MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

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

FROM: Sue Fahey, Chief Financial Officer; Sarah Gorsegner, Purchasing & Warehouse Supervisor

DATE: December 22, 2017

SUBJECT: Board Appointed Consultants

OBJECTIVE: Board Direction on Appointment Process for Board Appointed Consultants

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Issue

EWEB Public Contracting Rule 6-0130 designates Board Appointed Consultants as personal services that are not subject to competitive bidding requirements. The Board reviews and ratifies contracts with consultants awarded under Rule 6-0130 annually. The Board has asked for a review of the process and the associated contracts.

Background

EWEB's Board may appoint and retain consultants to independently advise them and provide professional direction without regard to management's position or interpretation. In the past, EWEB invoked Rule 6-0130 for many consultants and did not use a competitive procurement process. Several years ago the Board directed staff to complete formal solicitation processes for these contracts.

In January 2017 the Independent Auditor and Certified Public Accountant contract was the only contract presented to the Board for appointment, as all other contracts were awarded using standard procurement and approval processes.

Discussion

The Board has asked staff to focus the Board ratification process on consultants used primarily by the Board. Occasionally, consultants provide reports to the Board; however, consultants used primarily by the Board are limited. Consultants used primarily by staff are subject to Public Contracting Rules and may require a competitive process. The Board requires legal counsel and occasionally other consulting services.

Management is proposing to change the process for Board appointed consultants. Once the Board determines a service is required, staff will support the Board in selecting a provider(s) and negotiating the contract. Each fall the Board will review their direct appointment contracts to determine which contracts are still required and meet performance standards. Staff will send a list of proposed contracts for the following year to the Board for ratification.

The Board does not have any current contracts that used this exemption. Accordingly, no contracts require approval at this time. However, the Board may wish to initiate this process for "general legal counsel" going forward, which will establish contract(s) for Board-related services that are separate from those used by staff subject to public contracting rules.

Recommendation and Requested Board Action

Management requests feedback on the proposed Board appointed consultant process, and requests that the Board identify potential provider(s) for general legal counsel that will support the Board directly as Board Appointed Consultant(s).

MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

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

FROM: Mel Damewood, Chief Water Operations and Engineering Officer

DATE: December 22, 2017

SUBJECT: Emergency Water Supply Update

OBJECTIVE: Information Only

Issue

Efforts have begun on the Water Utility's Emergency Water Supply Program. This memo provides an update on the work to date related to this effort.

Background

For the last several years EWEB has been working on two efforts related to emergency water supply:

- Development of a 2nd Source. This project, commonly called AWS, included the development of a second water supply and treatment plant on the Willamette River. Planning and preliminary design have been completed and property was purchased for the treatment plant and river intake.

  Following the March 16, 2017 Strategic Planning Work Session a decision was made to defer this project.

- Emergency Water Supply. With the deferment of the 2nd Source Project, direction was given to bolster EWEB's existing Emergency Water Supply Program

  The existing project began in 2012 and was based on providing an emergency water supply at various distribution sites throughout the community. Water would be delivered to these sites where customers could fill jugs with drinking water. A total of 14 sites were initially selected with the knowledge that EWEB would not be able to access all of them following an earthquake or other event. To date, EWEB has constructed three distribution trailers and purchased tanks and other items to deliver water. In addition, EWEB is currently having a water treatment trailer constructed which will be completed in January. This trailer is designed to treat surface water for emergency use on a temporary basis.

  The greatest hurdle to the existing program is the logistics of transporting water to the distribution sits. This will require a significant amount of resources.

  To avoid the issues of delivering water to multiple sites, the new direction of the Emergency Water Supply Program is to establish permanent water distribution sites with established

sources of water. Placing distribution sites at neighborhood schools with existing wells was the original proposal.

Discussion
EWEB's efforts related to the establishment of the permanent distribution sites are discussed below.

Groundwater
With the initial focus on groundwater wells as the water source, EWEB retained GSI Water Solutions to evaluate the use of wells for emergency water supply. This evaluation was targeted at the use of wells at the five principle high schools in EWEB's service area:

- Churchill,
- North Eugene,
- Sheldon,
- South Eugene, and
- Willamette

A draft of the evaluation has been completed and is in review. Some observations from the report include:

- The aquifers underlying the EWEB service area can be grouped in two categories; alluvium (sediment and floodplain deposits) and consolidated rock.
- The alluvial aquifers are generally located north of Amazon Creek and wells located in this aquifer are much more productive than wells located in the consolidated rock aquifers to the south. A groundwater yield map for the EWEB service area is included as Attachment 1.
- Wells constructed in the northern Eugene in the alluvial aquifer could be expected to produce 200 gallons per minute (GPM) or more with relative certainty. Wells constructed in southern Eugene in the consolidate rock aquifer could be expected to produce on the order of 25 to 30 GPM with a high level of uncertainty.
- There are differences in the water quality in wells located in the alluvial aquifers compared to those in the consolidated rock aquifers. This will be discussed later herein.
- During seismic events wells can be damaged both by liquefaction (when soil loses strength and behaves like a liquid) and shaking during a seismic event.
- North Eugene, South Eugene, and Churchill are within zones of moderate liquefaction risk. Sheldon and Willamette do not appear to be in zones of liquefaction risk.
- All of the high schools are in areas expected to experience strong shaking.
- The Oregon Administrative Rules include a list of setbacks well sites must meet to be legally constructed. South Eugene does not meet the setback requirement for distance from a water body due to the proximity of Amazon Creek. It is not clear if this would apply to emergency wells.
- The cost to drill a new well is on the order of $100,000 to $150,000. This does not include the cost to outfit the wells with a pump and distribution equipment. The unit cost per yield (dollars per gallon per minute) would be approximately ten times higher for wells

constructed in the consolidated rock aquifers compared to those constructed in the alluvial aquifer.

- There is no formal guidance available on the water rights permitting for a well which will be used for emergency use. Discussions with the Oregon Water Resources Department (OWRD) have occurred and will continue as this project develops.

Groundwater Quality
EWEB has contacted the Oregon Health Authority (OHA) and discussed the use of wells for emergency water supply. Water treatment is not required as long as the wells are not under the influence of surface water and the groundwater meets the drinking water requirements for coliform bacteria, nitrate, and arsenic. These are the acute contaminants of concern in an emergency. Coliform bacteria and nitrate are normally associated with alluvial aquifers while arsenic is normally associated with consolidated rock aquifers.

Water quality sampling was recently completed at High Schools in North Eugene which have existing groundwater wells. These include North Eugene, Willamette, and Kalapuya High Schools. Sheldon also has a well however the electrical equipment associated with the well was recently destroyed in an arson fire and the well is not anticipated to be operational until near irrigation season.

EWEB is currently waiting for the complete results of the water quality sampling. An early result identified nitrate in the North Eugene High School well, however it was significantly below the drinking water maximum contaminant level (MCL). Also, previous test results shared with EWEB for a new well located at Kalapuya High School indicated it met drinking water requirements.

Continued coordination with the OHA will occur as this project develops.

Potential Permanent Emergency Water Distribution Sites
Potential permanent water distribution sites have been identified and are shown on Attachment 2 where the potential sites are overlain on top of a population heat map of EWEB's service area. The darker the color the higher density the population.

The potential distribution sites can be grouped into several categories which are discussed below:

Sites With Existing Wells/Available Groundwater
These are schools sites located above alluvial aquifers in North Eugene and include facilities in both the 4j and Bethel School Districts. EWEB has and will continue to have discussions with representatives from both districts as this project develops.

- Sheldon HS. This school is centrally located in the area bounded by the Willamette River and I-5 and it has an existing irrigation well that could be used as a water source.
- North Eugene HS. This is also an older school and there are plans to construct a new high school there in the near future which would be built to current structural codes. There is also an existing irrigation well at the site that could be used as a water source.
- Kelly/Howard Schools. This is close to North Eugene however, the structures are relatively new and there are plans to construct a new well at Howard Elementary. In the near term,

this may be a better site than North Eugene.

- Willamette HS. This is school is in a good location for the area west of Highway 99. It also has an existing irrigation well that could be used as a water source.
- Kalapuya HS. This school is on the list as it is a newer facility and it has a recently constructed well (at Bethel Farms).

Sites Without Wells/Limited Groundwater

These are sites located in the southern part of Eugene with more limited groundwater. These areas also correspond with the higher density population areas of Eugene. These sites are not believed to have existing wells.

- Hayward Field. This site is focused on the University of Oregon (UO) population and the surrounding areas. The actual distribution site would likely be on the expansive playing fields nearby.
- South Eugene HS/Roosevelt MS. These are located in a high density population area and have expansive fields nearby. The more likely site would be Roosevelt MS due to it being new, built per current structural codes.
- Cesar Chavez/Arts & Technology Academy (ATA). Only one would be used of these two, probably ATA as it is recently constructed with ample fields nearby with good access.
- Churchill HS. A distribution site at Churchill will be a must in the long term plan. It serves a large area and is near parcels of high density population. It is an older school, however, and getting a supply of water to that location could be difficult as groundwater appears to be limited in that area.

Federal Disaster Sites

There are three potential sites shown which have been identified as Federal Disaster Assistance Locations. These are the Fairgrounds, the Hilton/Conference Center (referred to as 'Downtown' on Attachment 2), and the Moshofsky Center. These site would have Federal Medical Stations and other Federal emergency operations functions.

EWEB anticipates there will be a need to provide a source of water for these locations, likely more than just for drinking water.

Water Supply Requirements

The minimum amount of water required for drinking water at each of the potential distribution sites has been calculated based on the following:

- A water supply of 2 gallons per person per day.
- The population density in the area applicable to each site.

The minimum amount of water estimated to be required at each site is shown in Table 1. The quantities are shown in GPM over a 24 hour and over a 10 hour period which may be more realistic assuming people will tend to arrive to get water during daylight hours.

Table 1. Minimum Required Water Supply at Emergency Distribution Sites

	GPM (24 Hr)	GPM (10 Hr)
Sheldon High School	40	100
North Eugene High School	30	60
Kelly Middle School/Howard Elementary	20	50
Willamette High School	20	50
Kalapuya High School	30	60
Hayward Field	20	50
South Eugene High School/Roosevelt Middle School	30	60
Cesar Chavez Elementary/ATA	20	40
Churchill High School	20	40
Fairgrounds	20	40
Downtown (Hilton/Conference Center)	20	40
Moshofsky Center	20	50

The above flows are minimum and it will be better to provide more, particularly at the Federal Disaster Sites.

Recall that wells constructed in northern Eugene in the alluvial aquifer could be expected to produce 200 GPM with relative certainty while wells constructed in southern Eugene in the consolidated rock aquifer could be expected to produce on the order of 25 to 30 GPM with a high level of uncertainty.

For comparison, EWEB's treatment trailer which is nearing completion has a capacity of approximately 60 GPM.

An Alternative Concept for South Eugene

Due to the limited groundwater in the higher density areas of South Eugene, an alternative concept is being explored to provide these areas with a reliable emergency water supply. This would consist of the following:

- A small package water treatment plant drawing water from the Willamette River. EWEB has had preliminary discussions with UO staff regarding this plant and has requested that they reserve space near their Central Plant facility off Franklin Blvd in the planning work that is occurring for that area. There is ample backup power at this location and a small treatment plant at that location has the potential to benefit both EWEB and UO.

  Additional sites for the package plant will also be considered going forward. These will likely include but not be limited to Valley River Center and Skinner Butte Park.

  The package plant would have a capacity between 300 and 500 GPM and would differ from EWEB's treatment trailer in that it would be designed for long term operation i.e. the filters in the plant could be backwashed or cleaned in place automatically. Many of the filters in the treatment trailer are disposable. This requires much more maintenance and the unit can only operate until you run out of the disposable filters.

- A 'micro' water distribution system. This system, supplied by the package treatment plant

would provide water to the sites in South Eugene. The distribution system would be constructed of small diameter (2-4 inch) flexible polyethylene pipe which has an excellent track record in seismic events. The system would also be connected into one of the transmission mains from Hayden Bridge so that it could provide water if Hayden Bridge is operational while the distribution system is being repaired.

It would be cost prohibitive to install this piping using conventional open cut trenching. As such, this concept assumes that the majority of this system would consist of small diameter pipe inserted (loosely) into abandoned steam lines and abandoned water pipe pipelines (every time EWEB replaces a water main, an existing main is left empty in the ground). The only connections that would be at the supply and at each distribution site to improve resiliency.

EWEB is currently vetting this concept. As mentioned, preliminary discussions have occurred regarding the siting of the treatment plant. In addition, a preliminary layout of the distribution system has been developed and EWEB operations staff are beginning to locate and verify the condition and access constraints of the abandoned water and steam lines.

Use of Treatment and Distribution Trailers

It is anticipated that the soon to be completed treatment trailer and existing distribution trailers will continue to be an integral part of the emergency water supply program. Their use will be necessary in the upper level systems and in other areas without a permanent distribution site nearby.

Next Steps

Major activities to occur in 2018 are summarized below:

General On-going Items (occurring all year):

- Further Vetting of South Eugene Concept: Operations staff will continue exploring the viability of 'micro' distribution system through field exploration. It is anticipated that the vetting of this concept will occur into 2019.
- Backup Power Discussions. It is anticipated the initial sites will be provided with an existing or new generator for backup power. Ultimately, an electric micro grid facility would be at several sites. This would be much easier to implement at newer schools but could take longer to implement than the water distribution equipment. How to phase this in will need to be discussed and planned.

2018-First Quarter Milestones

- Site Configuration Defined: Upon receipt of the complete water quality sample results, EWEB will layout the facilities to be located at each site with an existing or proposed groundwater well. If the results are similar to what was found at the Kalapuya well, there would be no treatment required. In this case, the equipment at the sites, with respect to water delivery, will be similar to what is contained within EWEB's existing water distribution trailers. This includes water distribution piping, supports, signage, and related accessories. The focus will be on standardization and modular components to the maximum extent possible.

- Specific 2018 Site Selection: In early discussions it was proposed that the first site would be located at Sheldon High School. Due to the fire damage at the Sheldon well, it might be better to place the first site at another location while additional security at Sheldon is being implemented. Kalapuya High School would be a good option as it has a new well and electrical equipment that could be incorporated into the improvements.
- Table Top Exercise: EWEB Operations and Engineering staff are planning a tabletop exercise for the deployment of distribution equipment at the first permanent distribution site. Note that while the initial deployment will involve EWEB staff, the long term plan would be for non-EWEB personnel to operate the facilities. Training will be conducted in the future to facilitate this transition.

2018-Second Quarter Milestones

- Distribution Site Equipment Procured. Equipment will be procured and staged for construction when school is not in session.
- Table Top Exercise – Treatment Trailer. A table top exercise is planned for the field deployment of the new treatment trailer and a distribution trailer. This is initially planned to occur at the Valley River Center.

2018-Third Quarter Milestones

- Placement/Construction of Distribution Site Equipment.
- Field Deployment and Exercise of Distribution Equipment at the First Permanent Site.

2018-Fourth Quarter

- Full Deployment of Treatment Trailer on the Willamette and Distribution of Water Using the Distribution Trailers.

Recommendation/Requested Board Action

This is an information item only. Input is desired from the Board on the direction of the project as described herein.

If you have any questions please contact Mel Damewood, Chief Water Engineering and Operations Officer at 541-685-7145 or email mel.damewood@eweb.org.

ATTACHMENT 1

Well Yields

Eugene Water and Electric Board

R5W R4W R3W R3W R2W

T17S T18S

NORTH EUGENE HIGH
WILLAMETTE HIGH
HENRY D SHELDON HIGH
WINSTON CHURCHILL HIGH
SOUTH EUGENE HIGH

Warren Slough
Flat Creek
Spring Creek
McKenzie River
Willamette River
Willow Creek
Amazon Creek
Mill Race
Russel Creek
Berkshire Slough
Spencer Creek

11795 57'
11800 70'
11814 56'
11798 59'
3365 157'
50313 88'
12170 53'
56763 98'
74384 105'
59896 219'
61227 80'
11995 53'
12014 123'
74335 70'
12034 60'
50663 79'
73012 98'
11198 87'
56427 78'
56428 77'
490 164'
67203 73'
12246 100'
12247 90'
74645 59'
68849 80'
56433 98'
56432 77'
12317 61'
12260 120'
68551 78'
12430 85'
12412 130'
12487 110'
12465 349'
12454 150'
12606 230'
12605 150'
12597 170'
12601 197'
12622 34'
12623 150'
8286 101'
12602 22'
1375 300'
16869 175'
16875 100'
73873 153'
73873 153'
73872 202'
16906 165'
1378 540'
73192 325'
2621 515'
16745 30'
16768 80'
12406 130'
12420 95'
12649 400'
12650 200'
1031 160'
11494 300'
11490 463'
11503 404'
11481 200'
11492 186'
11506 250'
11479 397'
11496 350'
11517 302'
11519 302'
11547 55'
11525 255'
11511 203'
75108 262'
57500 607'
11023 83'
11016 70'
71769 400'
68803 213'
11012 63'
10998 124'
11013 200'
64395 305'
52320 138'
61477 452'
68879 117'
11118 360'
4093 80'
11038 260'
68880 280'
11082 71'
64275 98'
61476 425'
261 66'
61476 425'
0 0'
0 0'
11148 200'
11119 380'
111118 360'
68912 240'
1017 255'
11229 255'
11228 255'
61162 252'
11224 132'
73340 79'
3784 119'
11160 220'
11263 62'
11278 70'
11299 75'
11284 68'
71037 120'
11292 172'
11245 200'
11246 160'
11242 140'
11476 60'
11455 60'
11464 450'
11461 300'
11459 67'
11437 135'
57281 98'
57124 81'
11424 234'
11465 152'

0 2,500 5,000 7,500
Feet

N

LEGEND

- Well ID
  Total Depth, in Feet
- High School

Yield, Gallons per mInute

- 0-25
- >25-50
- >50-100
- >100-250
- >250

All Other Features

- Major Road
- Watercourse
- Waterbody

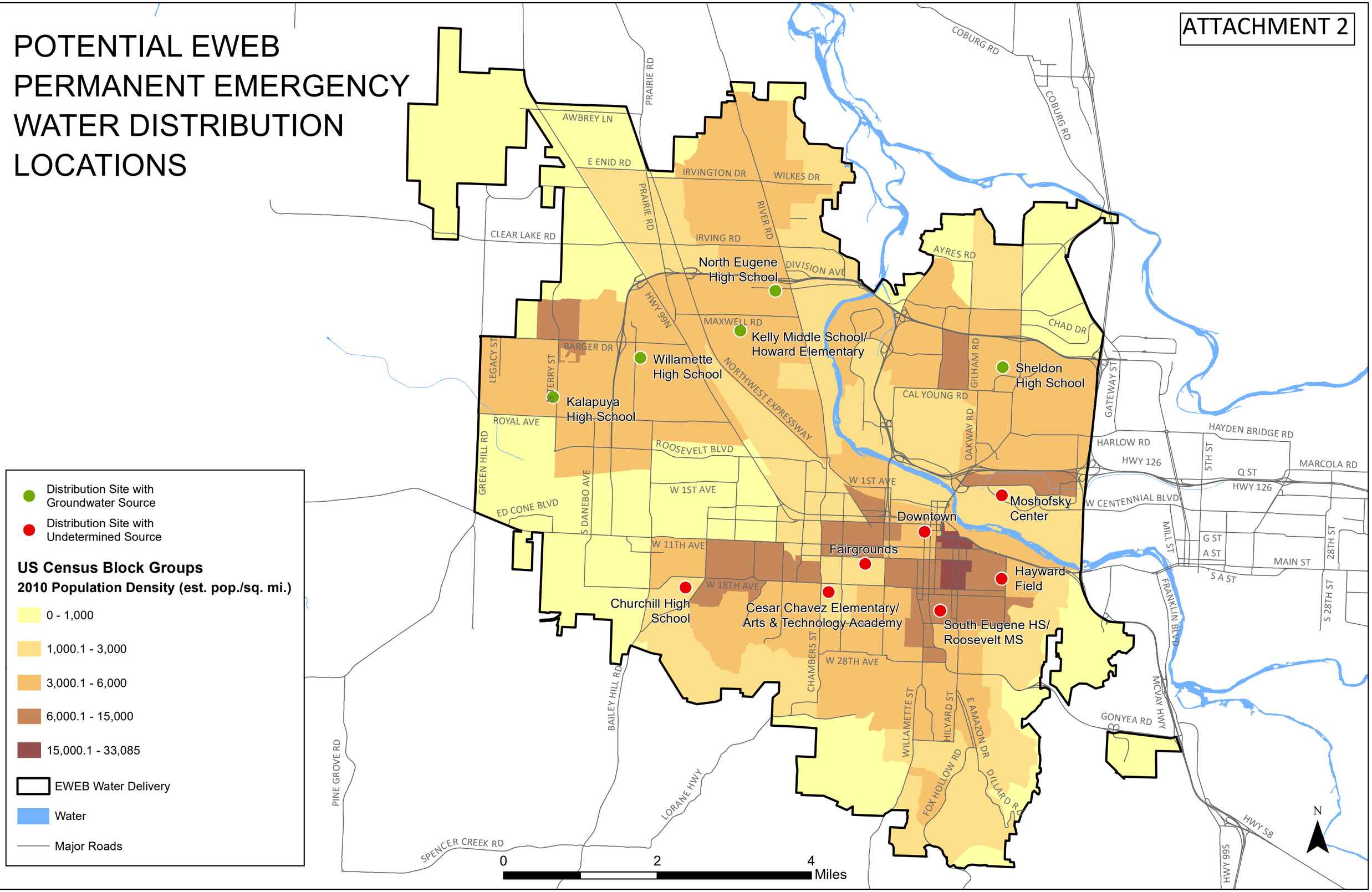
Date: November 9, 2017
Data Sources: BLM, ESRI, USGS

GSI Water Solutions, Inc.

Document Path: P:\Portland\182 - EWEB\012-Eval of Emergency Well Locations\Project_GIS\Project_mxds\Figure3_Well_Yields.mxd

ATTACHMENT 2

POTENTIAL EWEB PERMANENT EMERGENCY WATER DISTRIBUTION LOCATIONS



MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO:	Commissioners Helgeson, Brown, Carlson, Mital and Simpson
FROM:	Mike McCann, Electric Generation Manager; Lisa McLaughlin, Environmental Supervisor
DATE:	December 22, 2017
SUBJECT:	Lower McKenzie River Water Temperature Study - 2017 Results
OBJECTIVE:	Information Only

Issue

This memo presents preliminary data from 2017 for an ongoing study on river temperatures in the lower McKenzie River in proximity to EWEB's Leaburg and Walterville hydroelectric projects.

Background

On March 7, 2017, staff submitted a memorandum for Board consideration on the impacts of the Leaburg and Walterville hydroelectric projects on river temperatures in the lower McKenzie River. The March 7th memorandum entitled *Lower McKenzie River Water Temperature* contained background information on the temperature studies that had been conducted previously in support of the relicensing of the projects and the development of the Total Maximum Daily Loads (TMDLs) for the McKenzie River. Due to lack of recent temperature data, staff recommended that EWEB initiate a water temperature monitoring study in order to better understand temperature dynamics and the potential effect of the Leaburg and Walterville hydroelectric projects on water temperatures in the McKenzie River. In response to this staff recommendation, EWEB initiated a temperature study between May and October of 2017. This memorandum provides a description of the study design and highlights some of the data that was generated.

Results

Between May 15th and June 6th of 2017, EWEB deployed 20 *Tidbit* temperature loggers at various locations within the project area. All of the loggers were retrieved on October 17th. The loggers were deployed upstream and downstream of EWEB facilities and were programmed to record temperature readings every half hour. Ten of the loggers were deemed to be the most critical in determining potential impacts to water temperature and are the subject of this analysis. Their location within the project area is depicted in Figure 1. In an effort to compare study results with previous DEQ modeling efforts, the average of seven consecutive daily maximum temperatures (7DADM) on a rolling basis was used for this analysis.

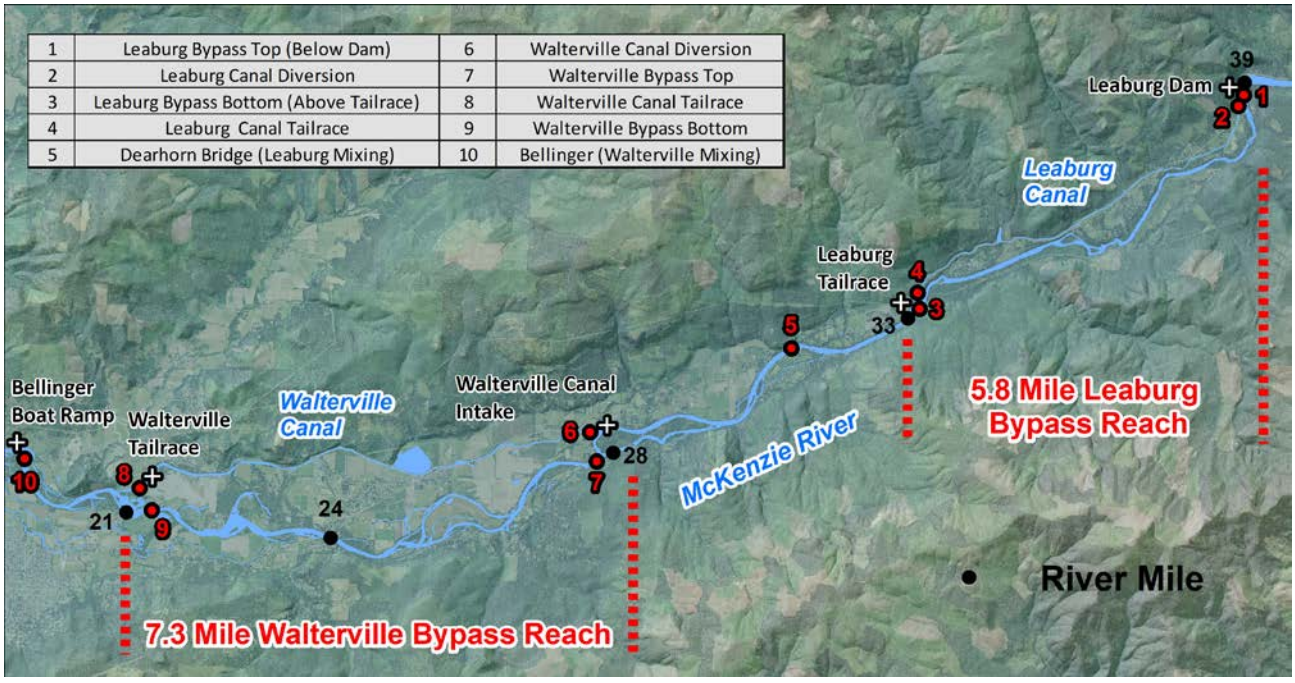


Figure 1. Locations of temperature loggers in the Leaburg-Walterville Project Area.

Leaburg Project –

In order to measure temperature impacts of the Leaburg Project, temperature loggers were placed at the top of the bypass reach below the dam (Logger 1), at the canal diversion (Logger 2), at the bottom of the bypass reach above the confluence with the tailrace (Logger 3) and in the tailrace below the powerhouse (Logger 4). Temperatures at the downstream locations were compared with their upstream counterparts to determine temperature variations in the canal and bypass reach. An additional logger (Logger 5) was placed at Dearhorn Bridge, approximately 2 miles downstream of the confluence of the Leaburg tailrace and the bypass, to measure if any potential temperature impacts were detectable below the mixing of the two flows.

In 2017, there was little discernable change in water temperature in the Leaburg bypass reach between the Leaburg canal diversion and the tailrace. The maximum change during the study period was 0.3 °C and the median change was 0 °C. There was also little discernable change in water temperature between the top of the Leaburg bypass reach and the bottom of the reach (Figure 2). The maximum change was 0.3 °C and the median change was 0 °C. There was slight warming observed at Deerhorn Bridge when compared to upstream sites but this warming may not be caused by EWEB's operations.

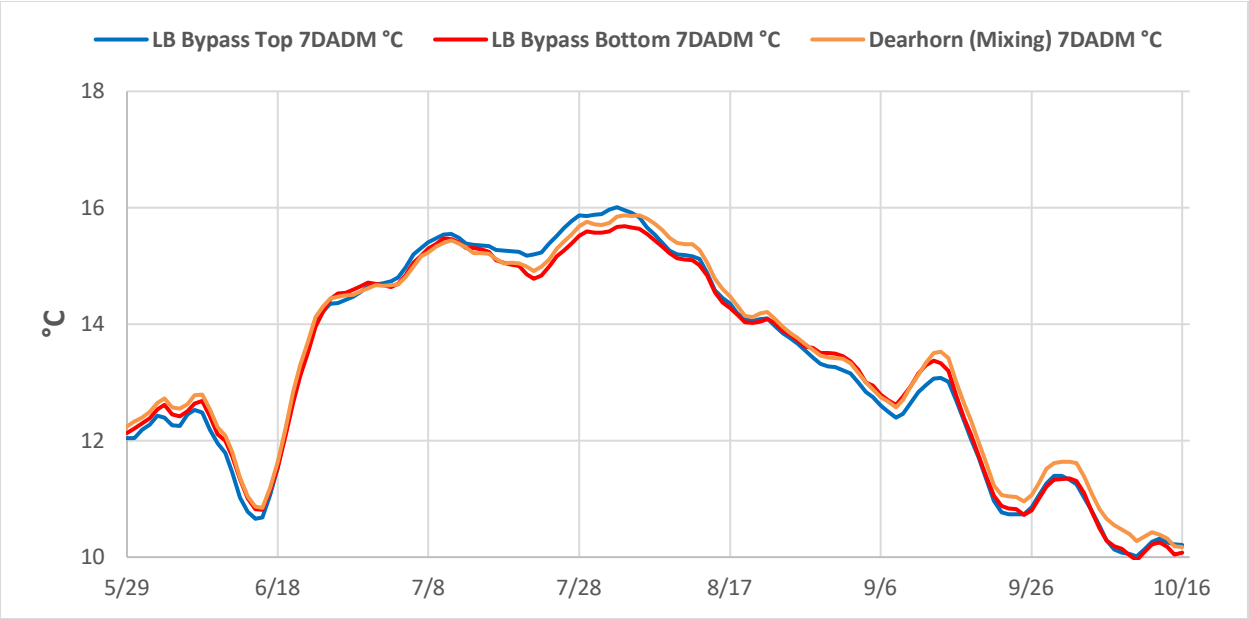


Figure 2. Comparison of temperatures (7DADM) at top of Leaburg bypass, bottom of Leaburg bypass, and Dearhorn Bridge.

Walterville Project –

To measure temperature impacts of the Walterville Project, temperature loggers were placed at the canal diversion (Logger 6), at the top of the bypass reach (Logger 7), in the tailrace above the barrier (Logger 8), and at the bottom of the bypass reach (Logger 9). Temperatures at the downstream locations were compared with their upstream counterparts to determine temperature variations in the canal and bypass reach. An additional logger (Logger 10) was placed at Bellinger Boat Ramp, approximately 2 miles downstream of the confluence of the tailrace and the bypass to measure if any potential temperature impacts were detectable below the mixing of the two flows.

In 2017, there was noticeable warming in the Walterville bypass reach between the canal diversion and the tailrace. The Walterville bypass reach experienced a maximum of 2.6 °C warming during the study period and the median change was 1.7 °C (Figure 4). The river at Bellinger Boat Ramp experienced a maximum of 1.4 °C cooling and a median of 0.9 °C, when compared to the warming that occurred in the bypass reach (Figures 3 and 4).

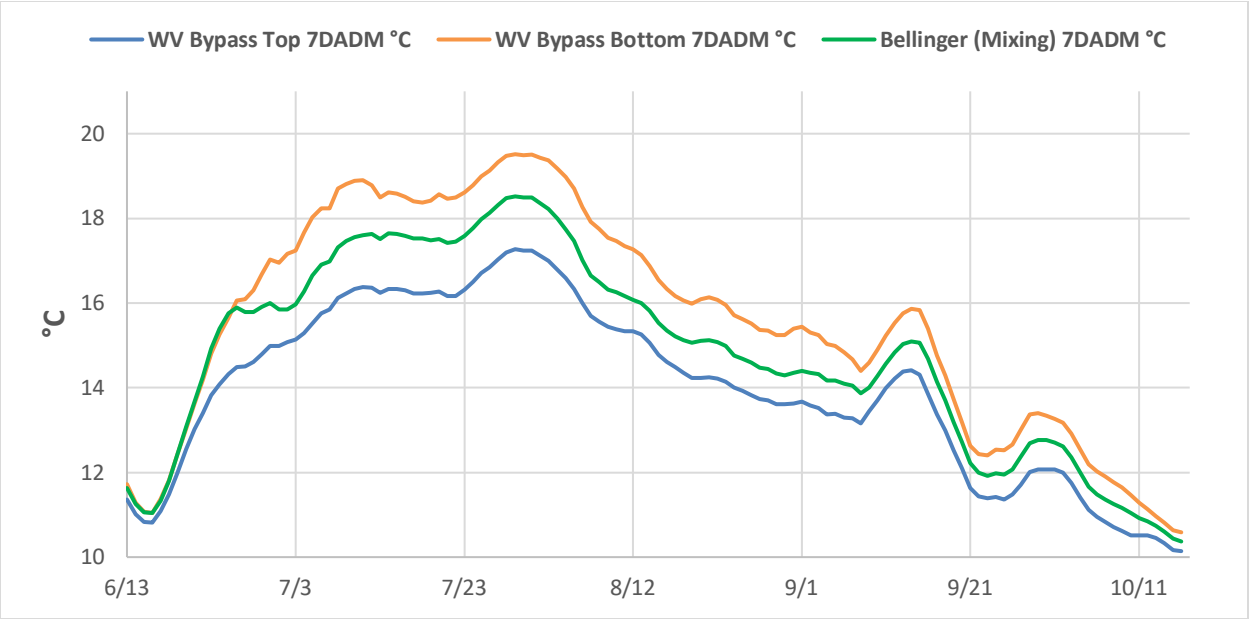


Figure 3. Comparison of temperatures (7DADM) at top of Walterville bypass, bottom of Walterville bypass and Bellinger Boat Ramp.

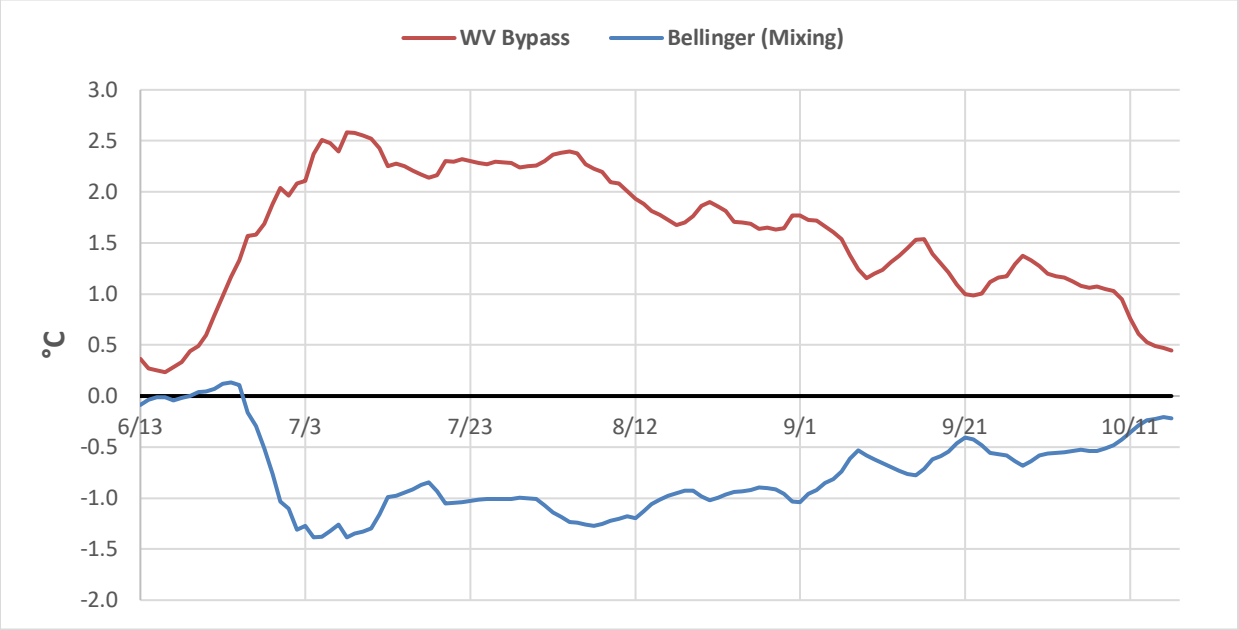


Figure 4. Comparison of warming (7DADM) in Walterville bypass reach and subsequent cooling at Bellinger Boat Ramp, below the mixing of the canal and bypass.

Discussion –

The 2017 results are similar to the findings of previous studies, in that the Leaburg Project had negligible temperature impacts while the Walterville Project looks to be a source of potential heating. The Walterville bypass reach experienced a maximum warming of 2.6 °C and a median of

1.7 °C during the study period. Even though the Walterville canal experienced some warming, there was up to 1.4 °C of cooling that occurred below the mixing of the canal and bypass at Bellinger Boat Ramp as the result of the thermal moderating effects of the canal. Water diverted through the canal is exposed to less solar radiation because flow velocities are greater and the canals are deeper and narrower than the bypass reach. Conversely, the increase in water temperature in the bypass reach is due to the reduction in flow which can result in reduced heat capacity, lower stream velocities and increased travel time. During the warm summer months, these factors allow for greater exposure to solar radiation heat loads and warmer temperatures in the bypass reach.

The warming that occurred in the Walterville bypass reach was likely exacerbated by the record breaking ambient temperatures in the Willamette Valley during the summer of 2017. The warming in the bypass is most readily observed when the reach recedes to just above the minimum flow of 1,000 cfs. This typically occurs in late June after the project outage. In 2017, this coincided with the first heat wave of the summer with consecutive days of air temperatures in the high 90s.

The varying temperature effects in the two bypass reaches are due in part to the geomorphology of the reaches themselves. The Leaburg bypass reach is located in the middle McKenzie River Basin and is characterized by narrow, confined, and stable riffle pool morphology which results in higher stream velocities and decreased travel times as compared to the Walterville bypass reach. The Walterville bypass is located in the lower McKenzie Basin and the reach is characterized by wide shallow glides, an unconfined floodplain containing numerous off-channels habitats and side-channels, all of which contribute to reduced stream velocities, increased travel time and therefore an increased potential for warming. The geomorphic features precede project operations and have likely contributed to historical variances in the temperature regimes of the reaches.

The results from this study are influenced by a combination of the operational, hydrological and atmospheric conditions that occurred during the 2017 study period. Further investigation into the temperature impacts of the projects will occur in 2018. A revised memorandum to the board will be issued at the conclusion of that year's study.

Requested Board Action

None. This memorandum is provided for informational purposes only.