Comments and Recommendations
Segment B Value Engineering Study and
Geotechnical Meeting, Southport Phase

Report Prepared by:

Board of Senior Consultants:

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March 6, 2013
Mr. Ken Ruzich  
General Manager  
West Sacramento Area Flood Control Agency (WSAFCA)  
1110 W. Capitol Ave.  
Sacramento, CA 95691

Subject: Comments and Recommendations Following Geotechnical Conference Call Meeting  
Concerning Blackburn Consulting (BCI), Segment B Geotechnical Value Engineering Study (GVES),  
Underseepage Sensitivity Evaluation, HDR Southport Sacramento River Levee (SSR Levee) Design,  
West Sacramento, CA

Dear Mr. Ruzich:

This report was prepared by the Board of Senior Consultants (BOSC) for the purpose referenced above  
concerning the Blackburn Consulting (BCI) Segment B Geotechnical Value Engineering Study (GVES),  
Underseepage Sensitivity Evaluation. The BOSC originally reviewed and provided comments on  
geologic, subsurface and laboratory data provided by BCI for Segment B on June 21, 2012. On July 31,  
2012, the BOSC held a Conference Call Meeting to discuss the varying opinions between the BOSC,  
HDR and BCI regarding the interpretation of the subsurface conditions in the upper 40 feet of Segment  
B and associated underseepage analysis and recommended mitigation alternatives. At the conclusion of  
the teleconference meeting, BCI, HDR, MBK, WSAFCA and the BOSC agreed that BCI should perform  
an underseepage sensitivity evaluation assuming the individual silty sand and sandy silt layers  
underlying the shallow clay layer be combined into one layer with uniform vertical and horizontal  
hydraulic conductivity values. BCI provided the results of that underseepage sensitivity evaluation  
prior to the August 29, 2012 Conference Call Meeting. The meeting was attended by BCI, HDR, MBK,  
WSAFCA and the BOSC.

The following pages summarize the BCI results presented during the meeting and the resulting  
discussion and recommendations.

Summary of BCI Presentation

BCI presented a summary of the three models developed and analyzed for the evaluation at two different  
cross-sections; one at existing levee Station 61+00 and one at existing levee Station 78+50. The models  
included a new adjacent levee at Station 61+00 and a setback levee at Station 78+50. The three models  
consisted of the following:

Model A-1: This model assumed a shallow clay layer and combined the underlying silty sand/sandy  
silt layers into one layer for analysis. The vertical hydraulic conductivity values, $K_v$, obtained from  
laboratory tests of the individual sandy silt and silty sand layers, were averaged to obtain the vertical  
hydraulic conductivity value for the combined layer. The horizontal hydraulic conductivity values  
for the individual layers were estimated using an anisotropy ratio of 0.25 and then were averaged to
develop the horizontal hydraulic conductivity value for the combined layer. BCI calculated the average exit gradient at the bottom of the shallow clay layer and at the bottom of the combined silty sand/sandy silt layer in each seepage analysis.

**Model A-2:** This model also assumes a combined silty sand/sandy silt layer underlying the shallow clay layer; however, the anisotropy ratio was changed to 0.115, which resulted in a vertical hydraulic conductivity value $K_v$ equal to the average of the individual $K_v$ values of the silt layers. As in Model A-1, BCI calculated the exit gradient at the bottom of the shallow clay layer and at the bottom of the combined layer.

**Model B:** This model was recommended by Dr. Les Harder, HDR’s technical reviewer for the Segment B GVES. Dr. Harder recommended continuous layers of silty sand and sandy silt underlying the shallow clay layer. The individual hydraulic conductivity values used in this model were the same as the combined hydraulic conductivity values for sand layers. Dr. Harder recommended a lower hydraulic conductivity value for the silt layers. BCI calculated the exit gradient at the bottom of the shallow clay layer and at the bottom of the bottom-most silt layer.

The analyses showed that a minimum seepage berm combined with a shallow cutoff wall would provide acceptable exit gradients with similar results obtained for each of the three models.

**Discussion of Results and Recommendations**

**Discussion Related to Cross Section at Station 61+00:** The attendees discussed the necessity for including a seepage berm in the design, along the adjacent levee section, given that the average exit gradients at the toe of the new levee calculated from the bottom of the combined sandy silt/silty sand layer met criteria without a minimum berm or shallow cutoff wall. BCI noted the following with respect to this cross section.

- The average exit gradients at the landside levee toe calculated from the bottom of the shallow clay layer without a minimum berm or shallow cutoff wall did not meet criteria for any models. The results obtained from blanket theory correlated well with these results using the Seep/W program. The addition of a shallow cutoff wall only slightly improved the gradients but they still did not meet criteria.
- The average exit gradients at the landside levee toe calculated from the bottom of the combined silty sand/sandy silt layer were only slightly affected with the inclusion of a shallow cutoff wall for all models and still met criteria.
- The addition of a minimum berm with the shallow cutoff wall greatly improved the average exit gradients for all models calculated from the bottom of the shallow clay layer, the bottom of the combined silty sand/sandy silt layer, and the bottom of the silt layer.

Please note that although the shallow cutoff wall does not provide a significant reduction in the modeled gradients at the toe of the adjacent levee, there are important technical reasons why it was included in the design. Firstly, the cutoff wall combines the many sand, silt and clay layers in the upper portion of the stratigraphy into a continuous blanket layer. The modeled stratigraphy is a simplified estimate of the in-situ stratigraphy and as such, actual performance may be less
satisfactory than indicated by the model results. Secondly, although some crevasse splays deposits have been mapped, there is the possibility that others are in existence in-situ at locations that have not been mapped. These features present a hazard with respect to significant under seepage flow and higher exit gradients if the shallow cutoff wall is not included in the design. The shallow cutoff wall also negates the need for the inspection trench; thus, the shallow cutoff wall is an effective mitigation method for these two reasons.

**Discussion Related to Cross Section at Station 78+50:** The attendees then discussed the same question as noted above for the section at Station 78+50 for the new setback levee.

- The average exit gradients at the landside levee toe calculated from the bottom of the shallow clay layer without a minimum berm but including a shallow cutoff wall did not meet criteria for any models. The results obtained from blanket theory correlated well with these results using the Seep/W program.
- The addition of a minimum berm with the shallow cutoff wall greatly improved the average exit gradients for all models calculated from the bottom of the shallow clay layer, the bottom of the combined silty sand/sandy silt layer, and the bottom of the silt layer.

The discussion above with respect to the inclusion of the shallow cutoff wall also applies to this cross section. BCI recommended the minimum berm because: 1) significant average exit gradient improvement resulted with the addition of the minimum berm and 2) heavy seepage has been historically observed in the area. With consideration of the above, the parties present at the meeting agreed that a minimum seepage berm combined with a shallow cutoff wall is appropriate to mitigate underseepage within Segment B along the 65% preferred levee alignment.

**Additional Items Discussed:** The following items were also discussed:

- It was agreed that minor modifications to the width of the minimum seepage berm can be included in the design for specific locations as necessary. The BOSC suggested that the calculated width of the seepage berm could be considered to begin at the landside levee toe of a projected 2H:1V (horizontal/vertical) landside levee slope, even if the landside design slope was 3H:1V.
- BCI recommended a seepage berm rather than relief wells as a mitigation measure because of the challenges associated with the potential water flow from the relief wells and the potential for nuisance seepage between the wells given the close proximity of homes in the area.
- The levee shell can consist of a more permeable material than soil classified as Type 1 when the seepage mitigation measure includes a central core of more plastic material.
- The BOSC has previously requested that BCI review the blanket theory analyses. BCI made slight modifications based on that review; however, the modifications did not significantly
change the results. The updated blanket theory analysis was also reviewed by the HDR Internal Technical Review (ITR).

Very truly yours,

West Sacramento Levee Improvement Program
Board of Senior Consultants

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