locations in the mitigation plan or if flushing flows do not alleviate problems with channel stability and sediment transport, then, in each case, Denver Water will provide $1 million for additional projects but will not be required to implement an enforcement or contingency plan to protect the aquatic environment per NEPA and CWA.

Contingency measures in the event that mitigation measures are not implemented or are not effective should be included in the FEIS mitigation plan and incorporated into the record prior to the 401 certification and issuance of the 404 permit.

7.4 Learn By Doing, Additional and Ongoing Monitoring

Per NEPA regulations (40 CFR 1505.2) a monitoring and enforcement program must be adopted for mitigation. Appendix M of the FEIS (mitigation) and negotiated agreements with various entities do not include detailed monitoring, with the exception of temperature monitoring at four locations, and enforcement plans.

A monitoring plan must be submitted as part of the FEIS and incorporated into the Record of Decision to assure that additional monitoring will provide, if the project is implemented, enough information to evaluate impacts of the project. The monitoring plan must include standard operating procedures to assure that sample collection and analysis is of sufficient quality.

As mentioned in Section 7.2 above, monitoring must commence prior to state certification and issuance of the 404 permit to address data gaps and for full evaluation of existing baseline conditions. This monitoring plan can then be used as the basis for ongoing monitoring and evaluation of basin health over time. Even though obligatory mitigation requirements are connected with sparse mitigation actions, overall, enhancement and mitigation actions must protect the use classifications of the upper watersheds per Colorado law. A comprehensive monitoring plan by which to evaluate basin health must be incorporated into the FEIS.
The LBD committee is tasked with developing an aquatic resource plan for the Fraser River and Colorado River basins. The monitoring plan is intended to enhance the existing Grand

County Stream Management Plan (GCSMP) by creating a common database for the Fraser River, essential for facilitating the transfer of information, and identifying and targeting critical stream reaches that will be monitored over the long term to assess impacts of additional diversions as they come on line. Water temperature, channel stability and sediment transport, benthic macroinvertebrate populations, and riparian and wetland areas, are all considered important parameters for inclusion in the monitoring plan.

Several parties would be partners in the LBD process; however, there is no provision in the CRCA for public or agency (Forest Service, EPA, State) review and comment. Input from entities other than those on the committee adds transparency to the process and are absolutely necessary to ensure that mitigation commitments incorporated into the NEPA process are being met.

<u>In this regard, the LBD process does not follow the intent of NEPA that stipulates public involvement and review of development of mitigation and monitoring procedures.</u> If LBD is considered as an element of the mitigation for the proposed project there must be a procedure by which the efficacy of decisions made by the LBD group is evaluated and, if LBD is shown to be ineffective, LBD must be replaced by another mechanism to monitor these important basins.

7.5 Potential Mitigation and Enhancement Actions

Aquatic Habitat Restoration

Money has been proffered for aquatic habitat restoration and environmental enhancements: on the Fraser and Williams Fork Rivers $750,000 and $72,500 (MECP under 404 permit), $1.25 million and $2 million (CRCA): and on the Upper Colorado as part of the IGA $1.5 million and $0.5 million along with $1 million for pumping at Windy Gap to circulate flows from Windy Gap to Lake Granby for enhancement of flow on the Colorado River between these locations.

"DW and CPW, in consultation with other members of the LBD Management committee, will determine appropriate locations and general concepts for the stream habitat restoration projects to compensate for reduced flows caused by the Project and the potential decrease in aquatic habitat in the Fraser and upper Williams Fork river basins" (Appendix M FEIS pg. 24). There is little information on where aquatic habitat restoration would be implemented, what it would consist of, and if the amount of money proffered will translate into projects that effectively protect use classifications of a cold water Class 1 fishery, Recreation Class E, and agriculture.

Upper reaches of the Fraser River and Vasquez Creek are currently on the 303(d) list of impaired waterbodies based on application of MMI to the aquatic life use. The FEIS fails to document that aquatic habitat restoration noted under the mitigation plan will be sufficient to mitigate any additional impairment caused by the proposed project. <u>CEQ states that clear documentation of mitigation commitments need to be incorporated into the EIS during the NEPA process.</u> Additional details about which stream segments will be targeted for restoration, restoration methods and plans, costs associated with each aquatic restoration project, and how success of the projects will be measured must be included in the mitigation plan.

Water for Temperature Mitigation, Flushing Flows, and Population Build Out

Water will be available for instream flows (1,000 AFY) in the Fraser Basin and on Williams Fork below the reservoir (1,000 AFY), minimum bypass flows will not be reduced in droughts (2,000 to 3,000 AF) except when Denver Water has banned residential lawn watering, 250 AF will be released if water temperature standards are exceeded between July 15 and August 31, and 375 AF for water providers and ski areas in Grand County. The latter mitigates the water supply shortfall predicted in Grand County at build-out. Generally, up to approximately 5,600 AFY will be made available to Grand County on a yearly basis. This represents 28 percent of the average yearly additional diversions needed for the proposed project.

Except for the 250 AFY and the 2,000 AFY of instream flows, delivery of the above quantities of water is not enforceable. In light of the independent firm yield analysis, it is unclear where 5,600 additional AFY of water will come from (perhaps Williams Fork?) as the majority of additional water available at Denver Water's existing diversion structures will be required to achieve the project yield.

Flushing flows will be provided 3 years out of every 10 on the Fraser, St. Louis Creek, Vasquez Creek, and Ranch Creek and on the upper three tributaries to the Williams Fork. Even though flushing flows are included as part of the FEIS mitigation, the wording of the action suggests that Denver Water can decide when, if, and how much water is available for flushing flows. This approach fails as mitigation as this action is not enforceable. It is also not clear how effective these flushing flows will be in maintaining the stream channel and providing sufficient sediment removal. The USACE must re-visit this mitigation proposal and develop a solidly supported, enforceable, and non-discretionary mitigation action.

Upgrades to in-basin WWTPs

Analyses in the 401 application predicted that the "SCT for phosphorus would be exceeded in most months under all hydrologic conditions," Table 5-1, 401 application. Even though phosphorus would exceed State water quality standards due to the proposed project, mitigation actions did not address this issue; however, the CRCA enhancement plan proffers $2 million for water quality projects in Grand County.

Phosphorous reduction should be mitigated as part of the FEIS. More detail on which WWTP would need to be upgraded, current loading rates not only for the targeted WWTP but all those discharging to the Fraser and Colorado Rivers, recalculation of the flows by which to evaluate the benefit of the upgrade and how this affects other WWTPs in the basin, and a cost estimate of the upgrade is required. If after the $2 million has been spent, it is determined additional load reduction is required, who will be the responsible party? Also, money to upgrade a facility does not include additional operation and maintenance costs, particularly for biological treatment. It appears that the upper basins will be taking on responsibility of maintaining water quality in their streams over the long term.

A short term infusion of cash may not fully address this problem. Additional information is required to determine if this "mitigation" will be effective. Also mentioned in Section 5.2.1 of that report are nutrient reduction measures, improvements to the Fraser Sanitation District wastewater treatment plant, to be implemented by NCWCD as part of their WGFP obligations. The USACE must respond to these concerns in a revised mitigation plan.

7.6 No Criteria Provided to Assess Effectiveness of Mitigation

As currently structured, the success of the mitigation efforts depends on money provided by Denver Water but there are few other measureable criteria for evaluation. The mitigation plan does not provide criteria by which to assess the effectiveness of the mitigation. In many instances, it is noted that by performing an action, Denver is in compliance with regulatory measures regardless of whether the action has the intended positive impact on stream function. This is not the intent of mitigation efforts.

If mitigation is not effective, for instance, if stream temperatures continue to be exceeded or sediment basins do not sufficiently reduce sediment loads, then Denver will provide $50,000 to additional sediment control and $1 million to LBD to implement projects for stream temperature issues. Money will be provided if mitigation does not effectively reduce temperature or sediment problems in the basin.

This is not the intent of a mitigation plan which requires careful evaluation and accounting of debits and credits to the stream system.

<u>Additional money does not constitute a viable enforcement plan required under NEPA.</u>
The FEIS must incorporate meaningful quantitative criteria for mitigation success that allow the USACE to determine if Denver Water is achieving the goals for the environment rather than merely measuring money spent. These criteria must be clearly stated in the FEIS and not delegated to future, unenforceable mechanisms. The USACE must make Denver Water's development and operation of the expanded Gross Reservoir contingent on Denver Water's success in meeting these goals.

If at any time Denver Water fails to meet the goals, USACE must suspend its permitting of the project and Denver Water must cease all diversions and address the shortfalls. Denver Water must not be allowed to return to the operations under the proposed project until the mitigation shortfalls are corrected and the mitigation plan is revised through a supplemental FEIS incorporating meaningful public input.

References

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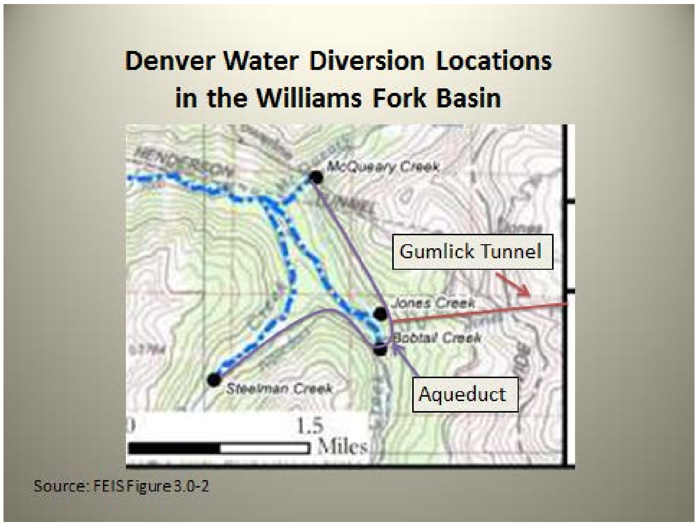
Appendix A: FEIS Figures ES-4, 1-2, and 3.0-2.

FEIS Fig ES_4a.PDF FEIS Fig ES_4b.PDF

FEIS Fig 1_2a.PDF FEIS Fig 1_2b.PDF


Denver Water Diversion Locations
in the Williams Fork Basin
McQueary Creek
Gumlick Tunnel
Jones Creek
Bobtail Creek
Steelman Creek
Aqueduct
1.5
Miles
Source: FEIS Figure 3.0-2

Final Firm Yield Calculation LRB 1 Oct 2015.pdf

Appendix B

Appendix C

Table C-1: Treated and Non-Potable Water Delivered by Denver Water 2000-2014					
	Total Treated Water (AF)	**Total Non-Potable Water (AF)**	**Total Water Delivered (AF)**	**Non-Revenue Water AF**	**NRW % of Treated Water**
2000	256,513	54,997	311,511	7,369	2.87
2001	248,737	35,213	283,951	11,667	4.69
2002	230,845	40,612	271,457	8,410	3.64
2003	200,703	39,979	240,682	5,387	2.68
2004	185,909	31,139	217,048	3,393	1.83
2005	210,138	37,060	247,198	3,984	1.90
2006	229,322	50,373	279,695	5,509	2.40
2007	216,294	32,538	248,832	5,415	2.50
2008	220,886	38,475	259,361	3,589	1.62
2009	190,599	28,396	218,995	2,267	1.19
2010	213,887	35,632	249,520	7,851	3.67
2011	209,484	37,751	247,236	10,544	5.03
2012	220,864	38,576	259,440	9,183	4.16
2013	184,785	30,804	215,589	6,936	3.75
2014	187,770	25,213	212,983	7,776	4.14
average	213,782	37,117	250,900	6,619	3.07
median	213,887	37,060	248,832	6,936	2.87

Source: Denver Water Comprehensive Yearly Financial Reports 2000 to 2014.
http://www.denverwater.org/AboutUs/FinancialInformation/

Final Firm Yield Calculation LRB 1 Oct 2015.pdf

Appendix D:

Attachment Q 07CW029 (00050387) (3).pdf

Appendix E: Colorado River Cooperative Agreement

LISA BUCHANAN_resume.pdf

Appendix F: Resume of Lisa R Buchanan