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TECHNICAL MEMORANDUM

March 3, 2016

Project: Cities of Lathrop and Manteca
Urban Levee Design Criteria (ULDC) Evaluation

Subject: 7.10 – Erosion

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1.0 PURPOSE

Detailed analyses and documentation have been performed and developed of the existing levee system of Reclamation District No. 17 (RD17) in order to determine the extent of Urban Levee Design Criteria (ULDC) compliance. The purpose of this technical memorandum is to present the data sources, assumptions, analyses, and results as they pertain to ULDC Item No. 7.10 – Erosion. The team responsible for undertaking this effort consists of Peterson, Brustad, Inc. (PBI), Kjeldsen, Sinnock and Neudeck, Inc. (KSN), and ENGEO, Inc.

2.0 PROJECT BACKGROUND

Legislation passed in 2007 substantially limits the ability of urban communities to approve residential, commercial and industrial development after July 2016 unless they have an Urban Level of Flood Protection (ULOP) or are making adequate progress toward achieving ULOP 200-year flood protection. Background on this mandate was summarized in "*Position Paper for City of Lathrop, Compliance with SB5: ULOP 200-Year Flood Protection for Lathrop (RD 17)*" dated February 3, 2014, by Glenn Gebhardt, City Engineer for the City of Lathrop.

In April 2014, PBI prepared a Strategic Plan for ULOP Compliance for RD17 communities, which outlined a strategic plan for complying with SB5 for the area protected by RD17 levees on a schedule that will meet the requirements of the law. The main component of this Strategic Plan was to perform a comprehensive ULDC analysis and identify areas of deficiencies for each of the ULDC criteria. The analyses presented in this technical memorandum pertain to one of these ULDC criteria: 7.10 – Erosion.

3.0 LEVEE ASSESSMENT

The analyses described in this technical memorandum have been developed at a detailed level using an assessment of the existing levee system to determine the extent of ULDC deficiencies. The assessment was based on a combination of new and existing information.

3.1 Data Sources

Existing data sources that were utilized in the levee assessment are as follows:

- Field Survey of Bank Conditions, performed by KSN in October 2015

3.2 Assumptions

Assumptions that were made in the levee assessment are as follows:

Separate Ongoing Projects:

Construction is currently underway on the RD17 Levee Seepage Repair Project (LSRP). The purpose of this project is to provide seepage remediation of various RD17 levee reaches along the San Joaquin River. Phase I and Phase II have both been completed at a combined cost of approximately $9 million. Phase III is in the midst of the design and permitting stages and is estimated to cost $35 million. The source of funding for LSRP is primarily from annual RD17 property owner assessments and DWR Early Implementation Program (EIP) grants. For purposes of this ULDC analysis, it was assumed that LSRP Phase III will be completed.

Basis of ULDC Analysis:

Erosion damage to the riverine levees is typically due to high velocity flows and/or boat wakes. A levee breach upstream of RD17 could potentially cause erosion damage to the Dryland Levee due to large waves developed by wind over a large, open body of water. ULDC identifies a number of factors that may increase the erosion hazard. The factors that could potentially apply to RD17 levees, and therefore were further analyzed, include:

- Compromised levee prism geometry
- Geomorphologic trends
- Streambed velocity and shear
- Erodible levee material
- Absence of slope protection

3.3 Analysis

Levee prism geometry was analyzed as part of the ULDC Item No. 7.8 – Levee Geometry evaluation. This evaluation did not indicate any compromised or deficient waterside levee slopes. Therefore, it was determined that compromised levee prism geometry was not a factor that could increase erosion hazard.

Geomorphologic trends were analyzed as part of the ULDC geotechnical evaluations. The geotechnical evaluations revealed the following:

> *"On the 1913 and 1915 United States Geological Survey (USGS) topographic maps, the locations of the main channel of the San Joaquin River and the bifurcation to the Old River appear to be essentially the same as the modern condition. The locations of the levees on the 1915 map also appear to be essentially the same as the modern condition, although the original levees were widened and raised in the 1960s. Review of aerial images from 1937 and 2010 show that the channel morphology and levee conditions have remained relatively stable over the last three decades."* [1]

[1] Urban Levee Design Criteria Evaluation, Mossdale Tract, Reclamation District No. 17, San Joaquin County, California, prepared by ENGEO Incorporated, and dated October 30, 2015

Therefore, it was determined that geomorphologic trends were not a factor that could increase erosion hazard.

The 200-year velocity values by stream are indicated below in Table 1.

Table 1 - 200-Year Velocities by Stream

Stream	Minimum Velocity (fps)	Maximum Velocity (fps)	Average Velocity (fps)
French Camp Slough	0.9	2.2	1.3
San Joaquin River	1.8	7.4	5.1
Walthall Slough	0.2	4.2	1.3
Dryland Levee	0.2	0.5	0.4

Based on the above-denoted stream velocities, it was determined that low to moderate erosion potential existed along the San Joaquin River and that minimal erosion potential existed elsewhere.

Levee soil material was also analyzed as part of the ULDC geotechnical evaluations. The geotechnical evaluations indicated a considerable presence of silty sands and sandy silts within the RD17 levees. Due to these low cohesion soils, it was determined that erodible levee material do exist that could lead to potential erosion.

Lastly, a field survey was performed to ascertain the level of slope protection coverage. Since it was previously determined that a potential for erosion did exist, it was important to quantify any slope protection deficiencies. Quarry stone riprap rock is the primary form of slope protection utilized on RD17 levees. Originally the U.S. Army Corps of Engineers generally constructed rock slope protection only up to approximately Mean Higher High Water (MHHW) level. Over the years RD17 has worked to achieve a higher level of protection up to DWSE plus 1'. Levee reaches in which adequate rock slope protection exists up to the DWSE plus 1' or in which a substantial waterside berm exists were deemed a Low Hazard. Levee reaches in which 1 to 1.5 tons of additional rock slope protection are required per linear foot of levee were deemed a Medium Hazard. Levee reaches in which 2 to 2.5 tons of additional rock slope protection are required per linear foot of levee were deemed a High Hazard. Typical levee sections are shown below in Figure 1.

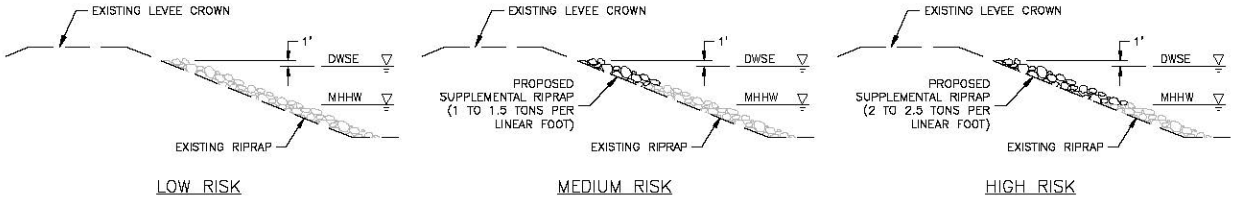

Figure 1 - Erosion Hazard Levels

4.0 DEFICIENCY RESULTS

The levee reaches that were identified as a Low Hazard are indicated below in Table 2. These reaches require only regular, ongoing maintenance and have historically performed well. Therefore, they are deemed compliant and no further action is required.

Table 2 – Erosion - Low Hazard

Station from	Station to	Length (feet)
0+00	114+00	11,400
124+00	143+00	1,900
267+00	284+00	1,700
376+00	405+00	2,900
428+00	472+00	4,400
499+00	534+00	3,500
613+00	702+00	8,900
716+00	729+00	1,300
		36,000

The levee sections that were identified as a Medium Hazard are indicated below in Table 2. These sections are deemed deficient.

Table 3 – Erosion - Medium Hazard

Station from	Station to	Length (feet)
143+00	267+00	12,400
284+00	376+00	9,200
534+00	613+00	7,900
822+00	972+25	15,025
		44,525

The levee sections that were identified as a High Hazard are indicated below in Table 3. These sections are also deemed deficient.

Table 4 - Erosion - High Hazard

Station from	Station to	Length (feet)
114+00	124+00	1,000
405+00	428+00	2,300
472+00	499+00	2,700
702+00	716+00	1,400
729+00	822+00	9,300
		16,700

It is recommended that all levee reaches deemed a Medium or High Hazard be reconstructed in compliance with ULDC guidelines consisting of providing supplemental quarry stone riprap rock slope protection up to the DWSE plus 1'. Resolution to the identified deficiencies has been addressed as indicated in the proposed ULDC improvement plans and cost estimate. Figure 2 consists of an overall map that summarizes the deficiencies of the RD17 levee system with respect to erosion.

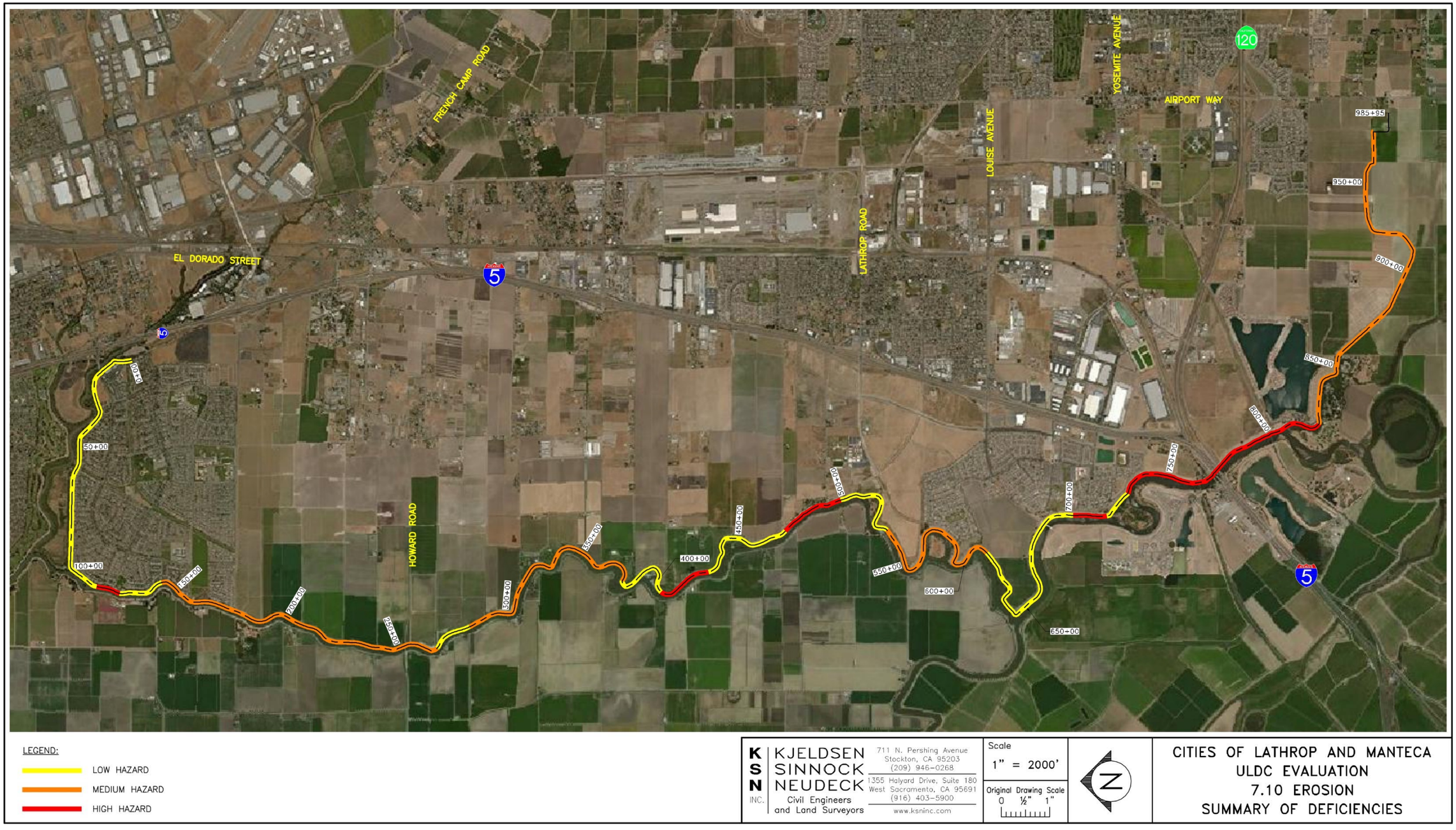

Figure 2 - Summary of Deficiencies