APPENDIX 5.5:

Analysis of the Risk of Oil Spills to the Southern Sea Otter Resulting from Tankering and from Ongoing, Projected, and Hypothetical OCS Development

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May 2001

The risks to the southern sea otter population resulting from ongoing and projected production from existing federal OCS facilities, hypothetical development of the 36 undeveloped leases, and non-OCS tankering offshore south-central California were examined using a model based on Ford and Bonnell (1987, 1995). Five different sources of oil spill risk were considered:

- Ongoing and projected production from existing federal OCS facilities from 2001 through the year 2005
- Ongoing and projected production from existing federal OCS facilities from 2006 through the year 2030
- Hypothetical development of the 36 undeveloped leases from 2006 through the year 2030
- Non-OCS tankering activity from 2001 through the year 2005
- Non-OCS tankering activity from 2006 through the year 2030

The number of sea otters contacted by oil spills originating from each of these potential sources of risk were simulated 100,000 times using randomized inputs in order to generate a distribution of the probability that a given number of otters would be contacted by oil. The model was structured as follows:

NUMBER OF SPILLS

The numbers of spills originating from a particular source are assumed to be Poisson distributed. Potential sources are production platforms, pipelines, and tanker routes. Using the methodology of Anderson and LaBelle (1994), the estimated mean of the Poisson distribution of spill frequency for each platform or transport segment is based on the volume of oil produced or transported. For production platforms and pipelines, the number of oil spills greater than 50 bbl is estimated to be 9.16 per billion bbl produced or transported (Anderson and LaBelle, 2001, in press). Production and transport volumes associated with existing, projected and hypothetical future OCS activities were estimated by the MMS and are listed in table 5.5 -1. Since all oil produced on offshore platforms must be transported to shore, we assume that accidents are equally likely to occur at the platform or along the associated pipeline carrying the oil to shore.

Table 5.5-1. Estimated production and transport volumes associated with ongoing, projected, and hypothetical OCS activities.

Status	Unit	Name	Launch Point	Type	bbl(millions)
Existing	Carpinteria Field	Houchin->Shore	PL10	Pipeline	3.3
		Platform Houchin	PF1	Platform	3.3
	Dos Cuadras Field	Hillhouse->Shore	PL2	Pipeline	12.7
		Platform Hillhouse	PF10	Platform	12.7
	Pt Arguello Unit	Hermosa->Shore	PL9	Pipeline	92.7
		Platform Harvest	PF15	Platform	30.9
		Platform Hermosa	PF16	Platform	30.9
		Platform Hidalgo	PF18	Platform	30.9
	Pt Hueneme Unit	Gina->Shore	PF5	Pipeline	0.7
		Platform Gina	PF5	Platform	0.7
	Santa Clara Unit	Gail->Grace	PL3	Pipeline	24.3
		Gilda->Shore	PL4	Pipeline	14.1
		Grace->Shore	PL6	Pipeline	24.3
		Platform Gail	PF6	Platform	48.6
		Platform Gilda	PF7	Platform	14.1
	Santa Ynez Unit	Harmony->Shore	PL7	Pipeline	192.3
		Platform Harmony	PF4	Platform	64.1
		Platform Heritage	PF2	Platform	64.1
		Platform Hondo	PF3	Platform	64.1
Proposed	Bonito Unit	Bonito Unit	L9	Platform	68.0
		Bonito Unit->Shore	L9	Pipeline	68.0
	Cavern Pt Unit	Gail->Grace	PL3	Pipeline	11.0
		Grace->Shore	PL6	Pipeline	11.0
		Platform Gail	PL3	Platform	22.0
	Gato Canyon Unit	Gato Canyon Unit	L10	Platform	77.0
		Gato Canyon Unit->Shore	L10	Pipeline	77.0
	Pt Pedernales Unit	Irene->Shore	PL11	Pipeline	19.0
		Platform Irene	PF17	Platform	19.0
	Pt Sal/Lion Rk Unit	Lion Rk Unit	L4	Platform	233.0
		Lion Rk Unit->Shore	L4	Pipeline	233.0
	Purisma Pt/Santa Maria Unit	Sant Maria South	L8	Platform	90.0
		Sant Maria South->Shore	L8	Pipeline	90.0
	Rocky Pt Unit	Harvest->Shore	PF15	Pipeline	13.0
		Hermosa->Shore	PF16	Pipeline	13.0
		Hidalgo->Shore	PL9	Pipeline	13.0
		Platform Harvest	PF15	Platform	13.0
		Platform Hermosa	PF16	Platform	13.0
		Platform Hidalgo	PF18	Platform	13.0
	Sword Unit	Hidalgo->Shore	PL9	Pipeline	29.0
		Platform Hidalgo	PF18	Platform	29.0

Anderson and LaBelle (1994) estimated that 0.42 spills greater than 1,000 bbl occur for every billion bbl of oil transported by tanker. These rates, however, are based on entire trips, and a spill might occur anywhere along a tanker's route. Since the MMS OSRA model partitions tanker routes into a number of sub-segments, we assume that for the coastal transport of oil (e.g. San Francisco Bay to Long Beach Harbor) spills are equally likely to occur anywhere along such a route. For example, if 2 billion bbl of oil were transported from San Francisco Bay to Long Beach Harbor, there would be an expectation of 2.0 x 0.42 = 0.84 spills greater than 1,000 bbl occurring somewhere along the route. OSRA sub-segment T7 represents a 28-km stretch of a trip totaling 737 km. The number of spills expected to occur along sub-segment T7 would therefore be (28/737) x 0.84 = 0.032. This methodology is the same as that used in Ford and Bonnell (1987) and Ford and Bonnell (1995). Tanker traffic along the sea otter range consists almost entirely of movement between San Francisco Bay and Long Beach Harbor (DNA Associates, 1993). While nearly all tanker traffic maintains a distance of 50 nm from the coast while transiting the sea otter range, it is likely that tankers in distress would be found away from their normal routes. We therefore use the OSRA segments T3, T4, T5, T6, T7, T8, T9, T11, T12, and T13, which lie about 25 nm from shore, as potential launch points for tanker spills.

Ford and Bonnell (1995) carried out a modeling effort similar to the one described here for tankers, but a different algorithm was used to determine the location of tanker spills. In that study, simulated spills were launched with equal likelihood within 25 nm of the shoreline from the Golden Gate to Pt. Conception. In the current study, spills resulting from coastal tankering were launched from a line 25 nm from the coastline (OSRA segments T6-T13). Additionally, although the OSRA model launch points did not extend north of Big Sur, Ford and Bonnell (1995) found that the area north of Monterey Bay represented the greatest risk to the sea otter range. Both of these factors would tend to lower the likelihood of a spill contacting the shoreline and would result in lower estimated impacts on sea otters. These factors do not affect the assessment of platform and pipeline spill risks.

Tanker routes that cross large stretches of open ocean will have a different distribution of spill locations than will coastal routes. Most spills occur within about 50 nm of land (Card et al., 1975), and it is reasonable to assume that about half occur on the outward leg, and half on the inward leg. We assume that trans-Pacific tanker traffic heading westward from Long Beach will travel along OSRA segments T23, T27, T26, T25, L17, L16, TF8, and TF7 before heading westward, and that half of the accidents associated with that route (i.e. 0.21 spills per billion bbl) will occur with equal likelihood along those segments.

The quantity of oil transported along the San Francisco Bay to Long Beach route was estimated by DNA Associates (1993) to be 292.3 million bbl per year. The trans-Pacific route was estimated to carry 5.8 million bbl per year. The volumes (corrected for the segment length) over a 30-year period are shown in table 5.5-2. Only sub-segments with a probability of shoreline contact greater than 0.0 are shown.

SPILL SIZE

The MMS's U.S. Oil Spill Database (C. Anderson, MMS, unpubl. data) includes Pacific and Gulf of Mexico OCS spills occurring between 1971 and 1999. Of the 2,125 total spills in the database, 106 are greater than or equal to 50 bbl. Of these, 79 are in the range 50 to 199 bbl, 22 are in the range 200 to 499 bbl, and 5 are greater than or equal to 500 bbl. Because the maximum platform or pipeline spill is assumed to be 2,000 bbl, we treat this value as the upper bound on the spill size distribution for these

Table 5.5-2. Estimated volumes transported over selected OSRA tanker segments.

Segment ID	Volume (Millions of bbl)	Route
T6	324.0	SF->LA-LB
T7	333.0	SF->LA-LB
T8	675.0	SF->LA-LB
T9	640.0	SF->LA-LB
T11	596.0	SF->LA-LB
T12	491.0	SF->LA-LB
T13	824.0	SF->LA-LB
TF7	15.0	Asia-Pacific->LA-LB
TF8	17.6	Asia-Pacific->LA-LB

sources.

There is a large database of tanker accidents, and the empirical distribution is well defined (Anderson and LaBelle, 1994). We used this distribution to simulate the size of spills resulting from tanker accidents. Because this database includes spills larger than the maximum capacity of tankers transiting this portion of the California coast, we truncated this distribution at 350,000 bbl (Ford and Bonnell, 1995).

The largest spill size analyzed in the EIS is a 22,800-bbl non-OCS tanker spill. This represents the mean spill size for tankers in U.S. waters, based on 1985-1999 data from the MMS Worldwide Tanker Spill Database (C. Anderson, MMS, unpubl. data). We conducted an additional run of the model for a 22,800-bbl tanker spill, assuming shoreline contact along the mainland north of Point Conception.

LIKELIHOOD OF SHORELINE CONTACT

We used output from the OSRA model to estimate the likelihood that a spill would contact the shoreline and where the center of that contact would be. According to the results of the OSRA model, 44 launch points had a non-zero probability of contact along the mainland coast within or near the sea otter range. Each time a spill was simulated, we used these probabilities to randomly determine whether the spill contacted the mainland, and where the center of the impact would be. To maintain consistency with the oil spill risk analysis presented in the EIS (section 5.1.3), contacts for platform and pipeline spills were calculated for 10-day periods; for tanker spills, with their much greater potential volumes, 30-day runs were used.

LENGTH OF COASTLINE AFFECTED

We used the statistical relationship between spill size, latitude, and length of coastline affected derived by Ford (1985) to determine how long a stretch of coastline would be affected by a spill of a given volume that came ashore. The equation was:

$$\text{Log (COAST)} = -0.8357 + .4525\ \text{Log(VOL)} + 0.0128\ \text{(LAT)} + \text{ZS}$$

COAST: Length of coastline affected in kilometers. VOL: Spill volume in barrels. LAT: Latitude of spill origin.

ZS: A normally distributed random variable based on the variation of COAST about the regression line.

A position along the shoreline within the quadrant where the spill came ashore was randomly selected as the spill center, assuming that all positions along the shoreline within the quadrant were equally likely. It was assumed that the area affected would extend equal distances to the north and to the south of the spill centroid.

NUMBER OF OTTERS CONTACTED

The mean density of otters per kilometer within each quadrant was estimated based on 1999 spring sea otter survey data transmitted to us by Brian Hatfield (USGS). The total number of otter contacts was calculated by summing the densities of sea otters in each kilometer that would be affected by oil in a given simulated spill. Note that the OSRA data are based on annual spill probabilities, whereas the spring otter distribution was used for calculating the number of contacts.

PRESENTATION OF RESULTS

The effects of each of the five categories of OCS development and transport on sea otters were simulated 100,000 times. The same was done for the 22,800-bbl tanker spill. The results of this analysis are presented as worst-case percentiles (See, for example, Ford et al., 1996). To do this, we ranked the outcomes in ascending order based on the numbers of otter contacts and used this ranking to determine worst-case percentiles. For example, outcome number 99,000 out of 100,000 trials is the 0.01 worst-case scenario, i.e., the maximum number of otters that would be expected to be contacted in 99 out of 100 trials. The results of this analysis are shown in table 5.5-3.

Brody et al. (1996) point out that for sea otters, “contact” with an oil spill is not necessarily equivalent to mortality. In the tanker analysis, many of the simulated contacts with the shoreline occurred between 10 and 30 days after the release of the oil. In such cases, the likelihood of survivorship of the affected otters would be improved, and some of these animals could be expected to survive.

Table 5.5-3. Estimated sea otter contacts (worst-case percentiles).

(a) Ongoing and projected OCS production, 2002-2005
(10-day contacts)

Worst-Case Percentile	*Otter Contacts*
0.1	0.0
0.01	4.3
0.001	38.0
0.0001	85.8

(b) Ongoing and projected OCS production, 2006-2030
(10-day contacts)

Worst-Case Percentile	*Otter Contacts*
0.1	0.7
0.01	26.6
0.001	77.0
0.0001	109.9

(c) Hypothetical development of 36 undeveloped leases, 2006-2030
(10-day contacts)

Worst-Case Percentile	*Otter Contacts*
0.1	6.6
0.01	64.4
0.001	198.8
0.0001	383.2

(d) Non-OCS tankering, 2001-2005
(30-day contacts)

Worst-Case Percentile	*Otter Contacts*
0.1	0.0
0.01	0.0
0.001	550.2
0.0001	1412.9

(e) Non-OCS tankering, 2006-2030
(30-day contacts)

Worst-Case Percentile	*Otter Contacts*
0.1	0.0
0.01	345.3
0.001	1340.7
0.0001	2001.5

(f) Non-OCS tanker spill, 22,800 bbl
(30-day contacts)

Worst-Case Percentile	*Otter Contacts*
0.1	699.2
0.01	1503.6
0.001	1975.6

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Spills from other exploratory sources including those related to support vessels

Of 239 exploratory wells drilled from 1970 to present, a total of 87 hydrocarbon spills occurred, spilling about 50 bbl of hydrocarbons.

An analysis of the spills that occurred during exploratory operations revealed the following data:

- Thirty-one crude oil spills accounted for 37 bbl;
- Thirty-five diesel spills accounted for 11.5 bbl;
- Thirteen lube oil spills accounted for 0.8 bbl;
- Seven hydraulic oil spills accounted for 0.5 bbl; and
- One waste oil spill accounted for 0.02 bbl.

Most of the most exploration drilling occurred during the 1980's; the last Pacific Region exploratory well was drilled in 1989.

Oil and Gas Development and Production activities

In the POCSR from 1970 through 2000, a total of 881 events resulted in 780 bbl of oil spilled from all sources related to development and production activities, while about 950 million bbl of oil was produced[1]. The January 1969 oil spill from Unocal's Platform A occurred during development drilling. The U. S. Geological Survey (USGS) immediately undertook an investigation into the cause of the spill and began to revise drilling and casing requirements in hopes of preventing a reoccurrence and to increase offshore safety and pollution prevention. In December 1969, a 900 bbl pipeline break occurred. The largest spill from a Pacific Region facility since 1970 was a 150-bbl spill from a platform.

There are four potential phases in development and production activities during which spills could occur:

- Platform installation;
- Development drilling;
- Production, including pipelines; and
- Decommissioning

[1] Neither of the 1969 spills are included in this database since regulations were changed soon after these events. In fact, there was a moratorium on drilling until around 1975 and the next platform to be installed was Platform Hondo in 1976.

Since the data is unavailable for determining a statistical relationship between these phases and recorded spill events, the following discussion will only address generic possibilities and scenarios.

<u>Platform installation</u>. Spills of diesel, lube oil and hydraulic oil are the most common spills to occur during platform installation and construction activities since no wells would have been drilled at that time. These types of spills can occur during all phases (including exploration) of offshore oil and gas activities. During construction and installation proceedings, there can be many vessels present at the platform installation site, including a large derrick barge and several supply and crew boats. Transfer of diesel fuel between the supply vessel and derrick barge can result in small spills. Occasionally, a hose may break or become accidentally disconnected or a spill may occur while disconnecting the hose. Lube and hydraulic oils are stored in drums or cans. To our knowledge, no drums of these types have been dropped into the sea that resulted in the spillage of oil. However, lines and hoses have broken resulting in small spills of lube and hydraulic oils into the sea.

<u>Development drilling</u>. During development drilling, the possibility of crude oil spills arises only when oil-bearing formations are contacted and/or when oil is brought to the surface. Of the 881 spills events that have occurred from 1970 to the late-1980's, when drilling activity was high in the Pacific Region, an estimated 1 in 25 events occurred due to drilling or while equipment was in a well during other operations. The level of drilling activity decreased after about 1990, increasing in the mid-1990's with the development drilling that occurred in the Santa Ynez Unit at Platforms Harmony and Heritage.

Most platforms have diesel fuel onboard even if they are powered from shore by electrical cable. The diesel is used for powering some cranes and for backup generators, especially for running fire water pumps in case of emergencies. Diesel is commonly stored in tanks in the pedestals that support the superstructure of the cranes. The use of hydraulic and lube oils continues in this phase since various pumps, compressors and other machinery require one or both of these.

<u>Production, including pipelines</u>. Hydrocarbon spills may occur during production of oil and gas and while the oil and gas is treated and pumped through pipelines to shore (<u>all</u> oil and gas is piped to shore in the POCSR). By far the most spills occur during this phase, since this phase lasts the longest, over 30 years per platform in some cases; the oldest platforms in the POCSR first produced oil in June of 1968, nearly 33 years ago. The largest spill that occurred on a facility during this phase was about 150-bbl. Otherwise, the 1997 Platform Irene pipeline spill of 163 bbl has been the largest in this phases (and largest overall since 1969).

Produced water discharges are another production-related source of oil into the sea. This effluent is regulated under the National Pollutant Discharge Elimination System (NPDES) regulations under the Environmental Protection Agency purview. The effluent is treated prior to discharge by various means. The most common treatment system used involves a combination of heat, chemicals (for example, emulsion breakers) and the use of mechanical forces (such as corrugated plates, bubbling air, etc.). Under normal operating and treatment circumstances, no slick will form on the ocean surface as from an oil spill. However, since NPDES permits allow some dissolved components of oil to remain in the effluent (currently ranging in the POCSR from 29 to 72 ppm) some amount of oil is discharged into the sea from this effluent. See section 6.2.2 for more detailed information on oil and grease in produced water discharges.

Decommissioning. The potential for oil spills from decommissioning activites is similar to those from platform installation. Since platform operations will cease, there is no chance for spills from oil wells. Thus, the greatest chance of spills from this phase would be due to the attendant vessels, including the derrick barge and the supply vessels.

TANKERS, BARGES AND OTHER SHIPPING.

Vessels that carry hydrocarbons, either as cargo or as fuel or both, ply the waters of the Study Area. The history of spills in the West Coast from vessels is brief (USCG, 2000). The largest spill was from the *American Trader* which spilled about 7,000 bbl of crude oil in 1990. The only other vessel spill was the *Pac Baroness* which spilled a small amount of fuel oil in 1987 when it collided with the *Atlantic Wing*, a car carrier, and sank south of Point Conception in 2,000 m (6,400 ft) of water. An immediate spill, estimated at 950 bbl, occurred with continued seepage of about 1 bbl/day for several weeks afterwards. Two other vessel spills occurred in 1973 and 1979. The 1973 spill was from the USNS *Private Joseph Merrel*, a Navy cargo ship. It spilled an estimated 381 bbl of fuel oil offshore Piedras Blancas (40 miles north of Morro Bay), none of which reached shore. The 1979 spill occurred from a Chevron tanker, the *Ogden Challenger*, while it was being filled at the Estero marine terminal (which is decommissioned). About 6 bbl of crude oil was spilled, some of which came ashore on Morro Strand Beach and was cleaned up. The barge *Apex Houston* spilled crude oil due to a loose hatch cover all along the central coast to short of Point Conception. While only about 600 bbl were spilled, numerous Common Murres were oiled along the 320-km (200-mi) track of the spill.

NATURAL SEEPS

For at least several thousand years, oil seeps were used as a key ingredient in *quap*, a popular sealant used among Chumash inhabitants and later traded far inland in the form of tar, fuel oil and gas. The earliest European accountings of area oil seepage dates from 1543, when Spanish explorer Juan Rodriquez Cabrillo caulked his ships with the local tar. A 1793 log entry from Captain George Vancouver noted the sea as being covered with a sticky smelly substance. In 1886, a traveler noted the presence of a seaside asphalt mine, on what is now the location of the U. C. Santa Barbara campus at Coal Oil Point.

At least 50 oil seepage areas exist between Point Arguello and Huntington Beach with at least 38 in the Ventura/Santa Barbara area. Seepage areas are also known to exist from Point Arguello to Monterey. Altogether, it is estimated that 40 to 670 bbl per day seep into the sea in the Santa Barbara Channel with the most concentrated occurring near Coal Oil Point where about 25 to 400 bbl/day seep out.

In 1982 Arco Oil Company, the owner (at the time) of several state leases near Coal Oil Point, installed two metal tents on the sea floor to capture as much of the oil and gas seepage as possible. These tents are still in place and are capturing several tens of barrels of oil and over 6 billion cubic feet of gas per year (according to the latest data available – 1999). Several authors (Hornafius, et al., 1999; Quigley, et al., 1999) have suggested that oil and gas production from Platform Holly, on California State Lease PRC 3242, has decreased the amount of seepage from the Coal Oil Point seep zone.

ONSHORE SOURCES

Onshore sources of oil spills that could enter rivers and, perhaps, the sea, include:

- refineries,
- oil and gas production facilities;
- oil and gas processing facilities, and
- pipelines.

Municipal and industrial wastes and urban runoff also contribute oil to the marine environment, likely in amounts much greater than those contributed by any other single source. These sources are difficult to measure and are largely unexamined (see sections 5.2.2.2, and 6.2.2 for further detail on these sources of hydrocarbons). For the purposes of this discussion, we will only examine the potential for oil spills from the sources listed above.

One refinery is located near the Santa Maria River in San Luis Obispo County while several others are located near the Los Angeles Harbor and sea shore near Los Angeles International Airport. To our knowledge, no spills from those refineries, if any have occurred, have entered either rivers or the sea.

Two separate but related incidents near Port San Luis, on the San Luis Obispo County coast, are the seepage of diluent from old oil fields near Guadalupe Dunes and seepage of oil from a tank farm which caused oil to penetrate ground water under the town of Port San Luis. Each of these were caused, in general, by poor maintenance and operational procedures by the Unocal, the oil field owner.

The Guadalupe Dunes diluent spill (diluent is a light hydrocarbon used to thin oil produced from formations to ease the pumping of the oil to and on the surface) was first noticed when hydrocarbons appeared in the surf zone. It was treated as an oil spill by the U. S. Coast Guard (USCG). The source of the "spill" was traced to underground pools of diluent which had settled atop of ground water then seeped downhill to the ocean. The USCG, with Unocal and the State, developed a response to the situation, at first by excavating the beach and inserting a barrier. Skimming of the surfacing diluent commenced. Further searches revealed many such pools scattered about the oil field. Unocal is presently in the process of cleaning up these spills.

The Avila Beach spill is another that is under ground. It was the result of long-term seepage of oil from tanks on the slopes above the town of Avila Beach. This resulted in the excavation of much of the town's streets in order to rectify the situation. Again, Unocal was the responsible party and has undertaken the entire cost of the clean up action.

Oil and gas processing facilities are located mostly near the shore and some are located in canyons that also contain small seasonal streams. In some cases, much effort has been expended to prevent any spilled oil from reaching the sea where there is a potential for oil to spill into a small stream and hence into the sea. The potential for oil to spill is large given the existence of large storage tanks which, while well-built, can be subject to large earthquakes in the southern California area. No such catastrophic event has occurred in the study area; however, the 1964, Alaskan earthquake collapsed two storage tanks in Prince William Sound, both, ironically, containing Monterey formation oil from southern California.

Processing facilities range in oil-handling capability from large (for example, Exxon's Los Flores Canyon), to medium (Nuevo's Mandalay Beach) to small (Pacific Offshore Operators', Rincon plant). All of these examples take wet oil from offshore, separate the water from the oil and gas, send the treated water back offshore for disposal, and ship the oil and gas into the local pipeline infrastructure. All are located on or near the shore, or in a canyon (in the Las Flores Canyon case). No oil spills from these facilities have been known to reach the sea or any nearby local stream which runs to the sea.

Pipelines are the primary way that oil is shipped both from offshore to onshore and from one place to another onshore. Since pipelines that run along the shore can cross waterways, the potential for a breakage and subsequent leakage into the stream or river exists. Some examples include:

- The 1997 Northridge earthquake caused the Line 63, owned by ARCO, to be broken in six places. At least one of those places caused oil to flow into the Ventura River. Some oil leaked into the stream bed, but did not reach the sea.
- A Unocal pipeline running from a tank farm in Avila Beach broke and spilled oil which ran down a cliff into the shallow tidal waters (both the tank farm and pipelines have since been decommissioned).
- On only one occasion has oil from a local oil field spilled into the sea. This was from a Berry Petroleum-owned pipeline breaking, the leaking oil flowing into a nearby agricultural drainage pond near McGrath State Beach, and being discharged with the water into the sea during routine pumping.

BEHAVIOR AND WEATHERING PROCESSES: HOW OIL CHANGES WHEN SPILLED AT SEA

When oil is spilled at sea it will normally break up and be dissipated or scattered into the marine environment over time. This dissipation is a result of a number of chemical and physical processes and are collectively known as weathering. Some of the processes, like dispersion of the oil into the water, cause part of the oil to leave the sea surface, while others, like evaporation or the formation of water in oil emulsions, cause the oil that remains on the surface to become more persistent. The time dissipation takes depends on a series of factors, including the amount and type of oil spilled, the weather conditions and whether the oil stays at sea or is washed ashore. Physical properties such as the density, viscosity and pour point of the oil also affect the speed and the resulting form of the oil during these weathering processes.

The way in which an oil slick breaks up and dissipates depends largely on how persistent the oil is. Non-persistent oils, such as kerosene, tend to evaporate and dissipate quickly and naturally and rarely need cleaning-up. In fact, due to fire danger and exposure to the fumes by responders, it may be more

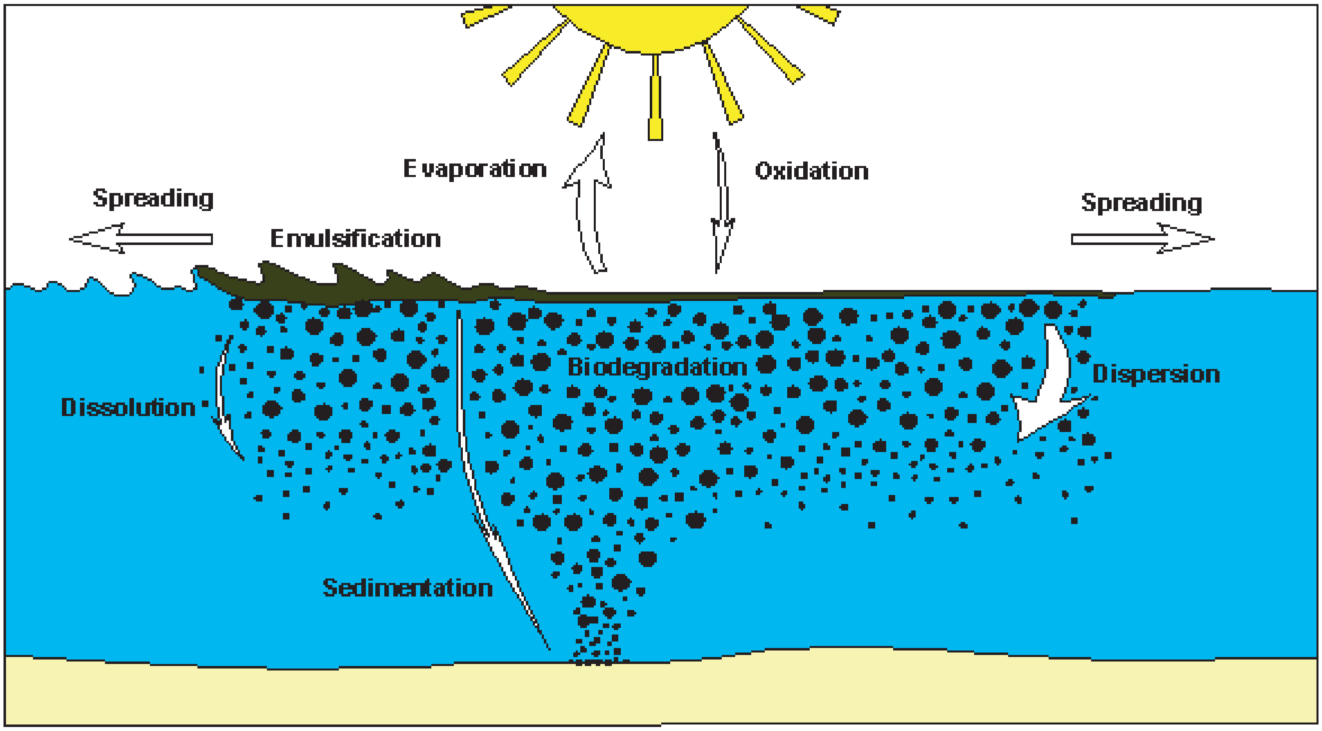

Figure 5.3-1. Fate of oil spilled at sea showing the main weathering processes. Source: ITOPF (2001).

dangerous to attempt to clean-up a non-persistent oil than to monitor it and let it dissipate. In contrast, persistent oils, such as many crude oils, break up and dissipate more slowly and usually require a clean-up response.

There are eight main processes that cause oil to weather (International Tanker Owners Pollution Federation (ITOPF), 2001). They are: spreading, evaporation, dispersion, emulsion, dissolution, oxidation, sedimentation/sinking, and biodegradation. The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill whilst oxidation, sedimentation and biodegradation are more important later on and determine the ultimate fate of the oil (ITOPF, 2001). They are described below in order of importance in terms of their effect on the percentage of total mass balance, the greatest loss in terms of percentage (Fingas, 2000), and illustrated in appendix figure 5.3-1.

Spreading. Since spreading is the first thing that oil does when it contacts the water and since spreading is the first and necessary aspect of weathering, it is discussed first. As soon as oil is spilled, it starts to spread out over the sea surface, initially as a single slick. The speed at which this takes place depends to a great extent upon the viscosity of the oil. Fluid, low viscosity oils, such as gasoline, diesel fuel and light crude oils, spread more quickly than those with a high viscosity and form very thin slicks Heavier crudes and bunkers spread to slicks of several millimeters. Heavy oils may also form tar balls or mats (see below) and not go through a progressive slick-forming process. Spreading is a gravity-driven process, combined with the interfacial tension between the oil and water, so that oil can spread rapidly even without wind and water currents. As time passes, the effect of gravity on the oil diminishes, but the force of the interfacial tension continues to spread the oil (Fingas, 2000).

Wind, waves and currents also spread the oil and speed up the process. Because of these forces, spreading is rarely uniform and large variations in the thickness of the oil are typical. After a few hours the slick will begin to break up and can form narrow bands or windrows parallel to the wind direction (if the wind is sufficiently strong). These zones of convergence are due to Langmuir circulation, a wind-driven process in the top 10 m of the water column. The rate at which the oil spreads is also determined by the prevailing conditions such as temperature, water currents, and tidal streams. The more severe the conditions, the more rapid the spreading and breaking up of the oil.

Evaporation. Evaporation is one of the most important weathering process, because it can result in the greatest loss of the originally-spilled oil from the sea surface than any other single process (Fingas, 2000). The more volatile components an oil or product contains, the greater the extent and rate of the evaporation. For example, at 15 °C (59 °F), over a two-day period, gasoline evaporates completely, while about 60 percent of diesel fuel, about 40 percent of a light crude, about 20 percent of a heavy crude, and about 3 percent of a bunker oil evaporate (Fingas, 2000). About 80 percent of evaporation occurs in the first few days after a spill (Fingas, 2000). In general, in temperate conditions, up to 50 percent of the oil can evaporate within the first 24 hours (MMS, 1996). Evaporation can increase as the oil spreads, due to the increased surface area of the slick. Rougher seas, high wind speeds and high temperatures also tend to increase the rate of evaporation and the proportion of an oil lost by this process (ITOPF, 2001).

The properties of an oil can change significantly as evaporation proceeds. If about 40 percent (by weight) of an oil evaporates, its viscosity could increase by as much as a thousandfold, its density could rise by as much as 10 percent and its flash point (the temperature at which an oil gives off enough vapors to ignite when exposed to an ignition source) by as much as 400 percent.

Emulsification. An emulsion is formed when two liquids combine, with one ending up suspended in the other. The formation of water-in-oil emulsions can drastically change the properties of the oil and how it affects the environment (Fingas, 2000). Emulsification of crude oils occurs when sea water droplets, ranging in size from about 10 to 25 μm, become suspended in the oil. This occurs by physical mixing promoted by turbulence at the sea surface. If the oil is viscous, an emulsion will not readily form (Fingas, 2000). Once in the oil, the water droplets interact with any asphaltenes or resins that are present by forming a stable emulsion. At least 8 percent asphaltenes must be present for this to occur. Emulsions of this type can have a viscosity of 500 to 800 times greater than the original oil and can exist for months or years before breaking-down naturally (Fingas, 2000).

There are two other types of emulsions: unstable and semi- or meso-stable (Fingas, 2000). Unstable emulsions occur when water droplets are mixed into the oil by wave action and there are not enough asphaltenes or resins to promote the formation of a stable emulsion. Once the seas calm, the water separates from the oil within minutes or a few hours. Semi- or meso-stable emulsions form when there is at least 3 percent asphaltene or resins present in the oil. The viscosity can be 20 to 80 times higher than the starting oil. This type of emulsion can break down into the oil and water components and sometimes a stable emulsion portion.

If an emulsion forms, it is usually very viscous and more persistent than the original oil and is often referred to as chocolate mousse because of its appearance. In fact, both the tastier version of chocolate mousse and butter are common examples of water-in-oil emulsions (Fingas, 2000).

When an emulsion forms, several important changes occur in the oil. First, and most important, an emulsion substantially increases the volume by as much as 70 percent. Also, the viscosity can increase by a thousandfold (Fingas, 2000). This slows and delays other processes, such as evaporation and biodegradation, which would allow the oil to dissipate. These changes make cleanup operations more difficult since skimmers designed to pickup liquid oil floating on the sea surface, can become clogged in the presence of highly viscous emulsions. Emulsions are also difficult to ignite, if *in-situ* burning is an available option. Chemicals can be applied to emulsions in an effort to break them down. This action would be subject to the decision-making process within the Unified Command System and would be a similar process to that for dispersants.

Natural Dispersion. Significant wave action is needed to naturally disperse oil (Fingas, 2000). Waves and turbulence at the sea surface can cause all or part of a slick to break up into fragments and droplets of varying sizes. These become mixed into the upper levels of the water column. Some of the smaller droplets (less than about 20 μm) will remain suspended in the sea water while the larger ones (greater than 100 μm) will tend to rise back to the surface, where they may either coalesce with other droplets to reform a slick or spread out to form a very thin film (ITOPF, 2001; Fingas, 2000). The oil that remains suspended in the water has a greater surface area than before dispersion occurred. This encourages other natural processes such as dissolution, biodegradation and sedimentation to occur.

The speed at which an oil disperses is largely dependent upon the nature of the oil and the sea state, and occurs most quickly if the oil is light and of low viscosity and if the sea is very rough. These factors led to the complete dispersion of the oil spilled from the *Braer* near the Shetland Islands in 1993 under hurricane force winds and extreme seas. The addition of chemical dispersants (discussed below) can accelerate this process.

Dissolution. Dissolution occurs immediately after a spill, decreasing rapidly as the soluble components are depleted (Fingas, 2000). This process depends on the composition and state of the oil, and occurs most quickly when the oil is finely dispersed in the water column. Components that are most soluble in sea water are the light aromatic hydrocarbon compounds such as benzene and toluene and some of the polar compounds, broadly known as resins.. However, these compounds are also the first to be lost through evaporation, a process which is 10-100 times faster than dissolution. Only small a percentage (1 – 5 percent) of these compounds may go into solution (MMS, 1996), so that the mass of the slick is not measurably changed (Fingas, 2000). The significance of dissolution is that soluble aromatic compounds are of the more toxic components of oil. Spills of light or refined products, such as gasoline, diesel fuel or light crude oil are most likely to cause aquatic toxicity in shallow or sheltered water situations. On open water, the concentrations of hydrocarbons in the water column are unlikely to be toxic to aquatic organisms (Fingas, 2000).

Photooxidation. Oils react chemically with oxygen either breaking down into soluble products, such as resins (Fingas, 2000), or forming such persistent compounds as tars. This process is promoted by sunlight and the extent to which it occurs depends on the type of oil and the form in which it is exposed to sunlight. However, this process is very slow and even in strong sunlight, thin films of oil break down at no more than 0.1 percent per day (ITOPF, 2001). The highly soluble products of photo-oxidation may be found below the slick in the upper parts of the water column (MMS, 1996).

Sedimentation and Adhesion. Some heavy, refined products have densities greater than one and so will sink in fresh or brackish water. However sea water has a density of approximately 1.025 and very few oils are dense enough or weather sufficiently, so that their residues will sink in the marine environment (ITOPF, 2001). If sinking does occur, it usually happens due to the adhesion of particles of sediment or organic matter to the oil. Nearshore waters are often laden with suspended solids providing favorable conditions for sedimentation (MMS, 1996). In a few spills, as much as 10 percent of the total mass of the oil was deposited on the sea floor (Fingas, 2000). Oil stranded on sandy shorelines often becomes mixed with sand and other sediments. If this mixture is subsequently washed off the beach back into the sea it may then sink. In addition, if the oil catches fire after it has been spilled, the residues that sometimes form can be sufficiently dense to sink (ITOPF, 2001).

Oil can be increasingly adhesive as weathering processes continue. This oil usually contains high percentages of aromatic and asphaltenes with high molecular weights. As such, it does not degrade significantly and can remain in the environment indefinitely (Fingas, 2000).

Biodegradation. This is a natural process that can occur both in the water and on the shore. Sea water contains a range of micro-organisms including bacteria, fungi and yeasts, that use petroleum hydrocarbons as an energy source (Fingas, 2000), and can partially or completely degrade oil to water soluble compounds and eventually to carbon dioxide and water (ITOPF, 2001). Many types of microbes exist and each tends to degrade a particular group of compounds in crude oil. However, some compounds in oil are very resistant to attack and may not degrade. Biodegradation products are generally the result of oxidization, and may be further degraded, may be soluble, or may accumulate in the remaining oil. The aquatic toxicity of the degraded products may be greater than that of the parent compounds (Fingas, 2000).

The main factors affecting the efficiency of biodegradation, are the nature of the hydrocarbons, the ambient temperature, the level of oxygen present, and the availability of nutrients (nitrogen and phosphorus) in the water. The rate of biodegradation is greatest on straight-chain saturated hydrocarbons, particularly those with 12 to 20 carbons (Fingas, 2000). Aromatics and asphaltene with high molecular weights, will degrade slowly, if at all. Diesel fuel and light crude oils degrade most readily. Nevertheless, unenhanced biodegradation can be a very slow process for some oils.

Generally, rates of degradation increase as temperature rises (Fingas, 2000). However, this varies according to the needs of the specific microbial degrader(s) that are present. Obviously, indigenous microbes are best adapted to the ambient temperatures and conditions.

As biodegradation can only take place in the presence of oxygen, including at the oil-water interface, in the sediments and on the shorelines, since no oxygen is available within the oil itself (ITOPF, 2001; MMS, 1996). In water, oxygen levels can be so low that degradation may be limited (Fingas, 2000). It is estimated that it would take all the dissolved oxygen in 400,000 liters (105,600 gal) of sea water to degrade one liter (0.26 gal) of oil.

Rates of biodegradation lastly depend on the availability of the oil to the microorganisms. Oil degrades significantly at the oil-water interface at sea or at the soil-oil interface on land. Increases in surface area, in general, will enhance the process of biodegradation.

Tar Balls and Mats. Heavy oil residues, or tar balls, often remain after all the short-term weathering processes have occurred. These residues are normally made up of the least volatile components of the oil (MMS, 1996). Tarballs, which are often found on shorelines, and have a solid outer crust surrounding a softer, less weathered interior, are a typical example of this process. The process forms an outer protective coating of heavy compounds that results in the increased persistence of the oil as a whole (ITOPF, 2001). The oil may come from spills, but may also arise from natural seeps or from deliberate (but illegal) operational releases from ships during bilge-cleaning operations (Fingas, 2000).

OIL SPILL RESPONSE PLANS

Planning for an oil spill response is essential to insure an effective, efficient and organized response. Oil Spill Response Planning is conducted at four distinct levels: the National, Regional, Area, and the Facility/Vessel. The first three levels of response planning are conducted by government agencies charged with protecting the environment under the National Response System. The Regional level is closely allied with the National level and includes several Federal agencies. The Area level of response planning includes input from both state and local government, as well as industry and other interested parties, while the facility response planning is conducted by the owner or operator of the oil and gas facility from which a spill could impact navigable waters.

National Response System (NRS). Under the direction of the Federal Water Pollution Control Act's federal removal authority used for all spills, the NRS is a three-tiered response and preparedness mechanism. The system supports the pre-designated Federal On Scene Coordinator (FOSC) in coordinating National, Regional, and local government agencies, industry, and the responsible party during a response. The goal is to apply a focused response strategy for the immediate and effective clean up of an oil or hazardous substance discharge.

When appropriate, the NRS is designed to incorporate a unified command and control support mechanism consisting of the FOSC, the State's Incident Commander, and the Responsible Party's (RP's) Incident Manager. During a response, these three positions are officially designated as the Unified Command (UC) A unified command approach has several advantages over other response structures including:

- Allowing for a coordinated response effort, which takes into account the Federal, State, local, and RP concerns and interests when implementing the response strategy;
- Establishing a forum for open, frank discussions on problems that must be addressed by the parties with primary responsibility for oil and hazardous substance discharge removal;
- Helping to ensure that a coordinated, effective response is carried out and that the particular needs of all parties involved are taken into consideration.

The FOSC plans and coordinates response strategy on scene. Using the support of the National Response Team (NRT), Regional Response Team (RRT), Area Committees (AC), and RP's as necessary, trained personnel, equipment, and scientific support can be supplied to complete an immediate and effective response to any oil or hazardous substance discharge.

The FOSC has the ultimate authority in response operations and will exert this authority only if the other members of the UC are not present or are unable to reach consensus within a reasonable time frame. During hazardous substance release responses in which local agencies usually assume a leading role, the local agency may assume one of the unified commander roles when a UC is used. During responses to oil spills, local agencies are not usually involved as part of a UC, but provide agency representatives who interface with the command structure through the Liaison Officer or the State representative.

The NRT is responsible for developing and maintaining the National Contingency Plan (NCP). The NCP would be enacted if an oil spill approaches the level of a Spill of National Significance where the resources at the local, state and regional levels are exhausted and resources at the national level must be called upon to respond to a spill.

Regional Response Planning. At the Regional level, the RRT's are responsible for developing and maintaining the Regional Contingency Plans (RCP's), which must be consistent with the NCP. The RRT is a group of 16 government agencies and state representatives charged with providing advice, counsel and other support. The team is co-chaired by the USCG and EPA. Regional Response Teams are activated when the size or impact of an oil spill exceeds the resources at the area level or transects state or international boundaries. Regional Response Teams are also activated when a spill substantially threatens U. S. public health and welfare or regionally-significant amounts of property, is a worst case discharge as defined in the NCP, or their assistance or consultation is requested by the FOSC.

The EPA Region 9 Mainland (Arizona, California, and Nevada) RCP/ACP has been developed in coordination with the NCP and the USCG area plans. The Eleventh USCG District (Arizona, California, Nevada, and Utah) is covered by six area contingency plans in Region 9. Each plan covers the coastal zone of the corresponding Marine Safety Office (MSO).

Area Committee. The primary role of the AC is to act as a preparedness and planning body. Area Committees are made up of experienced environmental and response representatives from Federal, State and local government agencies with definitive responsibilities for the area's environmental integrity (USCG, 2000). Each member is empowered by their own agency to make decisions on behalf of the agency and to commit the agency to carrying out roles and responsibilities as described in this plan.

An AC is chaired by the respective USCG Captain-of-the-Port (COTP), develops each ACP. He will designate the vice-chairman, select the Committee members, and provide general direction and guidance for the Committee as well as designate subcommittees for certain tasks. ACP's identify, prioritize and contain cleanup strategies for sensitive areas, and identify contractors and equipment. The plans also identify strategies for responding to a worst case discharge (EPA/USCG, RCP 2000). The ACP's are to meet the following requirements:

(1) When implemented with the NCP, are "adequate to remove a worst case discharge, and to mitigate or prevent the substantial threat of such discharge, from a vessel, offshore facility, or onshore facility;"

(2) Describe the area covered by the plan, including areas of special economic or environmental importance;

(3) Describe the responsibilities of the owner or operator and of Federal, State, and local agencies in preventing, mitigating, or removing a discharge;

(4) List all equipment, dispersants, and personnel available to an owner or operator, and to Federal, State, and local agencies, for any discharge or threat of discharge;

(5) Describe procedures for expediting decisions concerning use of dispersants;

(6) Describe in detail how the plan is integrated into other ACP's and vessel, offshore facility, and onshore facility response plans, and into operating procedures of the NRP;

(7) Any other information the President requires; and

(8) Periodic update by the Area Committee.

When a spill occurs in coastal and offshore navigable waters of the United States, the COTP's are designated as the FOSC's. There are currently 49 COTP areas nationwide.

Facility Response Plans. Response plans are written in compliance with regulations promulgated by the agency that has oil spill-response planning authority for the facility. Passage of the Oil Pollution Act of 1990 (OPA90) and the delegation of authority under Executive Order 12777 gave the U.S. Department of the Interior, Minerals Management Service (MMS) oil spill-response planning authority for all offshore oil and gas facilities (except those associated with deep water ports).

In the event of an oil spill at an OCS oil and gas exploration or production operation, the lessee would be the RP as defined in OPA90 and the NCP. Thus, it is the lessee who is in charge of an oil spill response, unless the spill (1) constitutes a substantial threat to the public health or welfare, or (2) is a worst-case discharge for the facility in question. In such cases, the FOSC usually directs all containment and cleanup efforts.

In response to the requirements of OPA90, the MMS promulgated the oil spill response plan (OSRP) requirements found at 30 CFR 254. Under these regulations, owners or operators of an oil handling, storage or transportation facility located seaward of the coastline are required to submit an oil spill response plan to the MMS for review and approval. One of the main components of these requirements is the development of the emergency response action plan (ERAP). The ERAP section is the core of the OSRP and has three key purposes:

- Designates individuals responsible for implementing removal actions and notification of appropriate Federal officials and response personnel and designates a trained spill management team and spill-response operating team;
- Identifies the location of the spill-response operations center, equipment available and procedures for early detection of a spill, spill notifications and procedures for responding to the spills of various sizes;
- Describes the methods used to monitor and predict spill movement, identify and prioritize the protection of coastal resources, ensure the mobilization of response equipment and personnel, and mitigate the clean up the spill.

A second major component of the OSRP is the worst-case discharge scenario. The worst-case discharge for an offshore facility is the largest foreseeable discharge of oil in adverse weather conditions. The facility operator must first calculate the amount of oil that can be spilled from their facility from a worst-case discharge. A scenario is then developed using this spill amount which describes the movement of the resulting oil slick, resources that could be impacted and the mitigation used enabling the operator to demonstrate the ability to respond to this spill.

As the MMS has the responsibility for oil spill response planning for offshore facilities seaward of the coastline, a regulatory overlap was created with other Federal, and State agencies. In California, the state agency that is charged with oil spill response planning is the California Department of Fish and Game's Office of Spill Prevention and Response (OSPR). To cope with the overlapping responsibilities, the MMS and OSPR have developed a Memorandum of Agreement (MOA) that fosters cooperation and facilitates coordination between the two agencies. Under this MOA, the MMS and OSPR developed a coordinated OSRP review process for facilities in state waters and for facilities in the Federal OCS from which a spill could impact state waters. This agreement allows MMS and OSPR to exercise their respective authorities regarding oil spill planning, prevention, and response in a manner that ensures the best achievable protection. The MMS has entered into similar memorandums with other agencies.

The MMS provides copies of the OSRPs to the USCG and other interested Federal and State agencies for review and comment. The MMS, as approving authority for these plans, can remand plans based on these reviews, changes in response capabilities or deficiencies observed during spill response exercises or actual responses.

For a good example of a generic, recently-written OSRP, see the main text and the key appendices A, C, D, E and F of Padre and Associates (2001). This plan covers oil spill response in the eastern Santa Barbara Channel and Santa Maria Basin area. The plan was written in accordance with MMS regulation found at 30 CFR 254. The main text of the plan describes the typical response organization and actions to be taken by an oil and gas operator. Appendix A discusses the spill response equipment available in this area and its maintenance and inspection. Appendix C describes a worst case discharge scenario for this area, where the discharged oil may occur, the resources at risk and the response for this spill. Appendices D and E are plans for the use of dispersants and *in-situ* burning, respectively. These spill response technologies could be used if their used demonstrated that a net environmental benefit would result. This section also includes the approval process for use of these technologies and procedures for their use. Appendix F discusses the spill response training and drills offshore personnel will undergo to prepare for a spill response.

OIL SPILL RESPONSE

A typical response potentially involves many Federal, State, and local agencies, as well as the RP, and various oil spill clean up entities in the form of cooperatives and contractors. The volume of the oil normally determines the identity and number of entities involved in the response. The EIS examines three different oil spill scenarios:

- 50 to 999-bbl spill with a most-likely volume of 200 bbl or less;
- 2,000 bbl, assumed to occur from a pipeline; and
- A 22,800 bbl tanker spill.

The agencies (discussed in more detail, below) that would always be involved in an oil spill response are the USCG and the OSPR, contained, administratively, within the Department of Fish and Game. MMS's responsibilities are also summarized below. Other than the members of the UC and MMS, other agencies and private organizations that might participate in a response (again, depending on size and location) could include the local county's Office of Emergency Services, Fire Department, Harbor Patrol, Department of Transportation's Office of Pipeline Safety, U. S. Park Service, Federal Emergency Management Agency, U. S. Fish and Wildlife, California Department of Fish and Game (the wildlife part), and various contractors that would provide personnel, equipment, food and housing services, disposal of oily debris and hazardous materials, and other services.

Operator Response

The operator's strategy for dealing with oil spills is to prevent their occurrence. Well-engineered facilities, good housekeeping practices, adequate equipment maintenance and adherence to proper operational procedures are diligently employed to reduce the likelihood of an oil spill to the lowest possible level. In the unlikely event that an oil spill occurs, response operations would be initiated immediately. Throughout all response operations, the highest priority would be placed upon personnel safety. In addition, environmental resource considerations would be taken into account in the selection of response techniques and equipment and in the conduct of response operations.

The Company's initial spill response procedures are designed to focus personnel on those operations in which they are specially trained. Initial response operations by facility personnel will be directed at stopping the release, notifying and mobilizing Clean Seas, and if possible containing the released oil on the facility. Additionally, operator personnel will monitor spill movement and direct the initial response operations by the dedicated spill response vessel and Clean Seas vessels to the leading edge of the spill. Depending upon specific conditions, equipment deployment operations may be initiated by either onsite response personnel or Clean Seas personnel. However, upon the spillage of oil, the operator's first concern is always the safety of the personnel at the site. This sometimes includes exposure to hydrogen sulfide (H_2S) and other combustible gases, as well as volatilizing portions of the spilled oil (for example benzene) that can be harmful if breathed in even low concentrations. Containment, including potential exposure of personnel to the health hazards of the spill, will not be initiated until after the Clean Seas initial response crew has completed a site characterization. Once the site has been cleared to initiate response operations, operator personnel will continue to conduct operations associated with stopping any additional spill release, while the specially-trained response vessel and Clean Seas personnel will be engaged in spill containment and recovery.

Notifications. Initially, the RP would begin by determining the cause of the spill and to abate it (shut it off) at the source. MMS personnel, when notified, would assist in this endeavor. While these initial actions are occurring, notifications to the USCG's National Response Center, and the State of California's Office of Emergency Services are made[2], along with several other agencies, including the State Lands Commission, the USCG at Long Beach and Santa Barbara, OSPR and the Oiled Wildlife Care Network. Other agencies that would be notified ,when time and if circumstances warrant, include the State Fire Marshall's office, California Division of Oil and Gas, Regional Water Quality Control Board, EPA, and other Federal, State and local agencies as necessary (for example, if a particular resource is threatened by the spill, the agency responsible for the resource might be notified (i.e., California State parks or the National Park Service)). If the spill is from a platform or pipeline under MMS's jurisdiction, MMS would be included in the initial notification and be on-scene as rapidly as possible. If the spill were from a tanker, the notifications would be substantially be the same, except that MMS and other agencies, with no direct jurisdiction, would not be initially notified. Under these circumstances, the USCG and OSPR would be the two primary agencies involved in the response.

The second type of entity to be commonly notified would be the local oil spill cooperative. For the Santa Barbara Channel and Santa Maria Basin that would be Clean Seas, and for offshore Los Angeles, Clean Coastal Waters. These two co-ops are the seagoing version of a fire department, on-call all day, every day. They have response equipment ranging from boats, booms, skimmers, and oil/water separators to sorbents, radios, onshore-staged equipment, and contractors (including a fishing vessel-based organization, the Fisherman Oilspill Response Team, which can serve as vessels-of-opportunity by towing and positioning booms and other tasks). Other co-op-type organizations that could contribute personnel and equipment include the USCG's Pacific Strike Team, the oil industry's Marine Spill Response Corporation, and the National Response Corporation, another major independent contractor. Each of these organizations would provide services only if specifically asked by either the RP or the USCG.

Equipment and Personnel Deployment. Once oil is in the water from either a platform or pipeline, equipment is deployed either directly from the spilling facility, or a co-op, or both. On-scene oversight is usually provided by a local co-op representative who, with the use of helicopter overflights, properly positions booms and vessels to most efficiently attack the thickest part of the oil slick.

If trajectory analysis indicates the possibility of shoreline contact, personnel may be deployed to remove debris from the beaches to avoid unnecessarily oiling large pieces of stranded kelp, driftwood or trash. Also, beach-goers would be warned and beaches closed to prevent exposure of the public to stranded oil.

Persons trained in wildlife capture and rehabilitation would begin to patrol the slick to both, prevent oiling of birds and some marine mammals, and to attempt to capture already-oiled creatures. Rehabilitation centers, some of which are pre-staged, would be manned and ready to receive, clean, and restore oiled animals.

A spill from a tanker, in addition to being very large, as compared to one from a platform or pipeline, would generally entail the mobilization of nearly all the resources discussed above and, potentially, others from other states and even countries. For example, for a major spill offshore southern California, equipment personnel could be "cascaded" from Alaska, Washington, and Oregon, as well as from the Gulf of Mexico and Hawaii, if necessary. The *Exxon Valdez* spill was just such an event, and equipment from all over the world was eventually mobilized to Prince William Sound, Alaska.

Day-to-Day Spill Response. The emergency phase of a spill lasts until the major assets are in-place and working. The UC is formed and four sub-units are set-up: Finance, Logistics, Operations, and Planning. The general philosophy is to initially over-react to any incident, so depending on the size of the spill, more or less equipment and personnel would be added or released from the spill scene. These decisions are made within the UC on a day-to-day basis. Night-time and foggy operations can continue, but often on a more limited basis. For example, foggy conditions greatly limit over flights, which are critical for proper positioning of booms, skimmers, and vessels. Spill tracking during both fog and at night has improved with the use of infrared detectors that can discern the heat differences between the oil and the underlying water. With this, and other, similar, tools, equipment can be positioned and ready for clean-up operations when clear, daytime conditions occur.

As a spill response continues, various auxiliary issued must be addressed. These include disposal of oily debris, recycling, disposal at sea of water separated from recovered oil, contaminated debris, sorbent use/reuse, petroleum-contaminated soil recycling and reuse, temporary storage, treatment of oily wastes, characterization of recovered material, transportation, hazardous waste, and nonhazardous wastes. All of these topics have their individual considerations that must be accounted for in any oil spill response.

[2] Both of these notifications go to entities who disseminate the information to many other agencies, usually by fax. In some cases, multiple notifications are made to the same agency by this methods, via the NRC or State OES, as well as directly by phone from the RP.

MMS Responsibilities

The OCS Lands Act (OCSLA) and the Federal Water Pollution Control Act (FWPCA) contain provisions relating to oil spill prevention and cleanup. Section 204(a) of the OCSLA (43 USC §1348 (a)) provides broad authority and responsibility to the Department of the Interior (DOI) and to the Department of Transportation (DOT) for the enforcement of safety and environmental regulations. This section provides that:

The Secretary [of the Interior], the Secretary of the Department in which the Coast Guard is operating, and the Secretary of the Army shall enforce safety and environmental regulations pursuant to this subchapter.

The OPA90 amended §311(c) of the FWPCA by providing authority to the President to take actions with regard to removal of an oil spill. It directs the President, "in accordance with the National Contingency Plan and any appropriate Area Contingency Plan, [to] ensure effective and immediate removal of a discharge, and mitigation or prevention of a substantial threat of discharge, of oil or a hazardous substance. . . ." Moreover, it authorizes the President to "direct or monitor all Federal, State, and private actions to remove a discharge;" and for any discharge posing a "substantial threat to the public health or welfare of the United States," it requires the President to "direct all Federal, State, and private actions to remove the discharge or to mitigate or prevent the threat of the discharge."

Prevention and Preparedness. The MMS strategy for dealing with oil spills is to prevent their occurrence. This prevention strategy includes a regulatory scheme that requires the use of the best available and safest technologies at the facilities, training standards for the operator's personnel and a rigorous inspection program. This strategy ensures that industry operates well-engineered facilities, with good housekeeping practices, adequate equipment maintenance, and adherence to proper operational procedures to reduce the likelihood of an oil spill.

The MMS has established inspection and reporting requirements designed to effect timely detection of spills, notification of proper authorities, and initiation of cleanup. Operators are required to conduct frequent periodic inspections to determine if pollution is occurring and to report sources of pollution to MMS. For all spills of oil and liquid pollutants, including a spill from the facility, an oil spill from another offshore facility or an offshore spill of unknown origin, the facility operator must immediately notify the National Response Center (1-800-424-8802). For spills of 1 barrel or more from their facility, a facility operator must also notify the Regional Supervisor and file a written report by the 15th day after the spillage has been stopped.

To insure that a facility is prepared in the unlikely event that oil is spilled, the MMS has a comprehensive oil spill response exercise program in place. The program tests a facility operator's response, as well as their knowledge and understanding of their individual OSRP. For planning purposes, the MMS adheres to the requirements of the USCG's National Preparedness for Response Exercises Program (PREP)[3]. Facility operators must exercise their entire response plan at least once every 3 years (triennial exercise). To satisfy the triennial exercise requirement an owner or operator must conduct the following aspects of their response capability (USCG, 1994):

- Annual spill management tabletop exercise;
- Annual deployment exercise of spill response equipment staged at onshore locations;
- Annual notification exercise; and
- Semiannual deployment exercise of any response equipment which the owner or operator must maintain at the facility of on dedicated vessels (MMS-initiated or actual spill responses can be used for credit for one of these exercises).

In an equipment deployment exercise, the facility operator demonstrates the ability to contain and recover a spill using operator or cooperative owned oil spill response equipment. In a tabletop exercise, the spill management team's organization, communication and decision making abilities in managing a response are tested.

In the POCSR, a facility will not face an MMS-initiated unannounced exercise more than once a year, unless the results of previous exercises warrant additional ones. These exercises either require the deployment of response equipment (minor exercise) or include a tabletop exercise and mobilization of the operator's spill-response operations center and communication system for a larger spill response scenario (major exercise). The MMS initiates a major exercise with one of the facility operators annually.

[3] The USCG's PREP was developed to meet the intent of section 4202 (a) of OPA90. PREP plays a key role in assuring that to successful responds to major oil and hazardous chemical incidents occurs. PREP incorporates the exercise requirements of the USCG, the EPA, the Research and Special Programs Administration (RSPA) [Office of Pipeline Safety] and the MMS. Using PREP guidelines and participating in PREP exercises will satisfy all OPA90-mandated federal pollution response exercise requirements. For more information on the PREP program, see the website at: http://www.uscg.mil/hq/nsfcc/nsfweb/nsfcc/prep/prephome.html.

For exploratory operations the MMS will conduct unannounced equipment deployment exercises at the site of every exploratory well prior to or close to spudding and prior to drill stem testing. There will be no more than a three-month lapse between equipment deployment exercises for the same well.

Response. In the event of an oil spill from a facility under the jurisdiction of the MMS, the MMS role by law, as mandated in the OCSLA, is twofold: (1) to ensure the source of the spill is abated, and (2) to ensure the RP mitigates the spill. Abatement of an oil spill often takes place at the spill site and may involve the closing of valves and controls and, likely, the shutting-in of the facility. MMS personnel who monitor the efforts taken by the RP are present to ensure that operations are conducted in a safe and environmentally sound manner consistent with all applicable rules, regulations and industry practices (POCSR, 1998). The investigation portion would become fully implemented only after the crisis portion of the spill response is over. Therefore, the primary role of the onsite personnel is abatement of the source of the spill.

Monitoring. The resources and actions to be taken by MMS personnel during a spill (and practiced during a drill) are outlined in the MMS POCSR's Regional Spill Response Action Plan (MMS, 1998). MMS personnel monitoring spill response efforts to ensure that the spill is cleaned up (mitigated), also determine if the RP followed procedures outlined in their OSRP and if the procedures and actions outlined in the plan were adequate to respond to the spill. Following the clean up of a spill, MMS personnel will conduct or participate in a critique of the response to determine if revisions need to be made to the OSRP to address any inadequacies.

Pacific OCS Regional personnel can be found in each of four places during an oil spill (or major drill): the source of the spill (most often a platform), the RP's command center, the Pacific OCS Regional command center, and, should the spill impact the shoreline MMS may deploy the MMS Intertidal Team (MINT). MINT's purpose is to gather before- and after-spill impact data in the intertidal areas and provide that information for later use during the Natural Resources Damage Assessment (NRDA) phase. Occasionally, MMS personnel may observe and/or interact with responders from spill response cooperatives such as MSRC and Clean Seas.

The POCSR has historically taken an interest in the overall spill response regardless of source. The Region would therefore provide the UC any personnel, expertise or other resources that are appropriate for the response. Thus, over the course of the past several years the POCSR personnel have been actively involved in responses with personnel at the spill site discussing response strategies, providing trajectory information, intertidal monitoring and assessments and assisting in other response-related activities as needed and/or requested by the UC.

For oil spill events not from OCS facilities or in state waters, the POCSR would take a supportive role by providing other federal agencies involved with a response with technical and logistical support as well as trained personnel.

Notifications. A vital step in the response procedure is the notification of others that an oil spill has occurred. Notification serves as the catalyst that activates response efforts of lead Federal and State agencies, response organizations, and other government agencies. Therefore, it is essential that the notification sequence occur efficiently and expeditiously. Once affected or potentially affected parties are alerted and provided with basic information on the spill, they can more easily assess the need to mobilize their resources and orchestrate any response efforts in coordination with the Unified Command.

Although the primary purpose of the notification procedure is to alert parties of an oil spill, it also serves as a way to initiate open lines of communication between the MMS and the notified parties. During the course of a spill response effort, an exchange of information between MMS and the notified parties is common and provides for a more coordinated response effort.

Equipment. Operators in the Pacific Region are required to keep sufficient equipment on or near the platform to enable them to initiate containment activities immediately. For a secondary level response, equipment at the platform is supplemented by equipment kept onshore and operated by oil spill cooperatives formed by the lessees and operators. For example, Clean Seas has pre-staged equipment located at Morro Bay, Avila Bay, Santa Barbara Harbor, the Carpinteria Yard, in the Ventura/Port Hueneme area, and at Point Mugu Navy Base. Various types of response equipment are stored at these locations. The three major cooperatives also have at least six dedicated ocean-going vessels with onboard containment and recovery equipment for oil spill response.

If the FOSC so requests, the Navy and the USCG can provide additional oil spill response equipment and personnel located at Stockton and at Hamilton Air Force Base in northern California. Also, the Marine Spill Response Corporation has established a Southwest Region Response Center at Port Hueneme on the Santa Barbara Channel. Equipment from this center may be used for response to a spill from OCS exploration and production operations if so directed by the FOSC.

The three oil spill response cooperatives on the California coast—Clean Bay, Clean Seas, and Clean Coastal Waters—have formally agreed to provide each other response assistance within the boundaries established by State and Federal regulatory authorities. These cooperatives have also been acquiring new equipment to supplement their existing inventories.

Specifications for the onsite response vessel and equipment are provided below. A Coast Guard-certified OSRV of at least 31 m (100 ft) must have the following minimum level of equipment:

- 1,000 barrels of on board recovered oil storage;
- Two advancing skimmers, capable of open ocean oil recovery;
- One Stationary Skimmer, capable of open ocean oil recovery;
- Communications equipment including fax, cell phones, VHF;
- Dual Radar, GPS, Forward Looking Infrared Radar;
- 3,000 feet of Open Ocean Boom;
- Sorbent boom and pads (10 bales each); and
- Boom deployment boat.

The inventory of equipment and materials maintained by Clean Seas is sufficient to meet the resources required by the OPA90 and the Lempert-Keene Seastrand Oil Spill Prevention and Response Act (also known as California Senate Bill 2040 [SB 2040]). Clean Seas is certified as an Oil Spill Responder by the USCG (Padre, Assoc., 2001).

Clean Seas and its member companies and contractors have an extensive inventory of spill containment and recovery equipment, response vessels, vehicles, sorbents, and miscellaneous support equipment. With its office and storage yard in Carpinteria, Clean Seas provides equipment and personnel for the protection of the California coast between and including Cape San Martin to the north and Point Dume to the south. This area includes both public and private properties, beaches, harbors, offshore islands, and waters extending to the Outer Continental Shelf. To facilitate a rapid response to a spill emergency, Clean Seas' equipment is stationed throughout the Area of Responsibility at designated land locations and on the response vessels. The Support Yard is Clean Seas' primary equipment maintenance and storage facility. The yard is managed by a crew who support ongoing land and sea operations for Clean Seas and member companies upon request. The personnel maintain a continual readiness for responding to an oil spill emergency through ongoing training exercises and maintaining the preparedness of all Clean Seas equipment. A complete description of the Clean Seas Central Operating Area and associated operating procedures are provided in the Clean Seas Regional Resource Manual (1999).

Additional spill-response resources, beyond the primary equipment on the platforms and the local oil spill cooperative, would come from several sources including:

- Clean Coastal Waters - Long Beach. Equipment inventory and located information are contained in the Cooperative's Regional Response Manual
- Any of several private onshore and supplemental contractors such as Advanced Cleanup Technologies, Inc. (ACTI), Crosby and Overton and Foss Environmental. ACTI has sufficient resources and enough trained employees to satisfy all federal and state shoreline cleanup planning requirements for all of the Company's facilities.
- Marine Spill Response Corporation (MSRC). MSRC has equipment stored at their Southwest Regional center in Port Hueneme, California and their primary oil spill response vessel in Long Beach Harbor.

Government agencies can also provide oil spill response equipment and other resources. They include:

- U.S. Navy Supervisor of Salvage – Port Hueneme. The U.S. Navy Supervisor of Salvage (SUPSALV) maintains an inventory of oil spill response equipment in Port Hueneme, California. This equipment comprises full-service spill response capability. The SUPSALV equipment is deployed and operated by trained contractor personnel. This equipment would be activated through the FOSC.
- U. S. Coast Guard's Pacific Strike Team. The Pacific Strike Team has been organized, staffed, and equipped to provide rapid response capability to contain and recover marine oil spills. Located at Hamilton Air Force Base in Marin County, California, the Pacific Strike Team is intended to be used in the absence of local commercially available spill response resources or to complement locally available resources in large spill situations. The Strike Team is a military-style organization with approximately 28 officers and enlisted personnel. The crews are cross-trained and most individuals are capable of deploying and operating all of the Team's equipment.