CLACKAMAS COUNTY BOARD OF COUNTY COMMISSIONERS

Policy Session Worksheet

Presentation Date: 02/26/19 **Approx. Start Time:** 3:00 p.m. **Approx. Length:** 30 mins.
Presentation Title: Willamette Falls Locks Briefing
Department: Public and Government Affairs
Presenters: Trent Wilson and Gary Schmidt
Other Invitees: Dan Johnson (DTD, Director); Greg Geist (WES, Director); Laura Zentner (BCS, Director); Danielle Cowan (Tourism & Cultural Affairs, Executive Director)

WHAT ACTION ARE YOU REQUESTING FROM THE BOARD?
The Board of County Commissioners is being asked to consider if Clackamas County is willing to be a recipient of state funding to repair the Willamette Falls Locks, and manage relevant repairs while a new owner is being established.

EXECUTIVE SUMMARY:

The Willamette Falls Locks State Commission (established by SB 256 in 2017) has advanced two legislative concepts for the 2019 State Legislative Session. HB 2304 authorizes issuance of lottery bonds to finance acquisition and restoration of Willamette Falls Locks. HB 2305 authorizes the Department of State Lands to perform work to acquire and restore operation of the Willamette Falls Locks. HB 2304 is a capital funding mechanism, while HB 2305 is a mechanism to determine non-federal ownership.

As discussions have evolved at the legislative session, leaders in Salem have asked for more work to be done on HB 2305, related to the ownership questions. This works is being done by the Willamette Falls Locks State Commission members and staff. Meanwhile, the funding bill continues with good support at the state level.

This separation of bills has left the question, if the funding bill were to pass and not the ownership bill, where will the money live should it be provided by the Legislature. While there remain many options, Clackamas County has been asked by state leadership if it is open to housing the funds and, to keep project momentum, manage the repair contract(s).

$7.5 million is currently identified in the Governor's budget for repair costs to the Willamette Falls Locks. However, the total project cost is estimated at $15.535 million. The Willamette Falls Commission took action at its meeting in January to recommend funding of $15.535 million.

County Department Directors have reviewed this question in advance of the policy session and determined there are significant risks to accepting this request, but it's acceptance under certain conditions could make this request manageable.

Opportunities:

- Action supports Clackamas County's 2014 resolution to support the repair and reopening of Willamette Falls Locks.
- Action aligns with Clackamas County's performance goals to:
    - Grow a vibrant economy
    - Build a strong infrastructure

- Action supports partner jurisdictions and stakeholders.

Concerns:

- Accepting the funds and conducting repairs could signal that Clackamas County is more than a supportive stakeholder, but also a willing owner of the Locks.
- Potential ownership would leave Clackamas County with management of a facility that potential controls the viability of upriver economies outside of Clackamas' jurisdiction.

Potential conditions of agreement:

- Clackamas County will not be an owner of the Locks, but remains a supportive stakeholder, recognizing the local economic potential for the entire Willamette Valley.
- Clackamas County is open to holding the capital funds while a permanent owner is established.
- Clackamas County is open to managing the capital repairs (with technical support by the US Army Corps of Engineers), under the following conditions:
    - All $15.535 million is accounted for by the state legislature, or other resources;
    - A permanent owner, agency, authority, or district is identified and undergoing a development process; and
    - Clackamas County is provided appropriate additional funding to perform administrative functions outside of its existing expertise.

FINANCIAL IMPLICATIONS (current year and ongoing):

There are no current year implications to this issue. However, if the Governor's funding request is approved then between $7.5 million and $15.535 million could come to Clackamas County with the intention to manage repair of the Willamette Falls Locks.

STRATEGIC PLAN ALIGNMENT:

- This item aligns with the Public and Government Affairs Strategic Business Plan goals to provide intergovernmental connections and relationship building, strategic policy development and messaging, legislative, advocacy, and outreach services to county elected officials and departments so they can build key partnerships to achieve policy goals important to Clackamas County, with special emphasis on the strategic results in the BCC Strategic Plan.
- This item aligns with all five of the County's Performance Clackamas goals:
    - Grow a vibrant economy;
    - Build a strong infrastructure

LEGAL/POLICY REQUIREMENTS:

N/A

PUBLIC/GOVERNMENTAL PARTICIPATION:

Public and Government Affairs (PGA) actively tracks legislation and policy on Willamette Falls Locks and an approved state and federal agenda item. Additionally, Clackamas County currently manages the "project management" contract for the Willamette Falls Locks State Commission.

OPTIONS:

- Accept the request to be a potential recipient of state funds and project manager for the repair of Willamette Falls Locks.
- Accept the request with conditions.
- Deny the request.

RECOMMENDATION:
Staff recommends the BCC's decision accomplishes the following principles:

- Supports recommendations by the Willamette Falls Locks State Commission
- Affirms Clackamas County is not a potential owner of Willamette Falls Locks

ATTACHMENTS:

- Local Economic Potential Report for Willamette Falls Locks
- KPFF Engineering Report for Willamette Falls Locks

SUBMITTED BY:
Division Director/Head Approval _____
Department Director/Head Approval _____
County Administrator Approval _s/Gary Schmidt_____ _____

For information on this issue or copies of attachments, please contact Gary Schmidt @ 503-742-5908

Economic Benefits of Reopening the Willamette Falls Locks

Prepared for The Willamette Falls Locks Working Group

January 2018

PREPARED BY:

ECONorthwest

ECONOMICS • FINANCE • PLANNING

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ACKNOWLEDGEMENTS

ECONorthwest prepared this report for Clackamas County on behalf of the Willamette Falls Locks Working Group. We received assistance and direction from Clackamas County staff and members of the Willamette Falls Working Group who served as the project's steering committee, including Trent Wilson, Gary Schmidt, John Williams, Andy Cotugno, Sandy Carter, Joe Bernert, and Greg Theisen. We also received valuable information and perspectives from numerous individuals, credited in Appendix F. That assistance notwithstanding, ECONorthwest is responsible for the content of this report. The staff at ECONorthwest prepared this report based on their general knowledge of economics and public policy, and on information derived from government agencies, private statistical services, the reports of others, interviews of individuals, or other sources believed to be reliable. ECONorthwest has not independently verified the accuracy of all such information, and makes no representation regarding its accuracy or completeness. Any statements nonfactual in nature constitute the authors' current opinions, which may change as more information becomes available.

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Cover photo: 2010 Lock Fest. *Courtesy of the Willamette Falls Heritage Foundation*

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SUMMARY

The Willamette Falls Locks ("the Locks") are an important piece of Oregon history and the oldest significant navigational facility west of the Rockies. Prior to their closure in 2011, the Locks provided a vital passage for freight and recreation users around Willamette Falls ("the Falls"), connecting the Mid-Willamette Valley to Portland and beyond.

Closing the Locks cut the Willamette River in two. No longer can boats upriver of the Falls access Portland and the Columbia River. At the same time, the two paper mills adjacent to the Falls have both closed, and the redevelopment possibilities on these sites have sparked the imagination of many local and state stakeholders.

The U.S. Army Corps of Engineers ("the Corps") has determined that insufficient "federal interest" exists to continue maintaining and operating the Locks. In May 2017, the Corps released a draft report (Disposition Study) describing its assessment of alternatives for transferring the Locks to another entity, or decommissioning them. The Corps concluded that from a federal perspective, the best disposition alternative is transferring the Locks to a new owner in a non-operational condition after completing minimal seismic upgrades.

Moving forward with the disposition of the Locks requires a willing partner who is aware of the potential costs and benefits of operating the Locks. To address this need, the Oregon Legislature allocated funds for an economic study of reopening the Locks. Clackamas County, on behalf of the Willamette Falls Locks Working Group, contracted with ECONorthwest to conduct an economic assessment of reopening the Locks. This assessment will help inform state and local decision making regarding the costs and benefits of operating the Locks by taking a broader view of the asset value of the Locks, focusing specifically on state and local interests. We inventoried and quantified, where possible, the benefits of an operational Locks across five categories: transportation, recreation and tourism, local and regional development, cultural and historical value, and infrastructure resiliency. We also summarized available information on the costs of operating the Locks.

Our analysis shows that the Locks remain a viable and valuable asset for local and regional economies and communities, and if reopened would produce millions of dollars of public and private benefits. If the Locks are decommissioned, the communities and stakeholders near the Locks would not be able to capitalize on the transportation, recreation, tourism, cultural, historic, and economic development benefits that one of the nation's most historic and unique transportation infrastructure assets could provide.

OVERVIEW OF BENEFITS

Our assessment evaluates how benefits and costs vary across two operational scenarios.

- The **Public Ownership** scenario assumes that a public entity would acquire and operate the Locks, much like it has operated historically.
- The **Private Ownership** scenario assumes that a private entity would acquire and operate the Locks for their own commercial interests.

BY THE NUMBERS:

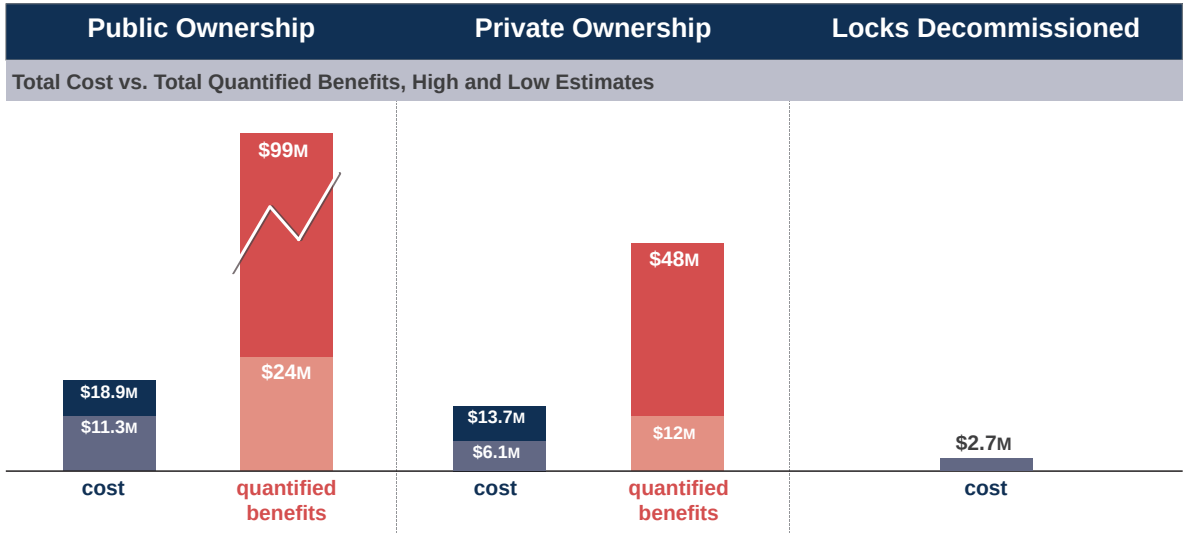
- Quantified transportation benefits of between **$12–$49 million** over 30 years.
- Quantified recreation benefits of between **$12–$50 million** over 30 years.
- **80,000–220,000 trucks trips removed** from Portland area roads over 30 years.
- **11,000–32,000 metric tons** of CO_2 reduced over 30 years.
- **5,400–15,400** metric tons of NO_X reduced over 30 years.
- **2-6%:** Cost as percent of Army Corps restoration investment above the Falls over 30 years.
- **Over 4,000 annually:** Estimated number of recreational boats that may use the Locks, based on historical use patterns, population growth, and increase in demand for recreational boating since 2000.

We compare the benefits and costs of these operational scenarios against a "Baseline" scenario in which the Corps decommissions the Locks and builds a concrete bulkhead at the upstream end of the Locks canal to regulate river levels upstream. The Corps stated in its Disposition Study that this would be the preferred course of action if a transferee is not identified.

We summarize the benefits and costs of each scenario in Figure 1. We divide the benefits into two categories:

- **Quantified Benefits:** In both the Public and Private Ownership scenarios, the quantified benefits of repairing and operating the Locks exceed the costs.
- **Unquantified Benefits:** The quantified benefits shown in Figure 1 do not capture all of the benefits that are likely to materialize, especially in the Public Ownership scenario. The lower half of Figure 1 outlines additional benefits we identified, but were not able to quantify. We grouped these benefits by their certainty to materialize: those that are certain but unquantifiable immediately add to the total quantified benefits. Those that are highly likely to occur now or in the future also imply our total quantified benefits are very likely underestimated. Benefits listed in the potential and unlikely categories may further increase the total benefits should they materialize in the future.

Figure 1. Cross-Scenario Comparison



Unquantified Benefits

Certain

Public Ownership	Private Ownership	Locks Decommissioned
• Additional Recreation-Tourism Revenue • Cultural and Spiritual • Historical Interpretation and Education Historic Preservation		

Highly Likely

Public Ownership	Private Ownership	Locks Decommissioned
• Transportation Infrastructure Resiliency	• Transportation Infrastructure Resiliency	

Likely

Public Ownership	Private Ownership	Locks Decommissioned
• Future Transportation Cost Savings • Future Environmental and Congestion • Future Recreation-Tourism Revenue • Local Development	• Historic Preservation • Future Transportation Cost Savings • Future Environmental and Congestion	

Potential

Public Ownership	Private Ownership	Locks Decommissioned
• Upriver and Downriver Development Benefits	• Cultural and Spiritual • Local Development • Upriver and Downriver Development Benefits	• Local Development

Unlikely

Public Ownership	Private Ownership	Locks Decommissioned
	• Recreation-Tourism Revenue • Historical Interpretation and Education	

Unquantified Costs

Public Ownership	Private Ownership	Locks Decommissioned
		• Additional NEPA study costs • Additional litigation costs

Figure 1 Notes:

All quantified benefits and costs are over 30 years, estimated in 2017 dollars, and discounted at 3 percent. For more information, see technical appendices.

The Corps estimated that all scenarios would protect its investment of $194-$694 million in restoration projects located upstream of the falls. Because this benefit is the same across all scenarios, we omit it from this analysis.

Our conclusion that benefits exceed costs holds, even though we employed conservative analytical assumptions that likely underestimate the true value of the benefits of reopening the Locks. For example, we assumed that during thirty years of future operations, no commodities other than aggregate would move through the Locks. In reality, it is highly likely that with the Locks operating on a regular schedule, businesses that produce and transport other goods and commodities would also take advantage of the cost savings that barging provides over trucking and ship their products through the Locks, especially as congestion increases on the region's highways.

Figure 2 shows a range of quantified benefits from the public ownership scenario. The major categories of benefits include revenues from overnight cruise operators ($11.7–$48.4 million), reduced moorage costs ($8.1–$40.4 million), and transportation cost savings ($2.0–$5.6 million).

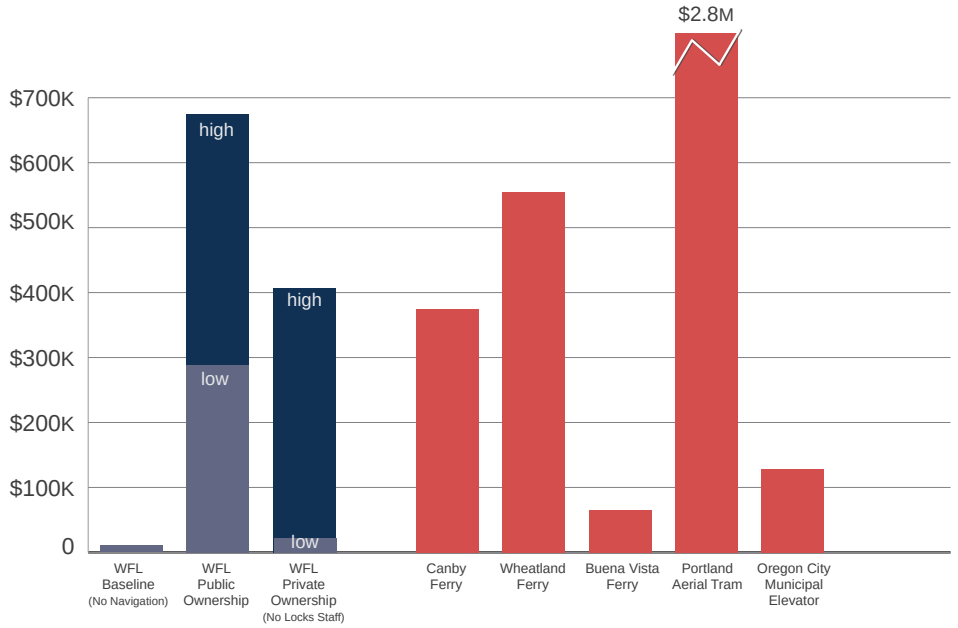
On the cost side, our high-end cost estimate is based on a conservative assumption of operating the Locks seven days per week, fifty-two weeks per year. This estimate likely overstates the true cost of operating the Locks, which would most likely run fewer days per week. For example, our low-end cost estimate assumes six months of operations at four days per week, and six months of operations at two days per week, which is a more realistic schedule, especially during the first few years of operations. We also found that the costs of operating the Locks are generally in line with the costs of operating other transportation assets in the region, e.g., ferries (see Figure 3).

Figure 2. Quantified Benefits for Public Operating Scenario over 30 years (2017 dollars)

	Low	High
Transportation Benefits		
Moorage Cost Savings	$8.1 million	$40.4 million
Transportation Cost Savings	$2.0 million	$5.6 million
In-Water Construction Cost Savings	$1.2 million	$1.2 million
Environmental and Congestion Benefits	$500,000	$1.4 million
Recreation		
Overnight Cruise Revenues	$11.7 million	$48.4 million
Personal Watercraft Recreation Benefits	$600,000	$2.4 million
Total Quantified Benefits	**$24.1 million**	**$99.4 million**

Note: Totals may not sum due to rounding.

Figure 3. Annual Operating Costs, The Locks vs. Other Portland Area Transportation Infrastructure (2017 dollars)



KEY TAKEAWAYS

Transportation

- Shipping aggregate by barge reduces transportation costs by approximately 18 percent compared with trucking. Reopening the Locks will provide millions of dollars of cost savings for aggregate shippers.
- There is a critical shortage of moorage sites for commercial vessels below the Falls. Reopening the Locks will provide much needed access to moorage sites for commercial vessels above the Falls at greatly reduced costs compared with costs below the Falls. These savings amount to tens of millions of dollars of reduced moorage costs over 30 years.
- Moving aggregate by barge could remove between 80,000 and 220,000 truck trips from Portland-area congested roadways over the next 30 years.
- Reducing truck traffic could also reduce the production of the greenhouse gas carbon dioxide (CO_2) by 46 percent and production of nitrogen oxides (NO_x) by 93 percent, compared with trucking. NO_x are respiratory irritants and contribute to the formation of acid rain and haze.

Recreation

- Recreation and tourism activities associated with the Locks would resume immediately after reopening, and use likely would expand beyond historical levels because of population growth and increased demand for water-based recreation since 2000.
- Quantified benefits associated with recreation, including guided overnight cruises and use by personal watercraft (e.g., motor boats and canoes) range from about $12 million to over $51 million over 30 years.
- Guided day tours, on-site visitation, and future tourism bolstered by potential development plans would all generate additional benefits beyond those quantified.

Development

- The sites immediately adjacent to the Locks, the West Linn Paper Mill and the Willamette Falls Legacy Project, will have the greatest potential development benefits from a reopened Locks.
- All of the riverfront sites near the Locks face significant infrastructure and market barriers to redevelopment that will require public-private partnerships to overcome.
- Redevelopment sites in the cities of Wilsonville and Newberg are most likely to capitalize on increased access to Portland, particularly if new overnight tourist boats visit those locations.

Cultural and Historic

- Cultural and historic benefits are unquantifiable in monetary terms, but are clearly revealed by past and current actions to protect the Locks for current and future generations.
- In addition to designations on the National Register of Historic Places and as a State Historic Civil Engineering Landmark, in 2012 the National Trust for Historic Preservation named the Locks a National Treasure, dedicating resources toward its long-term preservation.
- Willamette Falls is one of the most important gathering places for northwest Tribes. The Locks protect the Tribes' access around the Falls, especially after development eliminated traditional portage routes.

Resiliency

- During the short- and long-term recovery phases in the aftermath of the Cascadia Subduction Zone Earthquake, the Locks could provide critical transportation services long before the region's bridges and roadways return to functionality.
- These services include moving reconstruction materials, food, and fuel; reconnecting family members separated at the time of the earthquake; and, transporting volunteers and other recovery workers to damaged areas.

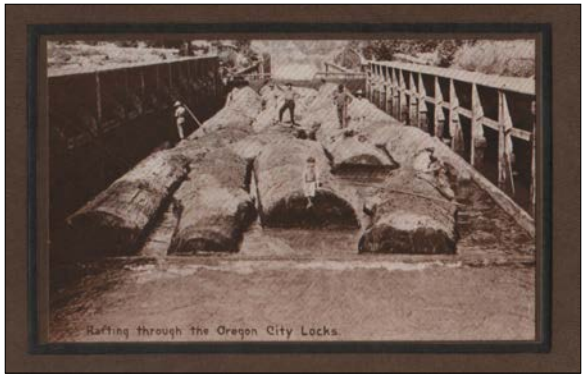
BACKGROUND AND INTRODUCTION

On January 1, 1873, the Locks opened and allowed passage around Willamette Falls, the second largest waterfall in the United States by volume (behind Niagara Falls). The Locks dramatically reduced transit times and transportation costs and were considered an engineering marvel at the time. The initial design for the way the Locks gates are beveled upstream came from drawings by Leonardo da Vinci.[1] Initially constructed as a private venture with financial support from the state of Oregon, in 1915 the Corps took ownership and provided free transit around Willamette Falls to encourage commerce.[2]

Fast-forward 96 years. In December 2011, in response to dwindling commercial tonnage passing through the Locks, and a mounting bill for anticipated deferred maintenance and repairs, the Corps changed the operational status of the Locks from "caretaker status" (operating the Locks at least once per month for maintenance) to "non-operational status" (Locks not operated at all).[3] That decision effectively cut the Willamette River in two. Commercial and recreational users upstream of the Falls can no longer access recreation sites, markets, or customers downstream via the river. Likewise, downstream businesses and recreational users can no longer access sites upstream from the Falls on the river.

By changing the operational status of the Locks to "non-operational" in 2011, the Corps signaled (based on their interpretation of the relevant operating and funding guidelines) that insufficient "federal interest" existed to continue maintaining and operating the Locks, given declining commercial traffic through the Locks. In May 2017, the Corps released a draft report of their assessment of alternatives for transferring ownership of the Locks to another entity or decommissioning the Locks, known as the "Disposition Study."[4] The Corps initially considered eight disposition alternatives including No Action, continuing caretaker status; Operational Lock, repairing and transferring fully-operational Locks; Non-Operational Lock, transferring non-operational Locks after minimum seismic repairs; and, a number of alternatives that would permanently disable the Locks making them unusable for navigation. After an initial screening process, the Corps studied three alternatives: No Action; Non-Operational Lock; and the Concrete Bulkhead alternative, which would permanently disable the Locks and make them unusable for future navigation. Based on their study of these three alternatives, the Corps selected the Non-Operational Lock as their preferred alternative.[5] Thus, the Corps concluded that from a federal perspective, the best alternative is transferring the Locks in a non-operational condition after completing minimal seismic upgrades.

The Locks have significant navigational, historical, and cultural importance to Oregonians. They have received official recognition as a valuable civil engineering achievement, and represent a keystone landmark in a region rich with markers of Oregon's early history.[6] But they are not just part of Oregon's past. Though the commercial



Above: Postcard circa late 19th century. Old growth logs moving through the canal. *Courtesy of the Willamette Falls Heritage Foundation.*

Below: Recreation boats: Corvallis-to-Portland Regatta sculling event. *Courtesy of Sandy Carter.*

importance of a water-based transportation corridor may have diminished due in part to expanded rail services and the construction of Interstate 5, the economic, practical, and psychological import of this connection has not disappeared. As commercial demand has waned, water-based recreational and tourism demands have grown. As the region plans for continued growth and prepares for future economic disruptions including the Cascadia earthquake and adaptation to climate change, a unified and navigable Willamette River that connects the Willamette Valley to the Portland Metro Area may hold benefits yet to be fully realized.

Recognizing these local and regional benefits, numerous cities, counties, regional governments, Tribes, and non-profit groups have passed resolutions supporting the repair and reopening of the Locks.[7] The Willamette Falls Locks Working Group, a coalition of local governments, businesses, and non-profit organizations, formed in 2015 with the primary goal of seeing the Locks repaired and reopened.[8] In 2015, the Oregon Legislature established the Willamette Falls Navigation Canal and Locks Task Force, whose charge included promoting and supporting efforts to repair and reopen the Locks.[9] In 2017, the Oregon Legislature established the Willamette Falls Locks Commission, which is a policy-making and advisory board for issues regarding the repair, reopening, and future transfer of ownership of the Locks from the federal government to another public or private entity.[10] (See the Timeline for additional significant dates in the Locks' history.)

In an effort to better understand the range of economic benefits of an operational Locks, the Oregon Legislature allocated funds for a study. Clackamas County, on behalf of the Willamette Falls Locks Working Group, contracted with ECONorthwest to conduct an economic assessment of reopening the Locks. Unconstrained by the guidelines under which the Corps conducted their recent draft Disposition Study, which focused on the federal interest in previous commercial traffic through the Locks and the Corps' interest in maintaining river levels above the Falls that ensure continuing efficacy of their upstream habitat and riparian restoration investments, our assessment takes a broader view of the asset value of the Locks, focusing specifically on state and local interests.* Our assessment includes six analytical components:

- **Transportation Benefit Assessment.** Presents the economic benefits of the Locks as an asset that facilitates commodity transport and other river-based commercial services (e.g., in-water work at docks and marinas).
- **Recreation and Tourism Benefit Assessment.** Presents the economic benefits of the Locks as an asset used by motorized and non-motorized personal watercraft that also contributes to the expansion of guided recreation and tourism opportunities.
- **Cultural and Historic Significance Assessment.** Presents the importance of the Locks to the region's Native American tribes, describes the Locks' historic significance, and their role in efforts to preserve and interpret early Oregon industrial and transportation history and interactions with Willamette Falls.
- **Economic Development Benefit Assessment.** Presents the benefits the Locks provide for proposed and potential economic development projects in the vicinity of the Locks, and for communities upriver and downriver of the Locks.
- **Resiliency Benefit Assessment.** Presents the benefits of the Locks as an additional or alternative transportation route after an earthquake or other disaster damages the region's transportation infrastructure.
- **Cost Assessment.** Presents estimated operations and maintenance costs of running the Locks on a regular, year-round basis.

Our assessment describes benefits and costs associated with three scenarios.

- A **Baseline** scenario assumes that the Locks are decommissioned in such a way that precludes future navigational use.
- A **Public Operations** scenario assumes public ownership and operation of the Locks for both public and private use and benefits.
- A **Private Operations** scenario assumes private ownership and operation of the Locks for private use and benefit.

*This analysis provides information about the types of considerations Congress recently instructed the Corps to consider in disposition studies. In section 1165 of the Water Infrastructure Improvements for the Nation Act, passed into law in December of 2016, Congress stipulated that disposition studies should address "the extent to which the property concerned has economic, cultural, historic, or recreational significance or impacts at the national, state, or local level."

This report summarizes the findings of our assessment. Appendices A through F provide technical memos that document the assumptions, data sources, and results of our assessment.

- Appendix A describes the scenarios
- Appendix B describes the costs of each scenario
- Appendices C through E provide the details of our transportation, recreation/tourism, and economic-development assessments
- Appendix F provides a complete list of the individuals consulted for our assessment

Willamette Falls Locks Timeline

Pre-1850	Native people live, travel through, and gather at Willamette Falls.		
1850's	**1858:** Willamette Falls Canal & Locks Company is established with intent to build a canal around Willamette Falls.		
1870's	**1872:** Construction begins on WFL.	**1873:** Open for business January 1.	
1880's	**1889:** Paper mill established.		
1910's	**1915:** USACE purchases WFL from Portland Railway Light and Power Co.	**1916:** USACE deepens the canal from 2' to 6'.	
1940's	**1940:** USACE upgrades WFL.	**1941:** WFL upgrades from manual operation to hydraulic operation.	
1970's	**1974:** Listed on the National Register of Historic Places.		
1990's	**1991:** Designated as a State Historic Civil Engineering Landmark by the American Society of Civil Engineers.	**1997:** West Linn Paper discontinues its use of WFL.	**1999:** Willamette River named American Heritage River.
2000's	**2001:** Transition from 365-day operation to seasonal schedule.*	**2002:** Willamette Falls Heritage Foundation organized by volunteers to advocate for WFL.	
	2004: First of six "Lock Fests" held to advocate for preservation and funding, and the first Congressional earmark for seasonal operations.	**2005:** USACE moves WFL to "Caretaker Status" with limited funding for maintenance, and Congressional earmark extended to maintain seasonal operations.	
	2006-2007: Seasonal operations supported with federal grant and local funds from Clackamas County and ODOT.		
	2008-2009: WFL closed for overdue inspections and repairs. Repairs funded by the American Recovery and Reinvestment Act of 2009.		
	2010: Last year of seasonal operations funded through Congressional earmark.	**2011:** USACE designated the status of WFL as "non-operational"; limited lockages for commercial traffic allowed until December.	
	2013: Special lockages for Canby Ferry (last lockage to date).		
	2014: Last Lock Fest held to date.	**2015:** Willamette Falls Locks Working Group established to build support for reopening WFL.	
	2016: First meeting of the State Locks Task Force to study and develop a plan for the sustainable operation of WFL.	**2017:** USACE releases Disposition Study; Oregon Legislature creates the Willamette Falls Locks Commission (to convene in 2018).	

* This date is unconfirmed: seasonal operation may have begun as early as 1999. https://www.willamettefalls.org/history-of- the-locks

TRANSPORTATION BENEFITS

Key Takeaway: Total transportation-related benefits of reopening the Locks over 30 years of future operations ranges from approximately $12 million to $49 million (2017 dollars).

This assessment estimates the cost savings for transportation-related activities that could result from reopening the Locks. These include the savings on transportation costs of moving commodities by barge on the Willamette River and through the Locks versus transporting commodities by truck. We also estimate the reduced cost of mooring barges and related vessels upriver of the Locks versus the costs of mooring these vessels in the Portland Harbor area. Reopening the Locks would also help reduce construction costs for in-water work on docks and other water-related infrastructure along the Willamette River above the Locks. We estimate these cost savings as well.

These benefits vary by scenario. Under the baseline scenario, none of these benefits would materialize. Under the public ownership scenario, all would materialize with some variation in magnitude, depending on operating schedule. Benefits under the private operating scenario would depend on the operator's activities, but presumably they would generate some of the benefits described in this section.

Barging Advantages	Barging Disadvantages
Larger capacity yet lower transportation costs per ton-mile. ■ Barges operate with engines of comparable size and power to trucks, but can move much greater tonnage per engine. Fewer trucks on the road and reduced traffic congestion. ■ One barge load is equivalent to 40 truckloads of aggregate. Fewer environmental pollutants produced. ■ Barging's larger transportation capacity per load reduces the total output of environmental pollutants. Lower accident rates. ■ Barging's larger capacity, fewer trips, and lower staffing levels reduce overall accident rates. Ability to ship bulky goods. ■ Barging's larger capacity and ease of loading and unloading provides superior ability to move bulky goods.	Longer transport times. ■ Barges operate at slower travel speeds and sometimes use longer, less direct routes. Limited flexibility of rerouting as needed. ■ Barges can only operate on waterways of sufficient depth. Limited capacity for quick turnaround scheduling. ■ Barges operate at slower travel speeds. Requires intermodal transfer facilities located adjacent to rivers. ■ Connecting barging with other transportation modes may require dedicated rail or truck access and loading and unloading facilities.

TRANSPORTATION BENEFITS OF MOVING COMMODITIES WITH BARGES

Our assessment of the cost savings for commodity transport began by identifying the commodities most likely to be transported by barge based on barging's advantages and disadvantages relative to truck and rail mode.*

We conducted a screening analysis of the commodities most likely to be transported through the reopened Locks, based on historical usage and current production patterns. These commodities included: aggregate; recycled metal and finished steel; wood pulp and finished paper products; logs; agricultural products; trash; and recycling. We found that barging's disadvantages or other limitations would likely prevent all but aggregate from moving through the Locks, at least initially after the Locks reopening. Table 1 presents our reasoning for this conclusion, by commodity.

*Likely beneficiary companies include Wilsonville Concrete Products and CalPortland Company, Inc.

Table 1. Summary of Screening Analysis Results for Commodities that Could Be Transported Through the Locks

Commodity	Included in Analysis?	Findings of Screening Analysis
Aggregate[11]	Yes	Factors that support moving aggregate through the Locks soon after reopening include: ■ There is a long history of moving aggregate through the Locks ■ Barges currently move aggregate throughout the lower Willamette River below the Locks ■ The barges, dredges, and tugs that move gravel on the lower river will fit in the Locks ■ The larger grained aggregate from mines above the Locks is desirable for construction projects throughout the Portland area
Recycled Metal and Finished Steel Products	No	Limitations that would need to be addressed before moving metal and steel products through the Locks include: ■ Constructing an intermodal rail-barge transfer facility in the Newberg area ■ Constructing a rail spur that connects the intermodal facility with the rail line that serves the Cascade Steel Rolling Mill in McMinnville, at $1 million to $2 million per mile ■ Determining if barging could provide adequate capacity for scrap metal and finished steel products on a delivery schedule that matches the Cascade mill's requirements
Wood Pulp and Finished Paper Products	No	The recent closure of the West Linn Paper Mill makes moot at this time the question of the potential transportation benefits to the mill of reopening the Locks. Should the mill reopen, however, constraints exist that would limit the feasibility of the mill switching from trucking to barge. These limitations include: ■ Constructing new loading infrastructure ■ Loading and unloading barges in the Port of Portland would probably require employing longshoremen, which would increase labor costs relative to trucking ■ There would be additional transport handling steps and costs relative to trucking ■ Determining if barging could provide adequate capacity for wood pulp and finished paper products on a schedule that matches the paper mill's requirements
Logs **Agricultural Products** **Trash** **Recycling**	No	Limitations that would need to be addressed before moving these commodities through the Locks include: ■ Identifying and purchasing suitable properties for intermodal transfer facilities on the Willamette River upriver from the Locks that would connect road, rail, and barge transportation modes ■ Building and operating the intermodal facilities ■ Determining if barging could provide adequate capacity on schedules that meet the needs of producers and shippers

Transportation Cost Savings and Environmental and Congestion Benefits

We estimated the cost savings of switching a small percentage of aggregate currently mined in counties that border the Willamette River from truck to barge.* We also estimated the economic value of environmental benefits of such a switch regarding impacts on the production of transportation-related greenhouse gases and air pollutants.

We developed three aggregate scenarios:

1. Moving aggregate from the Santosh aggregate mine in Scappoose, Oregon to the Wilsonville Concrete Products (WCP) plant in Wilsonville, Oregon (see Exhibit 1). This would facilitate mixing finer grain aggregate from the Santosh mine with coarser grain aggregate from WCP and CalPortland facilities when making concrete.
2. Moving aggregate from the Santosh aggregate mine to the CalPortland facility in Newberg, Oregon.
3. Moving aggregate from the WCP's Wilsonville facility during remediation of the Portland Harbor Superfund site. Coarser grain aggregate from the Wilsonville facility is preferred for capping contaminated sediment in riverbeds.[12]

For the three scenarios, we estimated the costs of moving aggregate by barge and by truck, and calculated the transportation benefits as the cost savings of moving aggregate by barge. Barging, in general, is a much more efficient method of shipping aggregate compared with trucking.

- Shipping by barge reduces transportation costs by 18 percent relative to shipping by truck.
- One barge has the capacity of 40 truckloads of aggregate.
- Moving the quantities of aggregate in our scenarios described above would remove approximately 80,000 to 220,000 truck trips from Portland-area roadways over 30 years of Locks operations (see Figure 4).

Shifting commodity movements from truck to barging yields environmental benefits in the form of reduced production of greenhouse gases and air pollutants including CO_2 and NO_X. Shifting aggregate transport from trucking to barging would reduce the production of CO_2 by 46 percent, with a total reduction of approximately 11,000 to 32,000 metric tons (see Figure 5).

*Less than 1 percent of aggregate mined in Clackamas, Marion, Multnomah, and Yamhill Counties in 2015.

Figure 4. Total Truck and Barge Trips Over 30 Years

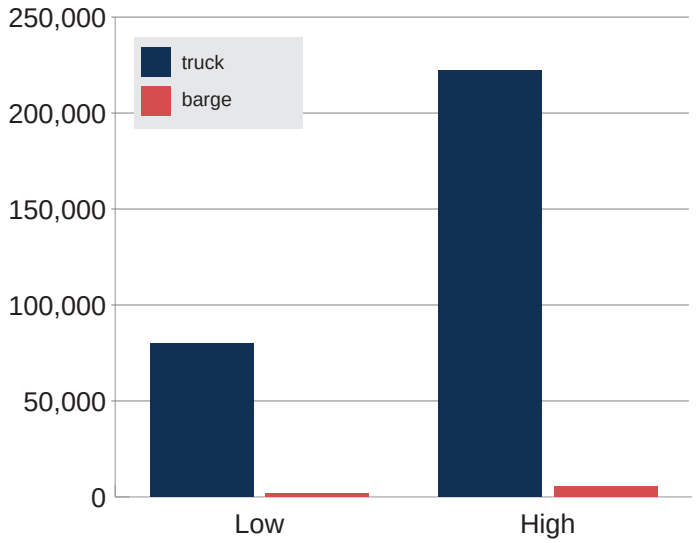
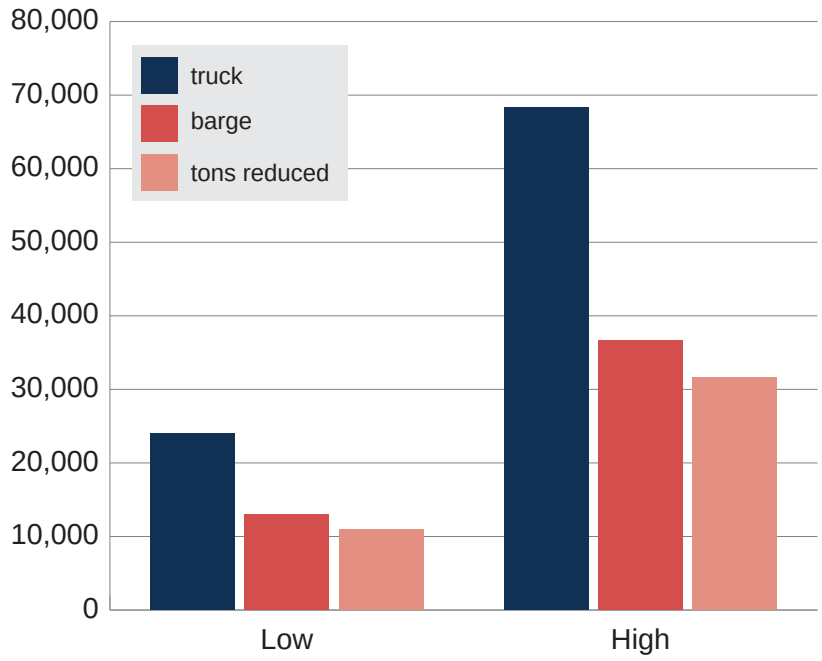
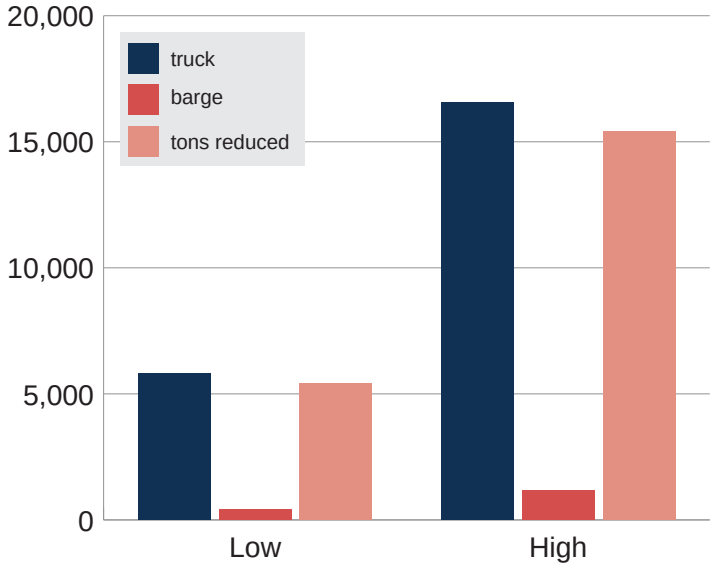


Figure 5. Metric Tons of CO_2 Produced Over 30 Years



Similarly, barging reduces the production of NO_x by 93 percent over 30 years, with a total reduction of approximately 5,400 to 15,400 metric tons (see Figure 6).

Figure 6. Metric Tons of NO_x Produced Over 30 Years



We estimate the economic value of reduced production of greenhouse gases and air pollutants based on the economic value of damages that these gases cause in the form of reduced agricultural productivity, human health effects, property damages from increased flood risks, and related costs.[13]

We estimate the total transportation benefit of barging aggregate, based on transportation cost savings and avoided costs associated with greenhouse gasses and air pollutants over 30 years of Locks operations, at between approximately $2.5 million and $7 million (in 2017 dollars).

Exhibit 1. Regional Context for Aggregate Barging Scenarios

Source: ECONorthwest

Moorage Benefits

Businesses such as Wilsonville Concrete Products (WCP) that operate commercial vessels on the Willamette River developed their business plans assuming access to their moorage facilities upriver of the Falls. These facilities are conveniently located adjacent to their processing plant in Wilsonville and many of the firm's workers lived in the vicinity. Closing the Locks forced WCP to find other moorage space downriver of the Locks or lose access to a significant portion of their business. Moorage in the Portland Harbor area is scarce and extremely expensive relative to WCP's moorage costs at its own facility on the Willamette River in Wilsonville. Moorage costs are higher because of lack of available moorage sites suitable for commercial barges and dredge,* higher fees charged by the Oregon Department of State Lands to occupy state water—which is based on assessed values of adjacent lands—and because WCP must pay rental fees that include costs for infrastructure and services that support their moorage. In addition to these costs, WCP's staff have a significantly longer commute from their homes to moorage sites in the Portland harbor area where WCP moors their vessels.

Reopening the Locks would allow barges, dredges, and tugs owned by WCP that are currently moored in the Portland Harbor area to move to WCP's moorage site in Wilsonville above the Locks. We estimated the moorage benefit based on WCP's current moorage costs in the Portland area and on the moorage costs they would pay if they could access their moorage sites adjacent to their Wilsonville facility. We calculate the moorage benefits over 30 years as the difference in these costs.

We estimate that the total moorage benefits over 30 years of Locks operations ranges from approximately $8 million to $40 million (in 2017 dollars).

In-Water Construction Benefits

A number of companies provide in-water construction services along the Willamette River, above and below the Locks. Barges with pile drivers and related equipment move up and down the river (typically during summer months), installing piles for existing or new docks and moorages at marinas and private residences. With the closure of the Locks, equipment and barges must be trucked above the Locks for work on the upper Willamette River. Reopening the Locks would allow contractors to revert to barging equipment upriver through the Locks, thus reducing their costs of operations relative to current conditions that requires additional trucking and handling costs.

We estimate that the total cost savings for in-water construction services upriver of the Falls over 30 years of Locks operations is approximately $1.2 million (in 2017 dollars).

SUMMARY OF TRANSPORTATION-RELATED BENEFITS

We summarize the results of our analysis of the transportation-related benefits over 30 years of reopening the Locks in Table 2. It includes the benefits described in each category above that we were able to quantify in monetary terms. The total benefits range from approximately $12 million to $49 million (in 2017 dollars).

Table 2. Transportation-Related Quantified Benefits of Locks Operations Over 30 Years (in 2017 dollars)

Benefit Category	Low Estimate	High Estimate
Transportation Cost Savings and Environmental and Congestion Benefits	$2.5 million	$7.0 million
Moorage Benefits	$8.1 million	$40.4 million
In-Water Construction Benefits	$1.2 million	$1.2 million
Total Transportation-Related Quantified Benefits	**$11.7 million**	**$48.5 million**

Totals may not sum due to rounding.
Source: ECONorthwest

Total transportation-related benefits over 30 years of Locks operations would likely exceed our totals in Table 2 for the following reasons:

- Actual transportation cost savings could be higher, if a larger quantity of aggregate moves through the Locks, or if other commodities begin to move through the Locks over time as businesses adapt to future predictability and certainty in Locks operations.
- We have not accounted for the benefits and cost savings of moving oversized cargo (e.g., the Spruce Goose) by barge rather than by truck or rail. In some cases, barging may be the only alternative given the size of the cargo.

*A phone survey of moorage and industrial sites in the Portland area and downriver to Longview found no moorage space available on a regular basis suitable for the commercial barges that WCP operates.

- Three ferries that operate upstream of the Falls will one day need to be replaced. If the Locks are not operational, replacing them may not be possible or would be more expensive.
- Complying with mandatory U.S. Coast Guard inspections for the three ferries and the Willamette Queen paddle wheeler that operates in the Salem area is more expensive because they cannot access boatyards in the Portland area.

Tug and barge on the Williamette River, Portland, OR. *Courtesy of John D, via Wikimedia.*

RECREATION AND TOURISM BENEFITS

Key Takeaways: Recreation and tourism activities associated with the Locks would resume immediately after reopening, and likely would expand beyond historical use. Quantified benefits associated with recreation, including guided overnight cruises and use by personal watercraft (e.g., motor boats and canoes) range from about $12 million to over $50 million (in 2017 dollars) over 30 years. Guided day tours, on-site visitation, and future tourism bolstered by potential development plans would all generate additional benefits beyond those quantified above.

People have moved through the Locks for recreation and tourism since their construction.[14] In the early days, steamboats transported people between Portland and the Willamette Valley for business and pleasure. As early as the first half of the twentieth century, the Locks were a draw for pleasure boaters in small recreational boats. As commercial traffic through the Locks waned in the last few decades of the twentieth century, recreational use of the Locks increased from guided river tours, paddlers traversing the Willamette River, and recreational boat owners from both upstream and downstream of the Locks. Our assessment of the recreation and tourism use of the Locks addresses the potential benefits from reopening the Locks across four categories, shown in Table 3.

Table 3. Summary of Recreation and Tourism Benefits

Use Category	Potential Benefits
Non-Motorized Watercraft. Owners of kayaks, canoes, and other human-powered, in-water recreational modes. Includes both local and non-local participants.	■ Increased value of a continuous paddle on the Willamette River Water Trail ■ Reduced cost of portage for through-paddles on the Willamette River Water Trail ■ Increased value of paddling through the Locks, a unique experience
Motorized Watercraft. Owners of motorized boats of all sizes	■ Increased value of connection between upper and lower Willamette River ■ Potential reduced cost of boat ownership for boats located above the Locks ■ Increased value of traversing through the Locks, a unique experience
Guided Day Tours. Operators of and participants in water-based guided tours that include the Locks	■ Increased value and revenue associated with through-Locks tours compared to existing offerings ■ Increased opportunities for cross-marketing with other regional tourism experiences
Guided Overnight Tours. Operators of and participants in hotel barge cruises to Oregon's wine country	■ Increased value and revenue associated with tours, not currently offered ■ Increased visibility and international interest in Oregon's wine country may lead to expanded revenue for the broader tourism industry.

They vary by scenario. Under the baseline scenario none of these benefits would materialize. Under the public ownership scenario, all would materialize, with some variation in magnitude, depending on operating schedule. Under the private operating scenarios, it is unlikely that these benefits would materialize, because allowing recreational use would require a private owner to operate the Locks on a predictable schedule and carry more insurance, without receiving additional compensation to cover these costs.

NON-MOTORIZED WATERCRAFT USERS

This category of use includes people who would travel through the Locks in canoes, kayaks, and rafts. Passage through the Locks could be part of a short-distance or long-distance trip. Though data on use of specific waterbodies in Oregon does not exist, there is clear demand for this kind of recreation in the area. Approximately 10 percent of the population in the regions that roughly correspond to the Willamette River watershed reported participating in flatwater rowing, paddling, tubing, and floating in 2011, the most recent year data were available.[15]

Local businesses have developed in the area that cater to people wanting to experience Willamette Falls and the natural area upstream of the falls up close, including eNRG Kayaking in Oregon City. On any summer day or evening, dozens of paddlers explore the flatwater below and above the falls, and over the course of the year, well over a thousand paddlers likely experience the immediate area upstream and downstream of the Falls.[16]

An operational Locks likely would increase the value of this area as a local trip destination, because paddlers could combine trips above and below the Falls, linking two beautiful natural destinations with Locks passage that would increase the diversity and points of interest of the trip.

Reopening the Locks would also have benefits for long-distance trips. There is growing interest locally and internationally in long-distance trips on the Willamette Water Trail, a paddle that begins in the upper reaches of the Willamette River and ends at its confluence with the Columbia downstream of Portland. The Willamette Water Trail is one of only 20 National Water Trails in the U.S., and Willamette Riverkeeper mails trail maps all over the U.S., Canada, and internationally. Interest has been growing from people wanting to complete the entire trail: dozens of people inquire directly to Willamette Riverkeeper about how to portage around the Falls every year. eNRG Kayaking also receives a half-dozen similar calls per year.

Left: Boaters returning from Steamboat Day at Champoeg in 1939. *Courtesy of the Clackamas County Historical Society.* Right: Corvallis-to-Portland Regatta sculling event. *Courtesy of Sandy Carter.*

The value the Locks would provide in completing the trail and avoiding an expensive, time-consuming, and interruptive portage cannot be understated. As with local trips, reopening the Locks would likely increase use of the entire length of the Willamette River Trail. Completing the entire trail without interruption likely would also increase the value that users place on the experience.

The total value of a day of paddling can be measured as the sum of two values: what people actually spend to participate (e.g., kayak rental or purchase, gas to drive to boat launch, etc.) and the extra amount people would have been willing to spend to participate. **Being able to paddle through an operational Locks would generate benefits to local businesses by increasing the number of people interested in paddling, the amount they are willing to spend for the trip, and the enjoyment they receive from the trip over and above what they would have been willing to pay.**

Data are not available to quantify exactly how many additional people may use the Locks for recreational purposes, how much they might spend above what they currently spend (assuming they are already taking the trip), and how much additional enjoyment they

get out of the trip. In the absence of data, we developed assumptions that allow us to model the potential benefits associated with use of the Locks by motorized and non-motorized watercraft users. The sidebar outlines our assumptions and results.

MOTORIZED WATERCRAFT USERS

Many of the benefits described above for non-motorized personal watercraft apply to users in motorized boats. Again, data on use of specific waterbodies in Oregon does not exist, however there is clear demand for motorized boating in the area. Approximately 15 percent of the population in the regions that roughly correspond to the Willamette River watershed reported participating in power boating in 2011, the most recent year data were available.[17] Although the number of boats registered in the five-county area surrounding the Locks has declined by about one percent per year since 2000,[18] demand for recreational moorage at the Boones Ferry Marina, the only public marina upstream of the Locks, has been increasing each year. The marina provides 105 in-water moorage spaces, and 22 on-land boatports. Moorage has sold out for the summer season and waiting lists build a year in advance of the season, with people paying $500 just to be included on the waitlist.[19] Sportcraft Marina immediately downstream of the Falls also reports robust demand for moorage facilities.

As with paddling, the Locks would provide for a longer, more diverse experience that users may value more highly. Reopening the Locks would also improve access to more points of interest, especially for boaters who typically moor their boats above the Falls. This could yield more trips per year, and more valuable trips, both a direct benefit of the Locks. The sidebar outlines our assumptions and results quantifying the benefits associated with use of the Locks by motorized and non-motorized watercraft users.

GUIDED DAY TRIPS

Reopening the Locks would expand the range of opportunities currently available for guided day trips on the Willamette River. Multiple tour operators have historically used the Locks to facilitate river tours in the area, and many tour operators continue to use the area, stopping at the Falls and the lower Lock chambers:

- Willamette Jetboat Excursions offers trips from downtown Portland to Willamette Falls, with views of the lower Lock chamber a highlight of the trip.
- Portland Spirit also offers a three-hour cruise to the base of the falls from May through October. Prior to WFL closure in 2011, Portland Spirit ran test cruises of a jetboat trip from Portland to Champoeg Park.
- Wy'East Expeditions, which ran school tours for 30 years through the Locks in the Talapas, a replica Native American dugout canoe, has shifted operations for all four of its boats to other locations on the Willamette and Columbia Rivers. Given the historical popularity and importance of the WFL cruise over the years, it is likely at least some through-Locks cruises would resume immediately.[20]
- eNRG Kayaking runs guided tours, classes, and kids' camps on the Willamette River below and above the Falls. Annual participation in these various guided trips that currently utilize the river below the Falls numbers in the thousands, if not more, and supports revenues for these businesses in the hundreds of thousands of dollars, conservatively.

Tours through the Locks would begin immediately upon reopening. Not all of the existing tour activity would incorporate a through-lock experience, because the lockage

Quantified Benefits to Personal Watercraft Users

To quantify the benefit associated with motorized and non-motorized watercraft users traveling through the Locks, we assumed that recreational traffic through the Locks would resume at levels similar to the 2000 peak reported in the Corps' recreational lockage data, which was 1,299 boats per year. We adjusted this number of boats to account for population growth and likely increase in demand since 2000. Based on lockage fees and similar access fees in place elsewhere in Canada and the U.S., people are willing to pay at least $5 and up to $20, which is an indication of the value they place on the experience of locking through. **Based on our analysis, over 30 years, recreational boaters would enjoy a benefit of between $600,000 and $2.4 million to be able to travel through the Locks. (2017 dollars)**

itself (up and down) adds over an hour to a trip. But some existing tours would be expanded and new tours would be created. It is likely, given the expanded length and unique experience, that tour operators would charge more for these tours, increasing their revenue. Customers, too, would enjoy benefits, as many of them would likely receive benefits from the experience above and beyond their willingness to pay for the trip. It is not possible, given information available at this time, to quantify the potential increase in trip offerings, demand for trips, or the new revenue and value associated with them. But the changes in participation, revenue to business owners, and additional value to participants, would likely be net positive.

GUIDED OVERNIGHT TOURS

Overnight tours did not occur through the Locks prior to their closure. However, at their closure, there was interest in replicating a model for overnight barge cruises through Oregon's wine country, which has proven successful in Europe. Since the closure of the Locks, overnight and week-long cruises have become popular on the Columbia River, suggesting there is a market for this kind of tourism in Oregon already. Driven by a limited supply of lodging, and especially luxury lodging in Oregon's wine country (limited primarily by land use laws), and an increasing profile and awareness of Oregon's wine country, hotel barge cruises could fit into an almost-certain pipeline of demand.

Prior to the Locks' permanent closure in 2011, several factors limited the development of this opportunity, including uncertainty of future Locks operation and prohibitions on overnight moorage and passenger access for commercial boats in Portland. The latter restrictions are in the process of being relaxed through changes to the City's Greenway Code, as part of the City's Central City 2035 planning effort, which should be finalized in Spring 2018. If the Locks were to reopen, this new type of business almost certainly would be developed. Assuming regulatory hurdles are lifted, no other technical reasons exist why operations could not begin within a short timeframe. For example, a cruise could begin in downtown Portland, and travel up through the Locks to Newberg, providing potential interpretive stops along the way. A land-based tour would take people through wine country, and return to the boat. The barge would return to downtown Portland through the Locks to complete the trip, which could be as short as two days, or longer if more side trips were included.

The Hotel Barge L'Impressionniste on the Burgundy Canal in France. *Courtesy of Oliver Barge, via Wikimedia.*

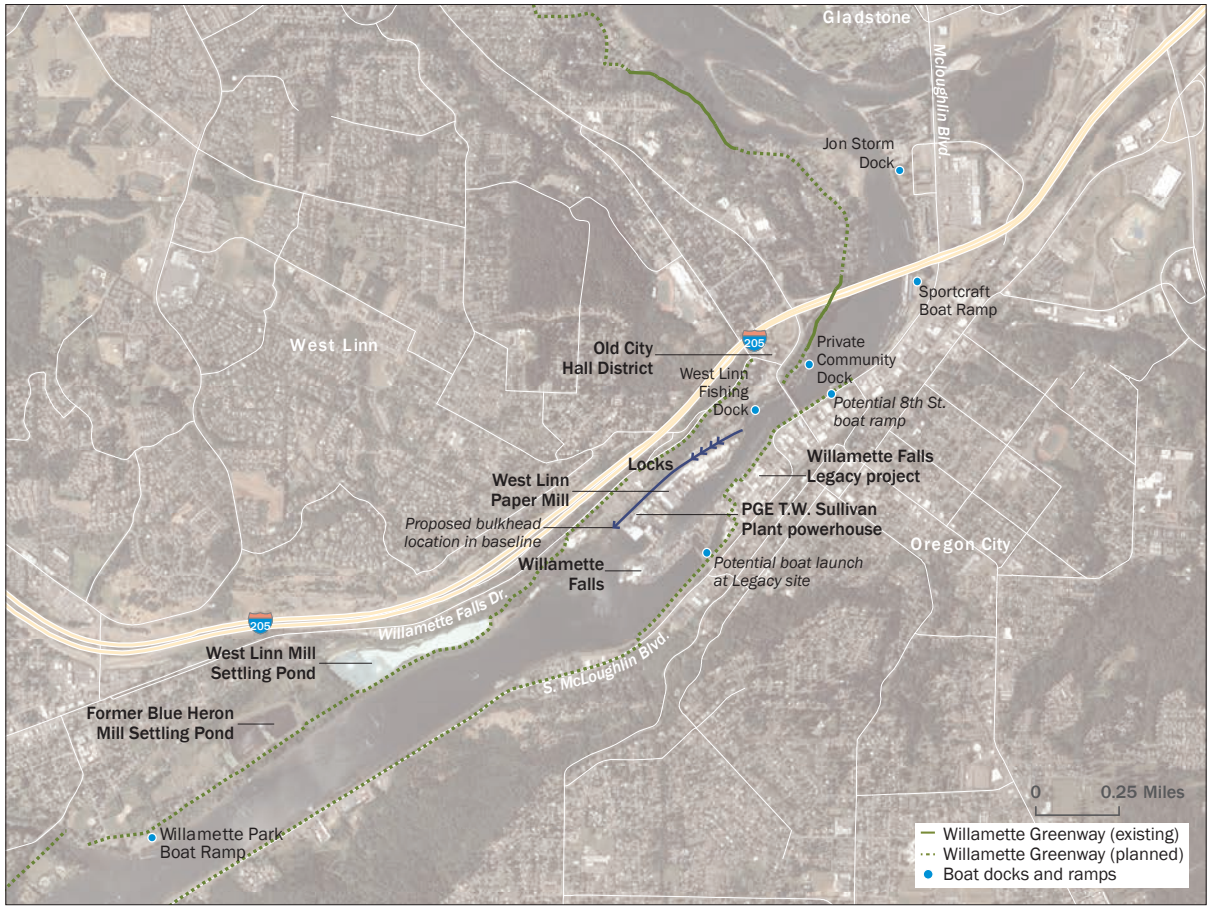
Because this type of operation could represent a substantial benefit of reopening the Locks, and would only be developed if the Locks are operating, we modeled operating scenarios based on European operations of similar cruises to estimate potential revenue over 30 years. Our assumptions are described in detail in Appendix D. Using what we believe are conservative assumptions about number of trips and rates, we estimate the benefit arising from guided

overnight trips, measured in terms of revenue over 30 years, ranges from approximately $12 to $48 million (in 2017 dollars).

NON-WATER-BASED RECREATION AND TOURISM

Recreation and tourism in the area surrounding the Locks is currently limited to the in-water recreation described above, to local parks, and to a widely distributed and diverse set of historical museums and attractions in Oregon City and West Linn. Reopening the Locks would restore public access to the Locks grounds, and potentially the historic museum that is located onsite. However, the impact this would have in terms of number of visitors or economic benefit (measured in terms of local spending or value enjoyed by the visitor) is uncertain. It likely would be positive, but under current conditions in which the Locks site and interpretive value is underdeveloped, the effect would likely be small. Looking forward to potential redevelopment possibilities described in more detail in the next section, reopening the Locks would work synergistically to enhance the value and economic potential of local redevelopment plans.

Exhibit 2. Key Recreation Features in the Local Area Surrounding the Locks



Source: ECONorthwest

DEVELOPMENT BENEFITS

Key Takeaways: The sites immediately adjacent to the Locks, the West Linn Paper Mill and the Willamette Falls Legacy Project, will have the greatest potential development benefits from a reopened Locks. All of the riverfront sites near the Locks face significant infrastructure and market barriers to redevelopment that will require public-private partnerships to overcome. Redevelopment sites in the cities of Wilsonville and Newberg are most likely to capitalize on increased access to Portland, particularly if there are new overnight tourist boats that visit those locations.

Our assessment of the development benefits of reopening the Locks looked qualitatively at the potential for opportunity sites upriver, downriver, and near the Locks, to capitalize on the transportation and recreational benefits of a reopened Locks. In addition, we considered the Locks as an amenity for the possible redevelopment sites in closest proximity to the facility. Reopening the Locks would provide an amenity that supports the broad goals of the Willamette Falls Heritage area. Our redevelopment analysis started with a series of interviews and small group meetings with local jurisdictions, stakeholders, and property owners.[21]

To qualitatively describe the benefits of the Locks, we developed a framework for thinking about the redevelopment impacts for the future of the Willamette Falls Locks (shown in Table 4). This framework summarizes the type of impact, potential benefits, and affected jurisdictions and sites.

Table 4. Summary of Redevelopment Impacts

Impact Type	Potential Benefits	Jurisdictions	Specific Sites
Local Impacts. Benefits of the Locks as an amenity that would drive traffic and interest to the West Linn Waterfront area.	■ Property values ■ Access to local sites ■ Historical value, including visibility ■ Immediate tourism impacts, including related to Willamette Falls Heritage Area	West Linn	■ Waterfront, including Old City Hall District, Pond Redevelopment District, and Industrial Redevelopment District ■ West Linn Paper Mill
		Oregon City	■ Willamette Falls Legacy Site ■ Downtown Oregon City redevelopment sites
Upriver Impacts. How transportation benefits can translate into redevelopment opportunities, including the potential for tourists to access riverfront sites coming on boat tours or in private boats from Portland.	■ Tourism related to Heritage Area ■ Access to downriver areas, including Portland capitalized into land values ■ Industrial site development	Canby	■ City-owned riverfront property
		Newberg	■ Closed SP Fiber Tech. Mill
		Wilsonville	■ Arrowhead Master Plan ■ Boones Ferry Master Plan area
Downriver Impacts. How redevelopment areas downriver from the Locks could capitalize on better access to upriver areas.	■ Tourism related to Heritage Area ■ Access to upriver areas	Lake Oswego	■ Foothills District
		Milwaukie	■ Downtown redevelopment sites surrounding Waterfront Park

LOCAL IMPACTS

The West Linn Paper Company property and the sites closest to it would see the greatest impacts from the reopening of the Locks. The West Linn Paper Company spans several Company-owned properties on the riverbank and Portland General Electric (PGE)-owned properties on Moore Island. While PGE is the main landowner in this area, the West Linn Paper Company, the Oregon Department of Fish and Wildlife, and the Corps also have facilities or interests in the area. Each of these entities has easements that allow access to their respective facilities across paper mill or Corps-owned property. According to a 2008 CEDER report that examined disposition options, these easement relationships are complicated and not well documented.

Table 5 summarizes development considerations and benefits of an operating Locks for each of the key sites shown in the overview map in Exhibit 3.[22]

Exhibit 3. Locks and Surrounding Properties Overview

[1]*Property ownership shading is based on Metro's Regional Land Information System, current as of August 2017. Actual property ownership delineation may differ somewhat, and alignment with other map features is approximate.*

Source: ECONorthwest

Table 5. Development Benefits at West Linn Paper Mill and Surrounding Properties

	Development Considerations	Benefits to Site of Operating Locks
A. Vacant Mill—A Building on PGE-owned Land	■ Historic buildings will require improvements to address seismic danger as well as failing roof infrastructure ■ Pedestrian and vehicular access challenges, likely requiring large capital investments to overcome. Options for visitor access include a blufftop pedestrian bridge, cable ferry, or at-grade vehicle/pedestrian bridge ■ Potential brownfield considerations that would require additional environmental assessment ■ Safety issues for PGE employees and visitors to the site ■ Seismic issues, if improvements are not made to address seepage and subsidence that has occurred at the edge of the Locks ■ Potential easement/property ownership issues unless clearly spelled out in lease agreement ■ If existing mill closes permanently, potential to master plan for the whole island and surrounding properties	■ Attract visitors to the site by providing key destination and focal point for the area ■ Capital investment at the Locks could address issues with seepage and subsidence ■ If the Mill were to close permanently, an operational Locks facility would provide visitor interest and a focal point for a redeveloped mill district ■ Potential synergy with Willamette Falls Legacy Project redevelopment efforts ■ Potential to attract visitors to the museum and watch the Locks in action ■ More attractive area with the potential for retail and recreational facilities, possibly housing ■ Could be tied into development concept for Mill A building, including pedestrian bridge across the Locks
B. Existing Mill—West Linn Paper Company Potentially Active Mill Buildings on PGE-owned Land	■ The drawbridge is in disrepair and needs to be replaced ■ If the mill closes permanently, it is likely the site could see some redevelopment, likely in concert with Mill A, the Locks properties, and the Willamette Falls Legacy site ■ Buildings would need to be assessed for reuse or removal ■ Potential for long-term pedestrian connection to Willamette Falls Legacy project	
C. Former Locks/Corps of Engineers Building and Museum	■ Potential rehabilitation and possible adaptive reuse of underutilized buildings ■ Potential to integrate this area with West Linn waterfront planning pedestrian and bicycle connections	
D. West Linn Paper Company Land and Parking Areas	■ The most promising development sites are parking lots and staging areas on top of the bluff near the Old City Hall District. These sites have visibility from Willamette Falls Drive and fit into the existing district ■ Lower sites could see potential development on the parking lots or adaptive reuse of the former mill office	

West Linn

The City of West Linn is starting a master planning process for the 2.5 mile stretch of waterfront between Arch Bridge (below the Falls) and the Former Blue Heron Mill Settling Pond (above the Falls). The plan is in progress, with a targeted completion date of 2018 to 2019. The purpose of this plan will be to "create a vision for future land uses and activities, based on both the past 30 years of planning/analysis work and current community values and aspirations."[23] This work will include transportation planning on Willamette Falls Drive, as well as planning for the creation of a multi-use path that would likely go along the bluff, using city easements near the settling ponds. There are several sites that could see redevelopment over the coming years within the waterfront master planning study area. The plan breaks the study area into three subareas:

- **The Old City Hall District.** Centered around the former City Hall at the intersection of Mill Street and Willamette Drive, this district faces a lack of parking availability and many transportation challenges, due to the presence of two state highways, ramps, freight routes, and city arterial routes.
- **Industrial Redevelopment District.** Though the future of the West Linn Paper Company is in flux, the plan will consider redevelopment options for other sites in the area which are currently underutilized and could be better integrated into the broader waterfront planning area. It is likely that the future of the West Linn Paper Company facilities will be better known when the Master Plan is complete. This area is described in more detail in the previous section.
- **Pond Redevelopment District.** At the upriver end of the study area, there are two settling ponds that could see redevelopment: the Blue Heron Pond and Mill Site pond. While most of the land in this area is located in the floodplain or in a wetland, these two ponds are not located in a sensitive area. These ponds could see redevelopment ranging from informal open space, formal parkland, to redevelopment into industrial, residential, or commercial pads.

A functioning Locks provides the greatest benefit to sites immediately adjacent to the facility, since an active facility would provide a focal point for West Linn's portion of the Willamette Falls Heritage Area. City of West Linn Staff recognized the opportunity for better planning on both sides of the river, to best catalyze redevelopment on the Oregon City and West Linn waterfronts. The Locks provide a historic amenity that would serve as a draw for visitors to redeveloped sites near the Locks at the bottom of the bluff.

Oregon City

WILLAMETTE FALLS LEGACY PROJECT AND OTHER DEVELOPMENT SITES

The Willamette Falls Legacy project is a partnership between four entities (Oregon City, Clackamas County, Metro, and the State of Oregon) to revitalize the former Blue Heron Paper Mill in Oregon City after its closure in 2011. While these partners were working on a framework plan for the site, it was purchased in 2014 by a private developer. Initial planning efforts have included development studies and the design of a public riverwalk that would provide the public with close-up views of Willamette Falls and potentially catalyze redevelopment of the site. Long-term public improvements include a pedestrian connection across the river to the West Linn Paper Mill site, which received broad public support throughout the framework planning process.

Staff at the City of Oregon City cited public support for the reopening of the Locks. The main benefit to the Legacy site of a functioning Locks would be the combined impacts associated with a vibrant Willamette Falls Heritage area. A functioning Locks would provide synergy with the historic preservation on the Legacy site, given that historic and cultural interpretation is one of the four core values of the Legacy project. In terms of these benefits, interviewees stressed that the Locks serve as one critical part of an array of historic resources that contribute to the heritage area. A functioning Locks could also enhance development interest by providing boat access to the upriver part of the Legacy site (above the Falls). A functioning Locks could also enhance development interest by providing boat access to the upriver part of the Legacy site (above the Falls). A functioning Locks would also provide a better connection for non-motorized boats upriver and downriver of the Falls. Identified as part of the framework plan, the site includes a portage connection through the site for non-motorized boaters.

Canby

The City of Canby has little river frontage that would be suitable for new, river-oriented development. However, downtown Canby is

seeing more development activity, including the Civic Block development, as well as the possible reuse of the library building and the Parsons Pharmacy. Access to the river contributes to local quality of life and can help to attract new residents. The Comprehensive Plan includes public access to the Willamette River as a key goal, including access for non-motorized boats. Besides the Canby Ferry, the City has no manufacturers or businesses that rely on riverfront access.

The benefits of a functioning Locks for the City of Canby include the potential economic activity generated from tourist traffic coming from Portland to access Wine Country destinations, such as Newberg. City of Canby staff indicated that the ideal operating schedule would be three days per week, including one day on the weekend, to help the area build tourism and develop new ideas for river-related recreation.

Wilsonville

The City of Wilsonville is a vocal supporter of a reopened Willamette Falls Locks. The City is undergoing several efforts to provide greater public access to the river and increase opportunities for economic development in the City:

- **Potential Port of Wilsonville.** The City's adopted Transportation System Plan identifies the potential for a river-based port that would rely on the reopening of the Locks to move forward.
- **Boones Ferry Area.** Drawing upon previous master planning efforts, the City is in the process of considering a master plan for a residential and commercial area west of I-5 and north of the Willamette River that would explore strategies for river-oriented development and increased access to the river for non-motorized boaters.[24]
- **Arrowhead Master Plan (Area G and K).** The 2005 Comprehensive Plan cites the need for future planning in this 100-acre area to consider how to balance the mix of industrial, office, and farming uses and mitigate conflicts between non-compatible uses.[25] The City is considering a Master Plan for the area by 2019 that would explore how to best balance the area's mix of uses while attracting new development that would be oriented toward the river.

A functioning Locks would open up new opportunities for the City of Wilsonville for economic development, including allowing for the City to explore the concept of a potential Port of Wilsonville. Beyond the near-term benefits to Wilsonville businesses (including Wilsonville Concrete), the City could capitalize on new opportunities to attract tourists from downriver locations, including Portland.

Newberg

The City of Newberg is starting a new state-funded Riverfront Master Plan, updating the vision for the area now that the bypass around downtown has been completed. The plan centers around the 220-acre former WestRock paper mill site, and will look at market conditions, transportation infrastructure, river-related recreation, and zoning considerations. The paper mill site faces several challenges to redevelopment, including its location next to the City's wastewater treatment plant, lack of utility access, and challenging river access given that the site is 60 feet above the river on a bluff.

Staff at the City of Newberg indicated that planning efforts to date have not considered the role of the Locks as it relates to redevelopment. Staff did indicate that the Locks benefit boaters using Roger's Landing, a popular boat launch near the former mill property. Over the coming decade, the former WestRock paper mill site is likely to redevelop, likely as a mixed-use, river-oriented district. A functioning Locks could allow for traffic from downriver communities coming via the river, especially tourists. It could also allow for overnight moorages from Portland that take advantage of a vibrant tourist destination.

DOWNRIVER IMPACTS

Though downriver benefits are somewhat more limited, some sites downriver of the Locks would benefit from increased access to upriver sites. There are several areas downriver of the Locks that would see minor benefits of a Locks reopening.

The City of Milwaukie's riverfront has recently seen some improvements to Riverfront Park and City partnership opportunities on possible development sites, showing the City's commitment to community quality of life.

The City of Lake Oswego's riverfront is anchored by Foothills Park, which was completed in 2006. In 2012, the City completed a framework plan for the surrounding 107-acre industrial district with a private developer. However, the development stalled and there has not been redevelopment in the area. This area remains a river-oriented

LESSONS ON ECONOMIC DEVELOPMENT NEAR OTHER LOCKS

Ballard Locks (Seattle, WA). The Ballard Locks, operated by the U.S. Army Corps, are a popular tourist attraction in Seattle, attracting over 1 million visitors each year to see the fish ladder, tour the gardens, and view the facility. This includes 150,000 tourists who book cruises through the Locks annually. The Locks are next to the Burke Gilman Regional Trail, and many nearby residents visit the area for strolling, bicycling, and picnicking. The City's Community Development Plan for the area calls for the area to be maintained as a working waterfront. Many area businesses have taken on Locks-related names, including the Lockspot Cafe and the Lockhaven Marina.[26]

Fox River Locks (Appleton, WI). The nonprofit-operated Fox River Lock System consists of 17 locks over 39 miles from Lake Michigan to Lake Winnebago, and is one of the only fully restored, hand operated locks systems in the United States. In 2017, over 18,000 boats went through the locks, even though the locks are not fully navigable due to invasive species issues. A 2017 Economic Impact Study looked at the potential economic benefits of different operating scenarios, highlighting the impact of lock users docking and accessing local services. One of the scenarios also includes the addition of a visitor center as part of a mixed-use development in downtown Appleton. This facility would serve as a major attraction for downtown Appleton, and connect with multi-use paths and river-related development activity already occurring in Appleton, including a hotel and a taphouse.[27]

opportunity area for the City.

A tour group at the Ballard Locks. *Courtesy of Wikimedia Commons, MB298*

CULTURAL AND HISTORIC BENEFITS

Key Takeaways: Cultural and historic benefits are unquantifiable in monetary terms, but are clearly revealed by past and current actions to protect the Locks for current and future generations. These benefits are unquestionably important to a wide range of people, and are certain to materialize under the public ownership scenario.

Our assessment of the cultural and historic benefits of the Locks addresses the effects that reopening the Locks would have for the people who have lived with Willamette Falls since time immemorial, and for all people—current and future generations—who wish to understand and experience an important era in Oregon history. These benefits are summarized in Table 6. We address all of these benefits qualitatively, and they vary by scenario. Under the baseline scenario, none of these benefits would materialize. Under the public ownership scenario, all would materialize regardless of operating schedule. Under the private ownership scenario, assuming no special access arrangements are made, the only benefit that would materialize is historic preservation. However, by preserving the Locks in working order, the private ownership scenario would hold open the option that additional benefits could be realized if private ownership transitioned to public ownership at some point in the future.

Table 6. Summary of Cultural and Historic Benefits

Impact Category	Potential Benefits
Tribal Connection to History and Place	■ Access to Locks and grounds provides connection to a place the Tribes have inhabited since time immemorial. ■ Tribal members participated in Locks construction, provides connection to that history
Tribal Access to Ecological Resources	■ Operational Locks may provide easier access to some food and fiber resources traditionally used by Tribes.
Tribal Treaty Rights to Portage	■ Operational Locks with guaranteed public access would preserve treaty right to access route around Falls ■ Uncertainty of the ability to preserve this right increases with transfer from the Corps, uncertainty varies by scenario
Spiritual Connection with River	■ Locks provide a route around the Falls that most closely mimics traditional portage routes ■ Approach to the Falls and departure below the Falls is closely maintained with Locks
Historical Interpretation and Experience	■ Locks provide a unique experience to connect people directly with the history of the area ■ Locks attract a wider variety of people than otherwise may visit historic sites, broadening potentially exposed audience ■ Locks serve as a focal point where many aspects of Oregon's history intersect, potentially broadening people's understanding of the breadth of this history
Historic Preservation	■ Protects a recognized national landmark, with local, regional, and national importance

BENEFITS TO NATIVE PEOPLES

It is difficult to overstate the importance of Willamette Falls and its surroundings as a place that holds meaning for the region's Native American people. Tribal history in the area goes back at least 14,000 years. Tribal ethnographic information, such as creation stories and oral traditions, potentially points to an even earlier presence at Willamette Falls; the phrase *from time immemorial* is commonly used to describe Native American presence in the area.[28] The Falls served as an important place for collecting food and fiber, a place of spirit and ceremony, and as such, was a regional gathering place for people from across the Columbia Basin and beyond. Members of the region's Tribes still come to Willamette Falls to fish, collect resources, and conduct ceremonies.

Tribal members passing through the Canal during 2010 Lock Fest. *Courtesy of Willamette Falls Heritage Foundation.*

Tribal members still use canoes for trips down the Willamette River, for a variety of ceremonial and practical purposes. Traditionally, this trip would pause at what is now Canemah upstream of the Falls where the portage route began. Upstream canoes would be traded for downstream canoes here, or the people living on the banks of the river would provide portage services in exchange for other goods or services. When the Locks construction began, amid rapid industrial development of both sides of the river over several decades, Native people from the Grand Ronde Reservation and elsewhere were hired to help dig. Once the Locks opened, members of the various Tribes in the region used them instead of portaging around the Falls, which had become difficult or impossible with development and enforcement of (relatively) newly acquired property rights.

Focusing on the feature of the Locks itself (apart from the Falls and the rich cultural landscape surrounding it) is difficult and complicates the story because the Locks undoubtedly contributed to both the development and destruction of many cultural resources in the area. The Locks also potentially mitigated some of the destruction by providing access around the Falls. One important aspect of this mitigation is guaranteed access to the banks of the Willamette River for portage around the Falls, as promised in the treaty between the United States and the Confederated Tribes of the Grand Ronde. Reopening the Locks would reestablish this linkage and allow the Tribe to resume its use of the River in a way that at least resembles its traditional use of the river. This benefit only materializes under the public ownership scenario.

Another important aspect of this mitigation is the way the Locks mimics the experience of the portage at Canemah. Traditionally, boaters were able to paddle almost to the Falls, take out above, and resume their journey just below the Falls. With the Locks closed, the closest portage takeout above the Falls is at Willamette Park in West Linn, and the closest put-in commonly used by paddlers is downstream, beyond the view of the Falls, at Oregon City's Sportcraft Boat Ramp or the dock at Jon Storm Park in Oregon City (see Exhibit 2 on page 18). The relatively new West Linn Fishing Dock, just upstream of the Arch Bridge and downstream of Lock Gate 1, may provide a closer put-in, though this was not mentioned by the paddlers we talked to. This disconnection from the Falls diminishes the experience of place and the cultural and spiritual significance of the journey. The Locks themselves do not enhance or diminish the availability of the ecological resources important to maintaining the cultural traditions of native people. They do, however, enhance access to the area, and in doing so, may reduce the costs associated with collecting resources.

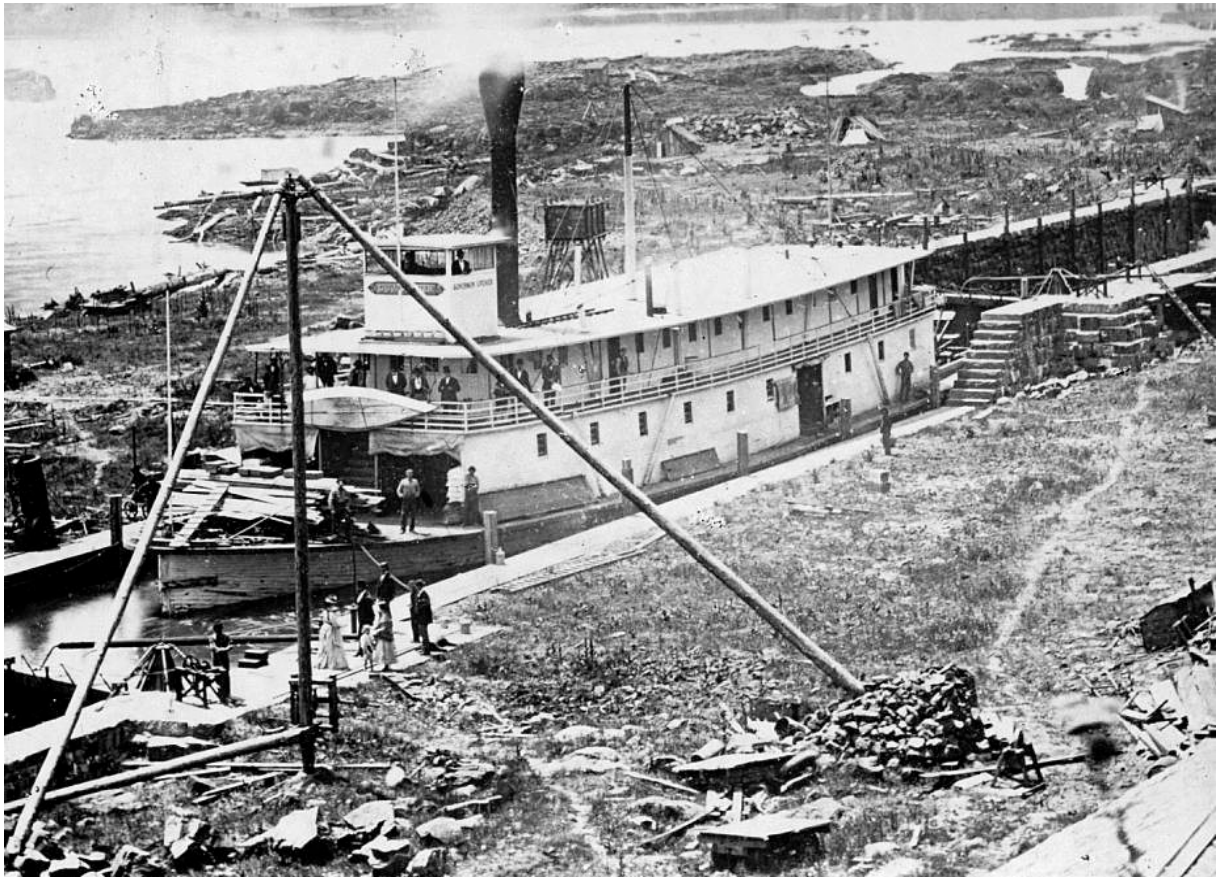
BENEFITS ASSOCIATED WITH PROTECTION AND TRANSMISSION OF HISTORY

Reopening the Locks would guarantee its continued existence for the foreseeable future and fulfill the protection goals implicit in its recognition by multiple authorities. In 1974, the Locks were listed on the National Register of Historic Places[29] and in 1991, they were designated a State Historic Civil Engineering Landmark by the American Society of Civil Engineers.[30] In 2012, the National Trust for Historic Preservation named the Locks as one of their first National Treasures, a portfolio of irreplaceable, threatened places of national significance that receive long-term organizational investments to protect.[31] The recognition that the Locks provide an important resource for connecting people with history is not new: in 1944, Congress formally recognized

the Locks' value as a historical and recreational asset, and authorized the Corps to provide a public park and recreational facilities at the Locks, opportunities to visit the Locks and the historic information center, and to safely use the recreational features on the premises (Section 4 of the Flood Control Act of December 22, 1944).[32]

The Locks are an important feature in several efforts to protect and interpret the region's history, including the recently established Willamette Falls State Heritage Area and the proposed National Heritage Area of the same name. As a feature in a broader landscape made up of many historical landmarks, the loss of the Locks would not eliminate the argument for protecting and interpreting the region, but it would diminish its value. The Locks represent one of the most interesting pieces of "working history," in the region. A functioning Locks would draw an audience that may not otherwise participate in "historical tourism" and give them a reason to connect with the region's past.

In the context of future development plans for the industrial sites on both sides of the Falls, the Locks' ability to speak for the past through continued operation becomes even more important. Development could occur—and may even be able to occur more cheaply—without the complication of the Locks. But apart from some abstract historic character in the redeveloped buildings themselves, the Locks would be the primary feature anchoring potential new hotels and restaurants to the area's historical identity.



The sternwheeler Governor Grover, in the locks at Oregon City, March 1873. *Salem Public Library, Ben Maxwell Collection.*

RESILIENCY BENEFITS

Key Takeaways: During the short- and long-term recovery phases in the aftermath of the Cascadia subduction zone earthquake, the Locks could provide critical transportation services long before the region's bridges and roadways return to functionality. These services include moving reconstruction materials, food, and fuel; reconnecting family members separated at the time of the earthquake; and, transporting volunteers and other recovery workers to damaged areas.

As described in the Oregon Resiliency Plan,[33] the Cascadia subduction zone earthquake will cause significant damage and disruption to the Willamette Valley's transportation system. These effects will make more difficult the tasks of responding to the quake and moving supplies and people to and from quake-damaged areas. The negative transportation impacts will also have considerable negative consequences for the state's economy. Most of Oregon's bridges and roads were constructed under building codes that did not take the Cascadia quake into account. As a result, many of the bridges in the Portland area will likely suffer serious damage while quake-triggered landslides will damage and close many roads, making them impassable.

Ship and barge movement on the Willamette River could provide critical transportation services in the aftermath of the Cascadia quake. A reopened Locks would allow water traffic between the upper and lower sections of the Willamette River. The Oregon Resiliency Plan notes that because of the likely sediment migration into shipping channels after the quake, that shallow draft barges of the type that move along the lower Willamette River—and are designed to fit in the Locks—may be the only viable option for moving materials along the river.[34] Experiences from other natural disasters support this conclusion. For example, barges were used to move supplies and clear debris in the aftermath of Superstorm Sandy in the New York City area.[35]

The general consensus among the resiliency experts that we interviewed is that the Locks could provide important transportation benefits in the aftermath of the Cascadia subduction zone earthquake. These experts distinguish between the response period immediately after the earthquake hits, and the short- and long-term recovery phases that follow. There is some uncertainty regarding the operational capability of the Locks immediately after the earthquake. These uncertainties have to do with factors such as the resiliency of electrical supplies to the Locks, the ability of staff to reach the Locks, debris in the vicinity of the Locks that prevents their operations, and downed bridges and other large debris that inhibits movement along the river. Our analysis assumes that before ownership transfer to another entity, that the Locks will have been seismically upgraded so that they function in the aftermath of the Cascadia earthquake.

It is during the short- and long-term recovery phases that the experts see the Locks providing significant transportation benefits. Experts anticipate that the Locks could be an integral component to the Willamette River providing much needed transportation services long before the region's bridges and roadways return to functionality. These transportation services include moving reconstruction materials, food, and fuel, reconnecting family members separated at the time of the earthquake, and transporting volunteers and other recovery workers to damaged areas.

COSTS OF OPERATING THE LOCKS

Key Takeaway: We estimate that the annual costs of operating the Locks under the highest operating cost scenario are generally in line with the costs of operating other transportation assets in the region, e.g., ferries.

Our assessment of costs includes the costs of implementing our three scenarios of Locks operations as well as the estimated annual operations and maintenance (O&M) costs. We report the estimated costs of implementing each Locks scenario based on the Corps' analysis of disposition alternatives as described in their Draft Disposition Study.[36] We estimate scenario O&M costs based on reports of the Corps' O&M costs during the last years of Locks operations, interviews with key informants knowledgeable about Locks operations, and on additional publically available data and information. We calculate high and low estimates of O&M costs. The high estimate assumes the Locks operate seven days per week and 52 weeks per year. Our low estimate assumes the Locks operate six months at four days per week and six months at two days per week. Our high estimate likely overstates the true cost of operating the Locks, which would most likely run fewer than seven days per week. We base our low estimate on a more realistic schedule, especially during the first few years of operations. We report our cost results in Table 7.

Table 7: Installation and O&M Costs by Locks Operating Scenario over 30 Years (2017 dollars)

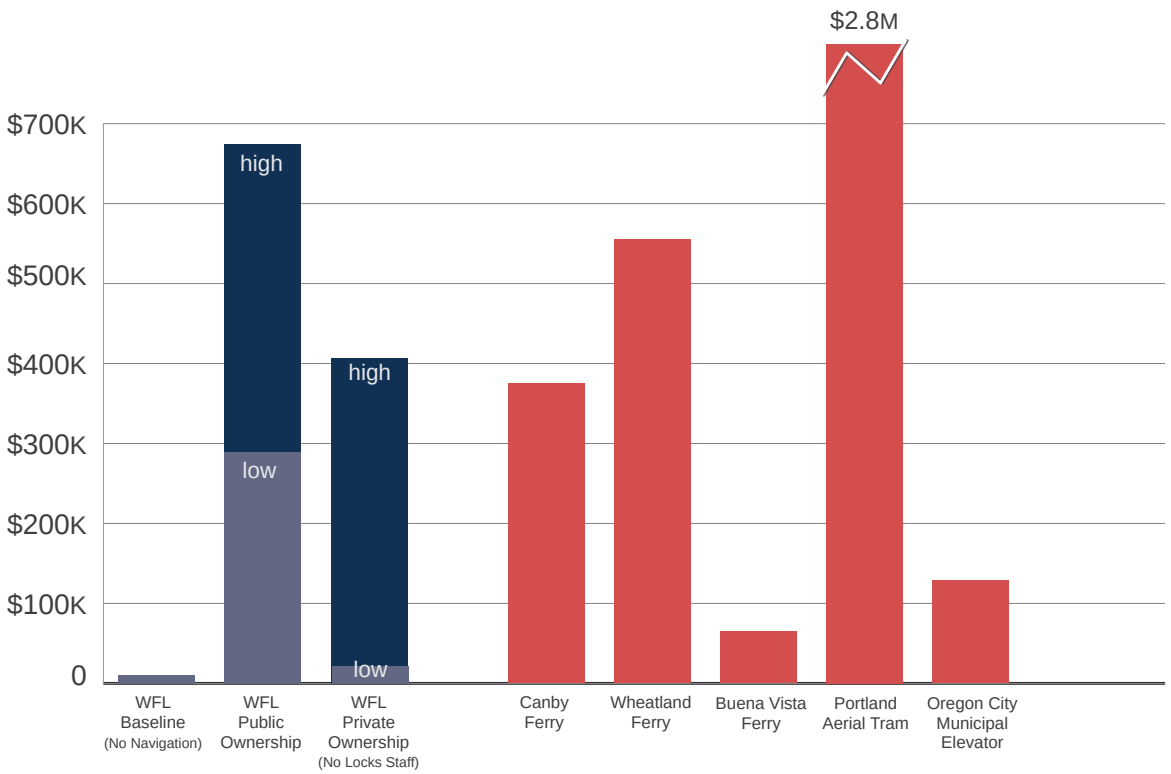
Locks Operating Scenario	Installation Costs	O&M		Total Cost	
		Low Estimate	High Estimate	Low Estimate	High Estimate
Baseline (No Navigation)	$2.5 million	$200,000	$200,000	$2.7 million	$2.7 million
Public Ownership	$5.7 million	$5.7 million	$13.2 million	$11.3 million	$18.9 million
Private Ownership	$5.7 million	$400,000	$8.0 million	$6.1 million	$13.7 million

Source: ECONorthwest

- The Baseline scenario with no navigational use of the Locks has the lowest total combined installation and O&M costs over 30 years of approximately $2.7 million (in 2017 dollars). Not included in this total are potential unquantified costs related to additional environmental study of the consequences of decommissioning the Locks and potential litigation costs, which likely would drive up the costs of this scenario if the Corps pursues it.
- The Public Ownership scenario has the highest combined cost of approximately $11 to $19 million over 30 years (in 2017 dollars).
- The Private Ownership scenario with no designated Locks staff—meaning that barge operators also operate the Locks—has a lower cost due to savings on labor expenses of approximately $6 to $14 million over 30 years (in 2017 dollars).

We note that the implementation costs listed in the Corps' disposition study likely overestimate the costs of completing these projects if private contractors did the work. For example, the Corps projects must comply with additional safety and other construction-related regulations that do not apply to private contractors. Complying with these regulations increases the Corps' estimated costs relative to the cost if private contractors completed the work.

Figure 7. Annual O&M Costs by Portland Area Transportation Infrastructure (2017 dollars).



For insight into the relative magnitudes of the annual O&M costs for Locks operations, we compare one year's O&M costs by operating scenario with O&M costs for other public transportation infrastructure in the Portland area. These include three ferries that cross the Willamette River, the Portland aerial tram, and the Oregon City municipal elevator. See Figure 7. We estimate that the annual costs of operating the Locks under the highest cost scenario (public ownership, seven days per week and 52 weeks per year) for one year are generally in line with the costs of operating other transportation assets in the region, e.g., ferries. We expect that, at least initially, the Locks will operate fewer days per week, and the actual costs of operating the locks will be lower than our high estimate.

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APPENDIX

SUPPLEMENTARY MAPS

Exhibit A.1. Regional Context for WFL Benefits Analysis (Overview)

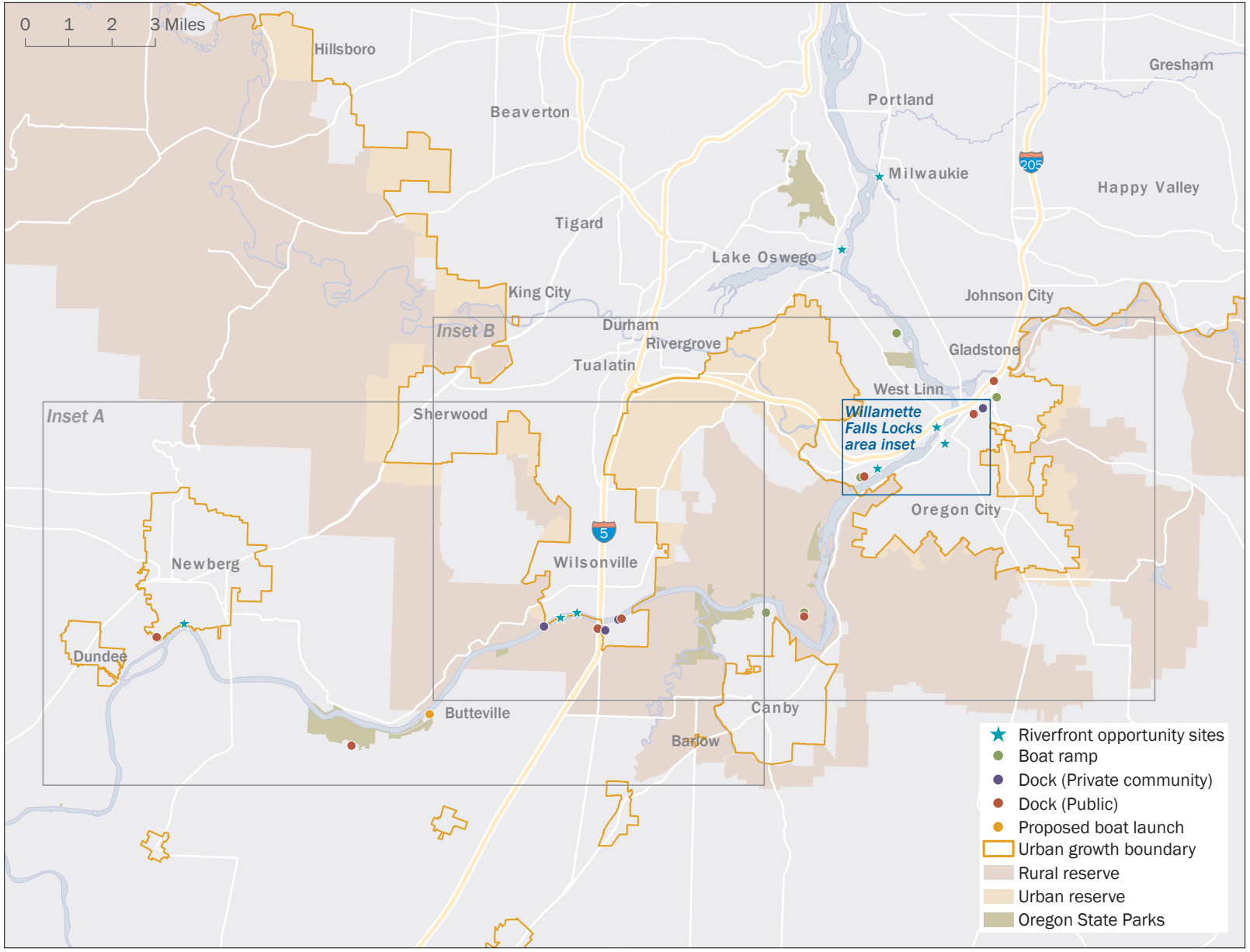
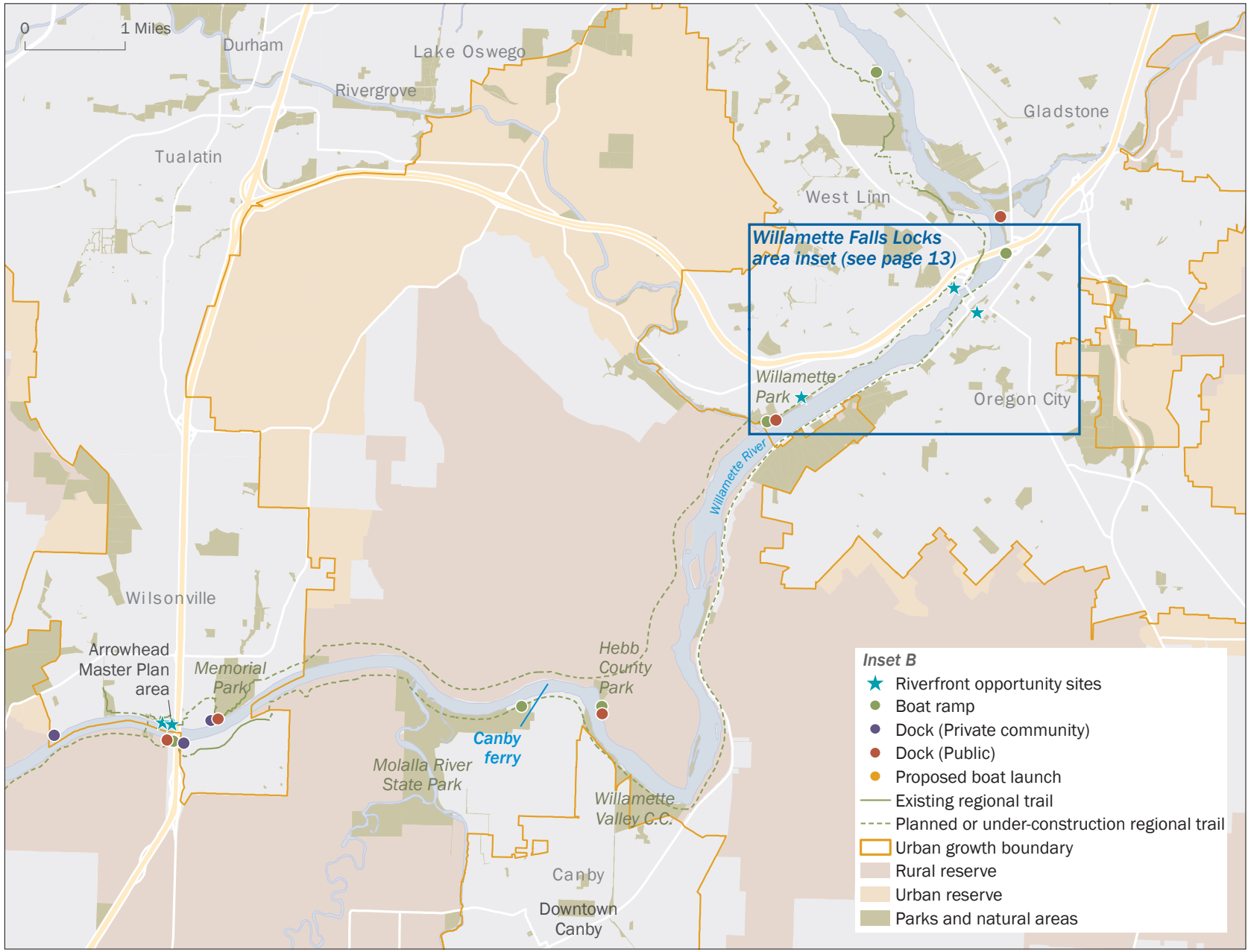


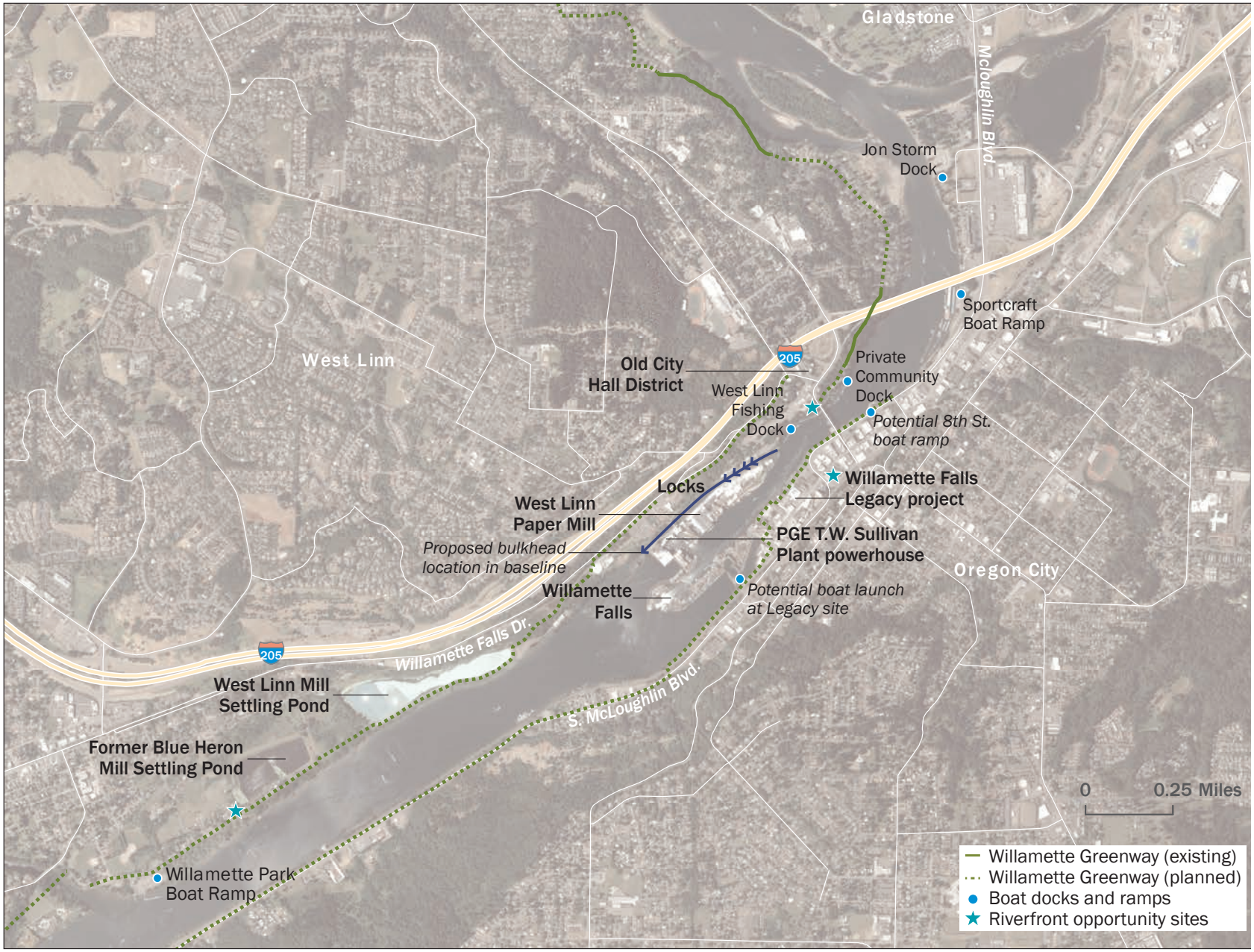
Exhibit A.2. Regional Context for WFL Benefits Analysis (Newberg to Wilsonville Detail)

Exhibit A.3. Regional Context for WFL Benefits Analysis (Wilsonville to Oregon City Detail)



Inset map shown in detail on following page.

Exhibit A.4. Key Features in the Local Area Surrounding the Locks



Willamette Falls Canal and Locks

Independent Condition Assessment and Recommendations for Recommissioning

Prepared for:
Willamette Falls Locks Commission (WFLC)

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RFP #2017- 89
KPFF # 1700288

October 10th 2018

kpff

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Appendix B – KPFF Draft Field Report

EXECUTIVE SUMMARY

In support of the Willamette Falls Locks Commission (WFLC), KPFF has completed an independent condition assessment of the Willamette Falls Canal and Locks. The assessment is based on field observations from a May 30th site visit as well as a comprehensive review of available technical documents. Critical technical documents include condition assessment reports for the facility completed in 2007 and 2011 (updated in 2013).

We found that the lock facility was in remarkably good condition for a civil works project nearing 150 years old. While the design and construction details are outdated, the facility has been very well maintained and all critical systems appear to be operable. Previous engineering assessments identified seismic safety concerns with the lock chamber walls and gate monoliths, uncertainty as to the remaining strength of the miter gate gudgeon anchors and localized erosion of backfill behind the lock wall structure. Assuming that these specific safety issues are addressed, we have concluded that the lock facility can be placed back into regular service with little additional capital improvements. Once back in service, additional capital improvements along with a well implemented continuous maintenance program will support economical and reliable operation of the facility into the foreseeable future.

Given these observations, we have developed a recommended program of capital improvements and maintenance activities for recommissioning and operating the locks. Our recommendations have been classified by priority of completion as follows:

- Critical Need: Complete prior to lock start up
- Moderate Need: Complete within the next five years
- Long Term Need : Complete within the next 10 years
- Future Capital Costs: (Gate inspection/refurbishment and other costs anticipated beyond the 10 year time frame).
- Maintenance Need: Complete on a repetitive basis (1 or 5 year cycle).

Our plan addresses the critical lock safety issues (Critical Need) prior to re-opening while making use of the existing mechanical and electrical/control systems to get the lock back into full operation.

Once the lock is operational, we have identified recommended routine maintenance (Maintenance Need) and additional capital improvements aimed at modernizing the lock system. Additional capital improvements are targeted for completion within 5 years (Moderate Need) or 10 years (Long Term Need) and are designed to improve the lock systems reliability and minimize operation and maintenance costs.

Finally we have identified significant future costs beyond the 10 year time frame (Future Capital Costs) that the new owner will need to plan for.

Future Capital Costs and 5 year cycle Maintenance Needs have been annualized to represent a recommended annual capital set aside and then added to the estimated annual maintenance costs.

Overall this plan of action is consistent with the recommendations contained in the 2007 and 2011/2013 reports. Our proposed seismic retrofit for the lock wall structures and gate monoliths is essentially identical to the solutions proposed in the earlier reports. It should be noted that the USACE Draft Disposition Study (DDS) included an additional seismic retrofit to the PGE/Ship Canal Wall that was not included in the earlier reports. Please see our discussion in the Cost Summary section titled "COMPARISON TO PREVIOUS REPORTS"for additional information. Our approach to the gudgeon anchorage is slightly different but accomplishes the same overall goal. Finally, our approach to stabilizing

the backfill erosion behind the lock wall is more substantial than proposed in the earlier reports but reflects the extensive additional damage that has occurred since the 2011 site investigation.

We estimate that our plan requires approximately $11.8M in new capital improvements over the next ten years with $8.6M to be completed prior to reopening the lock. This compares to approximately $19.03M in recommended capital improvements proposed over the same time horizon in the 2011/2013 report. Overall the seismic and structural repair costs contained in these two proposals are similar, but the control system and mechanical upgrades we are recommending are less costly.

Note that our recommended capital improvements only address functionality of the locks. Other enhancements to facility will be required to address public safety, state and local building code requirements, federal ADA requirements and recreational/historical enhancements including the historic museum on site. These enhancements will require additional capital improvement expenditures.

In addition to the estimated capital costs, we are recommending an ongoing routine maintenance program and future capital set aside program for the facility aimed at maintaining reliability and efficient operation of the facility. We estimate that this program will cost approximately $450K annually.

BACKGROUND

PURPOSE

Willamette Falls Locks is currently owned and operated by the United States Army Corps of Engineers (USACE). Willamette Falls Locks is currently not available for use to the public due to safety concerns outlined in a previous engineering evaluation. The Willamette Falls Locks Commission has been charged with determining the feasibility for potentially acquiring ownership of the Lock and envisions reopening the Willamette Falls Locks to the public to support industrial, tourism and recreational users. Summit Strategies hired KPFF Consulting Engineers to provide an independent evaluation of the facilities infrastructure needs and to advise the Commission on how best to re-open and operate the Willamette Falls Locks.

BASIS OF ASSESSMENT

This engineering assessment is based on a brief site visit and more extensive review of historic documents provided by USACE, as described in detail below.

SITE VISIT

A site visit to Willamette Falls Locks was conducted on May 30, 2018 by Bob Riley, PE, SE and Dan Hartford, PE. Both engineers spent approximately 3 hours at the locks. All gates lock chambers, and visible gate anchors were visually observed. Gates #1, #2, #3 and #4 were operated and observed. Gates #5, #6 and #7 were not operated during the site visit. A copy of our site observation report is included as Appendix B.

DOCUMENT REVIEW

Documents reviewed for this engineering evaluation are as follows:

A. *Willamette Falls Locks, Engineering Study, Large Scale Capital Costs*, July 2007. Prepared by INCA Engineers, Inc. for the Clackamas Heritage Partners.

B. *Willamette Falls Locks- Evaluation Report*, August 2011. Prepared by INCA Engineers/CH2MHill Joint Venture for USACE.
C. *Willamette Falls Locks, Interim Engineering Design Report,* March 2013, Prepared by Tetra Tech for USACE.
D. Section 216 Preliminary Draft Disposition Study with Integrated Environmental Assessment, Prepared by USACE, May of 2017.
E. *As-Built 1968.pdf*, Drawing package transferred from USACE.
F. WFL Calebs Folio.pdf, Drawing package transferred from USACE.

FACILITY ASSESSMENT

CONDITION ASSESSMENT

Based on our assessment, the facility is in remarkably good condition for a civil works project constructed in the late 19th century. While the Lock's design and construction is based on outdated practices, the facility has been very well maintained by the USACE since they took ownership in 1915.

STRUCTURAL CONDITION

The condition of the facilities' lock wall and gate monolith structures has been well documented by previous reports. Our site observations confirmed the general condition of these structures as previously reported. The size and extent of soil erosion behind the Corps side monolith and wall structure near gate 4 has significantly increased over what was reported in the 2011 evaluation report. Our review of previous structural calculations confirmed the USACE's concerns over seismic stability of the stacked ashlar masonry structure. The remediation measures recommended previously include installation of new vertically installed rock anchors drilled into the soils below the masonry walls. KPFF concurs with these recommendations and have included them in our repair recommendations.

Previous reports suggested a seismic retrofit scheme for the Chamber Walls and Gate Monolith structures assuming that the structures are classified as "normal" structures. We understand that the Commission may want to investigate the use of the Locks as a mode of transportation in an emergency situation where many of the nearby bridges may be out of service due to a large seismic event. If the Commission or another agency wishes to use the Locks in this type of emergency situation, then the structures should be classified as "critical" structures, rather than as "normal" structures. Designing a seismic retrofit with a critical classification would reduce the risk of these structures being damaged in a seismic event.

The impact of a "critical'' designation is that the required design Factor of Safety (FS) for wall or monolith sliding increases by 33% under normal loading conditions (FS of 2.0 vs 1.5), by 15% under the Operational Basis Earthquake (OBE) (FS of 1.5 vs 1.3), and stays the same under the Maximum Design Earthquake (MDE) (FS of 1.1). The Maximum Design Earthquake is the same design earthquake that would be required by local building codes and has a 950 year return period (10% chance of being exceeded in a 100 year period). The factor of safety is simply the ratio of the required structural capacity to actual demand. In this case, the actual demand is the same whether the structure is considered normal or critical; the difference is in the required structure's capacity. In order to increase the structural capacity under a "critical" designation, additional rock anchors over and above those already included in this report may be required. Given that performing this seismic stability analysis is fairly time consuming and beyond the scope of this report, KPFF has not been able to assess how many additional anchors

may be required to classify this as a critical facility. Additional analysis would be required to adequately address this question.

The condition of the Lock's miter gates is also well documented in the previous reports. These gates were removed, inspected, rehabilitated and then reinstalled in 2009. The rehabilitation addressed the primary gate structures, quoin blocks, miter blocks, gate seals and pintle bearings only. The gate gudgeon anchorage system was not refurbished. Our site observation confirmed that the primary gate structures are in good condition and consistent with what we would expect from a lightly used miter gate refurbished within the last 10 years.

The gudgeon anchorage system for the miter gates was observed to be in poor condition and to be consistent with conditions described by previous inspection reports. The gudgeon anchorage system consists of anchor rods either buried in the lock wall structure for the rods parallel with the lock or buried a significant distance below grade for the rods perpendicular to the lock. The exposed linkage components connect these anchor rods to the gudgeon pin. The true condition of the buried anchor rods cannot be assessed without substantial excavation. Based on the anchorage movements observed at gate 3 and on corrosion issues noted in previous reports, these anchor rods should be replaced to support reliable and safe operation of the miter gates in the future. Portions of the exposed linkage components appear to be in relatively good condition and can be refurbished to provide safe and reliable operation.

Mechanical and Electrical Condition

Lock mechanical equipment consists of miter gate operating cylinders, hydraulically operated lock fill/empty valves, a packaged hydraulic power unit adjacent to each miter gate, hydraulic piping/hoses, and an air bubbler system just upstream of each miter gate. With the exception of the bubbler system, all mechanical features were found to be functional and in relatively good condition. This is consistent with observations from previous inspection reports. Based on our assessment, we believe that the lock mechanical equipment can be put back into operation with minimal refurbishment and would support near term operation of the lock system.

Hydraulic power units for each gate are located adjacent to each lock gate monolith, on the Corps side (gates 1 through 5) and on the Mill side for gates 6 and 7. Hydraulic piping from the power units is routed directly to the near side gate leaf operator and to the fill/empty valves mounted on the near side gate leaf. Piping for the far side gate is routed from the HPU through a concrete encased trench down the nearside lock wall, along the sill of the lock chamber and then up the far side lock wall. Each HPU includes two solenoid operated directional control valves, one operating near side gate cylinders and the second operating far side cylinders. With only one valve operating both the miter gate and the fill/empty valve cylinders, sequencing of the various control functions is accomplished via a specialized hydraulic sequence valve. This design has a significant operational limitation in that adjustments to lock chamber water level can cause unwanted miter gate operation. Lock operators report that they routinely isolate miter gate cylinders from the HPU via manual ball valves when they are making lock chamber water level adjustments. This is time consuming and requires the significant expertise of a seasoned lock operator.

The hydraulic piping appears to be in relatively good condition, however much of it is fabricated using threaded pipe fittings and is prone to corrosion and leakage. This piping will eventually become a maintenance problem for the facility and presents a substantial risk of spilling hydraulic fluid into the river. Based on discussions with the operational staff, the hydraulic fluid in use is a biodegradable product; however any spill would trigger the need for environmental reporting and cleanup.

The bubbler system described above was non-functional during our May 30th site visit and was determined to be un-necessary for the future intended purpose of the facility. We concur with the USACE's conclusions regarding this system and recommend that it be abandoned.

The control and electrical system for the lock facility was also found to be functional and in roughly the same condition as described in the 2011 inspection report. Subsequent to the 2011 report, the elevated control house structure located at gate six (Control House 3) has been condemned and the lock gate controls located in the structure are no longer accessible. The loss of this control location has minimal impact on lock operations as lock gates 6 and 7 can still be operated from control house 2 adjacent to lock gate 4. Based on our observations and the previous reports, we believe that the lock system can be returned to operation with minimal refurbishment and repair of the electrical and control equipment.

While recognizing that the mechanical and electrical systems can be brought back to full functionality with minimal refurbishment, many of the components are nearing the end of their useful life. In addition, the existing control scheme relies almost completely on individual operator expertise to insure safe operation of the locks. This level of expertise is not likely consistent with anticipated future operations. Recognizing these issues, we are recommending significant capital improvements to the hydraulic and control systems.Generally these improvements are consistent with the measures proposed by previous evaluation reports but are tailored to the assumed future operational scenario. See the Needs Assessment section below for additional details. Note that full operation of the lock facility as assumed for this report should not begin until proposed mechanical and control systems capital improvements are completed.

Needs Assessment

Based on our site visit and review of existing documentation, we have developed a set of repairs and refurbishments that we are recommending to support future operation of the locks. Our recommendations have been classified by priority of completion as follows:

- Critical Need: Complete prior to lock start up
- Moderate Need: Complete within the next five years
- Long Term Need : Complete within the next 10 years
- Future Capital Costs: In addition to the 10 year outlook, there will be asset depreciation that will need to be planned for. The primary item being gate inspection and refurbishment.
- Maintenance Need: Complete on a repetitive basis (1 or 5 year cycle).

Our assessment is restricted to repairs and improvements required to make the lock system operable and to maintain reliable operation. Cost for capital improvements to address public safety, state and local building code requirements, federal ADA requirements and recreational/historical enhancements including the historic museum on site are not included in our estimates. Note that there may be significant financial advantages to combining these "facility enhancements" with the capital improvements and repairs recommended in this report. One typical example is the area lighting for the facility. Our recommendations restore the lighting system to support operations of the locks but do not provide area lighting that is appropriate for a public space. Combining our recommended repairs with any proposed site enhancements will result in substantial cost savings for the project. Our cost estimates also do not include costs of operation on an annual basis but do include costs of maintenance on an ongoing basis.

Needs are briefly discussed in the below sections. More detail of cost and scope are defined in Appendix A.

CRITICAL NEED

Critical Needs are repairs identified to be completed before startup of the locks. The following tasks are identified as needs required for the near term, **items in bold** are higher cost items and further described below:

1. Erosion Repair and Ground Improvements at Lock Chamber 3
2. **Erosion Repair and Ground Improvements at Gate 4 Monolith (Corps Side)**
3. Control Running Water via Drainage Trench at Gate 4 (Corps Side)
4. Hydrographic Survey
5. Reinstall Timber Brace for Wall Lagging, Lock 1 Mill Side
6. Replace Walkway and Walkway Framing Supports
7. **Stabilize Chamber Walls in Select Locations**
8. **Stabilize Monolith Walls in Select Locations**
9. **Replace Corroded Gudgeon Anchorages**
10. Operator Anchorage Repair
11. Replace Pedestrian Draw Bridge over Lock 4
12. Replace Gangway Float at Downstream Approach
13. Install new Piles in Concrete Foundation at Downstream Approach
14. Replace Timber Lining in Chamber 3
15. Replace all Hydraulic Hoses
16. Sample Hydraulic Fluid
17. Detailed Inspection/Documentation of All Fill/Empty Valves
18. Repairs to Valves (Projected)
19. Lubricate all Systems
20. Install New Gate & Valve Operating Cylinders at Gate #1
21. Salvage, Rebuild and Store Cylinders from Gate #1
22. Remove Debris
23. **Install Fire Protection Equipment**
24. Inspect / Repair Generator, Install Packaged Load Bank
25. Repair Broken Luminaires
26. Inspection/Documentation of Electrical Distribution System
27. Repair of Electrical Distribution System
28. Maintenance Activities

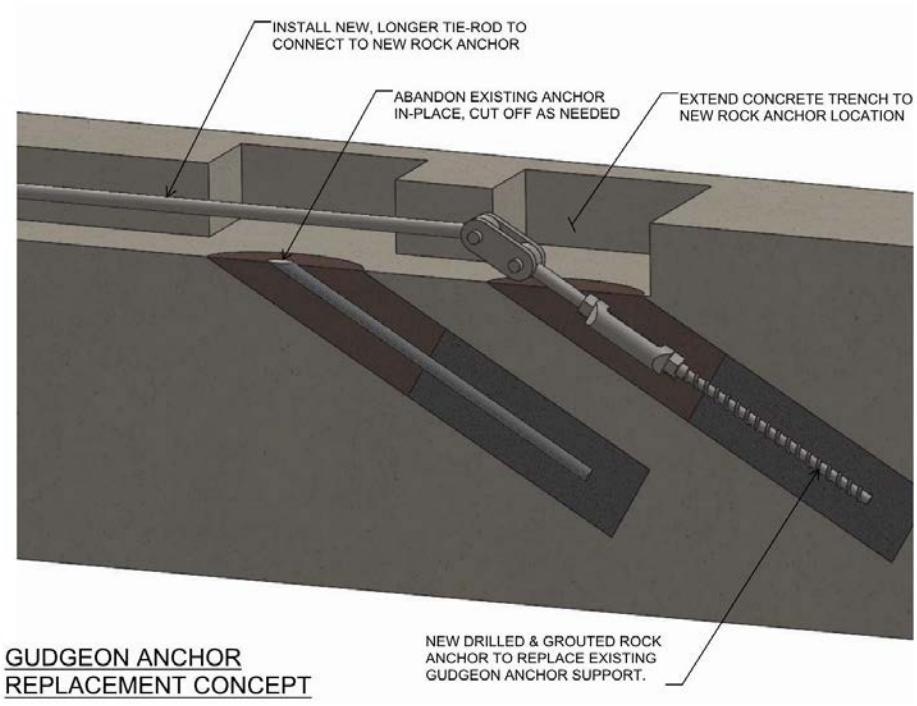
2. Erosion Repair and Ground Improvements at Gate 4 Monolith - Corps Side ($793K): It is our understanding that when Lock Chamber 4 is full, a significant amount of water seeps out of the chamber between the timber facing boards on the Corps side. This water has caused erosion behind the wall adjacent to the ashlar stone monolith that supports Gate 4. The water then travels downhill around the monolith and has caused significant erosion behind the lock chamber wall at Chamber 3 directly adjacent to the monolith. Costs for repairing this area of erosion at Lock 3 are identified in Item 1. KPFF has not been able to observe this seepage taking place in person, and is relying on video footage from 2010 provided by USACE for an understanding of this phenomenon. The 2011 INCA report identified a waterproofing repair to the Gate 4 monolith as an option for repair, which is the cost identified in this report. This repair, in conjunction with a new drainage trench identified in Item 3, will help to reduce the risk of future erosion. However, these measures do not stop the water from seeping out of lock Chamber 4 – they simply provide a means for conveying the water in a less destructive way. KPFF recommends further investigation at this area to better understand the problem and for more holistic solutions to stopping the source of the problem, if it can be accomplished for equal or less cost than proposed herein.

7. Stabilize Chamber Walls in Select Locations ($1.915M): Install vertical rock anchors at Chamber 2 (three anchors along a 20 ft long portion on Mill side), Chamber 3 (two anchors along a 10 ft long portion on both the Mill side and Corps side), Chamber 4 (the entire length with anchors spaced at 7'-6"), and the Guard Lock (the entire length with anchors spaced at 7'-6"). These anchor locations are based on the

2011 Corps Evaluation Report. Costs for this work take into account difficulty in access to the various anchor locations, as well as drilling vertically down through the center of the large masonry blocks and installing steel rod anchors that are grouted into the underlying soils (or rock) below the wall. The rock anchors will increase stability of the gate monoliths during the design level earthquake. This recommendation for repair and scope of work aligns with the 2011 USACE evaluation.

8. Stabilize Gate Monoliths in Select Locations ($1.163M): Install vertical rock anchors at Gate 4 (Corps and Mill side), Gate 5 (Corps and Mill side), Gate 6 (Mill side only), and Gate 7 (Mill side only) to address seismic stability concerns of the ashlar masonry walls. These anchor locations are based on the 2011 Corps Evaluation Report. The scope of KPFF's work did not allow sufficient time to perform an independent seismic stability analysis of these walls. However, we were able to review the original wall stability calculations and generally agreed with their approach. Costs for this work take into account difficulty in access to the various anchor locations, and the costs for drilling vertically down through the center of the large masonry blocks and installing steel rod anchors that are grouted into the underlying soils (or rock, depending upon subsurface conditions) below the wall. These rods are then post-tensioned to place a vertical load on the walls. This improves the stability of the walls by increasing the downward force on the masonry layers to increase the inter-layer friction. This recommendation for repair and scope of work aligns with the 2011 USACE evaluation.

9. Replace Corroded Gudgeon Anchorages ($540K) : This isn't one of the highest cost items, however it is heavily discussed in previous reports. This estimate assumes all gudgeon anchorages need to be replaced for gates #2, #3, #4, #5, #6, and #7 to mitigate any concerns regarding the safety of these anchorages. For the anchor rods that are parallel to the lock, these rods are assumed to be replaced in kind. For the anchor rods that are perpendicular to the lock, the approach is to abandon the existing anchor rod in place, and install new drilled in and grouted rock anchors a few feet further back from the gate and then installing longer tie rods to connect to the gate. This is true for all perpendicular gudgeon anchors except at Gates 4 & 5 Mill side, where they are replaced in kind. This recommendation for repair and scope of work is different from the 2011 USACE evaluation, which recommended abatement of existing corrosion and replacing only a handful of pieces of hardware, which did not address the potential for corroded and buried anchorages which are not accessible for inspection. See the figure below for a conceptual sketch of the replacement gudgeon anchor.



23. Install Fire Protection Equipment ($760K): Currently there is no fire protection equipment along the locks to protect the lock users. There is minimal hydrant access along the lock system for fire fighters to connect to, the closest documented hydrant is up on Willamette Falls Drive, approximately 250' from the locks. Installing a firewater system with multiple hose reels along the locks would increase fire protection coverage. This recommendation aligns with the 2011 USACE evaluation.

MODERATE NEED

Moderate Needs are repairs recommended to be completed within five years of operation, but not critical for start-up of the locks. The following tasks are identified as moderate needs, items in bold are higher cost items and further described below:

29. Replace Chamber Ladders
30. Replace Damaged Guardrails
31. **Install new Hydraulic Power Units**
32. Replace Bottom Seals
33. **Replace Lighting System**
34. **Replace/Refurbish Control System**

These items could be done earlier if budget allowed for it, and some items would be less expensive to execute if completed at the same time. An example is combining tasks that require dewatering within the locks.

31. Install new Hydraulic Power Units ($616K):

As discussed above, the existing hydraulic power units, control valves and piping are operable and would support routine operation of the lock facility by personnel of equivalent expertise and training as those employed by the USACE to operate the system today. While operable, the hydraulic and controls currently installed are nearing or past their recommended service life, have significant operational

limitations and would not allow operation of the facility under a more diverse and less highly trained group of operators. For these reasons we are recommending that the existing HPU's be replaced with new package commercial units.

Our recommendation is to replace the 7 existing HPU's with 14 smaller commercial packaged HPU's, one unit for each gate leaf. With this configuration, hydraulic piping under the lock chamber can be abandoned and risks of a hydraulic oil spill are substantially reduced. We further recommend that each HPU be equipped with multiple modular directional control valves, one to control the miter gate cylinder and one for each of the four fill-empty valve cylinders. This arrangement allows for independent control of all operations and eliminates the limitations created by the sequence valves in the existing hydraulic circuit.

We further recommend that all hydraulic piping from the HPU to the gate, as well as piping on the gate leaf be replaced by high quality stainless steel tubing.

This HPU and control valve scheme is contingent upon simultaneous installation of a modern digital control system and updated power distribution system as described in the work under items 33 and 34 below. Interconnecting these HPU's and the control valves via a networked control scheme allows control valves to be mounted in a manner that minimizes the required hydraulic piping.

33. Replace Lighting System ($782K): While the existing lighting system is functional, it is obsolete and should be replaced. In addition, our proposed scheme for the hydraulic power units requires electrical power at each gate monolith (Corps. and Mill Side of the locks.). We recommend that a new power distribution and lighting system be installed simultaneous with the new HPU and control system. Our cost for this item reflects a lighting system similar in performance to the existing system but using current state of the art luminaries. We also recommend that this work be coordinated with any public access improvements to the site as the end use of the facility may dictate a lighting system better suited for a public use facility.

341. Replace / Refurbish Control System ($1,209K): Currently the control system is an older analog system. It functions, however much of the equipment is obsolete and will be difficult to maintain/repair over time and eventually should be upgraded. Upgrading the control system will allow for better overall control of the facility as well as automation of the system that will allow use by a more diverse and less highly trained group of operators.

We propose to replace the existing analog control system with a digital programmable logic controller (PLC) based control system based on distributed network controls. The PLC and key control system functions would be installed in one of the existing control houses. All lock control would be handled through touch screen human machine interfaces (HMI's) distributed throughout the lock facility. HMI's would be installed adjacent to each lock gate monolith to allow for local operator control, and in the two lock control houses.

Control devices including limit switches and hydraulic control valves would be connected to the control system via a control network, eliminating the need for individual hard wiring from the PLC to each device. To automate the system, we recommend monitoring water surface elevations in all lock chambers via redundant ultrasonic liquid level sensors. These devices would also communicate with the PLC via the control network.

With this type of a control scheme in place, the PLC can provide operational oversight of the facility, insuring that the lock is operated in a safe manner regardless of the expertise of the operator.

This system is contingent on implementation of the new HPU as well as the power distribution and lighting upgrades proposed in items 32 and 33 above.

Long Term Need

Long Term Needs are repairs identified to be completed within 10 years of operation. There were no relatively high costs identified for long term needs. The following task is identified as needs to happen within 10 years:

35. Repair Loss of Masonry at Lowest Course at the Downstream Approach, Mill Side

Estimated Maintenance + Future Capital Improvement Set-Asides

Our cost estimate accounts for annual maintenance costs as well as long term maintenance and anticipated future capital costs under a single line item. In this cost line item, all costs are annualized and are presented as total annual cost.

Future Capital Costs

Future capital needs are forecasted high cost items that will be required after 10 years and need to be anticipated and planned. The major item here is the inspection and refurbishment of gate leaves. Likely this work will be required after 2030. The following tasks are identified as future capital costs, items in bold are higher cost items and further described below:

36. Inspect / Refurbish Gate Leaves
37. Flood Repair Contingency

36. Inspect / Refurbish Gate Leaves ($1.2M): This line item was added to anticipate this large expenditure in the future. Gate Leaves typically have a 25-50 year life and need to be inspected and refurbished. All gate leaves were inspected and refurbished in 2009, thus likely the gates will need to be refurbished between 2034 - 2059. This work aligns with the line item identified in the 2011 USACE evaluation report to install new miter blocks, since that activity would require removal of the gate leaves, however KPFF does not anticipate the need to replace the miter blocks within a 10 year period. Scope of work includes removing the gates via a barge + crane and transferred to a shop, strip the planks off the gates, sand blast the structure, detailed inspection, weld repair as needed, repaint, install new bottom seals and valve seals, install new bearings, install new quoin block/miter block, transfer the gates back to the site and reinstall the gate leaves via a barge and crane, and adjust the retention diagonals so the gates hang level. Note that it is recommended to keep either Gates #6 & #7, #6 & #5 or #5 & #7 installed at the same time to maintain pool integrity for the hydroelectric plant.

37. Flood Repair Contingency ($710K): This line item was added to allow a contingency fund for repairs needed for a future flooding event.

Routine Maintenance Need

Routine Maintenance Needs are preventative maintenance items to be completed on a routine basis. The following tasks are identified as needs required annually:

1. Inspect Timber Lining and Replace Rotting Pieces as Needed
2. Inspect Lock Walls and Region behind Lock Walls for Movement
3. Inspect Masonry for Structural Integrity
4. Remove Debris as Needed
5. Hydraulic Fluid Sampling
6. Replace One Set of Gate and Valve Hydraulic Cylinder Operators
7. Lubricate Systems

8. Run Generator on Load Bank Monthly
9. Limit Switch Inspection / Repair / Replacement

The following tasks are identified as needs required every 5 years:

10. Hydrographic Survey and Dredging
11. Adjust Retention Diagonals on Miter Gate Leaf
12. Testing and Correction of Grounding System
13. Replace Hydraulic Hoses
14. Slide Gate Inspection / J seal & J clamp PM

COMPARISON WITH PREVIOUS USACE NEEDS ASSESSMENT

In general, our recommendations and needs assessments for the facility are consistent with those recommended in the 2007, 2011 and 2013 reports. All deficiencies that we have identified are discussed by the previous reports and we have been able to identify any significant additional deficiencies in the system. In some cases we have identified slightly different solutions or we are proposing to phase capital improvements differently than proposed by previous reports. Overall our estimated costs for capital improvements are less than those listed in the 2011 report, but are substantially higher than those contained in the 2007 report. The discrepancy between engineering estimates is discussed in more detail under the Cost Summary section below.

Several specific capital improvements recommended by the 2007 and 2011 reports have not been included in our recommendations. Some of these recommendations were eliminated because of the anticipated operating methodology for the lock listed below. Other specific items were eliminated because repairs were made or because site conditions had changed subsequent to the report being issued. Please see below for a discussion on why each line item was not included. Some line items included on old reports that are not directly copied onto our report or shown below are incorporated into other line items.

Analyze Lock Control Stand at Gate 6 (Mill Side): The structure of the lock control stand has been condemned. At this point, there is no need to analyze the structure since it has already been deemed unsafe structurally. If the control stand is needed, the structure would need to be replaced. This activity would have added complexity with all of the utilities routed around, underneath and into the control stand. With the recommended operational methodology, the control stand is no longer needed.

Miter Block Repair: The USACE anticipated having to replace the miter blocks within a 10 year period. KPFF recommends deferring this work until the gates are inspected and refurbished in the future. The miter block repairs were recommended after noticing a miter block had cracking towards the top on at least one gate. The 2011 USACE evaluation report suggests that these cracks occur when the gates close, due to first contact being made at the top of the gate. KPFF has added a 5 year cycle maintenance task to adjust the retention diagonals so the gates sit square, as this will reduce the likelihood of damage to the miter blocks and enable the deferral of this item.

Gate limit switches (2nd set): The USACE recommended changing the operator methodology of the locks to decrease overall wear on the system. The addition of these limit switches would allow the future control system to slow gate travel as the gate neared its open or closed limit. This would reduce impact loading on the structure and the operators and would increase the service life of the components. We have assumed that the total number of annual lockages will remain relatively low when compared to the locks' historical use, and the cost for this additional control complexity is not justified.

CCTV Repair / Upgrade: With the recommended way of operating, it was determined CCTV is not required for operation of the lock. Both the 2011 and 2013 Corps Evaluation Reports recommend CCTV repairs/upgrades for remote operation; however under new ownership we have assumed that the lock will not be operated remotely and thus these improvements would not be required in the future.

Remote monitoring / operating system: This line item was added to enable USACE to operate the Willamette locks from Bonneville dam; however under different ownership and recommended operation methodology an operator would be onsite. With an operator onsite, this line item is no longer required.

Our proposed upgrades are substantially more extensive than the final recommendations presented by the Draft Disposition Study (DDS) prepared by the USACE. That study considered 8 alternatives for transferring the facility to a new owner. Eleven (11) measures were identified that could be implemented by the Corps to facilitate the transfer of the asset. Costs for each measure were assigned based on the 2011 report. Eight (8) different alternatives were then identified, with each alternative accomplishing some subset of the eleven measures. The eight alternatives were reduced to three based on a defined screening criteria and then a preferred alternative was selected based on minimizing the associated costs to the Federal Government. The preferred alternative presented by the DDS was alternative number 3, which would transfer a non-functional Lock to a new owner after addressing only seismic safety of structures retaining the upper pool. Given the limited scope of capital improvements proposed by the USACE in the DDS, the costs presented are substantially less than those identified in this report. See the Cost Summary section for additional details of the comparative costs.

Note that the proposed capital improvements to the facility are similar in scope to the following measures identified by the DDS:

1. Seismic Partial
2. Safety Functional
3. Safety Minimal
4. Seepage

If the costs of the above measures are combined, they are similar to the capital expenditures included within this report.

COST SUMMARY

ESTIMATED ROM COSTS

The costs shown in the table below represent our ROM estimate for completing the improvements we have proposed for this facility. Costs given are Rough Order of Magnitude (ROM) costs and given in 2018 dollar values. A 30% contingency was added to each line item since this is a high level engineering evaluation. Estimated engineering & permitting costs are also included in this estimate using an additional 20% markup added to the construction and contingency costs. Table 1 gives an overall cost estimate for each Need. Note that line item 4 includes the cost of annual routine maintenance as well as annual funding set-asides to finance major system, anticipated major capital improvements and periodic emergency repairs maintenance (not accounting for earned interest or future inflation). See Appendix A for further scope detail and cost of each Need Type.

Need Type	Amount ($2018)
Critical Need (Prior to Locks Re-Opening)	$8,610,000
Moderate Need (Within 5 years)	$2,940,000
Long Term Need (Within 10 years)	$240,000
Estimated Maintenance + Future Capital Improvement Set-Asides	$450,000

TABLE 1: SUMMARY OF OVERALL COSTS

COMPARISON TO PREVIOUS REPORTS

The Table below compares our cost estimates to those developed by other consultants for the 2011 report. This table presents an apples-to-apples comparison of our estimated costs to the previous estimate based on our proposed planning horizon.

As for USACE's Disposition Study, it is difficult for us to make direct cost comparisons to this study, primarily due to the fact that this study includes costs to seismically stabilize the shared PGE/Ship Canal wall, which is currently not included in our recommendations for repair. None of the previous 2007, 2011 or 2013 reports indicate that this wall requires seismic stabilization. KPFF has heard recent anecdotal concern from the Corps regarding this wall's stability. However, we have not had the opportunity to independently evaluate the need for stabilization of this wall.

The USACE's preferred solution in the Disposition Study is Alternative 3, which transfers a non-functioning lock and limits the scope of seismic improvements at the facility to structural elements needed to maintain the upper pool at the site. USACE reports the cost for this alternative at $1.963M, which includes $1.847M in seismic retrofit costs. The scope of these retrofits include stabilization of the PGE/Ship Canal wall, the guard lock wall and guard lock gate 6 & 7 monoliths on the River side. KPFF's study presented herein includes costs for seismic retrofit of the guard lock wall and gate 6 & 7 monoliths for a cost of approximately $1.3M, but this cost does not include retrofit of the PGE/Ship Canal wall. Further study would be required for KPFF to validate the need and cost for retrofit of the Ship Canal wall.

Planning Horizon	KPFF Estimate ($2018)	2011 Report ($2011)
Critical Need (Prior to Locks Re-Opening)	$8.61M	$7.84M
Moderate Need (Within 5 years)	$2.94M	$5.63M to $4.93M
Long Term Need (Within 10 years)	$240K	$5.66M

TABLE 2: COMPARISON TO 2011 REPORT

Note that our total ROM estimated costs for the project are somewhat less than those presented in the 2011 engineering report prepared by the joint venture INCA/CH2M team. This discrepancy is primarily related to the following issues:

1. Portions of our cost estimates are based on a more detailed take-off than was used to prepare the 2011 report.
2. For some scope items we are proposing slightly different design details.
3. For many items such as the electrical/control system and the gate mechanical systems, we are proposing systems that are more appropriate for the assumed future operation of this facility. As an example, the control system that we are proposing is appropriate for a lock operated locally. The 2011 report envisioned a lock control system that allowed USACE staff to fully operate the lock remotely.

Overall we believe that our estimate ROM costs are reasonable for the Commission's planning purposes and that they are in-line with the costs that were presented in the 2011 report, once the differences in proposed scope of work are accounted for.

Potential Issues

Some additional risks were identified during this scope of work due to unknowns associated with the site, such as:

- Erosion at Gate 4: The costs included in this report are based on the solutions presented in the 2011 report. KPFF recommends further investigation be conducted to determine if there is a solution to mitigate future erosion from occurring at Lock 3 due to seepage out of Lock Chamber 4 and the Gate 4 monolith. Upon discussion with the Corps, mitigating the seepage itself may not be realistic; however there may be better options for mitigating future erosion due to this seepage.

- Dredging: Upon discussion with the Corps, it appears that minimal sediment accumulates within the lock chambers. Therefore, for the purposes of estimating a dredging maintenance cost, we have assumed 2' of sediment accumulates and needs to be dredged out from two of the standard 210' long chambers every 5 years.

- Seismic stabilization of the PGE/Ship Canal wall: Costs for stabilizing this wall are currently not included in this report. Further investigations are required to determine if this activity needs to be undertaken and to determine the costs for these improvements.

- Operations: Repairs were assessed based on an assumed method of operations, which assumed the owner will pursue an onsite/manual approach. If the owner decides to operate the Locks differently, other repairs or improvements should be considered. Examples would be the need for a remote control stand at Gate 6, CCTV requirements, etc.

- Environmental assessment - no environmental assessments were performed as part of this scope of services. The USACE has prepared a comprehensive section 216 Preliminary Draft Disposition Study with Integrated Environmental Assessment. The Locks Commission should consider having this assessment reviewed by a qualified Environmental Consultant prior to assuming Ownership of the Locks.

- The project site has been damaged by extreme flood events in the past. The new owner should be aware of the flood hazard risk and should have a plan for operating the facility under flood hazard conditions.

- The Guard Lock walls, along with miter gates 6 and 7, retain the upper pool for the dam. Since this dam facility includes generating assets, it is governed by FERC licensing requirements. These requirements dictate dam safety inspections on a routine basis. Project re-licensing is also typically contingent on capital improvements aimed at environmental mitigation. We recommend that the Commission work with PG&E to define how these potential costly items will be handled.

Additional Items to be considered in the Future:

Through wall leakage in the Mill Monolith and side walls – This was an item identified in the 2007 report. This does not appear to be a safety or operational issue. It was a concern for the Mill storage. This is primarily something to be aware of and decide if it is an issue to address prior to assuming Ownership of the Locks. Cost for mitigating this issue is not included in our proposed plan.

Operational Assumptions

For the purposes of this report we have assumed that the lock will be operated as a mixed commercial, tourist and recreational facility. Key assumptions include:

- Operational year-round for commercial and major tourist operations. Lockages by these users may occur while the facility is or is not staffed.
- The facility will be staffed to support light recreational use either seasonally or year round.
- When dedicated operating staff is not on site, the lock would be operated by employees of commercial/tourist operations. These independent operators would travel with the commercial/tourist vessel, would access the facility via the floating docks, and would be specifically trained in proper lock operation.

Overall we anticipate that the total number of lockages will be on the order of 1700-2500 annually.

Recommissioning Approach

Per our needs assessment above, we have recommended capital improvements to the facility as well as a program of ongoing routine maintenance. These recommendations are aimed at returning the facility to reliable operation as a mixed commercial and recreational facility and then improving and maintaining that operation moving forward. In general, our recommendations are consistent with those contained in the 2007, 2011 and 2013 reports compiled by the USACE, but are more extensive than the recommendations presented by the Corps in the 2017 Draft Disposition Study.

Presumably any new entity established to take over and operate the locks will negotiate the formal terms of the property transfer. This transfer will likely entail some combination of federal funds along with other state and local funding sources. Where federal funds are being contributed, the new owner may be faced with choices as to how best proceed with any capital improvements accomplished using the federal funds. The new owner can request that the USACE complete agreed-to capital improvements prior to taking full ownership of the facility. Alternately, the two parties can agree on a stipulated funding level that the Federal Government will contribute to the project at the time of the transfer, and then the new owner would take responsibility for making the capital improvements.

There are advantages and disadvantages for the new owner related to each approach. Having the USACE complete any agreed-to capital improvements to the facility prior to the transfer minimizes the owner's risk related to those projects. Any unforeseen conditions or unanticipated costs would be the responsibility of the Federal government prior to the transfer of ownership. The downside to this approach is that the ownership transfer would be delayed until the project was completed and the new owner would not be able to start other capital improvement projects until the initial federal project was complete.

The primary advantage to taking early ownership of the facility is that the new owner will have more control over the capital improvement projects and will be able to proceed with all capital improvements simultaneously regardless of funding sources. This has the potential to make more efficient use of the available capital improvement funds.

Performing construction in a facility as old as the Locks is bound to encounter unforeseen conditions, which typically lead to substantial change orders in a public bid environment. The Commission should take this fact into account when negotiating a turn over strategy with the Corps. The original bid from a Contractor will not likely be the final contract amount. Managing the unknowns can be challenging and should be planned for with contingency or escrow accounts to manage these costs.

The construction work to be performed is specialized, and should be performed by a qualified Contractor. A phased bidding approach should be considered. KPFF recommends going through a pre-qualification phase where qualified bidders are short listed and then asked to prepare pricing for the actual work in a subsequent phase of bidding. In a Design-Bid-Build type of contract, the bid could be structured so that items that are at greater risk of encountering unknown conditions could ask for additional pricing based on a per quantity basis (such as excavation, drilling of rock anchors, or removal and replacement of structure in kind to provide access to certain areas).

The Commission could investigate contracting the work using a Design-Build approach. The advantage of these types of contracts is that they typically will allow the Owner to take on less risk, but usually this is only true if the scope of the work is well defined. Given the fact that the scope of work for this facility is likely to encounter some unknowns, a Design-Build approach may not be the best contracting option for this work.

A third option that could be explored is the use of a GC/CM type of approach. In this case, qualified bidders provide high level bids for a given scope of work that is at a 15-20% level of definition. The winning Contractor is then brought on board during design to help assist the team to define the scope of work given their preferred approach to the Construction. This may be the least risky approach to the Owner in defining and pricing the work at this type of facility.

APPENDIX A – COST ESTIMATE

Willamette Falls Locks

Rough Order of Magnitude Engineer's Estimate to Operate and Maintain the Locks Infrastructure

October 10, 2018

Capital Improvements (Estimated Costs in $2018)

	Item	Critical Need (Prior to Re-opening of Locks)	Moderate Need (Within Next 5 Years)	Long-Term Need (Within Next 10 Years)	Scope of Work
1	Erosion Repair and Ground Improvements at Lock Chamber 3	$ 249,000			Repair a 85' long by 6' wide by 10' deep area and a 35' long by 10' wide by 10' deep area based on KPFF's 5/30/18 site visit and 2011 Corps Evaluation Report. This includes removing steel plates and asphalt pavement at the sinkhole locations, excavating the sinkholes to expose the deteriorated timber lagging and lay back the temporary excavation slopes, removing and replacing the deteriorated timber lagging, place a non-woven drainage geotextile fabric, place new backfill, and place new asphalt pavement on the repaired areas.
2	Erosion Repair and Ground Improvements at Gate 4 Monolith (Corps Side)	$ 793,000			Repair a 20' long by 6' wide by 10' deep area based on KPFF's 5/30/18 site visit. This includes removing timber decking at the sinkhole locations, excavating the sinkholes to expose the deteriorated timber lagging and lay back the temporary excavation slopes, removing and replacing the deteriorated timber lagging, place a non-woven drainage geotextile fabric, place new backfill, and place new timber decking on the repaired areas.
3	Control Running Water Via Drainage Trench at Gate 4 (Corps Side)	$ 24,000			Construct a drainage trench from behind the Miter Gate 4 monolith to the timber faced wall downstream of the miter gate monolith per the 2011 Corps Evaluation Report
4	Hydrographic Survey	$ 94,000			Recommend a hydrographic survey be conducted to determine level of sedimentation within the locks and whether dredging may be required at this time
5	Reinstall Timber Brace for Wall Lagging, Lock 1 Mill Side	$ 4,000			Re-install the 12x12 horizontal timber brace on the Mill side of Lock 1. The work necessary is to loosen the anchor rod, lift the timber brace into place, and retighten the anchor rod per the 2011 Corps Evaluation Report
6	Replace Walkway and Walkway Framing Supports	$ 283,000			Remove and replace the walking surface, replace the missing posts, and recoating the deck at Corps side of Guard Lock and at Gate 2 per the 2011 Corps Evaluation Report.
7	Stabilize Chamber Walls in Select Locations	$ 1,915,000			Install vertical rock anchors at Gate 4 (Corps and Mill side), Gate 5 (Corps and Mill side), Gate 6 (Mill side only), and Gate 7 (Mill side only) per 2011 Corps Evaluation Report, taking into account costs for rig access.
8	Stabilize Gate Monoliths in Select Locations	$ 1,163,000			Install vertical rock anchors at Chamber 2 (three anchors along a 20 ft long portion on Mill side), Chamber 3 (two anchors along a 10 ft long portion on both the Mill side and Corps side), Chamber 4 (the entire length with anchors spaced at 7'-6"), and the Guard Lock (the entire length with anchors spaced at 7'-6"), per the 2011 Corps Evaluation Report, taking into account costs for rig access.
9	Replace Corroded Gudgeon Anchorages	$ 539,000			Replace all Gudgeon anchors from Gates 2-7. For the anchors that are parallel to the lock, replace in kind. For the anchor rods that are perpendicular to the lock, abandon the existing anchor rod in place, install new rock anchors further back from the gate and install longer tie rods.
10	Operator Anchorage Repair	$ 529,000			Replace the concrete foundation and anchor rods that hold the operating anchors down at various locations where needed. Two locations were reported in the 2011 Corps Evaluation Report.
11	Replace Pedestrian Draw Bridge over Lock 4	$ 528,000			Replace draw bridge in kind per KPFF site visit on May 30, 2018
12	Replace Gangway Float at Downstream Approach	$ 195,000			Replace in kind existing float supporting end of gangway
13	Install new Piles in Concrete Foundation at Downstream Approach	$ 78,000			Add new drilled in piles into existing concrete foundation that has been undermined by scour
14	Replace Timber Lining in Chamber #3	$ 202,000			Replace all of existing timber facing lining in lock chamber #3 as it is deteriorated and likely contributing to the erosion seen at the Corps side of this lock
15	Replace all Hydraulic Hoses	$ 57,000			Replace approximately 200 existing hydraulic hoses with new hydraulic hoses per KPFF site visit and 2011 Corps Evaluation Report. Hydraulic hoses typically have a 5 year expiration date and need to be periodically replaced.
16	Sample Hydraulic Fluid	$ 11,000			Sample existing hydraulic fluid to confirm fluid quality per KPFF site visit. Verify hydraulic fluid is environmentally safe.
17	Detailed Inspection/Documentation of all Fill/Empty Valves	$ 50,000			Inspect each gate valve for proper operation per KPFF site visit. Inspection list includes: actuator seals, actuator function, limit switch function, valve seals, control buttons, indicators, wiring, etc.
18	Repairs to Valves (Projected)	$ 553,000			Potential valve repair work includes: replace broken limit switches, replace valve actuator seals, replace/repair valve perimeter seals, replace/repair valve controllers. This cost includes installation of a coffer dam if needed. Projected repair work is based on 2011 Corps Evaluation Report. Scope includes replacing valve perimeter seals, valve limit switches, & potentially replace whole valves.
19	Lubricate all Systems	$ 29,000			Relubricate all systems per vendor recommendations per KPFF site visit.
20	Install New Gate & Valve Operating Cylinders at Gate #1	$ 59,000			Purchase and install two new gate hydraulic operators and eight hydraulic valve actuators per KPFF site visit. Salvage the existing hydraulic cylinders and have them refurbished per KPFF site visit. The design recommendation is replace in kind.
21	Salvage, Rebuild and Store Cylinders from Gate #1	$ 32,000			Send salvaged hydraulic cylinders, the gate operators as well as the valve operators, from Gate #1 to be rebuilt / refurbished per KPFF site visit. Store these cylinders on site as spares.
22	Remove Debris	$ 36,000			Clear debris from lock chambers to reduce damage on equipment per 2011 Corps Evaluation Report. Estimate is based on hiring an operator, renting a barge with a backhoe to remove debris, and transporting/disposing of debris.

23	Install Fire Protection Equipment	$ 760,000			Install a firewater system for fire protection of boaters in the locks per 2011 Corps Evaluation Report. The firewater system includes fire pumps, piping, hose stations and hydrants.
24	Inspect / Repair Generator, Install Packaged Load Bank	$ 64,000			Hire a Cummins representative to do an inspection on the generator and repair as need per 2007 report findings. Install a packaged load cell and coupler for monthly testing of generator.
25	Repair Broken Luminaires	$ 15,000			Replace two luminaires identified as broken and unrepairable in the 2011 Corps Evaluation Report. Added two luminaires and associated wiring to be replaced as contingency.
26	Inspect / Document of Electrical Distribution System	$ 117,000			As Built electrical, instrumentation and controls system to have adequate drawings for future trouble shooting of locks per 2007 report findings. Inspect electrical, instrumentation and controls equipment and document deficiencies for repair
27	Repair of Electrical Distribution System	$ 78,000			Repair/Replace broken conduit, conductors, enclosures and supports as determined during inspection. This estimate was generated based on reviews of photos of electrical equipment and repair recommendations from the 2011 Corps Evaluation Report
28	Maintenance Activities	$ 145,000			This line item is to account for the maintenance activities to be done before start up that aren't already included in other near term costs
29	Replace Chamber Ladders		$ 43,000		Remove existing ladders at lock chambers 1 through 4 and the ladder on the Mill. Furnish and install replacement ladders. Per 2011 Corps Evaluation Report
30	Replace Damaged Guardrails (Railing on Mill Side from Gate 1 to Gate 5, and Guard Lock)		$ 96,000		Replace the wood and metal guardrails near the oil storage building and the Guard Lock. Assume a majority of the railing on the Mill side from Gates 1 to 5 needs to be replaced. Per the 2011 Corps Evaluation Report
31	Install New Hydraulic Power Units		$ 616,000		Install 14 new hydraulic power units (HPU), 1 for each gate leaf. This scope of work includes demolishing the existing units, demolishing/abandoning both conduit & piping, disposing of oily waste, installing new piping to the gate leaves, installing new HPU's.
32	Replace Bottom Seals		$ 185,000		Replace in kind bottom seals as needed per 2011 Corps Evaluation Report
33	Replace Lighting System		$ 782,000		Scope of Work includes replacing all exterior luminaires, light poles, switches, junction boxes and rewiring entire lighting system per 2011 Corps Evaluation Report.
34	Replace/Refurbish Control System		$ 1,209,000		Replace control system with upgraded digital controls to allow for future automation if desired per 2011 Corps Evaluation Report.
35	Repair Loss of Masonry at Lowest Course at the Downstream Approach, Mill Side			$ 234,000	A portion of the downstream approach masonry wall is missing along the bottom length of the wall. Per the 2011 Corps Evaluation Report, mitigation would include replacing the missing portions with reinforced concrete.
	Total Cost Summary	***$ 8,610,000***	***$ 2,940,000***	***$ 240,000***	

Future Capital Costs (Estimated Costs in $2018)

36	Inspect/Refurbish Gate Leaves			$ 1,215,000	Lock Doors typically have a 25-50 year life and need to be inspected and refurbished. All of the doors were inspected and refurbished in 2009, thus likely the doors will need to be refurbished between 2034-2059. Scope of work includes removing the gates via a barge + crane and transferred to a shop, strip the planks off the gates, sand blast the structure, detailed inspection, weld repair as needed, repaint, install new bottom seals and valve seals, install new bearings, install new quoin block/miter block, transfer the gates back to the site and reinstall the gate leaves via a barge and crane, and adjust the retention diagonals so the gates hang level. Note that it is recommended to keep either Gates #6 & #7, #6 & #5 or #5 & #7 installed at the same time to maintain pool integrity for the hydroelectric plant.
37	Flood Repair Contingency			$ 710,000	After the 1996 flood, repairs were needed to the electrical system. It is referenced in the historical report that it is recommended to have a contingency fund in case another flood event occurs for potential repairs
				$ 1,930,000	

Routine Maintenance (Estimated Costs in $2018)

	Item	Annual Maint Costs	Five Year Maint Costs	Scope of Work
1	Inspect Timber Lining and Replace Rotting Pieces as Needed	$ 75,000		Physically inspect all of the timber lining for any rotten timber boards. Assume that 10% of lining will need to be replaced per year.
2	Inspect Lock Walls and Region behind Lock Walls for Movement	$ 4,000		
3	Inspect Masonry for Structural Integrity	$ 4,000		Visually inspect masonry for structural integrity. It is structurally acceptable to have 1 missing block sporadically. Repair is required if two blocks are missing adjacent to each other
4	Remove Debris as Needed	$ 17,000		As needed; it is estimated this activity will be needed post storms, approximately three times per year. This activity involves hiring a team to utilize a barge and backhoe and float through the lock system to remove debris.
5	Hydraulic Fluid Sampling	$ 16,000		Environmentally friendly Panalin hydraulic fluid is recommended to be sampled annually per vendor. This means establishing a baseline sample, and sampling each year for fluid for water content, viscosity, particulates and filtering and adding hydraulic fluid as needed. Estimate is based on a lump sum of testing and adding hydraulic fluid.
6	Replace One (1) Set of Gate and Valve Hydraulic Cylinder Operators	$ 60,000		The intent is to replace a set of hydraulic cylinder operators (Both gate and valve) for a gate each year. For year two of operation, install gate #1's refurbished hydraulic cylinders for Gate #2. Salvage Gate #2's hydraulic cylinder operators and refurbish and store as spares. For year three of operation, install gate #2's refurbished hydraulic cylinders on Gate #3, and so on. Once all of the gates have been done, start the cycle over for Gate #1.
7	Lubricate Systems	$ 29,000		Relubricate systems annually for increased equipment longevity and performance.
8	Run Generator on Load Bank Monthly	$ 5,000		This activity will reoccur monthly and run for a minimum of 30 minutes per manufacturer recommendations; Cost reflected is the projected annual cost for this activity
9	Limit Switch Inspection / Repair / Replacement	$ 57,000		Inspect / repair / and replace limit switches as need for control functionality

10	Hydrographic Survey and Dredging		$	188,000	As needed, assume removal of 2 feet of sedimentation in 2 lock chambers every 5 years.
11	Adjust Retention Diagonals on Miter Gate Leaf		$	30,000	This activity would allow the gates to level and not attempt to swing open or closed due to gravity. Over time of settling, the gates can get out of level and cause damage on other equipment such as the miter blocks
12	Testing and Correction of Grounding System		$	32,000	Test grounding system on a routine basis to verify the electrical system is grounded correctly; repair as needed.
13	Replace all Hydraulic Hoses		$	48,000	Hydraulic hoses typically have a 5 year life, replacing hoses every 5 years reduces the potential for leaks of hydraulic fluid.
14	Slide Gate Inspection / J seal & J clamp PM		$	246,000	Valve seals have a low design life and will need to be replaced as needed. This estimate assumed half of the valve seals need to be replaced every 5 years to be conservative.
	Total Cost Summary	***$ 270,000***	***$***	***550,000***	

Notes:

- A 30% contingency + a 20% engineering, design and permitting contingency is included in each value

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project: Willamette Falls Locks	by: KMB/CMK	sheet no.
location: West Linn, OR	10/10/2018	
client: Summit Strategies		job no.
Critical Need Requirements		

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost	Cost (2018 $)
	Erosion Repair and Ground Improvements at Lock Chamber 3				
1.00	Remove Steel Plates and Asphalt Pavement at Sinkhole Locations (2 Sinkholes)	825	SF	$ 6.00	$ 4,950
1.01	Excavate Sinkholes to Timber Lagging	5	DA	$ 2,500	$ 12,500
1.02	Remove and Replace Deteriorated Timber Lagging	1,205	LF	$ 32	$ 37,960
1.03	Furnish & Install Propex Geotextile 401	4,360	SF	$ 1.00	$ 4,360
1.04	Furnish & Install Controlled Density Fill	305	CY	$ 250	$ 76,350
1.05	Furnish & Install Base Course	8	CY	$ 75	$ 580
1.06	Furnish & Install New Asphalt Paving	10	TON	$ 144	$ 1,440
1.07	Utility repair allowance	1	LS	$ 20,000	$ 20,000
	Erosion Repair and Ground Improvements at Lock Chamber 3 Subtotal				***$ 159,000***
	Erosion Repair and Ground Improvements at Gate 4 Monolith (Corps Side)				
2.00	Gate 4 Monolith Repair	1	LS	$ 500,000	$ 500,000
2.01	Utility repair allowance	1	LS	$ 7,500	$ 7,500
	Erosion Repair and Ground Improvements at Lock Chamber 4 Subtotal				***$ 508,000***
	Control Running Water Via Drainage Trench at Gate 4 (Corps Side)				
3.00	Furnish and Install drainage trench at Gate 4 (Corps side)	1	LS	$ 14,700	$ 14,700
	Control Running Water Via Drainage Trench at Gate 4 (Corps Side) Subtotal				***$ 15,000***
	Hydrographic survey				
4.00	Hydrographic survey	1	LS	$ 60,000	$ 60,000
	Hydrographic SurveySubtotal				***$ 60,000***
	Reinstall Timber Brace for Wall Lagging, Lock 1 Mill Side				
5.00	Reinstall Timber Brace for Wall Lagging (Lock 1 Mill Side)	1	LS	$ 1,750	$ 1,750
	Reinstall Timber Brace for Wall Lagging (Lock 1 Mill Side) Subtotal				***$ 2,000***

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	10/10/2018
sheet no.	
job no.	

Replace Walkway and Walkway Framing Supports

6.00	Replace Walkway Framing Supports (Corps Side of Guard Lock and one at Gate 2)	1	LS	$	26,421	$	26,430
6.01	Remove and Dispose of Existing Timber Waolkways on Corps Side	5,930	LF	$	5	$	29,650
6.02	Furnish and Install New 3x12 Treated Timber	5,930	LF	$	21	$	124,530
	Replace Walkway and Walkway Framing Supports (Corps Side of Guard Lock) Subtotal					***$***	***181,000***

Stabilize Chamber Walls in Select Locations

7.00	Chamber 2 - Mill Side: Rock Anchors	3	EA	$	15,000	$	45,000
7.01	Chamber 2 - Mill Side: Access Contingency	1	LS	$	16,500	$	16,500
7.02	Chamber 3 - Corps and Mill Side: Rock Anchors	4	EA	$	15,000	$	60,000
7.03	Chamber 3 - Corps and Mill Side: Access Contingency	1	LS	$	2,000	$	2,000
7.04	Chamber 4 - Corps Side: Rock Anchors	25	EA	$	15,000	$	375,000
7.05	Chamber 4 - Corps Side: Access Contingency	1	LS	$	40,500	$	40,500
7.06	Guard Lock - Mill Side: Rock Anchors	25	EA	$	15,000	$	375,000
7.07	Guard Lock - Mill Side: Access Contingency	1	LS	$	137,500	$	137,500
	Stabilize Chamber Walls in Select Locations Subtotal					***$***	***1,052,000***
	Additional contingency to account for potential increased quantity of anchors (assume 10 add'l anchors @ $17.5K ea)					***$***	***175,000***
	Stabilize Chamber Walls in Select Locations Subtotal					***$***	***1,227,000***

Stabilize Gate Monoliths in Select Locations

8.00	Gate 4 - Corps and Mill Side: Rock Anchors	10	EA	$	15,000	$	150,000
8.01	Gate 4 - Corps and Mill Side: Access Contingency	1	LS	$	65,000	$	65,000
8.02	Gate 5 - Corps and Mill Side: Rock Anchors	10	EA	$	15,000	$	150,000
8.03	Gate 5 - Corps and Mill Side: Access Contingency	1	LS	$	55,000	$	55,000
8.04	Gate 6 - Mill Side: Rock Anchors	5	EA	$	15,000	$	75,000
8.05	Gate 6 - Mill Side: Access Contingency	1	LS	$	27,500	$	27,500
8.06	Gate 7 - Mill Side: Rock Anchors	5	EA	$	15,000	$	75,000
8.07	Gate 7 - Mill Side: Access Contingency	1	LS	$	27,500	$	27,500
	Stabilize Gate Monoliths in Select Locations Subtotal					***$***	***625,000***
	Additional contingency to account for potential increased quantity of anchors (assume 6 add'l anchors @ $20K ea)					***$***	***120,000***
	Stabilize Gate Monoliths in Select Locations Subtotal					***$***	***745,000***

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project: Willamette Falls Locks | by: KMB/CMK | sheet no.
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client: Summit Strategies | job no.
Critical Need Requirements

Replace Gudgeon Anchors

9.00	(12) Gudgeon Anchors Parallel to Lock: Remove Existing Gudgeon Anchors & Assoc Hardware	3,381	LB	$	1.00	$	3,390
9.01	Gudgeon Anchors Parallel to Lock: Furnish and Install 8'-9.5" Long 1.75" Dia. Tie Rods (2/Gate for 6 Gates)	865	LB	$	10.00	$	8,650
9.02	Gudgeon Anchors Parallel to Lock: Furnish and Install Link Plates (4x1x10") (4/Gate For 6 Gates)	273	LB	$	10.00	$	2,730
9.03	Gudgeon Anchors Parallel to Lock: Furnish & Install Support Plates (4x1.75x12") (4/Gate For 6 Gates)	573	LB	$	10.00	$	5,730
9.04	Gudgeon Anchors Parallel to Lock: Furnish & Install Bearing Plates (8x1.25x10") (2/Gate For 6 Gates)	341	LB	$	10.00	$	3,410
9.05	Gudgeon Anchors Parallel to Lock: Furnish & Install Eccen. Support Plates (7x1x9.5") (4/Gate For 6 Gates)	453	LB	$	10.00	$	4,540
9.06	Gudgeon Anchors Parallel to Lock: Furnish and Install 8'-9.5" Long 1.75" Dia. Anchor Rods (2/Gate for 6 Gates)	865	LB	$	10.00	$	8,650
9.07	Gudgeon Anchors Parallel to Lock: Furnish and Install 1.75" Dia. Turnbuckle Hex(2/Gate for 6 Gates)	12	EA	$	150	$	1,800
9.08	(2) Gudgeon Anchors Perpendicular to Lock: Remove Existing Gudgeon Anchors (Gate 4 & 5 on Mill Side)	421	LB	$	1.00	$	430
9.09	(2) Gudgeon Anchors Perpendicular to Lock: Furnish & Install 8'-9.5" Long 1.75" Dia Tie Rods (Gate 4 & 5 on Mill Side)	144	LB	$	10.00	$	1,440
9.10	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Link Plate (4x1x10") (4 Total)	45	LB	$	10.00	$	450
9.11	Gudgeon Anchors Perpendicular to Lock: Furnish and Install Support Plate (4x1.75x12") (4 Total)	95	LB	$	10.00	$	950
9.12	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Bearing Plates (8x1.25x10") (2 Total)	57	LB	$	10.00	$	570
9.13	Gudgeon Anchors Perpendicular to Lock: Furnish and Install Eccen. Support Plate (7x1x9.5") (4 Total)	76	LB	$	10.00	$	760
9.14	Gudgeon Anchors Perpendicular to Lock: Furnish and Install DWYIDAG Anchor Rod (2 Total)	2	EA	$	15,000.00	$	30,000
9.15	Gudgeon Anchors Perpendicular to Lock: Furnish & Install 1.75" Dia Turnbuckle Hex (2 Total)	2	EA	$	150.00	$	300
9.16	(10) Gudgeon Anchors Perpendicular to Lock: Abandon Existing Anchor Rods: Remove Rest of Connection	2,169	LB	$	1.00	$	2,170
9.17	Gudgeon Anchors Perpendicular to Lock: Furnish and Install 9'-9.5" Long 1.75" Dia. Tie Rod (2/Gate for 5 Gates)	803	LB	$	10.00	$	8,030
9.18	Gudgeon Anchors Perpendicular to Lock: Furnish and Install Link Plate (4x1x10") (4/Gate For 5 Gates)	227	LB	$	10	$	2,270
9.19	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Support Plate (4x1.75x12") (4/Gate For 5 Gates)	477	LB	$	10	$	4,770
9.20	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Bearing Plate (8x1.25x10") (2/Gate For 5 Gates)	284	LB	$	10	$	2,840
9.21	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Eccen. Support Plate (7x1x9.5") (4/Gate For 5 Gates)	378	LB	$	10	$	3,780
9.22	Gudgeon Anchors Perpendicular to Lock: Furnish & Install DWYIDAG Anchor Rod (2/Gate for 5 Gates)	10	EA	$	15,000	$	150,000
9.23	Gudgeon Anchors Perpendicular to Lock: Funish and Install 1.75" Dia. Turnbuckle Hex(2/Gate for 5 Gates)	10	EA	$	150	$	1,500
9.24	Remove existg and Form and Pour new concrete trenches at (12) locations (anchors perpendicular to lock)	9	CY	$	2,000	$	18,000
9.25	Trench plates over new concrete trenches at (12) locations	10	EA	$	500	$	5,000
9.26	Access Contingency: Gate 2	1	LS	$	13,000	$	13,000
9.27	Access Contingency: Gate 3	1	LS	$	6,000	$	6,000
9.28	Access Contingency: Gate 4	1	LS	$	13,000	$	13,000
9.29	Access Contingency: Gate 5	1	LS	$	11,000	$	11,000
9.30	Access Contingency: Gate 6	1	LS	$	18,000	$	18,000
9.31	Access Contingency: Gate 7	1	LS	$	11,000	$	11,000
	Replace Gudgeon Anchors Subtotal					***$***	***345,000***

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Critical Need Requirements

Operator Anchorage Repair

10.00	Demolish and Remove Existing Concrete Base (3.5'x2'x3.5' Triangular Pyramid + 3.5' Cube) for 6 Locations	13	CY	$	500	$	6,500
10.01	Remove Existing Anchors	92	LB	$	1	$	100
10.02	Pour Concrete Base (3.5'x2'x3.5' Triangular Pyramid + 3.5' Cube)	13	CY	$	1,250	$	16,250
10.03	Furnish 3/4" dia anchor rods (60' long ea)	360	LF	$	5	$	1,800
10.04	Drill (4) 13' long 4" Dia. Holes at 6 Different Locations	312	LF	$	150	$	46,800
10.05	Primary Grout	12	CY	$	1,000	$	11,560
10.06	Access Contingency	6	LS	$	12,500	$	75,000
10.07	Proof Testing of Anchor	24	EA	$	7,500	$	180,000
	Operator Anchorage Repair Subtotal					***$***	***339,000***

Replace Pedestrian Draw Bridge over Lock 4

11.00	Replace Pedestrian Draw Bridge Over Lock 4 (Assume 10' Width x 45' Length)	450	SF	$	750	$	337,500
	Pedestrian Draw Bridge Over Lock 4 Subtotal					***$***	***338,000***

Replace Gangway Float at Downstream Approach

12.00	Replace Gangway Float at Downstream Approach	250	SF	$	500	$	125,000
	Replace Gangway Float at Downstream Approach Subtotal					***$***	***125,000***

Install new Piles in Concrete Foundation at Downstream Approach

13.00	Install (2) New Piles in Existing Undermined Concrete Foundation	2	EA	$	25,000	$	50,000
	Install new Piles in Concrete Foundation at Downstream Approach Subtotal					***$***	***50,000***

Replace Timber Lining in Chamber #3

14.00	Remove and Dispose of Existing Timber Lining in Chamber #3	6,114	LF	$	5	$	30,570
14.01	Furnish and Install new 3x12 Treated Timber	6,114	LF	$	21	$	128,400
	Replace Timber Lining in Chamber #3 Subtotal					***$***	***129,000***

Replace all Hydraulic Hoses

15.00	Inspect & document hoses, collect proper size and data for ordering	40	HR	$	150	$	6,000
15.01	Replace 1/2" valve operator hoses, 1/2" ID, 3'L, 1000# rated - 3000# rated	56	EA	$	100	$	5,600
15.02	Replace 144 hoses with 3/4" ID, 3'L, 1000# rated - 3000# rated	144	EA	$	130	$	18,720
15.03	man hours to replace hoses	56	HR	$	110	$	6,160
	Replace Hydraulic Hoses Subtotal					***$***	***36,500***

Sample Hydraulic Fluid

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	Critical Need Requirements						
16.00	Sample Hydraulic Fluid / Replace Hydraulic Fluid	7	EA	$	1,000	$	7,000
	Hydraulic Fluid Subtotal					***$***	***7,000***

Detailed Inspection/Documentation of all Fill/Empty Valves

17.00	Manhours for inspection and operation of each valve	200	HR	$	110	$	22,000
17.01	Inspection of Gate 1 & Gate 7 slide gate valves	2	DY	$	5,000	$	10,000
	Detailed inspection/documentation of all fill/empty valves & valve operators Subtotal					***$***	***32,000***

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Repairs to Valves (Projected)

18.00	Valve actuator cylinder refurbish	10	EA	$	1,850	$	18,500
18.01	man hours to fix valves	640	HR	$	110	$	70,400
18.02	Total Valve Replacement	7	EA	$	10,000	$	70,000
18.03	Total Valve Replacement labor - diver	2	DY	$	5,000	$	10,000
18.04	Dewatering	2	LS	$	35,000	$	70,000
18.05	man hours to replace valves	320	HR	$	110	$	35,200
	gate 7 valve seal and perimeter seal					$	-
18.06	gate 7 perimeter seal material	8	EA	$	1,000	$	8,000
18.07	gate 7 valve seal repair - diver	4	DY	$	5,000	$	20,000
18.08	Limit switch Repair	2	LS	$	26,000	$	52,000
	Repairs to valves (estimated) Subtotal					***$***	***354,100***

Lubricate all Systems

19.00	Lubricant	1	LS	$	500	$	500
19.01	Manhours to complete lubrication	160	HR	$	110	$	17,600
	Lubricate all systems Subtotal					***$***	***18,100***

Install New Gate & Valve Operating Cylinders at Gate #1

20.00	Valve actuator cylinders	8	EA	$	2,000	$	16,000
20.01	gate operator cylinder	2	EA	$	4,000	$	8,000
20.02	Manhours to uninstall / install	120	HR	$	110	$	13,200
	Install Gate & Valve Operating Cylinders at Gate #1 Subtotal					***$***	***37,200***

Salvage, Rebuild and Store Cylinders from Gate #1

21.00	Gate operator cylinder rebuild + transportation	2	EA	$	1,850	$	3,700
21.01	Slide gate operator cylinder rebuild + transportation	8	EA	$	2,100	$	16,800
	Salvage, Rebuild and Store Cylinders from Gate #1 Subtotal					***$***	***20,500***

Remove Debris

22.00	Mobilize/Demobilize	1	LS	$	5,214	$	5,220
22.01	barge rental	10	DA	$	1,034	$	10,340
22.02	backhoe rental + operator	10	DA	$	514	$	5,140
22.03	Waste disposal/delivery	2,000	EA	$	0.95	$	1,900
	debris removal Subtotal					***$***	***22,600***

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Critical Need Requirements

Install Fire Protection Equipment

23.00	Install 6" pipe with supports	3,105	LF	$	100	$	310,500
23.01	Install branch, valve and hose reel every 100'	20	EA	$	2,000	$	40,000
23.02	Pump Contingency - in case city water is not enough pressure	2	EA	$	68,250	$	136,500
	Fire protection equipment Subtotal					***$***	***487,000***

Inspect / Repair Generator, Install Packaged Load Bank

24.00	Generator inspection and full service	5	HR	$	150	$	950
24.01	New Generator	1	EA	$	39,910	$	39,910
	Inspect Generator, repair as needed and install a packaged load cell Subtotal					***$***	***40,900***

Repair Broken Luminaires

25.00	LED Luminaires	4	EA	$	1,723	$	6,890
25.01	Demolition Wiring - within poles only	110	LF	$	3	$	290
25.02	Installation Wiring - within poles only	110	LF	$	8	$	830
25.03	Switch Estimation	4	EA	$	286	$	1,150
25.04	Junction Box Estimation	4	EA	$	48	$	200
	Lighting System Subtotal					***$***	***9,400***

Inspect / Document of Electrical Distribution System

26.00	Inspection - electrician, electrical engineer	240	HR	$	150	$	36,000
26.01	drafting hours	320	HR	$	120	$	38,400
	Inspection/Documentation of Electrical/Power System Subtotal					***$***	***74,400***

Repair of Electrical Distribution System

27.00	Contingency Estimate	1	LS	$	50,000	$	50,000
	Electrical distribution system- conduit, conductors, enclosures, and supports Subtotal					***$***	***50,000***

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Critical Need Requirements		

Assumptions:

1.02 Assume 3x12 treated timber members
1.07 Assumes existing cabling can be reused and is pulled through new conduit
7.00 Price includes materials and installation (typical for all of task)
7.01 Access contingency costs account for how difficult it will be to get to the location and install the anchors
9.00 Remove and Replace in Kind on Gates 2 -7 (6 total), assume removing same weight as New Anchor Components
9.02 Assume 0.284 lb/ft^3 steel density to find total weight of steel (for all LB Quantities in task)
9.06 Assume length of embedded anchor rod is same as tie rod
10.00 Assumed amount of concrete based on As Builts of 1968

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Moderate Need - 5 Year Requirements		

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost	Cost (2018 $)
	Replace Chamber Ladders				
29.00	Replace Chamber Ladders	1	LS	$ 26,400	$ 26,400
	Replace Chamber Ladders Subtotal				***$ 27,000***
	Replace Damaged Guardrails (Railing on Mill Side from Gate 1 to Gate 5, and Guard Lock)				
30.00	Removal of Existing Guardrail (Railing on on Mill Side from Gate 1 to Gate 5, and Guard Lock)	1,051	LF	$ 8.00	$ 8,410
30.01	Chamber 1 (Chamber Length: 210' on One Side of Channel)	210	LF	$ 50	$ 10,500
30.02	Chamber 2 (Chamber Length: 210' on One Side of Channel)	210	LF	$ 50	$ 10,500
30.03	Chamber 3 (Chamber Length: 210' on One Side of Channel)	210	LF	$ 50	$ 10,500
30.04	Chamber 4 (Chamber Length: 210' on One Side of Channel)	210	LF	$ 50	$ 10,500
30.05	Guard Lock (Chamber Length: 211' on One Side of Channel)	211	LF	$ 50	$ 10,550
	Guard Rails Subtotal				***$ 61,000***
	Install New Hydraulic Power Units				
31.00	New HPU Cost	14	EA	$ 14,500	$ 203,000
31.01	Install/Demo Costs	14	LS	$ 5,000	$ 70,000
31.02	Pipe Replacement - 1"	2,646	LF	$ 26	$ 67,940
31.03	pipe demolition - 1"	2,646	LF	$ 3	$ 8,470
31.04	valves - globe- 1"	140	EA	$ 322	$ 45,050
	Install new Hydraulic Power Units Subtotal				***$ 394,500***
	Replace Bottom Seals				
32.00	Seal material cost	14	EA	$ 750	$ 10,500
32.01	Install manhour costs - Diver gate 1 & 7	4	DY	$ 5,000	$ 20,000
32.02	Dewatering - lock chamber 2, 3, 4, canal, guard lock	2	LS	$ 35,000	$ 70,000
32.03	Manhours for seal install - gate 2, 3, 4, 5, 6	160	HR	$ 110	$ 17,600
	Bottom Seals Subtotal				***$ 118,100***

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Moderate Need - 5 Year Requirements			

Replace Lighting System

33.00	Replace Light Poles - 30' Aluminium	21	EA	$ 3,575	$ 75,080
33.01	Bracket Arms - 30' high	21	EA	$ 2,990	$ 62,790
33.02	LED Luminaires	19	EA	$ 1,723	$ 32,730
33.03	1000W flood lights replacement with LED's	4	EA	$ 2,795	$ 11,180
33.04	Demolition Wiring - within poles only	1,275	LF	$ 3	$ 3,290
33.05	Demolition poles	21	EA	$ 73	$ 1,550
33.06	Installation Wiring - within poles only	1,275	LF	$ 8	$ 9,620
33.07	Switch Estimation	120	EA	$ 286	$ 34,320
33.08	Junction Box Estimation	46	EA	$ 48	$ 2,220
33.09	20% Contingency for associated work & congested area work	1	LS	$ 42,736.00	$ 42,740
33.10	Guardlock wiring Replacement				$ -
33.11	Wiring installed overhead; #8 + overhead multiplier - corp side	1,236	LF	$ 11	$ 13,050
33.12	New conduit - mill side	67	LF	$ 16	$ 1,080
33.13	New wiring - mill side	379	LF	$ 6	$ 2,250
33.14	Wiring Demolition	1,615	LF	$ 3	$ 4,160
33.15	Conduit Demolition	100	LF	$ 3	$ 280
33.20	Wiring Replacement - Gate 1-5				$ -
33.21	Demolition wiring	19,815	LF	$ 3	$ 51,010
33.22	Demolition conduit	994	LF	$ 3	$ 2,690
33.23	Install 3/4" Conduit - 20% contingency for repair	419	LF	$ 13	$ 5,640
33.24	Install 1" Conduit - 20% contingency for repair	207	LF	$ 16	$ 3,330
33.25	Install 1.25" Conduit - 20% contingency for repair	368	LF	$ 19	$ 6,890
33.26	Install #8 wiring	11,845	LF	$ 8	$ 89,320
33.27	Install #10 wiring	5,680	LF	$ 6	$ 33,600
33.28	Install #12 wiring	2,290	LF	$ 5	$ 12,360
	Lighting System Subtotal				***$ 501,200***

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Replace/Refurbish Control System

34.00	Install new 2" conduit	5,500	LF	$ 26	$ 141,570
34.01	Install new 3/4" conduit	5,500	LF	$ 13	$ 74,010
34.02	Install new fiber optic cable - 4x 3/4" conduit run	22,000	LF	$ 1	$ 24,510
34.03	Install new wire #8, 3 conduit - 5x 2" run	33,000	LF	$ 8	$ 248,820
	Install of conduit through 2 lock chambers:				$ -
34.04	Dewatering	2	LS	$ 35,000	$ 70,000
34.05	Concrete - saw cut	240	LF	$ 8	$ 1,920
34.06	Waste Management - Concrete / oily waste	6	TN	$ 100	$ 610
34.07	install new concrete/re-enforced	3	CY	$ 850	$ 2,550
34.08	20x20 Enclosure NEMA 4X + install	4	EA	$ 1,000	$ 4,000
34.09	10x10 control/power Enclosure NEMA 4x + install	28	EA	$ 500	$ 14,000
34.10	HMI enclosure NEMA 4x + install	7	EA	$ 250	$ 1,750
34.11	Consoles for control houses + install	2	EA	$ 2,500	$ 5,000
34.12	Remote I/O's	15	EA	$ 400	$ 6,000
34.13	HMI screens + install	9	EA	$ 900	$ 8,100
34.14	PLC + install	1	EA	$ 10,000	$ 10,000
34.15	PLC programming	1	LS	$ 75,000	$ 75,000
34.16	Commissioning / start up	1	LS	$ 75,000	$ 75,000
34.17	Lock Chamber ultrasonic level sensors + backup, Lock chambers 1, 2, 3, 4, canal, guard lock	12	EA	$ 1,000	$ 12,000
34.18					$ -
34.19					$ -
	Control System Replacement Subtotal				***$ 774,840***

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Long Term Requirements		

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost	Cost (2018 $)
	Repair Loss of Masonry at Lowest Course at the Downstream Approach, Mill Side				
35.00	Replace Masonry at Lowest Course with Reinforced Concrete	1	LS	$ 150,000	$ 150,000
	Loss of Masonry at Lowest Course at Downstream Approach, Mill Side Subtotal				***$ 150,000***

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Future Capital Costs		

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost	Cost (2018 $)
	Inspect/Refurbish Gate Leaves				
36.00	Cost from 2009 Inspection and repair work in $2018	1	LS	$ 778,438	$ 778,440
	Refurbish Doors Subtotal				***$ 778,500***
	Flood Repair Contingency				
37.00	Repair contingency from 1996 flood repair work in $2018	1	LS	$ 449,960	$ 449,960
	Flood Contingency Subtotal				***$ 450,000***

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Routine Maintenance		

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost	Cost (2018 $)
	Inspect Timber Lining and Replace Rotting Pieces as Needed				
1.00	2 Inspectors for 40 Hours (1 Week for all Chambers)	80	HR	$ 75	$ 6,000
1.01	Boat for 5 days	5	DY	$ 300	$ 1,500
1.02	Replacement of 5% of Timber Lining Per Year	1,885	LF	$ 21	$ 39,580
	Inspect Timber Lining and Replace Rotting Pieces as Needed Subtotal				***$ 48,000***
	Inspect Lock Walls and Region behind Lock Walls for Movement				
2.00	Inspect lock walls and region behind lock walls for movement	1	LS	$ 2,100	$ 2,100
	Inspection Subtotal				***$ 2,100***
	Inspect Masonry for Structural Integrity				
3.00	Inspect masonry for 2 missing rocks adjacent to each other to maintain structural integrity	1	LS	$ 2,100	$ 2,100
	Inspection Subtotal				***$ 2,100***
	Remove Debris as Needed				
4.00	barge rental	5	DA	$ 795	$ 3,980
4.01	backhoe rental + operator	5	DA	$ 395	$ 1,980
4.02	Waste disposal/delivery	1	EA	$ 2,000	$ 2,000
4.03	mobe/demobe	1	EA	$ 2,500	$ 2,500
	Remove debris as needed Subtotal				***$ 10,500***
	Hydraulic Fluid Sampling				
5.00	Fluid Sampling and Filtering	1	LS	$ 10,000	$ 10,000
	Replace Hydraulic Hoses Subtotal				***$ 10,000***

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Replace One (1) Set of Gate and Valve Hydraulic Cylinder Operators

6.00	Valve actuator cylinders	8	EA	$	2,000	$	16,000
6.01	gate operator cylinder	2	EA	$	2,250	$	4,500
6.02	Manhours to uninstall / install	160	HT	$	110	$	17,600
	Replace one (1) set of gate and valve hydraulic cylinder operators					***$***	***38,100***

Lubricate Systems

7.00	Lubricant	1	LS	$	500	$	500
7.01	Manhours to complete lubrication	160	HR	$	110	$	17,600
	Lubricate all systems Subtotal					***$***	***18,100***

Run Generator on Load Bank Monthly

8.00	Operator Time	24	HR	$	110	$	2,640
8.01	Diesel fuel	24	GA	$	4	$	100
	Run generator on load cell for at least 30 minutes Subtotal					***$***	***2,800***

Limit Switch Inspection / Repair / Replacement

9.00	Limit Switch Inspection	40	HR	$	110	$	4,400
9.01	Replace gate limit switches	14	EA	$	1,000	$	14,000
9.02	Manhours to complete repairs/replacements	160	HR	$	110	$	17,600
	Limit Switch Subtotal					***$***	***36,000***

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Routine Maintenance			

Hydrographic Survey and Dredging

10.00	Mobilization and Demobilization for Dredging Only	1	LS	$	10,000	$	10,000
10.01	Hydrographic Survey (every 5 years)	1	LS	$	60,000	$	60,000
10.02	Downstream Approach (Chamber Size: 130' x 45', Dredge Depth: 4')	-	CY	$	30	$	-
10.03	Chamber 1 (Chamber Size: 210' x 45', Dredge Depth: 4')	700	CY	$	30	$	21,000
10.04	Chamber 2 (Chamber Size: 210' x 45', Dredge Depth: 4')	700	CY	$	30	$	21,000
10.05	Chamber 3 (Chamber Size: 210' x 45', Dredge Depth: 4')	-	CY	$	30	$	-
10.06	Chamber 4 (Chamber Size: 210' x 45', Dredge Depth: 4')	-	CY	$	30	$	-
10.07	Canal Basin (Chamber Size: 1272' x 45', Dredge Size: 4')	-	CY	$	30	$	-
10.08	Guard Lock (Chamber Size: 211' x 42'-5 7/16", Dredge Depth: 4')	-	CY	$	30	$	-
	Hydrographic Survey / Dredging Subtotal	-				***$***	***120,000***

Adjust Retention Diagonals on Miter Gate Leaf

11.00	barge rental	5	DA	$	795	$	3,980
11.01	backhoe rental + operator	5	DA	$	395	$	1,980
11.02	Manhours to complete task	120	HR	$	110	$	13,200
11.03						$	-
	Adjust retention diagonals Subtotal					***$***	***19,200***

Testing and Correction of Grounding System

12.00	Electrician time and Materials	1	LS	$	20,000	$	20,000
	Testing and Correction of grounding system Subtotal					***$***	***20,000***

Replace all Hydraulic Hoses

13.00	Replace 1/2" valve operator hoses, 1/2" ID, 3'L, 3000# rated	56	EA	$	100	$	5,600
13.01	Replace 144 hoses with 3/4" ID, 3'L, 3000# rated	144	EA	$	130	$	18,720
13.02	man hours to replace hoses	56	HR	$	110	$	6,160
	Replace all hydraulic hoses Subtotal					***$***	***30,500***

1601 5th Avenue, Suite 1300
Seattle, Washington 98101
p (206) 382-0600

project: Willamette Falls Locks	by: KMB/CMK	sheet no.
location: West Linn, OR	10/10/2018	
client: Summit Strategies		job no.
Routine Maintenance		

Slide Gate Inspection / J seal & J clamp PM

14.00	J seal and J clamp material costs	28	EA	$	1,000	$	28,000
14.01	Demolition / Installation costs - diver gate 1/7	4	DY	$	5,000	$	20,000
14.02	Dewatering - for repairs for valves on gates 2/3/4/5/6	2	LS	$	35,000	$	70,000
14.03	Manhours for repairs on gates 2/3/4/5/6	320	HR	$	110	$	35,200
14.04	Inspection Costs	40	HR	$	110	$	4,400
	J seal & J clamp PM Subtotal					***$***	***157,600***

Assumptions:

1.02 Total price is 3x the cost of a 3"x12" to account for installation and delivery

	Cost Accrued	Raw Estimated Costs	Annualized Costs ($2018)	Annualized Costs with Contengancy ($2018)
Annual Maintenance Costs	1	$ 168,000.00	$ 168,000.00	$ 262,080.00
Five Year Maintence Items	5	$ 348,000.00	$ 69,600.00	$ 108,576.00
Gate Inspection/Repair	25	$ 778,500.00	$ 31,140.00	$ 48,578.40
Flood Repairs	30	$ 450,000.00	$ 15,000.00	$ 23,400.00
				$ 443,000.00

APPENDIX B – KPFF DRAFT FIELD REPORT

FIELD REPORT - *DRAFT*

1601 Fifth Avenue, Suite 1300
Seattle, WA 98101
(206) 382-0600 I Fax (206) 382-0500

To:	**Michelle Giguere, Partner Summit Strategies**	Date:	**July 6, 2018**
		Job No.	**1800288**
		File No.	
		Location:	**West Linn, OR**
By:	**Dan Hartford, PE Bob Riley, PE, SE**	Weather:	**Overcast, High 50's**
Project:	**Willamette Falls Locks**	Others Present:	**Michelle Giguere & Kristine Phillips Everetz – Summit Strategies; Patrick Duyck - USACE**

The following was observed:

We met on site on May 30, 2018 at 8:30 am to perform a general condition assessment of the Willamette Falls Locks on the Willamette River in West Linn, Oregon. The lock is comprised of a series of 7 gates and 6 chambers. Gate 1 is furthest downstream and Gate 7 is furthest upstream, closest to the Falls. The uppermost chamber is the 210 foot long Guard Lock, followed by the approximately 1,275 foot Canal Basin, followed by Locks 4, 3, 2 and 1, each of which are also 210 feet long. A site overview map is provided by the USACE at the following link: Willamette Falls Locks Area Map.pdf (www.nwp.usace.army.mil/Portals/24/docs/maps/Willamette_Falls_Locks_area_map.pdf).

The Corps owns and operates the West Linn side of the lock, whereas the West Linn Paper Company and Portland General Electric (PGE) have been operating on the river side of the lock. It is our understanding that West Linn Paper Company has ceased operations at the facility within the last 6 months.

The facility was opened to operations in 1873 and has been in a non-operational status since 2011. Gates #1 & #6 are currently kept in an open position, with the remaining 5 gates kept closed. Lock chambers 1 thru 4 are currently kept empty, with the Guard Lock and Canal Basin kept full. It is our understanding that the US Army Corps of Engineers owned and maintained the facility from 1915 until present day, with much less maintenance in recent years. General observations are consistent with a facility that has been well maintained over the years, as much of the infrastructure was still in fair condition, considering the 145 year age of the facility.

It should be noted that performing a full detailed conditions assessment on a facility of this size would take several days. The results reported herein are based on spending 2 hours at the facility and are only based on our visual observations and available historic documentation. No material testing or detailed measurements were taken during our site visit.

General

All lock gates are miter style, consisting of two leaf structures supported by timber quoin blocks at the lock wall and by timber miter blocks at the lock centerline. When open, each gate leaf swings on a pintle bearing located under the quoin block and is held in place by two gudgeon anchors, one parallel to the lock to support the gate in the open position, and one lateral to the lock, in line with the gate when in the closed position. Each miter gate leaf is constructed from a steel frame with a steel face skin on the upstream surface and a timber facing on the downstream face. Each gate leaf is operated by a hydraulic cylinder located just upstream of the quoin block and anchored to the top of the lock wall. Figure 1 provides a typical plan view of the miter gates (note that the lock centerline is coincident with the miter block and only one of the two gate leaves is shown).

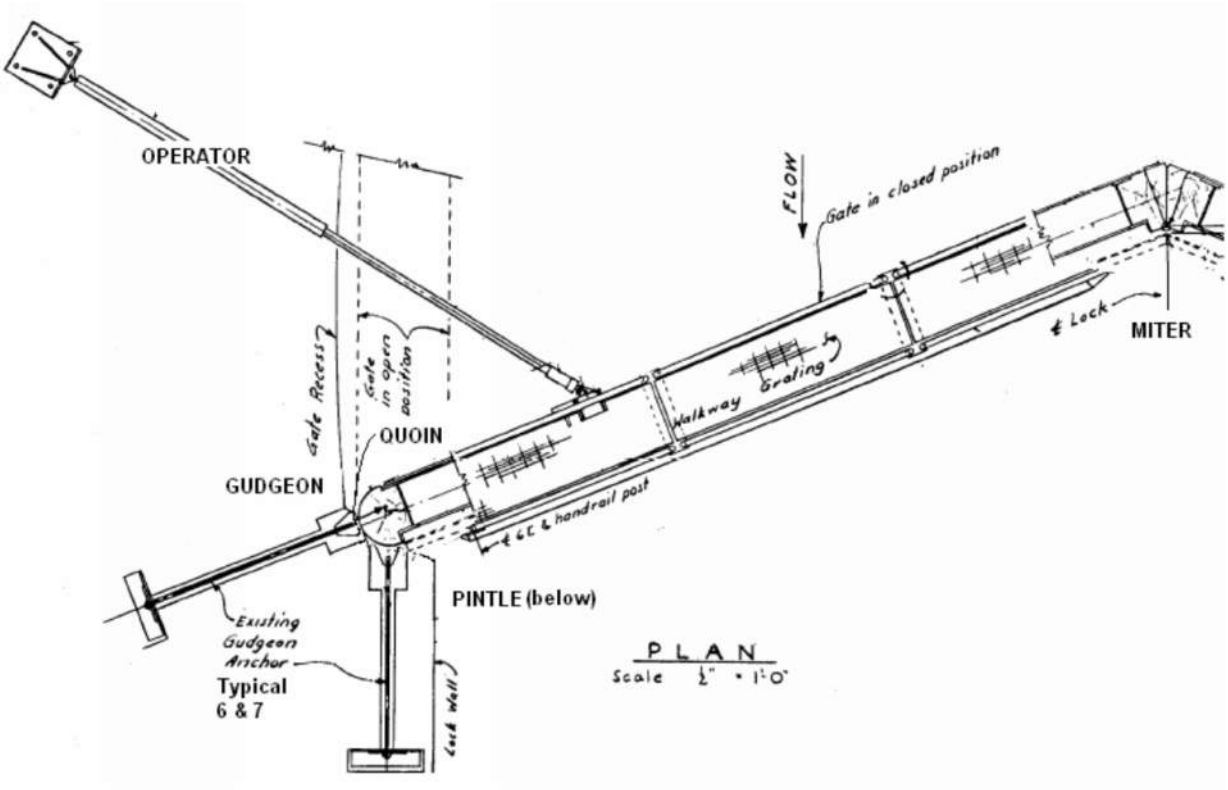

Figure 1 - Typical Miter Gate Plan

The gudgeon anchors are comprised of steel rods that are connected to a link plate that is then attached to a ground anchor rod. Gudgeon anchor configuration varies from gate to gate due to

geometric constraints at the site. The method of ground anchor rod attachment to the foundation is below grade and unknown.

The lock fill/empty system consists of hydraulic cylinder operated slide gates installed directly on the miter gate structures. Hydraulic power for both the miter gate cylinders and the fill/empty gate cylinders is provided by a small hydraulic power unit (HPU) located on top of the lock wall, just upstream of the quoin block on the West Linn side. High pressure oil from the HPU is carried by hard pipe to a location adjacent to each cylinder with the final connection being made with high pressure hydraulic hose. High pressure hydraulic hoses also connect gate mounted hard piping for the fill/empty cylinders to hard piping on the lock wall. Hydraulic fluid and controls for the opposite lock wall are routed from the HPU on the West Linn lock wall via trenches cut into the walls and across the lock chamber floor.

Gate actuation is accomplished electrically via controls mounted directly on each HPU or via remote control stations located at one of three Lock Control Stands (LCS). Lock Control Stands are numbered sequentially with LCS1 adjacent to Miter Gate 2 and LCS2 adjacent to Miter Gate 4, both on the West Linn side of the lock. LCS3 is located on the opposite side of the lock adjacent to Miter Gate 6. Miter Gates 1, 2 and 3 are remotely operated from LCS1 and Miter Gates 3, 4, 5, 6 and 7 are remotely operated from LCS2. LCS3 originally intended to remotely operate Miter Gates 6 and 7 is no longer used.

The lock electrical system consists of power distribution, lighting, controls, CCTV System and a standby generator. The majority of the power distribution, lighting, controls and the CCTV system were installed during the lock upgrades in 1966/1968. Much of the wiring, junction boxes and control components were replaced subsequent to flooding that occurred in 1996. In general, the electrical systems are functional but are in poor overall condition. The project staff at the site indicated that not all limit switches are functioning and that they cannot rely on control indicator lights to verify gate position. We noted at least one electrical junction box that was left uncovered, presumably to allow water to drain from the box. The standby generator and an automatic water balancing system was also added during the 1996 repairs.

<u>Lock 1</u>

This lock was created by cutting into the native rock, with the side walls comprised of timber facing in front of the native rock. This lock is bound by Miter Gate 1 on the downstream side and Miter Gate 2 on the upstream side. Gate 1 is kept in an open position, and Gate 2 is kept in a closed position. Total design lift on this lock is 20.5 feet. See photo #1 for an overall view of Lock 1 and photo #2 for Miter Gate 1 in the closed position. See photos #12 & #13 for close ups of Gate 1 in the open and closed positions.

At 31’- 9”, Gate 1 is the tallest of all Miter Gates used on the project. Aside from the height, the gate structure, quoin block, miter blocks, and other structural details appear to be similar to all other gates. Features unique to this gate include a roller/guide arrangement at the top of the miter block (likely intended to mechanically enforce alignment of the miter block), along with a unique gudgeon

anchorage that utilizes short anchor rods installed in keyed slots in the lock wall. See Photo #3 for the roller arrangement, Photo #4 for the quoin block and Photo #6 for the gudgeon anchorage.

The Miter gate was operated at our request by Corps personnel. The gate appeared to operate normally with no signs of malfunction or other mechanical concerns. The overall condition of the system appeared to be functional.

Shortly after gate operation, our team was able to observe a small quantity of liquid bubbling to the surface of the water and creating a small sheen on the water surface. The liquid appeared just downstream of the quoin block on the West Linn side gate. While we are not able to verify the specific fluid observed, it is possibly hydraulic fluid leaking from the hydraulic pressure pipes serving the gate operating equipment on the opposite lock wall. It may also be oils or other hydrocarbons stored in the built up sediments within the chamber that were disturbed upon gate operation.

The gate's gudgeon anchorage system functioned as designed. With the gate closed, each gate leaf was firmly seated between the miter and quoin blocks and the gudgeon anchors appeared to be unloaded. As soon as the gates started to open, a gap opened between the quoin post and the quoin block, transferring the gate's dead weight to the gudgeon anchor bars. (See Photo #5 and #6 for typical condition.)

The gate hydraulic operating cylinders appear to be National Fluid Power Association (NFPA) standard tie rod type industrial cylinders. The cylinders are connected to the gate via standard clevis and a short threaded rod with lock nuts. This arrangement allows the length of the cylinder to be adjusted to fine tune the location of the gate in the open position. Based on the cylinder's paint system and the use of threaded piping for the rod and blind end fluid connection, these cylinders were likely installed prior to 1970. Although some surface rust is apparent on the rod end connections and cylinder bodies, the cylinders are in relatively good condition and should provide reliable service if the system is put back in operation. That being said, these cylinders are well past the typical service life that would be expected and should be replaced or fully refurbished in the near future. This situation will be exacerbated by the current "care-taker" status of the facility, which dramatically limits the number of gate operations (cylinder extend/retract cycles) seen by each cylinder. (See Photos #7 and #8 for typical cylinder condition.)

On the lock wall, the miter gate cylinders are attached to steel brackets installed directly onto native stone. The steel brackets appear to be in good condition, solid and well anchored. (See Photo #9)

While we did not observe operation of the fill/empty valves, the operation staff indicated the system was operational and that there were no known issues. There is indication in the historic documents that at least 16 of the 56 total fill/empty system cylinders were replaced in 1993, however it is not clear where the 16 new cylinders were installed. Similar to the miter gate operating cylinders, these fill/empty system cylinders are well past their expected life and should be refurbished or replaced in the near future.

The hydraulic power unit (HPU) serving Miter Gate 1 appeared in relatively good condition considering its age and was fully functional. The unit consists of a rectangular reservoir and a reservoir-top mounted pump/motor group installed on a modular skid structure. Filters, solenoid operated directional control valves, motor controls and other ancillary components are all installed onto the skid structure above the reservoir. The HPU skid is enclosed by a free standing stainless steel shed and is accessible through hinged doors. (See Photo #10 for the Gate 1 HPU and Photo #11 for a typical HPU). Overall, these HPU's are well beyond their typical service life and will require more attention to maintenance and repair than a modern packaged hydraulic power unit. While individual components are relatively old technology, they are still functioning well and there is no reason that they cannot provide adequate service for future operation of the locks as long as they are carefully maintained. As components begin to fail, they can easily be replaced with their modern equivalent without needing to completely replace the entire HPU.

Hydraulic pressure piping between the HPU to the cylinders all appears to be carbon steel with threaded fittings. Overall the pipe appears to be in good condition with minor surface corrosion visible on portions of the pipe and pipe fittings. No obvious leaks or indication of leaks were observed, (with the exception of the possible underwater leak mentioned above), and there is no indication that the system would not support regular operation of the gate if the locks were placed back in service. While the system may be adequate to support operation, it will be more prone to developing leaks than a modern piping system due to the use of tapered pipe threads and threaded fittings. This type of fluid connection is not good practice and would not be allowed on a modern hydraulic piping system. Given the potential underwater leak, and the use of tapered pipe threads, this pipe system should be replaced by a modern welded pipe system. Ideally, this replacement would occur prior to returning the locks to full service. All hydraulic hoses on the system appear to be in good condition, but should all be replaced prior to placing the lock back in regular service as they have an expected service life of only about 5 years.

Operation of Gate 1 was accomplished using the local HPU mounted controls. The project staff member present indicated that the gate controls in LCS1 functioned properly and that there were no known issues operating the gate remotely. Based on the available documentation, we believe that remote control of the gates is accomplished through hard wired selector switches and control relays. There is an assertion in a July 27, 2007 report completed by INCA Engineers that the analog control system was replaced by a digital control system around 1996. The March 26, 2013 Interim Engineering Design Report (EDR) completed by Tetra Tech indicates that the gate controls are still analog and are still using the original 1966/1968 control devices.

Much of the lock is faced with timber to be used as fendering to protect vessels from hitting either the miter gate or the rock walls. Timber exposed to water is susceptible to decay and it should be expected to need to replace the timber facing on a fairly regular basis. Corps staff indicated that in the past they regularly replaced the timber facing due to rot and decay.

The steel gate framing was not visible due to the timber facing, so the extent of any corrosion could not be assessed. It would be reasonable to assume that the steel gates are galvanized, and in a fresh water environment, should have at least a 30 year life span before significant maintenance is required. Based on the 2007 report, all of the gates (except Gate 3) were rehabilitated between 1993 and 2001.

Further, based on the 2013 EDR , all gates were removed from the lock chamber, inspected, rehabilitated and reinstalled in 2009. At this time, the miter gate leaves, miter posts and quoin posts were judged to be sufficient to remain safe for up to 10 years without maintenance.

The gudgeon anchors are showing some signs of corrosion, but did not appear to be showing signs of significant section loss. At a time in the next 5 to 10 years, the gudgeon anchors should be replaced to reduce the risk of anchor failure due to further deterioration. Generally the anchors parallel to the lock chamber appear to be anchored to the lock wall and are readily accessible.

Lock 2

This lock was also constructed by cutting into the native rock, and has a similar timber side wall construction to Lock 1 for most of its length. Lock 2 is bound by Gate 2 on the downstream side and Gate 3 on the upstream side, both kept in a closed position. Approximately two-thirds of the downstream length of the lock has a timber facing, with the upstream one-third having an exposed ashlar masonry facing. This upper section of the lock was constructed out of large stacked masonry rock and was backfilled behind the masonry wall.

Many utilities cross under the lock within Lock 2 to feed the old Paper Mill across the chamber. These utilities appear to include water, sewer and electrical lines.

Similar to Lock 1, the timber facing is subject to decay and rot and should be expected to be maintained regularly.

Miter Gate 2 is 19'- 6 3/8" tall and is otherwise similar to the other Miter Gates on the project. Like Miter Gates 3, 4, 5 and 6, this Gate utilizes a linkage style gudgeon anchor. In this arrangement, long gudgeon bars are installed directly onto the gudgeon pin and are then connected to a small plate linkage. The plate linkage then connects to steel anchor rods installed in the lock wall. The plate linkage is intended to simultaneously allow the gudgeon bars to pull on the anchor rod while preventing them from pushing. For Gate 2, the gudgeon bars are showing some signs of corrosion, but did not appear to be showing signs of significant section loss.

Generally the anchor rods parallel to the lock chamber appear to be anchored to the lock wall and are readily accessible. The Corps has noted concern about the condition of the anchor rods used by the lateral gudgeon bars. Large portions of these anchor rods are not visible and cannot be visually assessed. To address this concern, two options may be undertaken. One would be to excavate around the anchor, where there is access, to the point at which the anchor is embedded in concrete (and should be corrosion free within the grout surrounding the anchor); or Two would be to perform a tension pull test on the anchor to verify its capacity. A third potential option would be to abandon the anchor completely and provide a new drilled in anchor with a known capacity. Note that access to the gudgeon anchors on the Corps side of the lock is difficult due to an existing framework of utilities supported by a timber boardwalk. See Photo #14.

The gate was operated by the Project staff from the remote control station in LCS1. Gate operation appeared normal with no signs of malfunction or other mechanical concerns. The overall condition of the system appeared to be functional.

Gate #3 is similar in construction to the other gates but is 19'- 5 3/8" tall. As this gate was operated, the lateral gudgeon anchor on the Corps side visibly displaced several inches upward as the gate leaf came back to the fully open position. In this position, the tension on the lateral anchor is relieved, and therefore the gudgeon anchor is free to relax. This may be indicative of the ground anchor not being fully embedded and likely requires some maintenance prior to any re-opening of the lock. The area around this anchor is free of obstructions and could easily be excavated to allow further investigation of the below ground condition. (See Photo #15)

Aside from the gudgeon anchor system and the gudgeon anchor issue noted above, the overall condition of the mechanical and electrical and systems is similar to that observed on Gates 1 and 2. The concrete pad provided to anchor the miter gate operating cylinder on the West Linn side of the lock is in poor condition and as a result, the cylinder mounting bracket moves substantially as the gate is operated. This condition is not optimal but creates no real safety issue for the gate. The gate operating cylinders are painted black and appear to have been replaced more recently than the cylinders on Gates 1 and 2.

Lock 3

This lock is bound by Gate 3 on the downstream side and Gate 4 on the upstream side, both kept in a closed position. It is our understanding that this lock was constructed with stacked ashlar masonry block and then backfilled. The lock walls are faced with timber fendering for their full height. There appears to be a several foot gap between the face of masonry and the timber facing, with the timber wall being built out several feet away from the masonry with timber cribbing and framing. On the Corps side of the lock, the downstream approximately 100 feet of ground surface adjacent to the lock wall has washed out. According to Corps staff, water got between the face of masonry and the backside face of the timber facing and washed out most of the backfill between these surfaces. There is currently orange fencing in place to keep people from walking in this area. See Photo #16.

When Lock 3 is full of water, the water leaks through the wall and continues around Gate 3 downstream to Lock 2, causing additional erosion around the base of the elevated Gate 3 control house and infrastructure just downstream of the gate house.

Gate 4 is identical to gate 2 and appears to be in similar condition to the other gates inspected. The main gate operating cylinders are painted black and appear to be installed more recently than the cylinders observed on Gates 1 and 2. Gate anchorage plates and other hardware appear to be in reasonable condition.

Lock 4

Lock 4 is similar to Lock 3 in its construction, with masonry walls and timber facing. This lock is bound by Gate 4 on the downstream side and Gate 5 on the upstream side, both kept in a closed position.

Gate 5 is holding back the Canal Basin, which is full of water. This gate appears to be leaking at the sill, the miter joint, and through a few of the slide gates within the miter gate. See Photo #17.

There is a pedestrian drawbridge in the middle of this lock that provides access from the Corps side to the Mill side of the lock. The drawbridge appears to be in moderate to poor condition.

At 12'–5 3/16" tall, Gate 5 is the smallest of the miter gates installed at the project. This gate was not operated during our site visit due to the amount of water on the Canal Basin side. A visual inspection of the structural, mechanical and electrical features of this gate confirmed that it's overall condition was similar to the other gates inspected.

Canal Basin

The Canal Basin is bound by Gate 5 on the downstream side and Gate 6 on the upstream side. Gate 5 retains the water elevation within the Basin to allow it to remain full. Gate 6 is kept open so that the Guard Lock and Canal Basin have the same water elevation.

The Corps side of the Basin appears to have a natural rock outcrop embankment, see photo #19. The Mill side of the Basin has a concrete bulkhead wall that acts as a loading dock for barges accessing the Mill facility. There also exists a hydraulically controlled loading ramp along this wall. See photo #18.

The upstream end of the Basin transitions from the Mill property to the Portland General Electrical power generation plant. At this section of the Basin, the PGE facility side has a large concrete bulkhead and intake structure for a fish ladder.

Guard Lock

The Guard Lock is bound by Gate 6 on the downstream side and Gate 7 on the upstream side. Gate 6 is kept in an open position and Gate 7 is kept closed. See photo #22 for a view of Gate 7 from upstream of the gate. The water elevation within the Guard Lock appears to be within 2 to 3 feet of the water elevation within the river, such that Gate 7 does not need to support a large head differential on one side of the gate.

The Corps side of the lock is constructed from a concrete counterfort wall, with a small section at the upstream end constructed from stacked ashlar masonry. The PGE side is constructed from stacked ashlar masonry with a 2 to 3 foot thick concrete cap on top of the masonry. See photo #20 for an overview of the Guard Lock looking downstream and photo #21 of the joint between the concrete counterfort wall and the ashlar masonry wall.

Neither gate 6 nor gate 7 were operated while we were on site. The gate and anchors appeared to be in a similar condition to the other gates further downstream. Gate machinery and electrical controls for these structures is similar to that observed on the other gates.

Note that LCS3 located on an elevated structure adjacent to Miter Gate 6 is in very poor condition. Project staff indicated that this structure has been condemned and is no longer used. Operation of

Miter Gate 6 and 7 is accomplished using the local control stations on the HPU or from LCS2 adjacent to Miter Gate 4. (See Photo #23)

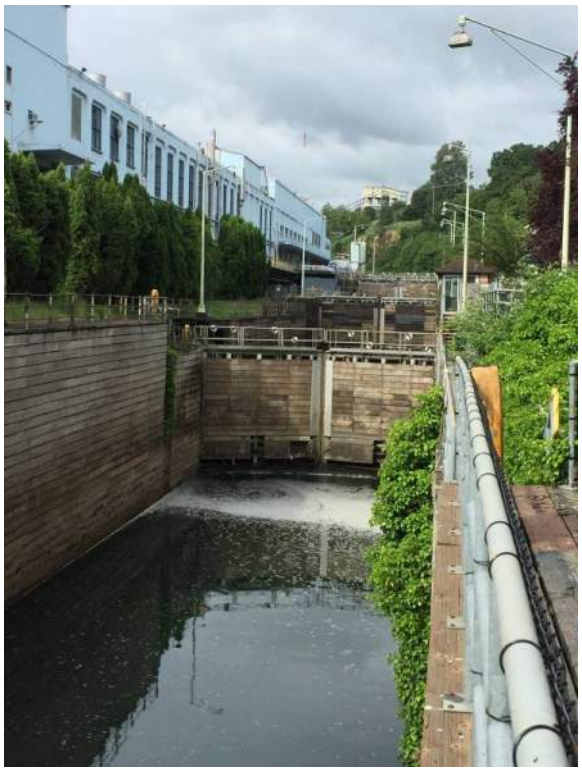

Photo #1

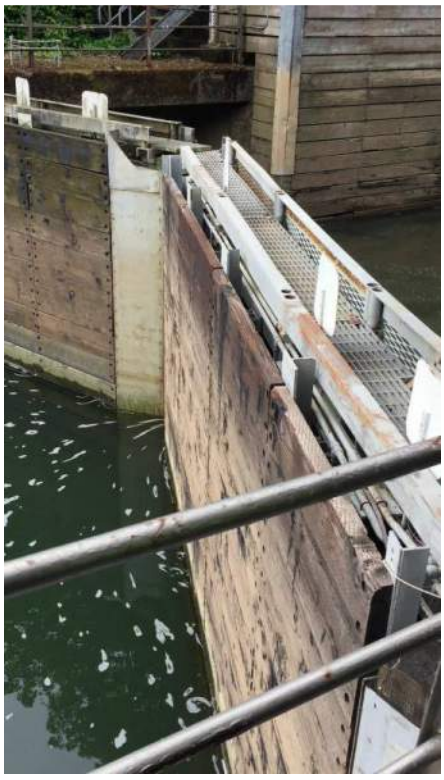

Photo #2

Photo #3

Photo #4

Photo #5

Photo #6

Photo #7

Photo #8

Photo #9

Photo #10

Photo #11

Photo #12

Photo #13

Photo #14

Photo #15

Photo #16

Photo #17

Photo #18

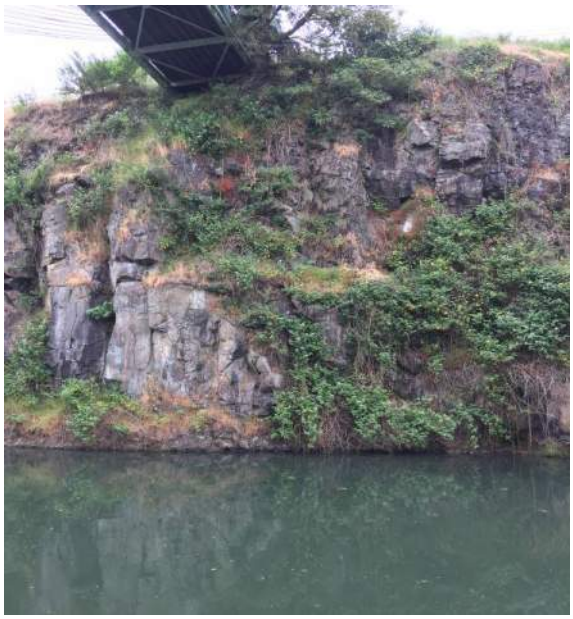

Photo #19

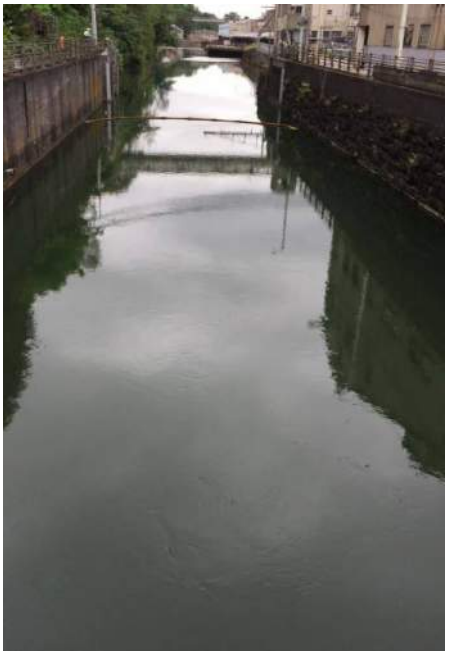

Photo #20

Photo #21

Photo #22

Photo #23