Gray Lodge Wildlife Area
WATER SUPPLY PROJECT
Biggs-West Gridley Water District
Benefits for Wildlife and Agriculture

Technical Summary Regarding Strategies for Minimizing Changes in Canal Seepage Resulting from the Gray Lodge Wildlife Area Water Supply Project

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1.0 Introduction

The draft *Design Data Report for Conveyance of Refuge Water Supply to Gray Lodge Wildlife Area*[1] (DDR) states that one of the measures of success of the Gray Lodge Wildlife Area Water Supply Project (the Project) is: "There will be no adverse impacts to Biggs-West Gridley WD, its facilities, its operations, its customers, or others as a result of the project." An important potential adverse impact of increasing the flow of water in the canals is the possibility of increased seepage from the canal into adjacent farmland. This is of particular concern during the field preparation and harvest seasons (April-June and August-September).

This Technical Summary describes project design features to be implemented during Project construction and operation to control, measure, and maintain water levels in the affected canals along the Belding, Schwind, Traynor, Rising River, and Cassady Laterals.

2.0 Prior Study

The DDR notes that usage of the Biggs-West Gridley Water District's (District) canals for conveying water to Gray Lodge Wildlife Area will result in full canals operating year-round. The *Measurement and Seepage Study*[2] that is incorporated into the DDR as Appendix A establishes a baseline of water levels and flows in the District canal system and attempted to examine whether higher water levels in the canals correlate with increased seepage to adjacent fields.

Fourteen shallow monitoring wells were placed along Traynor Lateral within the District for the *Measurement and Seepage Study*. Monitoring wells were placed at approximately 50 feet and 80 feet from the edge of the canal and aligned perpendicular to water level sensors in the canal so that the relationship between canal water levels and well water levels could be observed. It was difficult to determine the magnitude of the amount of seepage from the canals from the piezometer data because of the large distance from the canal bank and that the fields in which the piezometer were located were irrigated from time to time. It was difficult or impossible to determine if the changes in water levels in

[1] CH2MHILL August, 2009

[2] Gray Lodge Wildlife Area/Biggs-West Gridley Water District Canal Water Level, Flow Measurement, and Seepage Study Summary. CH2MHILL. Updated May, 2009

the fields were from the irrigation events and/or the removal of weirs in on-farm drainage ditches, or if the changes were a result of change in the water level in the irrigation canals.

The DDR identifies the following potential mitigation methods:

- Canal lining: The canal is fully or partially lined with concrete or a geomembrane to prevent seepage.
- Cut-off Walls: A soil-bentonite or cement-bentonite slurry wall is excavated either through the center or at the downstream toe of the canal.
- Seepage Canals: An interceptor ditch is maintained along the canal and water is pumped back into the canal using a relief well.

3.0 Project Position Paper on Seepage

The *Measurement and Seepage Study* addressed minimization of seepage changes as a result of the proposed project. The technical report made the following recommendations:

1) Establish a baseline estimate of the seepage currently leaving the canal system, and estimate changes in canal seepage that could be caused by proposed modifications to the canal system or modification of the existing flow regimes and water elevations; and

2) Prepare a mitigation plan that makes specific recommendations to minimize or mitigate any changes in the amount, timing or frequency of seepage from irrigation canals as a result of the proposed project.

The paper discussed the supporting reasons and considerations in reach the above conclusions and identified the following six Project Design Features or "tools" that may be used by the project to minimize changes to seepage as a result of the project:

Canal Water Level: Including this position paper, a number of position papers have been (or are being) developed for the project related to canal geometry, facilities, and operations. A primary objective (position) held by the design team is to maintain future operating water levels at or below historical operating levels. This objective is weighted higher than other considerations including cost and convenience for making flow changes.

Alternative Designs: The Rising River lateral canal should be considered for placement in underground RC pipeline. This pipeline alternative to an above grade earthen canal will nearly eliminate seepage year round and allow maximum delivery of water in the facility during any time of year.

Local Drainage: Intercepting drainage ditches should be constructed parallel to delivery canals where adequate ROW exists or can be economically obtained and where water can be conveyed by gravity to one of the existing regional drainage canals.

In-Situ Compaction: In-situ compaction of the sides and bottoms of any disturbed earth should be used at all canal bank locations where the bank is not excavated and rebuilt in compacted lifts.

Slurry Wall: Low permeability slurry walls should be considered for canal reaches that have high seepage rates, bank stability problems, and with limited ROW for intercepting drains or no drainage path to convey canal seepage into the regional drainage system.

Seepage Easements: In situations where no other mitigation method is economically feasible except a slurry wall, the District should consider as an alternative offering to purchase from owners of land adjacent to high seepage rate areas the right for the District to drain canal seepage through a portion of their property.

4.0 Methodology for Seepage Evaluation and Baseline

A reliable baseline estimate of current seepage from the canal system is required in order to evaluate the effects of proposed project design features. Two basic pieces of information are required to evaluate the effects of seepage:

1. The rate of migration of water out of the canal as a function of the water level in the canal; and

2. The response of the water table in the land adjacent to the canal to changes in canal elevation.

It is proposed to implement a program to quantify the amount at several locations throughout the District by:

1. Conducting ponding tests to determine the amount of seepage from the canal; and

2. Measurement of the water table elevation adjacent to canals at selected locations.

4.1 Ponding Tests

Ponding tests are conducted over one or more days by physically blocking the inlet and outlet of a canal reach and then filling this canal segment with water. The depth of the water is then recorded continuously or at set intervals for the duration of the test. Given the geometry of the canal, the seepage rate is determined by establishing the volume of water lost per unit of time. A rating curve is produced that indicates the rate of seepage for a given depth of water in the canal.

4.2 Piezometer and Water Depth Sensors

The elevation of the water table adjacent to the canals and within the canal at selected locations will be reorded using piezometers placed in shallow casings in or near fields that are could potentially be affected by seepage from the canals. A typical piezometer data logger and cable for PC connection is shown in Figure 1, and the locations of the sites where piezometer and canal water level monitoring is being done is shown in Figure 2.

Figure 1 - Instrumentation NW PT2X smart sensor and cable. Source: AW Blair Engineering

4.3 Identification of Land with Possible High Water Table

A high water table in irrigated fields can exist for several reasons other than seepage from irrigation canals. The design team is documenting existing locations that suggest areas of high water table, poor drainage, or crop production problems that are located within the scope of the project

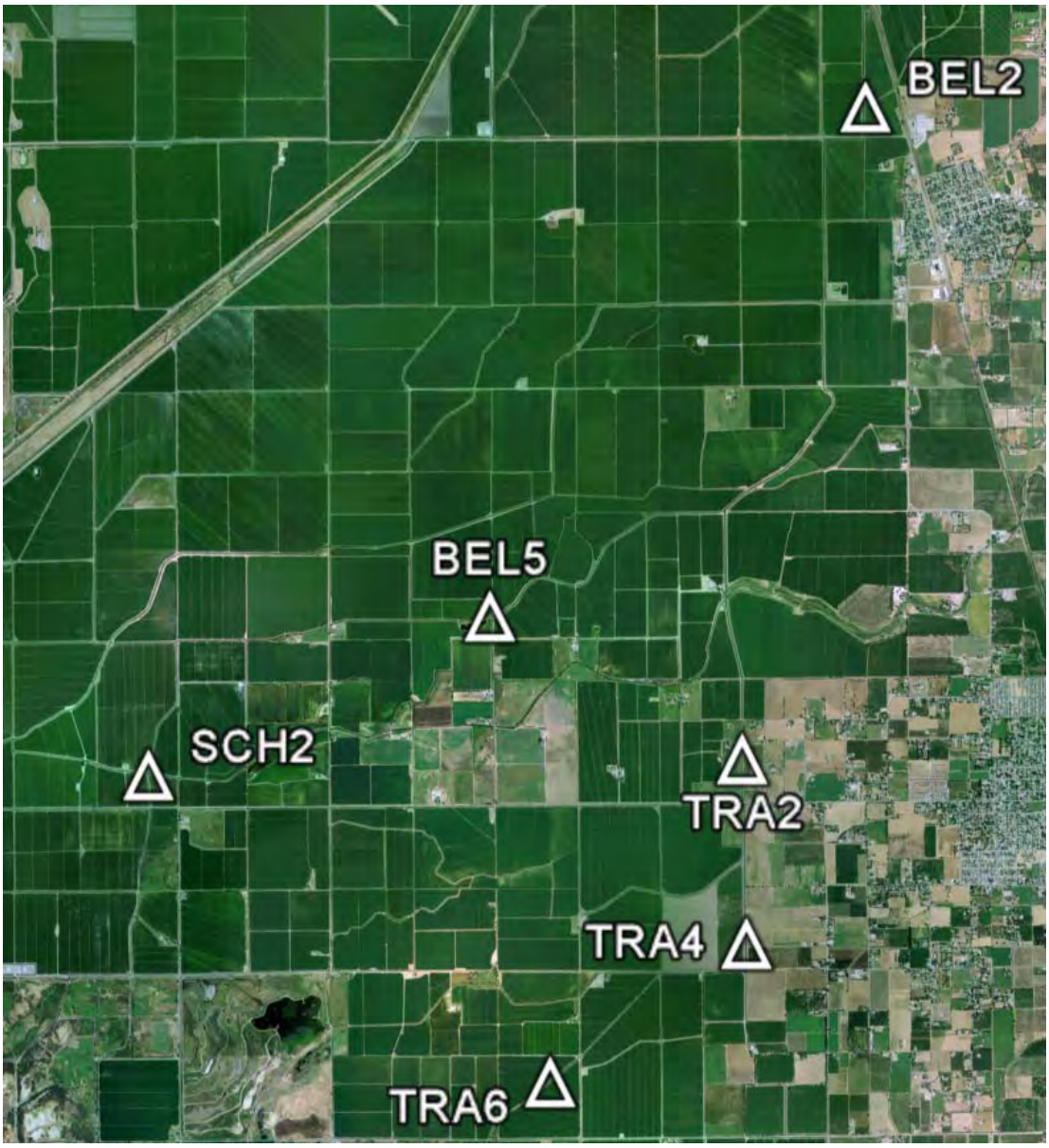

Figure 2 - Locations of Water Table Monitoring Sites

5.0 Strategies to Minimize Changes in Seepage

The *Measurement and Seepage Study* identified a number of Project Design Features or "tools", some of which were addressed in the DDR. For each of these "tools" there are design and operation requirements, including cost and effectiveness in preventing seepage, that will be considered for each alternative that will vary from site to site.

5.1 Canal Water Level

This strategy is based on minimizing any change to the existing water levels in the canal system. Increasing the water level in certain canal reaches would provide more head for farm deliveries and might make the canal system more controllable or easier to operate. However, currently, the travel times for canal water from the head gates at the top of the system to delivery points at the bottom of the system are less than 14 hours suggesting that the amount of water stored in the canal system is fairly small and increasing the depth of water in the canal system would provide little additional storage or controllability of the system. Any proposed increase in water level in a given canal reach will have to be evaluated specific to that reach to determine if the possible seepage issues can be resolved or mitigated. Figure 3 below shows the canal water level measured in the Rising River (tail end of the Traynor) Lateral Canal during previous studies and presented in the DDR.

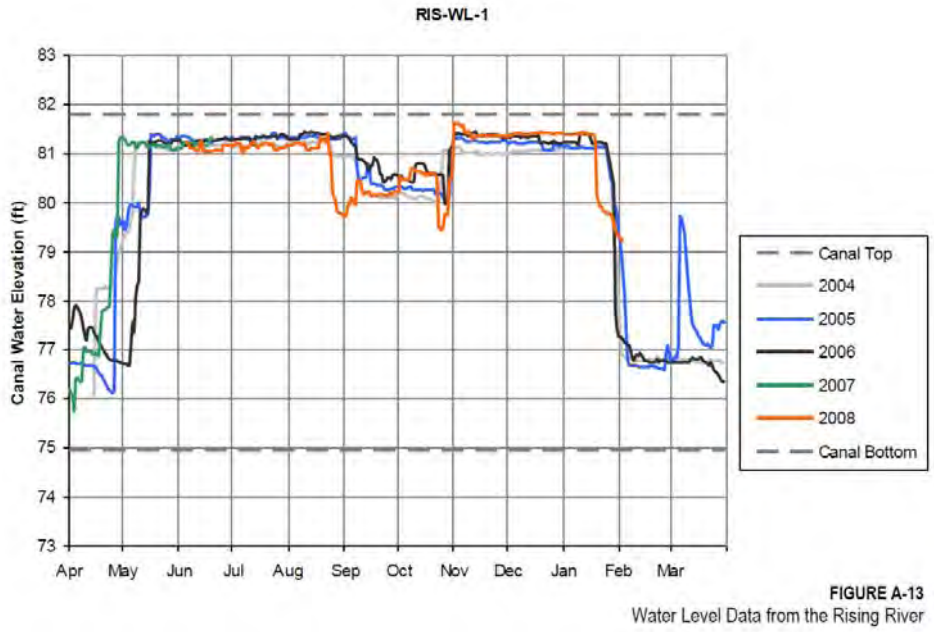

Figure 3 – DDR Figure A-13 showing water level in Rising River (Traynor) Lateral

5.2 Alternative Designs

Particular areas, such as the Rising River (tail end of Traynor) Lateral Canal, have been identified as candidates for placement of the canal underground or installation of an impervious canal lining. This location has a significant amount of aquatic vegetation that could impact design flows. While the initial cost is high, maintenance and operation costs are low.

Whether the lining is concrete or geomembrane, increased flow would result from lower friction coefficients in the canal walls, enabling the canal to convey more water at the same depth of water. Less infiltration would occur due to the impermeability of the lining materials, thereby enabling the canal level to be higher without increasing seepage. One significant operational consideration for lined canals is the local groundwater elevation adjacent to the canal. In areas with high water table, the canal must be kept full of water at all times to balance uplifting pressure on the lining. Dewatering the canal will cause the lining to buckle and crack; for this reason, this alternative does not appear to be viable. An example fiber-reinforced concrete application is shown in Figure 4.

Figure 4 - Fiber-reinforced shotcrete application. Source: AW Blair Engineering (2011)

5.3 Local Drainage (Interceptor Drainage Canals)

Seepage canals or interceptor drains are currently in use by the District. However, this method is not feasible at all locations due to right-of-way restrictions or insufficient grade to convey water to the regional drainage system.

5.4 In-Situ Compactions

A method of bank stabilization that provides reduced permeability in canal banks is in-situ compaction. Compaction is accomplished by applying an excavator-mounted flat plate vibratory compaction device to the canal bottom and sides. Permeability reduction is effective in the top 4 to 8 inches of soil. The soil should have sufficient clay content for the compaction to be effective. An example of this type of compaction device is shown in Figure 5.

Figure 5 - Vibratory compactor canal wall stabilization. Source: AW Blair Engineering (2011)

5.5 Slurry Wall

While slurry cut-off walls can be effective in areas of restricted right-of-way that preclude the use of intercepting drains, there is the potential for seepage to bypass the wall if there is a path for water to circumvent the wall either around or under the structure. A geotechnical study would be needed to establish the depth and extent of the required wall. An example of the placement of slurry in an intercepting trench is shown in Figure 6.

Figure 6 - Placement of slurry in prepared trench. Source: CSU Chico Research Foundation (2006)

5.6 Seepage Easements

Negotiated easements may be signed with individual land owners that provide compensation to the land owner for future potential damages that may be caused by seepage from the canals. The success of this method is unknown due to the variable nature of the perceived and actual potential damages and the value the individual may place on the use of the land. A modified version of a seepage easement may be considered that provides for right-of-way for the installation of an interceptor drain to convey any seepage from the outer toe of the irrigation canal to a regional drainage canal.