MEMORANDUM
OREGON DEPARTMENT OF FISH & WILDLIFE

DATE: May 26, 2020

TO: FILE- Springhill Pumping Plant Fish Screening Exemption

FROM: Ken Loffink, ODFW Fish Screening Program Coordinator

SUBJECT: Benefit Analysis- Joint Water Commission Springhill Pumping Plant Fish Screening Exemption Request

Overview and Project Proposal

The Joint Water Commission (JWC) is comprised of the Cities of Hillsboro, Beaverton, Forest Grove, and the Tualatin Valley Water District. The JWC operates a large point of diversion (POD) on the Tualatin River, which is located in Washington County, downstream of Scoggins Creek and Henry Hagg Lake. The POD is owned by the Bureau of Reclamation (BOR), and is comprised of a series of large pumps that withdraw water from an alcove that is directly connected to Tualatin River Surface flow. The POD, referred to as the Springhill Pumping Plant (SHPP), has multiple user groups, however, the maximum withdrawal rate of the JWC portion of the SHPP is 143cfs. The actual withdrawal rate varies seasonally and is dependent on a variety of factors including hydrography, climate, and need.

There are a variety of permits associated with the SHPP, several of which are in the process of being updated. The withdrawal and water delivery strategy for SHPP is complex and includes cross basin transfers from Barney Reservoir (Nestucca basin), reservoir flow releases from Henry Hagg Lake, and live flow from the Tualatin. These water rights work in combination and seasonally to allow water to be diverted at SHPP. When a water right is altered through the Oregon Water Resources Department, this constitutes a subsequent review by ODFW and triggers the requirement to install fish screens. Therefore, once new water right permits are issued for the JWC at SHPP by the Oregon Water Resources Department, fish screening will be required pursuant to ORS 498.306.

Currently, the SHPP has a series of traveling belt screens that operate at each one of their pumps associated with the diversion. However, these traveling screens are not equipped with mesh size that meets current National Marine Fisheries Service standards for anadromous fish protection. Furthermore, the screens do not uniformly distribute flow, there are holes and gaps present where fish may become easily entrained, and the total screen surface area is less than what is needed to meet performance criteria for approach velocity. Therefore, the fish screens present at SHPP do not meet State fish screening criteria.
As noted the SHPP is not actually owned by the JWC and is instead owned by the BOR. Any approval for modification of the superstructure to meet fish screening criteria would need to come from the federal government. There is no approval or funds appropriated from the BOR to allow for the SHPP to be upgraded with new criteria fish screens. Pursuant to ORS 498.316, the State may not require fish screening per ORS 498.306, in locations that the Oregon Fish and Wildlife Commission, by contract or other form of agreement with the water user, “has made such other provisions as the Commission determines is adequate for the protection of game fish in the body of water from which water is being diverted.”

The Oregon Department of Fish and Wildlife (ODFW) has interpreted ORS 498.316 to mean that a fish screening exemption (fish screening not required) can be granted if such provisions (mitigation) has been made to adequately protect fish. We have further interpreted that in order to prove this threshold of adequacy has been met, that mitigation in lieu of fish screening shall result in at least the same level of benefits to fish in the Tualatin River basin, as would have occurred if fish screening were to be installed.

The JWC has worked jointly with ODFW on developing a suitable mitigation plan, that would meet the requirements of ORS 498.316. In order to reach a plan, JWC and their consultants performed studies, and collected data to quantitatively assess the annual potential entrainment rate of juvenile salmonids into the SHPP. Entrainment, is considered to be any time a fish is trapped, injured, killed, or otherwise captured by SHPP water withdrawals. The entrainment rate study showed that an estimated 6,287 salmonids could be entrained or captured at SHPP annually, with the potential for 9,559 salmonids if maximum pumping capacity during peak migration periods was achieved (unlikely). Based on the estimated entrainment rate a mitigation plan was developed.

The mitigation plan developed by JWC and their consultants includes the replacement of two road stream crossings and the placement of large wood habitat structures in Bateman Creek, a tributary of Gales Creek in the upper Tualatin Basin. The location of mitigation was selected based on the priority of the waterbody (Bateman Creek) relative to the watershed, and the prevalence of cold-water habitat in a basin that is cold water limited. Based on analysis, the estimated steelhead and coho fry production that could result from removal of these two culverts is over 30,000 respectively, which is greater than the annual entrainment estimates at SHPP.

See Appendix A- “Mitigation Plan” for more information on project background and mitigation.

**Springhill Pumping Plant Site Conditions and Fisheries Impact Estimates**

**Location**
The SHPP is located in Washington County adjacent to SW Fern Hill Rd at GPS coordinates 45.492477 W and -123.092660 N. The SHPP location is downstream of Henry Hagg Lake (Scoggins Creek), immediately downstream of the confluence with Gales Creek, and is roughly South-Southwest of the City of Forest Grove. The pumping plant, as shown in Figure 1 and figure 2, is located at the end of a long alcove that connects to the mainstem Tualatin River.
Figure 1- Satellite View of SHPP Location
Fish Species Assemblage
The SHPP is located in the upper end of the Tualatin River watershed, however there is considerable drainage area and major tributaries located upstream of SHPP. Any and all of the fish species present in the Tualatin River basin could be present at the SHPP location. The following is a list of fish of note that are present in the Tualatin:

**Winter Steelhead** (*Oncorynchus mykiss*): An independent native population listed as threatened by the federal and state endangered species acts, steelhead are not present in strong numbers, but return annually and successfully spawn in tributaries both upstream and downstream of the SHPP.

**Coho Salmon** (*Oncorynchus kisutch*): Likely non-native to the basin, coho have spread into the Tualatin basin and are now an independent population that contributes to the ecological health of the Tualatin as well as contributes to a valuable fishery downstream. The SHPP backwater alcove, may be particularly attractive for juvenile coho rearing.

**Cutthroat trout** (*Oncorynchus clarkii*): Cutthroat trout are prevalent, native, and well spread throughout the Tualatin basin. Given their dynamic life history, it is difficult to determine when or if they would be present at SHPP in high numbers at any given time, but their presence is likely at some level nearly year round.

**Pacific Lamprey** (*Entosphenus tridentatus*): Pacific lamprey are native to the basin, have been observed and are present in the Tualatin, though their numbers and distribution are not well known. The alcove environment where SHPP is located is ideal habitat for juvenile lamprey.

**Largescale sucker** (*Catostomus macrocheilus*): Largescale sucker are native and prevalent throughout the Tualatin basin, particularly lower in the system where low gradient riverine habitat is ideal. They are well distributed in the system and are likely to be present at the SHPP.

Other species of interest:

**Warmwater fish**- bass, sunfish, bluegill are prevalent throughout the basin, particularly in the mainstem Tualatin and downstream of SHPP.

**Chinook salmon** (*Oncorynchus tshawytscha*): Chinook salmon of unknown origin (spring run, fall run, hatchery or wild) may be present at certain times in the Tualatin. Their distribution and prevalence is not well known, nor is locations where they might spawn or rear. Their presence in the Tualatin is considered to be dependent on other Willamette River Chinook populations and their observance in the system is considered to be random. For the purposes of this document, and for the reasons listed herein, Chinook are not considered to be present at SHPP.

**SHPP Fish Screening and Fish Entrainment**
The SHPP diverts water through a series of large traveling belt screens. As water passes through the screen material, the screen rotates carrying debris up and out of the water. The screens and debris then travel over a horizontal spray bar that sprays water to clean the screens, and all debris
is sprayed onto a debris rack for collection and disposal. Screen mesh is 1/8” in size whereas current standards for fry protection are 3/32” mesh. The screen dimensions are 10 feet 9 inches wide, with water depths ranging from 10 to 14 feet deep (see figure 3, and figure 4).

![Figure 3- SHPP Trash Racks (fish screens located underwater behind trash racks)](image)

In addition, water is not diverted through the screens uniformly resulting in hot spot formation. Hot spots occur when certain areas of the fish screen draw in water faster than other areas. This can result in increased debris accumulation and fish entrainment at the hot spot location. Similarly, SHPP screens are not adequately sized for the large amount of flow that is drawn through them resulting in approach velocities (water velocity as flow approaches the fish screen)
that exceed fish protection criteria. Fish protection criteria for self-cleaning screens dictates that approach velocities must be less than .4 feet per second. Approach velocity testing by ODFW in 2018 confirmed the presence of hot spots and approach velocities that exceeded fish protection criteria (see figure 5, and Appendix B for full report).

![Figure 5- Example flow distribution through fish screen (Orange is faster, Green is slower)](image)

The combination of mesh screen that is too large, un-uniform approach velocity, too high of approach velocity, and inadequate sweeping flow, means that this site does not meet fish screening criteria and may entrain fish as a result of diversion.

**Fish Entrainment at SHPP**

JWC and their consultants Mt Hood Environmental (MHE), developed a plan to estimate annual entrainment of fish at SHPP (see appendix C- Final Entrainment Report, and appendix D Mt Hood Environmental entrainment estimate summary). The entrainment study can be broken into two sections of equal importance- calculation of entrainment rates of fish at SHPP, and estimates of fish presence at or near the SHPP intake. Fish screens are designed to adequately protect juvenile anadromous salmonids. So, for the purposes of this report, entrainment rates for Coho salmon, Spring Chinook, and winter steelhead were estimated.

To calculate fish entrainment rates MHE deployed a variety of techniques including on site sampling, mark and recapture of fish, and actual trapping of fish entrained into the intake. Coho salmon fry were marked and released in distinct groups at different locations within the SHPP alcove. A trap and net bag was deployed behind the screen to capture any fish that were entrained. In addition, the rotating fish screens and debris collection racks were monitored to detect fish that had become impinged onto the fish screen. These tests were performed at various pumping and river stage conditions to capture a variety of different environmental conditions and capture velocities present at SHPP. The results of the entrainment study indicate that the entrainment rate at SHPP is approximately 1.5% (1.5% of fish that enter the intake channel will become entrained). Furthermore, entrainment was only observed on fish that were less than 50mm in fork length (MHE, 2019).

With the calculated entrainment rate the next step to calculating actual annual fish
loss/entrainment potential at SHPP was to estimate abundance of entrainable fish (salmonids<50mm) that may be present annually at SHPP during times when environmental conditions would be favorable for entrainment. Unfortunately there are no data sets for annual fish counts/escapement into the upper Tualatin. Escapement into the Tualatin was estimated by taking 20 years worth of data from Willamette Falls fish counts for Coho, Winter Steelhead and Spring Chinook, and then estimating species escapement into the Tualatin based on radio telemetry data collected on tagged fish in the Willamette above Willamette Falls. To further get at potential fish entrainment, fry production was estimated in the Tualatin. To calculate fry production, the number of estimated anadromous fish escapement into the Tualatin was divided by two to estimate female abundance (assuming average female abundance is 50% of the population), and then metrics for average fecundity and egg to fry survival were used to calculate fry production for each species.

With an estimated fry production in the Tualatin for each species (coho, chinook, steelhead), the analysis needs to be further broken down to estimate how many fry of entrainable size would enter the diversion intake and under what conditions. As a simple assumption, it was assumed that the prevalence of fish entering the intake channel would be consistent with the ratio of withdrawal flow compared to Tualatin river flow (if withdrawal flow is 50% of total Tualatin River flow, then rate of fish entrance into the intake channel is 50%). This final piece was used to calculate the average daily count of entrainable fish into the intake channel, and then the estimated entrainment rate of 1.5% was applied to these fish (if 100 fish less than 50mm entered the channel, it would be assumed that 1.5 would be entrained into SHPP). Entrainment estimates were calculated by applying the observed, maximum, and capacity withdrawal rates at SHPP to estimate fish entrainment losses at SHPP (Figure 6).

<table>
<thead>
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<th></th>
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</table>

Figure 6- Fry loss estimates (entrainment) by species annually at SHPP. Observed is the observed withdrawal data, while max is the permitted maximum withdrawal rate, while capacity is the pumping capacity of SHPP. The range of estimates is based on the 20 years of estimated escapement into the Tualatin (MHE-2019).

Fish Impacts Conclusion
Based on the studies discussed herein, ODFW concludes that there are annual fish losses of fry at the SHPP and concurs with the estimates provided by MHE, 2019. There were many assumptions built into this estimate, necessitated by the complex nature of the issue and the lack of empirical fish data in the Tualatin River. One of the biggest assumptions of the entrainment estimate is that 50% of the anadromous fish that escape into the Tualatin will spawn upstream of the SHPP. This should be considered an absolute maximum as there is less than 50% of the watershed located upstream of SHPP, and there is considerable available spawning habitat downstream. The goal of the entrainment study was to estimate maximum entrainment potential at SHPP, so many if not all of the assumptions sought to maximize potential fish numbers. This means that the fish entrainment numbers estimated herein are likely
overestimates, but for the purposes of this report and project, are considered accurate.

Spring Chinook were captured by MHE within the intake channel during MHE’s entrainment study. The presence of Chinook juveniles was a surprise. After further evaluation of Chinook in the basin, and as discussed in this report, chinook are not considered to be annually and predictably present in the Tualatin basin. Therefore, while estimates were provided for chinook entrainment, their potential entrainment is not considered as part of this exercise. There are other native species (cutthroat, resident rainbow trout, lamprey, and suckers) that could be entrained by SHPP. Obtaining an accurate entrainment estimate for these species would not be feasible and ODFW feels that for cutthroat and rainbow trout entrainment, that the annual estimates for coho and steelhead fry entrainment would also cover these species/life histories. Pacific lamprey and suckers, while present in the Tualatin would not be afforded full protection even if new updated fish screens were constructed at SHPP. Lamprey and sucker juveniles are very small and susceptible to entrainment at criteria fish screens. A new fish screen would offer greater protection to these species than the existing SHPP fish screens, but the difference would not be quantifiable, and losses could still occur. Therefore, for the purposes of this project and report, the annual entrainment estimates for coho and steelhead are assumed to adequately cover entrainment risk at SHPP.

Final estimated annual fish losses at SHPP (maximum):

Coho - 2680 fry (4163 at capacity pumping rates)
Steelhead – 1341 fry (2378 at capacity pumping rates)

Mitigation and the net benefit analysis will be based on these estimated fish losses at SHPP.

Mitigation

Location
Bateman Creek was selected as a preferred mitigation site based on its location within the watershed, presence of priority fish passage barriers (as listed on the ODFW 2019 fish passage priority list), and the valuable cold water habitat it provides. Bateman Creek is a tributary of Gales Creek in the upper Tualatin River watershed, and the mouth of the creek is located at approximate GPS coordinates 45.624947 W and -123.263665 N. The creek Flows from southwest to northeast and flows beneath OR Hwy 6 just NW of the small community of Balm Grove (see figure-7).
Fish Use and Habitat
Bateman Creek provides fair quality spawning and rearing habitat for coho and winter steelhead, in addition to cutthroat trout and rainbow trout (residualized steelhead). The presence of fish passage barriers inhibits fish from entering and using this habitat, and also impacts stream function and habitat quality. The riparian zone of the stream as relatively intact and was comprised of mature coniferous species and woody vegetation including alder and other deciduous fauna typical of the coast range.

Several site visits by ODFW, JWC, and David Evans and Associates (DEA) were performed to assess stream suitability and potential for mitigation. 5 road stream crossings were observed on Bateman Creek. The first of which is the highway 6 crossing which is a bridge and meets all fish passage criteria. The second just upstream of Highway 6 is also a bridge that meets all fish passage criteria. Further upstream two separate road-stream crossings of similar age and build were observed. Both crossings utilized an undersized “double-barreled” culvert array to convey flow (figures 8 and 9). All were estimated to be barriers at some during the year to adult species, but were not necessarily viewed to be complete fish passage barriers. For the purposes of this evaluation and consistent with metrics provided in the ODFW 2019 fish passage priority list, the culverts were estimated to be 80% barriers. Which means that 80% of the time they provide some hinderance to fish passage.
Figure 8- Lowermost Bateman Creek Barrier Culvert. Listed as a priority for removal in ODFW’s 2019 Fish Passage Priority List

Figure 9- Barrier culvert on Bateman Creek

The last fish passage barrier was also an undersized double barrel culvert located higher in the Bateman Creek watershed at a location where gradient increases quickly upstream (figure 10).
Further assessment of habitat within this reach indicated that while spawning gravels were present, they were not well sorted, and the lack of large woody debris hindered pool-glide development conducive for spawning and rearing habitat (figures 11 and 12).
Based on this habitat assessment it was ODFW’s recommendation that the stream was in need of large wood structures to promote healthy stream function and fully restore and enhance spawning and rearing potential.

**Proposed Mitigation**

Based on discussion and recommendations, JWC agreed to pursue removing the two lower fish passage impediments, with new bridges that span the active channel of Bateman Creek, which is estimated at approximately 12 feet. This action would result in opening up approximately 2100 feet of fish habitat to full fish access. Furthermore, JWC agreed to add large wood habitat structures to the reach in order to fully restore and enhance fish spawning and rearing opportunities.

The road-stream crossings will be replaced with bridges that meet both ODFW and NMFS fish passage criteria and will provide a clear span of 1.5 times the active channel of Bateman Creek (18 foot span (1.5 times 12 feet = 18 feet)). In addition, at the direction of ODFW the mitigation plan calls for the addition of at least 20 key pieces of large wood at least 24 feet in length and 16 inches in diameter (Appendix A).

**Fish Benefit from Mitigation**

JWC and their consultants DEA, in collaboration with ODFW sought to quantify the potential fish benefits from the proposed mitigation (Appendix E- Memo to Ken Loffink and Monica Blanchard, February, 2020). As indicated both coho and steelhead of multiple life stages are present in Bateman Creek. An assessment of the habitat made available by the proposed fish passage improvements indicated that 2100 feet of fish habitat would be made fully accessible. Further assessment showed that with the active channel width averaging 12 feet that the total stream area opened up for fish access is 25,200 square feet. As noted previously, the barriers being replaced as part of this proposed mitigation packages are estimated to be barriers to fish passage.
80% of the time. Some fish do access and spawn in this habitat currently. So, in order to estimate the steelhead and coho spawning in this stream reach, the amount of habitat opened up was prorated at 80%. With this proration, the estimated “new” habitat that would be available to fish is 20,160 square feet (25,200 x .80).

DEA estimated that approximately 30% of the available habitat could be considered spawning habitat for coho and 20% for steelhead. After further evaluation by ODFW, we could not discern potential steelhead habitat from coho habitat and agreed that the total available spawning habitat should be 30% for both coho and steelhead (this figure differs from the DEA Report). This results in approximately 6048 square feet of spawning habitat available in the mitigation reach (25,200 x .8 = 20,160 x .3 = 6048).

Assumptions were made on steelhead and coho fecundities, egg to fry survival, and redd size in order to better grasp potential steelhead and coho fry production in the basin. Based on the assumptions and analysis for reds per square foot for each species, the total potential reds was estimated to be 57 for coho and 59 for steelhead within this stream reach. This would assume that 100% of the habitat is occupied by spawning fish, which is not a realistic assumption. A more realistic assumption of spawning potential in Bateman Creek would be that 10% of the available spawning habitat could be occupied in a given year. This number would vary based on run sizes and environmental conditions, but represents a reasonable minimum for what we could expect to happen annually in Bateman Creek.

Based on fecundity and egg to fry survival estimates, each successful spawner would result in the following fry being produced (Macklin, 2020):

Coho: 2,500 eggs per red x .27 survival = 675 fry
Steelhead: 3,500 eggs per red x .18 survival = 630 fry.

Numbers of spawners, increased spawning success, and increased survival from improved rearing habitats is likely to occur as a result of this mitigation plan. Estimating exactly how this dynamic system will evolve is challenging, though as a reasonable assumption, as discussed ODFW estimates that in any given year 10% or more of the available spawning habitat could be occupied by both steelhead and coho. This would result in approximately 5.7 redds for coho and 5.9 redds for steelhead. Total fish production estimates are as follows:

Coho: 5.7 redds x 675 fry/redd = 3,847 fry
Steelhead: 5.9 redds x 630 fry/redd = 3,717 fry.

Though largely unquantifiable, ODFW believes that the addition of large wood to the stream will increase the overall habitat quality and function of Bateman Creek, which could lead to improved spawning success, higher egg-fry survival, and improved habitat for fish rearing. Thus leading to higher than estimated fry production and survival. In addition, Bateman Creek has high potential to be a quality stream for fish rearing and refuge due to its cold water and location within the watershed. The value of improved access for juveniles and the habitat uplift from the addition of large wood to the system could be significant and there are no metrics available to thoroughly measure or estimate this value.
Net Benefit Analysis

Based on the analysis of potential fish losses at SHPP and the potential fish benefits from the proposed mitigation as discussed herein we come up with the following estimates:

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<th>Max Capacity (unlikely)</th>
<th>Estimated</th>
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As discussed the max capacity fry loss estimates are not expected to occur as they fall outside of the SHPP operating parameters, and similarly the maximum fully seeded fry production is not realistic or expected to occur, but both are shown as reference. As shown the estimated fry production from the proposed mitigation exceeds the estimated annual fry loss at SHPP. Furthermore, when the addition of large wood is considered and the considerable habitat uplift that large wood could bring, the estimates for potential fry production should be considered a minimum. Also unquantifiable is the importance of the mitigation stream to juvenile rearing. The Tualatin River as well as Gales Creek can be temperature limited in the summer months. Fish often seek refuge in cold water tributaries to rear. Bateman Creek is uniquely positioned in the Upper Gales Creek watershed and is in an ideal location for juvenile fish seeking rearing habitat. Upstream of the confluence of Bateman Creek and Gales Creek, a waterfall exists in Gales Creek that blocks all juvenile passage. This means that Bateman Creek is one of the last creeks available for juvenile rearing as juveniles seek refuge habitat in Gales Creek. The value of increased access to increased quality rearing habitat is not reflected in the above fry production estimates.

Based on the assumptions and analyses discussed within this report, the annual entrainment estimates at SHPP should be considered high, while the annual fry production at the mitigation site should be considered low. This is by design to ensure that the proposed mitigation provides a net benefit to fish species affected.

As noted, the mitigation, nor the impacts at SHPP capture potential impacts to cutthroat trout, rainbow trout, suckers, or lamprey. Suckers and lamprey would not be adequately protected by screening at SHPP and therefore they are not considered as part of this benefit analysis. That being said, there would be ancillary benefits to both fish species by increased production in Bateman Creek and the resulting ecological uplift in the Tualatin basin. Cutthroat and rainbow trout were not included in the fry loss estimates at SHPP as their life histories would make it near impossible to gather an accurate estimate. ODFW does expect that some level of annual loss of trout could occur at SHPP. Cutthroat and resident rainbow trout are likely to be present in Bateman Creek and would greatly benefit from the proposed mitigation.

Based on this analysis, ODFW determines that the proposed mitigation actions will result in a net benefit (greater benefit) to fish species present in the Tualatin, as compared to annual estimated fry losses at SHPP.
Conclusion and Recommendation

ODFW concludes that the proposed mitigation will result in benefits to native fish in the Tualatin basin that are greater than the benefits that would occur if a fish screen meeting all criteria was installed at SHPP. ODFW understands the complexity and assumptions built into estimating fry loss at SHPP and fry production at the mitigation site, and fully understands that actual results may vary annually. To combat this, all assumptions built into estimates for both fry loss at SHPP and fry production at the mitigation site erred conservatively on the side of the fish. In simple terms, it is likely annual fish loss estimates are overestimated, while fish benefits are underestimated. This helps ensure that fish losses are adequately addressed by the mitigation.

Based on this conclusion, ODFW recommends that the fish screening exemption pursuant to ORS 498.316 be approved, as the proposed mitigation will result in a net benefit to native fish in the Tualatin Basin, as compared to installing fish screening at SHPP.
Literature Cited:


