



**ENVIRONMENTAL
RESEARCH
CONSULTING**

**Response Cost Modeling
For Washington State Oil Spill Scenarios
Phase II**

Prepared for

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Spills Program
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FOR WASHINGTON STATE OIL SPILL SCENARIOS**

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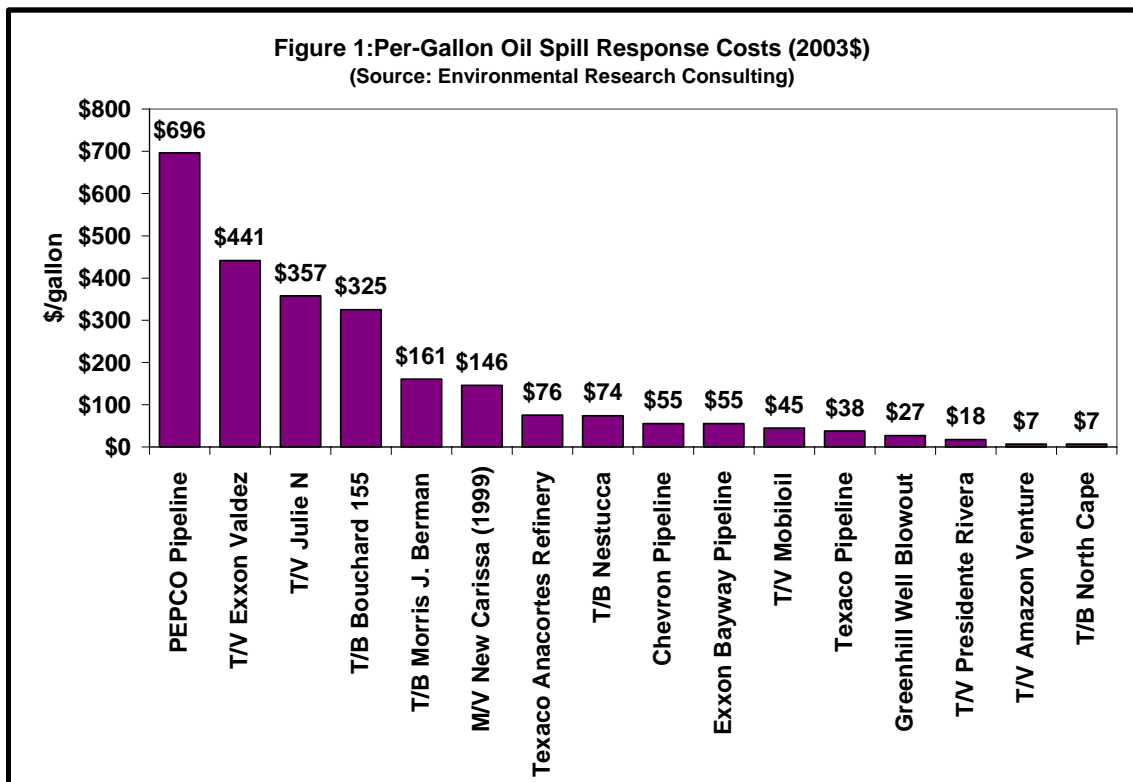
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This volume covers the modeling and estimation of oil spill response costs for the oil spill scenarios previously described in *Modeling Inputs and Assumptions For Washington State Oil Spill Scenarios Phases I and II* (Etkin, *et al.* 2005). Additional information on this project can be found in French-McCay, *et al.* (2005a, 2005b).

OVERVIEW OF OIL SPILL RESPONSE COSTS

Oil spill response costs vary by at least two orders of magnitude when viewed on a per-gallon or per-barrel basis, as shown in Figure 1. This makes simple cost estimations based on per-unit rates highly unreliable.



Each oil spill – and the costs associated with its cleanup response – is a unique event. But, there are patterns that emerge when reviewing historical oil spill case studies and contingency plans. The costs associated with oil spill response operations are strongly influenced by the specific circumstances surrounding the spill including: the type of oil product spilled; the location and timing of the spill; sensitive areas affected or threatened; local and national laws; the amount of oil spilled; and spill response strategy. The influence of these factors on oil spill response costs are reviewed in greater detail elsewhere (Etkin 1998a, 1998b, 1998c, 1999a, 2000, 2004).

Arguably, the most important determinant of cleanup costs is *location*. Location itself is a complex factor involving geographical, political, and legal considerations. The timing of a spill, both seasonally and diurnally (*e.g.*, tide cycles), can profoundly influence the nature and sensitivity of the geographical location. Both geographical location and timing can have a profound effect on the type and level of oil removal required with regards to logistics, type and amount of equipment required, personnel required, amount of work required, and available spill response options. Local or regional standards for the degree of “cleanliness” required for shoreline response operations are also key to determining costs.

Oil type is another important factor in determining oil spill response costs. It is considerably more time-consuming and, thus, more expensive to remove heavier oils than lighter ones. Heavier oils also require expensive decontamination processes for equipment and

Response strategy can also influence costs. Overall, dispersion or burning of oil on the water surface to prevent shoreline contamination tends to reduce overall response costs (Etkin 1998a, 1999b, 2000; Moller, Parker, and Nichols 1987). Shoreline cleanup is often the most time-consuming, labor-intensive, and costly part of a spill response.

Smaller spills are generally more expensive on a per-gallon basis due to the investment in initial mobilization of resources, personnel, and monitoring officials that is then averaged over a smaller number of gallons of oil. There can even be considerable expenses realized when there is merely the *threat* of oil spillage and response resources need to be mobilized on a precautionary basis.

Estimating response costs for hypothetical oil spill scenarios should rely heavily on patterns and data from previous oil spill cases. Since the number of moderate- to larger oil spills has decreased in recent years (Etkin 2001a, Etkin 2001c; 2003a, 2004b), there are fewer spills on which to base oil spill response cost models. Rather than relying exclusively on costs derived from past spills, it is also possible to enhance cost estimates by studying costs for resource and personnel allocations for hypothetical scenarios in area contingency plans and exercises. This also allows for oil spill costs to be estimated for hypothetical spills that are unlike other spills that have occurred in the past.

A combination of actual and modeled hypothetical spill response costs has been employed in various studies (Etkin 2001c, 2001d, 2004a; Etkin *et al.* 2003; Etkin *et al.* 2002; Etkin and Tebeau 2003; French-McCay *et al.* 2004). This methodology is also employed in the current study.

The question of “accuracy” for oil spill cost estimates arises when modeling hypothetical responses to hypothetical spill scenarios. It is virtually impossible to truly accurately predict the cost of any spill response, because there are too many unknown factors. The actual efficacy of spill response equipment and work crews, weather and other factors that can influence response progress, and the possibility of strategic or judgmental errors on the part of response officials or spill managers are all difficult to predict.

Another important set of factors that can influence costs, but also are difficult to foresee, are contractual problems, irregularities, errors, or even improprieties on the part of spill response contractors and spill management teams. There can be tremendous differences in the rates that spill response contractors charge to clients (responsible parties) that already have contractual agreements and those that do not. In addition, there are different governmental and commercial rates that come into play depending on whether the contractors are being hired directly by the responsible party or by government officials, who will then later seek reimbursement to the Oil Spill Liability Trust Fund from the responsible party, if known.

ASSUMPTIONS FOR MODELING OF OIL SPILL RESPONSE COSTS

Total response costs for the scenarios are the sum total of the following categories of costs: mobilization, protective booming, mechanical containment and recovery operations, spill management, spill monitoring by government officials, salvage (source control and stabilization), shoreline cleanup, decontamination of equipment and worker clothing/gear, wildlife rescue and rehabilitation, and disposal of collected oil and debris. These costs do not include any costs associated with restoration of natural resources. (Restoration costs are included under natural resource damages in an accompanying report by Applied Science Associates, Inc.)

The assumptions made in estimating the costs for each of these categories are as follows:

- **Mobilization:** This is the initial mobilization of response equipment and personnel as would be required at the notification of a major oil spill. These costs are based on the costs typically seen in past spills and for equipment-deployment spill exercises. The costs are assumed to \$500,000 for all spills, except for “no response”, assuming that it is known at the time of the initiation of response that no complex offshore response will take place.
- **Protective Boom:** Boom costs are based on the amount of boom deployed as per the applicable state response capabilities (as in Tables 3 – 9) for Washington and Oregon, and as per the US federal capabilities Canada. The costs are based on typical commercial costs for boom on a per-foot daily basis for the estimated time that booms would be in transit to and from the spill site and in place on site. “No response” scenarios are assumed to have no protective booming in place.
- **Mechanical:** Costs for mechanical containment and recovery equipment, personnel, and logistics based on the deployment of the relevant response capabilities for the amount of time it would be required to have equipment and personnel in transit to and from the site as well as the time that the oil on the water surface is at least 13 microns in thickness for diesel and crude scenarios and 50 microns for Bunker C based on the fates and trajectory modeling in SIMAP. Additional time is added for decontamination and demobilization. Costs are also based on spill size and oil type.

The pay scales for workers are based on a comprehensive survey of Basic Ordering Agreements made with the US Coast Guard (USCG) Office of Maintenance and Logistics for the 13th US Coast Guard District updated to 2003 dollars and adjusted for commercial rates. Wages are paid as: 67% straight wages, 20% premium wages, and 13% overtime wages. Cleanup crews work for 12-hour workdays. Crews consist of: 1% project managers, 3% supervisors, 67% skilled laborers, and 29% unskilled laborers. Worker numbers and ratios of worker types were verified by a review of Area Contingency Plans (*e.g.*, North Coast California; Central Coast California; San Francisco Bay & Delta, Baltimore; Long Angeles/Long Beach; Mid-Coast Atlantic; Galveston, Texas; Port Arthur, Texas; San Diego; New York/New Jersey), Incident Action Plans from past spills (*e.g.*, Cape Mohican; PEPCO Pipeline; New Carissa; Morris J. Berman), and oil company contingency plans. Equipment rental rates are based on a comprehensive survey of Basic Ordering Agreements made with the USCG Office of Maintenance and Logistics for the 13th US Coast Guard District updated to 2003 dollars and adjusted for commercial rates. Helicopter overflights are charged for 12-hour days (times two helicopters) for the entire time oil is present on the water surface, including for “no-

response” scenarios. Costs for shore-based support for skimming systems are assumed to be 12% of on-water costs (based on Michel and Cotsapas 1997).

- **Spill Management/Spill Monitoring:** Costs for responsible party-related spill management (Qualified Individual services and spill management teams) and response-related activities by responsible party personnel are based on reviews of previous responses to major spills in the ERC Oil Spill Cost Databases and other studies (*e.g.*, Etkin 1995; Michel, French-McCay and Etkin 2001, 2002). The costs are based on the level of effort required based on response type, spill size, and oil type (based on persistence, as in Davis, *et al.* 2004). The costs are assumed to be \$2 million for “no response” diesel and Bunker C scenarios, \$5 million for “no response” crude scenarios, \$4 million for 65,000-bbl diesel scenarios, and 25,000-bbl Bunker C spill scenarios; and \$15 million for 250,000-bbl mechanical-only crude scenarios.

Costs for federal, state, and local officials involved in overseeing and coordinating spill response operations are also included in this category. These costs are based on historical spill cases and estimates for government officials’ time at \$55,000 per day of on-water spill response operations and \$10,000 per day during shoreline cleanup operations (Etkin 1995; Etkin 1998*b*; Michel, French-McCay, and Etkin 2001, 2002).

- **Salvage:** Costs to control the source of leakage (tanker, cargo vessel, or barge), lighter remaining oil off vessel, and stabilize the vessel for public safety are included. Costs for repairing the vessel for future use by the owner or to sell the vessel are not included. Costs are based on information from US Maritime Administration and Navy SupSalv (Michel, French-McCay and Etkin 2001, 2002), as well as data from the Morris J. Berman tank barge spill (Etkin 1995). Costs are adjusted based on the size of the vessel and the type of oil involved. The costs are estimated to be: \$8 million for crude tanker spills; \$6 million for diesel tanker spills; and \$3 million for Bunker C barge or cargo vessel spills.
- **Wildlife Rescue/Rehabilitation:** Capture, treatment, and rehabilitation costs for oil-impacted and injured wildlife are included in this category. Costs are based on historical spill data, particularly the Exxon Valdez oil spill (Monahan and Maki 1991; Etkin 1998*b*). Estimates for wildlife rescue and rehabilitation services for “no response” scenarios are \$3 million for Bunker C spills (25,000 bbl), \$20 million for crude spills (250,000 bbl), and \$1 million for diesel spills (65,000 bbl). Costs are incurred for wildlife rescue and rehabilitation services to be on standby as well as for actual services rendered. These costs do not include “injuries” to wildlife or rehabilitation of habitats that are covered under “natural resource damages.”
- **Shoreline Cleanup:** Shoreline cleanup costs are based on area of oil impact by shoreline type and oil type (Etkin 2001*d*, 2003*b*). The characteristics of oil (as in Table 1) and the characteristics of the substrate (rocky, gravel, wetland, sand, *etc.*) influence the degree of penetration, persistence, and adhesion. All these factors determine the amount of labor necessary to remove the oil from impacted shorelines. In addition, some shoreline types – notably wetlands and mudflats – are extremely sensitive to the impacts of the spill response itself (moving of machinery and personnel) so that extraordinary measures need to be taken, making these shoreline types more expensive to clean up. Shoreline cleanup cost factors on a per area basis by oil type and shoreline type are shown in Table 2. Note that these costs do not include the disposal of oily debris and solid waste collected. Shoreline cleanup is assumed to continue at a rate of 2,000 m²/day.

Oil Type	Viscosity	Adhesion	Penetration	Degradation
Gasoline	1	1	5	4
Diesel	2	2	4	1
Crude	4	4	2	3
Heavy fuel oil	5	5	1	5

¹Lower numbers indicate more favorable conditions to the environment and faster recovery after a spill (based on Fingas 2001).

Oil Type	Bunker C		Diesel		ANS Crude	
Shoreline Type	<1 mm	>1 mm	<1 mm	>1 mm	<1 mm	>1 mm
Rocky shoreline	\$14	\$78	\$2	\$4	\$7	\$39
Gravel beach	\$20	\$140	\$3	\$5	\$10	\$70
Sand beach	\$24	\$78	\$3	\$6	\$12	\$39
Mud flat	\$70	\$156	\$10	\$18	\$35	\$78
Wetland	\$80	\$172	\$11	\$21	\$40	\$86
Artificial	\$8	\$46	\$1	\$2	\$4	\$23

Year 2003 \$ per m². Not including disposal costs

- Disposal:** Costs for the disposal of oil recovered on the water during mechanical containment and recovery operations as well as oily debris recovered from oil-impacted shorelines are included in this category. Oil disposal rates are based on a comprehensive survey of Basic Ordering Agreements made with the US Coast Guard Office of Maintenance and Logistics for the all US Coast Guard Districts updated to 2004 \$. The costs are \$216 per barrel of oil recovered mechanically and \$150 per m² shoreline impact of greater than 0.1mm. The costs *assume an emulsification factor of four – i.e.,* for each barrel of oil recovered, there are four barrels for disposal/separation due to emulsification and excess water recovery (Etkin 1995).
- Decontamination:** Removal of oil residue from equipment and personnel gear is assumed to be \$100 per barrel of crude removed, and \$200 per barrel of Bunker C removed, based on historical spill case studies, notably the Morris J. Berman barge spill (Etkin 1995) and the persistence of the oils (Davis *et al.* 2004; Fingas 2001). For diesel spills, \$10 per barrel recovered decontamination costs were added since the residue evaporates and is not persistent. For “no response” scenarios, decontamination of shoreline response equipment and gear was estimated at \$100,000 for Bunker C spills and \$300,000 for the crude spills.

OIL SPILL RESPONSE COST MODELING RESULTS

Oil spill response costs were estimated for each of the scenarios (varying spill location, oil type and amount, and response capability and strategy. Costs were estimated for all offshore response operations (mechanical containment/recovery) and all other aspects of spill response (management, monitoring, protective booming, and salvage), as well as for shoreline and disposal operations costs. For each scenario area, the cost results are presented in two parts – tables with offshore response, overall monitoring/management operations, salvage, and protective booming other, and tables with shoreline cleanup and disposal costs, and total costs.

Modeling of each spill scenario involved 100 simulations with different variations in winds, currents, and tides. The simulations (or “runs”) that gave worst-case results as defined by Department of Ecology in terms of impacts to specific sensitive locations and overall shoreline impact were considered for detailed analysis. The runs for the different scenarios are shown in Table 3.

Table 3: Key to Oil Spill Scenario Impact Codes						
Location	Scenario	Spill Type	Run Criteria	Results Code	Run² #	
Straits of Juan de Fuca	JF-B25K	25,000 bbl Bunker C	Worst shoreline impact ¹	WSH	23	
			Dungeness Spit (fastest impact w/100,000 g/m ²)	DS	51	
			Protection Island (fastest impact w/100,000 g/m ²)	PI	50	
		JF-D65K	65,000 bbl Diesel	Worst shoreline impact ¹	WSH	54
				Dungeness Spit (fastest impact w/100,000 g/m ²)	DS	15
				Protection Island (fastest impact w/100,000 g/m ²)	PI	50
		JF-C250K	250,000 bbl ANS Crude	Worst shoreline impact ¹	ESH	56
				Dungeness Spit (fastest impact w/100,000 g/m ²)	DS	51
				Protection Island (fastest impact w/100,000 g/m ²)	PI	50
San Juan Islands	SJ-C250K	250,000 bbl ANS Crude	Worst shoreline impact ¹	WSH	22	
			Lopez Island (fastest impact w/100,000 g/m ²)	LOP	13	
			Orcas Island (fastest impact w/100,000 g/m ²)	ORC	40	
			50 th percentile shoreline impact ³	50SH	2	
			Lummi Island (fastest impact w/100,000 g/m ²)	LUM	50	
			Padilla Bay (fastest impact w/100,000 g/m ²)	PAD	11	
Outer Coast	OC-C250K	250,000 bbl ANS Crude	Worst shoreline impact ¹	WSH	13	
			Olympic Coast National Marine Sanctuary (fastest impact w/100,000 g/m ²)	OLY	44	
			Tatoosh Island (fastest impact w/100,000 g/m ²)	TAT	72	
Lower Columbia River	CL-B25K	25,000 bbl Bunker C	Worst shoreline impact ¹	WSH	33	
			Baker Bay (fastest impact w/100,000 g/m ²)	BAK	10	
			Columbia National Marine Sanctuary (fastest impact w/100,000 g/m ²)	COL	93	
Upper Columbia River	CU-B25K	25,000 bbl Bunker C	Worst shoreline impact ¹	WSH	22	
			Ridgefield National Wildlife Refuge #1 (fastest impact w/100,000 g/m ²)	RD1	25	
			Ridgefield National Wildlife Refuge #2 (fastest impact w/100,000 g/m ²)	RD2	54	

¹Shoreline impact as “weighted” by factors related to degree of sensitivity and difficulty/cost of cleanup.
²Simulation run number within SIMAP modeling (from 100 simulations.) ³50th percentile weighted shoreline impact (as in 1) in which 50% of impacts are less and 50% are higher (*i.e.*, “median” impact)

San Juan Islands Scenarios

Estimated cost results for the San Juan Islands scenarios are in Tables 4 – 5, with shore impacts and oil removal rates shown in Table 6.

Scenario	Results Code	Mobilize ¹	Boom ²	Mech ³	Mgt + Monitor ⁴	Salvage ⁵	Decon ⁶	Wild-life ⁷	Non-Shoreline Non-Disposal TOTAL ⁸
SJ-C250K - N	WSH	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	LOP	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	ORC	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	50SH	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	LUM	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	PAD	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
SJ-C250K -R-FED	WSH	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$456	\$20,000	\$60,956
	LOP	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$511	\$20,000	\$61,011
	ORC	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$489	\$20,000	\$60,989
	50SH	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$402	\$20,000	\$60,902
	LUM	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$462	\$20,000	\$60,962
	PAD	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$336	\$20,000	\$60,836
SJ-C250K -R-WA	WSH	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$443	\$20,000	\$62,743
	LOP	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$571	\$20,000	\$62,871
	ORC	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$315	\$20,000	\$62,615
	50SH	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$1,056	\$20,000	\$63,356
	LUM	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$1,155	\$20,000	\$63,455
	PAD	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$1,111	\$20,000	\$63,411
SJ-C250K -R-3	WSH	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$916	\$20,000	\$63,816
	LOP	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$910	\$20,000	\$63,810
	ORC	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$841	\$20,000	\$63,741
	50SH	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$998	\$20,000	\$63,898
	LUM	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$1,251	\$20,000	\$64,151
	PAD	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$745	\$20,000	\$63,645

¹Initial mobilization of resources, including equipment and personnel, at first notification of major spill. These costs are charged to responsible party regardless of whether the equipment/personnel are ever deployed.
²Protective booming of sensitive resources based on Geographic Response Plans associated with Northwest Area Contingency Plan. ³On-water mechanical containment and recovery operations, including equipment and personnel. ⁴Spill management, qualified individual services, and other responsible-party associated costs, and government monitoring costs. ⁵Salvage or source control to stop leak of oil, lighter vessel, and protect public safety. ⁶Decontamination of oiled equipment, worker clothing, etc. ⁷Wildlife rescue, treatment, and rehabilitation. ⁸This sub-total does not include shoreline cleanup operations or disposal of on-water or on-shore collected oil and debris.

Table 5: Estimated Total Response Costs: San Juan Islands Scenarios (Costs in 1,000 dollars)						
Scenario	Results Code	Non-Shore/Disp TOTAL	Shoreline	Solid Disposal	Liquid Disposal	TOTAL (Rounded)
SJ-C250K-N	WSH	\$33,325	\$513,660	\$1,893,000	\$0	\$2,440,000
	LOP	\$33,325	\$159,370	\$625,800	\$0	\$818,500
	ORC	\$33,325	\$284,690	\$1,041,000	\$0	\$1,359,000
	50SH	\$33,325	\$202,950	\$720,300	\$0	\$956,600
	LUM	\$33,325	\$343,680	\$1,200,600	\$0	\$1,577,600
	PAD	\$33,325	\$338,040	\$656,100	\$0	\$1,027,500
	Mean	\$33,325	\$307,065	\$1,022,800	\$0	\$1,363,200
	Mean+2SD	\$33,325	\$557,083	\$1,991,418	\$0	\$2,581,800
	Mean - 2SD	\$33,325	\$57,047	\$54,182	\$0	\$144,600
SJ-C250K-R-FED	WSH	\$60,956	\$396,250	\$1,390,350	\$985	\$1,848,500
	LOP	\$61,011	\$193,480	\$771,300	\$1,104	\$1,026,900
	ORC	\$60,989	\$285,260	\$872,250	\$1,056	\$1,219,600
	50SH	\$60,902	\$429,810	\$891,000	\$869	\$1,382,600
	LUM	\$60,962	\$165,390	\$958,650	\$998	\$1,186,000
	PAD	\$60,836	\$227,010	\$756,450	\$725	\$1,045,000
	Mean	\$60,943	\$282,867	\$940,000	\$956	\$1,284,800
	Mean+2SD	\$61,070	\$500,792	\$1,406,737	\$1,233	\$1,969,800
	Mean - 2SD	\$60,815	\$64,941	\$473,263	\$680	\$599,700
SJ-C250K-R-WA	WSH	\$62,743	\$253,110	\$1,509,000	\$2,281	\$1,827,100
	LOP	\$62,871	\$264,410	\$663,900	\$2,495	\$993,700
	ORC	\$62,615	\$227,930	\$685,350	\$2,400	\$978,300
	50SH	\$63,356	\$161,840	\$698,400	\$1,979	\$925,600
	LUM	\$63,455	\$419,290	\$1,690,500	\$1,965	\$2,175,200
	PAD	\$63,411	\$299,460	\$1,118,700	\$1,817	\$1,483,400
	Mean	\$63,075	\$271,007	\$1,060,975	\$2,156	\$1,397,200
	Mean+2SD	\$63,823	\$442,900	\$1,968,977	\$2,703	\$2,478,400
	Mean - 2SD	\$62,327	\$99,113	\$152,973	\$1,610	\$316,000
SJ-C250K-R-3	WSH	\$63,816	\$414,920	\$1,534,500	\$3,211	\$2,016,400
	LOP	\$63,810	\$154,370	\$615,450	\$3,683	\$837,300
	ORC	\$63,741	\$236,440	\$778,050	\$3,493	\$1,081,700
	50SH	\$63,898	\$183,900	\$623,400	\$2,982	\$874,200
	LUM	\$64,151	\$274,200	\$959,550	\$2,794	\$1,300,700
	PAD	\$63,645	\$253,710	\$901,950	\$2,716	\$1,222,000
	Mean	\$63,844	\$252,923	\$902,150	\$3,146	\$1,222,100
	Mean+2SD	\$64,189	\$435,011	\$1,582,421	\$3,920	\$2,085,500
	Mean - 2SD	\$63,498	\$70,836	\$221,879	\$2,372	\$358,600

Table 6: Shoreline Impact and Bbl Oil Removed: San Juan Islands Scenarios					
Scenario	Results Code	Shoreline Impact (m ²)	% Oil Ashore	Bbl Oil Removed	% Removed Offshore
SJ-C250K-N	WSH	12,620,000	34.1%	0	0.00%
	LOP	4,172,000	24.9%	0	0.00%
	ORC	6,940,000	31.4%	0	0.00%
	50SH	4,802,000	26.1%	0	0.00%
	LUM	8,004,000	27.6%	0	0.00%
	PAD	4,374,000	29.8%	0	0.00%
	Mean	6,818,667	29.0%	0	0.00%
	Mean + 2SD	13,276,121	35.3%	0	0.00%
	Mean - 2SD	361,213	22.1%	0	0.00%
SJ-C250K-R-FED	WSH	9,269,000	33.0%	4,560	1.82%
	LOP	5,142,000	23.5%	5,111	2.04%
	ORC	5,815,000	31.7%	4,891	1.96%
	50SH	5,940,000	27.8%	4,024	1.61%
	LUM	6,391,000	24.4%	4,620	1.85%
	PAD	5,043,000	29.2%	3,356	1.34%
	Mean	6,266,667	28.3%	4,427	1.77%
	Mean + 2SD	9,378,247	35.2%	5,707	2.28%
	Mean - 2SD	3,155,087	20.6%	3,147	1.26%
SJ-C250K-R-WA	WSH	10,060,000	31.8%	10,559	4.22%
	LOP	4,426,000	23.1%	11,552	4.62%
	ORC	4,569,000	30.5%	11,113	4.45%
	50SH	4,656,000	24.6%	9,161	3.66%
	LUM	11,270,000	26.9%	9,096	3.64%
	PAD	7,458,000	29.2%	8,414	3.37%
	Mean	7,073,167	27.7%	9,982	3.99%
	Mean + 2SD	13,126,511	33.9%	12,512	5.00%
	Mean - 2SD	1,019,823	20.9%	7,453	2.98%
SJ-C250K-R-3	WSH	10,230,000	30.5%	14,866	5.95%
	LOP	4,103,000	24.0%	17,050	6.82%
	ORC	5,187,000	29.1%	16,170	6.47%
	50SH	4,156,000	23.9%	13,805	5.52%
	LUM	6,397,000	24.2%	12,934	5.17%
	PAD	6,013,000	29.0%	12,572	5.03%
	Mean	6,014,333	26.8%	14,566	5.83%
	Mean + 2SD	10,549,473	32.4%	18,150	7.26%
	Mean - 2SD	1,479,194	20.7%	10,982	4.39%

Strait of Juan de Fuca Scenarios

Estimated cost results for Strait of Juan de Fuca scenarios are in Tables 7 – 8. Shoreline impact and oil removal are shown in Table 9.

**Table 7: Modeled Oil Spill Response Costs Excluding Shoreline Response Costs and Disposal Costs:
Strait of Juan de Fuca Scenarios (Costs in 1,000 dollars)**

Scenario	Results Code	Mobilize ¹	Boom ²	Mech ³	Mgt + Monitor ⁴	Salvage ⁵	Decon ⁶	Wild-life ⁷	Non-Shoreline Non-Disposal TOTAL ⁸
JF-C250K - N	WSH	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	DS	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	PI	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
JF-C250K -R-FED	WSH	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$511	\$20,000	\$61,011
	DS	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$218	\$20,000	\$60,718
	PI	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$470	\$20,000	\$60,970
JF-C250K -R-WA	WSH	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$400	\$20,000	\$62,700
	DS	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$717	\$20,000	\$63,017
	PI	\$500	\$13,600	\$5,200	\$15,000	\$8,000	\$82	\$20,000	\$62,382
JF-C250K -R-3	WSH	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$1,132	\$20,000	\$64,032
	DS	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$584	\$20,000	\$63,484
	PI	\$500	\$13,600	\$5,800	\$15,000	\$8,000	\$1,053	\$20,000	\$63,953
JF-D65K - N	WSH	\$25	\$0	\$0	\$2,000	\$6,000	\$0	\$1,000	\$9,025
	DS	\$25	\$0	\$0	\$2,000	\$6,000	\$0	\$1,000	\$9,025
	PI	\$25	\$0	\$0	\$2,000	\$6,000	\$0	\$1,000	\$9,025
JF-D65K -R-FED	WSH	\$500	\$13,600	\$800	\$4,000	\$6,000	\$0	\$1,000	\$25,900
	DS	\$500	\$13,600	\$800	\$4,000	\$6,000	\$0	\$1,000	\$25,900
	PI	\$500	\$13,600	\$800	\$4,000	\$6,000	\$0	\$1,000	\$25,900
JF-D65K -R-WA	WSH	\$500	\$13,600	\$1,200	\$4,000	\$6,000	\$0	\$1,000	\$26,300
	DS	\$500	\$13,600	\$1,200	\$4,000	\$6,000	\$0	\$1,000	\$26,300
	PI	\$500	\$13,600	\$1,200	\$4,000	\$6,000	\$0	\$1,000	\$26,300
JF-D65K -R-3	WSH	\$500	\$13,600	\$1,500	\$4,000	\$6,000	\$0	\$1,000	\$26,600
	DS	\$500	\$13,600	\$1,500	\$4,000	\$6,000	\$0	\$1,000	\$26,600
	PI	\$500	\$13,600	\$1,500	\$4,000	\$6,000	\$0	\$1,000	\$26,600
JF-B25K - N	WSH	\$25	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,125
	DS	\$25	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,125
	PI	\$25	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,125
JF-B25K -R-FED	WSH	\$500	\$13,600	\$1,300	\$4,000	\$3,000	\$291	\$3,000	\$25,691
	DS	\$500	\$13,600	\$1,300	\$4,000	\$3,000	\$292	\$3,000	\$25,692
	PI	\$500	\$13,600	\$1,300	\$4,000	\$3,000	\$634	\$3,000	\$26,034
JF-B25K -R-WA	WSH	\$500	\$13,600	\$1,500	\$4,000	\$3,000	\$406	\$3,000	\$26,006
	DS	\$500	\$13,600	\$1,500	\$4,000	\$3,000	\$801	\$3,000	\$26,401
	PI	\$500	\$13,600	\$1,500	\$4,000	\$3,000	\$11	\$3,000	\$25,611
JF-B25K -R-3	WSH	\$500	\$13,600	\$1,700	\$4,000	\$3,000	\$423	\$3,000	\$26,223
	DS	\$500	\$13,600	\$1,700	\$4,000	\$3,000	\$728	\$3,000	\$26,528
	PI	\$500	\$13,600	\$1,700	\$4,000	\$3,000	\$1,419	\$3,000	\$27,219

¹Initial mobilization of resources, including equipment and personnel, at first notification of major spill. These costs are charged to responsible party regardless of whether the equipment/personnel are ever deployed.

²Protective booming of sensitive resources based on Geographic Response Plans associated with Northwest Area Contingency Plan. ³On-water mechanical containment and recovery operations, including equipment and personnel. ⁴Spill management, qualified individual services, and other responsible-party associated costs, and government monitoring costs. ⁵Salvage or source control to stop leak of oil, lighter vessel, and protect public safety. ⁶Decontamination of oiled equipment, worker clothing, etc. ⁷Wildlife rescue, treatment, and rehabilitation. ⁸This sub-total does not include shoreline cleanup operations or disposal of on-water or on-shore collected oil and debris.

Table 8: Estimated Total Response Costs: Strait of Juan de Fuca Scenarios (Costs in 1,000 dollars)						
Scenario	Results Code	Non-Shore/Disp TOTAL	Shoreline	Solid Disposal	Liquid Disposal	TOTAL (Rounded)
JF-C250K-N	WSH	\$33,325	\$141,030	\$1,297,500	\$0	\$1,471,900
	DS	\$33,325	\$103,640	\$286,500	\$0	\$423,500
	PI	\$33,325	\$141,440	\$374,250	\$0	\$549,000
	Mean	\$33,325	\$128,703	\$652,750	\$0	\$814,800
	Mean+2SD	\$33,325	\$172,116	\$1,772,932	\$0	\$1,978,400
	Mean - 2SD	\$33,325	\$85,290	\$0	\$0	\$118,600
JF-C250K-R-FED	WSH	\$61,011	\$254,700	\$1,134,750	\$1,104	\$1,451,600
	DS	\$60,718	\$102,530	\$316,500	\$470	\$480,200
	PI	\$60,970	\$143,490	\$393,450	\$1,015	\$598,900
	Mean	\$60,900	\$166,907	\$614,900	\$863	\$843,600
	Mean+2SD	\$61,217	\$324,389	\$1,518,589	\$1,550	\$1,905,700
	Mean - 2SD	\$60,582	\$9,424	\$0	\$177	\$70,200
JF-C250K-R-WA	WSH	\$62,700	\$239,600	\$1,061,850	\$2,444	\$1,366,600
	DS	\$63,017	\$90,315	\$210,450	\$1,262	\$365,000
	PI	\$62,382	\$141,970	\$397,950	\$2,274	\$604,600
	Mean	\$62,700	\$157,295	\$556,750	\$1,993	\$778,700
	Mean+2SD	\$63,335	\$308,921	\$1,451,476	\$3,272	\$1,827,000
	Mean - 2SD	\$62,065	\$5,669	\$0	\$715	\$68,400
JF-C250K-R-3	WSH	\$64,032	\$234,430	\$982,800	\$3,645	\$1,284,900
	DS	\$63,484	\$92,082	\$222,750	\$1,964	\$380,300
	PI	\$63,953	\$134,630	\$390,750	\$3,393	\$592,700
	Mean	\$63,823	\$153,714	\$532,100	\$3,001	\$752,600
	Mean+2SD	\$64,415	\$299,849	\$1,330,608	\$4,814	\$1,699,700
	Mean - 2SD	\$63,231	\$7,579	\$0	\$1,187	\$72,000
JF-D65K-N	WSH	\$9,025	\$36,459	\$385,950	\$0	\$431,400
	DS	\$9,025	\$24,903	\$234,750	\$0	\$268,700
	PI	\$9,025	\$8,904	\$115,155	\$0	\$133,100
	Mean	\$9,025	\$23,422	\$245,285	\$0	\$277,700
	Mean+2SD	\$9,025	\$51,096	\$516,694	\$0	\$576,800
	Mean - 2SD	\$9,025	\$0	\$0	\$0	\$9,000
JF-D65K-R-FED	WSH	\$25,900	\$14,815	\$166,500	\$389	\$207,600
	DS	\$25,900	\$24,841	\$228,750	\$583	\$280,100
	PI	\$25,900	\$9,738	\$141,990	\$536	\$178,200
	Mean	\$25,900	\$16,465	\$179,080	\$503	\$221,900
	Mean+2SD	\$25,900	\$31,836	\$268,534	\$705	\$327,000
	Mean - 2SD	\$25,900	\$1,094	\$89,626	\$301	\$116,900
JF-D65K-R-WA	WSH	\$26,300	\$14,633	\$181,350	\$546	\$222,800
	DS	\$26,300	\$26,954	\$245,700	\$1,294	\$300,200
	PI	\$26,300	\$6,802	\$99,885	\$1,177	\$134,200
	Mean	\$26,300	\$16,130	\$175,645	\$1,006	\$219,100
	Mean+2SD	\$26,300	\$36,448	\$321,794	\$1,811	\$386,400
	Mean - 2SD	\$26,300	\$0	\$29,496	\$200	\$56,000
JF-D65K-R-3	WSH	\$26,600	\$17,707	\$204,600	\$673	\$249,600
	DS	\$26,600	\$17,746	\$186,900	\$1,867	\$233,100
	PI	\$26,600	\$7,505	\$92,085	\$1,714	\$127,900
	Mean	\$26,600	\$14,319	\$161,195	\$1,418	\$203,500
	Mean+2SD	\$26,600	\$26,122	\$282,199	\$2,717	\$337,600
	Mean - 2SD	\$26,600	\$2,516	\$40,191	\$119	\$69,400

Table 8: Estimated Total Response Costs: Strait of Juan de Fuca Scenarios (Costs in 1,000 dollars) <i>(continued)</i>						
Scenario	Results Code	Non-Shore/Disp TOTAL	Shoreline	Solid Disposal	Liquid Disposal	TOTAL (Rounded)
JF-B25K-N	WSH	\$8,125	\$107,830	\$141,690	\$0	\$257,600
	DS	\$8,125	\$95,347	\$112,785	\$0	\$216,300
	PI	\$8,125	\$42,831	\$51,255	\$0	\$102,200
	Mean	\$8,125	\$82,003	\$101,910	\$0	\$192,000
	Mean+2SD	\$8,125	\$150,989	\$194,286	\$0	\$353,400
	Mean - 2SD	\$8,125	\$13,017	\$9,534	\$0	\$30,700
JF-B25K-R-FED	WSH	\$25,691	\$102,230	\$127,155	\$314	\$255,400
	DS	\$25,692	\$89,849	\$106,620	\$316	\$222,500
	PI	\$26,034	\$37,334	\$50,835	\$685	\$114,900
	Mean	\$25,806	\$76,471	\$94,870	\$438	\$197,600
	Mean+2SD	\$26,201	\$145,380	\$173,857	\$865	\$346,300
	Mean - 2SD	\$25,410	\$7,562	\$15,883	\$11	\$48,900
JF-B25K-R-WA	WSH	\$26,006	\$110,700	\$137,850	\$457	\$275,000
	DS	\$26,401	\$92,988	\$111,330	\$786	\$231,500
	PI	\$25,611	\$30,231	\$39,990	\$1,533	\$97,400
	Mean	\$26,006	\$77,973	\$96,390	\$925	\$201,300
	Mean+2SD	\$26,796	\$162,540	\$197,613	\$2,027	\$389,000
	Mean - 2SD	\$25,216	\$0	\$0	\$0	\$25,200
JF-B25K-R-3	WSH	\$26,223	\$96,424	\$122,340	\$627	\$245,600
	DS	\$26,528	\$89,954	\$101,070	\$1,299	\$218,900
	PI	\$27,219	\$28,284	\$40,695	\$2,273	\$98,500
	Mean	\$26,657	\$71,554	\$88,035	\$1,400	\$187,600
	Mean+2SD	\$27,677	\$146,779	\$172,744	\$3,056	\$350,300
	Mean - 2SD	\$25,636	\$0	\$3,326	\$0	\$29,000

Table 9: Shoreline Impact and Bbl Oil Removed: Strait of Juan de Fuca Scenarios					
Scenario	Results Code	Shoreline Impact (m ²)	% Oil Ashore	Bbl Oil Removed	% Removed Offshore
JF-C250K-N	WSH	8,650,000	25.8%	0	0.00%
	DS	1,910,000	32.4%	0	0.00%
	PI	2,495,000	23.8%	0	0.00%
	Mean	4,351,667	27.3%	0	0.00%
	Mean + 2SD	11,819,547	34.7%	0	0.00%
	Mean - 2SD	0	18.3%	0	0.00%
JF-C250K-R-FED	WSH	7,565,000	24.3%	5,111	2.04%
	DS	2,110,000	32.2%	2,178	0.87%
	PI	2,623,000	22.8%	4,701	1.88%
	Mean	4,099,333	26.4%	3,997	1.60%
	Mean + 2SD	10,123,925	34.7%	7,174	2.87%
	Mean - 2SD	0	16.3%	819	0.33%
JF-C250K-R-WA	WSH	7,079,000	25.1%	11,316	4.53%
	DS	1,403,000	33.0%	5,842	2.34%
	PI	2,653,000	22.6%	10,526	4.21%
	Mean	3,711,667	26.9%	9,228	3.69%
	Mean + 2SD	9,676,505	35.7%	15,146	6.06%
	Mean - 2SD	0	16.0%	3,310	1.32%
JF-C250K-R-3	WSH	6,552,000	23.0%	16,873	6.75%
	DS	1,485,000	31.9%	9,092	3.64%
	PI	2,605,000	21.7%	15,710	6.28%
	Mean	3,547,333	25.5%	13,892	5.56%
	Mean + 2SD	8,870,722	34.6%	22,286	8.91%
	Mean - 2SD	0	14.4%	5,497	2.20%
JF-D65K-N	WSH	2,573,000	13.8%	0	0.00%
	DS	1,565,000	17.5%	0	0.00%
	PI	767,700	6.0%	0	0.00%
	Mean	1,635,233	12.4%	0	0.00%
	Mean + 2SD	3,444,627	22.0%	0	0.00%
	Mean - 2SD	0	0.7%	0	0.00%
JF-D65K-R-FED	WSH	1,110,000	6.7%	1,801	2.77%
	DS	1,525,000	18.1%	2,697	4.15%
	PI	946,600	6.4%	2,481	3.82%
	Mean	1,193,867	10.4%	2,327	3.58%
	Mean + 2SD	1,790,228	21.3%	3,262	5.02%
	Mean - 2SD	597,505	0%	1,392	2.14%
JF-D65K-R-WA	WSH	1,209,000	7.7%	2,527	3.89%
	DS	1,638,000	18.9%	5,993	9.22%
	PI	665,900	5.1%	5,451	8.39%
	Mean	1,170,967	10.6%	4,657	7.16%
	Mean + 2SD	2,145,296	22.5%	8,386	12.90%
	Mean - 2SD	196,637	0%	928	1.43%
JF-D65K-R-3	WSH	1,364,000	9.1%	3,116	4.79%
	DS	1,246,000	16.9%	8,643	13.30%
	PI	613,900	5.2%	7,936	12.21%
	Mean	1,074,633	10.4%	6,565	10.10%
	Mean + 2SD	1,881,324	20.1%	12,580	19.35%
	Mean - 2SD	267,943	0%	549	0.85%

Table 9: Shoreline Impact and Bbl Oil Removed: Strait of Juan de Fuca Scenarios (continued)					
Scenario	Results Code	Shoreline Impact (m²)	% Oil Ashore	Bbl Oil Removed	% Removed Offshore
JF-B25K-N	WSH	944,600	62.6%	0	0.00%
	DS	751,900	68.9%	0	0.00%
	PI	341,700	60.9%	0	0.00%
	Mean	679,400	64.2%	0	0.00%
	Mean + 2SD	1,295,239	71.0%	0	0.00%
	Mean - 2SD	63,561	55.8%	0	0.00%
JF-B25K-R-FED	WSH	847,700	58.9%	1,454	5.82%
	DS	710,800	70.5%	1,461	5.85%
	PI	338,900	54.0%	3,169	12.67%
	Mean	632,467	61.1%	2,028	8.11%
	Mean + 2SD	1,159,046	75.0%	4,003	16.01%
	Mean - 2SD	105,887	44.2%	53	0.21%
JF-B25K-R-WA	WSH	919,000	57.4%	2,117	8.47%
	DS	742,200	60.4%	3,639	14.56%
	PI	266,600	45.5%	7,095	28.38%
	Mean	642,600	54.4%	4,283	17.13%
	Mean + 2SD	1,317,423	67.3%	9,385	37.54%
	Mean - 2SD	0	38.7%	0	0%
JF-B25K-R-3	WSH	815,600	55.9%	2,902	11.61%
	DS	673,800	53.7%	6,013	24.05%
	PI	271,300	36.5%	10,525	42.10%
	Mean	586,900	48.7%	6,480	25.92%
	Mean + 2SD	1,151,628	66.0%	14,146	56.58%
	Mean - 2SD	22,172	27.4%	0	0%

Outer Coast Scenarios

Estimated cost results for the Outer Coast scenarios are shown in Tables 10 – 11. Shoreline impacts and oil removal are shown in Table 12.

Table 10: Modeled Oil Spill Response Costs Excluding Shoreline Response Costs and Disposal Costs: Outer Coast Scenarios (Costs in 1,000 dollars)

Scenario	Results Code	Mobilize ¹	Boom ²	Mech ³	Mgt + Monitor ⁴	Salvage ⁵	Decon ⁶	Wild-life ⁷	Non-Shoreline Non-Disposal TOTAL ⁸
OC-C250K - N	WSH	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	OLY	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
	TAT	\$25	\$0	\$0	\$5,000	\$8,000	\$300	\$20,000	\$33,325
OC-C250K -R-FED	WSH	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$10	\$20,000	\$60,510
	OLY	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$179	\$20,000	\$60,679
	TAT	\$500	\$13,600	\$3,400	\$15,000	\$8,000	\$237	\$20,000	\$60,737
OC-C250K -R-WA	WSH	\$500	\$13,600	\$6,000	\$15,000	\$8,000	\$10	\$20,000	\$63,110
	OLY	\$500	\$13,600	\$6,000	\$15,000	\$8,000	\$824	\$20,000	\$63,924
	TAT	\$500	\$13,600	\$6,000	\$15,000	\$8,000	\$886	\$20,000	\$63,986
OC-C250K -R-3	WSH	\$500	\$13,600	\$6,800	\$15,000	\$8,000	\$120	\$20,000	\$64,020
	OLY	\$500	\$13,600	\$6,800	\$15,000	\$8,000	\$987	\$20,000	\$64,887
	TAT	\$500	\$13,600	\$6,800	\$15,000	\$8,000	\$1,076	\$20,000	\$64,976

¹Initial mobilization of resources, including equipment and personnel, at first notification of major spill. These costs are charged to responsible party regardless of whether the equipment/personnel are ever deployed.

²Protective booming of sensitive resources based on Geographic Response Plans associated with Northwest Area Contingency Plan. ³On-water mechanical containment and recovery operations, including equipment and personnel. ⁴Spill management, qualified individual services, and other responsible-party associated costs, and government monitoring costs. ⁵Salvage or source control to stop leak of oil, lighter vessel, and protect public safety. ⁶Decontamination of oiled equipment, worker clothing, *etc.* ⁷Wildlife rescue, treatment, and rehabilitation. ⁸This sub-total does not include shoreline cleanup operations or disposal of on-water or on-shore collected oil and debris.

Scenario	Results Code	Non-Shore/Disp TOTAL	Shoreline	Solid Disposal	Liquid Disposal	TOTAL (Rounded)
OC-C250K-N	WSH	\$33,325	\$256,160	\$1,077,300	\$0	\$1,366,800
	OLY	\$33,325	\$25,968	\$140,430	\$0	\$199,700
	TAT	\$33,325	\$86,946	\$538,500	\$0	\$658,800
	Mean	\$33,325	\$123,025	\$585,410	\$0	\$741,800
	Mean+2SD	\$33,325	\$361,548	\$1,525,797	\$0	\$1,920,700
	Mean - 2SD	\$33,325	\$0	\$0	\$0	\$33,300
OC-C250K-R-FED	WSH	\$60,510	\$238,130	\$1,199,850	\$22	\$1,498,500
	OLY	\$60,679	\$26,266	\$135,450	\$386	\$222,800
	TAT	\$60,737	\$85,741	\$566,550	\$513	\$713,500
	Mean	\$60,642	\$116,712	\$633,950	\$307	\$811,600
	Mean+2SD	\$60,878	\$335,262	\$1,704,733	\$816	\$2,101,700
	Mean - 2SD	\$60,406	\$0	\$0	\$0	\$60,400
OC-C250K-R-WA	WSH	\$63,110	\$238,130	\$1,199,850	\$22	\$1,501,100
	OLY	\$63,924	\$12,088	\$84,045	\$1,781	\$161,800
	TAT	\$63,986	\$103,680	\$645,900	\$1,914	\$815,500
	Mean	\$63,673	\$117,966	\$643,265	\$1,239	\$826,100
	Mean+2SD	\$64,651	\$345,358	\$1,759,079	\$3,350	\$2,172,400
	Mean - 2SD	\$62,696	\$0	\$0	\$0	\$62,700
OC-C250K-R-3	WSH	\$64,020	\$211,120	\$1,142,700	\$259	\$1,418,100
	OLY	\$64,887	\$21,398	\$135,345	\$2,133	\$223,800
	TAT	\$64,976	\$87,210	\$505,950	\$2,325	\$660,500
	Mean	\$64,628	\$106,576	\$594,665	\$1,572	\$767,400
	Mean+2SD	\$65,684	\$299,240	\$1,613,672	\$3,855	\$1,982,500
	Mean - 2SD	\$63,571	\$0	\$0	\$0	\$63,600

Scenario	Results Code	Shoreline Impact (m ²)	% Oil Ashore	Bbl Oil Removed	% Removed Offshore
OC-C250K-N	WSH	7,182,000	13.9%	0	0.00%
	OLY	936,200	11.1%	0	0.00%
	TAT	3,590,000	22.4%	0	0.00%
	Mean	3,902,733	15.8%	0	0.00%
	Mean + 2SD	10,171,978	25.4%	0	0.00%
	Mean - 2SD	0	4.1%	0	0.00%
OC-C250K-R-FED	WSH	7,999,000	15.8%	103	0.04%
	OLY	903,000	11.3%	1,789	0.72%
	TAT	3,777,000	21.8%	2,373	0.95%
	Mean	4,226,333	16.3%	1,422	0.57%
	Mean + 2SD	11,364,885	24.9%	3,779	1.51%
	Mean - 2SD	0	5.7%	0	0%
OC-C250K-R-WA	WSH	7,999,000	15.8%	103	0.04%
	OLY	560,300	6.4%	8,244	3.30%
	TAT	4,306,000	21.8%	8,860	3.54%
	Mean	4,288,433	14.7%	5,736	2.29%
	Mean + 2SD	11,727,196	27.3%	15,511	6.20%
	Mean - 2SD	0	-0.8%	0	0%
OC-C250K-R-3	WSH	7,618,000	15.9%	1,201	0.48%
	OLY	902,300	8.1%	9,873	3.95%
	TAT	3,373,000	21.4%	10,764	4.31%
	Mean	3,964,433	15.2%	7,279	2.91%
	Mean + 2SD	10,757,813	26.1%	17,845	7.14%
	Mean - 2SD	0	1.8%	0	0%

Lower Columbia River Scenarios

Estimated cost results for the Lower (western) Columbia River scenarios are shown in Tables 13 – 14. Shoreline impacts and oil removal are shown in Table 15.

Table 13: Modeled Oil Spill Response Costs Excluding Shoreline Response Costs and Disposal Costs: Lower Columbia River Scenarios (Costs in 1,000 dollars)									
Scenario	Results Code	Mobilize ¹	Boom ²	Mech ³	Mgt + Monitor ⁴	Salvage ⁵	Decon ⁶	Wild-life ⁷	Non-Shoreline Non-Disposal TOTAL ⁸
CL-B25K - N	WSH	\$25	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,125
	BAK	\$25	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,125
	COL	\$25	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,125
CL-B25K – R-FED	WSH	\$500	\$6,800	\$900	\$4,000	\$8,000	\$96	\$3,000	\$23,296
	BAK	\$500	\$6,800	\$900	\$4,000	\$8,000	\$110	\$3,000	\$23,310
	COL	\$500	\$6,800	\$900	\$4,000	\$8,000	\$87	\$3,000	\$23,287
CL-B25K – R-WA	WSH	\$500	\$6,800	\$1,400	\$4,000	\$8,000	\$98	\$3,000	\$23,798
	BAK	\$500	\$6,800	\$1,400	\$4,000	\$8,000	\$120	\$3,000	\$23,820
	COL	\$500	\$6,800	\$1,400	\$4,000	\$8,000	\$75	\$3,000	\$23,775
CL-B25K – R-3	WSH	\$500	\$6,800	\$1,650	\$4,000	\$8,000	\$203	\$3,000	\$24,153
	BAK	\$500	\$6,800	\$1,650	\$4,000	\$8,000	\$218	\$3,000	\$24,168
	COL	\$500	\$6,800	\$1,650	\$4,000	\$8,000	\$177	\$3,000	\$24,127

¹Initial mobilization of resources, including equipment and personnel, at first notification of major spill. These costs are charged to responsible party regardless of whether the equipment/personnel are ever deployed. ²Protective booming of sensitive resources based on Geographic Response Plans associated with Northwest Area Contingency Plan. ³On-water mechanical containment and recovery operations, including equipment and personnel. ⁴Spill management, qualified individual services, and other responsible-party associated costs, and government monitoring costs. ⁵Salvage or source control to stop leak of oil, lighter vessel, and protect public safety. ⁶Decontamination of oiled equipment, worker clothing, etc. ⁷Wildlife rescue, treatment, and rehabilitation. ⁸This sub-total does not include shoreline cleanup operations or disposal of on-water or on-shore collected oil and debris.

Table 14: Estimated Total Response Costs: Lower Columbia River Scenarios (Costs in 1,000 dollars)						
Scenario	Results Code	Non-Shore/Disp TOTAL	Shoreline	Solid Disposal	Liquid Disposal	TOTAL (Rounded)
CL-B25K-N	WSH	\$8,125	\$187,910	\$225,900	\$0	\$421,900
	BAK	\$8,125	\$111,050	\$192,600	\$0	\$311,800
	COL	\$8,125	\$167,220	\$260,700	\$0	\$436,000
	Mean	\$8,125	\$155,393	\$226,400	\$0	\$389,900
	Mean+2SD	\$8,125	\$234,936	\$294,506	\$0	\$537,600
	Mean - 2SD	\$8,125	\$75,850	\$158,295	\$0	\$242,300
CL-B25K-R-FED	WSH	\$23,296	\$242,370	\$345,300	\$103	\$611,100
	BAK	\$23,310	\$151,370	\$249,600	\$119	\$424,400
	COL	\$23,287	\$178,510	\$238,950	\$94	\$440,800
	Mean	\$23,298	\$190,750	\$277,950	\$105	\$492,100
	Mean+2SD	\$23,321	\$284,187	\$395,089	\$130	\$702,700
	Mean - 2SD	\$23,274	\$97,313	\$160,811	\$81	\$281,500
CL-B25K-R-WA	WSH	\$23,798	\$240,730	\$343,200	\$219	\$607,900
	BAK	\$23,820	\$142,590	\$234,150	\$235	\$400,800
	COL	\$23,775	\$182,760	\$229,200	\$192	\$435,900
	Mean	\$23,798	\$188,693	\$268,850	\$215	\$481,600
	Mean+2SD	\$23,843	\$287,370	\$397,723	\$260	\$709,200
	Mean - 2SD	\$23,753	\$90,017	\$139,977	\$171	\$253,900
CL-B25K-R-3	WSH	\$24,153	\$248,710	\$381,600	\$437	\$654,900
	BAK	\$24,168	\$133,720	\$230,400	\$453	\$388,700
	COL	\$24,127	\$165,020	\$213,750	\$374	\$403,300
	Mean	\$24,149	\$182,483	\$275,250	\$421	\$482,300
	Mean+2SD	\$24,191	\$301,385	\$460,205	\$505	\$786,300
	Mean - 2SD	\$24,108	\$63,582	\$90,296	\$338	\$178,300

Table 15: Shoreline Impact and Bbl Oil Removed: Lower Columbia River Scenarios					
Scenario	Results Code	Shoreline Impact (m ²)	% Oil Ashore	Bbl Oil Removed	% Removed Offshore
CL-B25K-N	WSH	1,506,000	73.4%	0	0.00%
	BAK	1,284,000	68.1%	0	0.00%
	COL	1,738,000	72.4%	0	0.00%
	Mean	1,509,333	71.3%	0	0.00%
	Mean + 2SD	1,963,370	75.9%	0	0.00%
	Mean - 2SD	1,055,297	65.7%	0	0.00%
CL-B25K-R-FED	WSH	2,302,000	72.1%	478	1.91%
	BAK	1,664,000	66.8%	549	2.19%
	COL	1,593,000	72.4%	437	1.75%
	Mean	1,853,000	70.5%	488	1.95%
	Mean + 2SD	2,633,925	75.6%	601	2.40%
	Mean - 2SD	1,072,075	64.1%	375	1.50%
CL-B25K-R-WA	WSH	2,288,000	73.0%	1,014	4.06%
	BAK	1,561,000	65.5%	1,090	4.36%
	COL	1,528,000	71.2%	887	3.55%
	Mean	1,792,333	69.9%	997	3.99%
	Mean + 2SD	2,651,487	76.3%	1,202	4.81%
	Mean - 2SD	933,179	62.1%	792	3.17%
CL-B25K-R-3	WSH	2,544,000	69.2%	2,024	8.10%
	BAK	1,536,000	64.1%	2,095	8.38%
	COL	1,425,000	70.0%	1,731	6.93%
	Mean	1,835,000	67.8%	1,950	7.80%
	Mean + 2SD	3,068,030	73.0%	2,336	9.34%
	Mean - 2SD	601,970	61.4%	1,565	6.26%

Upper Columbia River Scenarios

Estimated cost results for the Upper (eastern) Columbia River scenarios are shown in Tables 16 – 17. Shoreline impacts and oil removal are shown in Table 18.

Table 16: Modeled Oil Spill Response Costs Excluding Shoreline Response Costs and Disposal Costs: Upper Columbia River Scenarios (Costs in 1,000 dollars)									
Scenario	Results Code	Mobilize ¹	Boom ²	Mech ³	Mgt + Monitor ⁴	Salvage ⁵	Decon ⁶	Wild-life ⁷	Non-Shoreline Non-Disposal TOTAL ⁸
CU-B25K - N	WSH	\$500	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,600
	RD1	\$500	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,600
	RD2	\$500	\$0	\$0	\$2,000	\$3,000	\$100	\$3,000	\$8,600
CU-B25K – R-FED	WSH	\$500	\$6,800	\$900	\$4,000	\$8,000	\$91	\$3,000	\$23,291
	RD1	\$500	\$6,800	\$900	\$4,000	\$8,000	\$109	\$3,000	\$23,309
	RD2	\$500	\$6,800	\$900	\$4,000	\$8,000	\$110	\$3,000	\$23,310
CU-B25K – R-WA	WSH	\$500	\$6,800	\$1,400	\$4,000	\$8,000	\$103	\$3,000	\$23,803
	RD1	\$500	\$6,800	\$1,400	\$4,000	\$8,000	\$125	\$3,000	\$23,825
	RD2	\$500	\$6,800	\$1,400	\$4,000	\$8,000	\$82	\$3,000	\$23,782
CU-B25K – R-3	WSH	\$500	\$6,800	\$1,650	\$4,000	\$8,000	\$165	\$3,000	\$24,115
	RD1	\$500	\$6,800	\$1,650	\$4,000	\$8,000	\$164	\$3,000	\$24,114
	RD2	\$500	\$6,800	\$1,650	\$4,000	\$8,000	\$190	\$3,000	\$24,140

¹Initial mobilization of resources, including equipment and personnel, at first notification of major spill. These costs are charged to responsible party regardless of whether the equipment/personnel are ever deployed. ²Protective booming of sensitive resources based on Geographic Response Plans associated with Northwest Area Contingency Plan. ³On-water mechanical containment and recovery operations, including equipment and personnel. ⁴Spill management, qualified individual services, and other responsible-party associated costs, and government monitoring costs. ⁵Salvage or source control to stop leak of oil, lighter vessel, and protect public safety. ⁶Decontamination of oiled equipment, worker clothing, etc. ⁷Wildlife rescue, treatment, and rehabilitation. ⁸This sub-total does not include shoreline cleanup operations or disposal of on-water or on-shore collected oil and debris.

Table 17: Estimated Total Response Costs: Upper Columbia River Scenarios (Costs in 1,000 dollars)						
Scenario	Results Code	Non-Shore/Disp TOTAL	Shoreline	Solid Disposal	Liquid Disposal	TOTAL (Rounded)
CU-B25K-N	WSH	\$8,600	\$80,901	\$111,390	\$0	\$200,900
	RD1	\$8,600	\$30,330	\$46,395	\$0	\$85,300
	RD2	\$8,600	\$14,937	\$29,370	\$0	\$52,900
	Mean	\$8,600	\$42,056	\$62,385	\$0	\$113,000
	Mean+2SD	\$8,600	\$111,076	\$148,955	\$0	\$268,600
	Mean - 2SD	\$8,600	\$0	\$0	\$0	\$8,600
CU-B25K-R-FED	WSH	\$23,291	\$71,589	\$100,170	\$98	\$195,100
	RD1	\$23,309	\$31,726	\$43,380	\$118	\$98,500
	RD2	\$23,310	\$14,094	\$27,495	\$118	\$65,000
	Mean	\$23,303	\$39,136	\$57,015	\$111	\$119,600
	Mean+2SD	\$23,325	\$98,047	\$133,431	\$135	\$254,900
	Mean - 2SD	\$23,282	\$0	\$0	\$88	\$23,400
CU-B25K-R-WA	WSH	\$23,803	\$69,145	\$89,325	\$178	\$182,500
	RD1	\$23,825	\$28,884	\$44,130	\$177	\$97,000
	RD2	\$23,782	\$11,560	\$22,290	\$206	\$57,800
	Mean	\$23,803	\$36,530	\$51,915	\$187	\$112,400
	Mean+2SD	\$23,846	\$95,618	\$120,293	\$219	\$240,000
	Mean - 2SD	\$23,760	\$0	\$0	\$155	\$23,900
CU-B25K-R-3	WSH	\$24,115	\$61,470	\$92,565	\$287	\$178,400
	RD1	\$24,114	\$32,374	\$44,880	\$357	\$101,700
	RD2	\$24,140	\$13,973	\$26,730	\$398	\$65,200
	Mean	\$24,123	\$35,939	\$54,725	\$348	\$115,100
	Mean+2SD	\$24,152	\$83,836	\$122,733	\$460	\$231,200
	Mean - 2SD	\$24,094	\$0	\$0	\$235	\$24,300

Table 18: Shoreline Impact and Bbl Oil Removed: Upper Columbia River Scenarios					
Scenario	Results Code	Shoreline Impact (m²)	% Oil Ashore	Bbl Oil Removed	% Removed Offshore
CU-B25K-N	WSH	742,600	76.8%	0	0.00%
	RD1	309,300	75.7%	0	0.00%
	RD2	195,800	69.2%	0	0.00%
	Mean	415,900	73.9%	0	0.00%
	Mean + 2SD	993,032	80.6%	0	0.00%
	Mean - 2SD	-161,232	65.7%	0	0.00%
CU-B25K-R-FED	WSH	667,800	75.3%	454	1.81%
	RD1	289,200	75.1%	546	2.19%
	RD2	183,300	67.8%	548	2.19%
	Mean	380,100	72.7%	516	2.06%
	Mean + 2SD	889,540	79.7%	625	2.50%
	Mean - 2SD	-129,340	64.3%	408	1.63%
CU-B25K-R-WA	WSH	595,500	74.0%	824	3.30%
	RD1	294,200	73.6%	820	3.28%
	RD2	148,600	68.1%	952	3.81%
	Mean	346,100	71.9%	865	3.46%
	Mean + 2SD	801,951	77.3%	1,015	4.06%
	Mean - 2SD	-109,751	65.4%	716	2.86%
CU-B25K-R-3	WSH	617,100	72.5%	1,329	5.32%
	RD1	299,200	71.6%	1,655	6.62%
	RD2	178,200	68.0%	1,842	7.37%
	Mean	364,833	70.7%	1,609	6.43%
	Mean + 2SD	818,217	74.5%	2,128	8.51%
	Mean - 2SD	-88,550	65.9%	1,090	4.36%

COMPARISON OF RESPONSE CAPABILITIES AND RESPONSE METHODS

A comparison between the total modeled shoreline impacts with different response methods and response capabilities is shown in Table 19 for crude spills. The shore impacts are shown for no response and for offshore mechanical containment and recovery. The corresponding total response costs are shown in Table 20. Analogous results are shown for diesel spills in Tables 21 – 22, and bunker spills in Tables 23 – 24. A comparison of mean total response costs and cost reductions (compared to “no response”) with the various levels of response is shown in Table 25. A comparison of costs for state and 3rd alternative responses compared to the federal response are shown in Table 26. Impact reductions to specific sensitive areas are covered in *Phase II: Evaluation of the Consequences of Various Response Options Using Modeling of Fate, Effects and NRDA Costs for Oil Spills into Washington Waters Volume II: Summary of Results for All Scenarios* (French-McCay, et al. 2005).

Location	Response Type	No Response ¹	Federal ²	State (WA) ²	3 rd Alternative ²
San Juan Islands	None	6,818	-	-	-
	Mechanical	-	6,266	7,073	6,014
Str Juan de Fuca	None	4,352	-	-	-
	Mechanical	-	4,099	3,712	3,547
Outer Coast	None	3,903	-	-	-
	Mechanical	-	4,226	4,288	3,964

¹No on-water response. ²Mean shoreline impact with effective on-water mechanical response.

Location	Response Type	No Response ¹	Federal ²	State (WA) ²	3 rd Alternative ²
San Juan Islands	None	\$1,363M	-	-	-
	Mechanical	-	\$1,285M	\$1,397M	\$1,222M
Str Juan de Fuca	None	\$815M	-	-	-
	Mechanical	-	\$844M	\$779M	\$753M
Outer Coast	None	\$742M	-	-	-
	Mechanical	-	\$812M	\$826M	\$767M

¹Costs for shoreline cleanup and monitoring after no on-water response. ²Total response costs with effective on-water mechanical response.

Location	Response Type	No Response ¹	Federal ²	State (WA) ²	3 rd Alternative ²
Str Juan de Fuca	None	1,635	-	-	-
	Mechanical	-	1,194	1,170	1,075

¹No on-water response. ²Mean shoreline impact with effective on-water mechanical response.

Location	Response Type	No Response ¹	Federal ²	State (WA) ²	3 rd Alternative ²
Str Juan de Fuca	None	\$278M	-	-	-
	Mechanical	-	\$222M	\$219M	\$204M

¹Costs for shoreline cleanup and monitoring after no on-water response. ²Total response costs with effective on-water mechanical response.

Location	Response Type	No Response ¹	Federal ¹	State ¹	3 rd Alternative ¹
Str Juan de Fuca	None	679	-	-	-
	Mechanical	-	632	643	587
Lower Columbia River	None	1,509	-	-	-
	Mechanical	-	1,853	1,792	1,835
Upper Columbia River	None	416	-	-	-
	Mechanical	-	380	346	365

¹No on-water response. ²Mean shoreline impact with effective on-water mechanical response.

Location	Response Type	No Response	Federal	State	3 rd Alternative
Str Juan de Fuca	None	\$192M	-	-	-
	Mechanical	-	\$198M	\$201M	\$188M
Lower Columbia River	None	\$390M	-	-	-
	Mechanical	-	\$492M	\$482M	\$482M
Upper Columbia River	None	\$113M	-	-	-
	Mechanical	-	\$120M	\$112M	\$115M

¹Costs for shoreline cleanup and monitoring after no on-water response. ²Total response costs with effective on-water mechanical response.

Location	Scenario	% Difference in Mean Total Response Cost From No Response Mean Total Response Cost ¹		
		Federal	State	3 rd Alternative
San Juan Islands	Crude 250K bbl	5.7%	-0.2%	10.3%
Str Juan de Fuca	Crude 250K bbl	-3.6%	4.4%	7.6%
	Diesel 65K bbl	20.0%	21.2%	26.6%
	Bunker 25K bbl	-3.1%	-4.7%	2.1%
Outer Coast	Crude 250 K bbl	-9.4%	-11.3%	-3.4%
Lower Columbia	Bunker 25K bbl	-26.1%	-23.6%	-23.6%
Upper Columbia	Bunker 25K bbl	-6.2%	0.9%	-1.8%

¹Negative impact reduction would mean an increase in impacts. In some cases, protective booming causes oil to move to other locations and spread, protecting the sensitive sites at the expense of other shoreline areas.

Location	Scenario	% Difference From Federal Mean Total Response Cost ¹	
		State	3 rd Alternative
San Juan Islands	Crude 250K bbl	-8.7%	4.9%
Str Juan de Fuca	Crude 250K bbl	7.7%	10.8%
	Diesel 65K bbl	1.4%	8.1%
	Bunker 25K bbl	-1.5%	5.1%
Outer Coast	Crude 250 K bbl	-1.7%	5.5%
Lower Columbia	Bunker 25K bbl	2.0%	2.0%
Upper Columbia	Bunker 25K bbl	6.7%	4.2%

¹Negative impact reduction would mean an increase in impacts. In some cases, protective booming causes oil to move to other locations and spread, protecting the sensitive sites at the expense of other shoreline areas.

The differences in response costs between the various response planning standard levels are due mainly to differences in shoreline impact and necessary shoreline response. Tables 27 – 30 present the differences in shoreline impacts and shoreline response costs between response planning standards.

Table 27: Comparison of Response Methods: Reduction of Shore Impacts (Straits of Juan de Fuca)						
Scenario	Results Code	Location	Response	Total Shore Impact (m²)	Impact Reduction with Response¹	Total Shoreline Response²
JF-B25K	WSH	Worst shoreline	N	944,600	-	\$250M
			FED	847,700	10.26%	\$113M
			WA	919,000	2.71%	\$51M
			3RD	815,600	13.66%	\$127M
	DS	Dungeness Spit	N	751,900	-	\$107M
			FED	710,800	5.47%	\$51M
			WA	742,200	1.29%	\$138M
			3RD	673,800	10.39%	\$112M
	PI	Protection Island	N	341,700	-	\$41M
			FED	338,900	0.82%	\$122M
			WA	266,600	21.98%	\$102M
			3RD	271,300	20.60%	\$42M
JF-D65K	WSH	Worst shoreline	N	2,573,000	-	\$387M
			FED	1,110,000	56.86%	\$235M
			WA	1,209,000	53.01%	\$115M
			3RD	1,364,000	46.99%	\$167M
	DS	Dungeness Spit	N	1,565,000	-	\$229M
			FED	1,525,000	2.56%	\$143M
			WA	1,638,000	-4.66%	\$182M
			3RD	1,246,000	20.38%	\$246M
	PI	Protection Island	N	767,700	-	\$101M
			FED	946,600	-23.30%	\$205M
			WA	665,900	13.26%	\$188M
			3RD	613,900	20.03%	\$94M
JF-C250K	WSH	Worst shoreline	N	8,650,000	-	\$1,439M
			FED	7,565,000	12.54%	\$287M
			WA	7,079,000	18.16%	\$374M
			3RD	6,552,000	24.25%	\$1,135M
	DS	Dungeness Spit	N	1,910,000	-	\$318M
			FED	2,110,000	-10.47%	\$394M
			WA	1,403,000	26.54%	\$1,062M
			3RD	1,485,000	22.25%	\$213M
	PI	Protection Island	N	2,495,000	-	\$399M
			FED	2,623,000	-5.13%	\$984M
			WA	2,653,000	-6.33%	\$226M
			3RD	2,605,000	-4.41%	\$393M

¹Reduced shoreline impacts with response compared to no response. Negative impact reduction would mean an increase in impacts. In some cases, protective booming causes oil to move to other locations and spread, protecting the sensitive sites at the expense of other shoreline areas. ²Shoreline cleanup and debris disposal.

Scenario	Results Code	Location	Response	Total Shore Impact (m ²)	Impact Reduction with Response ¹	Total Shoreline Response ²
SJ-C250K	WSH	Worst shoreline	N	12,620,000	-	\$2,407M
			FED	9,269,000	26.55%	\$785M
			WA	10,060,000	20.29%	\$1,326M
			3RD	10,230,000	18.94%	\$923M
	LOP	Lopez Island	N	4,172,000	-	\$1,544M
			FED	5,142,000	-23.25%	\$994M
			WA	4,426,000	-6.09%	\$1,787M
			3RD	4,103,000	1.65%	\$965M
	ORC	Orcas Island	N	6,940,000	-	\$1,158M
			FED	5,815,000	16.21%	\$1,321M
			WA	4,569,000	34.16%	\$1,124M
			3RD	5,187,000	25.26%	\$983M
	50SH	50 th Percentile Shoreline	N	4,802,000	-	\$1,762M
			FED	5,940,000	-23.70%	\$928M
			WA	4,656,000	3.04%	\$913M
			3RD	4,156,000	13.45%	\$860M
	LUM	Lummi Island	N	8,004,000	-	\$2,110M
			FED	6,391,000	20.15%	\$1,418M
			WA	11,270,000	-40.80%	\$1,949M
			3RD	6,397,000	20.08%	\$770M
PAD	Padilla Bay	N	4,374,000	-	\$1,014M	
		FED	5,043,000	-15.29%	\$807M	
		WA	7,458,000	-70.51%	\$1,234M	
		3RD	6,013,000	-37.47%	\$1,156M	

¹Reduced shoreline impacts with response compared to no response. Negative impact reduction means an increase in impacts. In some cases, protective booming causes oil to move to other locations and spread, protecting the sensitive sites at the expense of other shoreline areas. ²Shoreline cleanup and debris disposal.

Scenario	Results Code	Location	Response	Total Shore Impact (m ²)	Impact Reduction with Response ¹	Total Shoreline Response ²
OC-C250K	WSH	Worst shoreline	N	7,182,000	-	\$1,333M
			FED	7,999,000	-11.38%	\$140M
			WA	7,999,000	-11.38%	\$539M
			3RD	7,618,000	-6.07%	\$1,200M
	OLY	Olympic Coast National Marine Sanctuary	N	936,200	-	\$135M
			FED	903,000	3.55%	\$567M
			WA	560,300	40.15%	\$1,200M
			3RD	902,300	3.62%	\$84M
	TAT	Tatoosh Island	N	3,590,000	-	\$648M
			FED	3,777,000	-5.21%	\$1,143M
			WA	4,306,000	-19.94%	\$136M
			3RD	3,373,000	6.04%	\$508M

¹Reduced shoreline impacts with response compared to no response. Negative impact reduction means an increase in impacts. In some cases, protective booming causes oil to move to other locations and spread, protecting the sensitive sites at the expense of other shoreline areas. ²Shoreline cleanup and debris disposal.

Scenario	Results Code	Location	Response	Total Shore Impact (m ²)	Impact Reduction with Response ¹	Total Shoreline Response ²
CL-B25K	WSH	Worst Shoreline	N	1,506,000	-	\$414M
			FED	2,302,000	-52.86%	\$193M
			WA	2,288,000	-51.93%	\$261M
			3RD	2,544,000	-68.92%	\$345M
	BAK	Baker Bay	N	1,284,000	-	\$250M
			FED	1,664,000	-29.60%	\$239M
			WA	1,561,000	-21.57%	\$343M
			3RD	1,536,000	-19.63%	\$234M
	COL	Columbia National Marine Sanctuary	N	1,738,000	-	\$229M
			FED	1,593,000	8.34%	\$382M
			WA	1,528,000	12.08%	\$231M
			3RD	1,425,000	18.01%	\$214M
CU-B25K	WSH	Worst Shoreline	N	742,600	-	\$192M
			FED	667,800	10.07%	\$46M
			WA	595,500	19.81%	\$29M
			3RD	617,100	16.90%	\$100M
	RD1	Ridgefield National Wildlife Refuge #1	N	309,300	-	\$43M
			FED	289,200	6.50%	\$28M
			WA	294,200	4.88%	\$89M
			3RD	299,200	3.27%	\$44M
	RD2	Ridgefield National Wildlife Refuge #2	N	195,800	-	\$22M
			FED	183,300	6.38%	\$93M
			WA	148,600	24.11%	\$45M
			3RD	178,200	8.99%	\$27M

¹Reduced shoreline impacts with response compared to no response. Negative impact reduction means an increase in impacts. In some cases, protective booming causes oil to move to other locations and spread, protecting the sensitive sites at the expense of other shoreline areas. ²Shoreline cleanup and debris disposal.

Location	Scenario	% Difference in Mean Shoreline Response Cost From No Response ¹		
		Federal	State	3 rd Alternative
San Juan Islands	Crude 250K bbl	37.4%	16.6%	43.4%
Str Juan de Fuca	Crude 250K bbl	22.8%	22.9%	19.2%
	Diesel 65K bbl	18.7%	32.4%	29.3%
	Bunker 25K bbl	28.1%	26.9%	29.4%
Outer Coast	Crude 250 K bbl	12.6%	11.4%	15.3%
Lower Columbia	Bunker 25K bbl	8.8%	6.5%	11.2%
Upper Columbia	Bunker 25K bbl	35.0%	36.6%	33.5%

¹Negative impact reduction would mean an increase in impacts. In some cases, protective booming causes oil to move to other locations and spread, protecting sensitive sites at the expense of other shoreline areas.

Location	Scenario	% Difference From Federal Mean Total Response Cost ¹	
		State	3 rd Alternative
San Juan Islands	Crude 250K bbl	-33.3%	9.5%
Str Juan de Fuca	Crude 250K bbl	0.2%	-4.6%
	Diesel 65K bbl	16.8%	15.0%
	Bunker 25K bbl	-1.7%	1.7%
Outer Coast	Crude 250 K bbl	-1.4%	3.2%
Lower Columbia	Bunker 25K bbl	-2.6%	2.6%
Upper Columbia	Bunker 25K bbl	2.4%	-2.4%

¹Negative impact reduction would mean an increase in impacts. In some cases, protective booming causes oil to move to other locations and spread, protecting sensitive sites at the expense of other shoreline areas.

SUMMARY AND CONCLUSIONS

Response Effectiveness

The spill responses that would occur at the level stipulated by the three response regimes would be considered minimal for the spill volumes used in the modeling. This is particularly true for the 250,000-bbl spill response. This spill – the size of the Exxon Valdez – would require an extensive response using considerably more equipment than would be available under even the strictest response planning standards. For a spill of this magnitude, response equipment from other parts of the country would likely be brought in.

However, it is important to understand that the most effective on-water oil recovery will occur in the first 24 to 48 hours. Beyond this time, minimal amounts of oil will be recovered due to the spreading of the oil. As the oil spreads and thins, more water is concurrently removed with any oil that is recovered. This creates the need for more storage and offloading capacity. This can often be a limiting factor. Any oil removal equipment brought in after the first 24 to 48 hours will have minimal impact on reducing shoreline oiling (which may not actually occur until days later if oil is spilled relatively far from land).

Mechanical containment and recovery can be very effective in recovering oil in test tanks and in limited field applications, such as sheltered areas, pre-boomed vessels during offloading/loading operations in port, and under very calm conditions (minimal waves, wind, and currents). These conditions are rarely realized in spills in open waters, such as were modeled in Phases I and II of this study. With relatively low effectiveness of on-water recovery options, there is inevitable shoreline impact unless the winds, tides, and currents work in such way to move the oil out into the ocean. Shoreline oil removal will then be necessary. The only other options are to employ alternative methods of on-water oil removal with *in situ* burning and/or chemical dispersant application. These options were explored in Phase I. The regulatory limitations of areas of application for these methods (with regard to distance to shore and water depth, as well as populated areas for *in situ* burning) limit their application in many parts of the state’s water with the exception of the outer coast.

Maximizing Response Effectiveness

On-water recovery efforts will be maximized with the earliest response possible. Training of response crews to deploy equipment promptly and effectively will be invaluable in increasing oil removal effectiveness. Including aerial surveillance and oil tracking will increase the ability of the responders to remove oil. An early response will allow the responders to act *strategically* (“staying ahead of the oil”) rather than reactively (“chasing the oil”). Bringing in more oil

removal equipment and effectively deploying it early in a response may increase overall oil removal.

Deflection booms deployed to contain and concentrate floating oil in areas that are easier to access and more sheltered can increase the effectiveness of nearshore oil removal through mechanical methods. Strategic planning before and during response operations can maximize the effectiveness of these operations.

Protective booming of sensitive shorelines is essential with the inevitability of shoreline impact. The timing of protective booming is important in maximizing protection of pre-determined sensitive sites, though the degree to which earlier booming increases this protection depends on the location. If the oil is spilled in a location near shore or in a situation in which winds, tides, and currents will drive the oil closer to the shoreline in a relatively short amount of time (say, one hour), booming at two hours may not provide any more protection than if deployed at six hours. In other situations, the oil may linger offshore for some time so that it may still not have hit the shore in 12 hours. Earlier booming may not help any more than somewhat later booming. Understanding the winds, currents, and tides by location and on a situational basis will be essential in maximizing the ability to protect shorelines with booms.

Increased effectiveness of the boom that is placed can be realized by following appropriate booming techniques, including proper anchorage and angles of deployment. This can be achieved with better training of response crews. Maintaining boom is vital to keeping it in a condition that will allow for maximal effectiveness. Different booms require different maintenance programs, but the investment in keeping booms in prime working condition is valuable. Defective boom will be the equivalent of little or no boom in protecting sensitive sites.

The state's Geographic Response Plans are very detailed and well organized in comparison to analogous documents in many other parts of the country. The maps and pictures associated with the GRPs are valuable. The addition of information on anchorage options and optimal angles of deployment (with respect to currents and tides) could enhance the effectiveness of the plans.

When a large amount of oil spills and on-water recovery efforts provide minimal or limited removal even under ideal conditions, oil will inevitably hit shorelines. It is unrealistic to assume that no shoreline oiling will occur or that it is possible to completely protect all shorelines. There simply is not enough boom available to achieve this, at least not in a cost-effective manner. In addition, it is important to note that the placement of boom in certain locations does not remove the oil, it simply deflects the oil to other areas where it will impact the shoreline. There are often tradeoffs involved. The oil will hit some shoreline. Strategic planning before and during the spill response can allow the responders to control what areas of the shoreline are hit and which ones are protected. Deflection booms deployed nearshore can concentrate oil in less sensitive areas that are less likely to be damaged heavily by oil to both protect more sensitive sites and to enhance oil recovery. It is essential for response planners to understand the nature of shoreline cleanup and the sensitivity of various types of shorelines in terms of oiling impacts and the impacts of intensive shoreline response operations that may do more harm than the oil itself.

For maximize effectiveness, spill response strategies need to be based on the specific conditions relevant to each spill. While the specific situations that will be encountered in a spill can rarely be predicted with any accuracy, there are certain common conditions that will occur with some predictability in general locations around the state's waters. The patterns of currents, tidal ebb and flow, predominant wind directions, sea states, and proximity of shorelines can be observed and recorded in advance to develop spill response strategies and preparedness plans that take these conditions into account. For example, locations in which currents exceed one knot will require

booming techniques and booming equipment for “fast water” situations (see US Coast Guard 1999b, 2001a, 2001b, 2003). Sea states in which wave heights that exceed one foot will require 18 – 42-inch “inland environment” boom, unless wave heights approach six feet, in which case “ocean” boom would be appropriate.

Oil Response Costs

Oil response costs depend on a variety of factors, including the oil type and volume, response strategy and effectiveness, location characteristics, and shoreline oiling. Overall, a spill of 250,000 bbl of crude oil will involve response costs between \$800,000 up to over \$1 billion with the equipment on-water recovery stipulated in the standards as modeled, depending on shoreline impacts. Spills of 65,000 bbl of diesel fuel will result in response costs of about \$200,000 due to the rapid evaporation and dissolution of the fuel. The costs are similar to those found with a much smaller volume (25,000 bbl) of Bunker, which is much more persistent and difficult to remove from shorelines.

Many of the components of costs associated with spills, such as mobilization of equipment, management, monitoring, salvage (source leak control), and wildlife response mobilization will be realized regardless of the actual fate of the oil and its shoreline impacts. The variations in spill response costs lie primarily with costs associated with shoreline oil removal, oil disposal, and decontamination of affected equipment.

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