

Memorandum

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To: CCBWQA Technical Advisory Committee
CC: Chuck Reid, Manager
From: William P. Ruzzo, P.E.
Date: December 27, 2010
Re: Cherry Creek Stream Reclamation at PJCOS – Modified Design

An analysis was conducted to identify water quality impacts due to changes in the design for the Cherry Creek Stream Reclamation at Parker Jordan Centennial Open Space (PJCOS). The purpose of this memorandum is to present the results of a quantitative analysis to assess the changes in water quality benefits associated with the modified design for the PJCOS reach of Cherry Creek.

Results and Conclusions

The results of analysis showed that the proposed design modifications:

1. Will lower stream velocities. However, results for the channel shear and stream power are mixed with the median values being the same but with greater variability for the modified design in the project reach.
2. Will increase the average annual wetted area for the project reach.

The conclusion of the analysis is that the modified design will not *decrease* water quality benefits associated with stream reclamation and may *improve* water quality benefits.

Also, the project total costs are anticipated to be lower for the modified design due primarily to the reduction in export of earth material and a reduction in disturbed area that needs to be reclaimed. However, the level of Authority funding stays the same as projected for the Authority's 2011 5-year CIP, which is shown in Table 1 of this report.

Finally, the PJCOS reach of Cherry Creek has experienced extremely high rates of erosion from 2006 to 2008, resulting in over 140 times the projected sediment rate used for cost benefit analysis of stream reclamation projects. The extreme erosion of the reach is a major factor in the high cost of the project but also results in a low cost per pound when compared

to other Authority projects if a site specific analysis is performed instead of just an approximate analysis¹.

BACKGROUND

The CCBWQA reviewed and commented² on the original design for the PJCOS reach of Cherry Creek and recommended the project for funding participation, at the request of the Parker Jordan Metro District³ (PJMD). The technical advisory committee (TAC) then recommended the Board include the PJCOS project in the Capital Improvement Program (CIP) for 2010. On June 17, 2010, the Board approved an IGA with the PJMD for funding the design portion of PJCOS project for \$56,000.

At the request of the PJMD, the Urban Drainage & Flood Control District (UDFCD) was asked to review the design in anticipation for maintenance eligibility under the UDFCD program for maintenance assistance. In July of 2010 however, the UDFCD responded that they were not ready to support the project for maintenance eligibility. After several meetings between the stakeholders⁴, a modified design concept was agreed upon, which required changes to the original design that included:

1. Eliminating the riffle/pool drop structures and replacing them with grouted boulder drop structures.
2. Additional raising of the existing channel invert to minimize disturbance area.
3. Additional bank protection.

Subsequently, the UDFCD approved the design modification⁵.

WATER QUALITY ANALYSIS

The Authority has developed an interim methodology⁶ to compare stream reclamation projects using hydraulic parameters of velocity, shear, stream power, and wetted area as measures of water quality benefits. The methodology uses the results of a detailed HECRAS backwater analysis to calculate mean and standard deviations for velocity, shear, and stream power. Channel wetted area is also determined from the backwater analysis for the full range of flood probabilities and then “integrated” to approximate the average annual wetted area for a unit length (i.e.: mile) of stream. Each of these parameters was calculated for the original and the modified design and is compared below.

¹ CCBWQA Technical Advisory Committee November 22, 2010 (draft). *Stream Reclamation Water Quality Benefit Evaluation – Interim Status Report*.

² William P. Ruzzo, PE, LLC March 24, 2010. *Cherry Creek Stream Reclamation at Parker Jordan Open Space (Vermillion)*.

³ Parker Jordan Metropolitan District March 8, 2010. *Parker Jordan Metro District (the “District”)/Cherry Creek Stream Reclamation Project (the “Project”)*

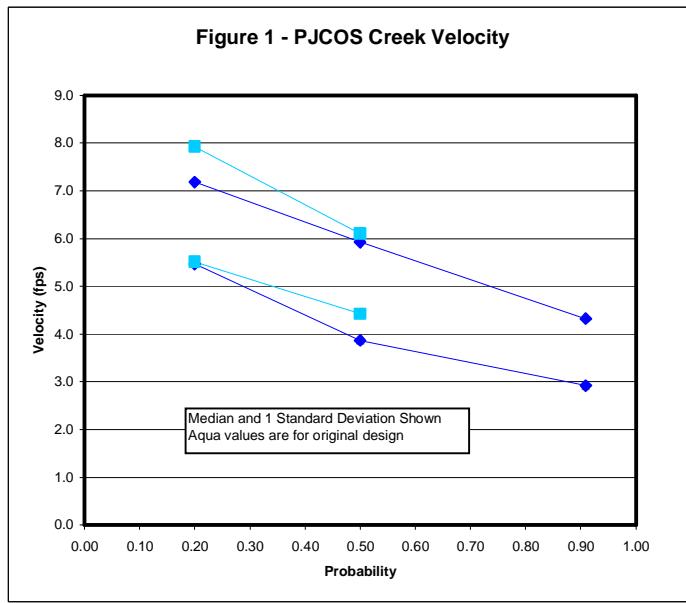
⁴ UDFCD, City of Centennial, SEMSWA, J3 Engineering and CCBWQA

⁵ David Mallory October 5, 2010. *Parker Jordan Centennial Open Space Project*

⁶ CCBWQA November 22, 2010. *Stream Reclamation Water Quality Benefit Evaluation – Interim Status Report*. (draft)

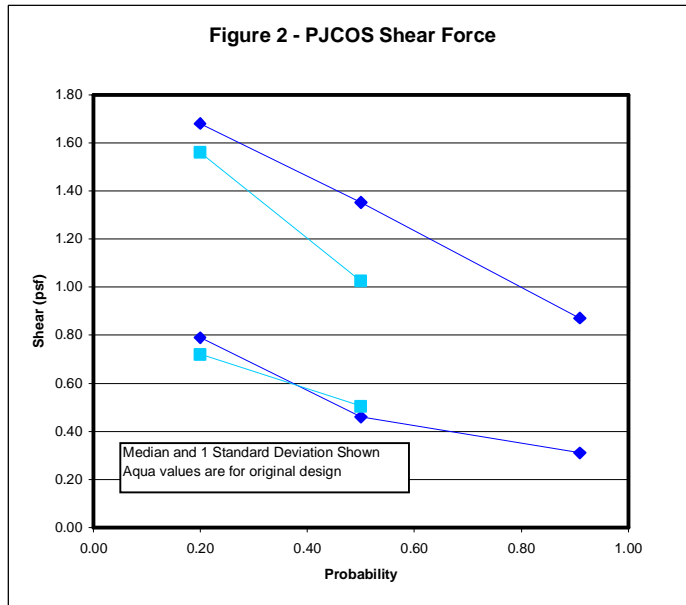
Channel Velocity

Figure 1 below shows that the modified design velocities are slightly lower for both the median and one standard deviation. This comparison suggests that the modified design is a slight improvement over the original design.



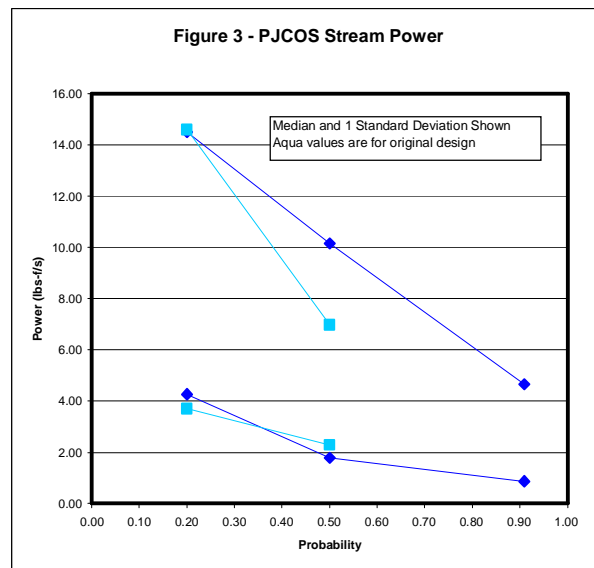
Channel Shear Force

Figure 2 below shows that the shear force for the modified design is about the same for the median value, but has a greater variability throughout the channel reach. This comparison suggests that the modified design *may* result in *lesser* water quality benefits than the original design but the comparison may also be inconclusive.



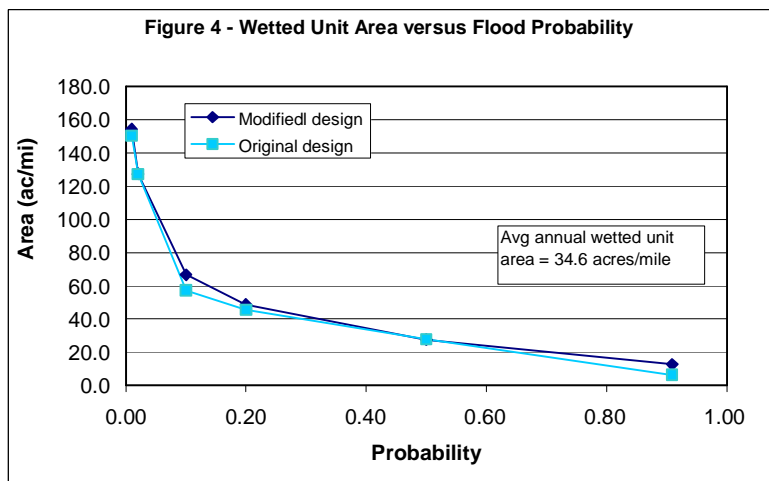
Channel Stream Power

Figure 3 below shows that the stream power for the modified design is about the same for the median value, but has a greater variability throughout the channel reach. This comparison suggests that the modified design *may* result in *lesser* water quality benefits than the original design but the comparison may also be inconclusive.



Wetted Area

Figure 4 below shows that the wetted area for the modified design is slightly greater than for the original design, which results in a higher average annual wetted area. This comparison suggests that the modified design is a slight improvement over the original design.



PJCOS Project Unit Costs

Presented in Table 1 is a comparison of the project costs and level of Authority funding provided by the 2010 and 2011 CIP programs⁷. Note that the project costs are for stream reclamation only and do not include recreational amenities. Also shown are the costs for the modified design of the PJCOS project.

⁷ Note that due to rounding of numbers the level of funding may not be identical to the Authority's final approved CIP budget.

**Table 1 - Cherry Creek Stream Reclamation at PJCOS
Comparison of Project Unit Costs**

Item	CCBWQA 2010 5-Year CIP	CCBWQA 2011 5-Year CIP	PJMD Modified Design
Project Length (ft)	2880	5100	5100
Total Projected Cost	\$ 1,323,000	\$ 4,025,800	\$ 3,514,200
Engineering	n/a	\$ 244,000	\$ 244,000
Construction	n/a	\$ 3,544,200	\$ 3,032,600
Construction Management	n/a	\$ 237,600	\$ 237,600
Annual Project Cost	\$ 101,900	\$ 310,000	\$ 270,600
Annual P Reduction Benefit (lbs/year)	49	87	87
Annual Cost per Pound of P	\$ 2,080	\$ 3,560	\$ 3,110
Approved Budget Amounts	\$ 370,000	\$ 671,000	\$ 671,000
2010 CIP (engineering)	\$ 56,000	\$ 56,000	\$ 56,000
2011 CIP (construction)	\$ 314,000	\$ 615,000	\$ 615,000
Authority funding amount (%)	28.0%	16.7%	19.1%
Authority cost per pound P	\$ 581	\$ 594	\$ 594

Examination of the table shows that:

1. The modified design reduced the annual cost per pound of phosphorus from \$3,560 to \$3,110.
2. The Authority's level of funding for the modified design will remain the same as for the 2011 total budget amount of \$671,000. Therefore, the Authority's cost per pound of phosphorus remains the same, but the Authority's percentage of the total project costs increases from 16.7% to 19.1%.
3. The Authority's cost per pound of phosphorus is below the suggested \$600 per pound upper threshold limit.

PJCOS Channel Erosion Rate

The reduction in phosphorus loads resulting from reclamation of PJCOS reach of Cherry Creek (Table 1) was determined using the "approximate method" which is based on annual sediment loads of 100-tons per mile and phosphorus concentrations of 1-pound per ton of sediment⁸.

Recent evaluation of the erosion of the PJCOS reach of Cherry Creek⁹ shows that over a two year period, the channel eroded around 4-feet through the one mile reach. Calculations show that over 28,000 tons of sediment eroded from the channel or more than 140 times the annual rate suggested by the approximate method. Whereas

⁸ CCBWQA Technical Advisory Committee November 22, 2010 (draft). *Stream Reclamation Water Quality Benefit Evaluation – Interim Status Report*.

⁹ GK Cotton Consulting, Inc. November 2010. *Cherry Creek Sedimentation Study Reservoir to Pine Lane Project Data and Evaluation*.

erosion would likely not continue at this accelerated rate, the comparison illustrates the importance of stabilizing the PJCOS reach of Cherry Creek. Even if no additional erosion occurred during the assumed life-span of the project (i.e.: 35-years), the annual rate would still be 400-tons per mile or 4-times that suggested by the approximate method used to calculate cost per pound. If this is the case, then the project cost per pound to the Authority for the PJCOS reach of Cherry Creek is closer to \$150, not \$600 as suggested by Table 1.