

**To:** FERC Project Team, FERC Executive Team

**From:** FERC Working Group 2 (Asset Management and Return on Investment)

**Cc:** Kristin Anderson

**Date:** 03/29/2023 (Updated)

**Re:** FERC Relicensing Consideration: Benefit-Cost Analysis

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## Introduction

The current Federal Energy Regulatory Commission (FERC) license to generate hydroelectric power for Portland's Hydroelectric Project (the Project) expires in March 2029. The Portland Hydroelectric Project (PHP) is exploring the viability of continuing to operate the Hydroelectric facilities. This memo presents a high-level evaluation of the economic viability and return on investment for relicensing and surrendering the license (terminating hydropower operations). Information contained in this memo and accompanying spreadsheets were compiled from City subject matter experts and consultants. It was necessarily developed under a compressed timeline and, accordingly, carries considerable uncertainty. Efforts were made to incorporate and describe this uncertainty to the extent possible. However, results may change if new and/or refined information becomes available.

### Working Group 2

Working Group 2 has been charged with creating this Technical Memorandum which provides a high-level Business-Case Analysis. Two alternatives have been explored:

- License Renewal - Comparing projected revenue from power production versus expected costs to maintain the license.
- License Surrender - Evaluating expected costs to surrender the license.

Because the Portland Water Bureau (PWB) and PHP are funded differently (general fund vs rate payer funded) each of these alternatives will be explored for each bureau. FERC's current default for a license renewal term is 40 years but can vary from 30-50 years. This Business-Case Analysis is based on a license renewal term of 40 years (through 2069). The analysis can be modified if desired to account for license renewal terms of 30 and/or 50 years.

Working group 2 is made of the following team members:

Lead: Tony Re

Stakeholders: David Peters, Glenn Pratt, Mert Muftugil, Eric Brainich, Jerry Pierce, Tim Collins, Tim Grandle, Dave Evonuk, Mike Saling, Jodie Inman, Cecelia Huynh, Janet Senior

This Business-Case Analysis is intended to help decision makers within Portland’s City government determine if the license should be renewed by evaluating economic viability and return on investment.

Working Group 2 has been working in parallel with Working Group 1 which is led by Kristin Anderson of PWB Resource Protection. Working group 1 is charged with assessing and describing the impacts of license surrender on water supply operations and regulatory commitments, including the Bull Run Water Supply Habitat Conservation Plan (HCP). Much of the work provided by Working Group 1 is referenced throughout this report.

## **Alternatives Summary**

This benefit-cost analysis looks at two alternatives, renewing and surrendering our existing FERC License for both PWB and PHP. The license allows the PHP to generate power and sell it to the power grid. For the renewal alternative, the projected revenue from power sales through year 2069 are compared to the expected costs associated with license renewal and to operate and maintain the Bureau of Hydroelectric Power over that time period. For the surrender alternative, revenue from power sales will only extend to the end of the current license period in 2029, and this is compared to costs associated with this alternative through 2069.

Table 1 provides a summary of estimated revenue and costs for each scenario. Revenue estimates are as calculated using the Business Case Analysis spreadsheet described below. Many of the cost-estimates provided are high-level estimates and are based on the experience and judgement of PWB engineering staff. Most of the cost estimates, in particular estimates that include larger-scale construction projects, have confidence ratings in the low to medium-low range. More engineering study would be required to develop estimates with higher confidence ratings.

**Revenue:** Three estimates for revenue have been included in the table for both license renewal and license surrender. A low estimate, a high estimate and most probable estimate are provided. Revenue projections have been provided by energy solutions consultant, EnergyGPS.

**Costs:** Three cost estimates have been included in the table for both license renewal and license surrender. A low estimate, a high estimate and most probable.

Individuals that have contributed to these cost estimates include Dave Evonuk, Mike Saling, Tim Collins, Kevin Larson, Glenn Pratt, Jerry Pierce, Jon Johnson, Liane Davis, Kristin Anderson, Eric Brainich and Mert Muftugil.

## **Costs Attributed to PWB and PHP**

Table 1 has a column showing which bureau costs are expected to be attributed to: Portland Water Bureau (PWB) or Bureau of Hydroelectric Power (PHP). Note that "PHP" is used in Table 1 and throughout this memo to identify General Fund costs and revenues, whether or not they are attributed directly to the Bureau of Hydroelectric Power. In the current structure, PHP typically pays expenses that are directly related to and necessary to continue production of hydropower. PWB

typically pays expenses that relate to storage, transmission and preservation of the water supply. At this time, it is unclear how that structure would change if the FERC license is surrendered. The bureau identified as responsible for the costs listed in Table 1 is the initial opinion of Working Group 2, more discussion and analysis on this subject may be required.

**Table 1 – Summary of Estimated Revenue and Costs**

License Renewal						
Revenue						
No.	Item	Timeline	Low Estimate	High Estimate	Most Probable	PHP or PWB
		2023 - 2069 Total, Present Value				
1	Projected Revenue for sale of hydroelectric power		\$84M	\$151M	\$108M	PHP
Costs						
No.	Item	Timeline	Low Estimate	High Estimate	Most Probable	PHP or PWB
1	Rewind Rotors and Stators - PH1 and PH2	2042	\$1.5M each	\$1.5M each	\$1.5M each	PHP
2	Install Digital Governor - PH2	2032	\$800K	\$800K	\$800K	PHP
3	New Roofs at PH1 and PH2	2026 & 2056	\$450K	\$450K	\$450K	PHP
4	Replace Protective Relays - PH1 and PH 2	Annual For 5 yrs start in 2025	\$125K	\$125K	\$125K	PHP
5	Replace Automatic Voltage Regulator -PH2	2023	\$220K	\$220K	\$220K	PHP
6	SCADA Improvements	2032 & 2052	\$50K	\$50K	\$50K	PHP
7	Operations and Maintenance	Annual	\$1.5M	\$1.5M	\$1.5M	PHP
8	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual	\$192K	\$192K	\$192K	PHP
9	PGE Service Contract	Annual	\$300K	\$400K	\$350K	PHP
10	Costs to Renew	2029	\$5M	\$10M	\$8m	PHP
11	Dam Inspections	Every 5 Years	\$800K	\$1.5M	\$1M	PWB
12	Additional FERC costs	Annual , skip every 5th year that include Dam Inspections	\$100K	\$140K	\$120K	PWB
13	Historic Preservation	2027	\$50K	\$200K	\$100K	PHP
14	Improvements or Mitigation	Annual	\$200K	\$400K	\$250K	PHP
15	Full Time Positions in Bureau of Hydro Electric Power	Annual	\$431K	\$431K	\$431K	\$175K PWB \$256K PHP
16	FERC Administrative Fees	Annual	\$50K	\$50K	\$50K	PHP
17	Oregon Water Resources Department (OWRD)	Annual	\$50K	\$50K	\$50K	PHP
License Surrender						
Revenue						
No.	Item	Timeline	Low Estimate	High Estimate	Most Probable	PHP or PWB
		2023 - 2029 Total, Present Value				
1	Projected Revenue for sale of hydroelectric power		\$21M	\$21M	\$21M	PHP
Costs						
Item	Timeline	Low Estimate	High Estimate	Most Probable	PHP or PWB	
1	Cost to Decommission Powerhouses	2029	\$2M	\$15M	\$8.5M	PHP
2	Maintenance of Powerhouses in Decommissioned State	Annual, Starting in 2029	\$20K	\$30K	\$20K	PHP
3	Cost to Surrender	2029	\$2.5M	\$5M	\$4M	PHP
4	Historic Preservation	2029	\$350K	\$950K	\$600K	PHP
5	Dam Safety Requirements	Annual, Starting in 2029	\$60K	\$120K	\$80K	PWB
6	Dam Inspections	2027	\$800K	\$1.5M	\$1M	PWB
7	Full Time Positions in Bureau of Hydro Electric Power	Annual, through 2028	\$431K	\$431K	\$431K	\$175K PWB \$256K PHP
8	Staff to Manage Dam Safety	Annual, Starting in 2029	\$225K	\$225K	\$225K	\$175K PWB \$50K PHP
9	Cost of Terminating PGE Contract	2029 - 2032	2029 - \$1.25M 2030 - \$1.67M 2031 - \$1.67M 2032 - \$800K	2029 - \$1.8M 2030 - \$2.4M 2031 - \$2.4M 2032 - \$1.2M	2029 - \$1.5M 2030 - \$2M 2031 - \$2M 2032 - \$1M	PHP
10	Improvements at Dam 1	2030	\$25M	\$65M	\$49M	PWB
11	Improvements at Dam 2	2020	\$10M	\$30M	\$20M	PWB
12	Diversion Pool Maintenance	Every 5 years, starting in 2029	\$80K	\$200K	\$100K	PWB
13	Cost of Electrical Service to Dam 1	2028	\$2M	\$3.3M	\$2.5M	PWB
14	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual, through 2028	\$192K	\$192K	\$192K	PHP
15	PGE Service Contract	Annual	\$300K thru 2028 \$200K after 2028	\$400K thru 2028 \$300K after 2028	\$350K thru 2028 \$250K after 2028	PHP
16	Treatment Staff to Monitor Water Conditions	Annual, Starting in 2029	\$87K	\$150K	\$87K	PWB
17	SRS Staff to manage flow	Annual, Starting in 2029	\$185K	\$300K	\$185K	PWB
18*	Social Cost of Carbon	Varies	2030 - \$2.5M 2031 - \$2.25M 2032 - \$1.25M 2033 - \$0	2030 - \$6M 2031 - \$3M 2032 - \$2M 2033 - \$1M	2030 - \$5M 2031 - \$2.5M 2032 - \$1.25M 2033 - \$1.25M	PWB
19	Improvements or Mitigation	Annual	\$50K	\$150K	\$50K	PWB

\* - This is a social cost, no funds are exchanged. Refer to description of this cost item for more information.

## Alternative Details

This section further explains the items and assumptions made for revenue and costs shown in Table 1 and included in the Business Case Analysis.

## Alternative 1 - FERC License Renewal

### Revenue Projections

PWB has retained the services of EnergyGPS, an energy consultant with expertise in analyzing energy producing assets and determining their value. EnergyGPS has produced a memo, dated November 20, 2022, that explores a range of alternatives that may be available for selling the power generated by the Portland Hydroelectric Project. The memo provides estimated revenue projections through the year 2069, the expected end of a FERC license renewal period (40 years).

Power volumes were projected based on streamflow data provided by the PWB Resource Protection group which include climate change scenarios. The projections reflect a continuation of wholesale electrical energy to Portland General Electric (PGE).

The low, high, and most probable revenue estimates shown in Table 1 represent the 25th, 50th, and 75th percentile values respectively from the Energy GPS model. For the Surrender alternative, these values are all the same (through 2029) as they are based on an existing contractual agreement with PGE.

### Costs

The following costs have been identified and are expected to be realized in a license renewal alternative. Each line from Table 1 (Lines 1-17) are described in this section.

1. **Rewind rotors and stators in Powerhouse 1 and Powerhouse 2.** This work is not required to be completed before the current license period ends in 2029 but certainly would have to be completed before 2069, when the expected license renewal would end. For the purposes of this analysis, it is assumed this work will be completed 20 years from today or in 2042. Cost for this work shown in Table 1 is as estimated by PHP Staff.
2. **Install new digital governor at Powerhouse 2.** The existing governor at Powerhouse 2 is showing signs of wear and a replacement timeline of 2032 is anticipated (in 10 years). Cost for this work shown in Table 1 is as estimated by PHP Staff.
3. **Install new roofs at Powerhouse 1 and Powerhouse 2.** The existing roofs are nearing 40 years of age and are showing signs of wear. It is expected they will have to be replaced in 2026 and again 30 years after that in 2056. The existing roofing material is tile and cost for replacement in-kind was estimated using an on-line roofing cost estimating tool.

4. **Replace Protective Relays at Powerhouse 1 and Powerhouse 2.** These are to be replaced in five different packages, one per year for five consecutive years starting in 2025. Cost for this work shown in Table 1 is as estimated by PHP Staff.
5. **Replace Automatic Voltage Regulator in Powerhouse 2.** For the purposes of this analysis, it assumed this work will be completed in 2023. Cost for this work shown in Table 1 is as estimated by PHP Staff.
6. **SCADA Improvements.** This is low priority work but desirable by Bureau of Hydroelectric Power Staff. In order to keep up with changes in technology it is necessary to upgrade equipment every 20 years. For the purposes of this analysis, it assumed this work will be completed in 2032 and again in 2052. Cost for this work shown in Table 1 is as estimated by PHP Staff.
7. **Operation and Maintenance Costs.** PHP has an existing annual contract with EnergyNW for Operations and Maintenance (O&M) Services of the Portland Hydroelectric Project Powerhouses 1 and 2 throughout. For this analysis the current cost of O&M Service is used as a basis for calculating this rate through 2069. Cost for this work shown in Table 1 reflects the cost of the current contract.
8. **EWEB Contract - Monitoring, Scheduling and Dispatching.** PHP has an existing contract with Eugene Water and Electric Board (EWEB) to monitor (via SCADA) equipment operation, stream flows, reservoir levels, and other data related to the generation of hydroelectric power and alert PHP, PWB and EnergyNW staff as necessary. They also play an important role in scheduling and dispatching with PGE by coordinating times when the powerhouses can come on (and off) line and send power to the PGE grid. Cost for this work shown in Table 1 reflects the cost of the current contract.
9. **PGE Service Contract.** PHP has an existing annual contract with PGE to maintain 57 kV powerlines to and from Dam 1. Low estimate for this work shown in Table 1 reflects a \$100,000 annual increase in the cost of the current contract which according to PHP staff is in need of such an increase. Most probable and high estimates reflect increases over this low value.
10. **Cost to Renew License.** This cost includes expenses related to license renewal which may include consultants to facilitate and assist with the relicensing process and regulatory negotiations, consultant studies required by FERC, development of the license application, environmental review, legal fees and relicense fees, and minor mitigation requirements. It is not intended to include large physical facility improvements which may be required by FERC in order to relicense. At this time this cost is very difficult to estimate but is aligned with costs presented in a [recent government report](#). The extent of what studies or documentation may be required as part of a relicense effort will not be known until regulators, stakeholders and Native American tribes are able to provide input.

It is believed the PWB would be in a good position going into these negotiations relative to other agencies that may go through a similar relicense process. PWB already has a Habitat Conservation Plan (HCP) for compliance with federal environmental laws and extensive environmental studies and monitoring in place. PWB also has 10 years of monitoring data that shows that the HCP performing very well in nearly every aspect which leaves PWB in a good position in most regulatory negotiations which may typically require additional study or facility improvements.

With input from PWB Resource Protection, a range of costs between \$5,000,000 and \$10,000,000 dollars is believed to be a good estimate for this cost. In Table 1, \$5,000,000 was used for the low estimate and \$10,000,000 was used for the high estimate. \$8,000,000 was used as the most probable estimate as it is near the middle of that range.

11. **Dam Inspections.** FERC regulations currently require inspection of Dam 1 and Dam 2 every five years. Every other one of these inspections is a “comprehensive” inspection which is approximately twice the cost of the other “periodic” inspection. The costs in Table 1 assume these inspections will get scheduled so that every five years there is a periodic inspection on one dam and a comprehensive inspection on the other. This results in a consistent estimated cost for dam inspection that is expected to occur every five years. The next scheduled year for dam inspections is 2027. Based on costs incurred in that last inspection cycle, a cost of \$1,000,000 has been estimated with input from PHP Staff and has been used in Table 1 as the most probable estimate. As actual costs will be unknown until the next inspection cycle a low estimate of \$800,000 and a high estimate of \$1,500,000 have been used.

**For additional information reference Working Group 1 Memo - FERC Relicensing Consideration: Dam Safety.**

12. **Additional FERC Costs.** In addition to Dam Inspections, FERC regulations and inspections lead to significant additional studies and documentation, typically on the order of approximately \$600,000 per regular inspection. This has been estimated as \$120,000 per year for years between inspections.
13. **Historic Preservation.** These costs are associated with requirements of the Oregon State Historic Preservation Office (SHPO) as they relate to modification of PHP assets. Since license renewal is not expected to require big infrastructure changes the costs in this case would include studies, plans and/or reports to be filed regarding historic preservation. PWB has an Historic Preservation Management Plan (HPMP) and a Manual for Built Resources (MBR) in progress which will provide guidance on historical preservation of our facilities. Additional studies or reports may be required. Costs for historic preservation shown in Table 1 has been estimated with help from Resource Protection staff and a consultant retained by them to address these and other SHPO related issues throughout the PWB system. A cost of \$100,000 has been established for the most probable estimate. As actual costs are unknown until PWB begins working with SHPO on this specific issue, a low estimate of \$50,000 and a high estimate of \$150,000 have been used.
14. **Improvements or Mitigation.** These costs include dam safety or environmental mitigation fees which may be required as a result of relicensing. Costs in this category would be subject to negotiation as part of the renewal process. PHP currently pays in excess of \$200,000 to the Oregon Department of Fish and Wildlife (ODFW) to support fish hatchery programs, costs such as these would fit into this category. Cost for this work shown in Table 1 has been estimated with help from Resource Protection staff. A cost of \$250,000 has been established for the most probable estimate. As actual mitigation costs cannot be known until PWB begins working with regulatory agencies and FERC on a license renewal process, a low estimate of \$200,000 and a high estimate of \$400,000 have been used. Mitigation requirements that arise as terms of license renewal that exceed amounts that

PHP is able to incur may trigger an eventual decision to surrender the license, which is a possible outcome even if the City decides to initially pursue relicensing.

15. **Full Time Positions in Bureau of Hydro Electric Power.** PHP is currently staffed by two full-time positions, both Analyst IIIs. If the license is renewed, it is expected that the Bureau will continue to be staffed at current levels. The cost for this staffing shown in Table 1 has been estimated using direct hourly costs according to current City labor rates. The PWB currently pays for approximately 80% of one Analyst III position to support Dam Safety work that is PWB responsibility as the owner of the dams.
16. **FERC Administrative Fees.** PHP currently pays FERC an annual administrative fee. The cost for this is expected to continue with license renewal and the cost reflected in Table 1 is based on the current rate.
17. **Oregon Water Resources Department (ORWD) Administrative Fees.** PHP currently pays FERC an annual administrative fee. The cost for this is expected to continue with license renewal and the cost reflected in Table 1 is based on the current rate.

## **Alternative 2 - FERC License Surrendered**

### Revenue Projections

In the event the FERC license is surrendered, revenue from sales of hydroelectric power will end when the current license expires in 2029. Revenue projections for this period are fixed as they are based on an existing contractual agreement with PGE. For the purpose of the economic analysis in this memo, under the license surrender alternative, no revenue is expected after year 2029.

### Costs

The following costs have been identified and are expected to be realized in a license surrender alternative. Each line from Table 1 (Lines 1-19) are described in this section.

1. **Cost to Decommission Powerhouses.** These costs are associated with permanently removing Powerhouse 1 and Powerhouse 2 from service and their ability to generate hydropower. The minimum requirements for decommissioning the powerhouses would not be known until further into a negotiation process with FERC should the license surrender alternative be selected. With input from PHP staff, the following cost estimates have been established and are reflected in Table 1. The low estimate of \$2,000,000 includes removal of equipment essential to the power generation process, such as removal of the automatic voltage regulators. The high estimate of \$15,000,000 includes complete demolition and removal of the powerhouses. For the most probable estimate, a cost in the middle of the low and high estimates was selected.
2. **Maintenance of Powerhouses in Decommissioned State.** If the powerhouses are not demolished and are left in place in a decommissioned state, a minimal amount of maintenance will be required. For the purposes of this analysis is assumed that this maintenance will be absorbed by Sandy River

Station (SRS) staff. It is estimated that this maintenance could be performed in 18 hours per month by an Operating Engineer III. The cost for this staffing shown in Table 1 has been estimated using current direct hourly costs according to current City labor rates. As it is unknown at this time exactly how much time and effort will be required for this work, the high estimate includes a \$10,000 annual increase over the low and most probable estimate.

- 3. Cost to Surrender.** This cost includes expenses related to surrendering the license which may include consultant studies required by FERC, legal and other fees. It is not intended to include physical facility improvements which may be required by FERC in order to surrender or other infrastructure changes that may be needed to meet all operational needs and regulatory commitments in the absence of hydropower facilities. At this time, this cost is very difficult to estimate. The extent of studies or documentation that may be required will not be known until regulators, stakeholders and Native American tribes are able to provide input. The license surrender process is also less defined in regulations than the relicensing process, which adds even greater uncertainty to the costs. In general, though, license surrender processes that do not involve dam removal are generally less lengthy and costly than comparable relicensing processes. Thus, these costs are expected to be less than the “Cost to Renew License” which is shown in the License Renewal section. Each of the estimated costs (low, high and most probable) for this item shown in Table 1 represents 50% of the same estimate in the Cost to Renew License item.
- 4. Historic Preservation.** A license surrender is, by its nature, a loss of federal jurisdiction. Loss of federal jurisdiction automatically triggers an adverse effect finding under (National Environmental Policy Act) NEPA that will likely require mitigation. For this reason, SHPO requirements for license surrender are generally expected to exceed those of relicensing. In addition, license surrender also includes the potential for physical infrastructure improvements related to PHP assets that will be needed to meet existing operational needs and regulatory requirements in the absence of hydropower facilities. It is expected that the cost for historic preservation will be a function of the cost of any physical improvements made at Dam 1 and/or Dam 2. For this analysis is assumed that 1% of any construction costs will be required for historic preservation. The cost low, high and most probable estimates for this item shown in Table 1 reflect 1% of the costs estimated for Item 9 – Improvements at Dam 1, and Item 10 – Improvements at Dam 2. These costs have been developed with help from Resource Protection staff and a consultant retained by them to address these and other SHPO related issues throughout the PWB system. Costs could be for additional reports or studies that may be needed in addition to infrastructure improvements earmarked for historic preservation.
- 5. Dam safety requirements.** If the FERC License is surrendered, regulation of dam safety switches from FERC to the Oregon Water Resources Division (OWRD). Due to the possibility that a failure of one our dams could lead to loss of life and significant property damage, it is expected that PWB’s dam safety program would remain in place. It is expected that the cost to meet regulatory requirements under OWRD will be significantly less than they are under FERC. The low, high and most probable cost estimates for this item shown in Table 1 have been estimated with input from PHP Staff and amount to 40% of the current cost of dam inspections under FERC regulation and as shown under the renewal alternative. Range for this cost is \$60,000 - \$120,000 annually.



6. **Dam Inspections.** Reference Item 11 under the FERC License Renewal Alternative above for more information about Dam Inspections. Under the FERC License Surrendered Alternative one more Dam Inspection process under FERC control would be required in 2027.
7. **Full Time Positions in Bureau of Hydro Electric Power.** The PHP is currently staffed by two full-time Analyst III positions. If the license is surrendered, it is expected that the Bureau will continue to be staffed at current levels through 2029. The cost for this staffing shown in Table 1 is has been estimated using current direct hourly costs according to current City labor rates.
8. **Staff to Manage Dam Safety.** If the FERC license is surrendered, it is assumed a full-time employee will be required to manage PWB's dam safety program and manage OWRD regulatory requirements. This position would be equivalent to one of the currently staffed positions in the PHP. The cost for this staffing shown in Table 1 has been estimated using current direct hourly costs according to current City labor rates and this cost would start in 2030.
9. **Cost of Terminating Portland General Electric (PGE) Contract Early.** PHP has an existing contract to sell the hydropower generated to PGE through 2032. If the FERC license is surrendered in 2029, hydropower generation would stop at that point and PHP would not be able to fulfill their contract with PGE. The most probable estimate for terminating this contract early is shown in Table 1. Information used to derive this estimate is based on information provided through the City Attorney's office. Exact costs cannot be known until we get further into a negotiation process with PGE should the license surrender alternative be chosen. The low estimate includes a 20% reduction and the high estimate includes a 20% increase over the most probable estimate.
10. **Improvements at Dam 1.** The powerhouse at Dam 1 is located on the north side of the dam and is a key piece of infrastructure which allows PHP to manage reservoir levels and stream flows through the dam. The flow capacity of the powerhouse is 2560 cfs. If the FERC license is surrendered, the ability to flow water through the powerhouse would be lost.

On the south side of the dam there are three fixed cone valves and an associated intake structure. Flow capacity through the south side infrastructure is not adequate to replace the flow capacity through the powerhouse if that pathway is lost through license surrender. Consult Working Group 1 memos referenced below for additional discussion on operational and regulatory risks associated with the loss of hydropower capacity. The intake structure is aging and has been identified as a single point of failure that could lead to an inability to access 63% of the Bull Run supply once water elevations dip below the spillway crest. If flow capacity is not replaced and PWB chooses to change the way it currently operates, more flow will go over the spillway which will increase Total Dissolved Gas (TDG) and may require improvements to the spillway to meet regulatory requirements.

The following options have been considered for improvements at Dam 1. The first three would replace flow capacity of the powerhouse and the fourth would attempt to address TDG if flow capacity was not replaced.

Costs for these improvements could potentially be shared between PWB and PHP but they most likely will go to PWB.

### **Option 1 – Install Pressure Reducing Valve At Powerhouse 1**

This option consists of removing the existing turbine and installing a 96” plunger valve within the existing Powerhouse 1 footprint. This option would reduce pipeline costs and allow us to take advantage of the existing powerhouse infrastructure to reduce riverbed erosion. The constructability of this option would have to be explored through additional engineering study.

### **Option 2 – Route Piping Around Powerhouse 1 and Discharge Downstream**

There are four sub-options related to Option 2:

- Install 2 - 60” Fixed Cone Valves
- Install 2 - 78” Plunger Valves
- Install 1 – 80” Fixed Cone Valve
- Install 1 – 96” Plunger Valve

This option consists of connecting to the existing penstocks at the face of Dam 1, routing piping around the Powerhouse and discharging downstream. These sub-options include the need for an energy dissipation structure in the case of fixed cone valves or an outfall structure in the case of plunger valves.

### **Option 3 – Demolish Powerhouse 1, Extend Piping and Discharge**

The same four sub-options as in Option 2 relate to Option 3:

- Install 2 - 60” Fixed Cone Valves
- Install 2 - 78” Plunger Valves
- Install 1 – 80” Fixed Cone Valve
- Install 1 – 96” Plunger Valve

This option consists of demolishing Powerhouse 1, extending shorter piping runs (as compared to Option 2) and discharging at the location of the existing Powerhouse. These sub-options include the need for an energy dissipation structure in the case of fixed cone valves or an outfall structure in the case of plunger valves.

Refer to Attachment 1 for figures and cost estimates for Options 1, 2 and 3.

### **Option 4 – Install Total Dissolved Gas (TDG) Mitigation at Dam 1 Spillway**

This option consists of installing flow deflectors, weirs, baffles or similar structures on the spillway to reduce the introduction of and mitigate the introduction of TDG to the water when spilled over the dam spillway. The cost estimate for this option, \$10M, was made by reviewing the cost of similar measures installed at several other dams in the Pacific Northwest. This estimate was not included in Table 1 because of uncertainty that it would completely resolve expected TDG issues.

Nine alternatives were estimated for this item, see Attachment 1. The low and high estimates in Table 1 are based on the lowest and highest of the nine cost estimates. The probable cost is based

on the Option 2a (Route Piping Around Powerhouse 1 and Install 2 - 60" Fixed Cone Valves) alternative because it seems to provide most of the benefits for the most reasonable cost.

For additional information on the subject of flow capacity at Dam 1, reference **Working Group 1 Memo - FERC Relicensing Consideration: Dam 1 Without Hydropower** and **Working Group 1 Memo - FERC Relicensing Consideration: Infrastructural Improvements at Dam 1 and Dam 2.**

#### 11. Improvements at Dam 2.

Working Group 1 has identified multiple risks associated with the loss of Powerhouse 2 infrastructure. The reduced flow capacity of the remaining infrastructure would increase spillway flow and decrease the mitigating benefit of dilution with low-Total Dissolved Gas (TDG) water passed through the dam, which would likely result in frequent occurrences of TDG levels above regulatory limits.

Costs for these improvements could potentially be shared between PWB and PHP but they most likely will go to PWB.

##### **Option 1 – Install Multi-level Intakes at Dam 2 South Tower**

Working Group 1 has identified the construction of multilevel intakes on the Dam 2 South Tower as an infrastructural improvement that would mitigate risks associated with a loss of hydropower facilities at Dam 2. Multilevel intakes on the South Tower would remove the limits on using the South Tower in March through September and thereby mitigate the risk of TDG exceedances and spillway wear from additional spilling.

##### **Option 2 - Install Total Dissolved Gas (TDG) Mitigation at Dam 2 Spillway**

Similar to Dam 1 Improvements Option 4, this option consists of reconfiguring the Dam 2 spillway and installing flow deflectors, weirs, baffles or similar structures to reduce the introduction of TDG to the Lower Bull Run River when spilled over the dam spillway. Due the nature of the existing spillway, the cost for this option (estimated at \$10M - \$20M) could be higher than what was estimated for similar improvements to Dam 1.

For additional information on the subject of flow capacity at Dam 2, reference **Working Group 1 Memo - FERC Relicensing Consideration: Dam 2 Without Hydropower** and **Working Group 1 Memo - FERC Relicensing Consideration: Infrastructural Improvements at Dam 1 and Dam 2.**

12. **Diversion Pool Maintenance.** In the event the FERC License is surrendered, the three Howell-Bunger valves at the diversion pool below Dam 2 would be used at high flow rates to pass water through Dam 2. This will create a tremendous amount of turbulence in the diversion pool and increase risk of erosion on the banks of the pool. This item is to address the cost of additional maintenance necessary to control this erosion. It is assumed the work would be done by SRS staff and the estimates in Table 1 were developed with input from PWB Engineering staff.
13. **Cost of Electrical Service to Dam 1.** There is an existing 57 kV powerline that conveys power from PGE's electrical grid to Dam 1 and Bear Creek House. This same 57 kV line conveys power produced

by Powerhouse 1 to the electrical grid. A transformer inside of Powerhouse 1 steps the power down from 57 kV and is used to power facilities and equipment at Dam 1 and Bear Creek House. Due to fire risks, Working Group 1 anticipates that the 57 kV line would not be kept in service if PHP is not providing power to the grid via that line. A new 13 kv line would have to be installed from Headworks (where an existing 13 kV line owned and maintained by PGE currently terminates) to Dam 1.

The estimated costs shown in Table 1 are based on a high-level estimated range provided by PGE. The most probable estimate is at the upper end of the range provided. The low estimate is at the low end of this range and will apply if it is determined that existing power poles can be re-used. The high estimate reflects a 30% increase over the upper end of PGE's high-level estimate.

**For additional information reference Working Group 1 Memo - FERC Relicensing Consideration: Power to Dam 1.**

14. **EWEB Contract – Monitoring, Scheduling and Dispatching.** PHP has an existing contract with Eugene Water and Electric Board (EWEB) to monitor, via SCADA, equipment operation, stream flows, reservoir levels, and other data related to the generation of hydroelectric power and alert PHP, PWB and EnergyNW staff as necessary. They also play an important role in scheduling and dispatching with PGE. They schedule with PGE times when the powerhouses can come on (and off) line and send power to their grid. Cost for this work shown in Table 1 reflects the cost of the current contract. This cost only applies to the end of the current license.
15. **PGE Service Contract.** In the event that the FERC license is surrendered and an electrical service line is extended from Headwork to Dam 1, PWB would need a service contract with PGE to maintain the new powerlines. This contract would be similar to the existing service contract that PHP has to maintain the existing 57 kV powerlines. The low-cost estimate for this work shown in Table 1 is based on the cost of the existing contract with a reduction in place for after 2028 as it is expected the cost to maintain 13 kV lines would be lower than the cost to maintain 57 kV lines. Most probable and high estimates reflect increases over this low value.
16. **Additional Treatment Staff to Monitor Water Conditions.** In the current operation scenario, contract hydroelectric operations staff has a real time operator on duty 24/7 to monitor stream flow, reservoir elevation levels, power output and the diversion pool level. It is assumed that this this work (monitoring) would be taken over by PWB treatment operators (currently at Headworks, to be moved to the filtration facility when it comes on-line in 2027). PWB treatment operators currently monitor reservoir and diversion pool levels, but their responsibility is limited. It is estimated that these additional duties could be covered by half of a full-time Water Treatment Operator II position. The low and most probable estimates for this staffing shown in Table 1 is has been estimated using current direct hourly costs according to current City labor rates. The high estimate reflects a 70% increase in the estimated staffing level.
17. **Additional Sandy River Station (SRS) Staff to Manage Flow.** To make up for work currently provided by contract hydroelectric operators EnergyNW, PWB would need staff available 24/7 to manage water flows at Dam 1 and Dam 2. This work includes operating fixed cone valves, sluice gates and spillway gates at Dam 1 and Howell-Bunger valves at Dam 2. In addition, reservoir levels and would have to be closely monitored to evaluate the reaction of water levels to changes in valve settings. Some of this manual work may be reduced with installation of additional SCADA controls

on existing valves. It is estimated that additional duties of SRS staff could be performed by a full-time Operating Engineer III position. The low and most probable estimates for this additional staffing shown in Table 1 has been estimated using current direct hourly costs according to current City labor rates. The high estimate reflects a 60% increase in the estimated staffing level.

18. **Social Cost of Carbon.** Hydroelectric power generated at Dam 1 and Dam 2 has additional value because, unlike coal and natural gas power plants, it does not involve the routine combustion of fossil fuel and the related carbon emissions into the global atmosphere. The City of Portland has goals associated with carbon emissions reduction and the associated global climate impact. BPS has provided cost information that should be used to calculate a “social cost” attributed to using carbon-producing power sources. The PWB Asset Management group has completed an analysis and calculated the estimated social cost. The low, high and most probable estimates reflected in Table 1 is based on the results of this analysis. The social cost of carbon is not an expense that would actually be paid by PWB or PHP but is an estimate of the externalized regional economic impact that would result from emitting carbon dioxide into the atmosphere because the replacement carbon generation has been externalized to the larger power grid. The assumption is that the lost hydropower could not be immediately or fully replaced by no-carbon power from another source; that replacement would take time and that delay is reflected in the cost estimate. The cost is included in the calculation for consideration in decision making in accordance with City policy and carbon cost estimates. The impact is limited to few years after license surrender until it is anticipated the regional utilities secure sufficient renewal energy sources to meet Oregon state goals. For the purposes of this analysis, this social cost is attributed to PWB.

19. **Improvements or Mitigation.** These costs include dam safety or environmental mitigation fees (beyond additional infrastructure projects previously covered) which may be required as a result of a surrender process. Costs in this category would be subject to negotiation as part of the license surrender process. The low, high, and most probable estimates shown in Table 1 have been estimated with help from Resource Protection staff.

## **Business Case Analysis**

The PWB Asset Management group has developed a spreadsheet to perform a Business Case Analysis to compare the alternatives. The spreadsheet has columns for each year from 2023 through 2069 that sum costs and/or revenue for that year. For costs, the spreadsheet calculates Present Value (PV) for each year using a 3% discount rate. For revenue it calculates Present Value (PV) using a 5% discount rate. The difference is to account for inflation which is included in the “Total Nominal Revenue” projections provided by EnergyGPS. The spreadsheet then calculates the sum of the PV costs for each year, subtracts any PV revenue, and provides a resulting overall net present value (NPV) in current dollar terms. Additionally, the NPV is expressed as a net equalized annual annuity over the life of the alternative. The equalized annual annuity approach calculates the constant annual cash flow over a project’s lifespan and is used to compare alternatives with different service lives, or to provide results in terms of annual impact as opposed to the total.

Both Net Present Value and Net Equalized Annual Annuity are presented below for comparison of the different scenarios.

For the license surrender alternative, revenue is generated only through end of the current license period (2029). For the license renewal alternative, costs and revenue are projected out to year 2069, 40 years past expiration of the current license in 2029. The costs used in the Business Case Analysis are summarized in Table 1. A sensitivity analysis could be completed using changing timelines, costs and other variables that would result in different alternatives to deal with the uncertainty associated with many of the items discussed in this memo.

For this Business Case Analysis a total of six calculations have been made for PHP and six for PWB; three each for both the license renewal and license surrender alternatives. Each calculation accounts for one of the following three scenarios:

- High Revenue and Low Cost (Lowest net revenue/cost)
- Low Revenue and High Cost (Highest net revenue/cost)
- Most Probable Revenue and Most Probable Cost (Most Probable net revenue/cost)

### **Business Case Analysis Summary**

**Table 2 – Business Case Analysis Calculations Summary** compares the net revenues or costs for both PHP and PWB, for the License Surrender and License Renewal alternatives. Results are shown in the form of Net Present Value and in Net Equalized Annual Annuity.

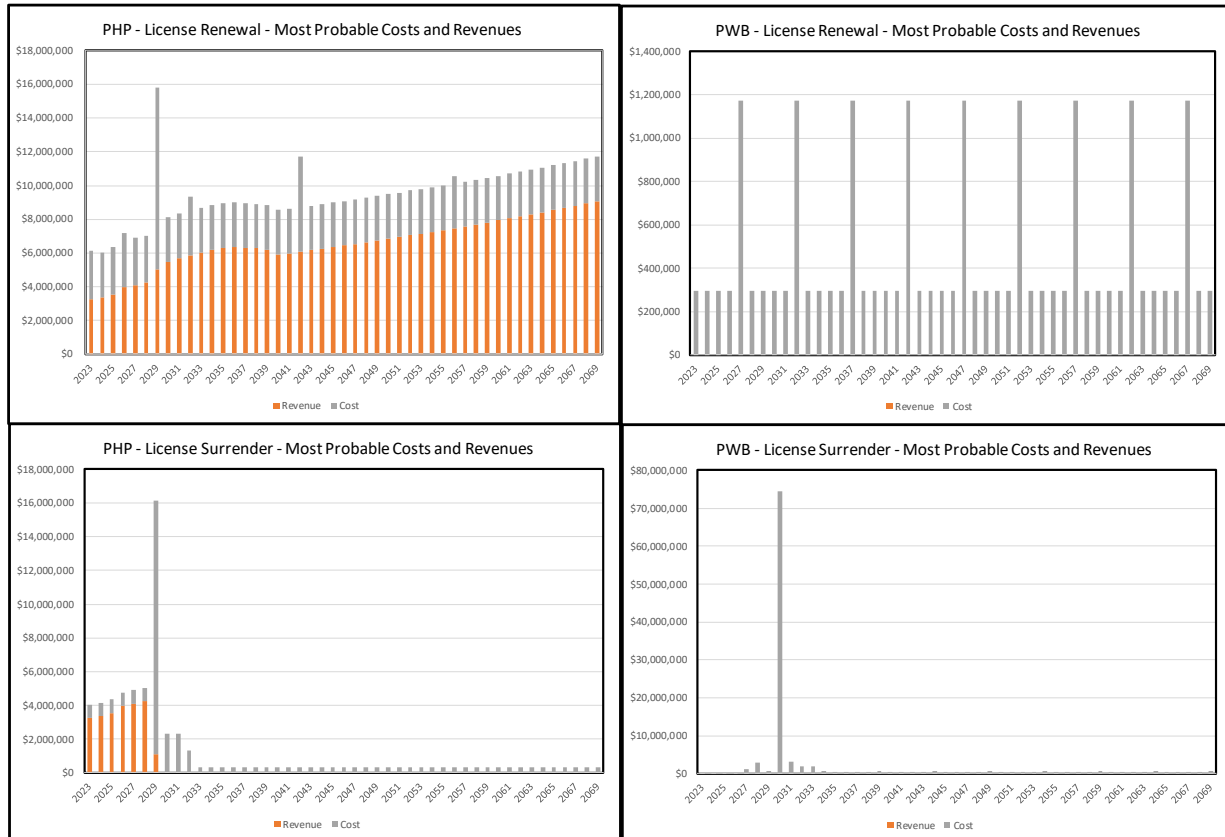
Refer to Attachment 2 to view the sum totals of the twelve Business Case Analysis calculations, values are rounded to the nearest \$1000.

**Table 3 - Cost and Revenues Bar Charts** has charts that show revenues and costs as they are spread out over time. This could affect conclusions about affordability in particular showing when the larger expenses are expected to be realized throughout the 47-year time period (2023 – 2069). The four charts show the most probable revenue and cost scenarios for both PHP and PWB under both renewal and surrender alternatives. Revenue is shown in Nominal Dollar Values and Cost are shown in Present Value.

**Table 2 – Business Case Analysis Calculations Summary**

Scenario	License Renewal		License Surrender	
	Net Present Value		Net Present Value	
	PHP	PWB	PHP	PWB
Scenario 1 - High Revenue/Low Cost	\$77,722,000	(\$10,418,000)	\$2,498,000	(\$48,493,000)
Scenario 2 - Low Revenue/ High Cost	(\$2,024,000)	(\$14,588,000)	(\$15,700,000)	(\$110,745,000)
Scenario 3 - Most Probable	\$28,818,000	(\$11,790,000)	(\$6,591,000)	(\$80,345,000)
	Net Equalized Annual Annuity		Net Equalized Annual Annuity	
	PHP	PWB	PHP	PWB
Scenario 1 - High Revenue/Low Cost	\$3,106,000	(\$416,000)	\$100,000	(\$1,938,000)
Scenario 2 - Low Revenue/ High Cost	(\$80,000)	(\$583,000)	(\$627,000)	(\$4,425,000)
Scenario 3 - Most Probable	\$1,152,000	(\$471,000)	(\$263,000)	(\$3,211,000)
<b>NET POSITIVE CASH FLOWS ARE INDICATED IN BLACK</b>				
<b>(NET NEGATIVE CASH FLOWS ARE INDICATED IN RED)</b>				

**Table 3 – Cost and Revenues Bar Charts**



## **Findings**

Under the constraints of this high-level assessment this analysis indicates the following:

### **License Renewal**

**PHP** - Results show the renewal alternative at a small negative cash flow under the low revenue/high cost scenario and positive cash flow under the other scenarios for PHP.

**PWB** – Results show the renewal alternative at consistent yet relatively low negative cash flow under all revenue/cost scenarios for PWB. This is primarily due to the ongoing Dam Safety inspections and requirements.

### **License Surrender**

**PHP** – Results show the surrender alternative at a near break-even cash flow to a modest negative cash flow for PHP.

**PWB** – Results show the surrender alternative will result in large negative cash flow under all scenarios for PWB, primarily driven by anticipated improvements to the dams to replace flow capacity and address TDG.

## **Recommended Further Analysis**

The cost estimates and revenue projections contained within this analysis are high-level, order of magnitude estimates intended to provide a rough idea about what we might expect for the identified projects as an initial screening. For the number of potential projects identified, estimating costs for each to a high level of certainty would require a tremendous amount of time and effort. Similar for revenue, more time and effort would be required to produce more refined projections.

These ballpark figures are intended to provide support for the FERC Executive Team in formulating an initial recommendation on whether or not to pursue renewal of the FERC license to generate hydroelectric power in the Bull Run Watershed. Getting a higher level of confidence on costs and revenue would require more study. Working Group 2 recommends that the consultant retained to help with the Renewal/Surrender decision review the cost estimates contained in this analysis to get a second opinion on order-of-magnitude costs.



ATTACHMENT 1

COST ESTIMATES FOR IMPROVEMENTS AT DAM 1 - OPTIONS 1, 2 AND 3

<b>Option 1 - Install PRV inside Existing PH1 Footprint</b>				
Item	Units	Price	Total	Confidence
96" Plunger Valve	1	\$2,200,000	\$2,200,000	Medium
Installation of Plunger Valve	1	\$5,000,000	\$5,000,000	Low
Remove Turbine	1	\$1,000,000	\$1,000,000	Low
Design and CM		40%	\$3,280,000	Medium
Bull Run Multiplier		25%	\$2,050,000	Medium
Sub-Total			\$14,000,000	
Contingency		75%	\$10,500,000	Medium
Total			\$24,500,000	Low

**Option 2a - Route Piping Around PH1, 2 Pipes, FCVs**

Item	Units	Price	Total	Confidence
60" Steel Pipe	680	\$15,000	\$10,200,000	Medium
60" Fixed Cone Valve	2	\$1,000,000	\$2,000,000	Medium
Energy Dissipation Structure	1	5,000,000	\$5,000,000	Low
Design and CM		40%	\$6,880,000	Medium
Bull Run Multiplier		25%	\$4,300,000	Medium
Sub-Total			\$28,000,000	
Contingency		75%	\$21,000,000	Medium
Total			\$49,000,000	Medium

**Option 2b - Route Piping Around PH1, 2 Pipes, Plunger Valves**

Item	Units	Price	Total	Confidence
78" Steel Pipe	680	\$19,000	\$12,920,000	Medium
78" Plunger Valve	2	\$3,200,000	\$6,400,000	Medium
Outfall Structure	1	\$2,500,000	\$2,500,000	Low
Design and CM		40%	\$8,728,000	Medium
Bull Run Multiplier		25%	\$5,455,000	Medium
Sub-Total			\$36,000,000	
Contingency		75%	\$27,000,000	Medium
Total			\$63,000,000	Medium

**Option 2c - Route Piping Around PH1, 1 Pipe, FCV**

Item	Units	Price	Total	Confidence
78" Steel Pipe	340	\$19,000	\$6,460,000	Medium
80" Fixed Cone Valve	1	\$1,400,000	\$1,400,000	Medium
Energy Dissipation Structure	1	\$5,000,000	\$5,000,000	Low
Design and CM		40%	\$5,144,000	Medium
Bull Run Multiplier		25%	\$3,215,000	Medium
Sub-Total			\$21,000,000	
Contingency		75%	\$15,750,000	Medium
Total			\$36,750,000	Medium

**Option 2d - Route Piping Around PH1, 1 Pipe, Plunger Valve**

Item	Units	Price	Total	Confidence
96" Steel Pipe	340	\$25,000	\$8,500,000	Medium
96" Plunger Valve	1	\$4,400,000	\$4,400,000	Medium
Outfall Structure	1	\$2,500,000	\$2,500,000	Low
Design and CM		40%	\$6,160,000	Medium
Bull Run Multiplier		25%	\$3,850,000	Medium
Sub-Total			\$25,000,000	
Contingency		75%	\$18,750,000	Medium
Total			\$43,750,000	Medium

**Option 3a - Demolish PH, 2 Pipes and FCVs**

Item	Units	Price	Total	Confidence
60" Steel Pipe	220	\$15,000	\$3,300,000	Medium
60" Fixed Cone Valve	2	\$1,000,000	\$2,000,000	Medium
Energy Dissipation Structure	1	\$5,000,000	\$5,000,000	Low
Demolish Powerhouse	1	\$5,000,000	\$5,000,000	Low
Design and CM		40%	\$6,120,000	Medium
Bull Run Multiplier		25%	\$3,825,000	Medium
Sub-Total			\$25,000,000	
Contingency		75%	\$18,750,000	Medium
Total			\$43,750,000	Low

**Option 3b - Demolish PH1, 2 Pipes, Plunger Valves**

Item	Units	Price	Total	Confidence
78" Steel Pipe	220	\$19,000	\$4,180,000	Low
78" Plunger Valve	2	\$3,200,000	\$6,400,000	Medium
Demolish Powerhouse	1	\$5,000,000	\$5,000,000	Low
Design and CM		40%	\$6,232,000	Low
Bull Run Multiplier		25%	\$3,895,000	Medium
Sub-Total			\$26,000,000	
Contingency		75%	\$19,500,000	Medium
Total			\$45,500,000	Low

**Option 3c - Demolish PH1, 1 Pipe, FCV**

Item	Units	Price	Total	Confidence
78" Steel Pipe	110	\$19,000	\$2,090,000	Low
80" Fixed Cone Valve	1	\$1,400,000	\$1,400,000	Medium
Energy Dissipation Structure	1	\$2,500,000	\$2,500,000	Low
Demolish Powerhouse	1	\$5,000,000	\$5,000,000	Low
Design and CM		40%	\$4,396,000	Medium
Bull Run Multiplier		25%	\$2,747,500	Medium
Sub-Total			\$18,000,000	
Contingency		75%	\$13,500,000	Medium
Total			\$31,500,000	Low

**Option 3d - Demolish PH1, 1 Pipe, Plunger Valve**

Item	Units	Price	Total	Confidence
96" Steel Pipe	110	\$25,000	\$2,750,000	Low
96" Plunger Valve	1	\$4,400,000	\$4,400,000	Medium
Demolish Powerhouse	1	\$5,000,000	\$5,000,000	Low
Design and CM		40%	\$4,860,000	Medium
Bull Run Multiplier		25%	\$3,037,500	Medium
Sub-Total			\$20,000,000	
Contingency		75%	\$15,000,000	Medium
Total			\$35,000,000	Low

ATTACHMENT 2 – SUM TOTALS OF BENEFIT-COST ANALYSIS CALCULATIONS

PHP Scenario 1: License Renewal - High Revenue and Low Cost

PORTLAND HYDROPOWER (PHP)					
	Renewal - High Revenue/Low Cost				SUM TOTAL
		Timeline	Revenue		
	REVENUE	Annual	As Entered	Discount Rate	\$454,051,000
1	PRESENT VALUE OF REVENUE			5%	\$151,370,000
	EQUALIZED ANNUAL ANNUITY	47			\$6,049,000
Costs					
No.	Item	Timeline	Low Estimate	PHP or PWB	Sum Total
1	Rewind Rotors and Stators - PH1 and PH2	2042	\$1.5M each	PHP	\$3,000,000
2	Install Digital Governor - PH2	2032	\$800K	PHP	\$800,000
3	New Roofs at PH1 and PH2	2026 & 2056	\$450K	PHP	\$900,000
4	Replace Protective Relays - PH1 and PH 2	Annual For 5 yrs start in 2025	\$125K	PHP	\$625,000
5	Replace Automatic Voltage Regulator -PH2	2023	\$220K	PHP	\$220,000
6	SCADA Improvements	2032 & 2052	\$50K	PHP	\$100,000
7	Operations and Maintenance	Annual	\$1.5M	PHP	\$70,500,000
8	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual	\$192K	PHP	\$9,024,000
9	PGE Service Contract	Annual	\$300K	PHP	\$14,100,000
10	Costs to Renew	2029	\$5M	PHP	\$5,000,000
11	Dam Inspections	Every 5 Years	\$800K	PWB	\$0
12	Additional FERC costs	Annual , skip every 5th year that include Dam Inspections	\$100K	PWB	\$0
13	Historic Preservation	2027	\$50K	PHP	\$50,000
14	Improvements or Mitigation	Annual	\$200K	PHP	\$9,400,000
15	Full Time Positions in Bureau of Hydro Electric Power	Annual	\$431K	\$175K PWB \$256K PHP	\$12,032,000
16	FERC Adminstrative Fees	Annual	\$50K	PHP	\$2,350,000
17	Oregon Water Resources Department (OWRD)	Annual	\$50K	PHP	\$2,350,000
	<b>SUM OF COSTS</b>			Discount Rate	\$130,451,000
	<b>PRESENT VALUE SUM OF COSTS</b>			3%	\$73,648,000
	<b>EQUALIZED ANNUAL ANNUITY</b>	47			\$2,943,000
	<b>NET PRESENT VALUE</b>	<b>NET REVENUE, REVENUE EXCEEDS COSTS</b>			\$77,722,000
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET REVENUE, REVENUE EXCEEDS COSTS</b>			\$3,106,000

PHP Scenario 2: License Renewal - Low Revenue and High Cost

PORTLAND HYDROPOWER (PHP)					
Renewal - Low Revenue/High Cost					SUM TOTAL
		Timeline	Revenue		
	REVENUE	Annual	As Entered	Discount Rate	\$230,117,000
1	PRESENT VALUE OF REVENUE			5%	\$83,545,000
	EQUALIZED ANNUAL ANNUITY	47			\$3,339,000
Costs					
No.	Item	Timeline	High Estimate	PHP or PWB	Sum Total
1	Rewind Rotors and Stators - PH1 and PH2	2042	\$1.5M each	PHP	\$3,000,000
2	Install Digital Governor - PH2	2032	\$800K	PHP	\$800,000
3	New Roofs at PH1 and PH2	2026 & 2056	\$450K	PHP	\$900,000
4	Replace Protective Relays - PH1 and PH 2	Annual For 5 yrs start in 2025	\$125K	PHP	\$625,000
5	Replace Automatic Voltage Regulator -PH2	2023	\$220K	PHP	\$220,000
6	SCADA Improvements	2032 & 2052	\$50K	PHP	\$100,000
7	Operations and Maintenance	Annual	\$1.5M	PHP	\$70,500,000
8	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual	\$192K	PHP	\$9,024,000
9	PGE Service Contract	Annual	\$400K	PHP	\$18,800,000
10	Costs to Renew	2029	\$10M	PHP	\$10,000,000
11	Dam Inspections	Every 5 Years	\$1.5M	PWB	\$0
12	Additional FERC costs	Annual , skip every 5th year that include Dam Inspections	\$140K	PWB	\$0
13	Historic Preservation	2027	\$200K	PHP	\$50,000
14	Improvements or Mitigation	Annual	\$400K	PHP	\$18,800,000
15	Full Time Positions in Bureau of Hydro Electric Power	Annual	\$431K	\$175K PWB \$256K PHP	\$12,032,000
16	FERC Adminstrative Fees	Annual	\$50K	PHP	\$2,350,000
17	Oregon Water Resources Department (OWRD)	Annual	\$50K	PHP	\$2,350,000
	<b>SUM OF COSTS</b>			<b>Discount Rate</b>	<b>\$149,551,000</b>
	<b>PRESENT VALUE SUM OF COSTS</b>			<b>3%</b>	<b>\$85,569,000</b>
	<b>EQUALIZED ANNUAL ANNUITY</b>	<b>47</b>			<b>\$3,419,000</b>
	<b>NET PRESENT VALUE</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$2,024,000)</b>
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$80,000)</b>

PHP Scenario 3: License Renewal - Most Probable Revenue and Most Probable Cost

PORTLAND HYDROPOWER (PHP)					
	Surrender - Probable Revenue/Probable Cost				SUM TOTAL
		Timeline	Revenue		
	REVENUE	Annual	As Entered	Discount Rate	\$309,394,000
1	PRESENT VALUE OF REVENUE			5%	\$107,556,000
	EQUALIZED ANNUAL ANNUITY	47			\$4,298,000
Costs					
No.	Item	Timeline	Most Probable	PHP or PWB	Sum Total
1	Rewind Rotors and Stators - PH1 and PH2	2042	\$1.5M each	PHP	\$3,000,000
2	Install Digital Governor - PH2	2032	\$800K	PHP	\$800,000
3	New Roofs at PH1 and PH2	2026 & 2056	\$450K	PHP	\$900,000
4	Replace Protective Relays - PH1 and PH 2	Annual For 5 yrs start in 2025	\$125K	PHP	\$625,000
5	Replace Automatic Voltage Regulator -PH2	2023	\$220K	PHP	\$220,000
6	SCADA Improvements	2032 & 2052	\$50K	PHP	\$100,000
7	Operations and Maintenance	Annual	\$1.5M	PHP	\$70,500,000
8	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual	\$192K	PHP	\$9,024,000
9	PGE Service Contract	Annual	\$350K	PHP	\$16,450,000
10	Costs to Renew	2029	\$8m	PHP	\$8,000,000
11	Dam Inspections	Every 5 Years	\$1M	PWB	\$0
12	Additional FERC costs	Annual , skip every 5th year that include Dam Inspections	\$120K	PWB	\$0
13	Historic Preservation	2027	\$100K	PHP	\$50,000
14	Improvements or Mitigation	Annual	\$250K	PHP	\$11,750,000
15	Full Time Positions in Bureau of Hydro Electric Power	Annual	\$431K	\$175K PWB \$256K PHP	\$12,032,000
16	FERC Adminstrative Fees	Annual	\$50K	PHP	\$2,350,000
17	Oregon Water Resources Department (OWRD)	Annual	\$50K	PHP	\$2,350,000
	<b>SUM OF COSTS</b>			Discount Rate	\$138,151,000
	<b>PRESENT VALUE SUM OF COSTS</b>			3%	\$78,738,000
	<b>EQUALIZED ANNUAL ANNUITY</b>	47			\$3,146,000
	<b>NET PRESENT VALUE</b>	<b>NET REVENUE, REVENUE EXCEEDS COSTS</b>			\$28,818,000
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET REVENUE, REVENUE EXCEEDS COSTS</b>			\$1,152,000

PHP Scenario 4: License Surrender - High Revenue and Low Cost

PORTLAND HYDROPOWER (PHP)					
Surrender - High Revenue/Low Cost				SUM TOTAL	
	Timeline	Revenue	Discount Rate		
REVENUE	Annual	As Entered	5%	\$23,577,000	
PRESENT VALUE OF REVENUE				\$20,623,000	
EQUALIZED ANNUAL ANNUITY				47 \$824,000	
Costs					
No.	Item	Timeline	Low Estimate	PHP or PWB	Sum Total
1	Cost to Decommission Powerhouses	2029	\$2M	PHP	\$2,000,000
2	Maintenance of Powerhouses in Decommissioned State	Annual, Starting in 2029	\$20K	PHP	\$815,000
3	Cost to Surrender	2029	\$2.5M	PHP	\$2,500,000
4	Historic Preservation	2029	\$350K	PHP	\$350,000
5	Dam Safety Requirements	Annual, Starting in 2029	\$60K	PWB	\$0
6	Dam Inspections	2027	\$800K	PWB	\$0
7	Full Time Positions in Bureau of Hydro Electric Power	Annual, through 2028	\$431K	\$175K PWB \$256K PHP	\$1,600,000
8	Staff to Manage Dam Safety	Annual, Starting in 2029	\$225K	\$175K PWB \$50K PHP	\$2,038,000
9	Cost of Terminating PGE Contract	2029 - 2032	2029 - \$1.25M 2030 - \$1.67M 2031 - \$1.67M 2032 - \$800K	PHP	\$5,390,000
10	Improvements at Dam 1	2030	\$25M	PWB	\$0
11	Improvements at Dam 2	2020	\$10M	PWB	\$0
12	Diversion Pool Maintenance	Every 5 years, starting in 2029	\$80K	PWB	\$0
13	Cost of Electrical Service to Dam 1	2028	\$2M	PWB	\$0
14	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual, through 2028	\$192K	PHP	\$1,200,000
15	PGE Service Contract	Annual	\$300K thru 2028 \$200K after 2028	PHP	\$10,025,000
16	Treatment Staff to Monitor Water Conditions	Annual, Starting in 2029	\$87K	PWB	\$0
17	SRS Staff to manage flow	Annual, Starting in 2029	\$185K	PWB	\$0
18*	Social Cost of Carbon	Varies	2030 - \$2.5M 2031 - \$2.25M 2032 - \$1.25M 2033 - \$0	PWB	\$0
19	Improvements or Mitigation	Annual, Starting in 2029	\$50K	PWB	\$0
<b>SUM OF COSTS</b>				<b>Discount Rate</b>	<b>\$25,918,000</b>
<b>PRESENT VALUE SUM OF COSTS</b>				<b>3%</b>	<b>\$18,125,000</b>
<b>EQUALIZED ANNUAL ANNUITY</b>				<b>47</b>	<b>\$724,000</b>
<b>NET PRESENT VALUE</b>		<b>NET REVENUE, REVENUE EXCEEDS COSTS</b>			<b>\$2,498,000</b>
<b>NET EQUALIZED ANNUAL ANNUITY</b>		<b>NET REVENUE, REVENUE EXCEEDS COSTS</b>			<b>\$100,000</b>

PHP Scenario 5: License Surrender - Low Revenue and High Cost

PORTLAND HYDROPOWER (PHP)					
Surrender - Low Revenue/High Cost				SUM TOTAL	
		Timeline	Revenue	Discount Rate	
	REVENUE	Annual	As Entered	5%	
	PRESENT VALUE OF REVENUE			\$23,577,000	
	EQUALIZED ANNUAL ANNUITY	47		\$20,623,000	
				\$824,000	
Costs					
No.	Item	Timeline	High Estimate	PHP or PWB	Sum Total
1	Cost to Decommission Powerhouses	2029	\$15M	PHP	\$15,000,000
2	Maintenance of Powerhouses in Decommissioned State	Annual, Starting in 2029	\$30K	PHP	\$1,223,000
3	Cost to Surrender	2029	\$5M	PHP	\$5,000,000
4	Historic Preservation	2029	\$950K	PHP	\$950,000
5	Dam Safety Requirements	Annual, Starting in 2029	\$120K	PWB	\$0
6	Dam Inspections	2027	\$1.5M	PWB	\$0
7	Full Time Positions in Bureau of Hydro Electric Power	Annual, through 2028	\$431K	\$175K PWB \$256K PHP	\$1,600,000
8	Staff to Manage Dam Safety	Annual, Starting in 2029	\$225K	\$175K PWB \$50K PHP	\$2,038,000
9	Cost of Terminating PGE Contract	2029 - 2032	2029 - \$1.8M 2030 - \$2.4M 2031 - \$2.4M 2032 - \$1.2M	PHP	\$7,800,000
10	Improvements at Dam 1	2030	\$65M	PWB	\$0
11	Improvements at Dam 2	2020	\$30M	PWB	\$0
12	Diversion Pool Maintenance	Every 5 years, starting in 2029	\$200K	PWB	\$0
13	Cost of Electrical Service to Dam 1	2028	\$3.3M	PWB	\$0
14	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual, through 2028	\$192K	PHP	\$1,200,000
15	PGE Service Contract	Annual	\$400K thru 2028 \$300K after 2028	PHP	\$14,725,000
16	Treatment Staff to Monitor Water Conditions	Annual, Starting in 2029	\$150K	PWB	\$0
17	SRS Staff to manage flow	Annual, Starting in 2029	\$300K	PWB	\$0
18*	Social Cost of Carbon	Varies	2030 - \$6M 2031 - \$3M 2032 - \$2M 2033 - \$1M	PWB	\$0
19	Improvements or Mitigation	Annual, Starting in 2029	\$150K	PWB	\$0
	<b>SUM OF COSTS</b>			<b>Discount Rate</b>	<b>\$49,536,000</b>
	<b>PRESENT VALUE SUM OF COSTS</b>			<b>3%</b>	<b>\$36,323,000</b>
	<b>EQUALIZED ANNUAL ANNUITY</b>	<b>47</b>			<b>\$1,451,000</b>
	<b>NET PRESENT VALUE</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$15,700,000)</b>
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$627,000)</b>



PHP Scenario 6: License Surrender - Most Probable Revenue and Most Probable Cost

PORTLAND HYDROPOWER (PHP)					
Surrender - Probable Revenue/Probable Cost					
		Timeline	Revenue	Discount Rate	Sum Total
	REVENUE	Annual	As Entered	5%	\$23,577,000
	PRESENT VALUE OF REVENUE				\$20,623,000
	EQUALIZED ANNUAL ANNUITY	47			\$824,000
Costs					
No.	Item	Timeline	Most Probable	PHP or PWB	Sum Total
1	Cost to Decommission Powerhouses	2029	\$8.5M	PHP	\$8,500,000
2	Maintenance of Powerhouses in Decommissioned State	Annual, Starting in 2029	\$20K	PHP	\$815,000
3	Cost to Surrender	2029	\$4M	PHP	\$4,000,000
4	Historic Preservation	2029	\$600K	PHP	\$600,000
5	Dam Safety Requirements	Annual, Starting in 2029	\$80K	PWB	\$0
6	Dam Inspections	2027	\$1M	PWB	\$0
7	Full Time Positions in Bureau of Hydro Electric Power	Annual, through 2028	\$431K	\$175K PWB \$256K PHP	\$1,600,000
8	Staff to Manage Dam Safety	Annual, Starting in 2029	\$225K	\$175K PWB \$50K PHP	\$2,038,000
9	Cost of Terminating PGE Contract	2029 - 2032	2029 - \$1.5M 2030 - \$2M 2031 - \$2M 2032 - \$1M	PHP	\$6,500,000
10	Improvements at Dam 1	2030	\$49M	PWB	\$0
11	Improvements at Dam 2	2020	\$20M	PWB	\$0
12	Diversion Pool Maintenance	Every 5 years, starting in 2029	\$100K	PWB	\$0
13	Cost of Electrical Service to Dam 1	2028	\$2.5M	PWB	\$0
14	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual, through 2028	\$192K	PHP	\$1,200,000
15	PGE Service Contract	Annual	\$350K thru 2028 \$250K after 2028	PHP	\$12,375,000
16	Treatment Staff to Monitor Water Conditions	Annual, Starting in 2029	\$87K	PWB	\$0
17	SRS Staff to manage flow	Annual, Starting in 2029	\$185K	PWB	\$0
18	Social Cost of Carbon	Varies	2030 - \$5M 2031 - \$2.5M 2032 - \$1.25M 2033 - \$1.25M	PWB	\$0
19	Improvements or Mitigation	Annual, Starting in 2029	\$50K	PWB	\$0
	<b>SUM OF COSTS</b>			<b>Discount Rate</b>	<b>\$37,628,000</b>
	<b>PRESENT VALUE SUM OF COSTS</b>			<b>3%</b>	<b>\$27,214,000</b>
	<b>EQUALIZED ANNUAL ANNUITY</b>	<b>47</b>			<b>\$1,087,000</b>
	<b>NET PRESENT VALUE</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$6,591,000)</b>
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$263,000)</b>

PWB Scenario 1: License Renewal - High Revenue and Low Cost

PORTLAND WATER BUREAU (PWB)					
Renewal - High Revenue/Low Cost				SUM TOTAL	
		Timeline	Revenue	PHP or PWB	
	REVENUE (HIGH)	Annual	As Entered		
1	PRESENT VALUE OF REVENUE			PHP	\$0
	EQUALIZED ANNUAL ANNUITY	47			\$0
<b>Costs</b>					
No.	Item	Timeline	Low Estimate	PHP or PWB	Sum Total
1	Rewind Rotors and Stators - PH1 and PH2	2042	\$1.5M each	PHP	\$0
2	Install Digital Governor - PH2	2032	\$800K	PHP	\$0
3	New Roofs at PH1 and PH2	2026 & 2056	\$450K	PHP	\$0
4	Replace Protective Relays - PH1 and PH 2	Annual For 5 yrs start in 2025	\$125K	PHP	\$0
5	Replace Automatic Voltage Regulator -PH2	2023	\$220K	PHP	\$0
6	SCADA Improvements	2032 & 2052	\$50K	PHP	\$0
7	Operations and Maintenance	Annual	\$1.5M	PHP	\$0
8	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual	\$192K	PHP	\$0
9	PGE Service Contract	Annual	\$300K	PHP	\$0
10	Costs to Renew	2029	\$5M	PHP	\$0
11	Dam Inspections	Every 5 Years	\$800K	PWB	\$7,200,000
12	Additional FERC costs	Annual , skip every 5th year that include Dam Inspections	\$100K	PWB	\$3,800,000
13	Historic Preservation	2027	\$50K	PHP	\$0
14	Improvements or Mitigation	Annual	\$200K	PHP	\$0
15	Full Time Positions in Bureau of Hydro Electric Power	Annual	\$431K	\$175K PWB \$256K PHP	\$8,225,000
16	FERC Adminstrative Fees	Annual	\$50K	PHP	\$0
17	Oregon Water Resources Department (OWRD)	Annual	\$50K	PHP	\$0
	<b>SUM OF COSTS</b>			<b>Discount Rate</b>	<b>\$19,225,000</b>
	<b>PRESENT VALUE SUM OF COSTS</b>			<b>3%</b>	<b>\$10,418,000</b>
	<b>EQUALIZED ANNUAL ANNUITY</b>	<b>47</b>			<b>\$416,000</b>
	<b>NET PRESENT VALUE</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$10,418,000)</b>
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$416,000)</b>

PWB Scenario 2: License Renewal - Low Revenue and High Cost

PORTLAND WATER BUREAU (PWB)					
Renewal - Low Revenue/High Cost				SUM TOTAL	
		Timeline	Revenue	PHP or PWB	
	REVENUE (LOW)	Annual	As Entered		
1	PRESENT VALUE OF REVENUE			PHP	\$0
	EQUALIZED ANNUAL ANNUITY	47			\$0
<b>Costs</b>					
No.	Item	Timeline	High Estimate	PHP or PWB	Sum Total
1	Rewind Rotors and Stators - PH1 and PH2	2042	\$1.5M each	PHP	\$0
2	Install Digital Governor - PH2	2032	\$800K	PHP	\$0
3	New Roofs at PH1 and PH2	2026 & 2056	\$450K	PHP	\$0
4	Replace Protective Relays - PH1 and PH 2	Annual For 5 yrs start in 2025	\$125K	PHP	\$0
5	Replace Automatic Voltage Regulator -PH2	2023	\$220K	PHP	\$0
6	SCADA Improvements	2032 & 2052	\$50K	PHP	\$0
7	Operations and Maintenance	Annual	\$1.5M	PHP	\$0
8	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual	\$192K	PHP	\$0
9	PGE Service Contract	Annual	\$400K	PHP	\$0
10	Costs to Renew	2029	\$10M	PHP	\$0
11	Dam Inspections	Every 5 Years	\$1.5M	PWB	\$13,500,000
12	Additional FERC costs	Annual , skip every 5th year that include Dam Inspections	\$140K	PWB	\$5,320,000
13	Historic Preservation	2027	\$200K	PHP	\$0
14	Improvements or Mitigation	Annual	\$400K	PHP	\$0
15	Full Time Positions in Bureau of Hydro Electric Power	Annual	\$431K	\$175K PWB \$256K PHP	\$8,225,000
16	FERC Adminstrative Fees	Annual	\$50K	PHP	\$0
17	Oregon Water Resources Department (OWRD)	Annual	\$50K	PHP	\$0
	<b>SUM OF COSTS</b>			<b>Discount Rate</b>	<b>\$27,045,000</b>
	<b>PRESENT VALUE SUM OF COSTS</b>			<b>3%</b>	<b>\$14,588,000</b>
	<b>EQUALIZED ANNUAL ANNUITY</b>	<b>47</b>			<b>\$583,000</b>
	<b>NET PRESENT VALUE</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$14,588,000)</b>
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$583,000)</b>

PWB Scenario 3: License Renewal - Most Probable Revenue and Most Probable Cost

PORTLAND WATER BUREAU (PWB)					
Renewal - Probable Revenue Probable Cost				SUM TOTAL	
		Timeline	Revenue	PHP or PWB	
	REVENUE (MOST PROBABLE)	Annual	As Entered		
1	PRESENT VALUE OF REVENUE			PHP	\$0
	EQUALIZED ANNUAL ANNUITY	47			\$0
<b>Costs</b>					
No.	Item	Timeline	Most Probable	PHP or PWB	Sum Total
1	Rewind Rotors and Stators - PH1 and PH2	2042	\$1.5M each	PHP	\$0
2	Install Digital Governor - PH2	2032	\$800K	PHP	\$0
3	New Roofs at PH1 and PH2	2026 & 2056	\$450K	PHP	\$0
4	Replace Protective Relays - PH1 and PH 2	Annual For 5 yrs start in 2025	\$125K	PHP	\$0
5	Replace Automatic Voltage Regulator -PH2	2023	\$220K	PHP	\$0
6	SCADA Improvements	2032 & 2052	\$50K	PHP	\$0
7	Operations and Maintenance	Annual	\$1.5M	PHP	\$0
8	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual	\$192K	PHP	\$0
9	PGE Service Contract	Annual	\$350K	PHP	\$0
10	Costs to Renew	2029	\$8m	PHP	\$0
11	Dam Inspections	Every 5 Years	\$1M	PWB	\$9,000,000
12	Additional FERC costs	Annual , skip every 5th year that include Dam Inspections	\$120K	PWB	\$4,560,000
13	Historic Preservation	2027	\$100K	PHP	\$0
14	Improvements or Mitigation	Annual	\$250K	PHP	\$0
15	Full Time Positions in Bureau of Hydro Electric Power	Annual	\$431K	\$175K PWB \$256K PHP	\$8,225,000
16	FERC Adminstrative Fees	Annual	\$50K	PHP	\$0
17	Oregon Water Resources Department (OWRD)	Annual	\$50K	PHP	\$0
	<b>SUM OF COSTS</b>			<b>Discount Rate</b>	<b>\$21,785,000</b>
	<b>PRESENT VALUE SUM OF COSTS</b>			<b>3%</b>	<b>\$11,790,000</b>
	<b>EQUALIZED ANNUAL ANNUITY</b>	<b>47</b>			<b>\$471,000</b>
	<b>NET PRESENT VALUE</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$11,790,000)</b>
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$471,000)</b>

PWB Scenario 4: License Surrender - High Revenue and Low Cost

PORTLAND WATER BUREAU (PWB)					
Surrender - High Revenue/Low Cost				SUM TOTAL	
		Timeline	Revenue		
REVENUE	Annual	As Entered		\$0	
PRESENT VALUE OF REVENUE				\$0	
EQUALIZED ANNUAL ANNUITY	47			\$0	
Costs					
No.	Item	Timeline	Low Estimate	PHP or PWB	Sum Total
1	Cost to Decommission Powerhouses	2029	\$2M	PHP	\$0
2	Maintenance of Powerhouses in Decommissioned State	Annual, Starting in 2029	\$20K	PHP	\$0
3	Cost to Surrender	2029	\$2.5M	PHP	\$0
4	Historic Preservation	2029	\$350K	PHP	\$0
5	Dam Safety Requirements	Annual, Starting in 2029	\$60K	PWB	\$2,505,000
6	Dam Inspections	2027	\$800K	PWB	\$800,000
7	Full Time Positions in Bureau of Hydro Electric Power	Annual, through 2028	\$431K	\$175K PWB \$256K PHP	\$919,000
8	Staff to Manage Dam Safety	Annual, Starting in 2029	\$225K	\$175K PWB \$50K PHP	\$7,306,000
9	Cost of Terminating PGE Contract	2029 - 2032	2029 - \$1.25M 2030 - \$1.67M 2031 - \$1.67M 2032 - \$800K	PHP	\$0
10	Improvements at Dam 1	2030	\$25M	PWB	\$25,000,000
11	Improvements at Dam 2	2030	\$10M	PWB	\$10,000,000
12	Diversion Pool Maintenance	Every 5 years, starting in 2029	\$80K	PWB	\$720,000
13	Cost of Electrical Service to Dam 1	2028	\$2M	PWB	\$2,000,000
14	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual, through 2028	\$192K	PHP	\$0
15	PGE Service Contract	Annual	\$300K thru 2028 \$200K after 2028	PHP	\$0
16	Treatment Staff to Monitor Water Conditions	Annual, Starting in 2029	\$87K	PWB	\$3,632,000
17	SRS Staff to manage flow	Annual, Starting in 2029	\$185K	PWB	\$7,724,000
18*	Social Cost of Carbon	Varies	2030 - \$2.5M 2031 - \$2.25M 2032 - \$1.25M 2033 - \$0	PWB	\$6,000,000
19	Improvements or Mitigation	Annual, Starting in 2029	\$50K	PWB	\$2,088,000
<b>SUM OF COSTS</b>				<b>Discount Rate</b>	<b>\$68,694,000</b>
<b>PRESENT VALUE SUM OF COSTS</b>				<b>3%</b>	<b>\$48,493,000</b>
<b>EQUALIZED ANNUAL ANNUITY</b>				<b>47</b>	<b>\$1,938,000</b>
<b>NET PRESENT VALUE</b>		<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$48,493,000)</b>
<b>NET EQUALIZED ANNUAL ANNUITY</b>		<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$1,938,000)</b>

PWB Scenario 5: License Surrender - Low Revenue and High Cost

PORTLAND WATER BUREAU (PWB)					
Surrender - Low Revenue/High Cost				SUM TOTAL	
		Timeline	Revenue		
	REVENUE	Annual	As Entered	\$0	
	PRESENT VALUE OF REVENUE			\$0	
	EQUALIZED ANNUAL ANNUITY	47		\$0	
<b>Costs</b>					
No.	Item	Timeline	High Estimate	PHP or PWB	Sum Total
1	Cost to Decommission Powerhouses	2029	\$15M	PHP	\$0
2	Maintenance of Powerhouses in Decommissioned State	Annual, Starting in 2029	\$30K	PHP	\$0
3	Cost to Surrender	2029	\$5M	PHP	\$0
4	Historic Preservation	2029	\$950K	PHP	\$0
5	Dam Safety Requirements	Annual, Starting in 2029	\$120K	PWB	\$4,890,000
6	Dam Inspections	2027	\$1.5M	PWB	\$1,500,000
7	Full Time Positions in Bureau of Hydro Electric Power	Annual, through 2028	\$431K	\$175K PWB \$256K PHP	\$1,094,000
8	Staff to Manage Dam Safety	Annual, Starting in 2029	\$225K	\$175K PWB \$50K PHP	\$7,131,000
9	Cost of Terminating PGE Contract	2029 - 2032	2029 - \$1.8M 2030 - \$2.4M 2031 - \$2.4M 2032 - \$1.2M	PHP	\$0
10	Improvements at Dam 1	2030	\$65M	PWB	\$65,000,000
11	Improvements at Dam 2	2030	\$30M	PWB	\$30,000,000
12	Diversion Pool Maintenance	Every 5 years, starting in 2029	\$200K	PWB	\$1,800,000
13	Cost of Electrical Service to Dam 1	2028	\$3.3M	PWB	\$3,300,000
14	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual, through 2028	\$192K	PHP	\$0
15	PGE Service Contract	Annual	\$400K thru 2028 \$300K after 2028	PHP	\$0
16	Treatment Staff to Monitor Water Conditions	Annual, Starting in 2029	\$150K	PWB	\$6,113,000
17	SRS Staff to manage flow	Annual, Starting in 2029	\$300K	PWB	\$12,225,000
18*	Social Cost of Carbon	Varies	2030 - \$6M 2031 - \$3M 2032 - \$2M 2033 - \$1M	PWB	\$12,000,000
19	Improvements or Mitigation	Annual, Starting in 2029	\$150K	PWB	\$6,113,000
	<b>SUM OF COSTS</b>			<b>Discount Rate</b>	<b>\$151,166,000</b>
	<b>PRESENT VALUE SUM OF COSTS</b>			<b>3%</b>	<b>\$110,745,000</b>
	<b>EQUALIZED ANNUAL ANNUITY</b>	<b>47</b>			<b>\$4,425,000</b>
	<b>NET PRESENT VALUE</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$110,745,000)</b>
	<b>NET EQUALIZED ANNUAL ANNUITY</b>	<b>NET COST, COSTS EXCEED REVENUE</b>			<b>(\$4,425,000)</b>

PWB Scenario 6: License Surrender - Most Probable Revenue and Most Probable Cost

PORTLAND WATER BUREAU (PWB)					
Surrender - Probable Revenue/Probable Cost					
		Timeline	Revenue		Sum Total
	REVENUE	Annual	As Entered		\$0
	PRESENT VALUE OF REVENUE				\$0
	EQUALIZED ANNUAL ANNUITY	47			\$0
Costs					
No.	Item	Timeline	Most Probable	PHP or PWB	Sum Total
1	Cost to Decommission Powerhouses	2029	\$8.5M	PHP	\$0
2	Maintenance of Powerhouses in Decommissioned State	Annual, Starting in 2029	\$20K	PHP	\$0
3	Cost to Surrender	2029	\$4M	PHP	\$0
4	Historic Preservation	2029	\$600K	PHP	\$0
5	Dam Safety Requirements	Annual, Starting in 2029	\$80K	PWB	\$3,260,000
6	Dam Inspections	2027	\$1M	PWB	\$1,000,000
7	Full Time Positions in Bureau of Hydro Electric Power	Annual, through 2028	\$431K	\$175K PWB \$256K PHP	\$1,094,000
8	Staff to Manage Dam Safety	Annual, Starting in 2029	\$225K	\$175K PWB \$50K PHP	\$7,131,000
9	Cost of Terminating PGE Contract	2029 - 2032	2029 - \$1.5M 2030 - \$2M 2031 - \$2M 2032 - \$1M	PHP	\$0
10	Improvements at Dam 1	2030	\$49M	PWB	\$49,000,000
11	Improvements at Dam 2	2020	\$20M	PWB	\$20,000,000
12	Diversion Pool Maintenance	Every 5 years, starting in 2029	\$100K	PWB	\$900,000
13	Cost of Electrical Service to Dam 1	2028	\$2.5M	PWB	\$2,500,000
14	EWEB Contract - Monitoring, Scheduling and Dispatching	Annual, through 2028	\$192K	PHP	\$0
15	PGE Service Contract	Annual	\$350K thru 2028 \$250K after 2028	PHP	\$0
16	Treatment Staff to Monitor Water Conditions	Annual, Starting in 2029	\$87K	PWB	\$3,632,000
17	SRS Staff to manage flow	Annual, Starting in 2029	\$185K	PWB	\$7,724,000
18	Social Cost of Carbon	Varies	2030 - \$5M 2031 - \$2.5M 2032 - \$1.25M 2033 - \$1.25M	PWB	\$10,000,000
19	Improvements or Mitigation	Annual, Starting in 2029	\$50K	PWB	\$2,088,000
	<b>SUM OF COSTS</b>			<b>Discount Rate</b>	<b>\$108,329,000</b>
	<b>PRESENT VALUE SUM OF COSTS</b>			<b>3%</b>	<b>\$80,345,000</b>
	<b>EQUALIZED ANNUAL ANNUITY</b>	<b>47</b>			<b>\$3,211,000</b>
	<b>NET PRESENT VALUE</b>		<b>NET COST, COSTS EXCEED REVENUE</b>		<b>(\$80,345,000)</b>
	<b>NET EQUALIZED ANNUAL ANNUITY</b>		<b>NET COST, COSTS EXCEED REVENUE</b>		<b>(\$3,211,000)</b>

ATTACHMENT 3 – SOCIAL COST OF CARBON

<b>FERC Relicensing Project</b>													
<b>Calculation of Social Cost of Carbon</b>													
<b>Eric Brainich, 9/6/22</b>													
<b>PWB / COP Hydroelectric</b>													
mWh goal for FY 22/23 <sup>a</sup>	86,000												
kWh goal for FY 22/23	86,000,000												
% of BR hydro supply reduction made up by natural gas generation	100%												
Natural gas generation pounds carbon per kWh <sup>b</sup>	0.91												
Annual carbon produced by natural gas generation (MT)	35,508												
COP carbon valuation per MT CO2 in 2025	\$143												
Annual value to the City	\$5,077,668												
a/ source: PWB FY 2022-2023 Requested budget, page 37 Hydroelectric Power <a href="https://www.portlandoregon.gov/cbo/article/798497">https://www.portlandoregon.gov/cbo/article/798497</a>													
b/ source: <a href="https://www.eia.gov/tools/faqs/faq.php?id=74&amp;t=11">https://www.eia.gov/tools/faqs/faq.php?id=74&amp;t=11</a>													
A typical PGE household customer uses about 800 kWh per month, or 9,600 kWh per year (2021 article, see link below)													
86,000 mWh provides enough electricity for 8,958 households in PGE territory													
<a href="https://oregoncub.org/news/blog/understanding-your-portland-general-electric-bill/2362/#:~:text=A%20typical%20PGE%20household%20uses,though%20amounts%20vary%20between%20households.">https://oregoncub.org/news/blog/understanding-your-portland-general-electric-bill/2362/#:~:text=A%20typical%20PGE%20household%20uses,though%20amounts%20vary%20between%20households.</a>													



**From:** [Brainich, Eric](#)  
**To:** [Re, Tony](#)  
**Subject:** RE: Social Cost of Carbon  
**Date:** Tuesday, September 6, 2022 10:22:25 AM

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I changed the internal cost of carbon in row 6 to \$143, the value City Council approved for 2030, but didn't save a new file before I sent it to you so what I sent you has \$130, so that should be changed to the 2030 value of \$143.

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**From:** Brainich, Eric  
**Sent:** Tuesday, September 6, 2022 10:19 AM  
**To:** Re, Tony <Tony.Re@portlandoregon.gov>; Senior, Janet <Janet.Senior@portlandoregon.gov>; Muftugil, Mert <Mert.Muftugil@portlandoregon.gov>; Evonuk, Dave <Dave.Evonuk@portlandoregon.gov>  
**Subject:** RE: Social Cost of Carbon

++ Janet, as she is also a key person in figuring out the assumptions on how much and when PGE or outside sources would fill the gap  
++ Mert as I've been discussing with him carbon issue and he'll help on the business case while I'm out  
++ Dave as he was in the meeting with Quisha

Attached is my calculation on the internal cost of carbon for the license surrender option. I used the mWh hydro production that is in our budget submission. Whatever generation amount is used to estimate the revenue in the relicensing option should be used here in cell B3 and B4, also a % of it in cell B5 depending on our assumptions of alternate green energy taking its place (see notes below).

The [internal cost of carbon adopted by COP](#) is \$143 in 2030, while it goes up every 5 years, we'd likely assume it won't take that long to offset the loss of hydro with new clean energy so use this value in 2029 and forward.

Quisha noted that if there is a loss of clean energy, as well as day to day supply gaps in green energy, the offset will come from natural gas production. She also concurred that the natural gas generation of pounds of carbon per kWh that I used from the US Energy Information Administration (row 6) is a reliable source and good estimate.

I can't find my notes from our meeting with Quisha (shame because I took good ones), but the most important I recall are these. As stated above, PGE utilizes natural gas as the supply that they use that will meet any gaps in clean energy supply and demand (there is coal, but she said that natural gas plant is the one they turn up and down to meet those short falls). She said that by 2030, PGE goal is to have all the green energy supply for their long-term supply targets but that there may be factors that delay this given the difficulties in the market and other issues. On the regional market supply that PGE uses she agreed if PGE takes up more from this pool then it is less overall for other utilities and that investments would come in over time (no specific time frame on how long it may take).

I recommend using a sensitivity analysis. Pick a low, medium and high value when we estimate how

much of the loss from hydro would be met by natural gas and, most importantly, for how long.

Starting with the medium, which might be a best guess (in my opinion) is that for the first year after giving up the license and stop producing hydro electricity there would be 100% offset from natural gas. PGE might take longer than 2030 to meet their goals so a 2<sup>nd</sup> and 3<sup>rd</sup> year option might reflect the risk that things don't go exactly as planned and also that other regional utilities might be without some green energy for a while when hydro is taken off line. I might use 50% in year 2 and 25% in year three.

I think a longer time from would be the upper limit or high estimate; something like 3 years at 100% offset by natural gas until some investors (PGE or other) are able to invest, develop and put online a clean energy facility to offset hydro's removal. A low estimate might be zero from the day hydro goes offline, but I personally think that unrealistic, but if PGE exceeds their goal then maybe 50% for one year for the regional pool to try and get more would be a shot.

I think Janet, Dave, and Mert could also comment on these options.

I'm here this week (Friday a few hours only in the AM) then out for 3 weeks. Let me know if you have questions on how to use this. It sounds like it would start in 2029 or 2030 so that is where it would go in the Excel benefit-cost sheet and it would be discounted into today's dollars along with all of the other costs in the same years.

Eric