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Technical Memorandum

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Project	Feather River West Levee
Date	June 8, 2012
Subject	Geotechnical Considerations for Landside Slopes of Segments 1 to 6 for the Feather River West Levee Project
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1.0 INTRODUCTION

The HDR team is providing design services to the Sutter Butte Flood Control Agency (SBFCA) for the Feather River West Levee (FRWL) Project. URS Corporation (URS), as a member of the HDR team, has been providing geotechnical engineering services for the FRWL Project.

This memorandum presents geotechnical considerations for the landside slopes of rehabilitated levee sections.

2.0 APPROACH FOR SLOPE STABILITY ANALYSIS

The URS team has performed steady-state slope stability analyses for landside slopes for reaches included in the draft Geotechnical Design Recommendations Report (GDRR) for Segments 1 to 6. The draft GDRR was submitted for SBFCA review on February 27, 2012.

Steady-state slope stability analyses were performed in accordance with USACE engineer manuals (EM) 1110-2-1913 and EM 1110-2-1902. The objective of this landside slope stability analysis was to evaluate long-term landside stability conditions that impact the global integrity of the levee under selected water levels. That is, the URS team's analysis was not concerned with shallow surficial sloughing failures that are considered a maintenance issue. It should be noted that shallow surficial sloughing in erosive soil may be a concern during high water events. However, considering the use of cutoff walls or seepage berms as rehabilitation measures for the FRWL Project, this type of surficial sloughing is considered unlikely due to high water events.

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The FRWL Project used SLOPE/W software to perform steady-state analyses using Spencer's method of analysis. Pore water pressures under steady-state conditions calculated by SEEP/W models were imported into SLOPE/W for use in slope stability analysis.

SLOPE/W search criteria were set so that a sufficient range of slip circles were analyzed, including small-radii circles impacting the lower portion of the landside slope to deeper, large-radii circles impacting the levee crown. A minimum depth criteria of 3 to 5 feet was set to screen out shallow slip surfaces, which are considered to be maintenance issues.

3.0 GEOTECHNICAL ANALYSIS OF LANDSIDE SLOPES

In February 2012, Wood-Rodgers (WR) has evaluated landside slopes at every 100-foot interval and prepared a set of maps identifying over 300 existing landside slopes that are 2.0H:1V or steeper. The URS team reviewed these slopes and identified that, in almost all cases, these steep slopes have an adequate factor of safety even with overall slopes as steep as 1.6H:1V.

The exception to this finding is at approximately Station 2109+00 in Reach 33, where even though the overall slope angle is not overly steep, the analysis section did not meet criteria from a global stability perspective because of underseepage conditions. Therefore, slope flattening is recommended. Analysis shows that, to meet the FRWL Project criteria, a slope of 2.3H:1V is required. The limits of slope flattening work are from Stations 2106+00 to 2113+00.

4.0 GEOTECHNICAL CONSIDERATIONS FOR LANDSIDE SLOPES

The URS team reviewed steep slopes identified by WR, and has the following observations and comments.

1. In many cases where a canal is adjacent to the FRWL, canal slopes are steep. In Reaches 26, 27, and 28, a canal is adjacent to the levee and canal slopes are steep (often steeper than 1.5H:1V), and the proposed levee rehabilitation measures will address canal slope stability issues. In other reaches where a canal is adjacent to the FRWL, the global slope stability meets criteria with rehabilitated conditions. However, steep canal slopes may have a potential for maintenance-type stability issues.

2. In some areas, there are slopes that have localized steeper portions in either the upper or lower portion of the slope (Figure 1 and Figure 2). That is, the slopes have a slightly concave or convex profile. The current proposal of only re-grading the portion of the slope above the degrade elevation would leave many of these localized steeper portions in place. These slopes have the potential for localized stability problems during construction and in the longer term.

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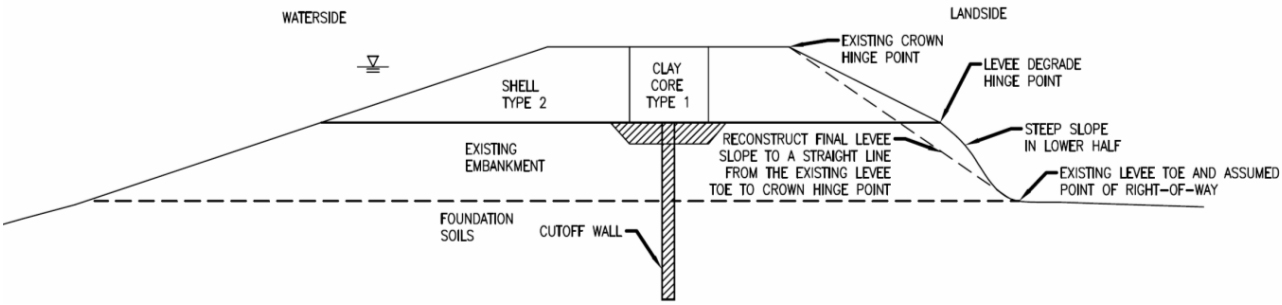

Figure 1: Levee Section with Steep Slope in Lower Half of the Levee

In levee sections with a steep slope in the upper half of the levee (steeper than 2H:1V), the URS team recommends that the currently proposed approach is changed so that during levee reconstruction the whole levee slope is re-graded to a straight line starting from the existing levee toe to the new levee crown hinge point. This procedure would require benching in the existing lower half of the slope to provide key-in to the existing slope. Figure 2 is a schematic drawing of the proposed slope re-grade for a levee section with a steep slope in the upper half of the levee.

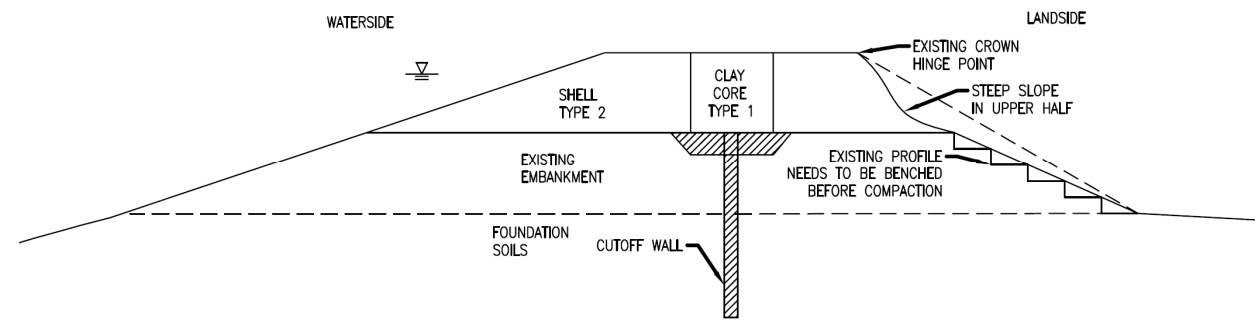

Figure 2: Levee Section with Steep Slope in Upper Half of the Levee

3. There are localized areas throughout the whole levee alignment where slopes are locally steeper than adjoining sections of levee due to the presence of access ramps. These access ramps and associated steep slopes will be reconstructed to their original geometry. Locally, there may be some shallow stability and maintenance issues associated with these steeper slopes, but the levee prism is wide in these areas, and the levee sections are satisfactory for global stability.

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5.0 LIMITATIONS

This technical memorandum was prepared in accordance with the standard of care commonly used as the state-of-practice in the engineering profession. Standard of care is defined as the ordinary diligence exercised by fellow practitioners in this area performing the same services under similar circumstances during the same period.

This draft technical memorandum is for the use and benefit of the HDR design team and SBFCA. Use by any other party is at their own discretion and risk.