MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO: Commissioners Helgeson, Brown, Mital, Simpson and Carlson

FROM: Mike McCann, Interim Chief Energy Officer, and Mark Zinniker, Generation Engineering Supervisor

DATE: October 27, 2017

SUBJECT: EWEB Power Canal Seepage

OBJECTIVE: Summarize EWEB's Seepage Management Approach for the Hydro Power Canals

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Issue

Water seeping through the earthen embankments of the Leaburg and Walterville Canals affects adjoining private properties to varying degrees. Seepage is present at various locations along the full length of both canals, resulting in effects on neighboring properties that range from the difficult to perceive (increased subsurface groundwater levels) to the obvious (small flowing streams through natural swales or drainage ditches). The extent of seepage varies with canal water level, peaking at full canal flow and essentially disappearing when the canals are dewatered for annual maintenance. Neighbor reactions to the seepage conditions are also variable, ranging from favorable (seepage is used by some property owners for landscaping ponds/features and shallow wells) to negative (threats of property damage claims). EWEB primarily receives seepage-related complaints during the wet weather season when the combination of canal seepage and precipitation-derived stormwater is most likely to overwhelm the drainage capacity of neighboring properties, resulting in areas of spongy soils and/or ponding.

Background

The Walterville Canal, with a length of approximately four miles, was originally constructed between 1909 and 1910. The Leaburg Canal, with a length of approximately five miles, was constructed between 1927 and 1928. The canals were constructed by excavating into the slopes and hillsides above the McKenzie River where native materials ranged from alluvial deposits of silty/sandy gravels to basalt bedrock that required blasting. The excavation spoils were used to construct the downhill canal embankments. Modern repair work typically reveals the presence of a thin layer of finer grained soil on the interior face of the canal embankments that creates an earthen 'liner' for the canals. The embankment materials were placed in shallow lifts and compacted using teams of horses. The quality of construction was likely variable and generally poor relative to modern earthwork standards.

As a result of the pre-modern earthwork designs and construction techniques, the presence of water seeping through the canal embankments is an expected and inevitable side effect of the power canals. As such, seepage impacts on neighboring properties became evident as soon as the power

canals were filled and went into operation. Archive records contain a significant volume of correspondence between EWEB and adjoining property owners regarding seepage impacts. These date from the initial days of canal operation to the present.

Neighboring properties with poor drainage tend to be the most sensitive to canal seepage. Examples include properties sandwiched between the power canals and Highway 126. The highway itself is constructed on a raised embankment that impedes the downhill flow of water (canal seepage as well as stormwater). The water must either find its way to a culvert passing beneath the highway or infiltrate into the ground. Figure 1 shows this type of property during the wet weather season after a period of heavy rainfall. The highway is just beyond the trees on the left side of the photo and canal slope on the right.

Figure 1. Ponding between the Leaburg Canal and Highway 126 following heavy rainfall

Other properties adjacent to the canals are relatively flat. An example of this type of property is shown in Figure 2. Even though not sandwiched between the canal and highway, the water must pond significantly before it can drain away, otherwise it must infiltrate into the groundwater table. Again, this type of ponding is typically only present during periods of heavy rainfall.

Figure 2. Seepage effects on flat farmland adjacent to the Walterville Canal

Canal Safety Surveillance and Monitoring

While water seeping through the earthen canal embankments is normal, EWEB staff are constantly alert to the possibility of normal, clear seepage becoming excessive. Excessive seepage refers to levels of leakage from the canal that contain enough energy to erode embankment materials, resulting in heavy flows of cloudy or muddy water. If left unchecked, excessive seepage could remove soils to the point of undermining the structural integrity of a canal embankment, resulting in an uncontrolled release of water or 'canal breach'. The entire Leaburg Canal and portions of the Walterville Canal are categorized by the Federal Energy Regulatory Commission (FERC) as High Hazard due to the potential for a failure to cause loss of life, property, or environmental resources. Prevention of a canal breach or uncontrolled release of water is the purpose of EWEB's Dam Safety Program, a formal program that guides a wide variety of dam safety activities that are performed by EWEB engineering and operations staff, various contractors, and dam safety specialists.

As part of the Dam Safety Program, EWEB staff regularly monitor seepage conditions along Leaburg and Walterville Canals. The monitoring activities include daily inspections of the high hazard portions of the canals by operations staff. On a weekly basis, operations staff also gather flow

measurements at permanent seepage weirs located at various known seepage points along the canals. These devices quantify the amount of seepage for analysis and trending by engineering staff. Figure 3 shows one of the seepage weirs. There are also numerous sites where seepage cannot be collected for measurement, but are still visually monitored and documented on weekly inspection checklists. These regular monitoring activities position EWEB staff to recognize any changed conditions that might warrant response. Additional dam safety inspections are conducted on monthly and quarterly intervals by EWEB operations and/or engineering staff. Dam safety engineers from the FERC inspect each canal annually. And every five years, an independent consultant hired by EWEB conducts an in-depth dam safety inspection and documentation review.

Figure 3. Permanent seepage weir monitoring station

Hazard Mitigation Control System

Given the recognized potential for emergent problems on the canals and the importance of a prompt response to avert an uncontrolled release of water, EWEB has installed a Hazard Mitigation Control

Systems (HMCS) on both the Leaburg and Walterville Canals. Figure 4 shows a solar-powered HMCS monitoring station along the Leaburg Canal.

Figure 4. HMCS water level monitoring station, Leaburg Canal

The HMCS systems monitor water levels in the canals to confirm that they remain within a normal range. If the water level falls below the normal range (or rises above normal due to a canal blockage), the HMCS will first alarm, and then automatically close the canal intake gates if the condition worsens. In the unlikely event that a leak were to progress to the point of creating an abnormal water level even in the middle of the night, the HMCS ensures a proactive mitigation action without human intervention.

Annual Canal Maintenance and Repairs

The EWEB management team approved an annual O&M budget increase in 2013 that authorized spending a minimum of $100,000 per year for canal repairs. The first round of canal repairs were designed later that year for review and approval by the FERC and in-water work permitting agencies so that the work could be completed during the 2014 annual canal outage. EWEB has continued to design and implement canal repairs during each subsequent year as follows:

- 2014: 500 linear feet near Cogswell Creek on the Leaburg Canal
- 2015: 100 linear feet near Johnson Creek on the Leaburg Canal
- 2016: 520 linear feet near Rawhide Creek on the Walterville Canal
- 2017: 120 linear feet near Johnson Creek on the Leaburg Canal

Construction timing for the repair work is constrained by several factors. Primary factors are the dependency of the McKenzie Hatchery and irrigators on the canals for water supply. The McKenzie

Hatchery can only tolerate a drawdown of the Leaburg Canal during the wet weather season. The hatchery's alternative water supply from Cogswell Creek generally becomes inadequate in May. Irrigators along the Walterville Canal typically need the canal full by late June to maintain their crops. Within these seasonal constraints, EWEB needs to find a dry weather period to complete the precipitation-sensitive earthwork. The canal repair contracts are set up to require contractor mobilization on short notice in order to take advantage of favorable weather conditions when they appear. Staff experience to date indicates that the duration of dry weather windows during the wet weather season doesn't permit much more than the currently targeted volume of earthwork at a given site. As a side note, EWEB completes annual maintenance on the fish screens and other activities that require a canal drawdown at the same time that the canal repairs are underway.

The linear footage of canal bank that can be improved in a given year is dependent on how much of the interior slope of the canal is targeted for repair. If monitoring data indicate that the seepage is originating in the upper portion of the embankment and a relatively shallow repair design is expected to suffice, the linear footage of repair will be greater than if monitoring data indicates that the seepage is sourced deep on the canal and coffer damming will be required to complete the repairs. Figure 4 shows relatively shallow repair work underway in 2014 and Figure 5 shows a deep repair in progress with a hydraulic cofferdam system.

Figure 4. Shallow canal slope repairs, Leaburg Canal 2014

The effectiveness of canal repairs completed to date, in terms of reduction in seepage, has been variable. While the 2015 and 2016 repairs were highly effective at reducing seepage, the effectiveness of the 2014 and 2017 canal repairs was marginal. This variability is indicative of the

inherent trickiness of sleuthing out the source of a water leak. Correctly identifying a needle-in-the-haystack type seepage source is tricky and may require multiple repair attempts to resolve.

Figure 5. Deep canal slope repairs with coffer dam, Leaburg Canal 2015

It is important to note that even marginally effective canal repairs yield valuable improvement to the canals. The canals are home to a number of rodent species including nutria, beaver, otter, and muskrat which might try to burrow into any exposed soils below the waterline of the canals. By restoring the coverage of rip rap on the interior slopes of the canal, EWEB effectively armors the canals against rodent burrowing. The improved armoring also protects the underlying soils of the canal embankments from scour.

Prioritization of Canal Repairs

Each fall, EWEB generation staff review the latest seepage monitoring data and surveillance information in order to select a portion or portions of the canal embankments for repair during the next year's annual canal outage. The following are the main considerations in order of importance that influence EWEB's prioritization of the canal repairs:

1. Seepage areas of concern that have been observed to be worsening.
2. Risk ranking for stable seepage areas:
    a. Perceived likelihood of failure
    b. Consequence of failure
3. In cases where the risk ranking is equal, the lower cost repair area may be prioritized if a delay in addressing the competing repair area is acceptable.

In the event that the cost to repair the priority seepage areas exceeds the baseline annual O&M budget allocation of $100,000, EWEB staff know that they have the ability to request additional funding from contingency reserves.

Requested Board Action

Information only, no Board action requested.