Yantao Cui, Ph.D., Hydraulic Engineer

Memorandum

To: Olen Zirkle, Ducks Unlimited

From: Yantao Cui, Ph.D., Hydraulic Engineer

CC: Bob Mussetter, Mike Harvey, Mussetter Engineering, Inc., and Eric Larsen, University of California, Davis

Date: February 3, 2005

Re: Spur dikes on the Sacramento River near M & T Pumping Plant

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The M & T / Llano Seco Fish Screen Facility Short-Term/Long-Term Protection Project Technical Review and Recommendation Workshop will reconvene on the 16th to 18th, January 2005. This short memorandum outlines some of my thoughts with regard to the proposed spur dike solution, based primarily on a review of the report entitled "Two-dimensional Modeling to Evaluate Potential River Training Works at M&T Pumping Plant Sacramento River, RM192.5," dated January 2005 by Mussetter Engineering, Inc. (MEI).

I believe MEI did an excellent job conducting the 2-dimensional hydraulic simulation, and the results have offered many insights with regard to the flow patterns in the study reach and the potential effects of the proposed spur dike solution. Instead of discussing all the points that I strongly concur with the MEI report, I would like to offer some cautionary comments toward MEI's conclusion No. 12, which states:

- "Based on the above results, the proposed dike field would prevent the river from migrating further to the west, and would likely prevent the gravel bar from continuing to enlarge. The low energy in the immediate vicinity of the M&T intake, however, indicates that this area will likely continue to be depositional, even in the presence of the dike field."

While I strongly agree that the proposed dike field would prevent the river from migrating further to the west, and would likely prevent the gravel bar from continuing to enlarge, I strongly caution against the conclusion that the M&T intake area will continue to be depositional in the presence of the dike field. Although it is possible that the M&T intake area will continue to be depositional in the presence of the proposed dike field, I believe there is no strong evidence to believe so based on the 2-dimensional hydraulic modeling results. This is because

1. While one- and two-dimensional hydraulic and sediment transport models are capable of offering excellent insights in sediment transport and depositional patterns in rivers on a reach-average scale (i.e., interpret results in channel segments of several channel width), they usually are not adequate in predicting sediment transport and deposition process at a local scale (i.e., within a reach of only a few channel width). This is evidenced that no numerical model is capable of reproducing local features such al alternate bars and pool-riffle sequences in rivers, and running any numerical model will result the disappearance of such features. Although the sediment deposition in the M&T intake area may have been influenced by the reach scale hydraulic and sediment transport processes, I believe it is more of a local process driven by the erosion of the west bank associated with the downstream migration of the gravel bar on the east bank near M&T intake. With that, we must be cautionary in predicting sediment transport process in such a scale with results from numerical models.

2. I believe the sediment deposition near M&T intake is mostly associated with the downstream migration of the gravel bar. If the dike field can reduce the size of the gravel bar, it will very likely solve the sediment deposition problem near the M&T intake. As mentioned earlier, I agree with MEI conclusion that the proposed dike field will prevent the gravel bar from continuing to enlarge. Here I would suggest one step farther, i.e., it is very likely that the proposed dike field will lock the gravel bar in place and reduce its size at the downstream end, and thus, solving the sedimentation problem at the M&T intake. This suggestion is partially based on the MEI results for the comparison of flow velocity and normalized grain shields with and without the proposed dike field. It is evident from MEI results that the proposed dike would push the high flow toward the east bank by 100 to 200 ft. Considering that the downstream end boundary of the MEI modeling was set only about one channel width downstream of the M&T intake, the actual high flow will most likely shift more than the predicted 100 to 200 ft toward the east bank, further increasing the potential for sediment erosion near the M&T intake. Shifting the high flow toward the east bank would result a redistribution of sediment deposition near the M&T intake, and it possible that the deposition near the intake will discontinue even if the area in general continue to be depositional.

Considering the huge difference in project costs for the proposed dike field and ground water options (~ $1.34 million vs. $11.5 – 14.4 million), it is reasonable to further study a potential solution with the proposed or modified dike system. I have no doubt that a solution exists either with the proposed dike system or by rearranging the number, size, and location of dikes. Continued two-dimensional hydraulic modeling by extending the downstream boundary further downstream and experimenting with different dike arrangements would help. Considering the huge project cost and the cost differential between different options, however, it would be appropriate to also conduct scaled physical modeling to further study dike arrangements to find a convincing solution.