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<td>Editor</td>
</tr>
</tbody>
</table>


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12/20/2018
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## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTV</td>
<td>Emergency response towing vessel</td>
</tr>
<tr>
<td>MRC</td>
<td>Marine Resources Committee</td>
</tr>
<tr>
<td>OFM</td>
<td>Office of Financial Management</td>
</tr>
<tr>
<td>RMM</td>
<td>Risk mitigation measure</td>
</tr>
<tr>
<td>SJC</td>
<td>San Juan County</td>
</tr>
<tr>
<td>WSMC</td>
<td>Washington State Maritime Cooperative</td>
</tr>
</tbody>
</table>
**Executive Summary**

This report provides cost estimates and other considerations for the long-term stationing of an emergency response towing vessel (ERTV) capable tugboat in or near San Juan County (SJC) in Washington. Positioning an ERTV to respond to a distressed vessel in Haro Strait and Boundary Pass has been recommended as a priority oil spill prevention risk mitigation measure by the Washington Department of Ecology, Puget Sound Partnership boards, and SJC through its Marine Resources Committee. The annual costs are evaluated for three alternative standby positions for the ERTV tug. The tug can be either permanently moored at a harbor in SJC, permanently on standby at sea (underway), or a combination of the two. SJC marinas experience seasonal traffic related to tourism and may not be able to accommodate a large tug during the summer months.

Annual costs of maintaining an ERTV in SJC are estimated to range from $4.4 to $6.3 million, as summarized in Table ES-1. The lowest cost of the three alternative methods is permanent moorage in a harbor, at $4.4 to $6.2 million. This scenario is consistent with the Neah Bay ERTV configuration and organization. When the ERTV is operated permanently underway there are no marina fees, but total cost increases by an estimated $109,000 due to increased consumption of diesel for electrical generators. A vessel which is moored only during the winter has partial savings on marina fees and an increase in diesel consumption. Compared to the case where the ERTV is permanently moored, the estimated cost of seasonal mooring is $65,000 more. Each scenario includes six training sessions per year, at three hours each.

<table>
<thead>
<tr>
<th>Rate</th>
<th>Permanently Moored</th>
<th>Permanently Underway</th>
<th>Seasonally Moored</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual Cost ($)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Daily Rate</td>
<td>4,351,000</td>
<td>4,460,000</td>
<td>4,416,000</td>
</tr>
<tr>
<td>High Daily Rate</td>
<td>6,176,000</td>
<td>6,285,000</td>
<td>6,241,000</td>
</tr>
</tbody>
</table>


The typical daily charter rate for a tug with ERTV capabilities ranges from $11,500 to $16,500 per day. This rate includes labor, operations and maintenance, profit, insurance, taxes, and the cost of provisions. Not included within these rates are marina fees and fuel surcharges for running the tug’s engines and electrical generators. Table ES-2 shows the relative portion of each cost component relative to total cost.

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Percentage of Total Annual Cost (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>50</td>
</tr>
<tr>
<td>Maintenance and Operations (including depreciation)</td>
<td>25</td>
</tr>
<tr>
<td>Profit</td>
<td>10-15</td>
</tr>
<tr>
<td>Insurance</td>
<td>5-10</td>
</tr>
<tr>
<td>Taxes/Provisions/Marina Fees</td>
<td>3-6</td>
</tr>
</tbody>
</table>


The estimates provided in Table ES-1 are sensitive to annual labor wages, which is the primary difference between the low and high daily charter rates used to calculate cost. Vessels capable of ERTV services may require a crew of up to seven, but as few as four. Additionally, the crew members can be unionized or non-unionized, which significantly affects their wage rates. These two factors alone
account for most of the variation in the estimate. Due to the business confidential nature of the information collected for this analysis, data have been aggregated and details withheld to protect the information. The estimates presented here are based on stationing the tug at a domestic port. If the tug were stationed at a location outside of the U.S., the actual cost could vary.
1 Introduction

San Juan County (SJC) is located in the Salish Sea, bounded by Haro Strait and Boundary Pass to the west, Rosario Strait to the east, Georgia Strait to the north, and Strait of Juan to Fuca to the south. While renowned for its remoteness and pristine natural beauty, the county is situated among major commercial shipping routes that connect ports in Washington and British Columbia and are vulnerable to the threat of oil spills caused by incidents involving both cargo vessels and oil tankers (Figure 1). Oil tanker traffic is projected to increase significantly with planned and ongoing expansions to port activities, which will in turn increase the risk of large oil spills in the region. Protection against a catastrophic oil spill is the highest environmental priority for SJC, as ranked by the Local Integrating Organization comprising local governmental, non-governmental, academic, and tribal representatives.

At its October 2016 Salish Sea Oil Spill Risk Mitigation Workshop, the Washington Department of Ecology solicited input on potential additional marine oil spill prevention risk mitigation measures (RMMs) from a diverse group of governmental, non-governmental, and tribal participants. The output of this workshop was a prioritized list of nine RMMs. Among the priorities is a measure that would reduce spill risk at particularly vulnerable locations. The measure would pre-position a fit-for-purpose multi-mission emergency response towing vessel (ERTV) based on best achievable technology for Boundary Pass and Haro Strait on the northwest and west sides of SJC. The recommended implementation strategy is to develop a strong case statement and a cost/benefit business model, drawing upon the success of the Neah Bay ERTV. This cost evaluation directly supports such a cost/benefit business model (Ecology 2016).

The scope of this project also is consistent with the recommendations made in the SJC Marine Resources Committee’s (MRC) 2015 and 2017 Marine Managers Workshops. It implements recommendations made by the MRC, approved by the Local Integrating Organization and adopted to the 2016 Action Agenda for Puget Sound. It is a central strategy of the San Juan Islands Action Area Ecosystem Protection and Recovery Plan to promote additional oil spill prevention measures and justify additional oil spill prevention financing for an ERTV positioned near Haro Strait/Boundary Pass to regulators and elected officials (AAOG 2017). The Puget Sound Partnership Ecosystem Coordination Board and Leadership Council have formally encouraged elected officials to support the ERTV and other high priority risk mitigation measures. Additionally, the Governor’s Southern Resident Orca Task Force has recommended the ERTV for this area (Task Force 2018).

This cost evaluation is based on the current operation of an ERTV at Neah Bay on Washington’s Olympic Peninsula at the entrance of the Strait of Juan de Fuca, an important maritime shipping route for both the State of Washington and Canada. In 1999, Washington leaders first developed the use of the emergency rescue tug at Neah Bay, which was only funded to operate during the harsh winter months (Ecology 2018). In 2008, year-round funding was established and in 2010 the state legislature created an industry-funded program to maintain the ERTV permanently in Neah Bay (RCW 88.46.130, 2016; WAC 173-182-242, 2013). The ERTV is funded by fees paid from all vessels over 300 gross tons traveling through Washington State waters to Washington ports. The first year-round contract for ERTV services at Neah Bay was awarded to Crowley in 2008. The current provider is Foss Maritime, which has held the contract for eight years.
Minimum requirements for the ERTV (according to State of Washington RCW 88.46.135) are as follows:

- Able to be underway within twenty minutes of a call to deploy
- Be available to deploy 24/7 and remain deployed for up to 48 hours
- Bollard pull of 70 short tons
- Capable of towing a disabled vessel of 180,000 dead weight metric tons
- Must have equipment to perform the following functions:
  - Ship anchor recovery hook and line throwing gun
  - Damage control patching
  - Vessel dewatering
  - Air safety monitoring
  - Digital photography

Since establishment, the ERTV has been deployed 68 times (Ecology 2018). It is an important tool in the prevention of ship groundings and ultimately oil spills. SCJ contracted Northern Economics, Inc. to provide an estimate for a similar ERTV that would be positioned to respond to distressed vessels in the Haro Strait, Boundary Pass, and a broader geographic area which includes Rosario Strait. The cost estimates summarized in this report cover a range of scenarios and alternatives.

The Washington Department of Ecology recently submitted a draft report on vessel traffic safety which included a review of the Neah Bay ERTV and its activity in the Strait of Juan de Fuca since implementation (Ecology 2018). The report recommended that a joint effort between U.S. and Canadian stakeholders, including tribes and First Nations, would be the best method for implementing additional standby tugs in the Haro Strait region. For the purposes of this report, cost estimates are based on domestic ports. An alternative to permanently stationing the tug within a harbor is to maintain the tug underway/offshore 24/7. This analysis considers the alternatives of maintaining an ERTV moored in Roche Harbor or Friday Harbor, underway 24/7, or a seasonal combination of the two. Deer Harbor Marina is not able to accommodate a vessel of the typical ERTV length (Broman 2018).
Figure 1 shows shipping lanes and marinas in SJC.

**Figure 1. Shipping Lanes and Marinas**
2 Approach and Methodology

The cost estimates provided in this report are limited to the operation and maintenance of an ERTV in preparation for emergency response. There are no estimates of response costs included here, since the costs will vary depending on the circumstances and all costs would be billed to the owner of the distressed vessel when the ERTV responds to a call.

The Neah Bay ERTV provides a baseline for developing a cost estimate for an ERTV based at a harbor in SJC. The Neah Bay vessel is moored at the marina year-round and pays fees to the Makah Tribe for the use of its facilities. Another possibility is for the tug to be on standby at sea (underway) permanently. Marinas in SJC become busy in the summer with seasonal traffic, so it may be more practical to station the ERTV offshore during the summer months. In the case of the Friday Harbor Marina, there is not enough room to accommodate a vessel during the summer (Long 2018). Permanent offshore stationing is the most expensive of the scenarios because it costs more to generate the vessel’s own electricity than to pay for metered shore power. This report presents low and high cost estimates for each of the discussed alternatives: permanent moorage in a marina, permanent offshore standby, and seasonal moorage in a marina.

There are five main sources of cost to maintaining an ERTV: labor wages, maintenance and operations (including depreciation), contractor profit, insurance, and fuel surcharges plus various other small fees. Northern Economics contracted with The Glosten Associates, a naval architectural and marine engineering firm, to provide rough order-of-magnitude estimates for a range of charter rates and electrical service loads. Northern Economics also reached out to marine shipping service companies to discuss the costs of obtaining and operating an ERTV and to understand the factors that affect costs.
3 Neah Bay ERTV Cost Estimates

The ERTV which has been stationed year-round at Neah Bay since 2008 is the primary basis for cost estimation of an ERTV in SJC. The ERTV at the Port of Neah Bay is maintained in the Makah Marina, which is owned and operated by the Makah Tribe.

The tugs stationed at Neah Bay have varied over time in age and length, while still meeting the minimum state law requirements. In general, the ERTVs at Neah Bay have been in the range of 100 to 130 feet but have been as large as 150 feet.1 Tugs meeting ERTV requirements usually have four to six crew members, who live onboard the vessel and work in alternating six-hour shifts. When moored in the harbor, the tug is connected to an electrical meter on the shoreline to draw power. The water and wastewater systems are self-contained on the vessel.

The tug is on standby 24/7 and must be prepared to respond to distressed vessels in the area. If the ERTV is called to assist a vessel, the vessel owner is billed for the service and additional expenses (e.g. time and fuel) are no longer the burden of the Washington State Maritime Cooperative (WSMC). The contractor is required to provide another tug meeting ERTV requirements while the stationed tug is responding to a call. If the stationed tug is expected to be away for more than 24 hours, the replacement tug is stationed in Neah Bay.

When the ERTV is away from the harbor, it consumes diesel for a generator to produce electricity which is a significant source of operating cost. The largest single component of cost for stationing an ERTV is labor, at about 50 percent of the total annual cost.

The tug stationed at Neah Bay has some additional fuel costs that are not anticipated at the locations evaluated in SJC. At Neah Bay, tidal fluctuations sometimes prevent the tug from being able to leave the harbor. During especially low tides, the draft of the tug is larger than the depth of water at the harbor entrance. Approximately 10 times per month, the tug must leave the harbor prior to low tide and remain outside the harbor until the tide rises again. This is to prevent the tug from being trapped within the bay should the tug be dispatched to a distressed vessel. The additional expense of fuel during these trips is passed on to the WSMC. This additional cost is not expected at Roche Harbor or the Friday Harbor Marina; however, the tug must make some trips outside the harbor for training exercises. The analysis assumes that the tug will conduct six training exercises per year, each lasting three hours, regardless of its stationed location.

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1 Vessel length is the basis for marina moorage. It is not an indicator of vessel capability or towing capacity.
4 Cost Estimates for San Juan County

Cost estimates for the long-term stationing of an ERTV in SJC are based on three generalized scenarios: permanent standby in an SJC harbor, standby when the ERTV is permanently underway, or standby while stationed in a harbor during the winter and underway during the summer.

An informal industry survey conducted by The Glosten Associates was used to obtain day charter rates for a tug capable of ERTV services. A tug with rated bollard pull of 80–100 short tons and with an appropriate winch package ranges from $11,500 to $16,500 per day. In addition to the daily rate, fuel consumption for engines and electrical generators are passed on as a surcharge\(^2\) and moorage fees must be paid to the harbor for use of their facilities.

4.1 ERTV Permanently Moored at a Domestic Harbor

Northern Economics reached out to Roche Harbor, Friday Harbor Marina, and Deer Harbor to obtain rates for moorage, metered electricity, and liveaboard fees. Deer Harbor currently does not have facilities to accommodate a vessel up to 130 feet. The Friday Harbor Marina provided monthly rates but noted that they did not have room for the ERTV during the summer months when recreational marine activity is greatest. Moorage rates for Roche Harbor were obtained from their website, but as a popular summertime resort destination they may not have room for the ERTV during the summer.

For the scenario where an ERTV is permanently moored at an SJC harbor, this report presents an average rate for moorage fees which is based on data obtained. For a 130-foot vessel, all-in marina fees would cost approximately $35,000 annually. Table 1 provides a breakdown of costs for the low and high day rates, and their associated percentages of total annual cost.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Cost Category} & \text{Low Daily Rate} & \text{High Daily Rate} & \text{Percent of Total} \\
\text{(annual $)} & \text{(annual $)} & \% \\
\hline
\text{Labor} & 2,160,000 & 3,070,000 & 50 \\
\text{Operations, Maintenance, Depreciation, Profit, Insurance, Taxes, Provisions, and Misc.} & 2,073,000 & 2,953,000 & 48 \\
\text{Fuel Surcharge (training exercises and generator)} & 83,000 & 119,000 & 2 \\
\text{Marina Fees} & 35,000 & 35,000 & 1 \\
\hline
\text{Annual Total} & 4,351,000 & 6,176,000 & 100 \\
\hline
\end{array}
\]


4.2 ERTV Permanently Underway

As an alternative to mooring the ERTV at a marina, the tug could be underway offshore 24/7. The vessel must return to shore for crew changes and for supplies, but it would remain at sea for the remainder of the time and the main engines would not be running. In this case, there would be no marina fees, but the vessel would incur additional expenses from the use of its electrical generator, which would increase the overall cost. The cost of metered shore-based power is less expensive than purchasing diesel for generators. Despite the savings on marina fees, the underway alternative would be more costly than

\(^2\) Diesel consumption for locomotion is approximately 200 gallons per hour, and consumption for electricity (when underway) is 75 to 100 gallons per day. A marine diesel price of $2.50/gal was used in the estimates.
permanent mooring by approximately $109,000 per year. This represents an increase of two to three percent over permanent mooring. Table 2 provides a breakdown of costs for the low and high day rates, and their associated percentages of total annual cost.

### Table 2. Cost Estimate Summary for Permanently Underway

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Low Daily Rate (annual $)</th>
<th>High Daily Rate (annual $)</th>
<th>Percent of Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>2,160,000</td>
<td>3,070,000</td>
<td>49</td>
</tr>
<tr>
<td>Operations, Maintenance, Depreciation, Profit, Insurance, Taxes, Provisions, and Misc.</td>
<td>2,139,000</td>
<td>2,952,000</td>
<td>47</td>
</tr>
<tr>
<td>Fuel Surcharge (training exercises and generator)</td>
<td>161,000</td>
<td>263,000</td>
<td>4</td>
</tr>
<tr>
<td>Marina Fees</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Annual Total</strong></td>
<td><strong>4,460,000</strong></td>
<td><strong>6,285,000</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


### 4.3 ERTV Seasonally Moored and Underway

Harbors in SJC have seasonal traffic related to tourism, fishing, and resorts at some marinas. A 130-foot tugboat is difficult to accommodate and maintain at a harbor during the summer months. An alternative to maintaining the ERTV permanently underway is mooring the vessel only during the winter. The vessel would be underway from May to September. The cost estimate is based on the vessel spending 60 percent of the year moored and 40 percent of the year underway. Table 3 provides a breakdown of costs for the low and high day rates, and their associated percentages of total annual cost.

### Table 3. Cost Estimate Summary for Seasonally Moored ERTV in SJC

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Low Daily Rate (annual $)</th>
<th>High Daily Rate (annual $)</th>
<th>Percent of Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>2,160,000</td>
<td>3,070,000</td>
<td>49</td>
</tr>
<tr>
<td>Operations, Maintenance, Depreciation, Profit, Insurance, Taxes, Provisions, and Misc.</td>
<td>2,105,000</td>
<td>2,945,000</td>
<td>47</td>
</tr>
<tr>
<td>Fuel Surcharge (training exercises and generator)</td>
<td>130,000</td>
<td>205,000</td>
<td>3</td>
</tr>
<tr>
<td>Marina Fees</td>
<td>21,000</td>
<td>21,000</td>
<td>0</td>
</tr>
<tr>
<td><strong>Annual Total</strong></td>
<td><strong>4,416,000</strong></td>
<td><strong>6,241,000</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

5 Other Potential Costs

The crew size, rate of fuel consumption (for both the engine and generator), and capital expenses all vary with individual tugboats. The ERTV requirements described in RCW 88.46.135 can be met by tugs of substantially different lengths and crew sizes because towing capabilities are primarily based on engine output and configuration. For example, the ERTV at Neah Bay has used crews of four to six and has varied in length from 100 to 130 feet. The estimates provided in this report considered vessels with a crew of four to seven people.

The three alternatives presented in Section 4 vary with respect to fuel surcharges and marina fees, which make up a small portion of the variation in total cost. The largest source of both total cost and uncertainty in cost are the labor wages of the tugboat crew. At 50 percent of the total annual cost, ERTV labor wages are approximately $2.2 to $3.1 million per year. There are several factors that influence variation in labor wages and help to explain the difference in the provided range of daily rates. The most significant factor is wage rates of unionized versus non-union workers. Similarly, state prevailing wages tend to increase non-union wage rates. The lowest wage rates are for non-union workers where state prevailing wages do not apply. The cost estimates presented in this report also do not account for inflation. Wage rates rise over time with a typical inflation rate of 3 to 3.5 percent annually. A long-term contract rate will likely factor in those increases.

It may be possible to negotiate discounted marina fees for a long-term service contract. Northern Economics’ cost estimates are based on published annual rates or rates provided by harbormasters.

Another consideration is the age of a tug and its ability to meet emissions requirements. California is well known for its clean air initiatives, which have forced some marine shipping companies to repower their old tugs to meet new emissions standards. If the State of Washington were to follow this trend it might affect the ERTV(s) in Washington. If an older tug is renovated to meet the state ERTV requirements, it could be impacted by changes to air quality initiatives. These changes may require capital in the future to repower the vessel and be accounted for through increased daily charter rates.
6 Summary

The typical daily charter rates for a tug with ERTV capabilities is $11,500 to $16,500 per day. This rate includes labor, operations and maintenance, profit, insurance, taxes, and the cost of provisions. Not included in these rates are marina fees and fuel surcharges for running the tug’s engines and electrical generators.

The lowest cost of the three alternative methods is permanent moorage in a harbor, estimated at $4.3 to $6.1 million. This scenario is consistent with the Neah Bay ERTV configuration and organization. When the ERTV is operated permanently underway, there would be no marina fees, but the total estimated cost would increase by $109,000 due to increased consumption of diesel for electrical generators. A vessel that is moored only during the winter would have partial savings on marina fees and an increase in diesel consumption. Compared to the case where the ERTV is permanently moored, the estimated cost of seasonal mooring is $65,000 more. Each of the scenarios accounts for six training sessions per year, lasting for three hours each.

<table>
<thead>
<tr>
<th>Rate</th>
<th>Permanently Moored</th>
<th>Permanently Underway</th>
<th>Seasonally Moored</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Daily Rate</strong></td>
<td>4,351,000</td>
<td>4,460,000</td>
<td>4,416,000</td>
</tr>
<tr>
<td><strong>High Daily Rate</strong></td>
<td>6,176,000</td>
<td>6,285,000</td>
<td>6,241,000</td>
</tr>
</tbody>
</table>

7 Limitations

An ERTV positioned for Haro Strait and Boundary Pass would be similar to the Neah Bay tug in specifications and in annual cost. Costs for maintaining the Neah Bay ERTV prior to 2011 are publicly available, because the program was funded by the State of Washington (tax dollars). From 2008 to 2009 the standby tug cost $3.65 million per year (nominal dollars), and from 2009 to 2011, the standby tug cost $3.6 million per year (nominal dollars) (OFM 2018a, 2018b). Since 2011 the Neah Bay ERTV has been funded by private industry, and the costs are considered business confidential information.

Similarly, the information used as the basis for analysis in this report was provided by private companies in the shipping industry, to which Northern Economics promised confidentiality of detailed costs. The information is therefore aggregated and summarized in this cost evaluation.

An ERTV positioned in or near SJC would be subject to a bidding process and rely on a contractor to provide the service. There is some uncertainty associated with future contracts negotiated through bidding, and the range of estimates presented in this evaluation attempts to capture the potential range of actual costs.

Costs estimates in this report are based on U.S. port locations. A cost estimate of an ERTV based at a port outside of the U.S. could vary substantially from the estimates provided in this report. Moorage fees, fuel prices, taxes, and wage rates would depend on the tug's standby location.
8 References


Appendix: Glosten Associates Rough Order-of-Magnitude ERTV Estimates
Introduction
Northern Economics, Inc. contracted Glosten to prepare annual cost estimates for stationing an Emergency Response Towing Vessel (ERTV) in San Juan County, Washington for the purpose of responding to vessel loss-of-propulsion events and other marine incidents on an emergency callout basis. It is assumed, consistent with standard industry practice, that ERTV services would be contracted through a marine towing or salvage company, with costs based on a fixed day rate for the contract period plus surcharges for fuel and shoreside electricity. This memorandum serves to provide a rough order of magnitude (ROM) cost for this service and identify basic requirements for a suitable ERTV berth.

Summary of Findings
Primary cost drivers for a permanently deployed ERTV include: crew size and union affiliation (i.e. union vs. nonunion); the age, size, horsepower, and outfit of the tug itself; and fuel consumption. Taking the above variables into consideration, current day rates for a modern ERTV with a rated bollard pull of 80-100 short tons, outfitted with an appropriate winch package and gear for emergency towing, are estimated to fall in the range of $11,500 to $16,500 per day, equating to a base annual cost of $4.20M to $6.02M. Fuel and shoreside power costs, which would likely be billed as a surcharge, are estimated between $83,000 and $119,000 annually, assuming shoreside power is available, and between $161,000 and $263,000 annually for the alternative case, in which the vessel must run one onboard generator continuously. Annual cost totals for both cases are presented in the table below.

Table 1 Estimated total annual costs

<table>
<thead>
<tr>
<th>Day Rate ($/day)</th>
<th>Case 1 (with shore power)</th>
<th>Case 2 (no shore power available)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Ship Service Load</td>
<td>High Ship Service Load</td>
</tr>
<tr>
<td>Low ($11,500)</td>
<td>$4,280,787</td>
<td>$4,316,065</td>
</tr>
<tr>
<td>High ($16,500)</td>
<td>$6,105,787</td>
<td>$6,141,065</td>
</tr>
</tbody>
</table>

Berthing costs are not included in this cost estimate, as rates are highly variable depending on location (not provided), facilities, ERTV funding mechanisms, and other factors. That noted, a suitable berth is critical for a dependable and cost-efficient ERTV program. Basic requirements for a suitable berth for an ERTV include:
- Adequate underkeel clearance (UKC) (>10% of draft) at all heights of tide
- Unrestricted passage in and out of the harbor at all heights of tide (i.e. no controlling depths <1.1 × vessel draft)
- Minimum overhead clearance of approximately 50' at all heights of tide
- Direct shoreside access (connected walkways) for crew changes and resupply of provisions/consumables
- Shoreside connections for sewage pump-out and fresh water fill
- Guaranteed berthing space for tug approximately 130' LOA
- Adequate dock strength to support a tug approximately 130' LOA
- Suitable mooring points for a tug approximately 130' LOA
- Shoreside power connection (ideally)
- Stores crane accessible on pier, such that equipment, replacement parts, provisions, etc. can be lifted on/off the vessel (ideally)

Methodology
Cost estimates were based on a recently constructed (<5 years old) towing vessel with a rated bollard pull in the 80-100 short ton range. This is consistent with other ERTVs deployed regionally; but it is noted that an ERTV with less bollard pull may be adequate in the partially-protected waters of Haro Strait, Rosario Strait, and Boundary Pass. No analysis was done to determine actual performance requirements for an ERTV in this area.

It is assumed that a marine towing company would charge for services on a standard day rate basis (365 days/year), with additional surcharges for fuel and shoreside power used. Day rates are assumed to be made up of the following operating and fixed costs:

- Labor (wage and fringe): ~50%
- Operations and maintenance (including depreciation): ~25%
- Provisions/commissary: ~1-3%
- Insurance: ~5-10%
- Taxes: ~1-3%
- Profit: ~10-15%

Day rates were estimated based on recent project experience and an informal and confidential survey of local marine towing companies.

For estimation of fuel and power consumption costs, it was assumed that fuel/power consumed at berth and during routine drills would be passed on as a surcharge; but fuel usage during emergency callouts would be billed directly to the subject vessel owner/operator. Drills were assumed to take place six times annually, each lasting for three hours with main engines run at an average of 75% load. Main engine sizing was based on a twin-screw arrangement designed to produce 100 short tons of bollard pull at maximum continuous rating.

Two cases were assumed for calculation of fuel and power consumption at berth: one in which the availability of a shoreside power connection allows onboard generators to be secured —i.e. not running— at all times, except during drills and routine start-ups (Case 1); and another in which the absence of a shoreside power connection requires the vessel to run an onboard generator at all times (Case 2).

In both cases, a high and low ship service load was calculated to contrast variability in possible fuel costs. The high ship service load was assumed as 150 kW (70% load of a large 215 kW
generator), while the low ship service load was assumed as 100 kW (85% load of a smaller 120 kW generator). Costs presented assume an average annual price of $2.50/gallon for marine diesel. For Case 1 (with shore power), Puget Sound Energy rate sheet Schedule 25 was used to calculate electricity cost and demand charge. A breakdown of annual energy costs for Case 1 is presented below.

Table 2 At-berth energy cost Case 1

<table>
<thead>
<tr>
<th></th>
<th>Fuel Cost ($)</th>
<th>Electricity Cost ($)</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low ship service load (100 kW)</td>
<td>$12,520</td>
<td>$70,767</td>
<td>$83,287</td>
</tr>
<tr>
<td>High ship service load (150 kW)</td>
<td>$12,729</td>
<td>$105,836</td>
<td>$118,565</td>
</tr>
</tbody>
</table>

Note that fuel costs shown in Table 2 are the result of routine drills, as discussed above. It is assumed the vessel is connected to shoreside power the remainder of the time, with onboard generators secured.

**Conclusion**

It is emphasized that total annual costs presented here are closely linked to crew size and union affiliation, and the assumed age, size, and horsepower of the tug. Selection of a smaller tug with a rated bollard pull of 60 short tons, for example, could result in a significant reduction in annual costs without compromising the intended function of the ERTV. To avoid unnecessary costs to the entities that fund an ERTV, regardless of location, it is imperative that clear mission objectives are defined early in the process and a formal analysis carried out to determine required performance characteristics of the tug to be deployed.