



Oil Spills at Sea

Potential Impacts on Hawaii

A supplemental report prepared for the
Department of Health, State of Hawaii
by the
University of Hawaii Sea Grant College Program
School of Ocean and Earth Science and Technology

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**Costs of At-Sea Response,
Shoreline Cleanup, and Waste Disposal
for a Catastrophic Oil Spill in Hawaii:
Assumptions and Cost Worksheets**

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Introduction

This document contains the assumptions, explanatory notes, and cost worksheets used in estimating the at-sea response, shoreline cleanup, and waste disposal costs incurred in the case of a hypothetical catastrophic oil spill in Hawaiian waters. The spill scenario was adapted from the catastrophic oil spill scenario developed by the U.S. Coast Guard in 1989. In addition to assumptions used in their scenario, a panel of experts composed of individuals knowledgeable in the area of oil spill response and cleanup was organized to provide more specific information on the quantities and prices of the equipment, materials, and personnel needed to respond to the spill. Summaries and discussions of these costs could be found in the report entitled *Oil Spills at Sea: Potential Impacts on Hawaii* prepared for the State of Hawaii Department of Health by the University of Hawaii Sea Grant College Program.

At-Sea Response Costs

The following are the items considered in determining the costs of at-sea response to a catastrophic oil spill. Refer to Table 1 for the cost worksheet.

Skimmers

It is estimated that 20 skimmers will have to be bought from the mainland and used during the first week of the response. Each of these skimmers will cost \$50,000, excluding freight costs. Three workers will be needed to tend each of the skimmers. They can be hired at \$40 per hour (150 percent beyond eight hours) on a 12-hour workday (\$560/day), for one week.

Tow boats

The skimmers described above will have to be deployed using tow boats. On the average, one boat is needed per skimmer. In addition, a crew of two per tow boat will also be hired at \$560 per day per person. Tow boats plus crew are needed during the entire skimming operation, which is expected to last for seven days.

Booms

It is estimated that about 300,000 feet of booms (harbor and offshore) will be needed to protect the sensitive coastlines of Oahu and Kauai. Purchase price is \$100/foot for offshore booms and \$15/foot for harbor booms, excluding transport cost. Work vessels will be used to deploy these booms.

Boom cleaning

About 50 percent of the offshore booms are expected to be disposed of because of damage during the response operations. The remaining 50 percent will have to be cleaned at approximately \$10 per foot. Harbor booms on the other hand, are disposable.

Dispersants

Dispersants can be used in water depth of at least 60 feet, but only after all available physical or mechanical removal methods have been found to be ineffective or infeasible (Memo of Agreement, EPA, SHDOH,

USCG). Of the dispersants approved by the EPA, only COREXIT 9527 currently is stockpiled in Hawaii. At this time, only 70 drums (3,500 gallons) of dispersants are stockpiled in Hawaii. It is expected that about 1,000 more drums will be needed. Thus, most of them will have to be bought and transported from the mainland. Each drum costs \$100, excluding the cost of transport.

Dispersant application costs

A plane (either a DC-6 or DC-4) will be used to apply the dispersants. One plane will be used for three days, spraying a total of 10 hours per day. The fixed cost of chartering a plane is \$72,000 plus \$1,200 per hour of flying time. Standby rates will be charged at \$1,200 per hour.

An example of an airplane contractor is Global Air of Arizona, which has specially equipped DC-6 or DC-4's contracted to Clean Seas of California.

Another possibility is Murray Air, an agricultural chemical spraying contractor in the islands, although actual tests on dispersant application have not been performed. The aircraft spraying rate is five gallons per acre.

Dispersant transport cost

It is assumed that dispersants will come from different parts of the U.S., specifically the West and Gulf coasts. It is estimated that transport using C-130's will cost \$250,000 per trip. Approximately two trips will be needed to transport the 1,000 drums of dispersant.

Work vessels

More work vessels will be used for advance offshore skimming. For seven days, it will be working 24 hours a day at the cost of \$150 per hour or \$3,600 per day. Six of these boats will be needed.

Work vessels crew

A crew of seven per work vessel is needed. They will be paid \$40 per hour or \$560 per 12-hour workday (including overtime). Work vessels crews will be needed for the first seven days of the response operation.

Fishing boats

Fishing boats will be hired from local fishermen. They will be used primarily for deploying booms. Twelve of them will be hired for the first seven days at \$600 per day.

Fishing boat crew

Seven crew members will be employed per fishing boat at the cost of \$40 per hour (plus overtime) for the first seven days. They will be tending to the booms and performing other necessary duties offshore.

Boom tenders

To tend to booms already deployed, about 12 boats with two crew members each are needed. Boat and crew will cost \$100/hr. Examples are Boston whalers from the Kaneohe Yacht Club.

Transport vessels

About 30 shallow-water vessels or water taxis will also be needed during the first seven days of the sea response operations. They will be hired at \$150 per hour or \$1,800 for a 12-hour day. Water taxis will be used for ferrying equipment and crew to and from the shore and other logistic and monitoring purposes.

Transport vessels crew

Three crew members per transport vessel will be hired, each at \$40 per hour (plus overtime) for a 12-hour work-day for the first seven days.

Tug boats

Ocean-going tug boats will be hired to perform salvage operations if the vessels involved in the collision are floating and can still be towed. Two tugboats are needed for three days at the cost of \$25,000 per day, including the crew members.

Barges

Barges are needed to contain the oil retrieved by the skimming devices. Two barges with a 30,000 gallon capacity will be needed. They could be rented (from the mainland if necessary) at a monthly rate of \$100,000. Two of these will be needed for two months.

Tow boats

To tow the barges, boats are needed. They could be hired at the same rate as the barges.

Tank ships

Use tank ships instead of portable barges. If commandeered on an emergency basis, they cost \$72,000 per day (\$3,000/hr). This will be the cost for the first five days. Afterwards, they will be paid at a regular rate of \$1,800/hour for nine more days. The tankship will hold the skimmed oil from the barges.

Respirators

Because workers are exposed to benzene and other hazardous gas poisoning, respirators are required for those working directly on the spilled oil. About 300 respirators have to be bought at \$20 each, to be used during the first three days when benzene concentration is very high.

Plane charter

Two planes from the mainland have to be chartered in order to transport equipment to Hawaii. The equipment will include booms, skimmers, and portable barges, but excludes dispersants, whose transport cost has been figured separately. Each of these flights will cost \$250,000.

Helicopter overflights

Several helicopter overflights will be commissioned for skimmer directions, oil tracking, assistance in beach cleanup, and public relations.

For skimmer directions, three helicopters will be hired to perform three two-hour overflights per day for the first seven days at \$900 per hour per helicopter.

For oil tracking, two helicopters will be hired to perform another three two-hour overflights per day for the first seven days at \$900 per hour per helicopter.

For assistance in beach cleanup, two helicopters will be hired to perform another three two-hour overflights per day for 30 days (the duration of intensive shore clean-up) at \$900 per hour per helicopter.

For public relations, two helicopters will be hired to perform another three two-hour overflights per day for the first seven days at \$900 per hour per helicopter. Passengers will include state officials who would assess the condition of the accident.

Command post

A command post must be set up to handle a centralized administrative, logistics, and public relations station. An office space of about 10,000 square feet will be needed and rented for two months. Rental costs of office space in downtown Honolulu can cost \$2.65 per square foot per month.

Staging area

The staging area will be used to store and stage equipment like booms, sorbents, skimmers, dispersants, and other supplies. Ideal location will be a deep draft harbor that could accommodate the ocean-going vessels that are required for the operations. Several staging areas will be needed. A total of 100,000 square feet will be needed. Rental cost, based on industrial space, is \$1.05 per square foot per month.

Shoreline Cleanup Costs

The following are the items considered in determining the costs of shoreline cleanup. Refer to Table 2 for the cost worksheet.

Contract laborers

Total daily contract laborer requirements to clean the entire coastline (primarily the beaches) of the island of Oahu will be 2,000 people for the first month, and 1,000 for the second month. These will be individuals working intensively on Oahu's coastlines, manually picking up, raking, or shoveling oil and oil-coated debris, or using sorbents to wipe out the oil. There are not enough contract laborers from Hawaii that could be easily recruited. Of the total requirements, about 50 percent are to be imported from the mainland, possibly through a contractor that specializes in oil spill worker training and hiring. These contract laborers have to undergo at least four hours of training before they could be put to work; full-time oil spill response laborers have to be trained at least 24 hours each year. The training is provided. These laborers will cost \$350 per day. Lunches and transportation will also be provided (see section on lunches and transportation). Those coming from the mainland will be provided with air fare, plus room and board allowances.

Volunteers

Volunteers from agencies such as American Red Cross and Salvation Army may be mobilized. Also, a large number of volunteers is anticipated. They will be included in the 1,000 island-recruited contract laborers. Volunteers to clean beaches will have to be hired or paid in order to cover them with insurance. Otherwise, they will not be allowed on beaches because of insurance liabilities. An activity where unpaid volunteers may be allowed is bird and other animal cleanup. For cleanup operations, the following local companies could be contracted: PENCO, UNITEK, P&S Pacific, Marine Industrial Technologies, Industrial Purifications, and Smith Services. Mainland companies like VECO may be contracted for trained labor. Also, landscaping companies could be a good source of labor.

Contract manager/foremen

About 200 contract manager/foremen will be needed per day during the first month. Ten laborers will be assigned per foreman. Half of these foremen will be coming from the mainland and will be provided with air fare, and room and board, in addition to free transportation and lunches. Foremen cost \$700 per day.

Company manager or supervisor

One company manager or supervisor (company men) will be hired for every three foremen. Only 12 of these company men are expected to come from the Islands. The rest will be contracted from the mainland. They each cost \$800 per day plus room and board allowance and a rental car.

Room and board

Contract laborers, contract managers (foremen), and company men are given different amounts of room and board allowances; per diem is \$75, \$175 and \$250 respectively.

Protective clothing (disposables)

Every contract laborer and foremen, as provided by law, has to wear protective clothing (disposables). The protective gear costs \$30 per set and is disposed of at the end of the day.

Lunch boxes

Laborers and foremen are provided lunch everyday at a cost of \$5 per person.

Transportation

Contract laborers and foremen are transported to the site of cleanup by buses. Fifty persons are accommodated per trip. Buses are rented at \$700 per week and make two trips each day to take workers to and from the worksite.

Car rental

Mainland-recruited company men are provided with rental cars. Cars are rented at \$180 per week.

Cellular phones

About 100 phones will be rented for use during the cleanup operations. They are rented on a monthly basis at \$1,000 per month.

Vacuum trucks

Vacuum trucks will be used to siphon oil from pockets on the beach. About 24 vacuum trucks will be deployed everyday at \$800 per day.

Fast tanks

Fast tanks will be used to as a temporary holding storage for recovered oil before they are siphoned by the vacuum trucks. About twenty-four 2,500-gallon tanks will be purchased at \$2,500 each.

Air fare

Workers recruited from the mainland will be provided with air fare estimated to be \$600 round trip on the average.

Sorbents

Different types of sorbents (booms, rolls, pads, pom-poms) will be used to "wipe off" oil on the beaches, rocky shorelines, and crevices. Approximately 20 containers costing \$25,000 each will be needed.

Rakes

Rakes will be used to manually clean up the debris. About 2,000 pieces will be needed at one per laborer during the whole clean-up duration. At wholesale prices, these rakes could cost \$11 each.

Shovels

To a limited extent, shovels will be used. About 10 percent of the contract workers will be using shovels, thus needing 200 pieces. They could be bought at \$18 each.

Oil and Oily Wastes Disposal Costs

The following are the items considered in determining the costs of oil and oily waste disposal. Refer to Table 3 for the cost worksheet.

Oil-water disposal

Oil-water emulsion from the skimming operations and shoreline cleanup (liquid form) is assumed to be disposed of either on-island or shipped to the mainland. On-island, it can be processed at recycling facilities for \$1.50/gallon. If it is to be shipped to the mainland, it may be taken to deep-well injection facilities at \$1.50/gallon plus transportation cost of \$7,000/5,000 gallon.

Sorbents

Three options were considered for sorbent disposal: (1) shipped to the mainland "dry", (2) shipped "wet", or (3) burned at H-power. To ship them dry costs \$85/ton plus \$5,000/20 tons for transportation plus \$1/pound for centrifuge processing. To ship them wet costs \$175/500 pound-drum plus shipping cost of \$6,000/20 tons. H-power is the cheapest at \$54/ton.

Booms

Two options are considered for boom disposal: shipping them to the mainland either as dry or wet wastes. Prices are the same as above (item 2).

Oil-coated debris

Options considered are the same as item 2 above.

Oil-coated sand

Two options are considered: options 1 and 2 of item 2 above.

Front end loaders

It is assumed that five loaders per day for two months will be needed at \$60/hour. Loaders will be used to load debris to the trucks. A total of 300-loader days will be needed.

Hauling costs

About 18,719 cubic yards of oil coated booms, sorbents, debris (trash) and sand will be transported from specific beaches to the on-island disposal facility. Hauling costs \$10/cubic yard or \$150/truckload.

Sand treatment

Before disposal, the contaminated sand could be treated to be suitable for disposal. Sand treatment involves the use of an equipment that will process the sand on-site. The process could be contracted for about \$95 per cubic yard.

Plastic bags

Approximately 31,500 boxes of 40-pound garbage bags will be needed to contain oil-coated debris, to be purchased at \$5 per box.

Table 1. Estimated at-sea response costs

Operation/Input	Quantity	Unit	Time (Days)	Cost/Unit(\$)	Total Cost(\$)	Assumptions/Remarks
SKIMMING						
Skimmers	20	#	—	50,000	1,000,000	to be bought; used for 1 week
crew	60	man-day	7	560	235,200	3 per skimmer; \$40/hr wage; 12-hr day
Workboats	20	boats	7	1,800	252,000	1 per skimmer
crew	40	man-day	7	560	156,800	2 per towboat
Work Vessels (offshore skimg)	6	wv-day	7	3,600	151,200	\$150/hr; 24-hr day; adv offshore skimming crew of 7 per boat; two 12-hr shifts per day
crew	84	man-day	7	560	329,280	
Barges, 30K bbl capacity	2	barge-month	30	100,000	200,000	
boat	2	boat-month	30	100,000	200,000	
Tankships	2	t' ship day	14		748,800	\$3,000/hr for 5 days; 1,800/hr for 9 days
BOOMING						
Booms, harbor	200,000	feet	—	15	3,000,000	boat crew deploys
Booms, offshore	100,000	feet	—	100	10,000,000	boat crew deploys
Fishing boats	12	boat-day	7	600	50,400	rent from fishermen
crew	84	man-day	7	560	329,280	crew of 7 per boat
Boom tenders (boats)	12	boat-day	7	1,200	100,800	to tend to booms; \$100/hr including crew
Boom cleaning	50,000	feet	—	10	500,000	to clean 50 percent of harbor booms at \$10/feet
DISPERSANT APPLICATION						
Dispertsants	1,000	drums	—	100	100,000	for offshore application; \$100/barrel
application (plane)	1	plane	3	12,000	108,000	\$72K to start; \$1,200/hr thereafter; 10 hr/day
Transport cost	24	plane-loads	—	50,000	1,200,000	transport cost from the mainland
LIGHTERING OPERATIONS						
Tug	1	tug-day	7	12,000	84,000	at \$500/hr
barge	1	barge/day	7	72,000	504,000	at \$3,000/hr
pumps	4	pump-days	7	2,500	70,000	4 pumps at \$2,500/day
SALVAGE OPERATIONS						
Tug boats	2	tb-day	3	25,000	150,000	for salvage oper; ocean going tugs; inc crew
OVERFLIGHTS						
for skimmer direction	3	heli	7	5,400	113,400	\$900/hr; three 2-hr flights per day
for tracking	2	heli	7	5,400	75,600	\$900/hr; three 2-hr flights per day
for beach clean-up	2	heli	30	5,400	324,000	\$900/hr; three 2-hr flights per day
for public relations	2	heli	7	5,400	75,600	\$900/hr; three 2-hr flights per day
LOGISTICS & OTHERS						
Transport vessels	30	boat-day	7	1,800	378,000	water taxis; shallow water vessels
crew	90	man-day	7	560	352,800	—
Plane charter	2	flights	—	250,000	500,000	to transport equipment
Command post	10,000	sq ft	60	5.3	53,000	rental, utilities etc.; at \$2.65/sq. ft./month
Staging area	100,000	sq ft	60	2.1	210,000	industrial space rental of \$1.05/sq. ft./month
Respirators	150	#	—	20	3,000	buy; use for 3 days

Table 2. Estimated costs for shoreline cleanup

Input	Quantity	Unit	Cost/Unit(\$)	Total Cost(\$)	Assumptions/Remarks
I. Daily (variable) costs (based on 12-hr workdays)					
Wages:					
Contracted laborer	2,000	man-day	350	700,000	50 percent from mainland
Contracted mgr/foremen	200	man-day	700	140,000	foreman-laborer ratio at 1:10
Company mgr/supervisor	67	man-day	800	53,600	company man-manager ratio at 1:3
Room & board:					
workers	1,000	day	75	75,000	for 1,000 mainland workers
managers	100	day	175	17,500	for 100 mgrs. from mainland
company men	55	day	250	13,750	for 55 co. men from mainland
Disposables (clothing)	2,200	pieces	30	66,000	
Lunch boxes	2,200	pieces	5	11,000	
Bus	44	bus-day	100	4,400	50 person per bus, \$50/trip
Car rental	55	car-day	26	1,430	for 55 company men from the mainland
Cellular phones	100	phones	33	3,333	at 1,000/mo
Vacuum trucks	60	truck-day	800	48,000	
Total Variable Costs				1,134,013	
II. Fixed costs					
Plane fare	1,155	tickets	600	693,000	for mainland workers on chartered plane
Sorbents (pompoms)	20	containers	25,000	500,000	
Rakes	2,000	pieces	11	22,000	1 per worker
Shovels	200	pieces	18	3,600	1 per 10 workers; check price
Total Fixed Costs				1,218,600	
III. Total labor costs for 2 months (estimated length of intensive clean-up)					
Variable costs, month 1				34,020,390	
Variable costs, month 2				17,010,195	assume 50 percent of the first month
Fixed costs				1,218,600	
Total Labor Costs				52,249,185	

Table 3. Estimated oil and oily waste disposal costs

Debris/Method/Operation	Quantity	Unit	Cost/Unit	Total Cost	Assumptions/Remarks
Oil-water from skimming operations					
Case 1. recycle on-island					
recycling fees - high	5,170,000	gal	1.50	7,755,000	if separable, at least 30 percent oil; recycle at Ewa facility
recycling fees - low	3,450,000	gal	1.50	5,175,000	high volume estimate of mousse
Case 2. ship to mainland					low volume estimate of mousse
disposal fees - high	5,170,000	gal	1.50	7,755,000	deep-well injection in Texas
transportation - high	1,034	5,000 gal	7,000	7,238,000	\$1.5/gal
sub-total - high				14,993,000	\$7,000/5,000 gal
disposal fees - low	3,450,000	gal	1.50	5,175,000	\$1.50/gal
transportation - low	690	5,000 gal	7,000	4,830,000	\$7,000/5,000 gal
sub-total - low				10,005,000	
Oil-water recovered from beaches					
Case 1. recycle on-island					
recycling fees - high	13,790,000	gal	1.50	20,685,000	if separable, at least 30% oil; recycle at Ewa facility
recycling fees - low	11,380,000	gal	1.50	17,070,000	high volume estimate of mousse
Case 2. ship to mainland					low volume estimate of mousse
disposal fees - high	13,790,000	gal	1.50	20,685,000	deep-well injection in Texas
transportation - high	2,758	5,000 gal	7,000	19,306,000	\$1.5/gal
sub-total - high				39,991,000	\$7,000/5,000 gal
disposal fees - low	11,380,000	gal	1.50	17,070,000	\$1.5/gal
transportation - low	2,276	5,000 gal	7,000	15,932,000	\$7,000/5,000 gal
sub-total - low				33,002,000	
Sorbents					
Case 1. ship to mainland "dry"					
disposal fees	161	tons	85	13,685	dispose at Class I landfills
transportation	8	20 tons	5,000	40,250	\$5,000/20 tons
wringing	360,640	lbs	1	360,640	use centrifuges for solidification/stabilization
sub-total				414,575	
Case 2. ship to mainland "wet"					
disposal fees	721	drums	175	126,224	500-lb drums; fee is \$175/drum
transportation	8	20 tons	6,000	48,300	\$6,000/20 tons; use roll off bins
sub-total				174,524	use centrifuges for solidification/stabilization
Case 3. II-power					
disposal fees	161	tons	54	8,694	\$54/ton disposal fee
Booms					
Case 1. ship to mainland "dry"					
disposal fees	134	tons	85	11,390	

Table 3. Estimated oil and oily waste disposal costs (continued)

Debris/Method/Operation	Quantity	Unit	Cost/Unit(\$)	Total Cost(\$)	Assumptions/Remarks
transportation	7	20 tons	5,000	33,500	\$5,000/20 tons
wringing	300,160	lbs	1	300,160	use centrifuges for solidification/stabilization
sub-total				345,050	
Case 2. ship to mainland "wet"					
disposal fees	600	drums	175	105,056	500-lb drums; fee is \$175/drum
transportation	7	20 tons	6,000	40,200	\$6,000/20 tons; use roll off bins
sub-total				145,256	use centrifuges for solidification/stabilization
Oil coated debris (trash, vegetation, seaweeds, etc.)					
Case 1. ship to mainland "dry"					dispose at Class I landfills
disposal fees	2,846	tons	85	241,910	
transportation	142	20 tons	5,000	711,500	\$5,000/20 tons
wringing	6,375,040	lbs	1	6,375,040	use centrifuges for solidification/stabilization
sub-total				7,328,450	
Case 2. ship to mainland "wet"					mainland facility solidify, stabilize, dispose
disposal fees	12,750	drums	175	2,231,264	500-lb drums; fee is \$175/drum
transportation	142	20 tons	6,000	853,800	\$6,000/20 tons; use roll off bins
sub-total				3,085,064	use centrifuges for solidification/stabilization
Case 3. H-power					\$54/ton disposal fee
disposal fees	2,846	tons	54	153,684	
Oil coated sand					
Case 1. ship to mainland "dry"					dispose at Class I landfills
disposal fees	22,932	tons	85	1,949,220	16,380 cu yds; 1.4 tons/cu yd
transportation	1,147	20 tons	5,000	5,733,000	\$5,000/20 tons
wringing	51,367,680	lbs	1	51,367,680	use centrifuges for solidification/stabilization
sub-total				59,049,900	
Case 2. ship to mainland "wet"					mainland facility solidify, stabilize, dispose
disposal fees	102,735	drums	175	17,978,688	500-lb drums; fee is \$175/drum
transportation	1,147	20 tons	6,000	6,879,600	\$6,000/20 tons; use roll off bins
sub-total				24,858,288	use centrifuges for solidification/stabilization
Miscellaneous costs					
Front end loaders	300	loader day	720	216,000	\$60/hr; 5 loaders/day; to load debris to truck
Truck (haulers)	18,719	cu yards	10	187,193	haul debris from beaches to on-island waste facility
Garbage bags	31,500	boxes	5	157,500	
TOTAL low estimate				47,971,615	
TOTAL high estimate				122,682,668	