



Hazardous Spills in the Southern California Bight

Pollution of the marine environment occurs through inadvertent losses of hazardous materials during production, transportation, refining, and utilization. In the past 25 years, there have been several significant hazardous material spills in the Southern California Bight (SCB). The blowout of Platform A in the Santa Barbara Channel in January 1969 released an estimated 12.3×10^6 L (3.25×10^6 gal) of oil in the first 100 days. The 70,000 t tanker *Sansinena* exploded and burned in December 1976 while it was docked in Los Angeles Harbor releasing about 5.1×10^6 L (32,000 bbl) of Bunker C fuel oil. In January 1990, the tanker *American Trader* ran aground and was punctured by its anchor spilling about 1.5×10^6 L (400,000 gal) of crude oil off Huntington Beach.

In this report, we summarize the existing data on hazardous material spills in the Southern California Bight between 1985 and 1990. The objective of this effort was to develop baseline information to provide insight into inadvertent spills in the SCB.

Methods

Data on hazardous material spills were obtained from the U.S. Coast Guard (Pollution Response Branch, Washington, D.C.) for 1985 through 1989. The Coast Guard categorizes the data by source (facility or vessel), type of material, and waterbody. They report the net amount spilled



Fuel dock in Los Angeles Harbor

(amount spilled minus amount recovered). The number of material and source categories were reduced for the tables and figures in this report. A complete list is provided in Appendix A and category definitions are provided in Appendix B.

We made several modifications to the classifications presented in the original data. We reclassified small harbors to "Pacific coastal harbors" and removed them from coastal and unclassified categories. Bays were reclassified with harbors. Turning basins in Los Angeles and Long Beach harbors were reclassified as Los Angeles/Long Beach Harbor. From 1986 on, inland spills were removed from the unclassified category and placed in an inland category. All U.S. ship spills were reclassified as "Navy vessels."

Results and Discussion

From 1985 through 1989, 327,115 L (86,424 gal or 2,058 bbl) of hazardous materials were spilled in 1,102 separate incidents in the SCB. The majority of spills (99% by volume and 96% by number) involved petroleum products (Table 1; Figure 1). Middle distillate fuels (diesel, fuel oil, jet fuel, and kerosene) were the largest class of materials spilled (50% by volume). The volume of individual spills was generally small; the median spill for all facilities was 15 L and the median spill for all vessels was 19 L (Table 1).

Spills from facilities accounted for 40% of the total number of spills and 60% of the total volume of material spilled. The greatest number and volume of facility spills involved crude oil (Table 1;

Figure 1). About 60% by number and 80% by volume of the classified facility spills originated on land (Table 2; Figure 2). About 40% of the classified facility spills by number and 20% by volume originated with offshore oil pipelines and platforms.

Spills from vessels accounted

for 60% of the total number of spills and 40% of the total volume of material spilled. The greatest number and volume of vessel spills involved fuel oil (Table 1; Figure 1). About 60% of the classified vessel spills by number were evenly divided among recreational boats, freighters, and

Table 1

Number and size of hazardous material spills from facilities and vessels in the Southern California Bight* from 1985 through 1989. Measurements are in liters except where noted.

Material	N	Median	Mean	Min	Max	Total
FACILITY SPILLS						
<i>Petroleum Products</i>						
Gas oil: cracked	4	13	15	4	30	61
Gasoline: other	4	6	6	4	8	23
Gasoline: automotive	16	28	1,040	4	15,140	16,646
Gasoline: aviation	8	87	1,061	4	7,949	8,486
Jet fuel/kerosene	4	66	76	11	159	303
Naptha	6	38	50	11	114	299
Oil: crude	138	19	840	4	33,459	115,885
Oil: diesel	79	19	161	4	7,002	12,706
Oil: fuel	77	8	465	4	23,054	35,783
Oil: lubricating	31	4	11	4	76	344
Oil: mineral	12	6	23	4	159	273
Oil: miscellaneous	10	13	27	4	79	273
Oil: motor	16	6	9	4	19	144
Oil: spray	8	28	307	4	1,893	2,453
Oil: waste/lubricants	10	11	30	4	189	303
Total	423					193,982
<i>Non-Petroleum Products</i>						
Chromic anhydride	1	341	341	341	341	341
Dichloromethane	1	34	34	34	34	34
Ethylene glycol	1	4	4	4	4	4
Hydrochloric acid	1	38	38	38	38	38
Hydrofluoric acid	1	19	19	19	19	19
Latex	1	4	4	4	4	4
Phosphoric acid	1	19	19	19	19	19
Sodium hypochlorite (kg)	2	537	537	53	1,020	1,073
Sodium hypochlorite (soln)	1	38	38	38	38	38
Solvents: mixed waste	8	11	108	4	757	867
Trichloroethylene	1	11	11	11	11	11
o-Xylene	1	4	4	4	4	4
Total	18					1,379
Total dry (kg)	2					1,073
Grand total	441					195,361
Grand total dry (kg)	2					1,073

tankers (Table 2). Most of the classified vessel spills by volume originated with the U.S. Navy and towboats (Table 2; Figure 2).

About 80% of the classified spills from vessels and 50% of the classified spills from facilities occurred in harbors and bays in the SCB (Figure 3; Table 3). Los

Angeles and Long Beach harbors received more facility spills (45% by volume) and vessel spills (29% by volume) than any other classified waterbody (Table 3). Within Los Angeles and Long Beach harbors, facilities spilled primarily crude oil from land facilities and vessels spilled mainly middle

distillate fuels from Navy and freight vessels (Figure 4).

The amount of hazardous material spilled varied from year to year (Figures 5, 6, and 7). Annual volumes spilled by facilities varied by a factor of 21 and annual volumes spilled by vessels varied by a factor of nine. Spills from land facilities varied by a factor of 33 and spills from vessels varied by a factor of 16. Annual volumes spilled in Los Angeles and Long Beach harbors varied by a factor of 43 for facility spills and 9 for vessel spills (Figure 8).

Conclusions

Petroleum products accounted for the majority of unintentional releases of pollutants to the Southern California Bight. Petroleum products also accounted for the majority of the volume of pollutants spilled, even in years without major accidents.

The volume of most spills was relatively small; a few spills, even in a period lacking a major spill, accounted for most of the inadvertent discharge. Since a few locations and facility types accounted for the majority of reported spills, the data assembled in this report may provide the basis for prioritizing and targeting improvements in oil spill prevention. ■

Acknowledgements

Author Valerie Raco thanks Dr. Gary Petrae (NOAA); Commander Doug Lentsch, Lieutenant Shane Ishiki, Chief Lewack, Ensign Lain Akana, and Petty Officer Bruce Daniels (U.S. Coast Guard); and system analyst Matt Black (California State University, Long Beach) for help with data acquisition and analysis.

Material	N	Median	Mean	Min	Max	Total
VESSEL SPILLS						
<i>Petroleum Products</i>						
Gas oil: cracked	3	8	130	4	379	390
Gasoline: other	6	19	20	4	38	121
Gasoline: automotive	41	11	83	4	1,908	3,391
Gasoline: aviation	3	95	208	57	473	625
Jet fuel	4	814	2,011	57	6,359	8,043
Naptha	2	28	28	4	53	57
Oil: crude	42	9	174	4	1,590	7,313
Oil: diesel	179	19	206	4	18,925	36,862
Oil: fuel	225	19	301	4	11,355	67,646
Oil: lubricating	46	6	64	4	2,385	2,922
Oil: mineral	5	4	51	4	189	257
Oil: miscellaneous	9	76	204	4	757	1,832
Oil: motor	33	8	19	4	83	628
Oil: spray	2	4	4	4	4	8
Oil: waste/lubricants	37	8	23	4	189	859
Total	637					130,954
<i>Non-Petroleum Products</i>						
Cumene	1	4	4	4	4	4
Solvents: mixed waste	19	15	35	4	358	791
Styrene	1	4	4	4	4	4
Tallow	1	4	4	4	4	4
Total	22					803
Grand total	659					131,757

*Between 32°30'N and 34°28'N, 117°00'W and 120°30'W

Figure 1

Types of hazardous material spilled in the Southern California Bight from A) facilities and B) vessels from 1985 through 1989. Proportion is by volume.

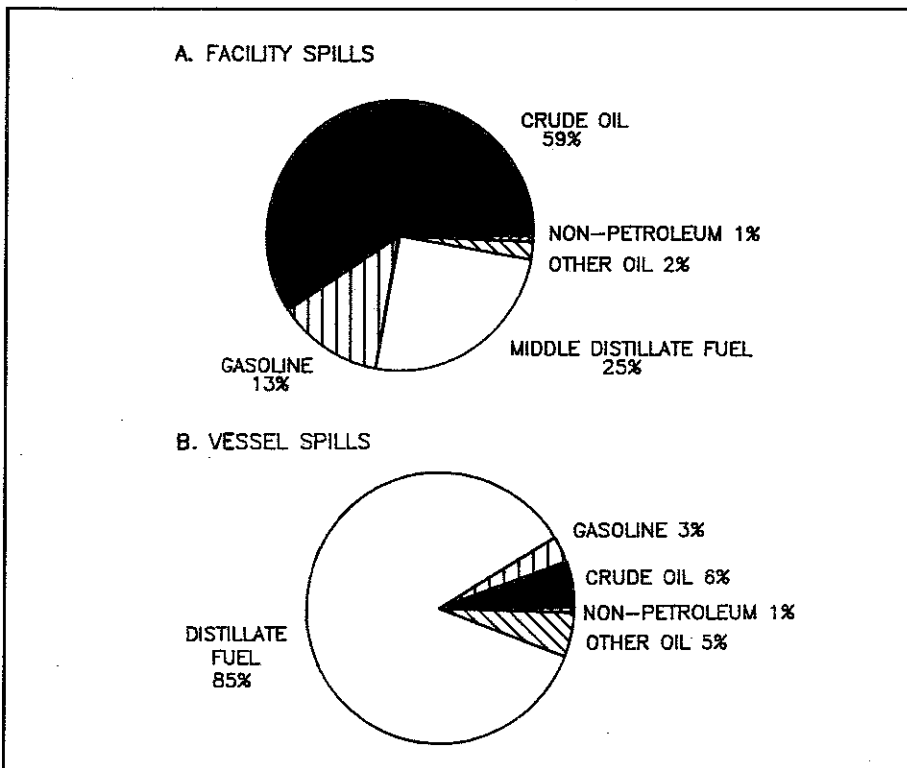
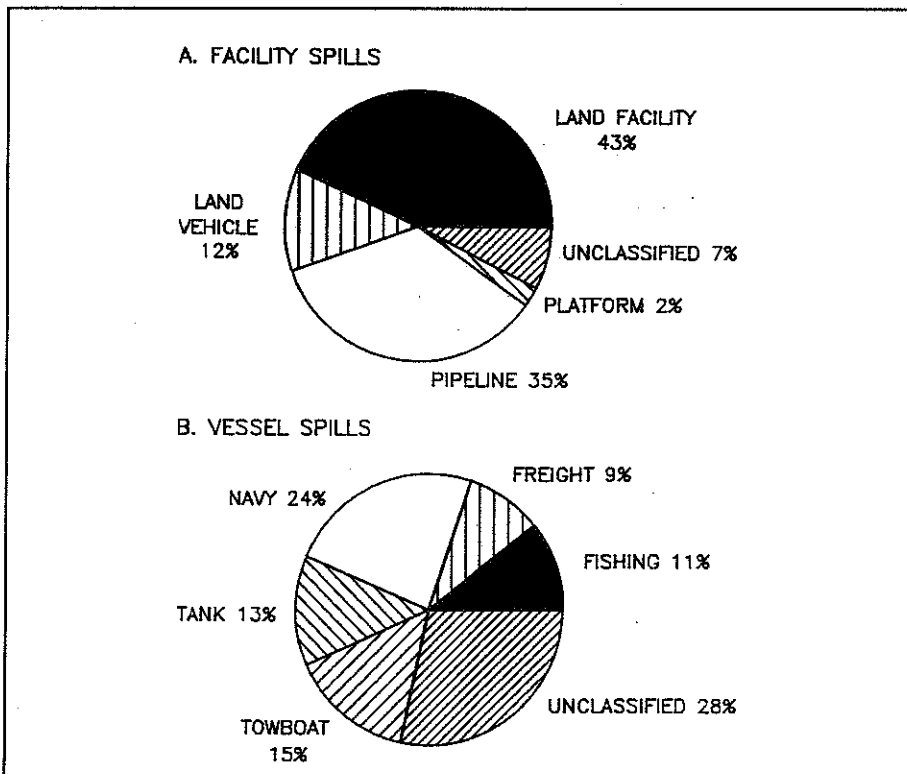


Figure 2

Source of hazardous material spilled in the Southern California Bight from A) facilities and B) vessels from 1985 through 1989. Proportion is by volume.



**Appendix A—
Category Constituents**

- **MATERIAL** (classifications refer to figures)

Middle distillate fuel: Diesel oil, fuel oil, jet fuel, kerosene.

Gasoline: Alkylates, automobile, aviation, casinghead, polymer, reformates, straight run.

Non Petroleum: see Table 1.

Other oil: Absorption oil, clarified oil, cracked gas oil, lubricating oil, mineral oil, motor oil, naptha, penetration oil, range oil, spindle oil, spray oil, turbine oil, waste oil.

- **SOURCE—Facility** (classifications refer to figures)

Miscellaneous and unclassified:

Aircraft, railroad tank car, unclassified spills.

- **SOURCE—Vessel** (classifications refer to figures)

Miscellaneous and unclassified:

Commercial, government owned, industrial, mobile offshore drilling unit, offshore supply vessel, passenger, recreation, research, unclassified spills.

- **WATERBODY** (classifications refer to figures)

Harbors: Alamitos Bay, Channel Islands Harbor, Huntington Harbor, Los Angeles/Long Beach harbors, Marina Del Rey, Newport Bay, Port Hueneme, San Diego Harbor/Mission Bay, Santa Barbara Harbor Ventura Marina.

Inland: Inland spills, rivers (facility spills).

Miscellaneous and unclassified:

Rivers (vessel spills), unclassified spills.

- **MATERIAL** (classifications refer to tables)

Gasoline: Alkylates, casinghead, polymer, reformates, straight run.

Jet fuel: JP-1, JP-4, JP-5.

Naptha: Mineral spirits, naptha.

Fuel oil: No. 1, 1-D, 2, 2-D, 4, 5, 6.

Miscellaneous oil: Absorption oil, clarified oil, penetration oil, range oil, spindle oil, turbine oil.

- **SOURCES** (classifications refer to tables)

Unclassified spills: Known source, not elsewhere classified, unknown source.

Appendix B—

Definitions

• PETROLEUM REFINING

Catalytic cracking: Cracking process in the presence of a catalyst.

Cracking: Process by which large molecules are broken into smaller

molecules with lower boiling points.

Straight run: Products from distillation rather than the cracking process.

• PETROLEUM MATERIALS

Gas oil: Liquid petroleum distillate with viscosity and boiling range between kerosene and lubricating oil. A mixture of straight chain,

cyclic and aromatic compounds C15 to C25 hydrocarbons. Used to make distillate-type fuel oils and diesel fuels.

Gas oil, cracked: Gas oil in which the large molecules have been broken into smaller, lower-boiling hydrocarbon molecules.

Table 2

Number and size of hazardous material spills from facilities and vessels in the Southern California Bight* from 1985 through 1989. Measurements are in liters except where noted.

Source	N	Median	Mean	Min	Max	Total
<i>Facility Spills</i>						
Aircraft	3	114	486	19	1,325	1,457
Designated waterfront facility ^b	29	19	920	4	23,846	26,680
Land facility	56	23	886	4	33,459	49,599
Dry (kg)	2	537	537	53	1,020	1,073
Land vehicle	18	28	1,192	4	15,140	21,453
North offshore oil platform ^c	85	4	37	4	636	3,179
South offshore oil platform ^c	32	8	48	4	636	1,525
Offshore pipeline	13	8	2,302	4	23,054	29,932
Onshore pipeline	22	17	1,713	4	15,897	37,691
Onshore marine facility	30	19	273	4	3,179	8,183
Railroad tank car	1	379	379	379	379	379
Tank truck	11	19	233	4	1,136	2,562
Unclassified	<u>141</u>	15	90	4	7,002	<u>12,718</u>
Total	441					195,358
Total dry (kg)	2					1,073
<i>Vessel Spills</i>						
Combatant/Navy	52	76	601	4	9,463	31,226
Commercial, industrial, research	10	8	16	4	76	163
Fishing (commercial)	36	19	392	4	11,355	14,099
Freight	88	19	139	4	3,179	12,203
Government owned	8	15	317	4	2,385	2,540
Mobile offshore drilling unit	1	76	76	76	76	76
Offshore supply	12	8	26	4	95	307
Passenger	34	11	56	4	757	1,908
Recreation	91	15	54	4	1,325	4,943
Tank	67	8	257	4	6,359	17,241
Towboat/tugboat	17	19	1,160	4	18,925	19,716
Unclassified	<u>243</u>	19	112	4	11,355	<u>27,335</u>
Total	659					131,757

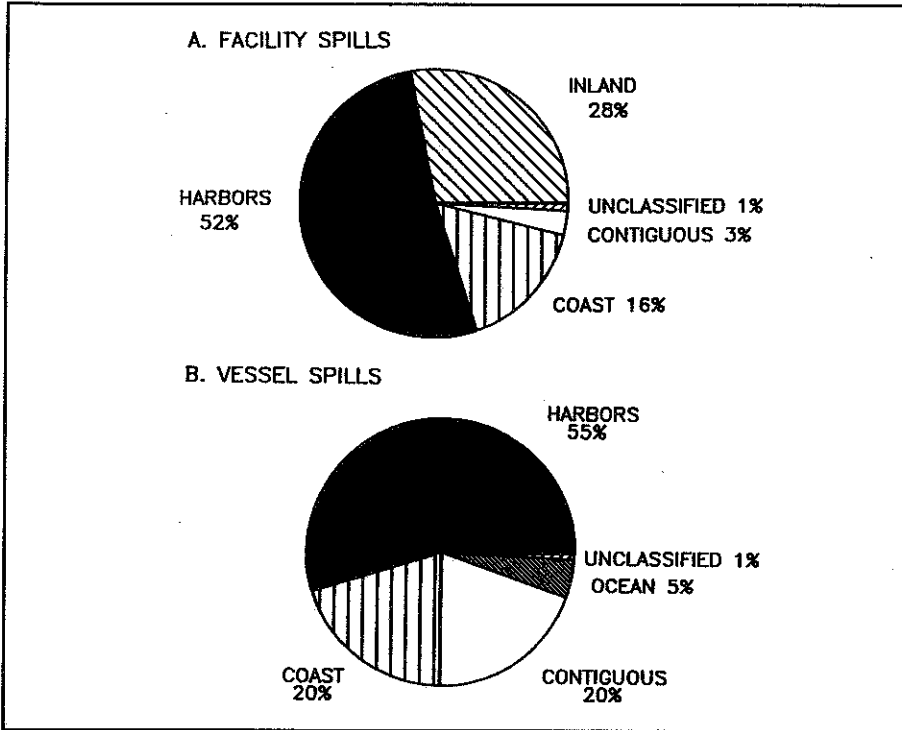
*Between 32°30'N and 34°28'N, 117°00'W and 120°30'W

^bMeet federal requirements to handle dangerous cargo

^cNorth = offshore platforms above 34° N latitude; South = below 34° N latitude

Figure 3

Location of waterbody receiving hazardous material spilled in the Southern California Bight from A) facilities and B) vessels from 1985 through 1989. Proportion is by volume.



Gasoline: C7 to C11 hydrocarbons; 10-60% straight chain paraffin content. Aromatics vary from 5-30% by weight of gasoline fraction; branched paraffins are 13-32% and cycloparaffins are 8-14%. Suitable for fuel in internal-combustion engines.

Gasoline, Automotive (4.23 g Pb/gal): Gasoline with a research octane number approximately 90 used in automobiles.

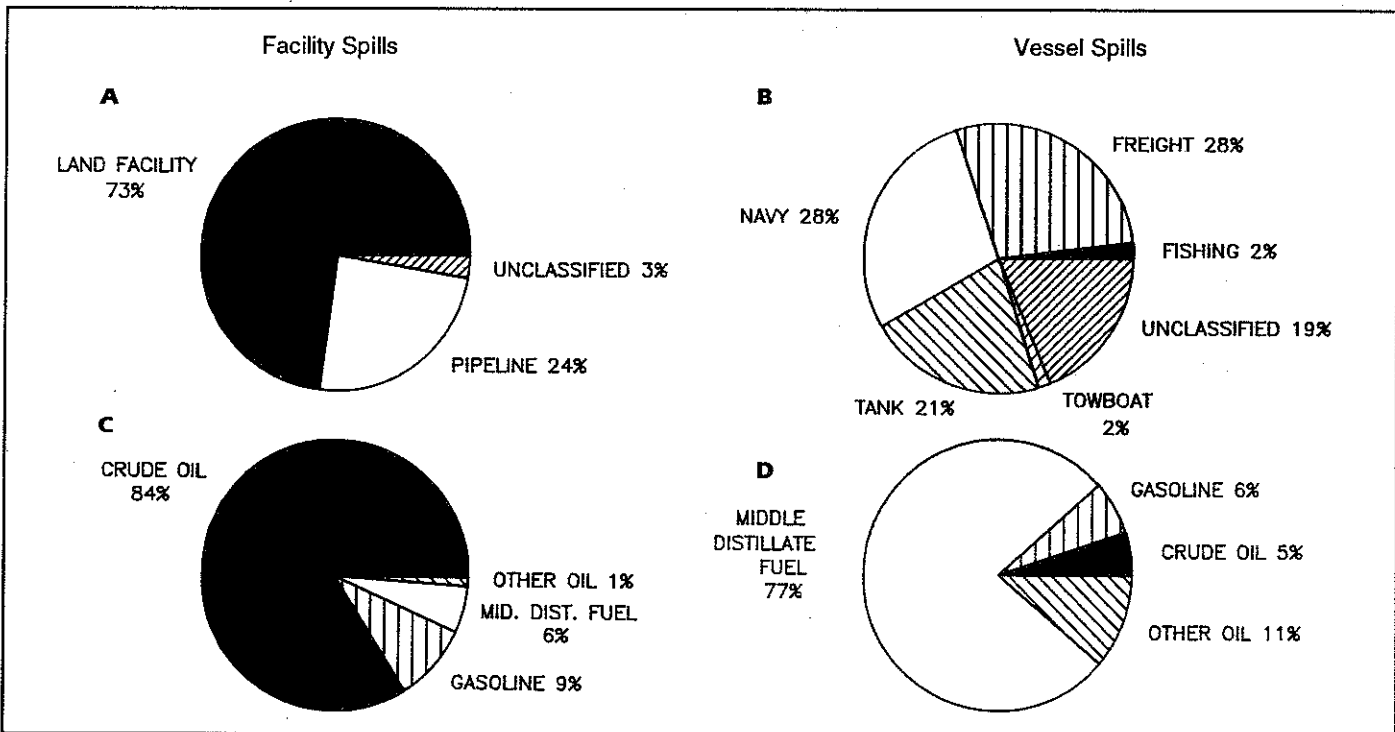
Gasoline, Aviation (4.86 g Pb/gal): Gasoline with a research octane number of 100 or more used in piston - engined aircraft.

Gasoline, Casinghead: Gasoline obtained by recovering butane, pentane, and hexane hydrocarbons present in small amounts in certain natural gases. Used in blending to produce a finished gasoline with adjusted volatility but low octane number.

Gasoline, Polymer: Gasoline produced by polymerization of low molecular weight hydrocarbons

Figure 4

Source of hazardous material spilled from A) facilities and B) vessels and type of hazardous material spilled from C) facilities and D) vessels in Los Angeles and Long Beach harbors from 1985 through 1989. Proportion is by volume.



such as ethylene, propene, and butenes. Used in small amounts for blending with other gasolines to improve octane number.

Gasoline, Straight run: Gasoline produced by distillation without cracking or other chemical conversion processes; contains high percentage of straight chain paraffins. Octane number is low. Gasoline blending stocks, Alkylates: High-octane product produced by petroleum refining and blended into premium motor gasoline and aviation gasoline.

Gasoline blending stocks, Reformates: High octane product obtained from low octane gasoline by heating vapors to high temperature or by passing vapors through catalyst. Blended into regular and premium gasoline.

Jet fuel: Material in kerosene boiling range used in gas-turbine jet engines.

Kerosene: Straight run fraction from crude oil; boiling range 150 to 250°C; aromatics range from 10-40%. More condensed naphtho-aromatics and multi-ring cyclop-

affins than in gasoline.

Mineral spirits: A grade of naphtha. **Naphtha solvent:** General term applied to refined, partly refined, or unrefined petroleum products and liquid products of natural gas. Used as solvents, dry-cleaning agents, and charge stocks to reforming (mild thermal cracking or catalytic conversion) units to make high octane gasoline. **Oil, Clarified:** Heavy oil product from catalytic cracking process from which catalyst has been removed. **Oil, Crude:** Liquid hydrocarbon

Figure 5

Amount of hazardous material spilled in the Southern California Bight from A) facilities and B) vessels from 1985 through 1989.

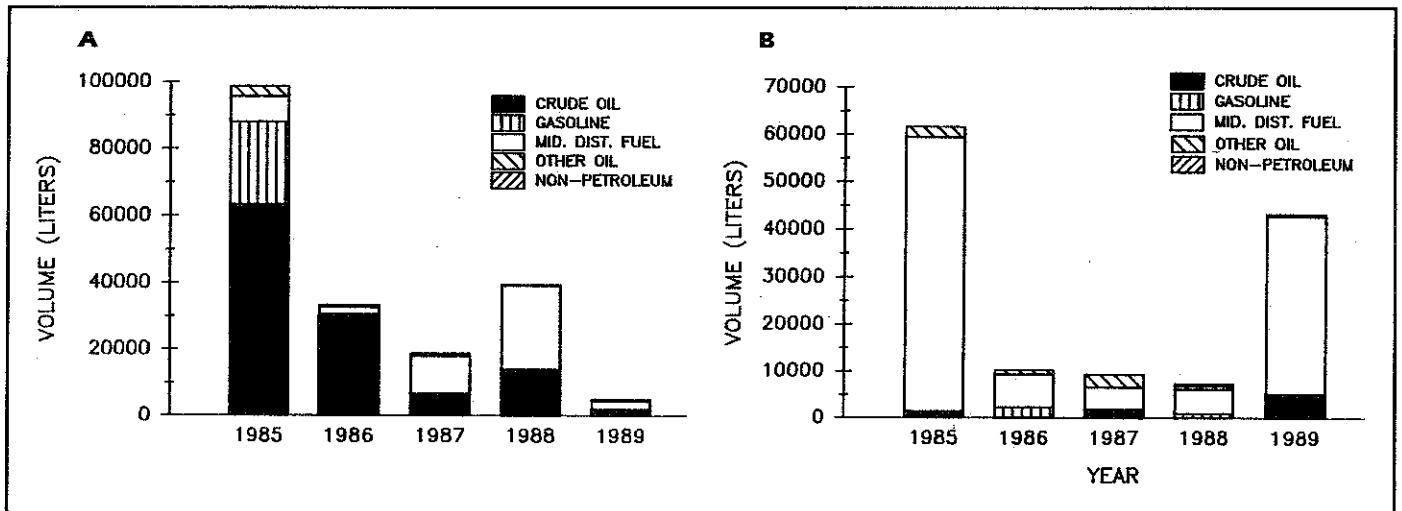


Figure 6

Source of hazardous material spilled in the Southern California Bight from A) facilities and B) vessels from 1985 through 1989.

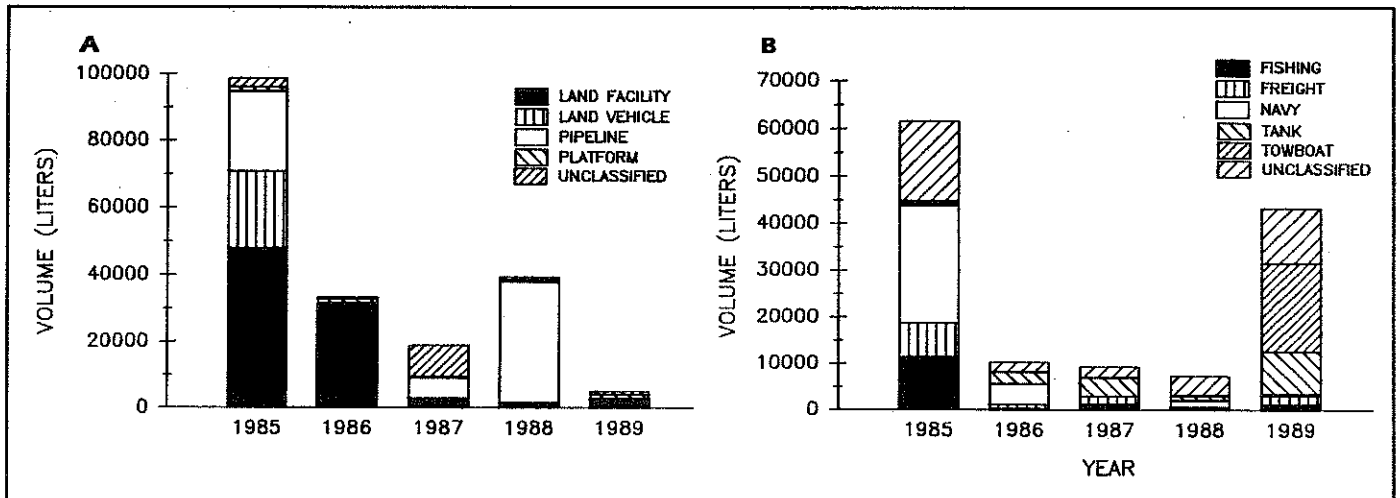


Table 3

Number and size of hazardous material spills from facilities and vessels in the Southern California Bight* from 1985 through 1989. Measurements are in liters except where noted.

Waterbody	N	Median	Mean	Min	Max	Total
<i>Facility Spills</i>						
Contiguous zone (3-12 mi)	91	4	63	4	2,385	5,727
Coastal zone (0-3 mi)	72	8	433	4	23,054	31,143
Dry (kg) ^b	1	53	53	53	53	53
Los Angeles/Long Beach harbors	138	11	645	4	33,459	89,053
San Diego Bay/Mission Bay	56	11	75	4	1,325	4,220
Small harbors ^c	29	19	294	4	7,002	8,512
Rivers	4	38	43	19	76	170
Inland ^d	36	114	1,518	4	15,897	54,640
Dry (kg) ^b	1	1,020	1,020	1,020	1,020	1,020
Unclassified	15	19	126	4	795	1,893
Total	441					195,358
Total dry (kg)	2					1,073
<i>Vessel Spills</i>						
Ocean (12-200 mi)	8	189	765	4	4,164	6,117
Contiguous zone (3-12 mi)	43	19	603	4	18,925	25,912
Coastal zone (0-3 mi)	72	19	367	4	11,355	26,393
Los Angeles/Long Beach harbors	273	19	141	4	7,570	38,418
San Diego Bay/Mission Bay	131	15	129	4	9,463	16,892
Small harbors ^c	106	11	161	4	11,355	17,112
Rivers	3	76	66	8	114	197
Unclassified	23	19	31	4	144	715
Total	659					131,756

*Between 32° 30'N and 34° 28'N, 117° 00'W and 120° 30'W

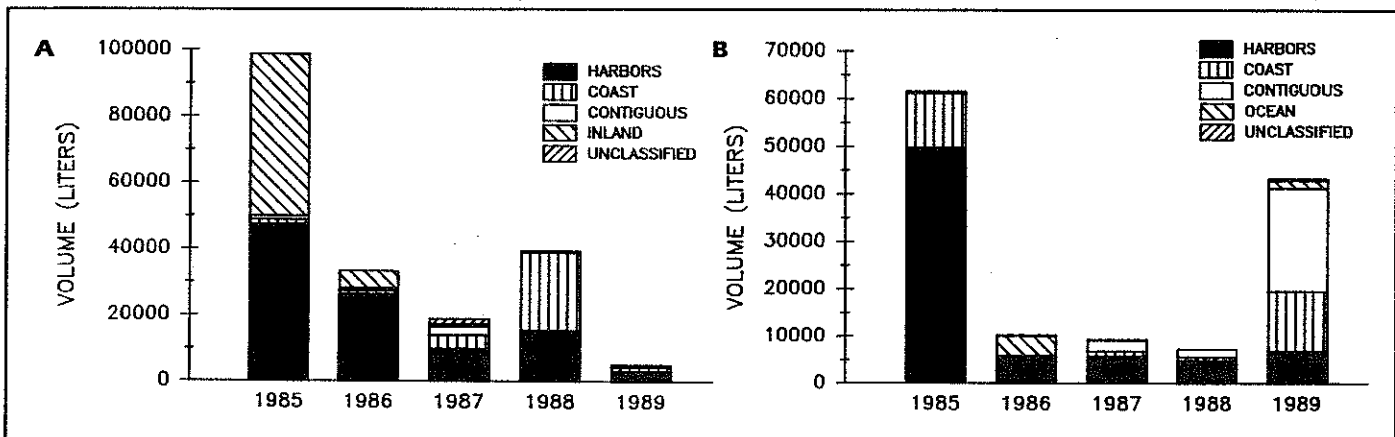
^bSodium hypochlorite

^cAlamitos Bay, Channel Islands Harbor, Huntington Harbour, Marina del Rey, Newport Bay, Port Hueneme, Santa Barbara Harbor, and Ventura Marina

^dSpills washed into street gutters that lead into storm drains and channels

Figure 7

Location of waterbody receiving hazardous material spilled in the Southern California Bight from A) facilities and B) vessels from 1985 through 1989.



mixture occurring naturally in the earth; may be treated to render it suitable for transportation. Includes crude oil from which certain distillate fractions have been removed and crude oil to which certain distillate fractions may have been added.

Oil, Diesel: Composed chiefly of unbranched paraffins; volatility is similar to that of gas oil. No. 2 fuel oil with additives.

Oil, Fuel No. 1: Straight run distillate, heavier than kerosene, used almost exclusively for domestic heating

Oil, Fuel No. 1-D: Type of diesel fuel oil. Used in engines with low fuel temperatures and in high-speed engines that have frequent and wide variations in loads and speeds.

Oil, Fuel No. 2: Straight-run or cracked distillates used as general purpose domestic or commercial fuel in atomizing-type burners.

Oil, Fuel No. 2-D: Type of diesel fuel oil. Used in high-speed engines with relatively high loads and uniform speeds.

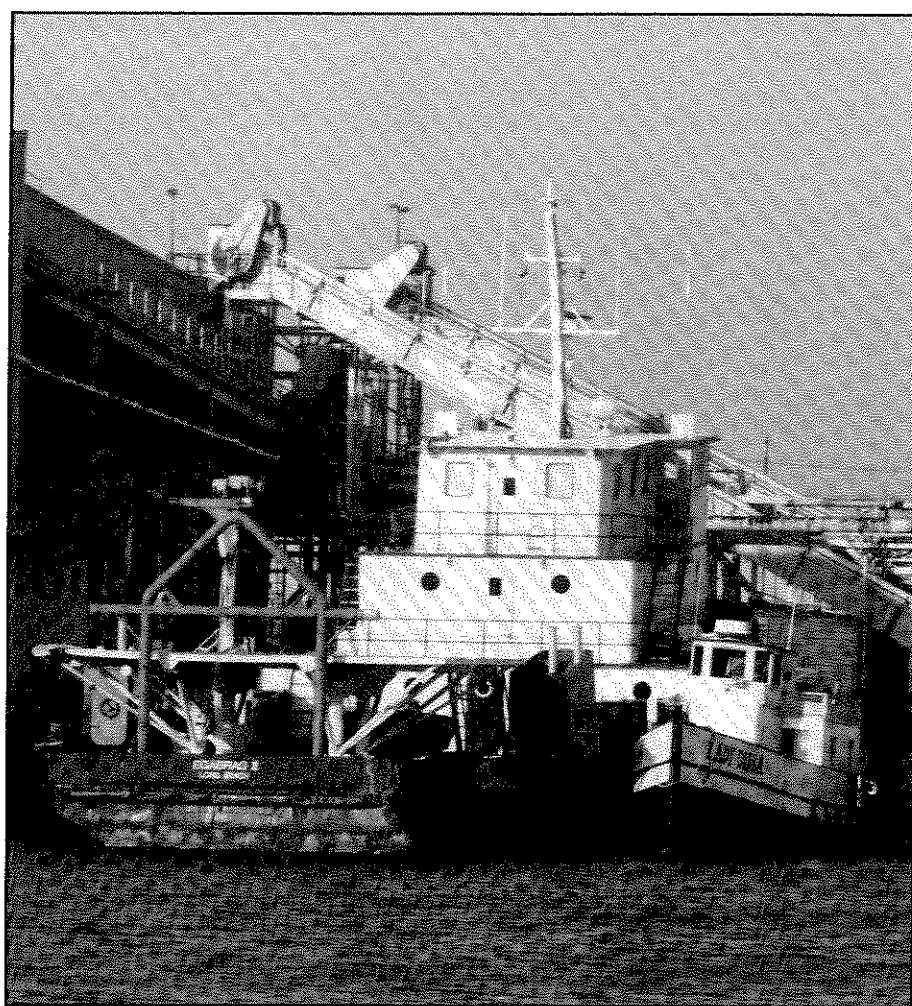
Oil, Fuel No. 4: Heavier straight run or cracked distillates used in commercial or industrial burner installations not equipped with preheating facilities.

Oil, Fuel No. 5: Bunker fuel used in furnaces and boilers of utility power plants, ships, locomotives, metallurgical operations, and industrial power plants.

Oil, Fuel No. 6: Bunker fuel (see Fuel Oil No. 5.).

Oil, Miscellaneous absorption: Miscellaneous hydrocarbon mixture; oil that extracts heavier components from a vapor mixture.

Oil, Miscellaneous lubricating: C20 to C50 compounds that include straight chain, branched, cycloparaffins, and aromatics similar to those in gas oil, but with a higher molecular weight. Usually have small amounts of additives to impart special properties such as



Boats unloading in Los Angeles Harbor

viscosity index and detergency.

Oil, Miscellaneous mineral: Oil derived from mineral substances.

Oil, Miscellaneous motor: Oils used to lubricate automotive, aircraft, and diesel engines.

Oil, Miscellaneous penetrating: Used to aid a bath or liquid penetrate a material.

Oil, Miscellaneous range: Type of kerosene used for space heating.

Oil, Miscellaneous spindle: Low viscosity lubricating oil for textile and other high speed machinery.

Oil, Miscellaneous spray: Low viscosity oil used as a pesticide for trees and shrubbery.

Oil, Miscellaneous turbine: Oil used to lubricate, cool, and inhibit rusting of turbines.

- **WATERBODYS**

Inland: Spills washed into street gutters that lead into storm drains and channels.

Coastal: 0-3 mi from shore.

Contiguous: 3-12 mi from shore.

Ocean: 12-200 mi from shore.

- **SOURCES—Facility Spills**

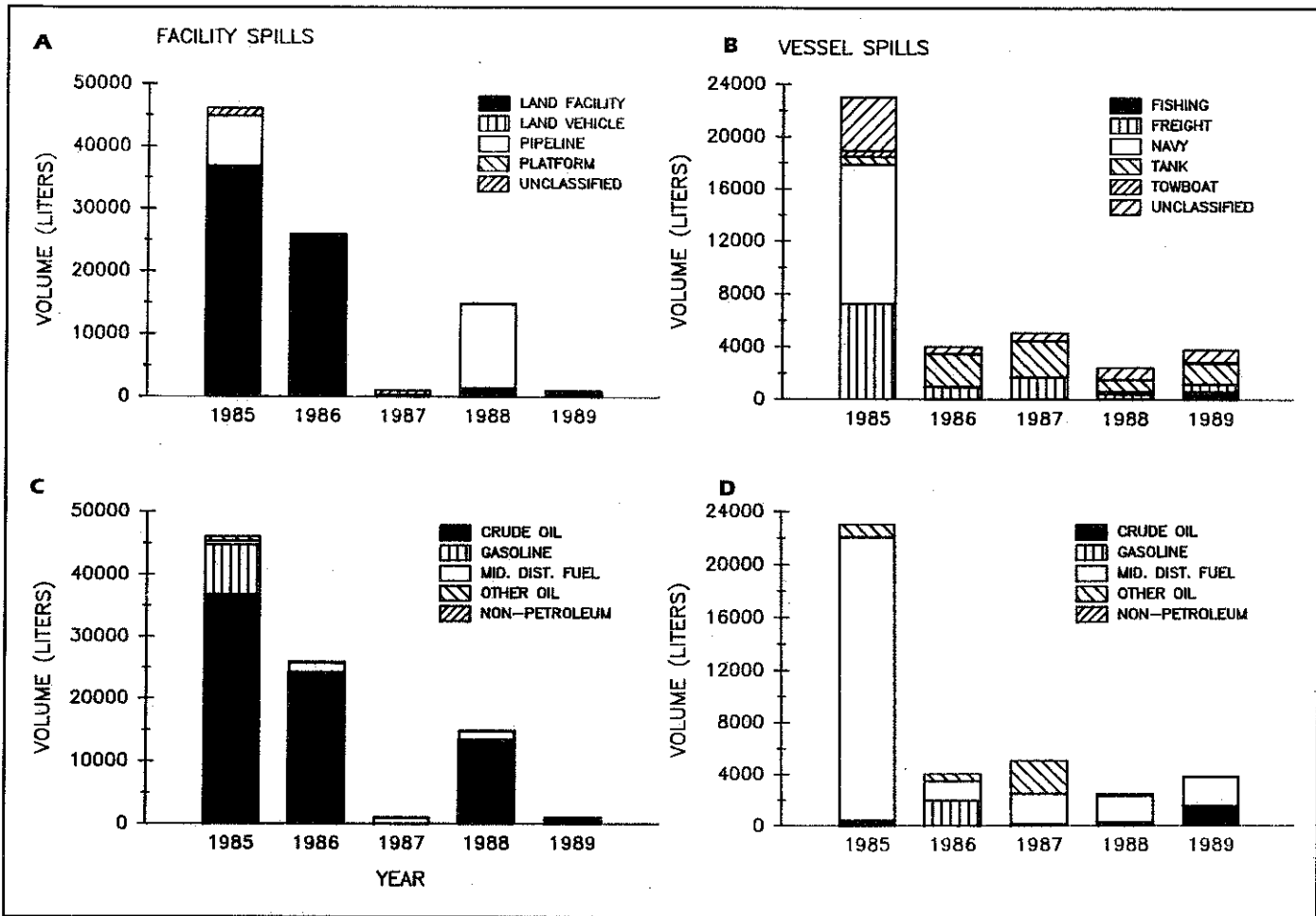
Designated water facility: Land facility that meets federal requirements to handle dangerous cargo.

Land facility: Land facility other than a designated water facility or onshore marine facility.

Onshore marine facility: Any facility that deals with marine related transportation.

Figure 8

Source of hazardous material spilled from A) facilities and B) vessels and type of hazardous material spilled from C) facilities and D) vessels in Los Angeles and Long Beach harbors from 1985 through 1989.



• **SOURCES—Vessel Spills**

Combatant: U.S. Navy.

Commercial: Any trade or business involving transportation of goods or individuals, except service performed by a combatant vessel.

Fishing: Vessel that commercially engages in catching, taking, or harvesting fish or activity expected to result in catching, taking, or harvesting fish.

Freight: Barge or motor vessel of more than 15 gross tons that carries freight for hire, except an oceanographic research vessel or an offshore supply vessel.

Government owned: Vessel owned or demise chartered and operated by U.S. Government or government

of a foreign country and not engaged in commercial service.

• **SOURCES—Industrial**

Mobile offshore drilling unit:

Vessel capable of drilling for the exploration or exploitation of subsea resources.

Offshore supply: Motor vessel of more than 15 gross tons, but less than 500 gross tons, that regularly carries goods, supplies, or equipment in support of exploration, exploitation, or production of offshore mineral or energy resources and is not a small passenger vessel.

Passenger: Vessel of at least 100 gross tons carrying at least one passenger for hire.

Recreation: Vessel manufactured or operated primarily for pleasure or leased, rented, or chartered to another for pleasure.

Research: Vessel that is employed in instruction of or research in oceanography or limnology.

Tank: Vessel of the barge or motor vessel that carries oil or hazardous material in bulk as cargo or cargo residue.

Towboat/tugboat: Commercial vessel engaged in, or intending to engage in, service of pulling along side, or any combination of pulling, pushing, pushing, or hauling along side.